

# Configuring Strimzi

# Table of Contents

1. Configuration overview .....	1
1.1. Configuring custom resources.....	1
1.2. Using ConfigMaps to add configuration .....	1
1.2.1. Naming custom ConfigMaps.....	3
1.3. Configuring listeners to connect to Kafka brokers .....	3
1.4. Document Conventions .....	4
1.5. Additional resources .....	4
2. Configuring a Strimzi deployment .....	5
2.1. Kafka cluster configuration .....	5
2.1.1. Configuring Kafka.....	5
2.1.2. Configuring the Entity Operator .....	11
2.1.3. Configuring Kafka and ZooKeeper storage.....	14
2.1.4. Scaling clusters .....	25
2.1.5. Retrieving JMX metrics with JmxTrans .....	37
2.1.6. Maintenance time windows for rolling updates.....	39
2.1.7. Connecting to ZooKeeper from a terminal .....	41
2.1.8. Deleting Kafka nodes manually.....	42
2.1.9. Deleting ZooKeeper nodes manually .....	42
2.1.10. List of Kafka cluster resources .....	43
2.2. Kafka Connect cluster configuration .....	48
2.2.1. Configuring Kafka Connect .....	48
2.2.2. Kafka Connect configuration for multiple instances .....	53
2.2.3. Configuring Kafka Connect user authorization .....	54
2.2.4. List of Kafka Connect cluster resources .....	56
2.3. Kafka MirrorMaker 2.0 cluster configuration .....	56
2.3.1. MirrorMaker 2.0 data replication .....	57
2.3.2. Connector configuration .....	61
2.3.3. Connector producer and consumer configuration .....	64
2.3.4. Specifying a maximum number of tasks .....	66
2.3.5. ACL rules synchronization .....	68
2.3.6. Configuring Kafka MirrorMaker 2.0 .....	68
2.3.7. Securing a Kafka MirrorMaker 2.0 deployment .....	74
2.3.8. Performing a restart of a Kafka MirrorMaker 2.0 connector .....	82
2.3.9. Performing a restart of a Kafka MirrorMaker 2.0 connector task .....	83
2.4. Kafka MirrorMaker cluster configuration .....	84
2.4.1. Configuring Kafka MirrorMaker .....	84
2.4.2. List of Kafka MirrorMaker cluster resources .....	88
2.5. Kafka Bridge cluster configuration .....	88

2.5.1. Configuring the Kafka Bridge .....	88
2.5.2. List of Kafka Bridge cluster resources .....	91
2.6. Customizing Kubernetes resources .....	92
2.6.1. Customizing the image pull policy .....	93
2.6.2. Applying a termination grace period .....	94
2.7. Configuring pod scheduling .....	94
2.7.1. Specifying affinity, tolerations, and topology spread constraints .....	94
2.7.2. Configuring pod anti-affinity to schedule each Kafka broker on a different worker node .....	96
2.7.3. Configuring pod anti-affinity in Kafka components .....	98
2.7.4. Configuring node affinity in Kafka components .....	99
2.7.5. Setting up dedicated nodes and scheduling pods on them .....	100
2.8. Logging configuration .....	101
2.8.1. Logging options for Kafka components and operators .....	102
2.8.2. Creating a ConfigMap for logging .....	102
2.8.3. Adding logging filters to Operators .....	103
3. Loading configuration values from external sources .....	107
3.1. Loading configuration values from a ConfigMap .....	107
3.2. Loading configuration values from environment variables .....	110
4. Applying security context to Strimzi pods and containers .....	112
4.1. How to configure security context .....	112
4.1.1. Template configuration for security context .....	113
4.1.2. Baseline Provider for pod security .....	113
4.1.3. Restricted Provider for pod security .....	114
4.2. Enabling the Restricted Provider for the Cluster Operator .....	115
4.3. Implementing a custom pod security provider .....	116
4.4. Handling of security context by Kubernetes platform .....	117
5. Accessing Kafka outside of the Kubernetes cluster .....	118
5.1. Accessing Kafka using node ports .....	118
5.2. Accessing Kafka using loadbalancers .....	119
5.3. Accessing Kafka using ingress .....	121
5.4. Accessing Kafka using OpenShift routes .....	123
6. Managing secure access to Kafka .....	125
6.1. Security options for Kafka .....	125
6.1.1. Listener authentication .....	125
6.1.2. Kafka authorization .....	128
6.2. Security options for Kafka clients .....	130
6.2.1. Identifying a Kafka cluster for user handling .....	130
6.2.2. User authentication .....	130
6.2.3. User authorization .....	134
6.3. Securing access to Kafka brokers .....	135

6.3.1. Securing Kafka brokers .....	136
6.3.2. Securing user access to Kafka .....	138
6.3.3. Restricting access to Kafka listeners using network policies .....	139
6.4. Using OAuth 2.0 token-based authentication .....	140
6.4.1. OAuth 2.0 authentication mechanisms .....	141
6.4.2. OAuth 2.0 Kafka broker configuration .....	143
6.4.3. Session re-authentication for Kafka brokers .....	146
6.4.4. OAuth 2.0 Kafka client configuration .....	147
6.4.5. OAuth 2.0 client authentication flows .....	148
6.4.6. Configuring OAuth 2.0 authentication .....	152
6.4.7. Authorization server examples .....	162
6.5. Using OAuth 2.0 token-based authorization .....	162
6.5.1. OAuth 2.0 authorization mechanism .....	163
6.5.2. Configuring OAuth 2.0 authorization support .....	163
6.5.3. Managing policies and permissions in Keycloak Authorization Services .....	165
6.5.4. Trying Keycloak Authorization Services .....	173
7. Using Strimzi Operators .....	187
7.1. Watching namespaces with Strimzi operators .....	187
7.2. Using the Cluster Operator .....	187
7.2.1. Role-Based Access Control (RBAC) resources .....	187
7.2.2. ConfigMap for Cluster Operator logging .....	200
7.2.3. Configuring the Cluster Operator with environment variables .....	201
7.2.4. Configuring the Cluster Operator with default proxy settings .....	207
7.2.5. Running multiple Cluster Operator replicas with leader election .....	209
7.2.6. Configuring FIPS mode in the Cluster Operator .....	212
7.3. Using the Topic Operator .....	213
7.3.1. Kafka topic resource .....	213
7.3.2. Topic Operator topic store .....	215
7.3.3. Configuring Kafka topics .....	218
7.3.4. Configuring the Topic Operator with resource requests and limits .....	220
7.4. Using the User Operator .....	221
7.4.1. Configuring Kafka users .....	222
7.4.2. Configuring the User Operator with resource requests and limits .....	225
7.5. Configuring feature gates .....	225
7.5.1. ControlPlaneListener feature gate .....	226
7.5.2. ServiceAccountPatching feature gate .....	226
7.5.3. UseStrimziPodSets feature gate .....	226
7.5.4. (Preview) UseKRaft feature gate .....	227
7.5.5. Feature gate releases .....	228
7.6. Monitoring operators using Prometheus metrics .....	229
8. Cruise Control for cluster rebalancing .....	230

8.1. Why use Cruise Control?	231
8.2. Optimization goals overview	231
8.2.1. Goals order of priority	231
8.2.2. Goals configuration in Strimzi custom resources	232
8.2.3. Hard and soft optimization goals	232
8.2.4. Main optimization goals	234
8.2.5. Default optimization goals	234
8.2.6. User-provided optimization goals	235
8.3. Optimization proposals overview	236
8.3.1. Rebalancing modes	236
8.3.2. The results of an optimization proposal	237
8.3.3. Manually approving or rejecting an optimization proposal	237
8.3.4. Automatically approving an optimization proposal	239
8.3.5. Optimization proposal summary properties	240
8.3.6. Broker load properties	241
8.3.7. Cached optimization proposal	242
8.4. Rebalance performance tuning overview	243
8.4.1. Partition reassignment commands	243
8.4.2. Replica movement strategies	243
8.4.3. Intra-broker disk balancing	244
8.4.4. Rebalance tuning options	244
8.5. Configuring and deploying Cruise Control with Kafka	247
8.6. Generating optimization proposals	250
8.7. Approving an optimization proposal	255
8.8. Stopping a cluster rebalance	257
8.9. Fixing problems with a <b>KafkaRebalance</b> resource	257
9. Managing TLS certificates	259
9.1. Certificate Authorities	260
9.1.1. CA certificates	260
9.1.2. Installing your own CA certificates	261
9.2. Secrets	264
9.2.1. Secrets in PEM and PKCS #12 formats	264
9.2.2. Secrets generated by the Cluster Operator	265
9.2.3. Cluster CA secrets	266
9.2.4. Client CA secrets	268
9.2.5. User secrets	269
9.2.6. Adding labels and annotations to cluster CA secrets	269
9.2.7. Disabling <b>ownerReference</b> in the CA secrets	270
9.3. Certificate renewal and validity periods	270
9.3.1. Renewal process with automatically generated CA certificates	272
9.3.2. Client certificate renewal	272

9.3.3. Manually renewing the CA certificates generated by the Cluster Operator .....	273
9.3.4. Replacing private keys used by the CA certificates generated by the Cluster Operator .....	274
9.3.5. Renewing your own CA certificates .....	275
9.3.6. Replacing private keys used by your own CA certificates .....	277
9.4. TLS connections .....	282
9.4.1. ZooKeeper communication .....	282
9.4.2. Kafka inter-broker communication .....	282
9.4.3. Topic and User Operators .....	282
9.4.4. Cruise Control .....	282
9.4.5. Kafka Client connections .....	282
9.5. Configuring internal clients to trust the cluster CA .....	283
9.6. Configuring external clients to trust the cluster CA .....	284
9.7. Kafka listener certificates .....	286
9.7.1. Providing your own Kafka listener certificates .....	286
9.7.2. Alternative subjects in server certificates for Kafka listeners .....	288
10. Managing Strimzi .....	290
10.1. Working with custom resources .....	290
10.1.1. Performing <code>kubectl</code> operations on custom resources .....	290
10.1.2. Strimzi custom resource status information .....	292
10.1.3. Finding the status of a custom resource .....	294
10.2. Pausing reconciliation of custom resources .....	295
10.3. Evicting pods with Strimzi Drain Cleaner .....	296
10.3.1. Prerequisites .....	297
10.3.2. Deploying the Strimzi Drain Cleaner .....	297
10.3.3. Using the Strimzi Drain Cleaner .....	300
10.4. Manually starting rolling updates of Kafka and ZooKeeper clusters .....	301
10.4.1. Prerequisites .....	301
10.4.2. Performing a rolling update using a pod management annotation .....	301
10.4.3. Performing a rolling update using a Pod annotation .....	302
10.5. Discovering services using labels and annotations .....	303
10.5.1. Returning connection details on services .....	305
10.6. Recovering a cluster from persistent volumes .....	305
10.6.1. Recovery from namespace deletion .....	305
10.6.2. Recovery from loss of a Kubernetes cluster .....	306
10.6.3. Recovering a deleted cluster from persistent volumes .....	306
10.7. Setting limits on brokers using the Kafka Static Quota plugin .....	311
10.8. Frequently asked questions .....	312
10.8.1. Questions related to the Cluster Operator .....	312
11. Tuning Kafka configuration .....	315
11.1. Tools that help with tuning .....	315
11.2. Managed broker configurations .....	315

11.3. Kafka broker configuration tuning .....	316
11.3.1. Basic broker configuration .....	316
11.3.2. Replicating topics for high availability .....	316
11.3.3. Internal topic settings for transactions and commits .....	317
11.3.4. Improving request handling throughput by increasing I/O threads .....	318
11.3.5. Increasing bandwidth for high latency connections .....	319
11.3.6. Managing logs with data retention policies .....	319
11.3.7. Removing log data with cleanup policies .....	321
11.3.8. Managing disk utilization .....	323
11.3.9. Handling large message sizes .....	324
11.3.10. Controlling the log flush of message data .....	326
11.3.11. Partition rebalancing for availability .....	327
11.3.12. Unclean leader election .....	328
11.3.13. Avoiding unnecessary consumer group rebalances .....	329
11.4. Kafka producer configuration tuning .....	329
11.4.1. Basic producer configuration .....	329
11.4.2. Data durability .....	330
11.4.3. Ordered delivery .....	331
11.4.4. Reliability guarantees .....	332
11.4.5. Optimizing producers for throughput and latency .....	332
11.5. Kafka consumer configuration tuning .....	334
11.5.1. Basic consumer configuration .....	335
11.5.2. Scaling data consumption using consumer groups .....	335
11.5.3. Message ordering guarantees .....	336
11.5.4. Optimizing consumers for throughput and latency .....	336
11.5.5. Avoiding data loss or duplication when committing offsets .....	337
11.5.6. Recovering from failure to avoid data loss .....	339
11.5.7. Managing offset policy .....	339
11.5.8. Minimizing the impact of rebalances .....	340
11.6. Handling high volumes of messages .....	341
11.6.1. Configuring Kafka Connect for high-volume messages .....	343
11.6.2. Configuring MirrorMaker 2.0 for high-volume messages .....	345
11.6.3. Checking the MirrorMaker 2.0 message flow .....	345
12. Custom resource API reference .....	347
12.1. Common configuration properties .....	347
12.1.1. <code>replicas</code> .....	347
12.1.2. <code>bootstrapServers</code> .....	347
12.1.3. <code>ssl</code> .....	347
12.1.4. <code>trustedCertificates</code> .....	348
12.1.5. <code>resources</code> .....	349
12.1.6. <code>image</code> .....	351

12.1.7. <code>livenessProbe</code> and <code>readinessProbe</code> healthchecks . . . . .	354
12.1.8. <code>metricsConfig</code> . . . . .	354
12.1.9. <code>jvmOptions</code> . . . . .	356
12.1.10. Garbage collector logging . . . . .	359
12.2. Schema properties . . . . .	359
12.2.1. <code>Kafka</code> schema reference . . . . .	359
12.2.2. <code>KafkaSpec</code> schema reference . . . . .	359
12.2.3. <code>KafkaClusterSpec</code> schema reference . . . . .	360
12.2.4. <code>GenericKafkaListener</code> schema reference . . . . .	366
12.2.5. <code>KafkaListenerAuthenticationTls</code> schema reference . . . . .	374
12.2.6. <code>KafkaListenerAuthenticationScramSha512</code> schema reference . . . . .	375
12.2.7. <code>KafkaListenerAuthenticationOAuth</code> schema reference . . . . .	375
12.2.8. <code>GenericSecretSource</code> schema reference . . . . .	379
12.2.9. <code>CertSecretSource</code> schema reference . . . . .	379
12.2.10. <code>KafkaListenerAuthenticationCustom</code> schema reference . . . . .	380
12.2.11. <code>GenericKafkaListenerConfiguration</code> schema reference . . . . .	382
12.2.12. <code>CertAndKeySecretSource</code> schema reference . . . . .	388
12.2.13. <code>GenericKafkaListenerConfigurationBootstrap</code> schema reference . . . . .	388
12.2.14. <code>GenericKafkaListenerConfigurationBroker</code> schema reference . . . . .	393
12.2.15. <code>EphemeralStorage</code> schema reference . . . . .	394
12.2.16. <code>PersistentClaimStorage</code> schema reference . . . . .	395
12.2.17. <code>PersistentClaimStorageOverride</code> schema reference . . . . .	395
12.2.18. <code>JbosStorage</code> schema reference . . . . .	396
12.2.19. <code>KafkaAuthorizationSimple</code> schema reference . . . . .	396
12.2.20. <code>KafkaAuthorizationOpa</code> schema reference . . . . .	397
12.2.21. <code>KafkaAuthorizationKeycloak</code> schema reference . . . . .	399
12.2.22. <code>KafkaAuthorizationCustom</code> schema reference . . . . .	400
12.2.23. <code>Rack</code> schema reference . . . . .	403
12.2.24. <code>Probe</code> schema reference . . . . .	406
12.2.25. <code>JvmOptions</code> schema reference . . . . .	407
12.2.26. <code>SystemProperty</code> schema reference . . . . .	407
12.2.27. <code>KafkaJmxOptions</code> schema reference . . . . .	407
12.2.28. <code>KafkaJmxAuthenticationPassword</code> schema reference . . . . .	409
12.2.29. <code>JmxPrometheusExporterMetrics</code> schema reference . . . . .	409
12.2.30. <code>ExternalConfigurationReference</code> schema reference . . . . .	410
12.2.31. <code>InlineLogging</code> schema reference . . . . .	410
12.2.32. <code>ExternalLogging</code> schema reference . . . . .	410
12.2.33. <code>KafkaClusterTemplate</code> schema reference . . . . .	411
12.2.34. <code>StatefulSetTemplate</code> schema reference . . . . .	412
12.2.35. <code>MetadataTemplate</code> schema reference . . . . .	412
12.2.36. <code>PodTemplate</code> schema reference . . . . .	413

12.2.37. <code>InternalServiceTemplate</code> schema reference .....	415
12.2.38. <code>ResourceTemplate</code> schema reference .....	416
12.2.39. <code>PodDisruptionBudgetTemplate</code> schema reference .....	416
12.2.40. <code>ContainerTemplate</code> schema reference .....	417
12.2.41. <code>ContainerEnvVar</code> schema reference .....	418
12.2.42. <code>ZookeeperClusterSpec</code> schema reference .....	418
12.2.43. <code>ZookeeperClusterTemplate</code> schema reference .....	422
12.2.44. <code>EntityOperatorSpec</code> schema reference .....	422
12.2.45. <code>EntityTopicOperatorSpec</code> schema reference .....	423
12.2.46. <code>EntityUserOperatorSpec</code> schema reference .....	425
12.2.47. <code>TlsSidecar</code> schema reference .....	428
12.2.48. <code>EntityOperatorTemplate</code> schema reference .....	429
12.2.49. <code>CertificateAuthority</code> schema reference .....	430
12.2.50. <code>CruiseControlSpec</code> schema reference .....	431
12.2.51. <code>CruiseControlTemplate</code> schema reference .....	438
12.2.52. <code>BrokerCapacity</code> schema reference .....	439
12.2.53. <code>BrokerCapacityOverride</code> schema reference .....	440
12.2.54. <code>JmxTransSpec</code> schema reference .....	440
12.2.55. <code>JmxTransOutputDefinitionTemplate</code> schema reference .....	441
12.2.56. <code>JmxTransQueryTemplate</code> schema reference .....	442
12.2.57. <code>JmxTransTemplate</code> schema reference .....	442
12.2.58. <code>KafkaExporterSpec</code> schema reference .....	442
12.2.59. <code>KafkaExporterTemplate</code> schema reference .....	443
12.2.60. <code>KafkaStatus</code> schema reference .....	443
12.2.61. <code>Condition</code> schema reference .....	444
12.2.62. <code>ListenerStatus</code> schema reference .....	444
12.2.63. <code>ListenerAddress</code> schema reference .....	445
12.2.64. <code>KafkaConnect</code> schema reference .....	445
12.2.65. <code>KafkaConnectSpec</code> schema reference .....	445
12.2.66. <code>ClientTls</code> schema reference .....	450
12.2.67. <code>KafkaClientAuthenticationTls</code> schema reference .....	451
12.2.68. <code>KafkaClientAuthenticationScramSha256</code> schema reference .....	452
12.2.69. <code>PasswordSecretSource</code> schema reference .....	453
12.2.70. <code>KafkaClientAuthenticationScramSha512</code> schema reference .....	453
12.2.71. <code>KafkaClientAuthenticationPlain</code> schema reference .....	455
12.2.72. <code>KafkaClientAuthenticationOAuth</code> schema reference .....	456
12.2.73. <code>JaegerTracing</code> schema reference .....	461
12.2.74. <code>OpenTelemetryTracing</code> schema reference .....	462
12.2.75. <code>KafkaConnectTemplate</code> schema reference .....	462
12.2.76. <code>DeploymentTemplate</code> schema reference .....	463
12.2.77. <code>BuildConfigTemplate</code> schema reference .....	463

12.2.78. <code>ExternalConfiguration</code> schema reference . . . . .	463
12.2.79. <code>ExternalConfigurationEnv</code> schema reference . . . . .	469
12.2.80. <code>ExternalConfigurationEnvVarSource</code> schema reference . . . . .	469
12.2.81. <code>ExternalConfigurationVolumeSource</code> schema reference . . . . .	469
12.2.82. <code>Build</code> schema reference . . . . .	470
12.2.83. <code>DockerOutput</code> schema reference . . . . .	476
12.2.84. <code>ImageStreamOutput</code> schema reference . . . . .	477
12.2.85. <code>Plugin</code> schema reference . . . . .	477
12.2.86. <code>JarArtifact</code> schema reference . . . . .	478
12.2.87. <code>TgzArtifact</code> schema reference . . . . .	478
12.2.88. <code>ZipArtifact</code> schema reference . . . . .	479
12.2.89. <code>MavenArtifact</code> schema reference . . . . .	480
12.2.90. <code>OtherArtifact</code> schema reference . . . . .	480
12.2.91. <code>KafkaConnectStatus</code> schema reference . . . . .	481
12.2.92. <code>ConnectorPlugin</code> schema reference . . . . .	482
12.2.93. <code>KafkaTopic</code> schema reference . . . . .	482
12.2.94. <code>KafkaTopicSpec</code> schema reference . . . . .	482
12.2.95. <code>KafkaTopicStatus</code> schema reference . . . . .	483
12.2.96. <code>KafkaUser</code> schema reference . . . . .	483
12.2.97. <code>KafkaUserSpec</code> schema reference . . . . .	483
12.2.98. <code>KafkaUserTlsClientAuthentication</code> schema reference . . . . .	484
12.2.99. <code>KafkaUserTlsExternalClientAuthentication</code> schema reference . . . . .	485
12.2.100. <code>KafkaUserScramSha512ClientAuthentication</code> schema reference . . . . .	485
12.2.101. <code>Password</code> schema reference . . . . .	485
12.2.102. <code>PasswordSource</code> schema reference . . . . .	485
12.2.103. <code>KafkaUserAuthorizationSimple</code> schema reference . . . . .	486
12.2.104. <code>AclRule</code> schema reference . . . . .	486
12.2.105. <code>AclRuleTopicResource</code> schema reference . . . . .	489
12.2.106. <code>AclRuleGroupResource</code> schema reference . . . . .	489
12.2.107. <code>AclRuleClusterResource</code> schema reference . . . . .	490
12.2.108. <code>AclRuleTransactionalIdResource</code> schema reference . . . . .	490
12.2.109. <code>KafkaUserQuotas</code> schema reference . . . . .	491
12.2.110. <code>KafkaUserTemplate</code> schema reference . . . . .	492
12.2.111. <code>KafkaUserStatus</code> schema reference . . . . .	493
12.2.112. <code>KafkaMirrorMaker</code> schema reference . . . . .	493
12.2.113. <code>KafkaMirrorMakerSpec</code> schema reference . . . . .	493
12.2.114. <code>KafkaMirrorMakerConsumerSpec</code> schema reference . . . . .	497
12.2.115. <code>KafkaMirrorMakerProducerSpec</code> schema reference . . . . .	499
12.2.116. <code>KafkaMirrorMakerTemplate</code> schema reference . . . . .	501
12.2.117. <code>KafkaMirrorMakerStatus</code> schema reference . . . . .	501
12.2.118. <code>KafkaBridge</code> schema reference . . . . .	502

12.2.119. <a href="#">KafkaBridgeSpec</a> schema reference . . . . .	502
12.2.120. <a href="#">KafkaBridgeHttpConfig</a> schema reference . . . . .	506
12.2.121. <a href="#">KafkaBridgeHttpCors</a> schema reference . . . . .	507
12.2.122. <a href="#">KafkaBridgeAdminClientSpec</a> schema reference . . . . .	507
12.2.123. <a href="#">KafkaBridgeConsumerSpec</a> schema reference . . . . .	507
12.2.124. <a href="#">KafkaBridgeProducerSpec</a> schema reference . . . . .	509
12.2.125. <a href="#">KafkaBridgeTemplate</a> schema reference . . . . .	510
12.2.126. <a href="#">KafkaBridgeStatus</a> schema reference . . . . .	510
12.2.127. <a href="#">KafkaConnector</a> schema reference . . . . .	511
12.2.128. <a href="#">KafkaConnectorSpec</a> schema reference . . . . .	511
12.2.129. <a href="#">KafkaConnectorStatus</a> schema reference . . . . .	511
12.2.130. <a href="#">KafkaMirrorMaker2</a> schema reference . . . . .	512
12.2.131. <a href="#">KafkaMirrorMaker2Spec</a> schema reference . . . . .	512
12.2.132. <a href="#">KafkaMirrorMaker2ClusterSpec</a> schema reference . . . . .	514
12.2.133. <a href="#">KafkaMirrorMaker2MirrorSpec</a> schema reference . . . . .	515
12.2.134. <a href="#">KafkaMirrorMaker2ConnectorSpec</a> schema reference . . . . .	516
12.2.135. <a href="#">KafkaMirrorMaker2Status</a> schema reference . . . . .	516
12.2.136. <a href="#">KafkaRebalance</a> schema reference . . . . .	516
12.2.137. <a href="#">KafkaRebalanceSpec</a> schema reference . . . . .	517
12.2.138. <a href="#">KafkaRebalanceStatus</a> schema reference . . . . .	518

# Chapter 1. Configuration overview

Strimzi simplifies the process of running Apache Kafka in a Kubernetes cluster.

This guide describes how to configure and manage a Strimzi deployment.

## 1.1. Configuring custom resources

Use custom resources to configure your Strimzi deployment.

You can use custom resources to configure and create instances of the following components:

- Kafka clusters
- Kafka Connect clusters
- Kafka MirrorMaker
- Kafka Bridge
- Cruise Control

You can also use custom resource configuration to manage your instances or modify your deployment to introduce additional features. This might include configuration that supports the following:

- Securing client access to Kafka brokers
- Accessing Kafka brokers from outside the cluster
- Creating topics
- Creating users (clients)
- Controlling feature gates
- Changing logging frequency
- Allocating resource limits and requests
- Introducing features, such as Strimzi Drain Cleaner, Cruise Control, or distributed tracing.

The [Custom resource API reference](#) describes the properties you can use in your configuration.

## 1.2. Using ConfigMaps to add configuration

Use [ConfigMap](#) resources to add specific configuration to your Strimzi deployment. ConfigMaps use key-value pairs to store non-confidential data. Configuration data added to ConfigMaps is maintained in one place and can be reused amongst components.

ConfigMaps can only store configuration data related to the following:

- Logging configuration
- Metrics configuration

- External configuration for Kafka Connect connectors

You can't use ConfigMaps for other areas of configuration.

When you configure a component, you can add a reference to a ConfigMap using the `configMapKeyRef` property.

For example, you can use `configMapKeyRef` to reference a ConfigMap that provides configuration for logging. You might use a ConfigMap to pass a Log4j configuration file. You add the reference to the `logging` configuration.

*Example ConfigMap for logging*

```
spec:
  # ...
logging:
  type: external
  valueFrom:
    configMapKeyRef:
      name: my-config-map
      key: my-config-map-key
```

To use a ConfigMap for metrics configuration, you add a reference to the `metricsConfig` configuration of the component in the same way.

`ExternalConfiguration` properties make data from a ConfigMap (or Secret) mounted to a pod available as environment variables or volumes. You can use external configuration data for the connectors used by Kafka Connect. The data might be related to an external data source, providing the values needed for the connector to communicate with that data source.

For example, you can use the `configMapKeyRef` property to pass configuration data from a ConfigMap as an environment variable.

*Example ConfigMap providing environment variable values*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  externalConfiguration:
    env:
      - name: MY_ENVIRONMENT_VARIABLE
        valueFrom:
          configMapKeyRef:
            name: my-config-map
            key: my-key
```

If you are using ConfigMaps that are managed externally, use configuration providers to load the

data in the ConfigMaps. For more information on using configuration providers, see [Loading configuration values from external sources](#).

### 1.2.1. Naming custom ConfigMaps

Strimzi [creates its own ConfigMaps and other resources](#) when it is deployed to Kubernetes. The ConfigMaps contain data necessary for running components. The ConfigMaps created by Strimzi must not be edited.

Make sure that any custom ConfigMaps you create do not have the same name as these default ConfigMaps. If they have the same name, they will be overwritten. For example, if your ConfigMap has the same name as the ConfigMap for the Kafka cluster, it will be overwritten when there is an update to the Kafka cluster.

*Additional resources*

- [List of Kafka cluster resources](#) (including ConfigMaps)
- [Logging configuration](#)
- `metricsConfig`
- [ExternalConfiguration schema reference](#)
- [Loading configuration values from external sources](#)

## 1.3. Configuring listeners to connect to Kafka brokers

Listeners are used to connect to Kafka brokers. Strimzi provides a generic [GenericKafkaListener](#) schema with properties to configure listeners through the [Kafka](#) resource.

The [GenericKafkaListener](#) provides a flexible approach to listener configuration. You can specify properties to configure *internal* listeners for connecting within the Kubernetes cluster, or *external* listeners for connecting outside the Kubernetes cluster.

Each listener is [defined as an array in the Kafka resource](#). You can configure as many listeners as required, as long as their names and ports are unique.

You might want to configure multiple external listeners, for example, to handle access from networks that require different authentication mechanisms. Or you might need to join your Kubernetes network to an outside network. In which case, you can configure internal listeners (using the `useServiceDnsDomain` property) so that the Kubernetes service DNS domain (typically `.cluster.local`) is not used.

For more information on the configuration options available for listeners, see the [GenericKafkaListener schema reference](#).

*Configuring listeners to secure access to Kafka brokers*

You can configure listeners for secure connection using authentication. For more information, see [Securing access to Kafka brokers](#).

*Configuring external listeners for client access outside Kubernetes*

You can configure external listeners for client access outside a Kubernetes environment using a specified connection mechanism, such as a loadbalancer. For more information on the configuration options for connecting an external client, see [Accessing Kafka from external clients outside of the Kubernetes cluster](#).

#### *Listener certificates*

You can provide your own server certificates, called *Kafka listener certificates*, for TLS listeners or external listeners which have TLS encryption enabled. For more information, see [Kafka listener certificates](#).

**NOTE**

If you scale your Kafka cluster while using external listeners, it might trigger a rolling update of all Kafka brokers. This depends on the configuration.

## 1.4. Document Conventions

#### *User-replaced values*

User-replaced values, also known as *replaceables*, are shown in *italics* with angle brackets (< >). Underscores ( \_ ) are used for multi-word values. If the value refers to code or commands, *monospace* is also used.

For example, in the following code, you will want to replace <my\_namespace> with the name of your namespace:

```
sed -i 's/namespace: .*/namespace: <my_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

## 1.5. Additional resources

- [Stimzi Overview](#)
- [Deploying and Upgrading Stimzi](#)
- [Using the Stimzi Kafka Bridge](#)

# Chapter 2. Configuring a Strimzi deployment

Configure your Strimzi deployment using custom resources. Strimzi provides [example configuration files](#), which can serve as a starting point when building your own Kafka component configuration for deployment.

**NOTE** Labels applied to a custom resource are also applied to the Kubernetes resources making up its cluster. This provides a convenient mechanism for resources to be labeled as required.

## *Monitoring a Strimzi deployment*

You can use Prometheus and Grafana to monitor your Strimzi deployment. For more information, see [Introducing metrics to Kafka](#).

## 2.1. Kafka cluster configuration

Configure a Kafka deployment using the [Kafka](#) resource. A Kafka cluster is deployed with a ZooKeeper cluster, so configuration options are also available for ZooKeeper within the [Kafka](#) resource. The Entity Operator comprises the Topic Operator and User Operator. You can also configure `entityOperator` properties in the [Kafka](#) resource to include the Topic Operator and User Operator in the deployment.

[Kafka schema reference](#) describes the full schema of the [Kafka](#) resource.

For more information about Apache Kafka, see the [Apache Kafka documentation](#).

### *Listener configuration*

You configure listeners for connecting clients to Kafka brokers. For more information on configuring listeners for connecting brokers, see [Listener configuration](#).

### *Authorizing access to Kafka*

You can configure your Kafka cluster to allow or decline actions executed by users. For more information, see [Securing access to Kafka brokers](#).

### *Managing TLS certificates*

When deploying Kafka, the Cluster Operator automatically sets up and renews TLS certificates to enable encryption and authentication within your cluster. If required, you can manually renew the cluster and client CA certificates before their renewal period ends. You can also replace the keys used by the cluster and client CA certificates. For more information, see [Renewing CA certificates manually](#) and [Replacing private keys](#).

### 2.1.1. Configuring Kafka

Use the properties of the [Kafka](#) resource to configure your Kafka deployment.

As well as configuring Kafka, you can add configuration for ZooKeeper and the Strimzi Operators. Common configuration properties, such as logging and healthchecks, are configured independently

for each component.

This procedure shows only some of the possible configuration options, but those that are particularly important include:

- Resource requests (CPU / Memory)
- JVM options for maximum and minimum memory allocation
- Listeners (and authentication of clients)
- Authentication
- Storage
- Rack awareness
- Metrics
- Cruise Control for cluster rebalancing

#### *Kafka versions*

The `inter.broker.protocol.version` property for the Kafka `config` must be the version supported by the specified Kafka version (`spec.kafka.version`). The property represents the version of Kafka protocol used in a Kafka cluster.

From Kafka 3.0.0, when the `inter.broker.protocol.version` is set to `3.0` or higher, the `log.message.format.version` option is ignored and doesn't need to be set.

An update to the `inter.broker.protocol.version` is required when upgrading your Kafka version. For more information, see [Upgrading Kafka](#).

#### *Prerequisites*

- A Kubernetes cluster
- A running Cluster Operator

See the *Deploying and Upgrading Strimzi* guide for instructions on deploying a:

- [Cluster Operator](#)
- [Kafka cluster](#)

#### *Procedure*

1. Edit the `spec` properties for the Kafka resource.

The properties you can configure are shown in this example configuration:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    replicas: 3 ①
```

```

version: 3.3.1 ②
logging: ③
  type: inline
  loggers:
    kafka.root.logger.level: "INFO"
resources: ④
  requests:
    memory: 64Gi
    cpu: "8"
  limits:
    memory: 64Gi
    cpu: "12"
readinessProbe: ⑤
  initialDelaySeconds: 15
  timeoutSeconds: 5
livenessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
jvmOptions: ⑥
  -Xms: 8192m
  -Xmx: 8192m
image: my-org/my-image:latest ⑦
listeners: ⑧
  - name: plain ⑨
    port: 9092 ⑩
    type: internal ⑪
    tls: false ⑫
    configuration:
      useServiceDnsDomain: true ⑬
  - name: tls
    port: 9093
    type: internal
    tls: true
    authentication: ⑭
      type: tls
  - name: external ⑮
    port: 9094
    type: route
    tls: true
    configuration:
      brokerCertChainAndKey: ⑯
        secretName: my-secret
        certificate: my-certificate.crt
        key: my-key.key
authorization: ⑰
  type: simple
config: ⑱
  auto.create.topics.enable: "false"
  offsets.topic.replication.factor: 3
  transaction.state.log.replication.factor: 3
  transaction.state.log.min_isr: 2

```

```

default.replication.factor: 3
min.insync.replicas: 2
inter.broker.protocol.version: "3.3"
ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384" ⑯
ssl.enabled.protocols: "TLSv1.2"
ssl.protocol: "TLSv1.2"
storage: ㉐
  type: persistent-claim
  size: 10000Gi
rack:
  topologyKey: topology.kubernetes.io/zone
metricsConfig:
  type: jmxPrometheusExporter
  valueFrom:
    configMapKeyRef:
      name: my-config-map
      key: my-key
# ...
zookeeper:
  replicas: 3
  logging:
    type: inline
    loggers:
      zookeeper.root.logger: "INFO"
resources:
  requests:
    memory: 8Gi
    cpu: "2"
  limits:
    memory: 8Gi
    cpu: "2"
jvmOptions:
  -Xms: 4096m
  -Xmx: 4096m
storage:
  type: persistent-claim
  size: 1000Gi
metricsConfig:
  # ...
entityOperator:
  tlsSidecar:
    resources:
      requests:
        cpu: 200m
        memory: 64Mi
      limits:
        cpu: 500m
        memory: 128Mi
topicOperator:
  watchedNamespace: my-topic-namespace
  reconciliationIntervalSeconds: 60

```

```

logging:
  type: inline
  loggers:
    rootLogger.level: "INFO"
resources:
  requests:
    memory: 512Mi
    cpu: "1"
  limits:
    memory: 512Mi
    cpu: "1"
userOperator:
  watchedNamespace: my-topic-namespace
  reconciliationIntervalSeconds: 60
  logging:
    type: inline
    loggers:
      rootLogger.level: INFO
resources:
  requests:
    memory: 512Mi
    cpu: "1"
  limits:
    memory: 512Mi
    cpu: "1"
kafkaExporter:
  # ...
cruiseControl:
  # ...

```

- ① The number of replica nodes. If your cluster already has topics defined, you can [scale clusters](#).
- ② Kafka version, which can be changed to a supported version by following [the upgrade procedure](#).
- ③ [Kafka loggers and log levels](#) added directly ([inline](#)) or indirectly ([external](#)) through a ConfigMap. A custom ConfigMap must be placed under the [log4j.properties](#) key. For the Kafka [kafka.root.logger.level](#) logger, you can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.
- ④ Requests for reservation of [supported resources](#), currently [cpu](#) and [memory](#), and limits to specify the maximum resources that can be consumed.
- ⑤ [Healthchecks](#) to know when to restart a container (liveness) and when a container can accept traffic (readiness).
- ⑥ [JVM configuration options](#) to optimize performance for the Virtual Machine (VM) running Kafka.
- ⑦ ADVANCED OPTION: [Container image configuration](#), which is recommended only in special situations.

- ⑧ Listeners configure how clients connect to the Kafka cluster via bootstrap addresses. Listeners are configured as *internal* or *external* listeners for connection from inside or outside the Kubernetes cluster.
- ⑨ Name to identify the listener. Must be unique within the Kafka cluster.
- ⑩ Port number used by the listener inside Kafka. The port number has to be unique within a given Kafka cluster. Allowed port numbers are 9092 and higher with the exception of ports 9404 and 9999, which are already used for Prometheus and JMX. Depending on the listener type, the port number might not be the same as the port number that connects Kafka clients.
- ⑪ Listener type specified as `internal`, or for external listeners, as `route`, `loadbalancer`, `nodeport` or `ingress`.
- ⑫ Enables TLS encryption for each listener. Default is `false`. TLS encryption is not required for `route` listeners.
- ⑬ Defines whether the fully-qualified DNS names including the cluster service suffix (usually `.cluster.local`) are assigned.
- ⑭ Listener authentication mechanism specified as mutual TLS, SCRAM-SHA-512 or token-based OAuth 2.0.
- ⑮ External listener configuration specifies how the Kafka cluster is exposed outside Kubernetes, such as through a `route`, `loadbalancer` or `nodeport`.
- ⑯ Optional configuration for a Kafka listener certificate managed by an external Certificate Authority. The `brokerCertChainAndKey` specifies a `Secret` that contains a server certificate and a private key. You can configure Kafka listener certificates on any listener with enabled TLS encryption.
- ⑰ Authorization enables simple, OAUTH 2.0, or OPA authorization on the Kafka broker. Simple authorization uses the `AclAuthorizer` Kafka plugin.
- ⑱ Broker configuration. Standard Apache Kafka configuration may be provided, restricted to those properties not managed directly by Strimzi.
- ⑲ SSL properties for listeners with TLS encryption enabled to enable a specific *cipher suite* or TLS version.
- ⑳ Storage is configured as `ephemeral`, `persistent-claim` or `jbod`.

Storage size for `persistent volumes` may be increased and additional volumes may be added to `JBOD storage`.

Persistent storage has `additional configuration options`, such as a storage `id` and `class` for dynamic volume provisioning.

`Rack awareness` configuration to spread replicas across different racks, data centers, or availability zones. The `topologyKey` must match a node label containing the rack ID. The example used in this configuration specifies a zone using the standard `topology.kubernetes.io/zone` label.

`Prometheus metrics` enabled. In this example, metrics are configured for the Prometheus JMX Exporter (the default metrics exporter).

Prometheus rules for exporting metrics to a Grafana dashboard through the Prometheus JMX Exporter, which are enabled by referencing a ConfigMap containing configuration for the

Prometheus JMX exporter. You can enable metrics without further configuration using a reference to a ConfigMap containing an empty file under `metricsConfig.valueFrom.configMapKeyRef.key`.

ZooKeeper-specific configuration, which contains properties similar to the Kafka configuration.

[The number of ZooKeeper nodes](#). ZooKeeper clusters or ensembles usually run with an odd number of nodes, typically three, five, or seven. The majority of nodes must be available in order to maintain an effective quorum. If the ZooKeeper cluster loses its quorum, it will stop responding to clients and the Kafka brokers will stop working. Having a stable and highly available ZooKeeper cluster is crucial for Strimzi.

Specified [ZooKeeper loggers and log levels](#).

Entity Operator configuration, which [specifies the configuration for the Topic Operator and User Operator](#).

Entity Operator [TLS sidecar configuration](#). Entity Operator uses the TLS sidecar for secure communication with ZooKeeper.

Specified [Topic Operator loggers and log levels](#). This example uses `inline` logging.

Specified [User Operator loggers and log levels](#).

Kafka Exporter configuration. [Kafka Exporter](#) is an optional component for extracting metrics data from Kafka brokers, in particular consumer lag data. For Kafka Exporter to be able to work properly, consumer groups need to be in use.

Optional configuration for Cruise Control, which is used to [rebalance the Kafka cluster](#).

## 2. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

### 2.1.2. Configuring the Entity Operator

The Entity Operator is responsible for managing Kafka-related entities in a running Kafka cluster.

The Entity Operator comprises the:

- Topic Operator to manage Kafka topics
- User Operator to manage Kafka users

Through [Kafka](#) resource configuration, the Cluster Operator can deploy the Entity Operator, including one or both operators, when deploying a Kafka cluster.

The operators are automatically configured to manage the topics and users of the Kafka cluster. The Topic Operator and User Operator can only watch a single namespace. For more information, see [Watching namespaces with Strimzi operators](#).

**NOTE**

When deployed, the Entity Operator pod contains the operators according to the deployment configuration.

## Entity Operator configuration properties

Use the `entityOperator` property in `Kafka.spec` to configure the Entity Operator.

The `entityOperator` property supports several sub-properties:

- `tlsSidecar`
- `topicOperator`
- `userOperator`
- `template`

The `tlsSidecar` property contains the configuration of the TLS sidecar container, which is used to communicate with ZooKeeper.

The `template` property contains the configuration of the Entity Operator pod, such as labels, annotations, affinity, and tolerations. For more information on configuring templates, see [Customizing Kubernetes resources](#).

The `topicOperator` property contains the configuration of the Topic Operator. When this option is missing, the Entity Operator is deployed without the Topic Operator.

The `userOperator` property contains the configuration of the User Operator. When this option is missing, the Entity Operator is deployed without the User Operator.

For more information on the properties used to configure the Entity Operator, see the [EntityUserOperatorSpec schema reference](#).

*Example of basic configuration enabling both operators*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    topicOperator: {}
    userOperator: {}
```

If an empty object (`{}`) is used for the `topicOperator` and `userOperator`, all properties use their default values.

When both `topicOperator` and `userOperator` properties are missing, the Entity Operator is not deployed.

## Topic Operator configuration properties

Topic Operator deployment can be configured using additional options inside the `topicOperator` object. The following properties are supported:

### `watchedNamespace`

The Kubernetes namespace in which the Topic Operator watches for `KafkaTopic` resources. Default is the namespace where the Kafka cluster is deployed.

### `reconciliationIntervalSeconds`

The interval between periodic reconciliations in seconds. Default `120`.

### `zookeeperSessionTimeoutSeconds`

The ZooKeeper session timeout in seconds. Default `18`.

### `topicMetadataMaxAttempts`

The number of attempts at getting topic metadata from Kafka. The time between each attempt is defined as an exponential back-off. Consider increasing this value when topic creation might take more time due to the number of partitions or replicas. Default `6`.

### `image`

The `image` property can be used to configure the container image which will be used. For more details about configuring custom container images, see [image](#).

### `resources`

The `resources` property configures the amount of resources allocated to the Topic Operator. For more details about resource request and limit configuration, see [resources](#).

### `logging`

The `logging` property configures the logging of the Topic Operator. For more details, see [logging](#).

### *Example Topic Operator configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    # ...
  topicOperator:
    watchedNamespace: my-topic-namespace
    reconciliationIntervalSeconds: 60
    # ...
```

## User Operator configuration properties

User Operator deployment can be configured using additional options inside the `userOperator` object. The following properties are supported:

### `watchedNamespace`

The Kubernetes namespace in which the User Operator watches for `KafkaUser` resources. Default is the namespace where the Kafka cluster is deployed.

### `reconciliationIntervalSeconds`

The interval between periodic reconciliations in seconds. Default `120`.

### `image`

The `image` property can be used to configure the container image which will be used. For more details about configuring custom container images, see [image](#).

### `resources`

The `resources` property configures the amount of resources allocated to the User Operator. For more details about resource request and limit configuration, see [resources](#).

### `logging`

The `logging` property configures the logging of the User Operator. For more details, see [logging](#).

### `secretPrefix`

The `secretPrefix` property adds a prefix to the name of all Secrets created from the `KafkaUser` resource. For example, `secretPrefix: kafka-` would prefix all Secret names with `kafka-`. So a `KafkaUser` named `my-user` would create a Secret named `kafka-my-user`.

### *Example User Operator configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    # ...
  userOperator:
    watchedNamespace: my-user-namespace
    reconciliationIntervalSeconds: 60
    # ...
```

## 2.1.3. Configuring Kafka and ZooKeeper storage

As stateful applications, Kafka and ZooKeeper store data on disk. Strimzi supports three storage

types for this data:

- Ephemeral (Recommended for development only)
- Persistent
- JBOD (**Kafka only** not ZooKeeper)

When configuring a **Kafka** resource, you can specify the type of storage used by the Kafka broker and its corresponding ZooKeeper node. You configure the storage type using the **storage** property in the following resources:

- `Kafka.spec.kafka`
- `Kafka.spec.zookeeper`

The storage type is configured in the `type` field.

Refer to the schema reference for more information on storage configuration properties:

- [EphemeralStorage schema reference](#)
- [PersistentClaimStorage schema reference](#)
- [JbodStorage schema reference](#)

**WARNING** The storage type cannot be changed after a Kafka cluster is deployed.

## Data storage considerations

For Strimzi to work well, an efficient data storage infrastructure is essential. Block storage is required. File storage, such as NFS, does not work with Kafka.

Choose one of the following options for your block storage:

- A cloud-based block storage solution, such as [Amazon Elastic Block Store \(EBS\)](#)
- Persistent storage using [local persistent volumes](#)
- Storage Area Network (SAN) volumes accessed by a protocol such as *Fibre Channel* or *iSCSI*

**NOTE** Strimzi does not require Kubernetes raw block volumes.

## File systems

Kafka uses a file system for storing messages. Strimzi is compatible with the XFS and ext4 file systems, which are commonly used with Kafka. Consider the underlying architecture and requirements of your deployment when choosing and setting up your file system.

For more information, refer to [Filesystem Selection](#) in the Kafka documentation.

## Disk usage

Use separate disks for Apache Kafka and ZooKeeper.

Solid-state drives (SSDs), though not essential, can improve the performance of Kafka in large clusters where data is sent to and received from multiple topics asynchronously. SSDs are particularly effective with ZooKeeper, which requires fast, low latency data access.

**NOTE**

You do not need to provision replicated storage because Kafka and ZooKeeper both have built-in data replication.

## Ephemeral storage

Ephemeral data storage is transient. All pods on a node share a local ephemeral storage space. Data is retained for as long as the pod that uses it is running. The data is lost when a pod is deleted. Although a pod can recover data in a highly available environment.

Because of its transient nature, ephemeral storage is only recommended for development and testing.

Ephemeral storage uses `emptyDir` volumes to store data. An `emptyDir` volume is created when a pod is assigned to a node. You can set the total amount of storage for the `emptyDir` using the `sizeLimit` property .

**IMPORTANT**

Ephemeral storage is not suitable for single-node ZooKeeper clusters or Kafka topics with a replication factor of 1.

To use ephemeral storage, you set the storage type configuration in the `Kafka` or `ZooKeeper` resource to `ephemeral`.

### *Example ephemeral storage configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    storage:
      type: ephemeral
    # ...
  zookeeper:
    # ...
    storage:
      type: ephemeral
    # ...
```

### Mount path of Kafka log directories

The ephemeral volume is used by Kafka brokers as log directories mounted into the following path:

```
/var/lib/kafka/data/kafka-logIDX
```

Where `IDX` is the Kafka broker pod index. For example `/var/lib/kafka/data/kafka-log0`.

## Persistent storage

Persistent data storage retains data in the event of system disruption. For pods that use persistent data storage, data is persisted across pod failures and restarts.

A dynamic provisioning framework enables clusters to be created with persistent storage. Pod configuration uses [Persistent Volume Claims](#) (PVCs) to make storage requests on persistent volumes (PVs). PVs are storage resources that represent a storage volume. PVs are independent of the pods that use them. The PVC requests the amount of storage required when a pod is being created. The underlying storage infrastructure of the PV does not need to be understood. If a PV matches the storage criteria, the PVC is bound to the PV.

Because of its permanent nature, persistent storage is recommended for production.

PVCs can request different types of persistent storage by specifying a [StorageClass](#). Storage classes define storage profiles and dynamically provision PVs. If a storage class is not specified, the default storage class is used. Persistent storage options might include SAN storage types or [local persistent volumes](#).

To use persistent storage, you set the storage type configuration in the [Kafka](#) or [ZooKeeper](#) resource to `persistent-claim`.

In the production environment, the following configuration is recommended:

- For Kafka, configure `type: jbod` with one or more `type: persistent-claim` volumes
- For ZooKeeper, configure `type: persistent-claim`

Persistent storage also has the following configuration options:

### **id (optional)**

A storage identification number. This option is mandatory for storage volumes defined in a JBOD storage declaration. Default is `0`.

### **size (required)**

The size of the persistent volume claim, for example, "1000Gi".

### **class (optional)**

The Kubernetes [StorageClass](#) to use for dynamic volume provisioning. Storage `class` configuration includes parameters that describe the profile of a volume in detail.

### **selector (optional)**

Configuration to specify a specific PV. Provides key:value pairs representing the labels of the volume selected.

### **deleteClaim (optional)**

Boolean value to specify whether the PVC is deleted when the cluster is uninstalled. Default is `false`.

#### **WARNING**

Increasing the size of persistent volumes in an existing Strimzi cluster is only supported in Kubernetes versions that support persistent volume resizing. The persistent volume to be resized must use a storage class that supports volume expansion. For other versions of Kubernetes and storage classes that do not support volume expansion, you must decide the necessary storage size before deploying the cluster. Decreasing the size of existing persistent volumes is not possible.

*Example persistent storage configuration for Kafka and ZooKeeper*

```
# ...
spec:
  kafka:
    # ...
    storage:
      type: jbod
      volumes:
        - id: 0
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
        - id: 1
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
        - id: 2
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
    # ...
  zookeeper:
    storage:
      type: persistent-claim
      size: 1000Gi
# ...
```

If you do not specify a storage class, the default is used. The following example specifies a storage class.

*Example persistent storage configuration with specific storage class*

```
# ...
storage:
  type: persistent-claim
  size: 1Gi
```

```
class: my-storage-class
# ...
```

Use a [selector](#) to specify a labeled persistent volume that provides certain features, such as an SSD.

*Example persistent storage configuration with selector*

```
# ...
storage:
  type: persistent-claim
  size: 1Gi
  selector:
    hdd-type: ssd
  deleteClaim: true
# ...
```

### Storage class overrides

Instead of using the default storage class, you can specify a different storage class for one or more Kafka brokers or ZooKeeper nodes. This is useful, for example, when storage classes are restricted to different availability zones or data centers. You can use the [overrides](#) field for this purpose.

In this example, the default storage class is named [my-storage-class](#):

*Example Strimzi cluster using storage class overrides*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  labels:
    app: my-cluster
    name: my-cluster
    namespace: myproject
spec:
  # ...
  kafka:
    replicas: 3
    storage:
      type: jbod
      volumes:
        - id: 0
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
          class: my-storage-class
        overrides:
          - broker: 0
            class: my-storage-class-zone-1a
          - broker: 1
            class: my-storage-class-zone-1b
```

```

    - broker: 2
      class: my-storage-class-zone-1c
    # ...
# ...
zookeeper:
  replicas: 3
  storage:
    deleteClaim: true
    size: 100Gi
    type: persistent-claim
    class: my-storage-class
  overrides:
    - broker: 0
      class: my-storage-class-zone-1a
    - broker: 1
      class: my-storage-class-zone-1b
    - broker: 2
      class: my-storage-class-zone-1c
# ...

```

As a result of the configured `overrides` property, the volumes use the following storage classes:

- The persistent volumes of ZooKeeper node 0 use `my-storage-class-zone-1a`.
- The persistent volumes of ZooKeeper node 1 use `my-storage-class-zone-1b`.
- The persistent volumes of ZooKeeper node 2 use `my-storage-class-zone-1c`.
- The persistent volumes of Kafka broker 0 use `my-storage-class-zone-1a`.
- The persistent volumes of Kafka broker 1 use `my-storage-class-zone-1b`.
- The persistent volumes of Kafka broker 2 use `my-storage-class-zone-1c`.

The `overrides` property is currently used only to override storage class configurations. Overrides for other storage configuration properties is not currently supported. Other storage configuration properties are currently not supported.

#### **PVC resources for persistent storage**

When persistent storage is used, it creates PVCs with the following names:

##### **data-cluster-name-kafka-idx**

PVC for the volume used for storing data for the Kafka broker pod `idx`.

##### **data-cluster-name-zookeeper-idx**

PVC for the volume used for storing data for the ZooKeeper node pod `idx`.

#### **Mount path of Kafka log directories**

The persistent volume is used by the Kafka brokers as log directories mounted into the following path:

```
/var/lib/kafka/data/kafka-logIDX
```

Where `IDX` is the Kafka broker pod index. For example `/var/lib/kafka/data/kafka-log0`.

## Resizing persistent volumes

You can provision increased storage capacity by increasing the size of the persistent volumes used by an existing Strimzi cluster. Resizing persistent volumes is supported in clusters that use either a single persistent volume or multiple persistent volumes in a JBOD storage configuration.

**NOTE** You can increase but not decrease the size of persistent volumes. Decreasing the size of persistent volumes is not currently supported in Kubernetes.

### Prerequisites

- A Kubernetes cluster with support for volume resizing.
- The Cluster Operator is running.
- A Kafka cluster using persistent volumes created using a storage class that supports volume expansion.

### Procedure

1. Edit the `Kafka` resource for your cluster.

Change the `size` property to increase the size of the persistent volume allocated to a Kafka cluster, a ZooKeeper cluster, or both.

- For Kafka clusters, update the `size` property under `spec.kafka.storage`.
- For ZooKeeper clusters, update the `size` property under `spec.zookeeper.storage`.

#### *Kafka configuration to increase the volume size to 2000Gi*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    storage:
      type: persistent-claim
      size: 2000Gi
      class: my-storage-class
    # ...
  zookeeper:
    # ...
```

2. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

Kubernetes increases the capacity of the selected persistent volumes in response to a request from the Cluster Operator. When the resizing is complete, the Cluster Operator restarts all pods that use the resized persistent volumes. This happens automatically.

- Verify that the storage capacity has increased for the relevant pods on the cluster:

```
kubectl get pv
```

*Kafka broker pods with increased storage*

NAME	CAPACITY	CLAIM
pvc-0ca459ce-...	2000Gi	my-project/data-my-cluster-kafka-2
pvc-6e1810be-...	2000Gi	my-project/data-my-cluster-kafka-0
pvc-82dc78c9-...	2000Gi	my-project/data-my-cluster-kafka-1

The output shows the names of each PVC associated with a broker pod.

#### *Additional resources*

- For more information about resizing persistent volumes in Kubernetes, see [Resizing Persistent Volumes using Kubernetes](#).

## **JBOD storage**

You can configure Strimzi to use JBOD, a data storage configuration of multiple disks or volumes. JBOD is one approach to providing increased data storage for Kafka brokers. It can also improve performance.

**NOTE**    JBOD storage is supported for **Kafka** only not ZooKeeper.

A JBOD configuration is described by one or more volumes, each of which can be either **ephemeral** or **persistent**. The rules and constraints for JBOD volume declarations are the same as those for ephemeral and persistent storage. For example, you cannot decrease the size of a persistent storage volume after it has been provisioned, or you cannot change the value of **sizeLimit** when the type is **ephemeral**.

To use JBOD storage, you set the storage type configuration in the **Kafka** resource to **jbod**. The **volumes** property allows you to describe the disks that make up your JBOD storage array or configuration.

#### *Example JBOD storage configuration*

```
# ...
storage:
  type: jbod
  volumes:
```

```
- id: 0
  type: persistent-claim
  size: 100Gi
  deleteClaim: false
- id: 1
  type: persistent-claim
  size: 100Gi
  deleteClaim: false
# ...
```

The IDs cannot be changed once the JBOD volumes are created. You can add or remove volumes from the JBOD configuration.

#### PVC resource for JBOD storage

When persistent storage is used to declare JBOD volumes, it creates a PVC with the following name:

#### **data-id-cluster-name-kafka-idx**

PVC for the volume used for storing data for the Kafka broker pod `idx`. The `id` is the ID of the volume used for storing data for Kafka broker pod.

#### Mount path of Kafka log directories

The JBOD volumes are used by Kafka brokers as log directories mounted into the following path:

```
/var/lib/kafka/data-id/kafka-logidx
```

Where `id` is the ID of the volume used for storing data for Kafka broker pod `idx`. For example `/var/lib/kafka/data-0/kafka-log0`.

#### Adding volumes to JBOD storage

This procedure describes how to add volumes to a Kafka cluster configured to use JBOD storage. It cannot be applied to Kafka clusters configured to use any other storage type.

**NOTE** When adding a new volume under an `id` which was already used in the past and removed, you have to make sure that the previously used `PersistentVolumeClaims` have been deleted.

#### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator
- A Kafka cluster with JBOD storage

#### Procedure

1. Edit the `spec.kafka.storage.volumes` property in the `Kafka` resource. Add the new volumes to the `volumes` array. For example, add the new volume with id `2`:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    storage:
      type: jbod
      volumes:
        - id: 0
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
        - id: 1
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
        - id: 2
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
    # ...
  zookeeper:
    # ...
```

## 2. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

## 3. Create new topics or reassign existing partitions to the new disks.

### *Additional resources*

For more information about reassigning topics, see [Partition reassignment tool](#).

## Removing volumes from JBOD storage

This procedure describes how to remove volumes from Kafka cluster configured to use JBOD storage. It cannot be applied to Kafka clusters configured to use any other storage type. The JBOD storage always has to contain at least one volume.

### **IMPORTANT**

To avoid data loss, you have to move all partitions before removing the volumes.

### *Prerequisites*

- A Kubernetes cluster
- A running Cluster Operator

- A Kafka cluster with JBOD storage with two or more volumes

#### *Procedure*

1. Reassign all partitions from the disks which are you going to remove. Any data in partitions still assigned to the disks which are going to be removed might be lost.
2. Edit the `spec.kafka.storage.volumes` property in the `Kafka` resource. Remove one or more volumes from the `volumes` array. For example, remove the volumes with ids **1** and **2**:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    storage:
      type: jbod
      volumes:
        - id: 0
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
    # ...
  zookeeper:
    # ...
```

3. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

#### *Additional resources*

For more information about reassigning topics, see [Partition reassignment tool](#).

### 2.1.4. Scaling clusters

Scale Kafka clusters by adding or removing brokers. If a cluster already has topics defined, you also have to reassign partitions.

You use the `kafka-reassign-partitions.sh` tool to reassign partitions. The tool uses a reassignment JSON file that specifies the topics to reassign.

You can generate a reassignment JSON file or create a file manually if you want to move specific partitions.

#### **Broker scaling configuration**

You configure the `Kafka.spec.kafka.replicas` configuration to add or reduce the number of brokers.

## Broker addition

The primary way of increasing throughput for a topic is to increase the number of partitions for that topic. That works because the extra partitions allow the load of the topic to be shared between the different brokers in the cluster. However, in situations where every broker is constrained by a particular resource (typically I/O) using more partitions will not result in increased throughput. Instead, you need to add brokers to the cluster.

When you add an extra broker to the cluster, Kafka does not assign any partitions to it automatically. You must decide which partitions to reassign from the existing brokers to the new broker.

Once the partitions have been redistributed between all the brokers, the resource utilization of each broker is reduced.

## Broker removal

If you are using [StatefulSets](#) to manage broker pods, you cannot remove *any* pod from the cluster. You can only remove one or more of the highest numbered pods from the cluster. For example, in a cluster of 12 brokers the pods are named `cluster-name-kafka-0` up to `cluster-name-kafka-11`. If you decide to scale down by one broker, the `cluster-name-kafka-11` will be removed.

Before you remove a broker from a cluster, ensure that it is not assigned to any partitions. You should also decide which of the remaining brokers will be responsible for each of the partitions on the broker being decommissioned. Once the broker has no assigned partitions, you can scale the cluster down safely.

## Partition reassignment tool

The Topic Operator does not currently support reassigning replicas to different brokers, so it is necessary to connect directly to broker pods to reassign replicas to brokers.

Within a broker pod, the `kafka-reassign-partitions.sh` tool allows you to reassign partitions to different brokers.

It has three different modes:

### --generate

Takes a set of topics and brokers and generates a *reassignment JSON file* which will result in the partitions of those topics being assigned to those brokers. Because this operates on whole topics, it cannot be used when you only want to reassign some partitions of some topics.

### --execute

Takes a *reassignment JSON file* and applies it to the partitions and brokers in the cluster. Brokers that gain partitions as a result become followers of the partition leader. For a given partition, once the new broker has caught up and joined the ISR (in-sync replicas) the old broker will stop being a follower and will delete its replica.

### --verify

Using the same *reassignment JSON file* as the `--execute` step, `--verify` checks whether all the

partitions in the file have been moved to their intended brokers. If the reassignment is complete, `--verify` also removes any traffic throttles (`--throttle`) that are in effect. Unless removed, throttles will continue to affect the cluster even after the reassignment has finished.

It is only possible to have one reassignment running in a cluster at any given time, and it is not possible to cancel a running reassignment. If you need to cancel a reassignment, wait for it to complete and then perform another reassignment to revert the effects of the first reassignment. The `kafka-reassign-partitions.sh` will print the reassignment JSON for this reversion as part of its output. Very large reassessments should be broken down into a number of smaller reassessments in case there is a need to stop in-progress reassignment.

### Partition reassignment JSON file

The *reassignment JSON file* has a specific structure:

```
{  
  "version": 1,  
  "partitions": [  
    <PartitionObjects>  
  ]  
}
```

Where `<PartitionObjects>` is a comma-separated list of objects like:

```
{  
  "topic": <TopicName>,  
  "partition": <Partition>,  
  "replicas": [ <AssignedBrokerIds> ]  
}
```

**NOTE**

Although Kafka also supports a `"log_dirs"` property this should not be used in Strimzi.

The following is an example reassignment JSON file that assigns partition 4 of topic `topic-a` to brokers 2, 4 and 7, and partition 2 of topic `topic-b` to brokers 1, 5 and 7:

#### Example partition reassignment file

```
{  
  "version": 1,  
  "partitions": [  
    {  
      "topic": "topic-a",  
      "partition": 4,  
      "replicas": [2,4,7]  
    },  
    {  
      "topic": "topic-b",  
    }  
  ]  
}
```

```
        "partition": 2,
        "replicas": [1,5,7]
    }
]
}
```

Partitions not included in the JSON are not changed.

### Partition reassignment between JBOD volumes

When using JBOD storage in your Kafka cluster, you can choose to reassign the partitions between specific volumes and their log directories (each volume has a single log directory). To reassign a partition to a specific volume, add the `log_dirs` option to `<PartitionObjects>` in the reassignment JSON file.

```
{
    "topic": <TopicName>,
    "partition": <Partition>,
    "replicas": [ <AssignedBrokerIds> ],
    "log_dirs": [ <AssignedLogDirs> ]
}
```

The `log_dirs` object should contain the same number of log directories as the number of replicas specified in the `replicas` object. The value should be either an absolute path to the log directory, or the `any` keyword.

*Example partition reassignment file specifying log directories*

```
{
    "topic": "topic-a",
    "partition": 4,
    "replicas": [2,4,7],
    "log_dirs": [ "/var/lib/kafka/data-0/kafka-log2", "/var/lib/kafka/data-0/kafka-log4", "/var/lib/kafka/data-0/kafka-log7" ]
}
```

### Partition reassignment throttles

Partition reassignment can be a slow process because it involves transferring large amounts of data between brokers. To avoid a detrimental impact on clients, you can throttle the reassignment process. Use the `--throttle` parameter with the `kafka-reassign-partitions.sh` tool to throttle a reassignment. You specify a maximum threshold in bytes per second for the movement of partitions between brokers. For example, `--throttle 5000000` sets a maximum threshold for moving partitions of 50 MBps.

Throttling might cause the reassignment to take longer to complete.

- If the throttle is too low, the newly assigned brokers will not be able to keep up with records

being published and the reassignment will never complete.

- If the throttle is too high, clients will be impacted.

For example, for producers, this could manifest as higher than normal latency waiting for acknowledgment. For consumers, this could manifest as a drop in throughput caused by higher latency between polls.

## Generating reassignment JSON files

This procedure describes how to generate a reassignment JSON file. Use the reassignment file with the `kafka-reassign-partitions.sh` tool to reassign partitions after scaling a Kafka cluster.

The steps describe a secure reassignment process that uses TLS. You'll need a Kafka cluster that uses TLS encryption and authentication.

### Prerequisites

- You have a running Cluster Operator.
- You have a running Kafka cluster based on a `Kafka` resource configured with internal TLS authentication and encryption.

### Kafka configuration with TLS

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    listeners:
      # ...
      - name: tls
        port: 9093
        type: internal
        tls: true ①
        authentication:
          type: tls ②
    # ...
```

① Enables TLS encryption for the internal listener.

② Listener authentication mechanism [specified as mutual TLS](#).

- The running Kafka cluster contains a set of topics and partitions to reassign.

### Example topic configuration for `my-topic`

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
```

```

name: my-topic
labels:
  strimzi.io/cluster: my-cluster
spec:
  partitions: 10
  replicas: 3
  config:
    retention.ms: 7200000
    segment.bytes: 1073741824
    # ...

```

- You have a `KafkaUser` configured with ACL rules that specify permission to produce and consume topics from the Kafka brokers.

*Example Kafka user configuration with ACL rules to allow operations on `my-topic` and `my-cluster`*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication: ①
    type: tls
  authorization:
    type: simple ②
    acls:
      # access to the topic
      - resource:
          type: topic
          name: my-topic
        operations:
          - Create
          - Describe
          - Read
          - AlterConfigs
        host: "*"
      # access to the cluster
      - resource:
          type: cluster
        operations:
          - Alter
          - AlterConfigs
        host: "*"
      # ...
    # ...

```

① User authentication mechanism defined as mutual `tls`.

## ② Simple authorization and accompanying list of ACL rules.

### Procedure

1. Extract the cluster CA certificate and password from the `<cluster_name>-cluster-ca-cert` Secret of the Kafka cluster.

```
kubectl get secret <cluster_name>-cluster-ca-cert -o jsonpath='{.data.ca\.p12}' |  
base64 -d > ca.p12
```

```
kubectl get secret <cluster_name>-cluster-ca-cert -o  
jsonpath='{.data.ca\.password}' | base64 -d > ca.password
```

Replace `<cluster_name>` with the name of the Kafka cluster. When you deploy Kafka using the **Kafka** resource, a Secret with the cluster CA certificate is created with the Kafka cluster name (`<cluster_name>-cluster-ca-cert`). For example, `my-cluster-cluster-ca-cert`.

2. Run a new interactive pod container using the Strimzi Kafka image to connect to a running Kafka broker.

```
kubectl run --restart=Never --image=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1  
<interactive_pod_name> -- /bin/sh -c "sleep 3600"
```

Replace `<interactive_pod_name>` with the name of the pod.

3. Copy the cluster CA certificate to the interactive pod container.

```
kubectl cp ca.p12 <interactive_pod_name>:/tmp
```

4. Extract the user CA certificate and password from the Secret of the Kafka user that has permission to access the Kafka brokers.

```
kubectl get secret <kafka_user> -o jsonpath='{.data.user\.p12}' | base64 -d >  
user.p12
```

```
kubectl get secret <kafka_user> -o jsonpath='{.data.user\.password}' | base64 -d >  
user.password
```

Replace `<kafka_user>` with the name of the Kafka user. When you create a Kafka user using the **KafkaUser** resource, a Secret with the user CA certificate is created with the Kafka user name. For example, `my-user`.

5. Copy the user CA certificate to the interactive pod container.

```
kubectl cp user.p12 <interactive_pod_name>:/tmp
```

The CA certificates allow the interactive pod container to connect to the Kafka broker using TLS.

6. Create a `config.properties` file to specify the truststore and keystore used to authenticate connection to the Kafka cluster.

Use the certificates and passwords you extracted in the previous steps.

```
bootstrap.servers=<kafka_cluster_name>-kafka-bootstrap:9093 ①  
security.protocol=SSL ②  
ssl.truststore.location=/tmp/ca.p12 ③  
ssl.truststore.password=<truststore_password> ④  
ssl.keystore.location=/tmp/user.p12 ⑤  
ssl.keystore.password=<keystore_password> ⑥
```

① The bootstrap server address to connect to the Kafka cluster. Use your own Kafka cluster name to replace `<kafka_cluster_name>`.

② The security protocol option when using TLS for encryption.

③ The truststore location contains the public key certificate (`ca.p12`) for the Kafka cluster.

④ The password (`ca.password`) for accessing the truststore.

⑤ The keystore location contains the public key certificate (`user.p12`) for the Kafka user.

⑥ The password (`user.password`) for accessing the keystore.

7. Copy the `config.properties` file to the interactive pod container.

```
kubectl cp config.properties <interactive_pod_name>:/tmp/config.properties
```

8. Prepare a JSON file named `topics.json` that specifies the topics to move.

Specify topic names as a comma-separated list.

*Example JSON file to reassign all the partitions of `topic-a` and `topic-b`*

```
{  
  "version": 1,  
  "topics": [  
    { "topic": "topic-a"},  
    { "topic": "topic-b"}  
  ]  
}
```

9. Copy the `topics.json` file to the interactive pod container.

```
kubectl cp topics.json <interactive_pod_name>:/tmp/topics.json
```

10. Start a shell process in the interactive pod container.

```
kubectl exec -n <namespace> -ti <interactive_pod_name> /bin/bash
```

Replace *<namespace>* with the Kubernetes namespace where the pod is running.

11. Use the `kafka-reassign-partitions.sh` command to generate the reassignment JSON.

*Example command to move all the partitions of topic-a and topic-b to brokers 0, 1 and 2*

```
bin/kafka-reassign-partitions.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 \
\ \
--command-config /tmp/config.properties \
--topics-to-move-json-file /tmp/topics.json \
--broker-list 0,1,2 \
--generate
```

#### *Additional resources*

- [Configuring Kafka](#)
- [Configuring a Kafka topic](#)
- [Securing user access to Kafka](#)

## Scaling up a Kafka cluster

Use a reassignment file to increase the number of brokers in a Kafka cluster.

The reassignment file should describe how partitions are reassigned to brokers in the enlarged Kafka cluster.

This procedure describes a secure scaling process that uses TLS. You'll need a Kafka cluster that uses TLS encryption and authentication.

#### *Prerequisites*

- You have a running Kafka cluster based on a `Kafka` resource configured with internal TLS authentication and encryption.
- You have generated a reassignment JSON file named `reassignment.json`.
- You are running an interactive pod container that is connected to the running Kafka broker.
- You are connected as a `KafkaUser` configured with ACL rules that specify permission to manage the Kafka cluster and its topics.

See [Generating reassignment JSON files](#).

#### *Procedure*

1. Add as many new brokers as you need by increasing the `Kafka.spec.kafka.replicas` configuration option.
2. Verify that the new broker pods have started.
3. If you haven't done so, run an interactive pod container to generate a reassignment JSON file named `reassignment.json`.
4. Copy the `reassignment.json` file to the interactive pod container.

```
kubectl cp reassignment.json <interactive_pod_name>:/tmp/reassignment.json
```

Replace `<interactive_pod_name>` with the name of the pod.

5. Start a shell process in the interactive pod container.

```
kubectl exec -n <namespace> -ti <interactive_pod_name> /bin/bash
```

Replace `<namespace>` with the Kubernetes namespace where the pod is running.

6. Run the partition reassignment using the `kafka-reassign-partitions.sh` script from the interactive pod container.

```
bin/kafka-reassign-partitions.sh --bootstrap-server
<cluster_name>-kafka-bootstrap:9093 \
--command-config /tmp/config.properties \
--reassignment-json-file /tmp/reassignment.json \
--execute
```

Replace `<cluster_name>` with the name of your Kafka cluster. For example, `my-cluster-kafka-bootstrap:9093`

If you are going to throttle replication, you can also pass the `--throttle` option with an inter-broker throttled rate in bytes per second. For example:

```
bin/kafka-reassign-partitions.sh --bootstrap-server
<cluster_name>-kafka-bootstrap:9093 \
--command-config /tmp/config.properties \
--reassignment-json-file /tmp/reassignment.json \
--throttle 5000000 \
--execute
```

This command will print out two reassignment JSON objects. The first records the current assignment for the partitions being moved. You should save this to a local file (not a file in the pod) in case you need to revert the reassignment later on. The second JSON object is the target reassignment you have passed in your reassignment JSON file.

If you need to change the throttle during reassignment, you can use the same command with a

different throttled rate. For example:

```
bin/kafka-reassign-partitions.sh --bootstrap-server  
<cluster_name>-kafka-bootstrap:9093 \  
--command-config /tmp/config.properties \  
--reassignment-json-file /tmp/reassignment.json \  
--throttle 10000000 \  
--execute
```

7. Verify that the reassignment has completed using the `kafka-reassign-partitions.sh` command line tool from any of the broker pods. This is the same command as the previous step, but with the `--verify` option instead of the `--execute` option.

```
bin/kafka-reassign-partitions.sh --bootstrap-server  
<cluster_name>-kafka-bootstrap:9093 \  
--command-config /tmp/config.properties \  
--reassignment-json-file /tmp/reassignment.json \  
--verify
```

The reassignment has finished when the `--verify` command reports that each of the partitions being moved has completed successfully. This final `--verify` will also have the effect of removing any reassignment throttles.

8. You can now delete the revert file if you saved the JSON for reverting the assignment to their original brokers.

## Scaling down a Kafka cluster

Use a reassignment file to decrease the number of brokers in a Kafka cluster.

The reassignment file must describe how partitions are reassigned to the remaining brokers in the Kafka cluster. Brokers in the highest numbered pods are removed first.

This procedure describes a secure scaling process that uses TLS. You'll need a Kafka cluster that uses TLS encryption and authentication.

### Prerequisites

- You have a running Kafka cluster based on a `Kafka` resource configured with internal TLS authentication and encryption.
- You have generated a reassignment JSON file named `reassignment.json`.
- You are running an interactive pod container that is connected to the running Kafka broker.
- You are connected as a `KafkaUser` configured with ACL rules that specify permission to manage the Kafka cluster and its topics.

See [Generating reassignment JSON files](#).

### Procedure

1. If you haven't done so, run an interactive pod container to generate a reassignment JSON file named `reassignment.json`.
2. Copy the `reassignment.json` file to the interactive pod container.

```
kubectl cp reassignment.json <interactive_pod_name>:/tmp/reassignment.json
```

Replace `<interactive_pod_name>` with the name of the pod.

3. Start a shell process in the interactive pod container.

```
kubectl exec -n <namespace> -ti <interactive_pod_name> /bin/bash
```

Replace `<namespace>` with the Kubernetes namespace where the pod is running.

4. Run the partition reassignment using the `kafka-reassign-partitions.sh` script from the interactive pod container.

```
bin/kafka-reassign-partitions.sh --bootstrap-server  
<cluster_name>-kafka-bootstrap:9093 \  
--command-config /tmp/config.properties \  
--reassignment-json-file /tmp/reassignment.json \  
--execute
```

Replace `<cluster_name>` with the name of your Kafka cluster. For example, `my-cluster-kafka-bootstrap:9093`

If you are going to throttle replication, you can also pass the `--throttle` option with an inter-broker throttled rate in bytes per second. For example:

```
bin/kafka-reassign-partitions.sh --bootstrap-server  
<cluster_name>-kafka-bootstrap:9093 \  
--command-config /tmp/config.properties \  
--reassignment-json-file /tmp/reassignment.json \  
--throttle 5000000 \  
--execute
```

This command will print out two reassignment JSON objects. The first records the current assignment for the partitions being moved. You should save this to a local file (not a file in the pod) in case you need to revert the reassignment later on. The second JSON object is the target reassignment you have passed in your reassignment JSON file.

If you need to change the throttle during reassignment, you can use the same command with a different throttled rate. For example:

```
bin/kafka-reassign-partitions.sh --bootstrap-server
```

```
<cluster_name>-kafka-bootstrap:9093 \
--command-config /tmp/config.properties \
--reassignment-json-file /tmp/reassignment.json \
--throttle 10000000 \
--execute
```

- Verify that the reassignment has completed using the `kafka-reassign-partitions.sh` command line tool from any of the broker pods. This is the same command as the previous step, but with the `--verify` option instead of the `--execute` option.

```
bin/kafka-reassign-partitions.sh --bootstrap-server
<cluster_name>-kafka-bootstrap:9093 \
--command-config /tmp/config.properties \
--reassignment-json-file /tmp/reassignment.json \
--verify
```

The reassignment has finished when the `--verify` command reports that each of the partitions being moved has completed successfully. This final `--verify` will also have the effect of removing any reassignment throttles.

- You can now delete the revert file if you saved the JSON for reverting the assignment to their original brokers.
- When all the partition reassessments have finished, the brokers being removed should not have responsibility for any of the partitions in the cluster. You can verify this by checking that the broker's data log directory does not contain any live partition logs. If the log directory on the broker contains a directory that does not match the extended regular expression `[a-zA-Z0-9.-]+.[a-zA-Z0-9]+-delete$`, the broker still has live partitions and should not be stopped.

You can check this by executing the command:

```
kubectl exec my-cluster-kafka-0 -c kafka -it -- \
/bin/bash -c \
"ls -l /var/lib/kafka/kafka-log_<n>_ | grep -E '^d' | grep -vE '[a-zA-Z0-9.-]+.[a-zA-Z0-9]+-delete$'"
```

where  $n$  is the number of the pods being deleted.

If the above command prints any output then the broker still has live partitions. In this case, either the reassignment has not finished or the reassignment JSON file was incorrect.

- When you have confirmed that the broker has no live partitions, you can edit the `Kafka.spec.kafka.replicas` property of your `Kafka` resource to reduce the number of brokers.

## 2.1.5. Retrieving JMX metrics with JmxTrans

`JmxTrans` is a tool for retrieving JMX metrics data from Java processes and pushing that data, in various formats, to remote sinks inside or outside the cluster. `JmxTrans` can communicate with a

secure JMX port.

Strimzi supports using JmxTrans to read JMX metrics from Kafka brokers.

JmxTrans reads JMX metrics data from secure or insecure Kafka brokers and pushes the data to remote sinks in various data formats. For example, JmxTrans can obtain JMX metrics about the request rate of each Kafka broker's network and then push the data to a Logstash database outside the Kubernetes cluster.

For more information about JmxTrans, see the [JmxTrans GitHub](#).

## Configuring a JmxTrans deployment

### Prerequisites

- A running Kubernetes cluster

You can configure a JmxTrans deployment by using the `Kafka.spec.jmxTrans` property. A JmxTrans deployment can read from a secure or insecure Kafka broker. To configure a JmxTrans deployment, define the following properties:

- `Kafka.spec.jmxTrans.outputDefinitions`
- `Kafka.spec.jmxTrans.kafkaQueries`

For more information on these properties, see the [JmxTransSpec schema reference](#).

**NOTE** To use JMXTrans, `jmxOptions` must be configured on the Kafka broker.

### Configuring JmxTrans output definitions

Output definitions specify where JMX metrics are pushed to, and in which data format. For information about supported data formats, see [Data formats](#). How many seconds JmxTrans agent waits for before pushing new data can be configured through the `flushDelay` property. The `host` and `port` properties define the target host address and target port the data is pushed to. The `name` property is a required property that is referenced by the `Kafka.spec.jmxTrans.kafkaQueries` property.

Here is an example configuration pushing JMX data in the Graphite format every 5 seconds to a Logstash database on `http://myLogstash:9999`, and another pushing to `standardOut` (standard output):

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  jmxTrans:
    outputDefinitions:
      - outputType: "com.googlecode.jmxtrans.model.output.GraphiteWriter"
        host: "http://myLogstash"
```

```

    port: 9999
    flushDelay: 5
    name: "logstash"
    - outputType: "com.googlecode.jmxtrans.model.output.StdOutWriter"
      name: "standardOut"
      # ...
    # ...
zookeeper:
  # ...

```

### Configuring JmxTrans queries

JmxTrans queries specify what JMX metrics are read from the Kafka brokers. Currently JmxTrans queries can only be sent to the Kafka Brokers. Configure the `targetMBean` property to specify which target MBean on the Kafka broker is addressed. Configuring the `attributes` property specifies which MBean attribute is read as JMX metrics from the target MBean. JmxTrans supports wildcards to read from target MBeans, and filter by specifying the `typeNames`. The `outputs` property defines where the metrics are pushed to by specifying the name of the output definitions.

The following JmxTrans deployment reads from all MBeans that match the pattern `kafka.server:type=BrokerTopicMetrics,name=*` and have `name` in the target MBean's name. From those Mbeans, it obtains JMX metrics about the `Count` attribute and pushes the metrics to standard output as defined by `outputs`.

```

apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  jmxTrans:
    kafkaQueries:
      - targetMBean: "kafka.server:type=BrokerTopicMetrics,*"
        typeNames: ["name"]
        attributes: ["Count"]
        outputs: ["standardOut"]
  zookeeper:
    # ...

```

## 2.1.6. Maintenance time windows for rolling updates

Maintenance time windows allow you to schedule certain rolling updates of your Kafka and ZooKeeper clusters to start at a convenient time.

### Maintenance time windows overview

In most cases, the Cluster Operator only updates your Kafka or ZooKeeper clusters in response to changes to the corresponding `Kafka` resource. This enables you to plan when to apply changes to a

[Kafka](#) resource to minimize the impact on Kafka client applications.

However, some updates to your Kafka and ZooKeeper clusters can happen without any corresponding change to the [Kafka](#) resource. For example, the Cluster Operator will need to perform a rolling restart if a CA (Certificate Authority) certificate that it manages is close to expiry.

While a rolling restart of the pods should not affect *availability* of the service (assuming correct broker and topic configurations), it could affect *performance* of the Kafka client applications. Maintenance time windows allow you to schedule such spontaneous rolling updates of your Kafka and ZooKeeper clusters to start at a convenient time. If maintenance time windows are not configured for a cluster then it is possible that such spontaneous rolling updates will happen at an inconvenient time, such as during a predictable period of high load.

## Maintenance time window definition

You configure maintenance time windows by entering an array of strings in the [Kafka.spec.maintenanceTimeWindows](#) property. Each string is a [cron expression](#) interpreted as being in UTC (Coordinated Universal Time, which for practical purposes is the same as Greenwich Mean Time).

The following example configures a single maintenance time window that starts at midnight and ends at 01:59am (UTC), on Sundays, Mondays, Tuesdays, Wednesdays, and Thursdays:

```
# ...
maintenanceTimeWindows:
- "* * 0-1 ? * SUN,MON,TUE,WED,THU *"
# ...
```

In practice, maintenance windows should be set in conjunction with the [Kafka.spec.clusterCa.renewalDays](#) and [Kafka.spec.clientsCa.renewalDays](#) properties of the [Kafka](#) resource, to ensure that the necessary CA certificate renewal can be completed in the configured maintenance time windows.

**NOTE**

Strimzi does not schedule maintenance operations exactly according to the given windows. Instead, for each reconciliation, it checks whether a maintenance window is currently "open". This means that the start of maintenance operations within a given time window can be delayed by up to the Cluster Operator reconciliation interval. Maintenance time windows must therefore be at least this long.

### Additional resources

- For more information about the Cluster Operator configuration, see [Configuring the Cluster Operator with environment variables](#).

## Configuring a maintenance time window

You can configure a maintenance time window for rolling updates triggered by supported processes.

### *Prerequisites*

- A Kubernetes cluster.
- The Cluster Operator is running.

### *Procedure*

1. Add or edit the `maintenanceTimeWindows` property in the `Kafka` resource. For example to allow maintenance between 0800 and 1059 and between 1400 and 1559 you would set the `maintenanceTimeWindows` as shown below:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  maintenanceTimeWindows:
    - "* * 8-10 * * ?"
    - "* * 14-15 * * ?"
```

2. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

### *Additional resources*

Performing rolling updates:

- [Performing a rolling update using a pod management annotation](#)
- [Performing a rolling update using a Pod annotation](#)

## **2.1.7. Connecting to ZooKeeper from a terminal**

Most Kafka CLI tools can connect directly to Kafka, so under normal circumstances you should not need to connect to ZooKeeper. ZooKeeper services are secured with encryption and authentication and are not intended to be used by external applications that are not part of Strimzi.

However, if you want to use Kafka CLI tools that require a connection to ZooKeeper, you can use a terminal inside a ZooKeeper container and connect to `localhost:12181` as the ZooKeeper address.

### *Prerequisites*

- A Kubernetes cluster is available.
- A Kafka cluster is running.
- The Cluster Operator is running.

#### Procedure

1. Open the terminal using the Kubernetes console or run the `exec` command from your CLI.

For example:

```
kubectl exec -ti my-cluster-zookeeper-0 -- bin/kafka-topics.sh --list --zookeeper localhost:12181
```

Be sure to use `localhost:12181`.

You can now run Kafka commands to ZooKeeper.

### 2.1.8. Deleting Kafka nodes manually

This procedure describes how to delete an existing Kafka node by using a Kubernetes annotation. Deleting a Kafka node consists of deleting both the `Pod` on which the Kafka broker is running and the related `PersistentVolumeClaim` (if the cluster was deployed with persistent storage). After deletion, the `Pod` and its related `PersistentVolumeClaim` are recreated automatically.

**WARNING**

Deleting a `PersistentVolumeClaim` can cause permanent data loss. The following procedure should only be performed if you have encountered storage issues.

#### Prerequisites

See the *Deploying and Upgrading Strimzi* guide for instructions on running a:

- [Cluster Operator](#)
- [Kafka cluster](#)

#### Procedure

1. Find the name of the `Pod` that you want to delete.

Kafka broker pods are named `<cluster-name>-kafka-<index>`, where `<index>` starts at zero and ends at the total number of replicas minus one. For example, `my-cluster-kafka-0`.

2. Annotate the `Pod` resource in Kubernetes.

Use `kubectl annotate`:

```
kubectl annotate pod cluster-name-kafka-index strimzi.io/delete-pod-and-pvc=true
```

3. Wait for the next reconciliation, when the annotated pod with the underlying persistent volume claim will be deleted and then recreated.

### 2.1.9. Deleting ZooKeeper nodes manually

This procedure describes how to delete an existing ZooKeeper node by using a Kubernetes annotation. Deleting a ZooKeeper node consists of deleting both the `Pod` on which ZooKeeper is

running and the related **PersistentVolumeClaim** (if the cluster was deployed with persistent storage). After deletion, the **Pod** and its related **PersistentVolumeClaim** are recreated automatically.

**WARNING**

Deleting a **PersistentVolumeClaim** can cause permanent data loss. The following procedure should only be performed if you have encountered storage issues.

*Prerequisites*

See the *Deploying and Upgrading Strimzi* guide for instructions on running a:

- [Cluster Operator](#)
- [Kafka cluster](#)

*Procedure*

1. Find the name of the **Pod** that you want to delete.

ZooKeeper pods are named `<cluster-name>-zookeeper-<index>`, where `<index>` starts at zero and ends at the total number of replicas minus one. For example, `my-cluster-zookeeper-0`.

2. Annotate the **Pod** resource in Kubernetes.

Use `kubectl annotate`:

```
kubectl annotate pod cluster-name-zookeeper-index strimzi.io/delete-pod-and-
pvc=true
```

3. Wait for the next reconciliation, when the annotated pod with the underlying persistent volume claim will be deleted and then recreated.

## 2.1.10. List of Kafka cluster resources

The following resources are created by the Cluster Operator in the Kubernetes cluster:

*Shared resources*

**cluster-name-cluster-ca**

Secret with the Cluster CA private key used to encrypt the cluster communication.

**cluster-name-cluster-ca-cert**

Secret with the Cluster CA public key. This key can be used to verify the identity of the Kafka brokers.

**cluster-name-clients-ca**

Secret with the Clients CA private key used to sign user certificates

**cluster-name-clients-ca-cert**

Secret with the Clients CA public key. This key can be used to verify the identity of the Kafka users.

## **cluster-name-cluster-operator-certs**

Secret with Cluster operators keys for communication with Kafka and ZooKeeper.

### *ZooKeeper nodes*

#### **cluster-name-zookeeper**

Name given to the following ZooKeeper resources:

- StatefulSet or StrimziPodSet (if the [UseStrimziPodSets](#) feature gate is enabled) for managing the ZooKeeper node pods.
- Service account used by the ZooKeeper nodes.
- PodDisruptionBudget configured for the ZooKeeper nodes.

#### **cluster-name-zookeeper-idx**

Pods created by the ZooKeeper StatefulSet or StrimziPodSet.

#### **cluster-name-zookeeper-nodes**

Headless Service needed to have DNS resolve the ZooKeeper pods IP addresses directly.

#### **cluster-name-zookeeper-client**

Service used by Kafka brokers to connect to ZooKeeper nodes as clients.

#### **cluster-name-zookeeper-config**

ConfigMap that contains the ZooKeeper ancillary configuration, and is mounted as a volume by the ZooKeeper node pods.

#### **cluster-name-zookeeper-nodes**

Secret with ZooKeeper node keys.

#### **cluster-name-network-policy-zookeeper**

Network policy managing access to the ZooKeeper services.

#### **data-cluster-name-zookeeper-idx**

Persistent Volume Claim for the volume used for storing data for the ZooKeeper node pod `idx`. This resource will be created only if persistent storage is selected for provisioning persistent volumes to store data.

### *Kafka brokers*

#### **cluster-name-kafka**

Name given to the following Kafka resources:

- StatefulSet or StrimziPodSet (if the [UseStrimziPodSets](#) feature gate is enabled) for managing the Kafka broker pods.
- Service account used by the Kafka pods.
- PodDisruptionBudget configured for the Kafka brokers.

#### **cluster-name-kafka-idx**

Name given to the following Kafka resources:

- Pods created by the Kafka StatefulSet or StrimziPodSet.
- ConfigMap with Kafka broker configuration (if the `UseStrimziPodSets` feature gate is enabled).

### **cluster-name-kafka-brokers**

Service needed to have DNS resolve the Kafka broker pods IP addresses directly.

### **cluster-name-kafka-bootstrap**

Service can be used as bootstrap servers for Kafka clients connecting from within the Kubernetes cluster.

### **cluster-name-kafka-external-bootstrap**

Bootstrap service for clients connecting from outside the Kubernetes cluster. This resource is created only when an external listener is enabled. The old service name will be used for backwards compatibility when the listener name is `external` and port is `9094`.

### **cluster-name-kafka-pod-id**

Service used to route traffic from outside the Kubernetes cluster to individual pods. This resource is created only when an external listener is enabled. The old service name will be used for backwards compatibility when the listener name is `external` and port is `9094`.

### **cluster-name-kafka-external-bootstrap**

Bootstrap route for clients connecting from outside the Kubernetes cluster. This resource is created only when an external listener is enabled and set to type `route`. The old route name will be used for backwards compatibility when the listener name is `external` and port is `9094`.

### **cluster-name-kafka-pod-id**

Route for traffic from outside the Kubernetes cluster to individual pods. This resource is created only when an external listener is enabled and set to type `route`. The old route name will be used for backwards compatibility when the listener name is `external` and port is `9094`.

### **cluster-name-kafka-listener-name-bootstrap**

Bootstrap service for clients connecting from outside the Kubernetes cluster. This resource is created only when an external listener is enabled. The new service name will be used for all other external listeners.

### **cluster-name-kafka-listener-name-pod-id**

Service used to route traffic from outside the Kubernetes cluster to individual pods. This resource is created only when an external listener is enabled. The new service name will be used for all other external listeners.

### **cluster-name-kafka-listener-name-bootstrap**

Bootstrap route for clients connecting from outside the Kubernetes cluster. This resource is created only when an external listener is enabled and set to type `route`. The new route name will be used for all other external listeners.

### **cluster-name-kafka-listener-name-pod-id**

Route for traffic from outside the Kubernetes cluster to individual pods. This resource is created

only when an external listener is enabled and set to type `route`. The new route name will be used for all other external listeners.

#### **cluster-name-kafka-config**

ConfigMap which contains the Kafka ancillary configuration and is mounted as a volume by the Kafka broker pods.

#### **cluster-name-kafka-brokers**

Secret with Kafka broker keys.

#### **cluster-name-network-policy-kafka**

Network policy managing access to the Kafka services.

#### **strimzi-namespace-name-cluster-name-kafka-init**

Cluster role binding used by the Kafka brokers.

#### **cluster-name-jmx**

Secret with JMX username and password used to secure the Kafka broker port. This resource is created only when JMX is enabled in Kafka.

#### **data-cluster-name-kafka-idx**

Persistent Volume Claim for the volume used for storing data for the Kafka broker pod `idx`. This resource is created only if persistent storage is selected for provisioning persistent volumes to store data.

#### **data-id-cluster-name-kafka-idx**

Persistent Volume Claim for the volume `id` used for storing data for the Kafka broker pod `idx`. This resource is created only if persistent storage is selected for JBOD volumes when provisioning persistent volumes to store data.

#### *Entity Operator*

These resources are only created if the Entity Operator is deployed using the Cluster Operator.

#### **cluster-name-entity-operator**

Name given to the following Entity Operator resources:

- Deployment with Topic and User Operators.
- Service account used by the Entity Operator.

#### **cluster-name-entity-operator-random-string**

Pod created by the Entity Operator deployment.

#### **cluster-name-entity-topic-operator-config**

ConfigMap with ancillary configuration for Topic Operators.

#### **cluster-name-entity-user-operator-config**

ConfigMap with ancillary configuration for User Operators.

### **cluster-name-entity-topic-operator-certs**

Secret with Topic Operator keys for communication with Kafka and ZooKeeper.

### **cluster-name-entity-user-operator-certs**

Secret with User Operator keys for communication with Kafka and ZooKeeper.

### **strimzi-cluster-name-entity-topic-operator**

Role binding used by the Entity Topic Operator.

### **strimzi-cluster-name-entity-user-operator**

Role binding used by the Entity User Operator.

#### *Kafka Exporter*

These resources are only created if the Kafka Exporter is deployed using the Cluster Operator.

### **cluster-name-kafka-exporter**

Name given to the following Kafka Exporter resources:

- Deployment with Kafka Exporter.
- Service used to collect consumer lag metrics.
- Service account used by the Kafka Exporter.

### **cluster-name-kafka-exporter-random-string**

Pod created by the Kafka Exporter deployment.

#### *Cruise Control*

These resources are only created if Cruise Control was deployed using the Cluster Operator.

### **cluster-name-cruise-control**

Name given to the following Cruise Control resources:

- Deployment with Cruise Control.
- Service used to communicate with Cruise Control.
- Service account used by the Cruise Control.

### **cluster-name-cruise-control-random-string**

Pod created by the Cruise Control deployment.

### **cluster-name-cruise-control-config**

ConfigMap that contains the Cruise Control ancillary configuration, and is mounted as a volume by the Cruise Control pods.

### **cluster-name-cruise-control-certs**

Secret with Cruise Control keys for communication with Kafka and ZooKeeper.

### **cluster-name-network-policy-cruise-control**

Network policy managing access to the Cruise Control service.

## *JMXTrans*

These resources are only created if JMXTrans is deployed using the Cluster Operator.

### **cluster-name-jmxtrans**

Name given to the following JMXTrans resources:

- Deployment with JMXTrans.
- Service account used by the JMXTrans.

### **cluster-name-jmxtrans-random-string**

Pod created by the JMXTrans deployment.

### **cluster-name-jmxtrans-config**

ConfigMap that contains the JMXTrans ancillary configuration, and is mounted as a volume by the JMXTrans pods.

## 2.2. Kafka Connect cluster configuration

Configure a Kafka Connect deployment using the [KafkaConnect](#) resource. Kafka Connect is an integration toolkit for streaming data between Kafka brokers and other systems using connector plugins. Kafka Connect provides a framework for integrating Kafka with an external data source or target, such as a database, for import or export of data using connectors. Connectors are plugins that provide the connection configuration needed.

[KafkaConnect schema reference](#) describes the full schema of the [KafkaConnect](#) resource.

For more information on deploying connector plugins, see [Extending Kafka Connect with connector plugins](#).

### 2.2.1. Configuring Kafka Connect

Use Kafka Connect to set up external data connections to your Kafka cluster. Use the properties of the [KafkaConnect](#) resource to configure your Kafka Connect deployment.

#### *KafkaConnector configuration*

[KafkaConnector](#) resources allow you to create and manage connector instances for Kafka Connect in a Kubernetes-native way.

In your Kafka Connect configuration, you enable KafkaConnectors for a Kafka Connect cluster by adding the `strimzi.io/use-connector-resources` annotation. You can also add a `build` configuration so that Strimzi automatically builds a container image with the connector plugins you require for your data connections. External configuration for Kafka Connect connectors is specified through the `externalConfiguration` property.

To manage connectors, you can use the Kafka Connect REST API, or use [KafkaConnector](#) custom resources. [KafkaConnector](#) resources must be deployed to the same namespace as the Kafka Connect cluster they link to. For more information on using these methods to create, reconfigure, or delete connectors, see [Creating and managing connectors](#).

Connector configuration is passed to Kafka Connect as part of an HTTP request and stored within Kafka itself. ConfigMaps and Secrets are standard Kubernetes resources used for storing configurations and confidential data. You can use ConfigMaps and Secrets to configure certain elements of a connector. You can then reference the configuration values in HTTP REST commands, which keeps the configuration separate and more secure, if needed. This method applies especially to confidential data, such as usernames, passwords, or certificates.

#### *Handling high volumes of messages*

You can tune the configuration to handle high volumes of messages. For more information, see [Handling high volumes of messages](#).

#### *Prerequisites*

- A Kubernetes cluster
- A running Cluster Operator

See the [Deploying and Upgrading Strimzi](#) guide for instructions on running a:

- [Cluster Operator](#)
- [Kafka cluster](#)

#### *Procedure*

1. Edit the `spec` properties of the `KafkaConnect` resource.

The properties you can configure are shown in this example configuration:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect ①
metadata:
  name: my-connect-cluster
  annotations:
    strimzi.io/use-connector-resources: "true" ②
spec:
  replicas: 3 ③
  authentication: ④
    type: tls
    certificateAndKey:
      certificate: source.crt
      key: source.key
      secretName: my-user-source
  bootstrapServers: my-cluster-kafka-bootstrap:9092 ⑤
  tls: ⑥
    trustedCertificates:
      - secretName: my-cluster-cluster-cert
        certificate: ca.crt
      - secretName: my-cluster-cluster-cert
        certificate: ca2.crt
  config: ⑦
    group.id: my-connect-cluster
    offset.storage.topic: my-connect-cluster-offsets
```

```

config.storage.topic: my-connect-cluster-configs
status.storage.topic: my-connect-cluster-status
key.converter: org.apache.kafka.connect.json.JsonConverter
value.converter: org.apache.kafka.connect.json.JsonConverter
key.converter.schemas.enable: true
value.converter.schemas.enable: true
config.storage.replication.factor: 3
offset.storage.replication.factor: 3
status.storage.replication.factor: 3
build: ⑧
  output: ⑨
    type: docker
    image: my-registry.io/my-org/my-connect-cluster:latest
    pushSecret: my-registry-credentials
plugins: ⑩
  - name: debezium-postgres-connector
    artifacts:
      - type: tgz
        url: https://repo1.maven.org/maven2/io/debezium/debezium-connector-
postgres/1.3.1.Final/debezium-connector-postgres-1.3.1.Final-plugin.tar.gz
        sha512sum:
962a12151bdf9a5a30627eebac739955a4fd95a08d373b86bdcea2b4d0c27dd6e1edd5cb548045e115e
33a9e69b1b2a352bee24df035a0447cb820077af00c03
      - name: camel-telegram
        artifacts:
          - type: tgz
            url:
https://repo.maven.apache.org/maven2/org/apache/camel/kafkaconnector/camel-
telegram-kafka-connector/0.7.0/camel-telegram-kafka-connector-0.7.0-package.tar.gz
            sha512sum:
a9b1ac63e3284bea7836d7d24d84208c49cdf5600070e6bd1535de654f6920b74ad950d51733e8020bf
4187870699819f54ef5859c7846ee4081507f48873479
  externalConfiguration: ⑪
  env:
    - name: AWS_ACCESS_KEY_ID
      valueFrom:
        secretKeyRef:
          name: aws-creds
          key: awsAccessKey
    - name: AWS_SECRET_ACCESS_KEY
      valueFrom:
        secretKeyRef:
          name: aws-creds
          key: awsSecretAccessKey
  resources: ⑫
    requests:
      cpu: "1"
      memory: 2Gi
    limits:
      cpu: "2"
      memory: 2Gi

```

```

logging: ⑯
  type: inline
  loggers:
    log4j.rootLogger: "INFO"
readinessProbe: ⑰
  initialDelaySeconds: 15
  timeoutSeconds: 5
livenessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
metricsConfig: ⑱
  type: jmxPrometheusExporter
  valueFrom:
    configMapKeyRef:
      name: my-config-map
      key: my-key
jvmOptions: ⑲
  "-Xmx": "1g"
  "-Xms": "1g"
image: my-org/my-image:latest ⑳
rack:
  topologyKey: topology.kubernetes.io/zone ㉑
template: ㉒
pod:
  affinity:
    podAntiAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
              - key: application
                operator: In
                values:
                  - postgresql
                  - mongodb
            topologyKey: "kubernetes.io/hostname"
connectContainer: ㉓
env:
  - name: JAAGER_SERVICE_NAME
    value: my-jaeger-service
  - name: JAAGER_AGENT_HOST
    value: jaeger-agent-name
  - name: JAAGER_AGENT_PORT
    value: "6831"

```

① Use [KafkaConnect](#).

② Enables KafkaConnectors for the Kafka Connect cluster.

③ The number of replica nodes for the workers that run tasks.

④ Authentication for the Kafka Connect cluster, using the [TLS](#) mechanism, as shown here, using [OAuth bearer tokens](#), or a SASL-based [SCRAM-SHA-256/SCRAM-SHA-512](#) or [PLAIN](#)

mechanism. By default, Kafka Connect connects to Kafka brokers using a plain text connection.

- ⑤ **Bootstrap server** for connection to the Kafka Connect cluster.
- ⑥ **TLS encryption** with key names under which TLS certificates are stored in X.509 format for the cluster. If certificates are stored in the same secret, it can be listed multiple times.
- ⑦ **Kafka Connect configuration** of workers (not connectors). Standard Apache Kafka configuration may be provided, restricted to those properties not managed directly by Strimzi.
- ⑧ **Build configuration properties** for building a container image with connector plugins automatically.
- ⑨ (Required) Configuration of the container registry where new images are pushed.
- ⑩ (Required) List of connector plugins and their artifacts to add to the new container image. Each plugin must be configured with at least one **artifact**.
- ⑪ **External configuration for Kafka connectors** using environment variables, as shown here, or volumes. You can also use *configuration provider plugins* to **load configuration values from external sources**.
- ⑫ Requests for reservation of **supported resources**, currently **cpu** and **memory**, and limits to specify the maximum resources that can be consumed.
- ⑬ Specified **Kafka Connect loggers and log levels** added directly (**inline**) or indirectly (**external**) through a ConfigMap. A custom ConfigMap must be placed under the **log4j.properties** or **log4j2.properties** key. For the Kafka Connect **log4j.rootLogger** logger, you can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.
- ⑭ **Healthchecks** to know when to restart a container (liveness) and when a container can accept traffic (readiness).
- ⑮ **Prometheus metrics**, which are enabled by referencing a ConfigMap containing configuration for the Prometheus JMX exporter in this example. You can enable metrics without further configuration using a reference to a ConfigMap containing an empty file under **metricsConfig.valueFrom.configMapKeyRef.key**.
- ⑯ **JVM configuration options** to optimize performance for the Virtual Machine (VM) running Kafka Connect.
- ⑰ ADVANCED OPTION: **Container image configuration**, which is recommended only in special situations.
- ⑱ SPECIALIZED OPTION: **Rack awareness** configuration for the deployment. This is a specialized option intended for a deployment within the same location, not across regions. Use this option if you want connectors to consume from the closest replica rather than the leader replica. In certain cases, consuming from the closest replica can improve network utilization or reduce costs . The **topologyKey** must match a node label containing the rack ID. The example used in this configuration specifies a zone using the standard **topology.kubernetes.io/zone** label. To consume from the closest replica, enable the **RackAwareReplicaSelector** in the Kafka broker configuration.
- ⑲ **Template customization**. Here a pod is scheduled with anti-affinity, so the pod is not scheduled on nodes with the same hostname.

㉚ Environment variables are set for distributed tracing.

## 2. Create or update the resource:

```
kubectl apply -f KAFKA-CONNECT-CONFIG-FILE
```

## 3. If authorization is enabled for Kafka Connect, [configure Kafka Connect users to enable access to the Kafka Connect consumer group and topics](#).

### *Additional resources*

- [Introducing distributed tracing](#)

### 2.2.2. Kafka Connect configuration for multiple instances

If you are running multiple instances of Kafka Connect, you have to change the default configuration of the following **config** properties:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  config:
    group.id: connect-cluster ①
    offset.storage.topic: connect-cluster-offsets ②
    config.storage.topic: connect-cluster-configs ③
    status.storage.topic: connect-cluster-status ④
    # ...
# ...
```

① The Kafka Connect cluster ID within Kafka.

② Kafka topic that stores connector offsets.

③ Kafka topic that stores connector and task status configurations.

④ Kafka topic that stores connector and task status updates.

#### NOTE

Values for the three topics must be the same for all Kafka Connect instances with the same **group.id**.

Unless you change the default settings, each Kafka Connect instance connecting to the same Kafka cluster is deployed with the same values. What happens, in effect, is all instances are coupled to run in a cluster and use the same topics.

If multiple Kafka Connect clusters try to use the same topics, Kafka Connect will not work as expected and generate errors.

If you wish to run multiple Kafka Connect instances, change the values of these properties for each

instance.

### 2.2.3. Configuring Kafka Connect user authorization

This procedure describes how to authorize user access to Kafka Connect.

When any type of authorization is being used in Kafka, a Kafka Connect user requires read/write access rights to the consumer group and the internal topics of Kafka Connect.

The properties for the consumer group and internal topics are automatically configured by Strimzi, or they can be specified explicitly in the `spec` of the [KafkaConnect](#) resource.

*Example configuration properties in the [KafkaConnect](#) resource*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  config:
    group.id: my-connect-cluster ①
    offset.storage.topic: my-connect-cluster-offsets ②
    config.storage.topic: my-connect-cluster-configs ③
    status.storage.topic: my-connect-cluster-status ④
    # ...
# ...
```

① The Kafka Connect cluster ID within Kafka.

② Kafka topic that stores connector offsets.

③ Kafka topic that stores connector and task status configurations.

④ Kafka topic that stores connector and task status updates.

This procedure shows how access is provided when `simple` authorization is being used.

Simple authorization uses ACL rules, handled by the Kafka [AclAuthorizer](#) plugin, to provide the right level of access. For more information on configuring a [KafkaUser](#) resource to use simple authorization, see the [AclRule schema reference](#).

**NOTE**

The default values for the consumer group and topics will differ when [running multiple instances](#).

#### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

#### Procedure

1. Edit the `authorization` property in the [KafkaUser](#) resource to provide access rights to the user.

In the following example, access rights are configured for the Kafka Connect topics and consumer group using `literal` name values:

Property	Name
<code>offset.storage.topic</code>	<code>connect-cluster-offsets</code>
<code>status.storage.topic</code>	<code>connect-cluster-status</code>
<code>config.storage.topic</code>	<code>connect-cluster-configs</code>
<code>group</code>	<code>connect-cluster</code>

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  # ...
  authorization:
    type: simple
    acls:
      # access to offset.storage.topic
      - resource:
          type: topic
          name: connect-cluster-offsets
          patternType: literal
          operations:
            - Create
            - Describe
            - Read
            - Write
          host: "*"
      # access to status.storage.topic
      - resource:
          type: topic
          name: connect-cluster-status
          patternType: literal
          operations:
            - Create
            - Describe
            - Read
            - Write
          host: "*"
      # access to config.storage.topic
      - resource:
          type: topic
          name: connect-cluster-configs
          patternType: literal
          operations:
            - Create
```

```

    - Describe
    - Read
    - Write
  host: "*"
# consumer group
- resource:
  type: group
  name: connect-cluster
  patternType: literal
  operations:
  - Read
  host: "*"

```

2. Create or update the resource.

```
kubectl apply -f KAFKA-USER-CONFIG-FILE
```

## 2.2.4. List of Kafka Connect cluster resources

The following resources are created by the Cluster Operator in the Kubernetes cluster:

### ***connect-cluster-name-connect***

Deployment which is in charge to create the Kafka Connect worker node pods.

### ***connect-cluster-name-connect-api***

Service which exposes the REST interface for managing the Kafka Connect cluster.

### ***connect-cluster-name-config***

ConfigMap which contains the Kafka Connect ancillary configuration and is mounted as a volume by the Kafka broker pods.

### ***connect-cluster-name-connect***

Pod Disruption Budget configured for the Kafka Connect worker nodes.

## 2.3. Kafka MirrorMaker 2.0 cluster configuration

Configure a Kafka MirrorMaker 2.0 deployment using the [KafkaMirrorMaker2](#) resource. MirrorMaker 2.0 replicates data between two or more Kafka clusters, within or across data centers.

[KafkaMirrorMaker2 schema reference](#) describes the full schema of the [KafkaMirrorMaker2](#) resource.

MirrorMaker 2.0 resource configuration differs from the previous version of MirrorMaker. If you choose to use MirrorMaker 2.0, there is currently no legacy support, so any resources must be manually converted into the new format.

### 2.3.1. MirrorMaker 2.0 data replication

Data replication across clusters supports scenarios that require:

- Recovery of data in the event of a system failure
- Aggregation of data for analysis
- Restriction of data access to a specific cluster
- Provision of data at a specific location to improve latency

#### MirrorMaker 2.0 configuration

MirrorMaker 2.0 consumes messages from a source Kafka cluster and writes them to a target Kafka cluster.

MirrorMaker 2.0 uses:

- Source cluster configuration to consume data from the source cluster
- Target cluster configuration to output data to the target cluster

MirrorMaker 2.0 is based on the Kafka Connect framework, *connectors* managing the transfer of data between clusters.

You configure MirrorMaker 2.0 to define the Kafka Connect deployment, including the connection details of the source and target clusters, and then run a set of MirrorMaker 2.0 connectors to make the connection.

MirrorMaker 2.0 consists of the following connectors:

##### **MirrorSourceConnector**

The source connector replicates topics from a source cluster to a target cluster. It also replicates ACLs and is necessary for the **MirrorCheckpointConnector** to run.

##### **MirrorCheckpointConnector**

The checkpoint connector periodically tracks offsets. If enabled, it also synchronizes consumer group offsets between the source and target cluster.

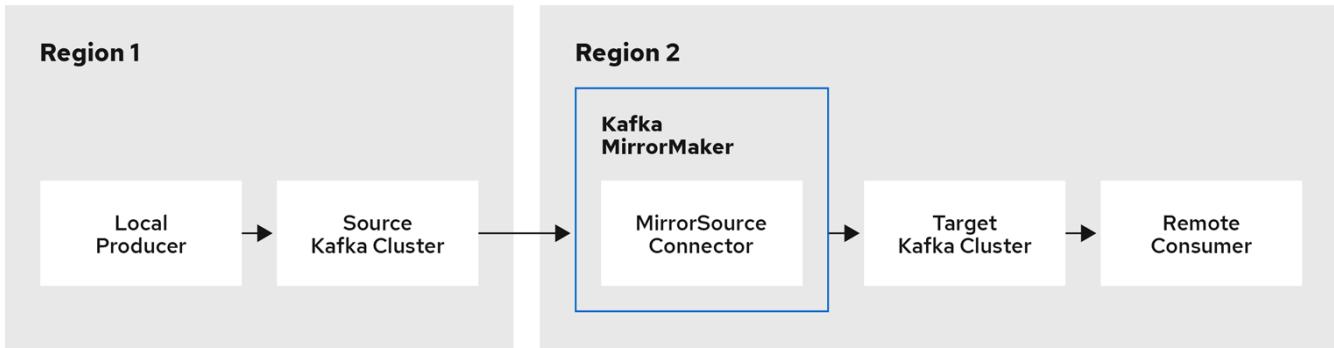
##### **MirrorHeartbeatConnector**

The heartbeat connector periodically checks connectivity between the source and target cluster.

##### **NOTE**

If you are using the User Operator to manage ACLs, ACL replication through the connector is not possible.

The process of *mirroring* data from a source cluster to a target cluster is asynchronous. Each MirrorMaker 2.0 instance mirrors data from one source cluster to one target cluster. You can use more than one MirrorMaker 2.0 instance to mirror data between any number of clusters.



222\_Streams\_0322

*Figure 1. Replication across two clusters*

By default, a check for new topics in the source cluster is made every 10 minutes. You can change the frequency by adding `refresh.topics.interval.seconds` to the source connector configuration.

### Cluster configuration

You can use MirrorMaker 2.0 in *active/passive* or *active/active* cluster configurations.

#### active/active cluster configuration

An active/active configuration has two active clusters replicating data bidirectionally. Applications can use either cluster. Each cluster can provide the same data. In this way, you can make the same data available in different geographical locations. As consumer groups are active in both clusters, consumer offsets for replicated topics are not synchronized back to the source cluster.

#### active/passive cluster configuration

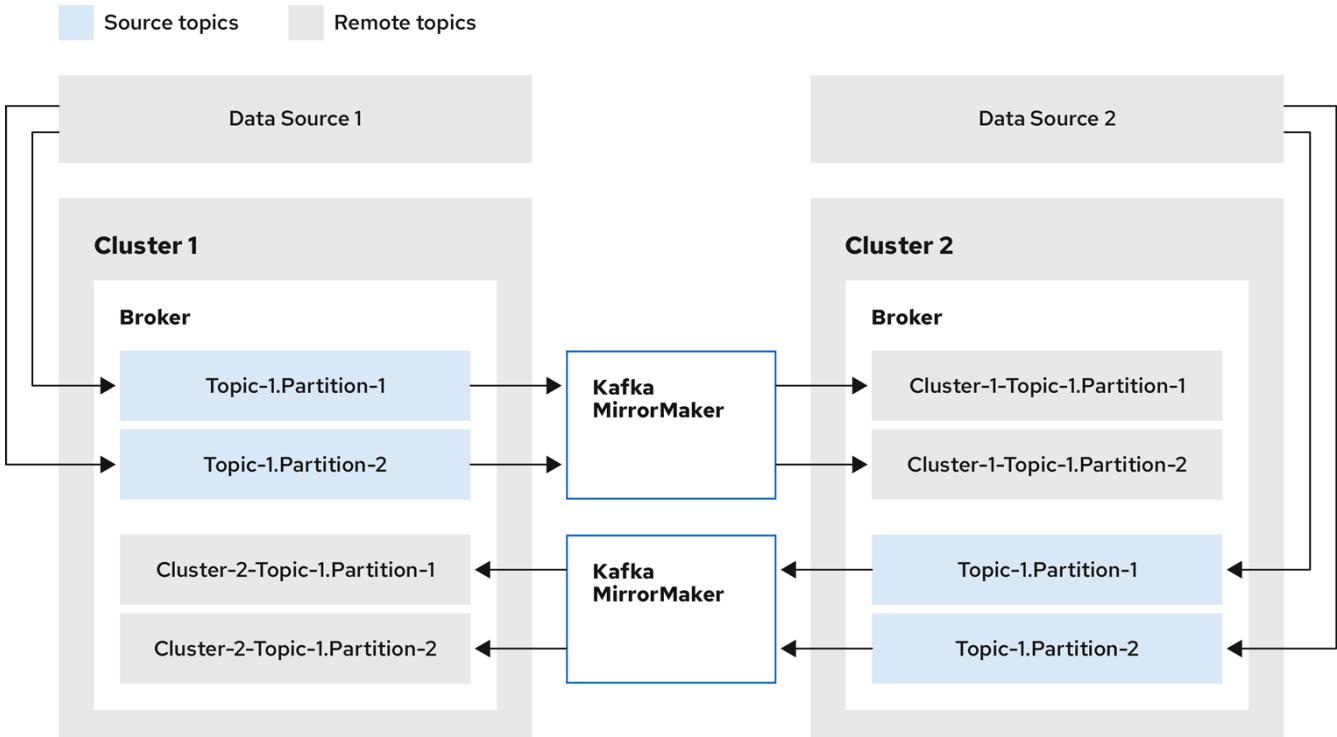
An active/passive configuration has an active cluster replicating data to a passive cluster. The passive cluster remains on standby. You might use the passive cluster for data recovery in the event of system failure.

The expectation is that producers and consumers connect to active clusters only. A MirrorMaker 2.0 cluster is required at each target destination.

#### Bidirectional replication (active/active)

The MirrorMaker 2.0 architecture supports bidirectional replication in an *active/active* cluster configuration.

Each cluster replicates the data of the other cluster using the concept of *source* and *remote* topics. As the same topics are stored in each cluster, remote topics are automatically renamed by MirrorMaker 2.0 to represent the source cluster. The name of the originating cluster is prepended to the name of the topic.



222\_Streams\_0322

Figure 2. Topic renaming

By flagging the originating cluster, topics are not replicated back to that cluster.

The concept of replication through *remote* topics is useful when configuring an architecture that requires data aggregation. Consumers can subscribe to source and remote topics within the same cluster, without the need for a separate aggregation cluster.

#### Unidirectional replication (active/passive)

The MirrorMaker 2.0 architecture supports unidirectional replication in an *active/passive* cluster configuration.

You can use an *active/passive* cluster configuration to make backups or migrate data to another cluster. In this situation, you might not want automatic renaming of remote topics.

You can override automatic renaming by adding `IdentityReplicationPolicy` to the source connector configuration. With this configuration applied, topics retain their original names.

#### Topic configuration synchronization

MirrorMaker 2.0 supports topic configuration synchronization between source and target clusters. You specify source topics in the MirrorMaker 2.0 configuration. MirrorMaker 2.0 monitors the source topics. MirrorMaker 2.0 detects and propagates changes to the source topics to the remote topics. Changes might include automatically creating missing topics and partitions.

##### NOTE

In most cases you write to local topics and read from remote topics. Though write operations are not prevented on remote topics, they should be avoided.

## Offset tracking

MirrorMaker 2.0 tracks offsets for consumer groups using internal topics.

### offset-syncs topic

The `offset-syncs` topic maps the source and target offsets for replicated topic partitions from record metadata.

### checkpoints topic

The `checkpoints` topic maps the last committed offset in the source and target cluster for replicated topic partitions in each consumer group.

As they are used internally by MirrorMaker 2.0, you do not interact directly with these topics.

`MirrorCheckpointConnector` emits `checkpoints` for offset tracking. Offsets for the `checkpoints` topic are tracked at predetermined intervals through configuration. Both topics enable replication to be fully restored from the correct offset position on failover.

The location of the `offset-syncs` topic is the `source` cluster by default. You can use the `offset-syncs.topic.location` connector configuration to change this to the `target` cluster. You need read/write access to the cluster that contains the topic. Using the target cluster as the location of the `offset-syncs` topic allows you to use MirrorMaker 2.0 even if you have only read access to the source cluster.

## Synchronizing consumer group offsets

The `__consumer_offsets` topic stores information on committed offsets for each consumer group. Offset synchronization periodically transfers the consumer offsets for the consumer groups of a source cluster into the consumer offsets topic of a target cluster.

Offset synchronization is particularly useful in an *active/passive* configuration. If the active cluster goes down, consumer applications can switch to the passive (standby) cluster and pick up from the last transferred offset position.

To use topic offset synchronization, enable the synchronization by adding `sync.group.offsets.enabled` to the checkpoint connector configuration, and setting the property to `true`. Synchronization is disabled by default.

When using the `IdentityReplicationPolicy` in the source connector, it also has to be configured in the checkpoint connector configuration. This ensures that the mirrored consumer offsets will be applied for the correct topics.

Consumer offsets are only synchronized for consumer groups that are not active in the target cluster. If the consumer groups are in the target cluster, the synchronization cannot be performed and an `UNKNOWN_MEMBER_ID` error is returned.

If enabled, the synchronization of offsets from the source cluster is made periodically. You can change the frequency by adding `sync.group.offsets.interval.seconds` and `emit.checkpoints.interval.seconds` to the checkpoint connector configuration. The properties specify the frequency in seconds that the consumer group offsets are synchronized, and the

frequency of checkpoints emitted for offset tracking. The default for both properties is 60 seconds. You can also change the frequency of checks for new consumer groups using the `refresh.groups.interval.seconds` property, which is performed every 10 minutes by default.

Because the synchronization is time-based, any switchover by consumers to a passive cluster will likely result in some duplication of messages.

**NOTE** If you have an application written in Java, you can use the `RemoteClusterUtils.java` utility to synchronize offsets through the application. The utility fetches remote offsets for a consumer group from the `checkpoints` topic.

## Connectivity checks

`MirrorHeartbeatConnector` emits *heartbeats* to check connectivity between clusters.

An internal `heartbeat` topic is replicated from the source cluster. Target clusters use the `heartbeat` topic to check the following:

- The connector managing connectivity between clusters is running
- The source cluster is available

### 2.3.2. Connector configuration

Use Mirrormaker 2.0 connector configuration for the internal connectors that orchestrate the synchronization of data between Kafka clusters.

The following table describes connector properties and the connectors you configure to use them.

*Table 1. MirrorMaker 2.0 connector configuration properties*

Property	sourceConnector	checkpointConnector	heartbeatConnector
<b>admin.timeout.ms</b>  Timeout for admin tasks, such as detecting new topics. Default is <code>60000</code> (1 minute).	□	□	□
<b>replication.policy.class</b>  Policy to define the remote topic naming convention. Default is <code>org.apache.kafka.connect.mirror.DefaultReplicationPolicy</code> .	□	□	□
<b>replication.policy.separator</b>  The separator used for topic naming in the target cluster. Default is <code>.</code> (dot). It is only used when the <code>replication.policy.class</code> is the <code>DefaultReplicationPolicy</code> .	□	□	□

Property	sourceConnector	checkpointConnector	heartbeatConnector
<b>consumer.poll.timeout.ms</b>  Timeout when polling the source cluster. Default is <b>1000</b> (1 second).	□	□	
<b>offset-syncs.topic.location</b>  The location of the <b>offset-syncs</b> topic, which can be the <b>source</b> (default) or <b>target</b> cluster.	□	□	
<b>topic.filter.class</b>  Topic filter to select the topics to replicate. Default is <b>org.apache.kafka.connect.mirror.DefaultTopicFilter</b> .	□	□	
<b>config.property.filter.class</b>  Topic filter to select the topic configuration properties to replicate. Default is <b>org.apache.kafka.connect.mirror.DefaultConfigPropertyFilter</b> .	□		
<b>config.properties.exclude</b>  Topic configuration properties that should not be replicated. Supports comma-separated property names and regular expressions.	□		
<b>offset.lag.max</b>  Maximum allowable (out-of-sync) offset lag before a remote partition is synchronized. Default is <b>100</b> .	□		
<b>offset-syncs.topic.replication.factor</b>  Replication factor for the internal <b>offset-syncs</b> topic. Default is <b>3</b> .	□		
<b>refresh.topics.enabled</b>  Enables check for new topics and partitions. Default is <b>true</b> .	□		
<b>refresh.topics.interval.seconds</b>  Frequency of topic refresh. Default is <b>600</b> (10 minutes).	□		
<b>replication.factor</b>  The replication factor for new topics. Default is <b>2</b> .	□		

Property	sourceConnector	checkpointConnector	heartbeatConnector
<b>sync.topic.acls.enabled</b>  Enables synchronization of ACLs from the source cluster. Default is <code>true</code> . Not compatible with the User Operator.	□		
<b>sync.topic.acls.interval.seconds</b>  Frequency of ACL synchronization. Default is <code>600</code> (10 minutes).	□		
<b>sync.topic.configs.enabled</b>  Enables synchronization of topic configuration from the source cluster. Default is <code>true</code> .	□		
<b>sync.topic.configs.interval.seconds</b>  Frequency of topic configuration synchronization. Default <code>600</code> (10 minutes).	□		
<b>checkpoints.topic.replication.factor</b>  Replication factor for the internal <code>checkpoints</code> topic. Default is <code>3</code> .		□	
<b>emit.checkpoints.enabled</b>  Enables synchronization of consumer offsets to the target cluster. Default is <code>true</code> .		□	
<b>emit.checkpoints.interval.seconds</b>  Frequency of consumer offset synchronization. Default is <code>60</code> (1 minute).		□	
<b>group.filter.class</b>  Group filter to select the consumer groups to replicate. Default is <code>org.apache.kafka.connect.mirror.DefaultGroupFilter</code> .		□	
<b>refresh.groups.enabled</b>  Enables check for new consumer groups. Default is <code>true</code> .		□	
<b>refresh.groups.interval.seconds</b>  Frequency of consumer group refresh. Default is <code>600</code> (10 minutes).		□	

Property	sourceConnector	checkpointConnector	heartbeatConnector
<b>sync.group.offsets.enabled</b>  Enables synchronization of consumer group offsets to the target cluster <code>__consumer_offsets</code> topic. Default is <code>false</code> .		□	
<b>sync.group.offsets.interval.seconds</b>  Frequency of consumer group offset synchronization. Default is <code>60</code> (1 minute).		□	
<b>emit.heartbeats.enabled</b>  Enables connectivity checks on the target cluster. Default is <code>true</code> .			□
<b>emit.heartbeats.interval.seconds</b>  Frequency of connectivity checks. Default is <code>1</code> (1 second).			□
<b>heartbeats.topic.replication.factor</b>  Replication factor for the internal <code>heartbeats</code> topic. Default is <code>3</code> .			□

### 2.3.3. Connector producer and consumer configuration

MirrorMaker 2.0 connectors use internal producers and consumers. If needed, you can configure these producers and consumers to override the default settings.

For example, you can increase the `batch.size` for the source producer that sends topics to the target Kafka cluster to better accommodate large volumes of messages.

**IMPORTANT**

Producer and consumer configuration options depend on the MirrorMaker 2.0 implementation, and may be subject to change.

The following tables describe the producers and consumers for each of the connectors and where you can add configuration.

*Table 2. Source connector producers and consumers*

Type	Description	Configuration
Producer	Sends topic messages to the target Kafka cluster. Consider tuning the configuration of this producer when it is handling large volumes of data.	<code>mirrors.sourceConnector.config: producer.override.*</code>
Producer	Writes to the <code>offset-syncs</code> topic, which maps the source and target offsets for replicated topic partitions.	<code>mirrors.sourceConnector.config: producer.*</code>
Consumer	Retrieves topic messages from the source Kafka cluster.	<code>mirrors.sourceConnector.config: consumer.*</code>

Table 3. Checkpoint connector producers and consumers

Type	Description	Configuration
Producer	Emits consumer offset checkpoints.	<code>mirrors.checkpointConnector.config: producer.override.*</code>
Consumer	Loads the <code>offset-syncs</code> topic.	<code>mirrors.checkpointConnector.config: consumer.*</code>

**NOTE**

You can set `offset-syncs.topic.location` to `target` to use the target Kafka cluster as the location of the `offset-syncs` topic.

Table 4. Heartbeat connector producer

Type	Description	Configuration
Producer	Emits heartbeats.	<code>mirrors.heartbeatConnector.config: producer.override.*</code>

The following example shows how you configure the producers and consumers.

*Example configuration for connector producers and consumers*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
```

```

spec:
  version: 3.3.1
  # ...
  mirrors:
    - sourceCluster: "my-cluster-source"
      targetCluster: "my-cluster-target"
      sourceConnector:
        tasksMax: 5
        config:
          producer.override.batch.size: 327680
          producer.override.linger.ms: 100
          producer.request.timeout.ms: 30000
          consumer.fetch.max.bytes: 52428800
          # ...
      checkpointConnector:
        config:
          producer.override.request.timeout.ms: 30000
          consumer.max.poll.interval.ms: 300000
          # ...
      heartbeatConnector:
        config:
          producer.override.request.timeout.ms: 30000
          # ...

```

#### *Additional resources*

- [KafkaMirrorMaker2ConnectorSpec schema reference](#)
- [KafkaMirrorMaker2MirrorSpec schema reference](#)

### 2.3.4. Specifying a maximum number of tasks

Connectors create the tasks that are responsible for moving data in and out of Kafka. Each connector comprises one or more tasks that are distributed across a group of worker pods that run the tasks. Increasing the number of tasks can help with performance issues when replicating a large number of partitions or synchronizing the offsets of a large number of consumer groups.

Tasks run in parallel. Workers are assigned one or more tasks. A single task is handled by one worker pod, so you don't need more worker pods than tasks. If there are more tasks than workers, workers handle multiple tasks.

You can specify the maximum number of connector tasks in your MirrorMaker configuration using the `tasksMax` property. Without specifying a maximum number of tasks, the default setting is a single task.

The heartbeat connector always uses a single task.

The number of tasks that are started for the source and checkpoint connectors is the lower value between the maximum number of possible tasks and the value for `tasksMax`. For the source connector, the maximum number of tasks possible is one for each partition being replicated from the source cluster. For the checkpoint connector, the maximum number of tasks possible is one for

each consumer group being replicated from the source cluster. When setting a maximum number of tasks, consider the number of partitions and the hardware resources that support the process.

If the infrastructure supports the processing overhead, increasing the number of tasks can improve throughput and latency. For example, adding more tasks reduces the time taken to poll the source cluster when there is a high number of partitions or consumer groups.

Increasing the number of tasks for the checkpoint connector is useful when you have a large number of partitions.

#### *Increasing the number of tasks for the source connector*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
spec:
  # ...
  mirrors:
  - sourceCluster: "my-cluster-source"
    targetCluster: "my-cluster-target"
    sourceConnector:
      tasksMax: 10
  # ...
```

Increasing the number of tasks for the checkpoint connector is useful when you have a large number of consumer groups.

#### *Increasing the number of tasks for the checkpoint connector*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
spec:
  # ...
  mirrors:
  - sourceCluster: "my-cluster-source"
    targetCluster: "my-cluster-target"
    checkpointConnector:
      tasksMax: 10
  # ...
```

By default, MirrorMaker 2.0 checks for new consumer groups every 10 minutes. You can adjust the `refresh.groups.interval.seconds` configuration to change the frequency. Take care when adjusting lower. More frequent checks can have a negative impact on performance.

## **Checking connector task operations**

If you are using Prometheus and Grafana to monitor your deployment, you can check MirrorMaker

2.0 performance. The example MirrorMaker 2.0 Grafana dashboard provided with Strimzi shows the following metrics related to tasks and latency.

- The number of tasks
- Replication latency
- Offset synchronization latency

*Additional resources*

- [Grafana dashboards](#)

### 2.3.5. ACL rules synchronization

ACL access to remote topics is possible if you are **not** using the User Operator.

If **AclAuthorizer** is being used, without the User Operator, ACL rules that manage access to brokers also apply to remote topics. Users that can read a source topic can read its remote equivalent.

**NOTE** OAuth 2.0 authorization does not support access to remote topics in this way.

### 2.3.6. Configuring Kafka MirrorMaker 2.0

Use the properties of the **KafkaMirrorMaker2** resource to configure your Kafka MirrorMaker 2.0 deployment. Use MirrorMaker 2.0 to synchronize data between Kafka clusters.

The configuration must specify:

- Each Kafka cluster
- Connection information for each cluster, including TLS authentication
- The replication flow and direction
  - Cluster to cluster
  - Topic to topic

**NOTE** The previous version of MirrorMaker continues to be supported. If you wish to use the resources configured for the previous version, they must be updated to the format supported by MirrorMaker 2.0.

MirrorMaker 2.0 provides default configuration values for properties such as replication factors. A minimal configuration, with defaults left unchanged, would be something like this example:

*Minimal configuration for MirrorMaker 2.0*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
spec:
  version: 3.3.1
```

```

connectCluster: "my-cluster-target"
clusters:
- alias: "my-cluster-source"
  bootstrapServers: my-cluster-source-kafka-bootstrap:9092
- alias: "my-cluster-target"
  bootstrapServers: my-cluster-target-kafka-bootstrap:9092
mirrors:
- sourceCluster: "my-cluster-source"
  targetCluster: "my-cluster-target"
  sourceConnector: {}

```

You can configure access control for source and target clusters using TLS or SASL authentication. This procedure shows a configuration that uses TLS encryption and authentication for the source and target cluster.

You can specify the topics and consumer groups you wish to replicate from a source cluster in the [KafkaMirrorMaker2](#) resource. You use the [topicsPattern](#) and [groupsPattern](#) properties to do this. You can provide a list of names or use a regular expression. By default, all topics and consumer groups are replicated if you do not set the [topicsPattern](#) and [groupsPattern](#) properties. You can also replicate all topics and consumer groups by using `".*"` as a regular expression. However, try to specify only the topics and consumer groups you need to avoid causing any unnecessary extra load on the cluster.

#### *Handling high volumes of messages*

You can tune the configuration to handle high volumes of messages. For more information, see [Handling high volumes of messages](#).

#### *Prerequisites*

- Strimzi is running
- Source and target Kafka clusters are available

#### *Procedure*

1. Edit the [spec](#) properties for the [KafkaMirrorMaker2](#) resource.

The properties you can configure are shown in this example configuration:

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
spec:
  version: 3.3.1 ①
  replicas: 3 ②
  connectCluster: "my-cluster-target" ③
  clusters: ④
    - alias: "my-cluster-source" ⑤
      authentication: ⑥
      certificateAndKey:

```

```

certificate: source.crt
key: source.key
secretName: my-user-source
type: tls
bootstrapServers: my-cluster-source-kafka-bootstrap:9092 ⑦
tls: ⑧
trustedCertificates:
- certificate: ca.crt
  secretName: my-cluster-source-cluster-ca-cert
- alias: "my-cluster-target" ⑨
authentication: ⑩
certificateAndKey:
  certificate: target.crt
  key: target.key
  secretName: my-user-target
type: tls
bootstrapServers: my-cluster-target-kafka-bootstrap:9092 ⑪
config: ⑫
  config.storage.replication.factor: 1
  offset.storage.replication.factor: 1
  status.storage.replication.factor: 1
  ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384" ⑬
  ssl.enabled.protocols: "TLSv1.2"
  ssl.protocol: "TLSv1.2"
  ssl.endpoint.identification.algorithm: HTTPS ⑭
tls: ⑮
trustedCertificates:
- certificate: ca.crt
  secretName: my-cluster-target-cluster-ca-cert
mirrors: ⑯
- sourceCluster: "my-cluster-source" ⑰
  targetCluster: "my-cluster-target" ⑱
sourceConnector: ⑲
  tasksMax: 10 ⑳
  config:
    replication.factor: 1
    offset-syncs.topic.replication.factor: 1
    sync.topic.acls.enabled: "false"
    refresh.topics.interval.seconds: 60
    replication.policy.separator: ""
    replication.policy.class:
      "org.apache.kafka.connect.mirror.IdentityReplicationPolicy"
heartbeatConnector:
  config:
    heartbeats.topic.replication.factor: 1
checkpointConnector:
  config:
    checkpoints.topic.replication.factor: 1
    refresh.groups.interval.seconds: 600
    sync.group.offsets.enabled: true
    sync.group.offsets.interval.seconds: 60

```

```

    emit.checkpoints.interval.seconds: 60
    replication.policy.class:
    "org.apache.kafka.connect.mirror.IdentityReplicationPolicy"
    topicsPattern: "topic1|topic2|topic3"
    groupsPattern: "group1|group2|group3"
resources:
  requests:
    cpu: "1"
    memory: 2Gi
  limits:
    cpu: "2"
    memory: 2Gi
logging:
  type: inline
  loggers:
    connect.root.logger.level: "INFO"
readinessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
livenessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
jvmOptions:
  "-Xmx": "1g"
  "-Xms": "1g"
image: my-org/my-image:latest
rack:
  topologyKey: topology.kubernetes.io/zone
template:
  pod:
    affinity:
      podAntiAffinity:
        requiredDuringSchedulingIgnoredDuringExecution:
          - labelSelector:
              matchExpressions:
                - key: application
                  operator: In
                  values:
                    - postgresql
                    - mongodb
            topologyKey: "kubernetes.io/hostname"
connectContainer:
  env:
    - name: JAEGER_SERVICE_NAME
      value: my-jaeger-service
    - name: JAEGER_AGENT_HOST
      value: jaeger-agent-name
    - name: JAEGER_AGENT_PORT
      value: "6831"
tracing:
  type: jaeger

```

```

externalConfiguration:
  env:
    - name: AWS_ACCESS_KEY_ID
      valueFrom:
        secretKeyRef:
          name: aws-creds
          key: awsAccessKey
    - name: AWS_SECRET_ACCESS_KEY
      valueFrom:
        secretKeyRef:
          name: aws-creds
          key: awsSecretAccessKey

```

- ① The Kafka Connect and Mirror Maker 2.0 [version](#), which will always be the same.
- ② The number of [replica nodes](#) for the workers that run tasks.
- ③ [Kafka cluster alias](#) for Kafka Connect, which must specify the **target** Kafka cluster. The Kafka cluster is used by Kafka Connect for its internal topics.
- ④ [Specification](#) for the Kafka clusters being synchronized.
- ⑤ [Cluster alias](#) for the source Kafka cluster.
- ⑥ Authentication for the source cluster, using the [TLS mechanism](#), as shown here, using [OAuth bearer tokens](#), or a SASL-based [SCRAM-SHA-256/SCRAM-SHA-512](#) or [PLAIN](#) mechanism.
- ⑦ [Bootstrap server](#) for connection to the source Kafka cluster.
- ⑧ [TLS encryption](#) with key names under which TLS certificates are stored in X.509 format for the source Kafka cluster. If certificates are stored in the same secret, it can be listed multiple times.
- ⑨ [Cluster alias](#) for the target Kafka cluster.
- ⑩ Authentication for the target Kafka cluster is configured in the same way as for the source Kafka cluster.
- ⑪ [Bootstrap server](#) for connection to the target Kafka cluster.
- ⑫ [Kafka Connect configuration](#). Standard Apache Kafka configuration may be provided, restricted to those properties not managed directly by Strimzi.
- ⑬ [SSL properties](#) for external listeners to run with a specific *cipher suite* for a TLS version.
- ⑭ [Hostname verification is enabled](#) by setting to [HTTPS](#). An empty string disables the verification.
- ⑮ TLS encryption for the target Kafka cluster is configured in the same way as for the source Kafka cluster.
- ⑯ [MirrorMaker 2.0 connectors](#).
- ⑰ [Cluster alias](#) for the source cluster used by the MirrorMaker 2.0 connectors.
- ⑱ [Cluster alias](#) for the target cluster used by the MirrorMaker 2.0 connectors.
- ⑲ [Configuration for the MirrorSourceConnector](#) that creates remote topics. The [config](#) overrides the default configuration options.

㉚ The maximum number of tasks that the connector may create. Tasks handle the data replication and run in parallel. If the infrastructure supports the processing overhead, increasing this value can improve throughput. Kafka Connect distributes the tasks between members of the cluster. If there are more tasks than workers, workers are assigned multiple tasks. For sink connectors, aim to have one task for each topic partition consumed. For source connectors, the number of tasks that can run in parallel may also depend on the external system. The connector creates fewer than the maximum number of tasks if it cannot achieve the parallelism.

Replication factor for mirrored topics created at the target cluster.

Replication factor for the [MirrorSourceConnector offset-syncs](#) internal topic that maps the offsets of the source and target clusters.

When [ACL rules synchronization](#) is enabled, ACLs are applied to synchronized topics. The default is `true`. This feature is not compatible with the User Operator. If you are using the User Operator, set this property to `false`.

Optional setting to change the frequency of checks for new topics. The default is for a check every 10 minutes.

Defines the separator used for the renaming of remote topics.

Adds a policy that overrides the automatic renaming of remote topics. Instead of prepending the name with the name of the source cluster, the topic retains its original name. This optional setting is useful for active/passive backups and data migration. To configure topic offset synchronization, this property must also be set for the [checkpointConnector.config](#).

[Configuration for the MirrorHeartbeatConnector](#) that performs connectivity checks. The `config` overrides the default configuration options.

Replication factor for the heartbeat topic created at the target cluster.

[Configuration for the MirrorCheckpointConnector](#) that tracks offsets. The `config` overrides the default configuration options.

Replication factor for the checkpoints topic created at the target cluster.

Optional setting to change the frequency of checks for new consumer groups. The default is for a check every 10 minutes.

Optional setting to synchronize consumer group offsets, which is useful for recovery in an active/passive configuration. Synchronization is not enabled by default.

If the synchronization of consumer group offsets is enabled, you can adjust the frequency of the synchronization.

Adjusts the frequency of checks for offset tracking. If you change the frequency of offset synchronization, you might also need to adjust the frequency of these checks.

Topic replication from the source cluster [defined as a comma-separated list or regular expression pattern](#). The source connector replicates the specified topics. The checkpoint connector tracks offsets for the specified topics. Here we request three topics by name.

Consumer group replication from the source cluster [defined as a comma-separated list or regular expression pattern](#). The checkpoint connector replicates the specified consumer groups. Here we request three consumer groups by name.

Requests for reservation of [supported resources](#), currently `cpu` and `memory`, and limits to specify the maximum resources that can be consumed.

Specified [Kafka Connect loggers and log levels](#) added directly ([inline](#)) or indirectly ([external](#)) through a ConfigMap. A custom ConfigMap must be placed under the `log4j.properties` or `log4j2.properties` key. For the Kafka Connect `log4j.rootLogger` logger, you can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.

[Healthchecks](#) to know when to restart a container (liveness) and when a container can accept traffic (readiness).

[JVM configuration options](#) to optimize performance for the Virtual Machine (VM) running Kafka MirrorMaker.

ADVANCED OPTION: [Container image configuration](#), which is recommended only in special situations.

SPECIALIZED OPTION: [Rack awareness](#) configuration for the deployment. This is a specialized option intended for a deployment within the same location, not across regions. Use this option if you want connectors to consume from the closest replica rather than the leader replica. In certain cases, consuming from the closest replica can improve network utilization or reduce costs . The `topologyKey` must match a node label containing the rack ID. The example used in this configuration specifies a zone using the standard `topology.kubernetes.io/zone` label. To consume from the closest replica, enable the `RackAwareReplicaSelector` in the Kafka broker configuration.

[Template customization](#). Here a pod is scheduled with anti-affinity, so the pod is not scheduled on nodes with the same hostname.

Environment variables are set for distributed tracing.

Distributed tracing is enabled for Jaeger.

[External configuration](#) for a Kubernetes Secret mounted to Kafka MirrorMaker as an environment variable. You can also use *configuration provider plugins* to [load configuration values from external sources](#).

## 2. Create or update the resource:

```
kubectl apply -f MIRRORMAKER-CONFIGURATION-FILE
```

### Additional resources

- [Introducing distributed tracing](#)

### 2.3.7. Securing a Kafka MirrorMaker 2.0 deployment

This procedure describes in outline the configuration required to secure a MirrorMaker 2.0 deployment.

You need separate configuration for the source Kafka cluster and the target Kafka cluster. You also need separate user configuration to provide the credentials required for MirrorMaker to connect to the source and target Kafka clusters.

For the Kafka clusters, you specify internal listeners for secure connections within a Kubernetes cluster and external listeners for connections outside the Kubernetes cluster.

You can configure authentication and authorization mechanisms. The security options implemented for the source and target Kafka clusters must be compatible with the security options implemented for MirrorMaker 2.0.

After you have created the cluster and user authentication credentials, you specify them in your MirrorMaker configuration for secure connections.

**NOTE**

In this procedure, the certificates generated by the Cluster Operator are used, but you can replace them by [installing your own certificates](#). You can also configure your listener to [use a Kafka listener certificate managed by an external Certificate Authority](#).

*Before you start*

Before starting this procedure, take a look at the [example configuration files](#) provided by Strimzi. They include examples for securing a deployment of MirrorMaker 2.0 using TLS or SCRAM-SHA-512 authentication. The examples specify internal listeners for connecting within a Kubernetes cluster.

The examples provide the configuration for full authorization, including all the ACLs needed by MirrorMaker 2.0 to allow operations on the source and target Kafka clusters.

*Prerequisites*

- Strimzi is running
- Separate namespaces for source and target clusters

The procedure assumes that the source and target Kafka clusters are installed to separate namespaces. If you want to use the Topic Operator, you'll need to do this. The Topic Operator only watches a single cluster in a specified namespace.

By separating the clusters into namespaces, you will need to copy the cluster secrets so they can be accessed outside the namespace. You need to reference the secrets in the MirrorMaker configuration.

*Procedure*

1. Configure two **Kafka** resources, one to secure the source Kafka cluster and one to secure the target Kafka cluster.

You can add listener configuration for authentication and enable authorization.

In this example, an internal listener is configured for a Kafka cluster with TLS encryption and authentication. Kafka **simple** authorization is enabled.

*Example source Kafka cluster configuration with TLS authentication*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
```

```

name: my-source-cluster
spec:
  kafka:
    version: 3.3.1
    replicas: 1
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: tls
    authorization:
      type: simple
    config:
      offsets.topic.replication.factor: 1
      transaction.state.log.replication.factor: 1
      transaction.state.log.min_isr: 1
      default.replication.factor: 1
      min.insync.replicas: 1
      inter.broker.protocol.version: "3.3"
    storage:
      type: jbod
      volumes:
        - id: 0
          type: persistent-claim
          size: 100Gi
          deleteClaim: false
  zookeeper:
    replicas: 1
    storage:
      type: persistent-claim
      size: 100Gi
      deleteClaim: false
  entityOperator:
    topicOperator: {}
    userOperator: {}

```

*Example target Kafka cluster configuration with TLS authentication*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-target-cluster
spec:
  kafka:
    version: 3.3.1
    replicas: 1
    listeners:
      - name: tls

```

```

    port: 9093
    type: internal
    tls: true
    authentication:
      type: tls
  authorization:
    type: simple
  config:
    offsets.topic.replication.factor: 1
    transaction.state.log.replication.factor: 1
    transaction.state.log.min_isr: 1
    default.replication.factor: 1
    min.insync.replicas: 1
    inter.broker.protocol.version: "3.3"
  storage:
    type: jbod
    volumes:
      - id: 0
        type: persistent-claim
        size: 100Gi
        deleteClaim: false
  zookeeper:
    replicas: 1
    storage:
      type: persistent-claim
      size: 100Gi
      deleteClaim: false
  entityOperator:
    topicOperator: {}
    userOperator: {}

```

2. Create or update the **Kafka** resources in separate namespaces.

```
kubectl apply -f <kafka_configuration_file> -n <namespace>
```

The Cluster Operator creates the listeners and sets up the cluster and client certificate authority (CA) certificates to enable authentication within the Kafka cluster.

The certificates are created in the secret `<cluster_name>-cluster-ca-cert`.

3. Configure two **KafkaUser** resources, one for a user of the source Kafka cluster and one for a user of the target Kafka cluster.
  - Configure the same authentication and authorization types as the corresponding source and target Kafka cluster. For example, if you used `tls` authentication and `simple` authorization type in the **Kafka** configuration for the source Kafka cluster, use the same in the **KafkaUser** configuration.
  - Configure the ACLs needed by MirrorMaker 2.0 to allow operations on the source and target Kafka clusters.

The ACLs are used by the internal MirrorMaker connectors, and by the underlying Kafka Connect framework.

*Example source user configuration for TLS client authentication*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-source-user
  labels:
    strimzi.io/cluster: my-source-cluster
spec:
  authentication:
    type: tls
  authorization:
    type: simple
    acls:
      # MirrorSourceConnector
      - resource: # Not needed if offset-syncs.topic.location=target
        type: topic
        name: mm2-offset-syncs.my-target-cluster.internal
        operations:
          - Create
          - DescribeConfigs
          - Read
          - Write
      - resource: # Needed for every topic which is mirrored
        type: topic
        name: "*"
        operations:
          - DescribeConfigs
          - Read
      # MirrorCheckpointConnector
      - resource:
          type: cluster
        operations:
          - Describe
      - resource: # Needed for every group for which offsets are synced
        type: group
        name: "*"
        operations:
          - Describe
      - resource: # Not needed if offset-syncs.topic.location=target
        type: topic
        name: mm2-offset-syncs.my-target-cluster.internal
        operations:
          - Read
```

*Example target user configuration for TLS client authentication*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-target-user
  labels:
    strimzi.io/cluster: my-target-cluster
spec:
  authentication:
    type: tls
  authorization:
    type: simple
    acls:
      # Underlying Kafka Connect internal topics to store configuration, offsets,
      or status
      - resource:
          type: group
          name: mirrormaker2-cluster
          operations:
            - Read
      - resource:
          type: topic
          name: mirrormaker2-cluster-configs
          operations:
            - Create
            - Describe
            - DescribeConfigs
            - Read
            - Write
      - resource:
          type: topic
          name: mirrormaker2-cluster-status
          operations:
            - Create
            - Describe
            - DescribeConfigs
            - Read
            - Write
      - resource:
          type: topic
          name: mirrormaker2-cluster-offsets
          operations:
            - Create
            - Describe
            - DescribeConfigs
            - Read
            - Write
  # MirrorSourceConnector
  - resource: # Needed for every topic which is mirrored
    type: topic
```

```

name: "*"
operations:
  - Create
  - Alter
  - AlterConfigs
  - Write
# MirrorCheckpointConnector
- resource:
    type: cluster
  operations:
    - Describe
- resource:
    type: topic
    name: my-source-cluster.checkpoints.internal
  operations:
    - Create
    - Describe
    - Read
    - Write
- resource: # Needed for every group for which the offset is synced
  type: group
  name: "*"
  operations:
    - Read
    - Describe
# MirrorHeartbeatConnector
- resource:
    type: topic
    name: heartbeats
  operations:
    - Create
    - Describe
    - Write

```

**NOTE**

You can use a certificate issued outside the User Operator by setting `type` to `tls-external`. For more information, see [User authentication](#).

4. Create or update a `KafkaUser` resource in each of the namespaces you created for the source and target Kafka clusters.

```
kubectl apply -f <kafka_user_configuration_file> -n <namespace>
```

The User Operator creates the users representing the client (MirrorMaker), and the security credentials used for client authentication, based on the chosen authentication type.

The User Operator creates a new secret with the same name as the `KafkaUser` resource. The secret contains a private and public key for TLS client authentication. The public key is contained in a user certificate, which is signed by the client Certificate Authority (CA).

- Configure a [KafkaMirrorMaker2](#) resource with the authentication details to connect to the source and target Kafka clusters.

*Example MirrorMaker 2.0 configuration with TLS authentication*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker-2
spec:
  version: 3.3.1
  replicas: 1
  connectCluster: "my-target-cluster"
  clusters:
    - alias: "my-source-cluster"
      bootstrapServers: my-source-cluster-kafka-bootstrap:9093
      tls: ①
        trustedCertificates:
          - secretName: my-source-cluster-cluster-ca-cert
            certificate: ca.crt
      authentication: ②
        type: tls
        certificateAndKey:
          secretName: my-source-user
          certificate: user.crt
          key: user.key
    - alias: "my-target-cluster"
      bootstrapServers: my-target-cluster-kafka-bootstrap:9093
      tls: ③
        trustedCertificates:
          - secretName: my-target-cluster-cluster-ca-cert
            certificate: ca.crt
      authentication: ④
        type: tls
        certificateAndKey:
          secretName: my-target-user
          certificate: user.crt
          key: user.key
    config:
      # -1 means it will use the default replication factor configured in the
      broker
      config.storage.replication.factor: -1
      offset.storage.replication.factor: -1
      status.storage.replication.factor: -1
    mirrors:
      - sourceCluster: "my-source-cluster"
        targetCluster: "my-target-cluster"
        sourceConnector:
          config:
            replication.factor: 1
            offset-syncs.topic.replication.factor: 1

```

```

    sync.topic.acls.enabled: "false"
  heartbeatConnector:
    config:
      heartbeats.topic.replication.factor: 1
  checkpointConnector:
    config:
      checkpoints.topic.replication.factor: 1
      sync.group.offsets.enabled: "true"
  topicsPattern: "topic1|topic2|topic3"
  groupsPattern: "group1|group2|group3"

```

- ① The TLS certificates for the source Kafka cluster. If they are in a separate namespace, copy the cluster secrets from the namespace of the Kafka cluster.
  - ② The user authentication for accessing the source Kafka cluster using the [TLS mechanism](#).
  - ③ The TLS certificates for the target Kafka cluster.
  - ④ The user authentication for accessing the target Kafka cluster.
6. Create or update the [KafkaMirrorMaker2](#) resource in the same namespace as the target Kafka cluster.

```
kubectl apply -f <mirrormaker2_configuration_file> -n <namespace_of_target_cluster>
```

#### *Additional resources*

- [Supported listener authentication options](#)
- [Supported authorization options for a Kafka cluster](#)
- [Securing Kafka brokers](#)
- [Securing user access to Kafka](#)
- [Managing TLS certificates](#)

### **2.3.8. Performing a restart of a Kafka MirrorMaker 2.0 connector**

This procedure describes how to manually trigger a restart of a Kafka MirrorMaker 2.0 connector by using a Kubernetes annotation.

#### *Prerequisites*

- The Cluster Operator is running.

#### *Procedure*

1. Find the name of the [KafkaMirrorMaker2](#) custom resource that controls the Kafka MirrorMaker 2.0 connector you want to restart:

```
kubectl get KafkaMirrorMaker2
```

2. Find the name of the Kafka MirrorMaker 2.0 connector to be restarted from the

**KafkaMirrorMaker2** custom resource.

```
kubectl describe KafkaMirrorMaker2 KAFKAMIRRORMAKER-2-NAME
```

3. To restart the connector, annotate the **KafkaMirrorMaker2** resource in Kubernetes. In this example, `kubectl annotate` restarts a connector named `my-source->my-target.MirrorSourceConnector`:

```
kubectl annotate KafkaMirrorMaker2 KAFKAMIRRORMAKER-2-NAME "strimzi.io/restart-connector=my-source->my-target.MirrorSourceConnector"
```

4. Wait for the next reconciliation to occur (every two minutes by default).

The Kafka MirrorMaker 2.0 connector is restarted, as long as the annotation was detected by the reconciliation process. When the restart request is accepted, the annotation is removed from the **KafkaMirrorMaker2** custom resource.

#### *Additional resources*

- [Kafka MirrorMaker 2.0 cluster configuration](#).

### **2.3.9. Performing a restart of a Kafka MirrorMaker 2.0 connector task**

This procedure describes how to manually trigger a restart of a Kafka MirrorMaker 2.0 connector task by using a Kubernetes annotation.

#### *Prerequisites*

- The Cluster Operator is running.

#### *Procedure*

1. Find the name of the **KafkaMirrorMaker2** custom resource that controls the Kafka MirrorMaker 2.0 connector you want to restart:

```
kubectl get KafkaMirrorMaker2
```

2. Find the name of the Kafka MirrorMaker 2.0 connector and the ID of the task to be restarted from the **KafkaMirrorMaker2** custom resource. Task IDs are non-negative integers, starting from 0.

```
kubectl describe KafkaMirrorMaker2 KAFKAMIRRORMAKER-2-NAME
```

3. To restart the connector task, annotate the **KafkaMirrorMaker2** resource in Kubernetes. In this example, `kubectl annotate` restarts task 0 of a connector named `my-source->my-target.MirrorSourceConnector`:

```
kubectl annotate KafkaMirrorMaker2 KAFKAMIRRORMAKER-2-NAME "strimzi.io/restart-connector-task=my-source->my-target.MirrorSourceConnector:0"
```

4. Wait for the next reconciliation to occur (every two minutes by default).

The Kafka MirrorMaker 2.0 connector task is restarted, as long as the annotation was detected by the reconciliation process. When the restart task request is accepted, the annotation is removed from the [KafkaMirrorMaker2](#) custom resource.

#### *Additional resources*

- [Kafka MirrorMaker 2.0 cluster configuration](#).

## 2.4. Kafka MirrorMaker cluster configuration

Configure a Kafka MirrorMaker deployment using the [KafkaMirrorMaker](#) resource. KafkaMirrorMaker replicates data between Kafka clusters.

[KafkaMirrorMaker schema reference](#) describes the full schema of the [KafkaMirrorMaker](#) resource.

You can use Strimzi with MirrorMaker or [MirrorMaker 2.0](#). MirrorMaker 2.0 is the latest version, and offers a more efficient way to mirror data between Kafka clusters.

#### **IMPORTANT**

Kafka MirrorMaker 1 (referred to as just *MirrorMaker* in the documentation) has been deprecated in Apache Kafka 3.0.0 and will be removed in Apache Kafka 4.0.0. As a result, the [KafkaMirrorMaker](#) custom resource which is used to deploy Kafka MirrorMaker 1 has been deprecated in Strimzi as well. The [KafkaMirrorMaker](#) resource will be removed from Strimzi when we adopt Apache Kafka 4.0.0. As a replacement, use the [KafkaMirrorMaker2](#) custom resource with the [IdentityReplicationPolicy](#).

### 2.4.1. Configuring Kafka MirrorMaker

Use the properties of the [KafkaMirrorMaker](#) resource to configure your Kafka MirrorMaker deployment.

You can configure access control for producers and consumers using TLS or SASL authentication. This procedure shows a configuration that uses TLS encryption and authentication on the consumer and producer side.

#### *Prerequisites*

- See the [Deploying and Upgrading Strimzi](#) guide for instructions on running a:
  - [Cluster Operator](#)
  - [Kafka cluster](#)
- Source and target Kafka clusters must be available

#### *Procedure*

## 1. Edit the `spec` properties for the `KafkaMirrorMaker` resource.

The properties you can configure are shown in this example configuration:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker
metadata:
  name: my-mirror-maker
spec:
  replicas: 3 ①
  consumer:
    bootstrapServers: my-source-cluster-kafka-bootstrap:9092 ②
    groupId: "my-group" ③
    numStreams: 2 ④
    offsetCommitInterval: 120000 ⑤
    tls: ⑥
      trustedCertificates:
        - secretName: my-source-cluster-ca-cert
          certificate: ca.crt
    authentication: ⑦
      type: tls
      certificateAndKey:
        secretName: my-source-secret
        certificate: public.crt
        key: private.key
  config: ⑧
    max.poll.records: 100
    receive.buffer.bytes: 32768
    ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384" ⑨
    ssl.enabled.protocols: "TLSv1.2"
    ssl.protocol: "TLSv1.2"
    ssl.endpoint.identification.algorithm: HTTPS ⑩
  producer:
    bootstrapServers: my-target-cluster-kafka-bootstrap:9092
    abortOnSendFailure: false ⑪
    tls:
      trustedCertificates:
        - secretName: my-target-cluster-ca-cert
          certificate: ca.crt
    authentication:
      type: tls
      certificateAndKey:
        secretName: my-target-secret
        certificate: public.crt
        key: private.key
  config:
    compression.type: gzip
    batch.size: 8192
    ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384" ⑫
    ssl.enabled.protocols: "TLSv1.2"
```

```

    ssl.protocol: "TLSv1.2"
    ssl.endpoint.identification.algorithm: HTTPS ⑯
  include: "my-topic|other-topic" ⑰
  resources: ⑱
    requests:
      cpu: "1"
      memory: 2Gi
    limits:
      cpu: "2"
      memory: 2Gi
  logging: ⑲
    type: inline
    loggers:
      mirrormaker.root.logger: "INFO"
  readinessProbe: ⑳
    initialDelaySeconds: 15
    timeoutSeconds: 5
  livenessProbe:
    initialDelaySeconds: 15
    timeoutSeconds: 5
  metricsConfig: ㉑
    type: jmxPrometheusExporter
    valueFrom:
      configMapKeyRef:
        name: my-config-map
        key: my-key
  jvmOptions: ㉒
    "-Xmx": "1g"
    "-Xms": "1g"
  image: my-org/my-image:latest ㉓
  template:
    pod:
      affinity:
        podAntiAffinity:
          requiredDuringSchedulingIgnoredDuringExecution:
            - labelSelector:
                matchExpressions:
                  - key: application
                    operator: In
                    values:
                      - postgresql
                      - mongodb
              topologyKey: "kubernetes.io/hostname"
  connectContainer:
    env:
      - name: JAEGER_SERVICE_NAME
        value: my-jaeger-service
      - name: JAEGER_AGENT_HOST
        value: jaeger-agent-name
      - name: JAEGER_AGENT_PORT
        value: "6831"

```

```
tracing:  
  type: jaeger
```

- ① The number of replica nodes.
- ② Bootstrap servers for consumer and producer.
- ③ Group ID for the consumer.
- ④ The number of consumer streams.
- ⑤ The offset auto-commit interval in milliseconds.
- ⑥ TLS encryption with key names under which TLS certificates are stored in X.509 format for consumer or producer. If certificates are stored in the same secret, it can be listed multiple times.
- ⑦ Authentication for consumer or producer, using the TLS mechanism, as shown here, using OAuth bearer tokens, or a SASL-based SCRAM-SHA-256/SCRAM-SHA-512 or PLAIN mechanism.
- ⑧ Kafka configuration options for consumer and producer.
- ⑨ SSL properties for external listeners to run with a specific *cipher suite* for a TLS version.
- ⑩ Hostname verification is enabled by setting to HTTPS. An empty string disables the verification.
- ⑪ If the abortOnSendFailure property is set to true, Kafka MirrorMaker will exit and the container will restart following a send failure for a message.
- ⑫ SSL properties for external listeners to run with a specific *cipher suite* for a TLS version.
- ⑬ Hostname verification is enabled by setting to HTTPS. An empty string disables the verification.
- ⑭ A included topics mirrored from source to target Kafka cluster.
- ⑮ Requests for reservation of supported resources, currently cpu and memory, and limits to specify the maximum resources that can be consumed.
- ⑯ Specified loggers and log levels added directly (inline) or indirectly (external) through a ConfigMap. A custom ConfigMap must be placed under the log4j.properties or log4j2.properties key. MirrorMaker has a single logger called `mirrormaker.root.logger`. You can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.
- ⑰ Healthchecks to know when to restart a container (liveness) and when a container can accept traffic (readiness).
- ⑱ Prometheus metrics, which are enabled by referencing a ConfigMap containing configuration for the Prometheus JMX exporter in this example. You can enable metrics without further configuration using a reference to a ConfigMap containing an empty file under `metricsConfig.valueFrom.configMapKeyRef.key`.
- ⑲ JVM configuration options to optimize performance for the Virtual Machine (VM) running Kafka MirrorMaker.
- ⑳ ADVANCED OPTION: Container image configuration, which is recommended only in special situations.

[Template customization](#). Here a pod is scheduled with anti-affinity, so the pod is not scheduled on nodes with the same hostname.

Environment variables are set for distributed tracing.

Distributed tracing is enabled for Jaeger.

**WARNING**

With the `abortOnSendFailure` property set to `false`, the producer attempts to send the next message in a topic. The original message might be lost, as there is no attempt to resend a failed message.

2. Create or update the resource:

```
kubectl apply -f <your-file>
```

*Additional resources*

- [Introducing distributed tracing](#)

## 2.4.2. List of Kafka MirrorMaker cluster resources

The following resources are created by the Cluster Operator in the Kubernetes cluster:

### **<mirror-maker-name>-mirror-maker**

Deployment which is responsible for creating the Kafka MirrorMaker pods.

### **<mirror-maker-name>-config**

ConfigMap which contains ancillary configuration for the Kafka MirrorMaker, and is mounted as a volume by the Kafka broker pods.

### **<mirror-maker-name>-mirror-maker**

Pod Disruption Budget configured for the Kafka MirrorMaker worker nodes.

## 2.5. Kafka Bridge cluster configuration

Configure a Kafka Bridge deployment using the [KafkaBridge](#) resource. Kafka Bridge provides an API for integrating HTTP-based clients with a Kafka cluster.

[KafkaBridge schema reference](#) describes the full schema of the [KafkaBridge](#) resource.

### 2.5.1. Configuring the Kafka Bridge

Use the Kafka Bridge to make HTTP-based requests to the Kafka cluster.

Use the properties of the [KafkaBridge](#) resource to configure your Kafka Bridge deployment.

In order to prevent issues arising when client consumer requests are processed by different Kafka Bridge instances, address-based routing must be employed to ensure that requests are routed to the right Kafka Bridge instance. Additionally, each independent Kafka Bridge instance must have a replica. A Kafka Bridge instance has its own state which is not shared with another instances.

## Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

See the *Deploying and Upgrading Strimzi* guide for instructions on running a:

- [Cluster Operator](#)
- [Kafka cluster](#)

## Procedure

1. Edit the `spec` properties for the [KafkaBridge](#) resource.

The properties you can configure are shown in this example configuration:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  replicas: 3 ①
  bootstrapServers: <cluster_name>-cluster-kafka-bootstrap:9092 ②
  tls: ③
    trustedCertificates:
      - secretName: my-cluster-cluster-cert
        certificate: ca.crt
      - secretName: my-cluster-cluster-cert
        certificate: ca2.crt
  authentication: ④
    type: tls
    certificateAndKey:
      secretName: my-secret
      certificate: public.crt
      key: private.key
  http: ⑤
    port: 8080
    cors: ⑥
      allowedOrigins: "https://strimzi.io"
      allowedMethods: "GET,POST,PUT,DELETE,OPTIONS,PATCH"
  consumer: ⑦
    config:
      auto.offset.reset: earliest
  producer: ⑧
    config:
      delivery.timeout.ms: 300000
  resources: ⑨
    requests:
      cpu: "1"
      memory: 2Gi
    limits:
```

```

cpu: "2"
memory: 2Gi
logging: ⑩
  type: inline
  loggers:
    logger.bridge.level: "INFO"
    # enabling DEBUG just for send operation
    logger.send.name: "http.openapi.operation.send"
    logger.send.level: "DEBUG"
jvmOptions: ⑪
  "-Xmx": "1g"
  "-Xms": "1g"
readinessProbe: ⑫
  initialDelaySeconds: 15
  timeoutSeconds: 5
livenessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
image: my-org/my-image:latest ⑬
template: ⑭
pod:
  affinity:
    podAntiAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
              - key: application
                operator: In
                values:
                  - postgresql
                  - mongodb
            topologyKey: "kubernetes.io/hostname"
bridgeContainer: ⑮
env:
  - name: JAEGER_SERVICE_NAME
    value: my-jaeger-service
  - name: JAEGER_AGENT_HOST
    value: jaeger-agent-name
  - name: JAEGER_AGENT_PORT
    value: "6831"

```

① The number of replica nodes.

② Bootstrap server for connection to the target Kafka cluster. Use the name of the Kafka cluster as the <cluster\_name>.

③ TLS encryption with key names under which TLS certificates are stored in X.509 format for the source Kafka cluster. If certificates are stored in the same secret, it can be listed multiple times.

④ Authentication for the Kafka Bridge cluster, using the TLS mechanism, as shown here, using OAuth bearer tokens, or a SASL-based SCRAM-SHA-256/SCRAM-SHA-512 or PLAIN

mechanism. By default, the Kafka Bridge connects to Kafka brokers without authentication.

- ⑤ [HTTP access](#) to Kafka brokers.
- ⑥ [CORS access](#) specifying selected resources and access methods. Additional HTTP headers in requests describe the origins that are permitted access to the Kafka cluster.
- ⑦ [Consumer configuration](#) options.
- ⑧ [Producer configuration](#) options.
- ⑨ Requests for reservation of [supported resources](#), currently `cpu` and `memory`, and limits to specify the maximum resources that can be consumed.
- ⑩ Specified [Kafka Bridge loggers and log levels](#) added directly ([inline](#)) or indirectly ([external](#)) through a ConfigMap. A custom ConfigMap must be placed under the `log4j.properties` or `log4j2.properties` key. For the Kafka Bridge loggers, you can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.
- ⑪ [JVM configuration options](#) to optimize performance for the Virtual Machine (VM) running the Kafka Bridge.
- ⑫ [Healthchecks](#) to know when to restart a container (liveness) and when a container can accept traffic (readiness).
- ⑬ Optional: [Container image configuration](#), which is recommended only in special situations.
- ⑭ [Template customization](#). Here a pod is scheduled with anti-affinity, so the pod is not scheduled on nodes with the same hostname.
- ⑮ Environment variables are set for distributed tracing.

## 2. Create or update the resource:

```
kubectl apply -f KAFKA-BRIDGE-CONFIG-FILE
```

### *Additional resources*

- [Using the Strimzi Kafka Bridge](#)
- [Introducing distributed tracing](#)

## 2.5.2. List of Kafka Bridge cluster resources

The following resources are created by the Cluster Operator in the Kubernetes cluster:

### ***bridge-cluster-name-bridge***

Deployment which is in charge to create the Kafka Bridge worker node pods.

### ***bridge-cluster-name-bridge-service***

Service which exposes the REST interface of the Kafka Bridge cluster.

### ***bridge-cluster-name-bridge-config***

ConfigMap which contains the Kafka Bridge ancillary configuration and is mounted as a volume by the Kafka broker pods.

## **bridge-cluster-name-bridge**

Pod Disruption Budget configured for the Kafka Bridge worker nodes.

## **2.6. Customizing Kubernetes resources**

A Strimzi deployment creates Kubernetes resources, such as [Deployments](#), [StatefulSets](#), [Pods](#), and [Services](#). These resources are managed by Strimzi operators. Only the operator that is responsible for managing a particular Kubernetes resource can change that resource. If you try to manually change an operator-managed Kubernetes resource, the operator will revert your changes back.

Changing an operator-managed Kubernetes resource can be useful if you want to perform certain tasks, such as:

- Adding custom labels or annotations that control how [Pods](#) are treated by Istio or other services
- Managing how [Loadbalancer](#)-type Services are created by the cluster

You can make the changes using the [template](#) property in the Strimzi custom resources. The [template](#) property is supported in the following resources. The API reference provides more details about the customizable fields.

### **Kafka.spec.kafka**

See [KafkaClusterTemplate schema reference](#)

### **Kafka.spec.zookeeper**

See [ZookeeperClusterTemplate schema reference](#)

### **Kafka.spec.entityOperator**

See [EntityOperatorTemplate schema reference](#)

### **Kafka.spec.kafkaExporter**

See [KafkaExporterTemplate schema reference](#)

### **Kafka.spec.cruiseControl**

See [CruiseControlTemplate schema reference](#)

### **Kafka.spec.jmxTrans**

See [JmxTransTemplate schema reference](#)

### **KafkaConnect.spec**

See [KafkaConnectTemplate schema reference](#)

### **KafkaMirrorMaker.spec**

See [KafkaMirrorMakerTemplate schema reference](#)

### **KafkaMirrorMaker2.spec**

See [KafkaConnectTemplate schema reference](#)

## KafkaBridge.spec

See [KafkaBridgeTemplate schema reference](#)

## KafkaUser.spec

See [KafkaUserTemplate schema reference](#)

In the following example, the `template` property is used to modify the labels in a Kafka broker's pod.

*Example template customization*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  labels:
    app: my-cluster
spec:
  kafka:
    # ...
    template:
      pod:
        metadata:
          labels:
            mylabel: myvalue
# ...
```

### 2.6.1. Customizing the image pull policy

Strimzi allows you to customize the image pull policy for containers in all pods deployed by the Cluster Operator. The image pull policy is configured using the environment variable `STRIMZI_IMAGE_PULL_POLICY` in the Cluster Operator deployment. The `STRIMZI_IMAGE_PULL_POLICY` environment variable can be set to three different values:

#### Always

Container images are pulled from the registry every time the pod is started or restarted.

#### IfNotPresent

Container images are pulled from the registry only when they were not pulled before.

#### Never

Container images are never pulled from the registry.

The image pull policy can be currently customized only for all Kafka, Kafka Connect, and Kafka MirrorMaker clusters at once. Changing the policy will result in a rolling update of all your Kafka, Kafka Connect, and Kafka MirrorMaker clusters.

*Additional resources*

- For more information about Cluster Operator configuration, see [Using the Cluster Operator](#).

- For more information about Image Pull Policies, see [Disruptions](#).

## 2.6.2. Applying a termination grace period

Apply a termination grace period to give a Kafka cluster enough time to shut down cleanly.

Specify the time using the `terminationGracePeriodSeconds` property. Add the property to the `template.pod` configuration of the `Kafka` custom resource.

The time you add will depend on the size of your Kafka cluster. The Kubernetes default for the termination grace period is 30 seconds. If you observe that your clusters are not shutting down cleanly, you can increase the termination grace period.

A termination grace period is applied every time a pod is restarted. The period begins when Kubernetes sends a *term* (termination) signal to the processes running in the pod. The period should reflect the amount of time required to transfer the processes of the terminating pod to another pod before they are stopped. After the period ends, a *kill* signal stops any processes still running in the pod.

The following example adds a termination grace period of 120 seconds to the `Kafka` custom resource. You can also specify the configuration in the custom resources of other Kafka components.

*Example termination grace period configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    template:
      pod:
        terminationGracePeriodSeconds: 120
        # ...
    # ...
```

## 2.7. Configuring pod scheduling

When two applications are scheduled to the same Kubernetes node, both applications might use the same resources like disk I/O and impact performance. That can lead to performance degradation. Scheduling Kafka pods in a way that avoids sharing nodes with other critical workloads, using the right nodes or dedicated a set of nodes only for Kafka are the best ways how to avoid such problems.

### 2.7.1. Specifying affinity, tolerations, and topology spread constraints

Use affinity, tolerations and topology spread constraints to schedule the pods of kafka resources

onto nodes. Affinity, tolerations and topology spread constraints are configured using the `affinity`, `tolerations`, and `topologySpreadConstraint` properties in following resources:

- `Kafka.spec.kafka.template.pod`
- `Kafka.spec.zookeeper.template.pod`
- `Kafka.spec.entityOperator.template.pod`
- `KafkaConnect.spec.template.pod`
- `KafkaBridge.spec.template.pod`
- `KafkaMirrorMaker.spec.template.pod`
- `KafkaMirrorMaker2.spec.template.pod`

The format of the `affinity`, `tolerations`, and `topologySpreadConstraint` properties follows the Kubernetes specification. The affinity configuration can include different types of affinity:

- Pod affinity and anti-affinity
- Node affinity

#### *Additional resources*

- [Kubernetes node and pod affinity documentation](#)
- [Kubernetes taints and tolerations](#)
- [Kubernetes Topology Spread Constraints](#)

### **Use pod anti-affinity to avoid critical applications sharing nodes**

Use pod anti-affinity to ensure that critical applications are never scheduled on the same disk. When running a Kafka cluster, it is recommended to use pod anti-affinity to ensure that the Kafka brokers do not share nodes with other workloads, such as databases.

### **Use node affinity to schedule workloads onto specific nodes**

The Kubernetes cluster usually consists of many different types of worker nodes. Some are optimized for CPU heavy workloads, some for memory, while other might be optimized for storage (fast local SSDs) or network. Using different nodes helps to optimize both costs and performance. To achieve the best possible performance, it is important to allow scheduling of Strimzi components to use the right nodes.

Kubernetes uses node affinity to schedule workloads onto specific nodes. Node affinity allows you to create a scheduling constraint for the node on which the pod will be scheduled. The constraint is specified as a label selector. You can specify the label using either the built-in node label like `beta.kubernetes.io/instance-type` or custom labels to select the right node.

### **Use node affinity and tolerations for dedicated nodes**

Use taints to create dedicated nodes, then schedule Kafka pods on the dedicated nodes by configuring node affinity and tolerations.

Cluster administrators can mark selected Kubernetes nodes as tainted. Nodes with taints are excluded from regular scheduling and normal pods will not be scheduled to run on them. Only services which can tolerate the taint set on the node can be scheduled on it. The only other services running on such nodes will be system services such as log collectors or software defined networks.

Running Kafka and its components on dedicated nodes can have many advantages. There will be no other applications running on the same nodes which could cause disturbance or consume the resources needed for Kafka. That can lead to improved performance and stability.

## 2.7.2. Configuring pod anti-affinity to schedule each Kafka broker on a different worker node

Many Kafka brokers or ZooKeeper nodes can run on the same Kubernetes worker node. If the worker node fails, they will all become unavailable at the same time. To improve reliability, you can use `podAntiAffinity` configuration to schedule each Kafka broker or ZooKeeper node on a different Kubernetes worker node.

### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

### Procedure

1. Edit the `affinity` property in the resource specifying the cluster deployment. To make sure that no worker nodes are shared by Kafka brokers or ZooKeeper nodes, use the `strimzi.io/name` label. Set the `topologyKey` to `kubernetes.io/hostname` to specify that the selected pods are not scheduled on nodes with the same hostname. This will still allow the same worker node to be shared by a single Kafka broker and a single ZooKeeper node. For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    template:
      pod:
        affinity:
          podAntiAffinity:
            requiredDuringSchedulingIgnoredDuringExecution:
              - labelSelector:
                  matchExpressions:
                    - key: strimzi.io/name
                      operator: In
                      values:
                        - CLUSTER-NAME-kafka
            topologyKey: "kubernetes.io/hostname"
    # ...
  zookeeper:
    # ...
```

```

template:
  pod:
    affinity:
      podAntiAffinity:
        requiredDuringSchedulingIgnoredDuringExecution:
          - labelSelector:
              matchExpressions:
                - key: strimzi.io/name
                  operator: In
                  values:
                    - CLUSTER-NAME-zookeeper
            topologyKey: "kubernetes.io/hostname"
  # ...

```

Where `CLUSTER-NAME` is the name of your Kafka custom resource.

2. If you even want to make sure that a Kafka broker and ZooKeeper node do not share the same worker node, use the `strimzi.io/cluster` label. For example:

```

apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    template:
      pod:
        affinity:
          podAntiAffinity:
            requiredDuringSchedulingIgnoredDuringExecution:
              - labelSelector:
                  matchExpressions:
                    - key: strimzi.io/cluster
                      operator: In
                      values:
                        - CLUSTER-NAME
            topologyKey: "kubernetes.io/hostname"
  # ...
  zookeeper:
    # ...
    template:
      pod:
        affinity:
          podAntiAffinity:
            requiredDuringSchedulingIgnoredDuringExecution:
              - labelSelector:
                  matchExpressions:
                    - key: strimzi.io/cluster
                      operator: In
                      values:
                        - CLUSTER-NAME

```

```
        topologyKey: "kubernetes.io/hostname"  
    # ...
```

Where `CLUSTER-NAME` is the name of your Kafka custom resource.

3. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

### 2.7.3. Configuring pod anti-affinity in Kafka components

Pod anti-affinity configuration helps with the stability and performance of Kafka brokers. By using `podAntiAffinity`, Kubernetes will not schedule Kafka brokers on the same nodes as other workloads. Typically, you want to avoid Kafka running on the same worker node as other network or storage intensive applications such as databases, storage or other messaging platforms.

#### *Prerequisites*

- A Kubernetes cluster
- A running Cluster Operator

#### *Procedure*

1. Edit the `affinity` property in the resource specifying the cluster deployment. Use labels to specify the pods which should not be scheduled on the same nodes. The `topologyKey` should be set to `kubernetes.io/hostname` to specify that the selected pods should not be scheduled on nodes with the same hostname. For example:

```
apiVersion: kafka.strimzi.io/v1beta2  
kind: Kafka  
spec:  
  kafka:  
    # ...  
  template:  
    pod:  
      affinity:  
        podAntiAffinity:  
          requiredDuringSchedulingIgnoredDuringExecution:  
            - labelSelector:  
                matchExpressions:  
                  - key: application  
                    operator: In  
                    values:  
                      - postgresql  
                      - mongodb  
          topologyKey: "kubernetes.io/hostname"  
    # ...  
  zookeeper:
```

```
# ...
```

2. Create or update the resource.

This can be done using `kubectl apply`:

```
kubectl apply -f <kafka_configuration_file>
```

## 2.7.4. Configuring node affinity in Kafka components

### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

### Procedure

1. Label the nodes where Strimzi components should be scheduled.

This can be done using `kubectl label`:

```
kubectl label node NAME-OF-NODE node-type=fast-network
```

Alternatively, some of the existing labels might be reused.

2. Edit the `affinity` property in the resource specifying the cluster deployment. For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    template:
      pod:
        affinity:
          nodeAffinity:
            requiredDuringSchedulingIgnoredDuringExecution:
              nodeSelectorTerms:
                - matchExpressions:
                    - key: node-type
                      operator: In
                      values:
                        - fast-network
    # ...
  zookeeper:
    # ...
```

3. Create or update the resource.

This can be done using `kubectl apply`:

```
kubectl apply -f <kafka_configuration_file>
```

## 2.7.5. Setting up dedicated nodes and scheduling pods on them

### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

### Procedure

1. Select the nodes which should be used as dedicated.
2. Make sure there are no workloads scheduled on these nodes.
3. Set the taints on the selected nodes:

This can be done using `kubectl taint`:

```
kubectl taint node NAME-OF-NODE dedicated=Kafka:NoSchedule
```

4. Additionally, add a label to the selected nodes as well.

This can be done using `kubectl label`:

```
kubectl label node NAME-OF-NODE dedicated=Kafka
```

5. Edit the `affinity` and `tolerations` properties in the resource specifying the cluster deployment.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    template:
      pod:
        tolerations:
          - key: "dedicated"
            operator: "Equal"
            value: "Kafka"
            effect: "NoSchedule"
        affinity:
          nodeAffinity:
            requiredDuringSchedulingIgnoredDuringExecution:
              nodeSelectorTerms:
```

```

    - matchExpressions:
      - key: dedicated
        operator: In
        values:
        - Kafka
      # ...
  zookeeper:
  # ...

```

6. Create or update the resource.

This can be done using `kubectl apply`:

```
kubectl apply -f <kafka_configuration_file>
```

## 2.8. Logging configuration

Configure logging levels in the custom resources of Kafka components and Strimzi Operators. You can specify the logging levels directly in the `spec.logging` property of the custom resource. Or you can define the logging properties in a ConfigMap that's referenced in the custom resource using the `configMapKeyRef` property.

The advantages of using a ConfigMap are that the logging properties are maintained in one place and are accessible to more than one resource. You can also reuse the ConfigMap for more than one resource. If you are using a ConfigMap to specify loggers for Strimzi Operators, you can also append the logging specification to add filters.

You specify a logging `type` in your logging specification:

- `inline` when specifying logging levels directly
- `external` when referencing a ConfigMap

*Example inline logging configuration*

```

spec:
# ...
logging:
  type: inline
  loggers:
    kafka.root.logger.level: "INFO"

```

*Example external logging configuration*

```

spec:
# ...
logging:
  type: external
  valueFrom:

```

```
configMapKeyRef:  
  name: my-config-map  
  key: my-config-map-key
```

Values for the `name` and `key` of the ConfigMap are mandatory. Default logging is used if the `name` or `key` is not set.

### 2.8.1. Logging options for Kafka components and operators

For more information on configuring logging for specific Kafka components or operators, see the following sections.

*Kafka component logging*

- [Kafka logging](#)
- [ZooKeeper logging](#)
- [Kafka Connect and Mirror Maker 2.0 logging](#)
- [MirrorMaker logging](#)
- [Kafka Bridge logging](#)
- [Cruise Control logging](#)

*Operator logging*

- [Cluster Operator logging](#)
- [Topic Operator logging](#)
- [User Operator logging](#)

### 2.8.2. Creating a ConfigMap for logging

To use a ConfigMap to define logging properties, you create the ConfigMap and then reference it as part of the logging definition in the `spec` of a resource.

The ConfigMap must contain the appropriate logging configuration.

- `log4j.properties` for Kafka components, ZooKeeper, and the Kafka Bridge
- `log4j2.properties` for the Topic Operator and User Operator

The configuration must be placed under these properties.

In this procedure a ConfigMap defines a root logger for a Kafka resource.

*Procedure*

1. Create the ConfigMap.

You can create the ConfigMap as a YAML file or from a properties file.

ConfigMap example with a root logger definition for Kafka:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: logging-configmap
data:
  log4j.properties:
    kafka.root.logger.level="INFO"
```

If you are using a properties file, specify the file at the command line:

```
kubectl create configmap logging-configmap --from-file=log4j.properties
```

The properties file defines the logging configuration:

```
# Define the logger
kafka.root.logger.level="INFO"
# ...
```

2. Define *external* logging in the `spec` of the resource, setting the `logging.valueFrom.configMapKeyRef.name` to the name of the ConfigMap and `logging.valueFrom.configMapKeyRef.key` to the key in this ConfigMap.

```
spec:
  # ...
  logging:
    type: external
    valueFrom:
      configMapKeyRef:
        name: logging-configmap
        key: log4j.properties
```

3. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

### 2.8.3. Adding logging filters to Operators

If you are using a ConfigMap to configure the (log4j2) logging levels for Strimzi Operators, you can also define logging filters to limit what's returned in the log.

Logging filters are useful when you have a large number of logging messages. Suppose you set the log level for the logger as DEBUG (`rootLogger.level="DEBUG"`). Logging filters reduce the number of logs returned for the logger at that level, so you can focus on a specific resource. When the filter is set, only log messages matching the filter are logged.

Filters use *markers* to specify what to include in the log. You specify a kind, namespace and name for the marker. For example, if a Kafka cluster is failing, you can isolate the logs by specifying the kind as **Kafka**, and use the namespace and name of the failing cluster.

This example shows a marker filter for a Kafka cluster named **my-kafka-cluster**.

#### *Basic logging filter configuration*

```
rootLogger.level="INFO"
appender.console.filter.filter1.type=MarkerFilter ①
appender.console.filter.filter1.onMatch=ACCEPT ②
appender.console.filter.filter1.onMismatch=DENY ③
appender.console.filter.filter1.marker=Kafka(my-namespace/my-kafka-cluster) ④
```

- ① The **MarkerFilter** type compares a specified marker for filtering.
- ② The **onMatch** property accepts the log if the marker matches.
- ③ The **onMismatch** property rejects the log if the marker does not match.
- ④ The marker used for filtering is in the format *KIND(NAMESPACE/NAME-OF-RESOURCE)*.

You can create one or more filters. Here, the log is filtered for two Kafka clusters.

#### *Multiple logging filter configuration*

```
appender.console.filter.filter1.type=MarkerFilter
appender.console.filter.filter1.onMatch=ACCEPT
appender.console.filter.filter1.onMismatch=DENY
appender.console.filter.filter1.marker=Kafka(my-namespace/my-kafka-cluster-1)
appender.console.filter.filter2.type=MarkerFilter
appender.console.filter.filter2.onMatch=ACCEPT
appender.console.filter.filter2.onMismatch=DENY
appender.console.filter.filter2.marker=Kafka(my-namespace/my-kafka-cluster-2)
```

#### *Adding filters to the Cluster Operator*

To add filters to the Cluster Operator, update its logging ConfigMap YAML file ([install/cluster-operator/050-ConfigMap-strimzi-cluster-operator.yaml](#)).

#### *Procedure*

1. Update the **050-ConfigMap-strimzi-cluster-operator.yaml** file to add the filter properties to the ConfigMap.

In this example, the filter properties return logs only for the **my-kafka-cluster** Kafka cluster:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: strimzi-cluster-operator
data:
  log4j2.properties:
```

```
#...
appender.console.filter.filter1.type=MarkerFilter
appender.console.filter.filter1.onMatch=ACCEPT
appender.console.filter.filter1.onMismatch=DENY
appender.console.filter.filter1.marker=Kafka(my-namespace/my-kafka-cluster)
```

Alternatively, edit the [ConfigMap](#) directly:

```
kubectl edit configmap strimzi-cluster-operator
```

2. If you updated the YAML file instead of editing the [ConfigMap](#) directly, apply the changes by deploying the ConfigMap:

```
kubectl create -f install/cluster-operator/050-ConfigMap-strimzi-cluster-
operator.yaml
```

#### *Adding filters to the Topic Operator or User Operator*

To add filters to the Topic Operator or User Operator, create or edit a logging ConfigMap.

In this procedure a logging ConfigMap is created with filters for the Topic Operator. The same approach is used for the User Operator.

#### *Procedure*

1. Create the ConfigMap.

You can create the ConfigMap as a YAML file or from a properties file.

In this example, the filter properties return logs only for the `my-topic` topic:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: logging-configmap
data:
  log4j2.properties:
    rootLogger.level="INFO"
    appender.console.filter.filter1.type=MarkerFilter
    appender.console.filter.filter1.onMatch=ACCEPT
    appender.console.filter.filter1.onMismatch=DENY
    appender.console.filter.filter1.marker=KafkaTopic(my-namespace/my-topic)
```

If you are using a properties file, specify the file at the command line:

```
kubectl create configmap logging-configmap --from-file=log4j2.properties
```

The properties file defines the logging configuration:

```
# Define the logger
rootLogger.level="INFO"
# Set the filters
appender.console.filter.filter1.type=MarkerFilter
appender.console.filter.filter1.onMatch=ACCEPT
appender.console.filter.filter1.onMismatch=DENY
appender.console.filter.filter1.marker=KafkaTopic(my-namespace/my-topic)
# ...
```

2. Define *external* logging in the `spec` of the resource, setting the `logging.valueFrom.configMapKeyRef.name` to the name of the ConfigMap and `logging.valueFrom.configMapKeyRef.key` to the key in this ConfigMap.

For the Topic Operator, logging is specified in the `topicOperator` configuration of the `Kafka` resource.

```
spec:
  # ...
  entityOperator:
    topicOperator:
      logging:
        type: external
        valueFrom:
          configMapKeyRef:
            name: logging-configmap
            key: log4j2.properties
```

3. Apply the changes by deploying the Cluster Operator:

```
create -f install/cluster-operator -n my-cluster-operator-namespace
```

#### Additional resources

- [Configuring Kafka](#)
- [Cluster Operator logging](#)
- [Topic Operator logging](#)
- [User Operator logging](#)

# Chapter 3. Loading configuration values from external sources

Use configuration provider plugins to load configuration data from external sources. The providers operate independently of Strimzi. You can use them to load configuration data for all Kafka components, including producers and consumers. Use them, for example, to provide the credentials for Kafka Connect connector configuration.

## Kubernetes Configuration Provider

The Kubernetes Configuration Provider plugin loads configuration data from Kubernetes secrets or ConfigMaps.

Suppose you have a [Secret](#) object that's managed outside the Kafka namespace, or outside the Kafka cluster. The Kubernetes Configuration Provider allows you to reference the values of the secret in your configuration without extracting the files. You just need to tell the provider what secret to use and provide access rights. The provider loads the data without needing to restart the Kafka component, even when using a new [Secret](#) or [ConfigMap](#) object. This capability avoids disruption when a Kafka Connect instance hosts multiple connectors.

## Environment Variables Configuration Provider

The Environment Variables Configuration Provider plugin loads configuration data from environment variables.

The values for the environment variables can be mapped from secrets or ConfigMaps. You can use the Environment Variables Configuration Provider, for example, to load certificates or JAAS configuration from environment variables mapped from Kubernetes secrets.

Kubernetes Configuration Provider can't use mounted files. For example, it can't load values that need the location of a truststore or keystore. Instead, you can mount ConfigMaps or secrets into a Kafka Connect pod as environment variables or volumes. You can use the Environment Variables Configuration Provider to load values for environment variables. You add configuration using the [externalConfiguration](#) property in [KafkaConnect.spec](#). You don't need to set up access rights with this approach. However, Kafka Connect will need a restart when using a new [Secret](#) or [ConfigMap](#) for a connector. This will cause disruption to all the Kafka Connect instance's connectors.

## 3.1. Loading configuration values from a ConfigMap

This procedure shows how to use the Kubernetes Configuration Provider plugin.

In the procedure, an external [ConfigMap](#) object provides configuration properties for a connector.

### *Prerequisites*

- A Kubernetes cluster is available.
- A Kafka cluster is running.

- The Cluster Operator is running.

#### *Procedure*

1. Create a **ConfigMap** or **Secret** that contains the configuration properties.

In this example, a **ConfigMap** object named `my-connector-configuration` contains connector properties:

*Example ConfigMap with connector properties*

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: my-connector-configuration
data:
  option1: value1
  option2: value2
```

2. Specify the Kubernetes Configuration Provider in the Kafka Connect configuration.

The specification shown here can support loading values from secrets and ConfigMaps.

*Example Kafka Connect configuration to enable the Kubernetes Configuration Provider*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
  annotations:
    strimzi.io/use-connector-resources: "true"
spec:
  # ...
  config:
    # ...
    config.providers: secrets,configmaps ①
    config.providers.secrets.class: io.strimzi.kafka.KubernetesSecretConfigProvider
    ②
    config.providers.configmaps.class:
      io.strimzi.kafka.KubernetesConfigMapConfigProvider ③
    # ...
```

① The alias for the configuration provider is used to define other configuration parameters. The provider parameters use the alias from `config.providers`, taking the form `config.providers.${alias}.class`.

② **KubernetesSecretConfigProvider** provides values from secrets.

③ **KubernetesConfigMapConfigProvider** provides values from config maps.

3. Create or update the resource to enable the provider.

```
kubectl apply -f <kafka_connect_configuration_file>
```

4. Create a role that permits access to the values in the external config map.

*Example role to access values from a config map*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: connector-configuration-role
rules:
- apiGroups: []
  resources: ["configmaps"]
  resourceNames: ["my-connector-configuration"]
  verbs: ["get"]
# ...
```

The rule gives the role permission to access the **my-connector-configuration** config map.

5. Create a role binding to permit access to the namespace that contains the config map.

*Example role binding to access the namespace that contains the config map*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: connector-configuration-role-binding
subjects:
- kind: ServiceAccount
  name: my-connect-connect
  namespace: my-project
roleRef:
  kind: Role
  name: connector-configuration-role
  apiGroup: rbac.authorization.k8s.io
# ...
```

The role binding gives the role permission to access the **my-project** namespace.

The service account must be the same one used by the Kafka Connect deployment. The service account name format is **<cluster\_name>-connect**, where **<cluster\_name>** is the name of the **KafkaConnect** custom resource.

6. Reference the config map in the connector configuration.

*Example connector configuration referencing the config map*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
```

```

metadata:
  name: my-connector
  labels:
    strimzi.io/cluster: my-connect
spec:
  # ...
  config:
    option: ${configmaps:my-project/my-connector-configuration:option1}
    # ...
# ...

```

Placeholders for the property values in the config map are referenced in the connector configuration. The placeholder structure is `configmaps:<path_and_file_name>:<property>`. `KubernetesConfigMapConfigProvider` reads and extracts the `option1` property value from the external config map.

## 3.2. Loading configuration values from environment variables

This procedure shows how to use the Environment Variables Configuration Provider plugin.

In the procedure, environment variables provide configuration properties for a connector. A database password is specified as an environment variable.

### Prerequisites

- A Kubernetes cluster is available.
- A Kafka cluster is running.
- The Cluster Operator is running.

### Procedure

1. Specify the Environment Variables Configuration Provider in the Kafka Connect configuration.

Define environment variables using the `externalConfiguration` property.

*Example Kafka Connect configuration to enable the Environment Variables Configuration Provider*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
  annotations:
    strimzi.io/use-connector-resources: "true"
spec:
  # ...
  config:
    # ...
    config.providers: env ①
    config.providers.env.class: io.strimzi.kafka.EnvVarConfigProvider ②

```

```

# ...
externalConfiguration:
  env:
    - name: DB_PASSWORD ③
      valueFrom:
        secretKeyRef:
          name: db-creds ④
          key: dbPassword ⑤
# ...

```

① The alias for the configuration provider is used to define other configuration parameters. The provider parameters use the alias from `config.providers`, taking the form `config.providers.${alias}.class`.

② `EnvVarConfigProvider` provides values from environment variables.

③ The `DB_PASSWORD` environment variable takes a password value from a secret.

④ The name of the secret containing the predefined password.

⑤ The key for the password stored inside the secret.

2. Create or update the resource to enable the provider.

```
kubectl apply -f <kafka_connect_configuration_file>
```

3. Reference the environment variable in the connector configuration.

*Example connector configuration referencing the environment variable*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-connector
  labels:
    strimzi.io/cluster: my-connect
spec:
  # ...
  config:
    option: ${env:DB_PASSWORD}
    # ...
# ...

```

# Chapter 4. Applying security context to Strimzi pods and containers

Security context defines constraints on pods and containers. By specifying a security context, pods and containers only have the permissions they need. For example, permissions can control runtime operations or access to resources.

## 4.1. How to configure security context

Use security provider plugins or template configuration to apply security context to Strimzi pods and containers.

Apply security context at the pod or container level:

### Pod-level security context

Pod-level security context is applied to all containers in a specific pod.

### Container-level security context

Container-level security context is applied to a specific container.

With Strimzi, security context is applied through one or both of the following methods:

#### Template configuration

Use `template` configuration of Strimzi custom resources to specify security context at the pod or container level.

#### Pod security provider plugins

Use pod security provider plugins to automatically set security context across all pods and containers using preconfigured settings.

Pod security providers offer a simpler alternative to specifying security context through `template` configuration. You can use both approaches. The `template` approach has a higher priority. Security context configured through `template` properties overrides the configuration set by pod security providers. So you might use pod security providers to automatically configure the security context for most containers. And also use `template` configuration to set container-specific security context where needed.

The `template` approach provides flexibility, but it also means you have to configure security context in numerous places to capture the security you want for all pods and containers. For example, you'll need to apply the configuration to each pod in a Kafka cluster, as well as the pods for deployments of other Kafka components.

To avoid repeating the same configuration, you can use the following pod security provider plugins so that the security configuration is in one place.

#### Baseline Provider

The Baseline Provider is based on the Kubernetes *baseline* security profile. The baseline profile

prevents privilege escalations and defines other standard access controls and limitations.

## Restricted Provider

The Restricted Provider is based on the Kubernetes *restricted* security profile. The restricted profile is more restrictive than the baseline profile, and is used where security needs to be tighter.

For more information on the Kubernetes security profiles, see [Pod security standards](#).

### 4.1.1. Template configuration for security context

In the following example, security context is configured for Kafka brokers in the `template` configuration of the `Kafka` resource. Security context is specified at the pod and container level.

*Example template configuration for security context*

```
apiVersion: {KafkaApiVersion}
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  kafka:
    template:
      pod: ①
        securityContext:
          runAsUser: 1000001
          fsGroup: 0
      kafkaContainer: ②
        securityContext:
          runAsUser: 2000
    # ...
```

① Pod security context

② Container security context of the Kafka broker container

### 4.1.2. Baseline Provider for pod security

The Baseline Provider is the default pod security provider. It configures the pods managed by Strimzi with a baseline security profile. The baseline profile is compatible with previous versions of Strimzi.

The Baseline Provider is enabled by default if you don't specify a provider. Though you can enable it explicitly by setting the `STRIMZI_POD_SECURITY_PROVIDER_CLASS` environment variable to `baseline` when [configuring the Cluster Operator](#).

*Configuration for the Baseline Provider*

```
# ...
env:
```

```
# ...
- name: STRIMZI_POD_SECURITY_PROVIDER_CLASS
  value: baseline
# ...
```

Instead of specifying `baseline` as the value, you can specify the `io.strimzi.plugin.securityprofiles.impl.BaselinePodSecurityProvider` fully-qualified domain name.

#### 4.1.3. Restricted Provider for pod security

The Restricted Provider provides a higher level of security than the Baseline Provider. It configures the pods managed by Strimzi with a restricted security profile.

You enable the Restricted Provider by setting the `STRIMZI_POD_SECURITY_PROVIDER_CLASS` environment variable to `restricted` when [configuring the Cluster Operator](#).

*Configuration for the Restricted Provider*

```
# ...
env:
# ...
- name: STRIMZI_POD_SECURITY_PROVIDER_CLASS
  value: restricted
# ...
```

Instead of specifying `restricted` as the value, you can specify the `io.strimzi.plugin.securityprofiles.impl.RestrictedPodSecurityProvider` fully-qualified domain name.

If you change to the Restricted Provider from the default Baseline Provider, the following restrictions are implemented in addition to the constraints defined in the baseline security profile:

- Limits allowed volume types
- Disallows privilege escalation
- Requires applications to run under a non-root user
- Requires `seccomp` (secure computing mode) profiles to be set as `RuntimeDefault` or `Localhost`
- Limits container capabilities to use only the `NET_BIND_SERVICE` capability

With the Restricted Provider enabled, containers created by the Cluster Operator are set with the following security context.

*Cluster Operator with restricted security context configuration*

```
# ...
securityContext:
  allowPrivilegeEscalation: false
  capabilities:
```

```
drop:  
  - ALL  
runAsNonRoot: true  
seccompProfile:  
  type: RuntimeDefault  
# ...
```

Container capabilities and `seccomp` are Linux kernel features that support container security.

**NOTE**

- Capabilities add fine-grained privileges for processes running on a container. The `NET_BIND_SERVICE` capability allows non-root user applications to bind to ports below 1024.
- `seccomp` profiles limit the processes running in a container to only a subset of system calls. The `RuntimeDefault` profile provides a default set of system calls. A `LocalHost` profile uses a profile defined in a file on the node.

*Additional resources*

- [Security context](#) on Kubernetes
- [Pod security standards](#) on Kubernetes (including profile descriptions)
- [ContainerTemplate schema reference](#)

## 4.2. Enabling the Restricted Provider for the Cluster Operator

Security pod providers configure the security context constraints of the pods and containers created by the Cluster Operator. The Baseline Provider is the default pod security provider used by Strimzi. You can switch to the Restricted Provider by changing the `STRIMZI_POD_SECURITY_PROVIDER_CLASS` environment variable in the Cluster Operator configuration.

To make the required changes, configure the `060-Deployment-strimzi-cluster-operator.yaml` Cluster Operator installation file located in `install/cluster-operator/`.

By enabling a new pod security provider, any pods or containers created by the Cluster Operator are subject to the limitations it imposes. Pods and containers that are already running are restarted for the changes to take affect.

*Prerequisites*

- You need an account with permission to create and manage `CustomResourceDefinition` and RBAC (`ClusterRole`, and `RoleBinding`) resources.

*Procedure*

Edit the `Deployment` resource that is used to deploy the Cluster Operator, which is defined in the `060-Deployment-strimzi-cluster-operator.yaml` file.

1. Add or amend the `STRIMZI_POD_SECURITY_PROVIDER_CLASS` environment variable with a value of

**restricted.**

*Cluster Operator configuration for the Restricted Provider*

```
# ...
env:
# ...
- name: STRIMZI_POD_SECURITY_PROVIDER_CLASS
  value: restricted
# ...
```

Or you can specify the `io.strimzi.plugin.security.profiles.impl.RestrictedPodSecurityProvider` fully-qualified domain name.

## 2. Deploy the Cluster Operator:

```
kubectl create -f install/cluster-operator -n myproject
```

## 3. (Optional) Use `template` configuration to set security context for specific components at the pod or container level.

*Adding security context through `template` configuration*

```
template:
pod:
  securityContext:
    runAsUser: 1000001
    fsGroup: 0
kafkaContainer:
  securityContext:
    runAsUser: 2000
# ...
```

If you apply specific security context for a component using `template` configuration, it takes priority over the general configuration provided by the pod security provider.

## 4.3. Implementing a custom pod security provider

If Strimzi's Baseline Provider and Restricted Provider don't quite match your needs, you can develop a custom pod security provider to deliver all-encompassing pod and container security context constraints.

Implement a custom pod security provider to apply your own security context profile. You can decide what applications and privileges to include in the profile.

Your custom pod security provider can implement the `PodSecurityProvider.java` interface that gets the security context for pods and containers; or it can extend the Baseline Provider or Restricted

Provider classes.

The pod security provider plugins use the Java Service Provider Interface, so your custom pod security provider also requires a provider configuration file for service discovery.

To implement your own provider, the general steps include the following:

1. Build the JAR file for the provider.
2. Add the JAR file to the Cluster Operator image.
3. Specify the custom pod security provider when setting the Cluster Operator environment variable `STRIMZI_POD_SECURITY_PROVIDER_CLASS`.

*Additional resources*

- [Pod security provider interface](#)
- [Baseline Provider and Restricted Provider classes](#)
- [Provider configuration file](#)
- [Java Service Provider Interface](#)

## 4.4. Handling of security context by Kubernetes platform

Handling of security context depends on the tooling of the Kubernetes platform you are using.

For example, OpenShift uses built-in security context constraints (SCCs) to control permissions. SCCs are the settings and strategies that control the security features a pod has access to.

By default, OpenShift injects security context configuration automatically. In most cases, this means you don't need to configure security context for the pods and containers created by the Cluster Operator. Although you can still create and manage your own SCCs.

For more information, see the [OpenShift documentation](#).

# Chapter 5. Accessing Kafka outside of the Kubernetes cluster

Use an external listener to expose your Strimzi Kafka cluster to a client outside a Kubernetes environment.

Specify the connection `type` to expose Kafka in the external listener configuration.

- `nodeport` uses `NodePort` type `Services`
- `loadbalancer` uses `Loadbalancer` type `Services`
- `ingress` uses Kubernetes `Ingress` and the `NGINX Ingress Controller for Kubernetes`
- `route` uses OpenShift `Routes` and the HAProxy router

For more information on listener configuration, see [GenericKafkaListener schema reference](#).

If you want to know more about the pros and cons of each connection type, refer to [Accessing Apache Kafka in Strimzi](#).

**NOTE**    `route` is only supported on OpenShift

## 5.1. Accessing Kafka using node ports

This procedure describes how to access a Strimzi Kafka cluster from an external client using node ports.

To connect to a broker, you need a hostname and port number for the Kafka *bootstrap address*, as well as the certificate used for authentication.

### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

### Procedure

1. Configure a `Kafka` resource with an external listener set to the `nodeport` type.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    listeners:
      - name: external
        port: 9094
        type: nodeport
```

```
  tls: true
  authentication:
    type: tls
    # ...
  # ...
zookeeper:
  # ...
```

2. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

**NodePort** type services are created for each Kafka broker, as well as an external *bootstrap service*. The bootstrap service routes external traffic to the Kafka brokers. Node addresses used for connection are propagated to the **status** of the Kafka custom resource.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret **<cluster\_name>-cluster-ca-cert**.

3. Retrieve the bootstrap address you can use to access the Kafka cluster from the status of the **Kafka** resource.

```
kubectl get kafka <kafka_cluster_name> -
-o=jsonpath='{.status.listeners[?(@.name=="<listener_name>")].bootstrapServers}{"\n"}'
```

For example:

```
kubectl get kafka my-cluster
-o=jsonpath='{.status.listeners[?(@.name=="external")].bootstrapServers}{"\n"}'
```

4. If TLS encryption is enabled, extract the public certificate of the broker certification authority.

```
kubectl get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.crt}'
| base64 -d > ca.crt
```

Use the extracted certificate in your Kafka client to configure TLS connection. If you enabled any authentication, you will also need to configure SASL or TLS authentication.

## 5.2. Accessing Kafka using loadbalancers

This procedure describes how to access a Strimzi Kafka cluster from an external client using loadbalancers.

To connect to a broker, you need the address of the *bootstrap loadbalancer*, as well as the certificate

used for TLS encryption.

#### Prerequisites

- A Kubernetes cluster
- A running Cluster Operator

#### Procedure

1. Configure a **Kafka** resource with an external listener set to the **loadbalancer** type.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    listeners:
      - name: external
        port: 9094
        type: loadbalancer
        tls: true
        # ...
        # ...
    zookeeper:
      # ...
```

2. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

**loadbalancer** type services and loadbalancers are created for each Kafka broker, as well as an external *bootstrap service*. The bootstrap service routes external traffic to all Kafka brokers. DNS names and IP addresses used for connection are propagated to the **status** of each service.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret `<cluster_name>-cluster-ca-cert`.

3. Retrieve the address of the bootstrap service you can use to access the Kafka cluster from the status of the **Kafka** resource.

```
kubectl get kafka <kafka_cluster_name> -
o=jsonpath='{.status.listeners[?(@.name=="<listener_name>")].bootstrapServers}{"\n"}'
```

For example:

```
kubectl get kafka my-cluster  
-o=jsonpath='{.status.listeners[?(@.name=="external")].bootstrapServers}{"\n"}'
```

4. If TLS encryption is enabled, extract the public certificate of the broker certification authority.

```
kubectl get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.crt}'  
| base64 -d > ca.crt
```

Use the extracted certificate in your Kafka client to configure TLS connection. If you enabled any authentication, you will also need to configure SASL or TLS authentication.

## 5.3. Accessing Kafka using ingress

This procedure shows how to access a Strimzi Kafka cluster from an external client outside of Kubernetes using Nginx Ingress.

To connect to a broker, you need a hostname (advertised address) for the Ingress *bootstrap address*, as well as the certificate used for authentication.

For access using Ingress, the port is always 443.

### TLS passthrough

Kafka uses a binary protocol over TCP, but the [NGINX Ingress Controller for Kubernetes](#) is designed to work with the HTTP protocol. To be able to pass the Kafka connections through the Ingress, Strimzi uses the TLS passthrough feature of the [NGINX Ingress Controller for Kubernetes](#). Ensure TLS passthrough is enabled in your [NGINX Ingress Controller for Kubernetes](#) deployment.

Because it is using the TLS passthrough functionality, TLS encryption cannot be disabled when exposing Kafka using [Ingress](#).

For more information about enabling TLS passthrough, see [TLS passthrough documentation](#).

### Prerequisites

- Kubernetes cluster
- Deployed [NGINX Ingress Controller for Kubernetes](#) with TLS passthrough enabled
- A running Cluster Operator

### Procedure

1. Configure a [Kafka](#) resource with an external listener set to the [ingress](#) type.

Specify the Ingress hosts for the bootstrap service and Kafka brokers.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2  
kind: Kafka
```

```

spec:
  kafka:
    # ...
    listeners:
      - name: external
        port: 9094
        type: ingress
        tls: true
        authentication:
          type: tls
    configuration: ①
      bootstrap:
        host: bootstrap.myingress.com
    brokers:
      - broker: 0
        host: broker-0.myingress.com
      - broker: 1
        host: broker-1.myingress.com
      - broker: 2
        host: broker-2.myingress.com
    # ...
  zookeeper:
    # ...

```

① Ingress hosts for the bootstrap service and Kafka brokers.

## 2. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

**ClusterIP** type services are created for each Kafka broker, as well as an additional *bootstrap service*. These services are used by the Ingress controller to route traffic to the Kafka brokers. An **Ingress** resource is also created for each service to expose them using the Ingress controller. The Ingress hosts are propagated to the **status** of each service.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret **<cluster\_name>-cluster-ca-cert**.

Use the address for the bootstrap host you specified in the **configuration** and port 443 (*BOOTSTRAP-HOST:443*) in your Kafka client as the *bootstrap address* to connect to the Kafka cluster.

## 3. Extract the public certificate of the broker certificate authority.

```
kubectl get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.crt}'
| base64 -d > ca.crt
```

Use the extracted certificate in your Kafka client to configure the TLS connection. If you enabled

any authentication, you will also need to configure SASL or TLS authentication.

## 5.4. Accessing Kafka using OpenShift routes

This procedure describes how to access a Strimzi Kafka cluster from an external client outside of OpenShift using routes.

To connect to a broker, you need a hostname for the route *bootstrap address*, as well as the certificate used for TLS encryption.

For access using routes, the port is always 443.

### Prerequisites

- An OpenShift cluster
- A running Cluster Operator

### Procedure

1. Configure a **Kafka** resource with an external listener set to the **route** type.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  labels:
    app: my-cluster
    name: my-cluster
    namespace: myproject
spec:
  kafka:
    # ...
    listeners:
      - name: listener1
        port: 9094
        type: route
        tls: true
        # ...
      # ...
  zookeeper:
    # ...
```

### WARNING

An OpenShift Route address comprises the name of the Kafka cluster, the name of the listener, and the name of the namespace it is created in. For example, **my-cluster-kafka-listener1-bootstrap-myproject** (*CLUSTER-NAME*-kafka-*LISTENER-NAME*-bootstrap-*NAMESPACE*). Be careful that the whole length of the address does not exceed a maximum limit of 63 characters.

2. Create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

**ClusterIP** type services are created for each Kafka broker, as well as an external *bootstrap service*. The services route the traffic from the OpenShift Routes to the Kafka brokers. An OpenShift **Route** resource is also created for each service to expose them using the HAProxy load balancer. DNS addresses used for connection are propagated to the **status** of each service.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret **<cluster\_name>-cluster-ca-cert**.

3. Retrieve the address of the bootstrap service you can use to access the Kafka cluster from the status of the **Kafka** resource.

```
kubectl get kafka <kafka_cluster_name> -o=jsonpath='{.status.listeners[?(@.name=="<listener_name>")].bootstrapServers}{"\n"}'
```

For example:

```
kubectl get kafka my-cluster -o=jsonpath='{.status.listeners[?(@.name=="listener1")].bootstrapServers}{"\n"}'
```

4. Extract the public certificate of the broker certification authority.

```
kubectl get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.crt}' | base64 -d > ca.crt
```

Use the extracted certificate in your Kafka client to configure TLS connection. If you enabled any authentication, you will also need to configure SASL or TLS authentication.

# Chapter 6. Managing secure access to Kafka

You can secure your Kafka cluster by managing the access each client has to the Kafka brokers.

A secure connection between Kafka brokers and clients can encompass:

- Encryption for data exchange
- Authentication to prove identity
- Authorization to allow or decline actions executed by users

This chapter explains how to set up secure connections between Kafka brokers and clients, with sections describing:

- Security options for Kafka clusters and clients
- How to secure Kafka brokers
- How to use an authorization server for OAuth 2.0 token-based authentication and authorization

## 6.1. Security options for Kafka

Use the [Kafka](#) resource to configure the mechanisms used for Kafka authentication and authorization.

### 6.1.1. Listener authentication

For clients inside the Kubernetes cluster, you can create `plain` (without encryption) or `tls internal` listeners. For clients outside the Kubernetes cluster, you create *external* listeners and specify a connection mechanism, which can be `nodeport`, `loadbalancer`, `ingress` or `route` (on OpenShift).

For more information on the configuration options for connecting an external client, see [Accessing Kafka outside of the Kubernetes cluster](#).

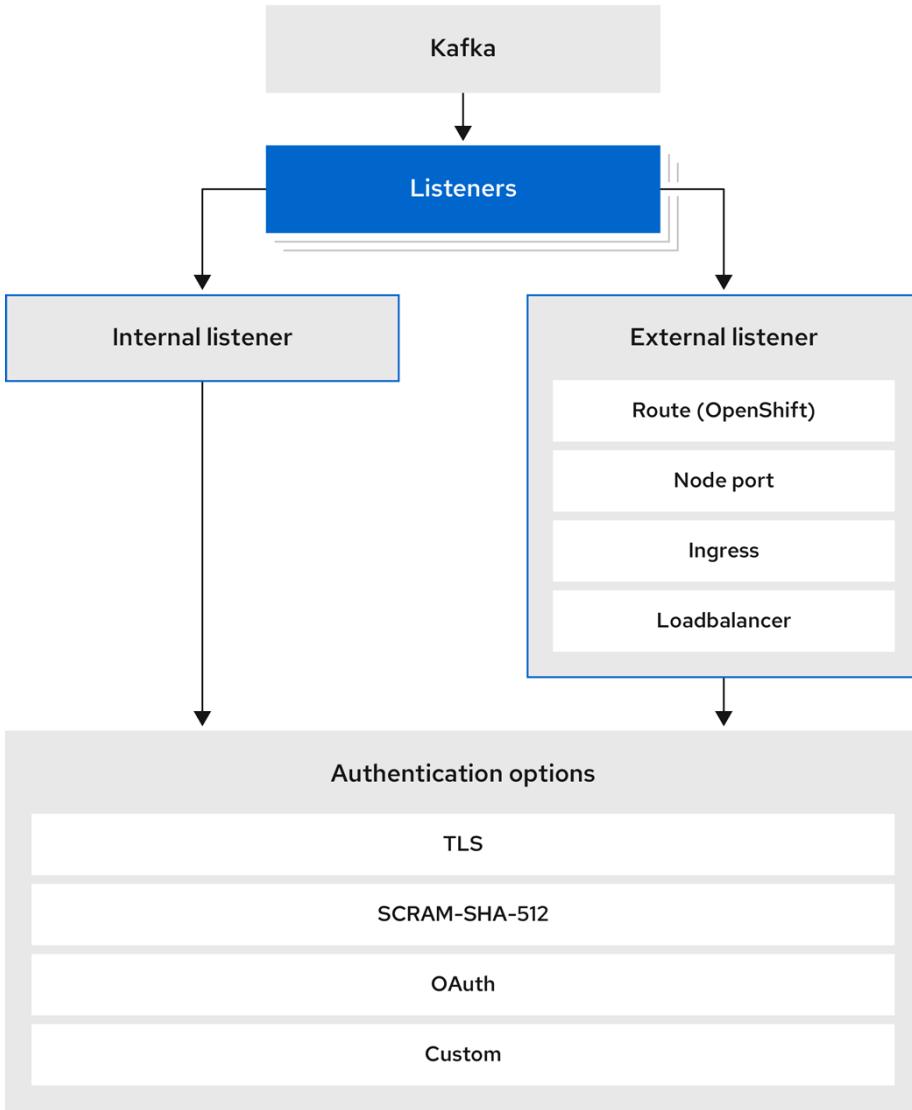
Supported authentication options:

1. Mutual TLS authentication (only on the listeners with TLS enabled encryption)
2. SCRAM-SHA-512 authentication
3. [OAuth 2.0 token-based authentication](#)
4. [Custom authentication](#)

The authentication option you choose depends on how you wish to authenticate client access to Kafka brokers.

**NOTE**

Try exploring the standard authentication options before using custom authentication. Custom authentication allows for any type of kafka-supported authentication. It can provide more flexibility, but also adds complexity.



222\_Streams\_0322

*Figure 3. Kafka listener authentication options*

The listener `authentication` property is used to specify an authentication mechanism specific to that listener.

If no `authentication` property is specified then the listener does not authenticate clients which connect through that listener. The listener will accept all connections without authentication.

Authentication must be configured when using the User Operator to manage `KafkaUsers`.

The following example shows:

- A `plain` listener configured for SCRAM-SHA-512 authentication
- A `tls` listener with mutual TLS authentication
- An `external` listener with mutual TLS authentication

Each listener is configured with a unique name and port within a Kafka cluster.

**NOTE**

Listeners cannot be configured to use the ports reserved for inter-broker communication (9091 or 9090) and metrics (9404).

## An example showing listener authentication configuration

```
# ...
listeners:
- name: plain
  port: 9092
  type: internal
  tls: true
  authentication:
    type: scram-sha-512
- name: tls
  port: 9093
  type: internal
  tls: true
  authentication:
    type: tls
- name: external
  port: 9094
  type: loadbalancer
  tls: true
  authentication:
    type: tls
# ...
```

## Mutual TLS authentication

Mutual TLS authentication is always used for the communication between Kafka brokers and ZooKeeper pods.

Strimzi can configure Kafka to use TLS (Transport Layer Security) to provide encrypted communication between Kafka brokers and clients either with or without mutual authentication. For mutual, or two-way, authentication, both the server and the client present certificates. When you configure mutual authentication, the broker authenticates the client (client authentication) and the client authenticates the broker (server authentication).

**NOTE** TLS authentication is more commonly one-way, with one party authenticating the identity of another. For example, when HTTPS is used between a web browser and a web server, the browser obtains proof of the identity of the web server.

## SCRAM-SHA-512 authentication

SCRAM (Salted Challenge Response Authentication Mechanism) is an authentication protocol that can establish mutual authentication using passwords. Strimzi can configure Kafka to use SASL (Simple Authentication and Security Layer) SCRAM-SHA-512 to provide authentication on both unencrypted and encrypted client connections.

When SCRAM-SHA-512 authentication is used with a TLS client connection, the TLS protocol provides the encryption, but is not used for authentication.

The following properties of SCRAM make it safe to use SCRAM-SHA-512 even on unencrypted connections:

- The passwords are not sent in the clear over the communication channel. Instead the client and the server are each challenged by the other to offer proof that they know the password of the authenticating user.
- The server and client each generate a new challenge for each authentication exchange. This means that the exchange is resilient against replay attacks.

When a `KafkaUser.spec.authentication.type` is configured with `scram-sha-512` the User Operator will generate a random 12-character password consisting of upper and lowercase ASCII letters and numbers.

## Network policies

By default, Strimzi automatically creates a `NetworkPolicy` resource for every listener that is enabled on a Kafka broker. This `NetworkPolicy` allows applications to connect to listeners in all namespaces. Use network policies as part of the listener configuration.

If you want to restrict access to a listener at the network level to only selected applications or namespaces, use the `networkPolicyPeers` property. Each listener can have a different `networkPolicyPeers` configuration. For more information on network policy peers, refer to the [NetworkPolicyPeer API reference](#).

If you want to use custom network policies, you can set the `STRIMZI_NETWORK_POLICY_GENERATION` environment variable to `false` in the Cluster Operator configuration. For more information, see [Cluster Operator configuration](#).

**NOTE**

Your configuration of Kubernetes must support ingress `NetworkPolicies` in order to use network policies in Strimzi.

## Additional listener configuration options

You can use the properties of the `GenericKafkaListenerConfiguration` schema to add further configuration to listeners.

### 6.1.2. Kafka authorization

You can configure authorization for Kafka brokers using the `authorization` property in the `Kafka.spec.kafka` resource. If the `authorization` property is missing, no authorization is enabled and clients have no restrictions. When enabled, authorization is applied to all enabled listeners. The authorization method is defined in the `type` field.

Supported authorization options:

- [Simple authorization](#)
- [OAuth 2.0 authorization](#) (if you are using OAuth 2.0 token based authentication)
- [Open Policy Agent \(OPA\) authorization](#)

- Custom authorization

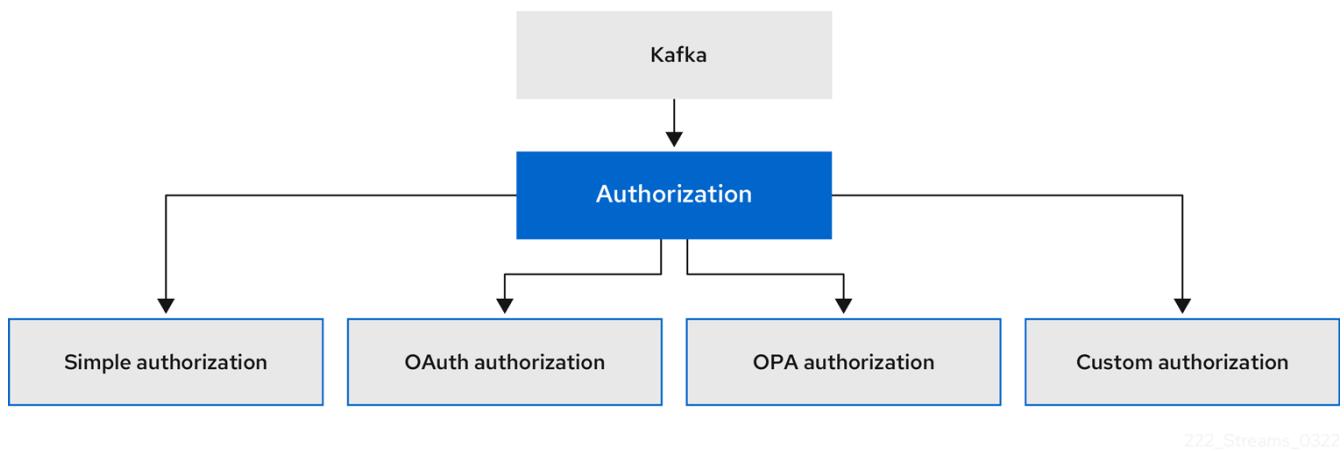


Figure 4. Kafka cluster authorization options

## Super users

Super users can access all resources in your Kafka cluster regardless of any access restrictions, and are supported by all authorization mechanisms.

To designate super users for a Kafka cluster, add a list of user principals to the `superUsers` property. If a user uses TLS client authentication, their username is the common name from their certificate subject prefixed with `CN=`. Otherwise, if not using the User Operator and using your own certificates for TLS client authentication, their username is their full certificate subject, with the fields formatted as: `CN=user,OU=my_ou,O=my_org,L=my_location,ST=my_state,C=my_country_code`. Note that some fields may not be present in the certificate's subject, and thus should be omitted.

*An example configuration with super users*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
  kafka:
    # ...
    authorization:
      type: simple
      superUsers:
        - CN=client_1
        - user_2
        - CN=client_3
        - CN=client_4,OU=my_ou,O=my_org,L=my_location,ST=my_state,C=US
        - CN=client_5,OU=my_ou,O=my_org,C=GB
        - CN=client_6,O=my_org
    # ...
  
```

## 6.2. Security options for Kafka clients

Use the [KafkaUser](#) resource to configure the authentication mechanism, authorization mechanism, and access rights for Kafka clients. In terms of configuring security, clients are represented as users.

You can authenticate and authorize user access to Kafka brokers. Authentication permits access, and authorization constrains the access to permissible actions.

You can also create *super users* that have unconstrained access to Kafka brokers.

The authentication and authorization mechanisms must match the [specification for the listener used to access the Kafka brokers](#).

*Configuring users for secure access to Kafka brokers*

For more information on configuring a [KafkaUser](#) resource to access Kafka brokers securely, see the following sections:

- [Securing user access to Kafka](#)
- [Setting up access for clients outside of Kubernetes](#)

### 6.2.1. Identifying a Kafka cluster for user handling

A [KafkaUser](#) resource includes a label that defines the appropriate name of the Kafka cluster (derived from the name of the [Kafka](#) resource) to which it belongs.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
```

The label is used by the User Operator to identify the [KafkaUser](#) resource and create a new user, and also in subsequent handling of the user.

If the label does not match the Kafka cluster, the User Operator cannot identify the [KafkaUser](#) and the user is not created.

If the status of the [KafkaUser](#) resource remains empty, check your label.

### 6.2.2. User authentication

User authentication is configured using the [authentication](#) property in [KafkaUser.spec](#). The authentication mechanism enabled for the user is specified using the [type](#) field.

Supported authentication types:

- [tls](#) for TLS client authentication

- `tls-external` for TLS client authentication using external certificates
- `scram-sha-512` for SCRAM-SHA-512 authentication

If `tls` or `scram-sha-512` is specified, the User Operator creates authentication credentials when it creates the user. If `tls-external` is specified, the user still uses TLS client authentication, but no authentication credentials are created. Use this option when you're providing your own certificates. When no authentication type is specified, the User Operator does not create the user or its credentials.

You can use `tls-external` to authenticate with TLS client authentication using a certificate issued outside the User Operator. The User Operator does not generate a TLS certificate or a secret. You can still manage ACL rules and quotas through the User Operator in the same way as when you're using the `tls` mechanism. This means that you use the `CN=USER-NAME` format when specifying ACL rules and quotas. *USER-NAME* is the common name given in a TLS certificate.

#### *Additional resources*

- [When to use mutual TLS authentication or SCRAM-SHA Authentication authentication for clients](#)
- [KafkaUserSpec schema reference](#)

### TLS client authentication

To use TLS client authentication, you set the `type` field in the `KafkaUser` resource to `tls`.

#### *Example user with TLS client authentication enabled*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication:
    type: tls
  # ...
```

When the user is created by the User Operator, it creates a new secret with the same name as the `KafkaUser` resource. The secret contains a private and public key for TLS client authentication. The public key is contained in a user certificate, which is signed by the client Certificate Authority (CA).

If you are using the clients CA generated by the Cluster Operator, the user certificates generated by the User Operator are also renewed when the client CA is renewed by the Cluster Operator.

All keys are in X.509 format.

Secrets provide private keys and certificates in PEM and PKCS #12 formats.

For more information on securing Kafka communication with secrets, see [Managing TLS](#)

[certificates](#).

*Example secret with user credentials*

```
apiVersion: v1
kind: Secret
metadata:
  name: my-user
  labels:
    strimzi.io/kind: KafkaUser
    strimzi.io/cluster: my-cluster
type: Opaque
data:
  ca.crt: # Public key of the client CA
  user.crt: # User certificate that contains the public key of the user
  user.key: # Private key of the user
  user.p12: # PKCS #12 archive file for storing certificates and keys
  user.password: # Password for protecting the PKCS #12 archive file
```

## TLS client authentication using a certificate issued outside the User Operator

To use TLS client authentication using a certificate issued outside the User Operator, you set the `type` field in the [KafkaUser](#) resource to `tls-external`. A secret and credentials are not created for the user.

*Example user with TLS client authentication that uses a certificate issued outside the User Operator*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication:
    type: tls-external
    # ...
```

## SCRAM-SHA-512 authentication

To use the SCRAM-SHA-512 authentication mechanism, you set the `type` field in the [KafkaUser](#) resource to `scram-sha-512`.

*Example user with SCRAM-SHA-512 authentication enabled*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
```

```
  strimzi.io/cluster: my-cluster
spec:
  authentication:
    type: scram-sha-512
  # ...
```

When the user is created by the User Operator, it creates a new secret with the same name as the [KafkaUser](#) resource. The secret contains the generated password in the `password` key, which is encoded with base64. In order to use the password, it must be decoded.

*Example secret with user credentials*

```
apiVersion: v1
kind: Secret
metadata:
  name: my-user
  labels:
    strimzi.io/kind: KafkaUser
    strimzi.io/cluster: my-cluster
type: Opaque
data:
  password: Z2VuZXJhdGVkcGFzc3dvcmQ= ①
  sasl.jaas.config:
    b3JnLmFwYWNoZS5rYWZrYS5jb21tb24uc2VjdXJpdHkuc2NyYW0uU2NyYW1Mb2dpbk1vZHVsZSBzXF1aXJlZC
    B1c2VybmtT0ibXktDXNlcIlgcGFzc3dvcmQ9ImdlbmVyYXR1ZHhc3N3b3JkIjsK ②
```

① The generated password, base64 encoded.

② The JAAS configuration string for SASL SCRAM-SHA-512 authentication, base64 encoded.

Decoding the generated password:

```
echo "Z2VuZXJhdGVkcGFzc3dvcmQ=" | base64 --decode
```

### Custom password configuration

When a user is created, Strimzi generates a random password. You can use your own password instead of the one generated by Strimzi. To do so, create a secret with the password and reference it in the [KafkaUser](#) resource.

*Example user with a password set for SCRAM-SHA-512 authentication*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication:
```

```
type: scram-sha-512
password:
  valueFrom:
    secretKeyRef:
      name: my-secret ①
      key: my-password ②
# ...
```

① The name of the secret containing the predefined password.

② The key for the password stored inside the secret.

### 6.2.3. User authorization

User authorization is configured using the `authorization` property in `KafkaUser.spec`. The authorization type enabled for a user is specified using the `type` field.

To use simple authorization, you set the `type` property to `simple` in `KafkaUser.spec.authorization`. The simple authorization will use the Kafka Admin API to manage the ACL rules inside your Kafka cluster. Whether ACL management in the User Operator is enabled or not depends on your authorization configuration in the Kafka cluster.

- For simple authorization, ACL management is always enabled.
- For OPA authorization, ACL management is always disabled. Authorization rules are configured in the OPA server.
- For Keycloak authorization, you can manage the ACL rules directly in Keycloak. You can also delegate authorization to the simple authorizer as a fallback option in the configuration. When delegation to the simple authorizer is enabled, the User Operator will enable management of ACL rules as well.
- For custom authorization using a custom authorization plugin, use the `supportsAdminApi` property in the `.spec.kafka.authorization` configuration of the `Kafka` custom resource to enable or disable the support.

If ACL management is not enabled, Strimzi rejects a resource if it contains any ACL rules.

If you're using a standalone deployment of the User Operator, ACL management is enabled by default. You can disable it using the `STRIMZI_ACLS_ADMIN_API_SUPPORTED` environment variable.

If no authorization is specified, the User Operator does not provision any access rights for the user. Whether such a `KafkaUser` can still access resources depends on the authorizer being used. For example, for the `AclAuthorizer` this is determined by its `allow.everyone.if.no.acl.found` configuration.

#### ACL rules

`AclAuthorizer` uses ACL rules to manage access to Kafka brokers.

ACL rules grant access rights to the user, which you specify in the `acls` property.

For more information about the `AclRule` object, see the [AclRule schema reference](#).

## Super user access to Kafka brokers

If a user is added to a list of super users in a Kafka broker configuration, the user is allowed unlimited access to the cluster regardless of any authorization constraints defined in ACLs in [KafkaUser](#).

For more information on configuring super user access to brokers, see [Kafka authorization](#).

## User quotas

You can configure the `spec` for the [KafkaUser](#) resource to enforce quotas so that a user does not exceed a configured level of access to Kafka brokers. You can set size-based network usage and time-based CPU utilization thresholds. You can also add a partition mutation quota to control the rate at which requests to change partitions are accepted for user requests.

An example [KafkaUser](#) with user quotas

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  # ...
  quotas:
    producerByteRate: 1048576 ①
    consumerByteRate: 2097152 ②
    requestPercentage: 55 ③
    controllerMutationRate: 10 ④
```

① Byte-per-second quota on the amount of data the user can push to a Kafka broker

② Byte-per-second quota on the amount of data the user can fetch from a Kafka broker

③ CPU utilization limit as a percentage of time for a client group

④ Number of concurrent partition creation and deletion operations (mutations) allowed per second

For more information on these properties, see the [KafkaUserQuotas schema reference](#).

## 6.3. Securing access to Kafka brokers

To establish secure access to Kafka brokers, you configure and apply:

- A [Kafka](#) resource to:
  - Create listeners with a specified authentication type
  - Configure authorization for the whole Kafka cluster
- A [KafkaUser](#) resource to access the Kafka brokers securely through the listeners

Configure the [Kafka](#) resource to set up:

- Listener authentication
- Network policies that restrict access to Kafka listeners
- Kafka authorization
- Super users for unconstrained access to brokers

Authentication is configured independently for each listener. Authorization is always configured for the whole Kafka cluster.

The Cluster Operator creates the listeners and sets up the cluster and client certificate authority (CA) certificates to enable authentication within the Kafka cluster.

You can replace the certificates generated by the Cluster Operator by [installing your own certificates](#). You can also [configure your listener to use a Kafka listener certificate managed by an external Certificate Authority](#). Certificates are available in PKCS #12 format (.p12) and PEM (.crt) formats.

Use [KafkaUser](#) to enable the authentication and authorization mechanisms that a specific client uses to access Kafka.

Configure the [KafkaUser](#) resource to set up:

- Authentication to match the enabled listener authentication
- Authorization to match the enabled Kafka authorization
- Quotas to control the use of resources by clients

The User Operator creates the user representing the client and the security credentials used for client authentication, based on the chosen authentication type.

Refer to the schema reference for more information on access configuration properties:

- [Kafka schema reference](#)
- [KafkaUser schema reference](#)
- [GenericKafkaListener schema reference](#)

### 6.3.1. Securing Kafka brokers

This procedure shows the steps involved in securing Kafka brokers when running Strimzi.

The security implemented for Kafka brokers must be compatible with the security implemented for the clients requiring access.

- `Kafka.spec.kafka.listeners[*].authentication` matches `KafkaUser.spec.authentication`
- `Kafka.spec.kafka.authorization` matches `KafkaUser.spec.authorization`

The steps show the configuration for simple authorization and a listener using TLS authentication. For more information on listener configuration, see [GenericKafkaListener schema reference](#).

Alternatively, you can use SCRAM-SHA or OAuth 2.0 for [listener authentication](#), and OAuth 2.0 or OPA for [Kafka authorization](#).

#### Procedure

1. Configure the [Kafka](#) resource.
  - a. Configure the [authorization](#) property for authorization.
  - b. Configure the [listeners](#) property to create a listener with authentication.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    authorization: ①
      type: simple
    superUsers: ②
      - CN=client_1
      - user_2
      - CN=client_3
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: tls ③
    # ...
  zookeeper:
    # ...
```

① Authorization enables [simple authorization](#) on the Kafka broker using the [AclAuthorizer Kafka plugin](#).

② List of user principals with unlimited access to Kafka. *CN* is the common name from the client certificate when TLS authentication is used.

③ Listener authentication mechanisms may be configured for each listener, and [specified as mutual TLS, SCRAM-SHA-512 or token-based OAuth 2.0](#).

If you are configuring an external listener, the configuration is dependent on the chosen connection mechanism.

2. Create or update the [Kafka](#) resource.

```
kubectl apply -f <kafka_configuration_file>
```

The Kafka cluster is configured with a Kafka broker listener using TLS authentication.

A service is created for each Kafka broker pod.

A service is created to serve as the *bootstrap address* for connection to the Kafka cluster.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret `<cluster_name>-cluster-ca-cert`.

### 6.3.2. Securing user access to Kafka

Create or modify a `KafkaUser` to represent a client that requires secure access to the Kafka cluster.

When you configure the `KafkaUser` authentication and authorization mechanisms, ensure they match the equivalent `Kafka` configuration:

- `KafkaUser.spec.authentication` matches `Kafka.spec.kafka.listeners[*].authentication`
- `KafkaUser.spec.authorization` matches `Kafka.spec.kafka.authorization`

This procedure shows how a user is created with TLS authentication. You can also create a user with SCRAM-SHA authentication.

The authentication required depends on the [type of authentication configured for the Kafka broker listener](#).

**NOTE** Authentication between Kafka users and Kafka brokers depends on the authentication settings for each. For example, it is not possible to authenticate a user with TLS if it is not also enabled in the Kafka configuration.

#### Prerequisites

- A running Kafka cluster [configured with a Kafka broker listener using TLS authentication and encryption](#).
- A running User Operator (typically [deployed with the Entity Operator](#)).

The authentication type in `KafkaUser` should match the authentication configured in `Kafka` brokers.

#### Procedure

1. Configure the `KafkaUser` resource.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication: ①
    type: tls
  authorization:
```

```

type: simple ②
acls:
  - resource:
      type: topic
      name: my-topic
      patternType: literal
      operations:
        - Describe
        - Read
  - resource:
      type: group
      name: my-group
      patternType: literal
      operations:
        - Read

```

① User authentication mechanism, defined as mutual `tls` or `scram-sha-512`.

② Simple authorization, which requires an accompanying list of ACL rules.

2. Create or update the `KafkaUser` resource.

```
kubectl apply -f <user_config_file>
```

The user is created, as well as a Secret with the same name as the `KafkaUser` resource. The Secret contains a private and public key for TLS client authentication.

For information on configuring a Kafka client with properties for secure connection to Kafka brokers, see [Setting up access for clients outside of Kubernetes](#).

### 6.3.3. Restricting access to Kafka listeners using network policies

You can restrict access to a listener to only selected applications by using the `networkPolicyPeers` property.

#### *Prerequisites*

- A Kubernetes cluster with support for Ingress NetworkPolicies.
- The Cluster Operator is running.

#### *Procedure*

1. Open the `Kafka` resource.
2. In the `networkPolicyPeers` property, define the application pods or namespaces that will be allowed to access the Kafka cluster.

For example, to configure a `tls` listener to allow connections only from application pods with the label `app` set to `kafka-client`:

```
apiVersion: kafka.strimzi.io/v1beta2
```

```
kind: Kafka
spec:
  kafka:
    # ...
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: tls
    networkPolicyPeers:
      - podSelector:
          matchLabels:
            app: kafka-client
    # ...
  zookeeper:
    # ...
```

### 3. Create or update the resource.

Use `kubectl apply`:

```
kubectl apply -f your-file
```

#### *Additional resources*

- [networkPolicyPeers configuration](#)
- [NetworkPolicyPeer API reference](#)

## 6.4. Using OAuth 2.0 token-based authentication

Strimzi supports the use of [OAuth 2.0 authentication](#) using the *OAUTHBEARER* and *PLAIN* mechanisms.

OAuth 2.0 enables standardized token-based authentication and authorization between applications, using a central authorization server to issue tokens that grant limited access to resources.

Kafka brokers and clients both need to be configured to use OAuth 2.0. You can configure OAuth 2.0 authentication, then [OAuth 2.0 authorization](#).

**NOTE**    OAuth 2.0 authentication can be used in conjunction with [Kafka authorization](#).

Using OAuth 2.0 authentication, application clients can access resources on application servers (called *resource servers*) without exposing account credentials.

The application client passes an access token as a means of authenticating, which application

servers can also use to determine the level of access to grant. The authorization server handles the granting of access and inquiries about access.

In the context of Strimzi:

- Kafka brokers act as OAuth 2.0 resource servers
- Kafka clients act as OAuth 2.0 application clients

Kafka clients authenticate to Kafka brokers. The brokers and clients communicate with the OAuth 2.0 authorization server, as necessary, to obtain or validate access tokens.

For a deployment of Strimzi, OAuth 2.0 integration provides:

- Server-side OAuth 2.0 support for Kafka brokers
- Client-side OAuth 2.0 support for Kafka MirrorMaker, Kafka Connect, and the Kafka Bridge

#### 6.4.1. OAuth 2.0 authentication mechanisms

Strimzi supports the OAUTHBearer and PLAIN mechanisms for OAuth 2.0 authentication. Both mechanisms allow Kafka clients to establish authenticated sessions with Kafka brokers. The authentication flow between clients, the authorization server, and Kafka brokers is different for each mechanism.

We recommend that you configure clients to use OAUTHBearer whenever possible. OAUTHBearer provides a higher level of security than PLAIN because client credentials are *never* shared with Kafka brokers. Consider using PLAIN only with Kafka clients that do not support OAUTHBearer.

You configure Kafka broker listeners to use OAuth 2.0 authentication for connecting clients. If necessary, you can use the OAUTHBearer and PLAIN mechanisms on the same `oauth` listener. The properties to support each mechanism must be explicitly specified in the `oauth` listener configuration.

##### OAUTHBearer overview

OAUTHBearer is automatically enabled in the `oauth` listener configuration for the Kafka broker. You can set the `enableOauthBearer` property to `true`, though this is not required.

```
# ...
authentication:
  type: oauth
  # ...
  enableOauthBearer: true
```

Many Kafka client tools use libraries that provide basic support for OAUTHBearer at the protocol level. To support application development, Strimzi provides an *OAuth callback handler* for the upstream Kafka Client Java libraries (but not for other libraries). Therefore, you do not need to write your own callback handlers. An application client can use the callback handler to provide the access token. Clients written in other languages, such as Go, must use custom code to connect to the

authorization server and obtain the access token.

With OAUTHBEARER, the client initiates a session with the Kafka broker for credentials exchange, where credentials take the form of a bearer token provided by the callback handler. Using the callbacks, you can configure token provision in one of three ways:

- Client ID and Secret (by using the *OAuth 2.0 client credentials* mechanism)
- A long-lived access token, obtained manually at configuration time
- A long-lived refresh token, obtained manually at configuration time

**NOTE**

OAUTHBEARER authentication can only be used by Kafka clients that support the OAUTHBEARER mechanism at the protocol level.

### PLAIN overview

To use PLAIN, you must enable it in the `oauth` listener configuration for the Kafka broker.

In the following example, PLAIN is enabled in addition to OAUTHBEARER, which is enabled by default. If you want to use PLAIN only, you can disable OAUTHBEARER by setting `enableOauthBearer` to `false`.

```
# ...
authentication:
  type: oauth
  # ...
  enablePlain: true
  tokenEndpointUri: https://OAUTH-SERVER-
ADDRESS/auth/realms/external/protocol/openid-connect/token
```

PLAIN is a simple authentication mechanism used by all Kafka client tools. To enable PLAIN to be used with OAuth 2.0 authentication, Strimzi provides *OAuth 2.0 over PLAIN* server-side callbacks.

With the Strimzi implementation of PLAIN, the client credentials are not stored in ZooKeeper. Instead, client credentials are handled centrally behind a compliant authorization server, similar to when OAUTHBEARER authentication is used.

When used with the OAuth 2.0 over PLAIN callbacks, Kafka clients authenticate with Kafka brokers using either of the following methods:

- Client ID and secret (by using the OAuth 2.0 client credentials mechanism)
- A long-lived access token, obtained manually at configuration time

For both methods, the client must provide the PLAIN `username` and `password` properties to pass credentials to the Kafka broker. The client uses these properties to pass a client ID and secret or username and access token.

Client IDs and secrets are used to obtain access tokens.

Access tokens are passed as `password` property values. You pass the access token with or without an

`$accessToken`: prefix.

- If you configure a token endpoint (`tokenEndpointUri`) in the listener configuration, you need the prefix.
- If you don't configure a token endpoint (`tokenEndpointUri`) in the listener configuration, you don't need the prefix. The Kafka broker interprets the password as a raw access token.

If the `password` is set as the access token, the `username` must be set to the same principal name that the Kafka broker obtains from the access token. You can specify username extraction options in your listener using the `userNameClaim`, `fallbackUserNameClaim`, `fallbackUsernamePrefix`, and `userInfoEndpointUri` properties. The username extraction process also depends on your authorization server; in particular, how it maps client IDs to account names.

**NOTE** OAuth over PLAIN does not support `password grant` mechanism. You can only 'proxy' through SASL PLAIN mechanism the `client credentials` (`clientId + secret`) or the access token as described above.

#### Additional resources

- [Configuring OAuth 2.0 support for Kafka brokers](#)

### 6.4.2. OAuth 2.0 Kafka broker configuration

Kafka broker configuration for OAuth 2.0 involves:

- Creating the OAuth 2.0 client in the authorization server
- Configuring OAuth 2.0 authentication in the Kafka custom resource

**NOTE** In relation to the authorization server, Kafka brokers and Kafka clients are both regarded as OAuth 2.0 clients.

#### OAuth 2.0 client configuration on an authorization server

To configure a Kafka broker to validate the token received during session initiation, the recommended approach is to create an OAuth 2.0 *client* definition in an authorization server, configured as *confidential*, with the following client credentials enabled:

- Client ID of `kafka` (for example)
- Client ID and Secret as the authentication mechanism

**NOTE** You only need to use a client ID and secret when using a non-public introspection endpoint of the authorization server. The credentials are not typically required when using public authorization server endpoints, as with fast local JWT token validation.

#### OAuth 2.0 authentication configuration in the Kafka cluster

To use OAuth 2.0 authentication in the Kafka cluster, you specify, for example, a TLS listener

configuration for your Kafka cluster custom resource with the authentication method **oauth**:

#### *Assigning the authentication method type for OAuth 2.0*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: oauth
#...
```

You can configure **plain**, **tls** and **external** listeners, but it is recommended not to use **plain** listeners or **external** listeners with disabled TLS encryption with OAuth 2.0 as this creates a vulnerability to network eavesdropping and unauthorized access through token theft.

You configure an **external** listener with **type: oauth** for a secure transport layer to communicate with the client.

#### *Using OAuth 2.0 with an external listener*

```
# ...
listeners:
  - name: external
    port: 9094
    type: loadbalancer
    tls: true
    authentication:
      type: oauth
#...
```

The **tls** property is *false* by default, so it must be enabled.

When you have defined the type of authentication as OAuth 2.0, you add configuration based on the type of validation, either as [fast local JWT validation](#) or [token validation using an introspection endpoint](#).

The procedure to configure OAuth 2.0 for listeners, with descriptions and examples, is described in [Configuring OAuth 2.0 support for Kafka brokers](#).

### **Fast local JWT token validation configuration**

Fast local JWT token validation checks a JWT token signature locally.

The local check ensures that a token:

- Conforms to type by containing a `(typ)` claim value of `Bearer` for an access token
- Is valid (not expired)
- Has an issuer that matches a `validIssuerURI`

You specify a `validIssuerURI` attribute when you configure the listener, so that any tokens not issued by the authorization server are rejected.

The authorization server does not need to be contacted during fast local JWT token validation. You activate fast local JWT token validation by specifying a `jwksEndpointUri` attribute, the endpoint exposed by the OAuth 2.0 authorization server. The endpoint contains the public keys used to validate signed JWT tokens, which are sent as credentials by Kafka clients.

**NOTE**

All communication with the authorization server should be performed using TLS encryption.

You can configure a certificate truststore as a Kubernetes Secret in your Strimzi project namespace, and use a `tlsTrustedCertificates` attribute to point to the Kubernetes Secret containing the truststore file.

You might want to configure a `userNameClaim` to properly extract a username from the JWT token. If you want to use Kafka ACL authorization, you need to identify the user by their username during authentication. (The `sub` claim in JWT tokens is typically a unique ID, not a username.)

*Example configuration for fast local JWT token validation*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    #...
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: oauth
          validIssuerUri: <https://<auth-server-address>/auth/realm/tls>
          jwksEndpointUri: <https://<auth-server-
address>/auth/realm/tls/protocol/openid-connect/certs>
          userNameClaim: preferred_username
          maxSecondsWithoutReauthentication: 3600
        tlsTrustedCertificates:
          - secretName: oauth-server-cert
            certificate: ca.crt
    #...
```

## OAuth 2.0 introspection endpoint configuration

Token validation using an OAuth 2.0 introspection endpoint treats a received access token as opaque. The Kafka broker sends an access token to the introspection endpoint, which responds with the token information necessary for validation. Importantly, it returns up-to-date information if the specific access token is valid, and also information about when the token expires.

To configure OAuth 2.0 introspection-based validation, you specify an `introspectionEndpointUri` attribute rather than the `jwksEndpointUri` attribute specified for fast local JWT token validation. Depending on the authorization server, you typically have to specify a `clientId` and `clientSecret`, because the introspection endpoint is usually protected.

*Example configuration for an introspection endpoint*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    listeners:
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: oauth
          clientId: kafka-broker
          clientSecret:
            secretName: my-cluster-oauth
            key: clientSecret
          validIssuerUri: <https://<auth-server-address>/auth/realms/tls>
          introspectionEndpointUri: <https://<auth-server-
address>/auth/realms/tls/protocol/openid-connect/token/introspect>
          userNameClaim: preferred_username
          maxSecondsWithoutReauthentication: 3600
          tlsTrustedCertificates:
            - secretName: oauth-server-cert
              certificate: ca.crt
```

### 6.4.3. Session re-authentication for Kafka brokers

You can configure `oauth` listeners to use Kafka *session re-authentication* for OAuth 2.0 sessions between Kafka clients and Kafka brokers. This mechanism enforces the expiry of an authenticated session between the client and the broker after a defined period of time. When a session expires, the client immediately starts a new session by reusing the existing connection rather than dropping it.

Session re-authentication is disabled by default. To enable it, you set a time value for `maxSecondsWithoutReauthentication` in the `oauth` listener configuration. The same property is used to configure session re-authentication for OAUTHBEARER and PLAIN authentication. For an example configuration, see [Configuring OAuth 2.0 support for Kafka brokers](#).

Session re-authentication must be supported by the Kafka client libraries used by the client.

Session re-authentication can be used with *fast local JWT* or *introspection endpoint* token validation.

#### *Client re-authentication*

When the broker's authenticated session expires, the client must re-authenticate to the existing session by sending a new, valid access token to the broker, without dropping the connection.

If token validation is successful, a new client session is started using the existing connection. If the client fails to re-authenticate, the broker will close the connection if further attempts are made to send or receive messages. Java clients that use Kafka client library 2.2 or later automatically re-authenticate if the re-authentication mechanism is enabled on the broker.

Session re-authentication also applies to refresh tokens, if used. When the session expires, the client refreshes the access token by using its refresh token. The client then uses the new access token to re-authenticate to the existing session.

#### *Session expiry for OAUTHBEARER and PLAIN*

When session re-authentication is configured, session expiry works differently for OAUTHBEARER and PLAIN authentication.

For OAUTHBEARER and PLAIN, using the client ID and secret method:

- The broker's authenticated session will expire at the configured `maxSecondsWithoutReauthentication`.
- The session will expire earlier if the access token expires before the configured time.

For PLAIN using the long-lived access token method:

- The broker's authenticated session will expire at the configured `maxSecondsWithoutReauthentication`.
- Re-authentication will fail if the access token expires before the configured time. Although session re-authentication is attempted, PLAIN has no mechanism for refreshing tokens.

If `maxSecondsWithoutReauthentication` is *not* configured, OAUTHBEARER and PLAIN clients can remain connected to brokers indefinitely, without needing to re-authenticate. Authenticated sessions do not end with access token expiry. However, this can be considered when configuring authorization, for example, by using `keycloak` authorization or installing a custom authorizer.

#### *Additional resources*

- [OAuth 2.0 Kafka broker configuration](#)
- [Configuring OAuth 2.0 support for Kafka brokers](#)
- [KafkaListenerAuthenticationOAuth schema reference](#)
- [KIP-368](#)

### **6.4.4. OAuth 2.0 Kafka client configuration**

A Kafka client is configured with either:

- The credentials required to obtain a valid access token from an authorization server (client ID and Secret)
- A valid long-lived access token or refresh token, obtained using tools provided by an authorization server

The only information ever sent to the Kafka broker is an access token. The credentials used to authenticate with the authorization server to obtain the access token are never sent to the broker.

When a client obtains an access token, no further communication with the authorization server is needed.

The simplest mechanism is authentication with a client ID and Secret. Using a long-lived access token, or a long-lived refresh token, adds more complexity because there is an additional dependency on authorization server tools.

**NOTE**

If you are using long-lived access tokens, you may need to configure the client in the authorization server to increase the maximum lifetime of the token.

If the Kafka client is not configured with an access token directly, the client exchanges credentials for an access token during Kafka session initiation by contacting the authorization server. The Kafka client exchanges either:

- Client ID and Secret
- Client ID, refresh token, and (optionally) a secret
- Username and password, with client ID and (optionally) a secret

#### 6.4.5. OAuth 2.0 client authentication flows

OAuth 2.0 authentication flows depend on the underlying Kafka client and Kafka broker configuration. The flows must also be supported by the authorization server used.

The Kafka broker listener configuration determines how clients authenticate using an access token. The client can pass a client ID and secret to request an access token.

If a listener is configured to use PLAIN authentication, the client can authenticate with a client ID and secret or username and access token. These values are passed as the `username` and `password` properties of the PLAIN mechanism.

Listener configuration supports the following token validation options:

- You can use fast local token validation based on JWT signature checking and local token introspection, without contacting an authorization server. The authorization server provides a JWKS endpoint with public certificates that are used to validate signatures on the tokens.
- You can use a call to a token introspection endpoint provided by an authorization server. Each time a new Kafka broker connection is established, the broker passes the access token received from the client to the authorization server. The Kafka broker checks the response to confirm whether or not the token is valid.

**NOTE**

An authorization server might only allow the use of opaque access tokens, which means that local token validation is not possible.

Kafka client credentials can also be configured for the following types of authentication:

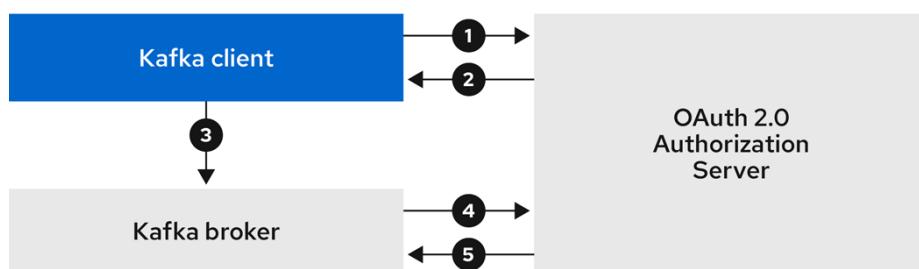
- Direct local access using a previously generated long-lived access token
- Contact with the authorization server for a new access token to be issued (using a client ID and a secret, or a refresh token, or a username and a password)

### Example client authentication flows using the SASL OAUTHBEARER mechanism

You can use the following communication flows for Kafka authentication using the SASL OAUTHBEARER mechanism.

- Client using client ID and secret, with broker delegating validation to authorization server
- Client using client ID and secret, with broker performing fast local token validation
- Client using long-lived access token, with broker delegating validation to authorization server
- Client using long-lived access token, with broker performing fast local validation

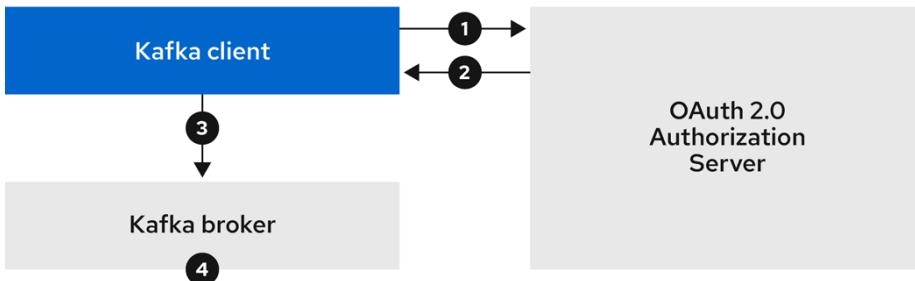
*Client using client ID and secret, with broker delegating validation to authorization server*



222\_Streams\_0322

1. The Kafka client requests an access token from the authorization server using a client ID and secret, and optionally a refresh token. Alternatively, the client may authenticate using a username and a password.
2. The authorization server generates a new access token.
3. The Kafka client authenticates with the Kafka broker using the SASL OAUTHBEARER mechanism to pass the access token.
4. The Kafka broker validates the access token by calling a token introspection endpoint on the authorization server using its own client ID and secret.
5. A Kafka client session is established if the token is valid.

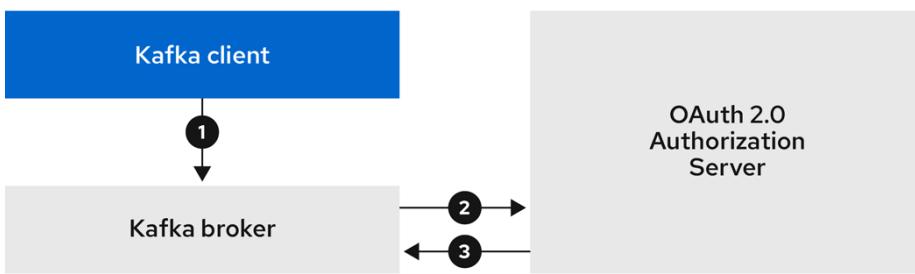
*Client using client ID and secret, with broker performing fast local token validation*



222\_Streams\_0322

1. The Kafka client authenticates with the authorization server from the token endpoint, using a client ID and secret, and optionally a refresh token. Alternatively, the client may authenticate using a username and a password.
2. The authorization server generates a new access token.
3. The Kafka client authenticates with the Kafka broker using the SASL OAUTHBEARER mechanism to pass the access token.
4. The Kafka broker validates the access token locally using a JWT token signature check, and local token introspection.

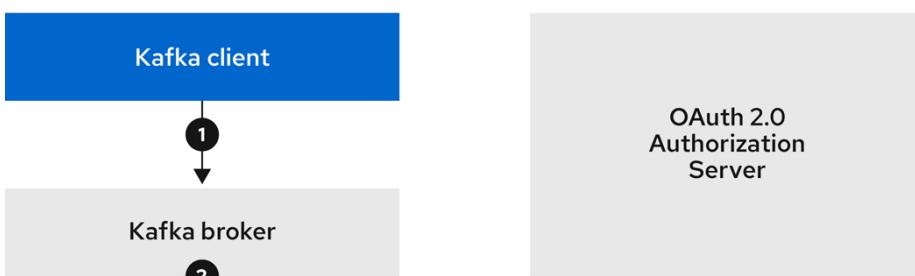
*Client using long-lived access token, with broker delegating validation to authorization server*



222\_Streams\_0322

1. The Kafka client authenticates with the Kafka broker using the SASL OAUTHBEARER mechanism to pass the long-lived access token.
2. The Kafka broker validates the access token by calling a token introspection endpoint on the authorization server, using its own client ID and secret.
3. A Kafka client session is established if the token is valid.

*Client using long-lived access token, with broker performing fast local validation*



222\_Streams\_0322

1. The Kafka client authenticates with the Kafka broker using the SASL OAUTHBEARER mechanism to pass the long-lived access token.
2. The Kafka broker validates the access token locally using a JWT token signature check and local token introspection.

token introspection.

**WARNING**

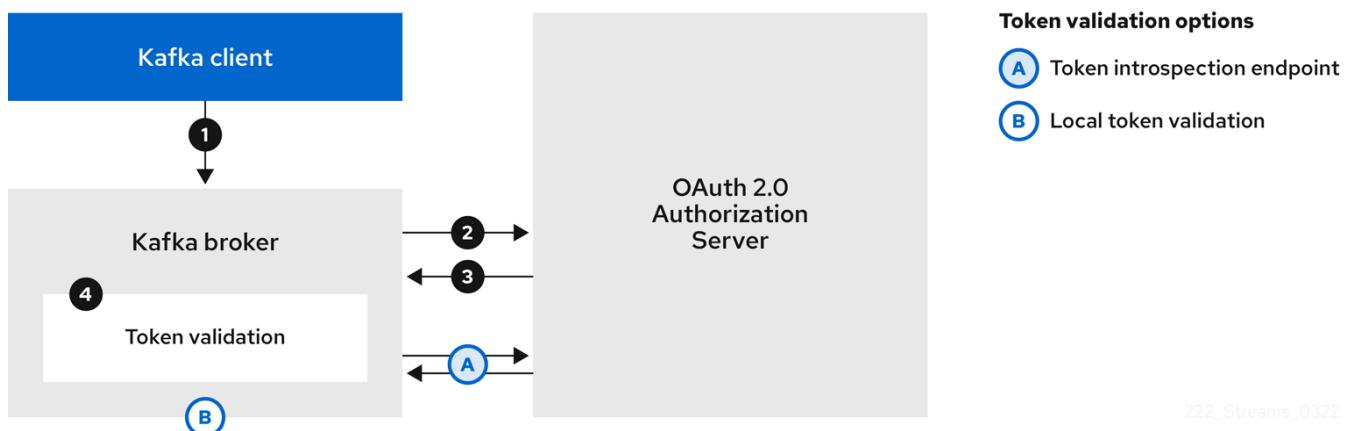
Fast local JWT token signature validation is suitable only for short-lived tokens as there is no check with the authorization server if a token has been revoked. Token expiration is written into the token, but revocation can happen at any time, so cannot be accounted for without contacting the authorization server. Any issued token would be considered valid until it expires.

### Example client authentication flows using the SASL PLAIN mechanism

You can use the following communication flows for Kafka authentication using the OAuth PLAIN mechanism.

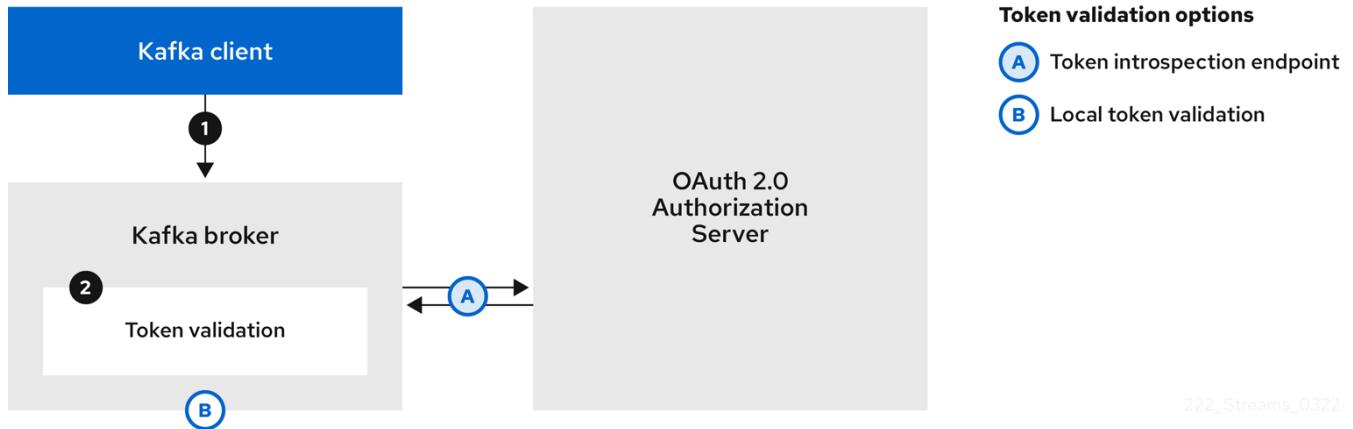
- [Client using a client ID and secret, with the broker obtaining the access token for the client](#)
- [Client using a long-lived access token without a client ID and secret](#)

*Client using a client ID and secret, with the broker obtaining the access token for the client*



1. The Kafka client passes a `clientId` as a username and a `secret` as a password.
2. The Kafka broker uses a token endpoint to pass the `clientId` and `secret` to the authorization server.
3. The authorization server returns a fresh access token or an error if the client credentials are not valid.
4. The Kafka broker validates the token in one of the following ways:
  - a. If a token introspection endpoint is specified, the Kafka broker validates the access token by calling the endpoint on the authorization server. A session is established if the token validation is successful.
  - b. If local token introspection is used, a request is not made to the authorization server. The Kafka broker validates the access token locally using a JWT token signature check.

*Client using a long-lived access token without a client ID and secret*



1. The Kafka client passes a username and password. The password provides the value of an access token that was obtained manually and configured before running the client.
2. The password is passed with or without an `$accessToken`: string prefix depending on whether or not the Kafka broker listener is configured with a token endpoint for authentication.
  - a. If the token endpoint is configured, the password should be prefixed by `$accessToken`: to let the broker know that the password parameter contains an access token rather than a client secret. The Kafka broker interprets the username as the account username.
  - b. If the token endpoint is not configured on the Kafka broker listener (enforcing a `no-client-credentials mode`), the password should provide the access token without the prefix. The Kafka broker interprets the username as the account username. In this mode, the client doesn't use a client ID and secret, and the `password` parameter is always interpreted as a raw access token.
3. The Kafka broker validates the token in one of the following ways:
  - a. If a token introspection endpoint is specified, the Kafka broker validates the access token by calling the endpoint on the authorization server. A session is established if token validation is successful.
  - b. If local token introspection is used, there is no request made to the authorization server. Kafka broker validates the access token locally using a JWT token signature check.

#### 6.4.6. Configuring OAuth 2.0 authentication

OAuth 2.0 is used for interaction between Kafka clients and Strimzi components.

In order to use OAuth 2.0 for Strimzi, you must:

1. [Configure an OAuth 2.0 authorization server for the Strimzi cluster and Kafka clients](#)
2. [Deploy or update the Kafka cluster with Kafka broker listeners configured to use OAuth 2.0](#)
3. [Update your Java-based Kafka clients to use OAuth 2.0](#)
4. [Update Kafka component clients to use OAuth 2.0](#)

##### Configuring an OAuth 2.0 authorization server

This procedure describes in general what you need to do to configure an authorization server for

integration with Strimzi.

These instructions are not product specific.

The steps are dependent on the chosen authorization server. Consult the product documentation for the authorization server for information on how to set up OAuth 2.0 access.

**NOTE**

If you already have an authorization server deployed, you can skip the deployment step and use your current deployment.

*Procedure*

1. Deploy the authorization server to your cluster.
2. Access the CLI or admin console for the authorization server to configure OAuth 2.0 for Strimzi.

Now prepare the authorization server to work with Strimzi.

3. Configure a **kafka-broker** client.
4. Configure clients for each Kafka client component of your application.

*What to do next*

After deploying and configuring the authorization server, [configure the Kafka brokers to use OAuth 2.0](#).

## Configuring OAuth 2.0 support for Kafka brokers

This procedure describes how to configure Kafka brokers so that the broker listeners are enabled to use OAuth 2.0 authentication using an authorization server.

We advise use of OAuth 2.0 over an encrypted interface through configuration of TLS listeners. Plain listeners are not recommended.

If the authorization server is using certificates signed by the trusted CA and matching the OAuth 2.0 server hostname, TLS connection works using the default settings. Otherwise, you may need to configure the truststore with proper certificates or disable the certificate hostname validation.

When configuring the Kafka broker you have two options for the mechanism used to validate the access token during OAuth 2.0 authentication of the newly connected Kafka client:

- [Configuring fast local JWT token validation](#)
- [Configuring token validation using an introspection endpoint](#)

*Before you start*

For more information on the configuration of OAuth 2.0 authentication for Kafka broker listeners, see:

- [KafkaListenerAuthenticationOAuth schema reference](#)
- [OAuth 2.0 authentication mechanisms](#)

*Prerequisites*

- Strimzi and Kafka are running
- An OAuth 2.0 authorization server is deployed

#### Procedure

1. Update the Kafka broker configuration ([Kafka.spec.kafka](#)) of your **Kafka** resource in an editor.

```
kubectl edit kafka my-cluster
```

2. Configure the Kafka broker **listeners** configuration.

The configuration for each type of listener does not have to be the same, as they are independent.

The examples here show the configuration options as configured for external listeners.

#### *Example 1: Configuring fast local JWT token validation*

```
#...
- name: external
  port: 9094
  type: loadbalancer
  tls: true
  authentication:
    type: oauth ①
    validIssuerUri: <https://<auth-server-address>/auth/realm</external> ②
    jwksEndpointUri: <https://<auth-server-
address>/auth/realm</external>/protocol/openid-connect/certs> ③
    userNameClaim: preferred_username ④
    maxSecondsWithoutReauthentication: 3600 ⑤
    tlsTrustedCertificates: ⑥
    - secretName: oauth-server-cert
      certificate: ca.crt
    disableTlsHostnameVerification: true ⑦
    jwksExpirySeconds: 360 ⑧
    jwksRefreshSeconds: 300 ⑨
    jwksMinRefreshPauseSeconds: 1 ⑩
```

① Listener type set to **oauth**.

② URI of the token issuer used for authentication.

③ URI of the JWKS certificate endpoint used for local JWT validation.

④ The token claim (or key) that contains the actual user name in the token. The user name is the *principal* used to identify the user. The **userNameClaim** value will depend on the authentication flow and the authorization server used.

⑤ (Optional) Activates the Kafka re-authentication mechanism that enforces session expiry to the same length of time as the access token. If the specified value is less than the time left for the access token to expire, then the client will have to re-authenticate before the actual token expiry. By default, the session does not expire when the access token expires, and the client

does not attempt re-authentication.

- ⑥ (Optional) Trusted certificates for TLS connection to the authorization server.
- ⑦ (Optional) Disable TLS hostname verification. Default is `false`.
- ⑧ The duration the JWKS certificates are considered valid before they expire. Default is `360` seconds. If you specify a longer time, consider the risk of allowing access to revoked certificates.
- ⑨ The period between refreshes of JWKS certificates. The interval must be at least 60 seconds shorter than the expiry interval. Default is `300` seconds.
- ⑩ The minimum pause in seconds between consecutive attempts to refresh JWKS public keys. When an unknown signing key is encountered, the JWKS keys refresh is scheduled outside the regular periodic schedule with at least the specified pause since the last refresh attempt. The refreshing of keys follows the rule of exponential backoff, retrying on unsuccessful refreshes with ever increasing pause, until it reaches `jwksRefreshSeconds`. The default value is 1.

*Example 2: Configuring token validation using an introspection endpoint*

```
- name: external
  port: 9094
  type: loadbalancer
  tls: true
  authentication:
    type: oauth
    validIssuerUri: <https://<auth-server-address>/auth/realms/external>
    introspectionEndpointUri: <https://<auth-server-
address>/auth/realms/external/protocol/openid-connect/token/introspect> ①
    clientId: kafka-broker ②
    clientSecret: ③
    secretName: my-cluster-oauth
    key: clientSecret
    userNameClaim: preferred_username ④
    maxSecondsWithoutReauthentication: 3600 ⑤
```

① URI of the token introspection endpoint.

② Client ID to identify the client.

③ Client Secret and client ID is used for authentication.

④ The token claim (or key) that contains the actual user name in the token. The user name is the *principal* used to identify the user. The `userNameClaim` value will depend on the authorization server used.

⑤ (Optional) Activates the Kafka re-authentication mechanism that enforces session expiry to the same length of time as the access token. If the specified value is less than the time left for the access token to expire, then the client will have to re-authenticate before the actual token expiry. By default, the session does not expire when the access token expires, and the client does not attempt re-authentication.

Depending on how you apply OAuth 2.0 authentication, and the type of authorization server, there are additional (optional) configuration settings you can use:

```
# ...
authentication:
  type: oauth
  # ...
  checkIssuer: false ①
  checkAudience: true ②
  fallbackUserNameClaim: client_id ③
  fallbackUserNamePrefix: client-account- ④
  validTokenType: bearer ⑤
  userInfoEndpointUri: https://OAUTH-SERVER-
ADDRESS/auth/realms/external/protocol/openid-connect/userinfo ⑥
  enableOAuthBearer: false ⑦
  enablePlain: true ⑧
  tokenEndpointUri: https://OAUTH-SERVER-
ADDRESS/auth/realms/external/protocol/openid-connect/token ⑨
  customClaimCheck: "@.custom == 'custom-value'" ⑩
  clientAudience: AUDIENCE ⑪
  clientScope: SCOPE ⑫
  connectTimeoutSeconds: 60 ⑬
  readTimeoutSeconds: 60 ⑭
  groupsClaim: "$.groups" ⑮
  groupsClaimDelimiter: "," ⑯
```

- ① If your authorization server does not provide an `iss` claim, it is not possible to perform an issuer check. In this situation, set `checkIssuer` to `false` and do not specify a `validIssuerUri`. Default is `true`.
- ② If your authorization server provides an `aud` (audience) claim, and you want to enforce an audience check, set `checkAudience` to `true`. Audience checks identify the intended recipients of tokens. As a result, the Kafka broker will reject tokens that do not have its `clientId` in their `aud` claim. Default is `false`.
- ③ An authorization server may not provide a single attribute to identify both regular users and clients. When a client authenticates in its own name, the server might provide a *client ID*. When a user authenticates using a username and password, to obtain a refresh token or an access token, the server might provide a *username* attribute in addition to a client ID. Use this fallback option to specify the username claim (attribute) to use if a primary user ID attribute is not available.
- ④ In situations where `fallbackUserNameClaim` is applicable, it may also be necessary to prevent name collisions between the values of the `username` claim, and those of the fallback `username` claim. Consider a situation where a client called `producer` exists, but also a regular user called `producer` exists. In order to differentiate between the two, you can use this property to add a prefix to the user ID of the client.
- ⑤ (Only applicable when using `introspectionEndpointUri`) Depending on the authorization server you are using, the introspection endpoint may or may not return the *token type* attribute, or it may contain different values. You can specify a valid token type value that the

response from the introspection endpoint has to contain.

- ⑥ (Only applicable when using `introspectionEndpointUri`) The authorization server may be configured or implemented in such a way to not provide any identifiable information in an Introspection Endpoint response. In order to obtain the user ID, you can configure the URI of the `userinfo` endpoint as a fallback. The `userNameClaim`, `fallbackUserNameClaim`, and `fallbackUserNamePrefix` settings are applied to the response of `userinfo` endpoint.
- ⑦ Set this to `false` to disable the OAUTHBEARER mechanism on the listener. At least one of PLAIN or OAUTHBEARER has to be enabled. Default is `true`.
- ⑧ Set to `true` to enable PLAIN authentication on the listener, which is supported for clients on all platforms.
- ⑨ Additional configuration for the PLAIN mechanism. If specified, clients can authenticate over PLAIN by passing an access token as the `password` using an `$accessToken:` prefix. For production, always use `https://` urls.
- ⑩ Additional custom rules can be imposed on the JWT access token during validation by setting this to a JsonPath filter query. If the access token does not contain the necessary data, it is rejected. When using the `introspectionEndpointUri`, the custom check is applied to the introspection endpoint response JSON.
- ⑪ An `audience` parameter passed to the token endpoint. An *audience* is used when obtaining an access token for inter-broker authentication. It is also used in the name of a client for OAuth 2.0 over PLAIN client authentication using a `clientId` and `secret`. This only affects the ability to obtain the token, and the content of the token, depending on the authorization server. It does not affect token validation rules by the listener.
- ⑫ A `scope` parameter passed to the token endpoint. A *scope* is used when obtaining an access token for inter-broker authentication. It is also used in the name of a client for OAuth 2.0 over PLAIN client authentication using a `clientId` and `secret`. This only affects the ability to obtain the token, and the content of the token, depending on the authorization server. It does not affect token validation rules by the listener.
- ⑬ The connect timeout in seconds when connecting to the authorization server. The default value is 60.
- ⑭ The read timeout in seconds when connecting to the authorization server. The default value is 60.
- ⑮ A JsonPath query used to extract groups information from JWT token or introspection endpoint response. Not set by default. This can be used by a custom authorizer to make authorization decisions based on user groups.
- ⑯ A delimiter used to parse groups information when returned as a single delimited string. The default value is ',' (comma).

3. Save and exit the editor, then wait for rolling updates to complete.

4. Check the update in the logs or by watching the pod state transitions:

```
kubectl logs -f ${POD_NAME} -c ${CONTAINER_NAME}  
kubectl get pod -w
```

The rolling update configures the brokers to use OAuth 2.0 authentication.

#### What to do next

- [Configure your Kafka clients to use OAuth 2.0](#)

## Configuring Kafka Java clients to use OAuth 2.0

This procedure describes how to configure Kafka producer and consumer APIs to use OAuth 2.0 for interaction with Kafka brokers.

Add a client callback plugin to your `pom.xml` file, and configure the system properties.

#### Prerequisites

- Strimzi and Kafka are running
- An OAuth 2.0 authorization server is deployed and configured for OAuth access to Kafka brokers
- Kafka brokers are configured for OAuth 2.0

#### Procedure

1. Add the client library with OAuth 2.0 support to the `pom.xml` file for the Kafka client:

```
<dependency>
  <groupId>io.strimzi</groupId>
  <artifactId>kafka-oauth-client</artifactId>
  <version>0.11.0</version>
</dependency>
```

2. Configure the system properties for the callback:

For example:

```
System.setProperty(ClientConfig.OAUTH_TOKEN_ENDPOINT_URI, "https://<auth-server-
address>/auth/realms/master/protocol/openid-connect/token"); ①
System.setProperty(ClientConfig.OAUTH_CLIENT_ID, "<client_name>"); ②
System.setProperty(ClientConfig.OAUTH_CLIENT_SECRET, "<client_secret>"); ③
System.setProperty(ClientConfig.OAUTH_SCOPE, "<scope_value>") ④
System.setProperty(ClientConfig.OAUTH_AUDIENCE, "<audience_value>") ⑤
```

① URI of the authorization server token endpoint.

② Client ID, which is the name used when creating the *client* in the authorization server.

③ Client secret created when creating the *client* in the authorization server.

④ (Optional) The `scope` for requesting the token from the token endpoint. An authorization server may require a client to specify the scope.

⑤ (Optional) The `audience` for requesting the token from the token endpoint. An authorization server may require a client to specify the audience.

3. Enable the *OAUTHBEARER* or *PLAIN* mechanism on a TLS encrypted connection in the Kafka client configuration.

For example:

#### *Enabling OAUTHBEARER for a Kafka client*

```
props.put("sasl.jaas.config",
  "org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required;");
props.put("security.protocol", "SASL_SSL");
props.put("sasl.mechanism", "OAUTHBEARER");
props.put("sasl.login.callback.handler.class",
  "io.strimzi.kafka.oauth.client.JaasClientOAuthLoginCallbackHandler");
```

#### *Enabling PLAIN for a Kafka client*

```
props.put("sasl.jaas.config",
  "org.apache.kafka.common.security.plain.PlainLoginModule required
username=\"$CLIENT_ID_OR_ACCOUNT_NAME\" password=\"$SECRET_OR_ACCESS_TOKEN\" ");
props.put("security.protocol", "SASL_SSL"); ①
props.put("sasl.mechanism", "PLAIN");
```

① Here we use *SASL\_SSL* for use over TLS connections. Use *SASL\_PLAINTEXT* over unencrypted connections for local development only.

4. Verify that the Kafka client can access the Kafka brokers.

## Configuring OAuth 2.0 for Kafka components

This procedure describes how to configure Kafka components to use OAuth 2.0 authentication using an authorization server.

You can configure authentication for:

- Kafka Connect
- Kafka MirrorMaker
- Kafka Bridge

In this scenario, the Kafka component and the authorization server are running in the same cluster.

#### *Before you start*

For more information on the configuration of OAuth 2.0 authentication for Kafka components, see:

- [KafkaClientAuthenticationOAuth schema reference](#)

#### *Prerequisites*

- Strimzi and Kafka are running
- An OAuth 2.0 authorization server is deployed and configured for OAuth access to Kafka brokers

- Kafka brokers are configured for OAuth 2.0

#### *Procedure*

1. Create a client secret and mount it to the component as an environment variable.

For example, here we are creating a client **Secret** for the Kafka Bridge:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Secret
metadata:
  name: my-bridge-oauth
type: Opaque
data:
  clientSecret: MGQ10TRmMzYtZTl1ZS00MDY2LWI50GEtMTM5MzM2Njd1ZjQw ①
```

① The **clientSecret** key must be in base64 format.

2. Create or edit the resource for the Kafka component so that OAuth 2.0 authentication is configured for the authentication property.

For OAuth 2.0 authentication, you can use:

- Client ID and secret
- Client ID and refresh token
- Access token
- Username and password
- TLS

[KafkaClientAuthenticationOAuth schema reference](#) provides examples of each.

For example, here OAuth 2.0 is assigned to the Kafka Bridge client using a client ID and secret, and TLS:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  # ...
  authentication:
    type: oauth ①
    tokenEndpointUri: https://<auth-server-
address>/auth/realms/master/protocol/openid-connect/token ②
    clientId: kafka-bridge
    clientSecret:
      secretName: my-bridge-oauth
      key: clientSecret
    tlsTrustedCertificates: ③
```

```
- secretName: oauth-server-cert  
certificate: tls.crt
```

- ① Authentication type set to `oauth`.
- ② URI of the token endpoint for authentication.
- ③ Trusted certificates for TLS connection to the authorization server.

Depending on how you apply OAuth 2.0 authentication, and the type of authorization server, there are additional configuration options you can use:

```
# ...  
spec:  
  # ...  
  authentication:  
    # ...  
    disableTlsHostnameVerification: true ①  
    checkAccessTokenType: false ②  
    accessTokenIsJwt: false ③  
    scope: any ④  
    audience: kafka ⑤  
    connectTimeoutSeconds: 60 ⑥  
    readTimeoutSeconds: 60 ⑦
```

- ① (Optional) Disable TLS hostname verification. Default is `false`.
- ② If the authorization server does not return a `typ` (type) claim inside the JWT token, you can apply `checkAccessTokenType: false` to skip the token type check. Default is `true`.
- ③ If you are using opaque tokens, you can apply `accessTokenIsJwt: false` so that access tokens are not treated as JWT tokens.
- ④ (Optional) The `scope` for requesting the token from the token endpoint. An authorization server may require a client to specify the scope. In this case it is `any`.
- ⑤ (Optional) The `audience` for requesting the token from the token endpoint. An authorization server may require a client to specify the audience. In this case it is `kafka`.
- ⑥ (Optional) The connect timeout in seconds when connecting to the authorization server. The default value is 60.
- ⑦ (Optional) The read timeout in seconds when connecting to the authorization server. The default value is 60.

3. Apply the changes to the deployment of your Kafka resource.

```
kubectl apply -f your-file
```

4. Check the update in the logs or by watching the pod state transitions:

```
kubectl logs -f ${POD_NAME} -c ${CONTAINER_NAME}
```

```
kubectl get pod -w
```

The rolling updates configure the component for interaction with Kafka brokers using OAuth 2.0 authentication.

#### 6.4.7. Authorization server examples

When choosing an authorization server, consider the features that best support configuration of your chosen authentication flow.

For the purposes of testing OAuth 2.0 with Strimzi, Keycloak and ORY Hydra were implemented as the OAuth 2.0 authorization server.

For more information, see:

- [Kafka authentication using OAuth 2.0](#)
- [Using Keycloak as the OAuth 2.0 authorization server](#)
- [Using Hydra as the OAuth 2.0 authorization server](#)

## 6.5. Using OAuth 2.0 token-based authorization

If you are using OAuth 2.0 with Keycloak for token-based authentication, you can also use Keycloak to configure authorization rules to constrain client access to Kafka brokers. Authentication establishes the identity of a user. Authorization decides the level of access for that user.

Strimzi supports the use of OAuth 2.0 token-based authorization through Keycloak [Keycloak Authorization Services](#), which allows you to manage security policies and permissions centrally.

Security policies and permissions defined in Keycloak are used to grant access to resources on Kafka brokers. Users and clients are matched against policies that permit access to perform specific actions on Kafka brokers.

Kafka allows all users full access to brokers by default, and also provides the [AclAuthorizer](#) plugin to configure authorization based on Access Control Lists (ACLs).

ZooKeeper stores ACL rules that grant or deny access to resources based on *username*. However, OAuth 2.0 token-based authorization with Keycloak offers far greater flexibility on how you wish to implement access control to Kafka brokers. In addition, you can configure your Kafka brokers to use OAuth 2.0 authorization and ACLs.

*Additional resources*

- [Using OAuth 2.0 token-based authentication](#)
- [Kafka Authorization](#)
- [Keycloak documentation](#)

## 6.5.1. OAuth 2.0 authorization mechanism

OAuth 2.0 authorization in Strimzi uses Keycloak server Authorization Services REST endpoints to extend token-based authentication with Keycloak by applying defined security policies on a particular user, and providing a list of permissions granted on different resources for that user. Policies use roles and groups to match permissions to users. OAuth 2.0 authorization enforces permissions locally based on the received list of grants for the user from Keycloak Authorization Services.

### Kafka broker custom authorizer

A Keycloak *authorizer* ([KeycloakRBACAuthorizer](#)) is provided with Strimzi. To be able to use the Keycloak REST endpoints for Authorization Services provided by Keycloak, you configure a custom authorizer on the Kafka broker.

The authorizer fetches a list of granted permissions from the authorization server as needed, and enforces authorization locally on the Kafka Broker, making rapid authorization decisions for each client request.

## 6.5.2. Configuring OAuth 2.0 authorization support

This procedure describes how to configure Kafka brokers to use OAuth 2.0 authorization using Keycloak Authorization Services.

### *Before you begin*

Consider the access you require or want to limit for certain users. You can use a combination of Keycloak *groups*, *roles*, *clients*, and *users* to configure access in Keycloak.

Typically, groups are used to match users based on organizational departments or geographical locations. And roles are used to match users based on their function.

With Keycloak, you can store users and groups in LDAP, whereas clients and roles cannot be stored this way. Storage and access to user data may be a factor in how you choose to configure authorization policies.

### NOTE

[Super users](#) always have unconstrained access to a Kafka broker regardless of the authorization implemented on the Kafka broker.

### *Prerequisites*

- Strimzi must be configured to use OAuth 2.0 with Keycloak for [token-based authentication](#). You use the same Keycloak server endpoint when you set up authorization.
- OAuth 2.0 authentication must be configured with the [maxSecondsWithoutReauthentication](#) option to enable re-authentication.

### *Procedure*

1. Access the Keycloak Admin Console or use the Keycloak Admin CLI to enable Authorization Services for the Kafka broker client you created when setting up OAuth 2.0 authentication.
2. Use Authorization Services to define resources, authorization scopes, policies, and permissions

for the client.

3. Bind the permissions to users and clients by assigning them roles and groups.
4. Configure the Kafka brokers to use Keycloak authorization by updating the Kafka broker configuration (`Kafka.spec.kafka`) of your `Kafka` resource in an editor.

```
kubectl edit kafka my-cluster
```

5. Configure the Kafka broker `kafka` configuration to use `keycloak` authorization, and to be able to access the authorization server and Authorization Services.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    authorization:
      type: keycloak ①
      tokenEndpointUri: <https://<auth-server-
address>/auth/realms/external/protocol/openid-connect/token> ②
      clientId: kafka ③
      delegateToKafkaAcls: false ④
      disableTlsHostnameVerification: false ⑤
      superUsers: ⑥
      - CN=fred
      - sam
      - CN=edward
      tlsTrustedCertificates: ⑦
      - secretName: oauth-server-cert
        certificate: ca.crt
      grantsRefreshPeriodSeconds: 60 ⑧
      grantsRefreshPoolSize: 5 ⑨
      connectTimeoutSeconds: 60 ⑩
      readTimeoutSeconds: 60 ⑪
    #...
```

① Type `keycloak` enables Keycloak authorization.

② URI of the Keycloak token endpoint. For production, always use `https://` urls. When you configure token-based `oauth` authentication, you specify a `jwksEndpointUri` as the URI for local JWT validation. The hostname for the `tokenEndpointUri` URI must be the same.

③ The client ID of the OAuth 2.0 client definition in Keycloak that has Authorization Services enabled. Typically, `kafka` is used as the ID.

④ (Optional) Delegate authorization to Kafka `AclAuthorizer` if access is denied by Keycloak

Authorization Services policies. Default is `false`.

- ⑤ (Optional) Disable TLS hostname verification. Default is `false`.
- ⑥ (Optional) Designated [super users](#).
- ⑦ (Optional) Trusted certificates for TLS connection to the authorization server.
- ⑧ (Optional) The time between two consecutive grants refresh runs. That is the maximum time for active sessions to detect any permissions changes for the user on Keycloak. The default value is 60.
- ⑨ (Optional) The number of threads to use to refresh (in parallel) the grants for the active sessions. The default value is 5.
- ⑩ (Optional) The connect timeout in seconds when connecting to the Keycloak token endpoint. The default value is 60.
- ⑪ (Optional) The read timeout in seconds when connecting to the Keycloak token endpoint. The default value is 60.

6. Save and exit the editor, then wait for rolling updates to complete.

7. Check the update in the logs or by watching the pod state transitions:

```
kubectl logs -f ${POD_NAME} -c kafka  
kubectl get pod -w
```

The rolling update configures the brokers to use OAuth 2.0 authorization.

8. Verify the configured permissions by accessing Kafka brokers as clients or users with specific roles, making sure they have the necessary access, or do not have the access they are not supposed to have.

### 6.5.3. Managing policies and permissions in Keycloak Authorization Services

This section describes the authorization models used by Keycloak Authorization Services and Kafka, and defines the important concepts in each model.

To grant permissions to access Kafka, you can map Keycloak Authorization Services objects to Kafka resources by creating an *OAuth client specification* in Keycloak. Kafka permissions are granted to user accounts or service accounts using Keycloak Authorization Services rules.

[Examples](#) are shown of the different user permissions required for common Kafka operations, such as creating and listing topics.

#### Kafka and Keycloak authorization models overview

Kafka and Keycloak Authorization Services use different authorization models.

## Kafka authorization model

Kafka's authorization model uses *resource types*. When a Kafka client performs an action on a broker, the broker uses the configured `KeycloakRBACAuthorizer` to check the client's permissions, based on the action and resource type.

Kafka uses five resource types to control access: `Topic`, `Group`, `Cluster`, `TransactionalId`, and `DelegationToken`. Each resource type has a set of available permissions.

### Topic

- `Create`
- `Write`
- `Read`
- `Delete`
- `Describe`
- `DescribeConfigs`
- `Alter`
- `AlterConfigs`

### Group

- `Read`
- `Describe`
- `Delete`

### Cluster

- `Create`
- `Describe`
- `Alter`
- `DescribeConfigs`
- `AlterConfigs`
- `IdempotentWrite`
- `ClusterAction`

### TransactionalId

- `Describe`
- `Write`

### DelegationToken

- `Describe`

## Keycloak Authorization Services model

The Keycloak Authorization Services model has four concepts for defining and granting permissions: *resources*, *authorization scopes*, *policies*, and *permissions*.

### Resources

A resource is a set of resource definitions that are used to match resources with permitted actions. A resource might be an individual topic, for example, or all topics with names starting with the same prefix. A resource definition is associated with a set of available authorization scopes, which represent a set of all actions available on the resource. Often, only a subset of these actions is actually permitted.

### Authorization scopes

An authorization scope is a set of all the available actions on a specific resource definition. When you define a new resource, you add scopes from the set of all scopes.

### Policies

A policy is an authorization rule that uses criteria to match against a list of accounts. Policies can match:

- *Service accounts* based on client ID or roles
- *User accounts* based on username, groups, or roles.

### Permissions

A permission grants a subset of authorization scopes on a specific resource definition to a set of users.

#### *Additional resources*

- [Kafka authorization model](#)

## Map Keycloak Authorization Services to the Kafka authorization model

The Kafka authorization model is used as a basis for defining the Keycloak roles and resources that will control access to Kafka.

To grant Kafka permissions to user accounts or service accounts, you first create an *OAuth client specification* in Keycloak for the Kafka broker. You then specify Keycloak Authorization Services rules on the client. Typically, the client id of the OAuth client that represents the broker is **kafka**. The [example configuration files](#) provided with Strimzi use **kafka** as the OAuth client id.

#### NOTE

If you have multiple Kafka clusters, you can use a single OAuth client (**kafka**) for all of them. This gives you a single, unified space in which to define and manage authorization rules. However, you can also use different OAuth client ids (for example, **my-cluster-kafka** or **cluster-dev-kafka**) and define authorization rules for each cluster within each client configuration.

The **kafka** client definition must have the **Authorization Enabled** option enabled in the Keycloak Admin Console.

All permissions exist within the scope of the `kafka` client. If you have different Kafka clusters configured with different OAuth client IDs, they each need a separate set of permissions even though they're part of the same Keycloak realm.

When the Kafka client uses `OAUTHBEARER` authentication, the Keycloak authorizer (`KeycloakRBACAuthorizer`) uses the access token of the current session to retrieve a list of grants from the Keycloak server. To retrieve the grants, the authorizer evaluates the Keycloak Authorization Services policies and permissions.

#### *Authorization scopes for Kafka permissions*

An initial Keycloak configuration usually involves uploading authorization scopes to create a list of all possible actions that can be performed on each Kafka resource type. This step is performed once only, before defining any permissions. You can add authorization scopes manually instead of uploading them.

Authorization scopes must contain all the possible Kafka permissions regardless of the resource type:

- `Create`
- `Write`
- `Read`
- `Delete`
- `Describe`
- `Alter`
- `DescribeConfig`
- `AlterConfig`
- `ClusterAction`
- `IdempotentWrite`

**NOTE** If you're certain you won't need a permission (for example, `IdempotentWrite`), you can omit it from the list of authorization scopes. However, that permission won't be available to target on Kafka resources.

#### *Resource patterns for permissions checks*

Resource patterns are used for pattern matching against the targeted resources when performing permission checks. The general pattern format is `RESOURCE-TYPE: PATTERN-NAME`.

The resource types mirror the Kafka authorization model. The pattern allows for two matching options:

- Exact matching (when the pattern does not end with `*`)
- Prefix matching (when the pattern ends with `*`)

## *Example patterns for resources*

```
Topic:my-topic  
Topic:orders-*  
Group:orders-*  
Cluster:*
```

Additionally, the general pattern format can be prefixed by `kafka-cluster:CLUSTER-NAME` followed by a comma, where `CLUSTER-NAME` refers to the `metadata.name` in the Kafka custom resource.

## *Example patterns for resources with cluster prefix*

```
kafka-cluster:my-cluster,Topic:*
```

```
kafka-cluster:*,Group:b_*
```

When the `kafka-cluster` prefix is missing, it is assumed to be `kafka-cluster:*`.

When defining a resource, you can associate it with a list of possible authorization scopes which are relevant to the resource. Set whatever actions make sense for the targeted resource type.

Though you may add any authorization scope to any resource, only the scopes supported by the resource type are considered for access control.

## *Policies for applying access permission*

Policies are used to target permissions to one or more user accounts or service accounts. Targeting can refer to:

- Specific user or service accounts
- Realm roles or client roles
- User groups
- JavaScript rules to match a client IP address

A policy is given a unique name and can be reused to target multiple permissions to multiple resources.

## *Permissions to grant access*

Use fine-grained permissions to pull together the policies, resources, and authorization scopes that grant access to users.

The name of each permission should clearly define which permissions it grants to which users. For example, `Dev Team B can read from topics starting with x`.

## *Additional resources*

- For more information about how to configure permissions through Keycloak Authorization Services, see [Trying Keycloak Authorization Services](#).

## Example permissions required for Kafka operations

The following examples demonstrate the user permissions required for performing common operations on Kafka.

### Create a topic

To create a topic, the `Create` permission is required for the specific topic, or for `Cluster:kafka-cluster`.

```
bin/kafka-topics.sh --create --topic my-topic \
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command
-config=/tmp/config.properties
```

### List topics

If a user has the `Describe` permission on a specified topic, the topic is listed.

```
bin/kafka-topics.sh --list \
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command
-config=/tmp/config.properties
```

### Display topic details

To display a topic's details, `Describe` and `DescribeConfigs` permissions are required on the topic.

```
bin/kafka-topics.sh --describe --topic my-topic \
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command
-config=/tmp/config.properties
```

### Produce messages to a topic

To produce messages to a topic, `Describe` and `Write` permissions are required on the topic.

If the topic hasn't been created yet, and topic auto-creation is enabled, the permissions to create a topic are required.

```
bin/kafka-console-producer.sh --topic my-topic \
--bootstrap-server my-cluster-kafka-bootstrap:9092
--producer.config=/tmp/config.properties
```

### Consume messages from a topic

To consume messages from a topic, `Describe` and `Read` permissions are required on the topic. Consuming from the topic normally relies on storing the consumer offsets in a consumer group, which requires additional `Describe` and `Read` permissions on the consumer group.

Two `resources` are needed for matching. For example:

```
Topic:my-topic  
Group:my-group-*
```

```
bin/kafka-console-consumer.sh --topic my-topic --group my-group-1 --from-beginning \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --consumer.config  
/tmp/config.properties
```

#### *Produce messages to a topic using an idempotent producer*

As well as the permissions for producing to a topic, an additional **IdempotentWrite** permission is required on the **Cluster:kafka-cluster** resource.

Two **resources** are needed for matching. For example:

```
Topic:my-topic  
Cluster:kafka-cluster
```

```
bin/kafka-console-producer.sh --topic my-topic \  
--bootstrap-server my-cluster-kafka-bootstrap:9092  
--producer.config=/tmp/config.properties --producer-property enable.idempotence=true  
--request-required-acks -1
```

#### *List consumer groups*

When listing consumer groups, only the groups on which the user has the **Describe** permissions are returned. Alternatively, if the user has the **Describe** permission on the **Cluster:kafka-cluster**, all the consumer groups are returned.

```
bin/kafka-consumer-groups.sh --list \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Display consumer group details*

To display a consumer group's details, the **Describe** permission is required on the group and the topics associated with the group.

```
bin/kafka-consumer-groups.sh --describe --group my-group-1 \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Change topic configuration*

To change a topic's configuration, the **Describe** and **Alter** permissions are required on the topic.

```
bin/kafka-topics.sh --alter --topic my-topic --partitions 2 \  
--replication-factor 1
```

```
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Display Kafka broker configuration*

In order to use `kafka-configs.sh` to get a broker's configuration, the `DescribeConfigs` permission is required on the `Cluster:kafka-cluster`.

```
bin/kafka-configs.sh --entity-type brokers --entity-name 0 --describe --all \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Change Kafka broker configuration*

To change a Kafka broker's configuration, `DescribeConfigs` and `AlterConfigs` permissions are required on `Cluster:kafka-cluster`.

```
bin/kafka-configs --entity-type brokers --entity-name 0 --alter --add-config  
log.cleaner.threads=2 \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Delete a topic*

To delete a topic, the `Describe` and `Delete` permissions are required on the topic.

```
bin/kafka-topics.sh --delete --topic my-topic \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command  
-config=/tmp/config.properties
```

#### *Select a lead partition*

To run leader selection for topic partitions, the `Alter` permission is required on the `Cluster:kafka-cluster`.

```
bin/kafka-leader-election.sh --topic my-topic --partition 0 --election-type PREFERRED  
/  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --admin.config  
/tmp/config.properties
```

#### *Reassign partitions*

To generate a partition reassignment file, `Describe` permissions are required on the topics involved.

```
bin/kafka-reassign-partitions.sh --topics-to-move-json-file /tmp/topics-to-move.json  
--broker-list "0,1" --generate \  
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command-config  
/tmp/config.properties > /tmp/partition-reassignment.json
```

To execute the partition reassignment, `Describe` and `Alter` permissions are required on `Cluster:kafka-cluster`. Also, `Describe` permissions are required on the topics involved.

```
bin/kafka-reassign-partitions.sh --reassignment-json-file /tmp/partition-reassignment.json --execute \
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command-config /tmp/config.properties
```

To verify partition reassignment, `Describe`, and `AlterConfigs` permissions are required on `Cluster:kafka-cluster`, and on each of the topics involved.

```
bin/kafka-reassign-partitions.sh --reassignment-json-file /tmp/partition-reassignment.json --verify \
--bootstrap-server my-cluster-kafka-bootstrap:9092 --command-config /tmp/config.properties
```

#### 6.5.4. Trying Keycloak Authorization Services

This example explains how to use Keycloak Authorization Services with `keycloak` authorization. Use Keycloak Authorization Services to enforce access restrictions on Kafka clients. Keycloak Authorization Services use authorization scopes, policies and permissions to define and apply access control to resources.

Keycloak Authorization Services REST endpoints provide a list of granted permissions on resources for authenticated users. The list of grants (permissions) is fetched from the Keycloak server as the first action after an authenticated session is established by the Kafka client. The list is refreshed in the background so that changes to the grants are detected. Grants are cached and enforced locally on the Kafka broker for each user session to provide fast authorization decisions.

Strimzi provides [example configuration files](#). These include the following example files for setting up Keycloak:

##### `kafka-ephemeral-oauth-single-keycloak-authz.yaml`

An example `Kafka` custom resource configured for OAuth 2.0 token-based authorization using Keycloak. You can use the custom resource to deploy a Kafka cluster that uses `keycloak` authorization and token-based `oauth` authentication.

##### `kafka-authz-realm.json`

An example Keycloak realm configured with sample groups, users, roles and clients. You can import the realm into a Keycloak instance to set up fine-grained permissions to access Kafka.

If you want to try the example with Keycloak, use these files to perform the tasks outlined in this section in the order shown.

1. [Accessing the Keycloak Admin Console](#)
2. [Deploying a Kafka cluster with Keycloak authorization](#)

3. [Preparing TLS connectivity for a CLI Kafka client session](#)
4. [Checking authorized access to Kafka using a CLI Kafka client session](#)

#### *Authentication*

When you configure token-based `oauth` authentication, you specify a `jwksEndpointUri` as the URI for local JWT validation. When you configure `keycloak` authorization, you specify a `tokenEndpointUri` as the URI of the Keycloak token endpoint. The hostname for both URIs must be the same.

#### *Targeted permissions with group or role policies*

In Keycloak, confidential clients with service accounts enabled can authenticate to the server in their own name using a client ID and a secret. This is convenient for microservices that typically act in their own name, and not as agents of a particular user (like a web site). Service accounts can have roles assigned like regular users. They cannot, however, have groups assigned. As a consequence, if you want to target permissions to microservices using service accounts, you cannot use group policies, and should instead use role policies. Conversely, if you want to limit certain permissions only to regular user accounts where authentication with a username and password is required, you can achieve that as a side effect of using the group policies rather than the role policies. This is what is used in this example for permissions that start with `ClusterManager`. Performing cluster management is usually done interactively using CLI tools. It makes sense to require the user to log in before using the resulting access token to authenticate to the Kafka broker. In this case, the access token represents the specific user, rather than the client application.

## **Accessing the Keycloak Admin Console**

Set up Keycloak, then connect to its Admin Console and add the preconfigured realm. Use the example `kafka-authz-realm.json` file to import the realm. You can check the authorization rules defined for the realm in the Admin Console. The rules grant access to the resources on the Kafka cluster configured to use the example Keycloak realm.

#### *Prerequisites*

- A running Kubernetes cluster.
- The Strimzi `examples/security/keycloak-authorization/kafka-authz-realm.json` file that contains the preconfigured realm.

#### *Procedure*

1. Install the Keycloak server using the Keycloak Operator as described in [Installing the Keycloak Operator](#) in the Keycloak documentation.
2. Wait until the Keycloak instance is running.
3. Get the external hostname to be able to access the Admin Console.

```
NS=sso
kubectl get ingress keycloak -n $NS
```

In this example, we assume the Keycloak server is running in the `sso` namespace.

4. Get the password for the `admin` user.

```
kubectl get -n $NS pod keycloak-0 -o yaml | less
```

The password is stored as a secret, so get the configuration YAML file for the Keycloak instance to identify the name of the secret (`secretKeyRef.name`).

5. Use the name of the secret to obtain the clear text password.

```
SECRET_NAME=credential-keycloak
kubectl get -n $NS secret $SECRET_NAME -o yaml | grep PASSWORD | awk '{print $2}' |
base64 -D
```

In this example, we assume the name of the secret is `credential-keycloak`.

6. Log in to the Admin Console with the username `admin` and the password you obtained.

Use <https://HOSTNAME> to access the Kubernetes ingress.

You can now upload the example realm to Keycloak using the Admin Console.

7. Click **Add Realm** to import the example realm.
8. Add the [examples/security/keycloak-authorization/kafka-authz-realm.json](#) file, and then click **Create**.

You now have `kafka-authz` as your current realm in the Admin Console.

The default view displays the **Master** realm.

9. In the Keycloak Admin Console, go to **Clients** > **kafka** > **Authorization** > **Settings** and check that **Decision Strategy** is set to **Affirmative**.

An affirmative policy means that at least one policy must be satisfied for a client to access the Kafka cluster.

10. In the Keycloak Admin Console, go to **Groups**, **Users**, **Roles** and **Clients** to view the realm configuration.

## Groups

**Groups** are used to create user groups and set user permissions. Groups are sets of users with a name assigned. They are used to compartmentalize users into geographical, organizational or departmental units. Groups can be linked to an LDAP identity provider. You can make a user a member of a group through a custom LDAP server admin user interface, for example, to grant permissions on Kafka resources.

## Users

**Users** are used to create users. For this example, `alice` and `bob` are defined. `alice` is a member of the `ClusterManager` group and `bob` is a member of `ClusterManager-my-cluster` group. Users can be stored in an LDAP identity provider.

## Roles

**Roles** mark users or clients as having certain permissions. Roles are a concept analogous to groups. They are usually used to *tag* users with organizational roles and have the requisite permissions. Roles cannot be stored in an LDAP identity provider. If LDAP is a requirement, you can use groups instead, and add Keycloak roles to the groups so that when users are assigned a group they also get a corresponding role.

## Clients

**Clients** can have specific configurations. For this example, **kafka**, **kafka-cli**, **team-a-client**, and **team-b-client** clients are configured.

- The **kafka** client is used by Kafka brokers to perform the necessary OAuth 2.0 communication for access token validation. This client also contains the authorization services resource definitions, policies, and authorization scopes used to perform authorization on the Kafka brokers. The authorization configuration is defined in the **kafka** client from the **Authorization** tab, which becomes visible when **Authorization Enabled** is switched on from the **Settings** tab.
- The **kafka-cli** client is a public client that is used by the Kafka command line tools when authenticating with username and password to obtain an access token or a refresh token.
- The **team-a-client** and **team-b-client** clients are confidential clients representing services with partial access to certain Kafka topics.

11. In the Keycloak Admin Console, go to **Authorization > Permissions** to see the granted permissions that use the resources and policies defined for the realm.

For example, the **kafka** client has the following permissions:

```
Dev Team A can write to topics that start with x_ on any cluster
Dev Team B can read from topics that start with x_ on any cluster
Dev Team B can update consumer group offsets that start with x_ on any cluster
ClusterManager of my-cluster Group has full access to cluster config on my-cluster
ClusterManager of my-cluster Group has full access to consumer groups on my-cluster
ClusterManager of my-cluster Group has full access to topics on my-cluster
```

### Dev Team A

The Dev Team A realm role can write to topics that start with **x\_** on any cluster. This combines a resource called **Topic:x\_\***, **Describe** and **Write** scopes, and the **Dev Team A** policy. The **Dev Team A** policy matches all users that have a realm role called **Dev Team A**.

### Dev Team B

The Dev Team B realm role can read from topics that start with **x\_** on any cluster. This combines **Topic:x\_\***, **Group:x\_\*** resources, **Describe** and **Read** scopes, and the **Dev Team B** policy. The **Dev Team B** policy matches all users that have a realm role called **Dev Team B**. Matching users and clients have the ability to read from topics, and update the consumed offsets for topics and consumer groups that have names starting with **x\_**.

## Deploying a Kafka cluster with Keycloak authorization

Deploy a Kafka cluster configured to connect to the Keycloak server. Use the example `kafka-ephemeral-oauth-single-keycloak-authz.yaml` file to deploy the Kafka cluster as a `Kafka` custom resource. The example deploys a single-node Kafka cluster with `keycloak` authorization and `oauth` authentication.

### Prerequisites

- The Keycloak authorization server is deployed to your Kubernetes cluster and loaded with the example realm.
- The Cluster Operator is deployed to your Kubernetes cluster.
- The Strimzi `examples/security/keycloak-authorization/kafka-ephemeral-oauth-single-keycloak-authz.yaml` custom resource.

### Procedure

1. Use the hostname of the Keycloak instance you deployed to prepare a truststore certificate for Kafka brokers to communicate with the Keycloak server.

```
SSO_HOST=SSO-HOSTNAME
SSO_HOST_PORT=$SSO_HOST:443
STOREPASS=storepass

echo "Q" | openssl s_client -showcerts -connect $SSO_HOST_PORT 2>/dev/null | awk '
/BEGIN CERTIFICATE/,/END CERTIFICATE/ { print $0 } ' > /tmp/sso.crt
```

The certificate is required as Kubernetes ingress is used to make a secure (HTTPS) connection.

2. Deploy the certificate to Kubernetes as a secret.

```
kubectl create secret generic oauth-server-cert --from-file=/tmp/sso.crt -n $NS
```

3. Set the hostname as an environment variable

```
SSO_HOST=SSO-HOSTNAME
```

4. Create and deploy the example Kafka cluster.

```
cat examples/security/keycloak-authorization/kafka-ephemeral-oauth-single-keycloak-authz.yaml | sed -E 's#\${SSO_HOST}#"#$SSO_HOST#" | kubectl create -n $NS -f -
```

## Preparing TLS connectivity for a CLI Kafka client session

Create a new pod for an interactive CLI session. Set up a truststore with a Keycloak certificate for TLS connectivity. The truststore is to connect to Keycloak and the Kafka broker.

## Prerequisites

- The Keycloak authorization server is deployed to your Kubernetes cluster and loaded with the example realm.

In the Keycloak Admin Console, check the roles assigned to the clients are displayed in **Clients > Service Account Roles**.

- The Kafka cluster configured to connect with Keycloak is deployed to your Kubernetes cluster.

## Procedure

1. Run a new interactive pod container using the Strimzi Kafka image to connect to a running Kafka broker.

```
NS=sso
kubectl run -ti --restart=Never --image=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1
kafka-cli -n $NS -- /bin/sh
```

**NOTE**

If `kubectl` times out waiting on the image download, subsequent attempts may result in an *AlreadyExists* error.

2. Attach to the pod container.

```
kubectl attach -ti kafka-cli -n $NS
```

3. Use the hostname of the Keycloak instance to prepare a certificate for client connection using TLS.

```
SSO_HOST=SSO-HOSTNAME
SSO_HOST_PORT=$SSO_HOST:443
STOREPASS=storepass

echo "Q" | openssl s_client -showcerts -connect $SSO_HOST_PORT 2>/dev/null | awk '
/BEGIN CERTIFICATE/,/END CERTIFICATE/ { print $0 } ' > /tmp/sso.crt
```

4. Create a truststore for TLS connection to the Kafka brokers.

```
keytool -keystore /tmp/truststore.p12 -storetype pkcs12 -alias sso -storepass
$STOREPASS -import -file /tmp/sso.crt -noprompt
```

5. Use the Kafka bootstrap address as the hostname of the Kafka broker and the `tls` listener port (9093) to prepare a certificate for the Kafka broker.

```
KAFKA_HOST_PORT=my-cluster-kafka-bootstrap:9093
STOREPASS=storepass
```

```
echo "Q" | openssl s_client -showcerts -connect $KAFKA_HOST_PORT 2>/dev/null | awk  
' /BEGIN CERTIFICATE/,/END CERTIFICATE/ { print $0 } ' > /tmp/my-cluster-kafka.crt
```

6. Add the certificate for the Kafka broker to the truststore.

```
keytool -keystore /tmp/truststore.p12 -storetype pkcs12 -alias my-cluster-kafka  
-storepass $STOREPASS -import -file /tmp/my-cluster-kafka.crt -noprompt
```

Keep the session open to check authorized access.

### Checking authorized access to Kafka using a CLI Kafka client session

Check the authorization rules applied through the Keycloak realm using an interactive CLI session. Apply the checks using Kafka's example producer and consumer clients to create topics with user and service accounts that have different levels of access.

Use the [team-a-client](#) and [team-b-client](#) clients to check the authorization rules. Use the [alice](#) admin user to perform additional administrative tasks on Kafka.

The Strimzi Kafka image used in this example contains Kafka producer and consumer binaries.

#### Prerequisites

- ZooKeeper and Kafka are running in the Kubernetes cluster to be able to send and receive messages.
- The [interactive CLI Kafka client session](#) is started.

#### Apache Kafka download.

#### Setting up client and admin user configuration

1. Prepare a Kafka configuration file with authentication properties for the [team-a-client](#) client.

```
SSO_HOST=$SSO-HOSTNAME

cat > /tmp/team-a-client.properties << EOF
security.protocol=SASL_SSL
ssl.truststore.location=/tmp/truststore.p12
ssl.truststore.password=$STOREPASS
ssl.truststore.type=PKCS12
sasl.mechanism=OAUTHBEARER
sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
    oauth.client.id="team-a-client" \
    oauth.client.secret="team-a-client-secret" \
    oauth.ssl.truststore.location="/tmp/truststore.p12" \
    oauth.ssl.truststore.password="$STOREPASS" \
    oauth.ssl.truststore.type="PKCS12" \
    oauth.token.endpoint.uri="https://$SSO_HOST/auth/realms/kafka-authz/protocol/openid-connect/token" ;
```

```
sasl.login.callback.handler.class=io.strimzi.kafka.oauth.client.JaasClientOAuthLogi  
nCallbackHandler  
EOF
```

The SASL OAUTHBEARER mechanism is used. This mechanism requires a client ID and client secret, which means the client first connects to the Keycloak server to obtain an access token. The client then connects to the Kafka broker and uses the access token to authenticate.

2. Prepare a Kafka configuration file with authentication properties for the `team-b-client` client.

```
cat > /tmp/team-b-client.properties << EOF  
security.protocol=SASL_SSL  
ssl.truststore.location=/tmp/truststore.p12  
ssl.truststore.password=$STOREPASS  
ssl.truststore.type=PKCS12  
sasl.mechanism=OAUTHBEARER  
sasl.jaas.config=org.apache.kafka.common.security.oauthbearer OAuthBearerLoginModul  
e required \  
    oauth.client.id="team-b-client" \  
    oauth.client.secret="team-b-client-secret" \  
    oauth.ssl.truststore.location="/tmp/truststore.p12" \  
    oauth.ssl.truststore.password="$STOREPASS" \  
    oauth.ssl.truststore.type="PKCS12" \  
    oauth.token.endpoint.uri="https://$SSO_HOST/auth/realms/kafka-  
authz/protocol/openid-connect/token" ;  
sasl.login.callback.handler.class=io.strimzi.kafka.oauth.client.JaasClientOAuthLogi  
nCallbackHandler  
EOF
```

3. Authenticate admin user `alice` by using `curl` and performing a password grant authentication to obtain a refresh token.

```
USERNAME=alice  
PASSWORD=alice-password  
  
GRANT_RESPONSE=$(curl -X POST "https://$SSO_HOST/auth/realms/kafka-  
authz/protocol/openid-connect/token" -H 'Content-Type: application/x-www-form-  
urlencoded' -d  
"grant_type=password&username=$USERNAME&password=$PASSWORD&client_id=kafka-  
cli&scope=offline_access" -s -k)  
  
REFRESH_TOKEN=$(echo $GRANT_RESPONSE | awk -F "refresh_token\":\""" '{printf $2}' |  
awk -F "\"" '{printf $1}'")
```

The refresh token is an offline token that is long-lived and does not expire.

4. Prepare a Kafka configuration file with authentication properties for the admin user `alice`.

```

cat > /tmp/alice.properties << EOF
security.protocol=SASL_SSL
ssl.truststore.location=/tmp/truststore.p12
ssl.truststore.password=$STOREPASS
ssl.truststore.type=PKCS12
sasl.mechanism=OAUTHBEARER
sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
    oauth.refresh.token="$REFRESH_TOKEN" \
    oauth.client.id="kafka-cli" \
    oauth.ssl.truststore.location="/tmp/truststore.p12" \
    oauth.ssl.truststore.password="$STOREPASS" \
    oauth.ssl.truststore.type="PKCS12" \
    oauth.token.endpoint.uri="https://$SSO_HOST/auth/realm/kafka-authz/protocol/openid-connect/token" ;
sasl.login.callback.handler.class=io.strimzi.kafka.oauth.client.JaasClientOAuthLoginCallbackHandler
EOF

```

The `kafka-cli` public client is used for the `oauth.client.id` in the `sasl.jaas.config`. Since it's a public client it does not require a secret. The client authenticates with the refresh token that was authenticated in the previous step. The refresh token requests an access token behind the scenes, which is then sent to the Kafka broker for authentication.

#### *Producing messages with authorized access*

Use the `team-a-client` configuration to check that you can produce messages to topics that start with `a_` or `x_`.

1. Write to topic `my-topic`.

```

bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
--topic my-topic \
--producer.config=/tmp/team-a-client.properties
First message

```

This request returns a `Not authorized to access topics: [my-topic]` error.

`team-a-client` has a `Dev Team A` role that gives it permission to perform any supported actions on topics that start with `a_`, but can only write to topics that start with `x_`. The topic named `my-topic` matches neither of those rules.

2. Write to topic `a_messages`.

```

bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
--topic a_messages \
--producer.config /tmp/team-a-client.properties
First message

```

## Second message

Messages are produced to Kafka successfully.

3. Press CTRL+C to exit the CLI application.
4. Check the Kafka container log for a debug log of **Authorization GRANTED** for the request.

```
kubectl logs my-cluster-kafka-0 -f -n $NS
```

## Consuming messages with authorized access

Use the **team-a-client** configuration to consume messages from topic **a\_messages**.

1. Fetch messages from topic **a\_messages**.

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic a_messages \  
--from-beginning --consumer.config /tmp/team-a-client.properties
```

The request returns an error because the **Dev Team A** role for **team-a-client** only has access to consumer groups that have names starting with **a\_**.

2. Update the **team-a-client** properties to specify the custom consumer group it is permitted to use.

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic a_messages \  
--from-beginning --consumer.config /tmp/team-a-client.properties --group  
a_consumer_group_1
```

The consumer receives all the messages from the **a\_messages** topic.

## Administering Kafka with authorized access

The **team-a-client** is an account without any cluster-level access, but it can be used with some administrative operations.

1. List topics.

```
bin/kafka-topics.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command  
-config /tmp/team-a-client.properties --list
```

The **a\_messages** topic is returned.

2. List consumer groups.

```
bin/kafka-consumer-groups.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
```

```
--command-config /tmp/team-a-client.properties --list
```

The `a_consumer_group_1` consumer group is returned.

Fetch details on the cluster configuration.

```
bin/kafka-configs.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command
--config /tmp/team-a-client.properties \
--entity-type brokers --describe --entity-default
```

The request returns an error because the operation requires cluster level permissions that `team-a-client` does not have.

#### *Using clients with different permissions*

Use the `team-b-client` configuration to produce messages to topics that start with `b_`.

1. Write to topic `a_messages`.

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
--topic a_messages \
--producer.config /tmp/team-b-client.properties
Message 1
```

This request returns a `Not authorized to access topics: [a_messages]` error.

2. Write to topic `b_messages`.

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
--topic b_messages \
--producer.config /tmp/team-b-client.properties
Message 1
Message 2
Message 3
```

Messages are produced to Kafka successfully.

3. Write to topic `x_messages`.

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
--topic x_messages \
--producer.config /tmp/team-b-client.properties
Message 1
```

A `Not authorized to access topics: [x_messages]` error is returned, The `team-b-client` can only read from topic `x_messages`.

4. Write to topic `x_messages` using `team-a-client`.

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--producer.config /tmp/team-a-client.properties  
Message 1
```

This request returns a `Not authorized to access topics: [x_messages]` error. The `team-a-client` can write to the `x_messages` topic, but it does not have a permission to create a topic if it does not yet exist. Before `team-a-client` can write to the `x_messages` topic, an admin *power user* must create it with the correct configuration, such as the number of partitions and replicas.

#### *Managing Kafka with an authorized admin user*

Use admin user `alice` to manage Kafka. `alice` has full access to manage everything on any Kafka cluster.

1. Create the `x_messages` topic as `alice`.

```
bin/kafka-topics.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command  
-config /tmp/alice.properties \  
--topic x_messages --create --replication-factor 1 --partitions 1
```

The topic is created successfully.

2. List all topics as `alice`.

```
bin/kafka-topics.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command  
-config /tmp/alice.properties --list  
bin/kafka-topics.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command  
-config /tmp/team-a-client.properties --list  
bin/kafka-topics.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command  
-config /tmp/team-b-client.properties --list
```

Admin user `alice` can list all the topics, whereas `team-a-client` and `team-b-client` can only list the topics they have access to.

The `Dev Team A` and `Dev Team B` roles both have `Describe` permission on topics that start with `x_`, but they cannot see the other team's topics because they do not have `Describe` permissions on them.

3. Use the `team-a-client` to produce messages to the `x_messages` topic:

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--producer.config /tmp/team-a-client.properties  
Message 1  
Message 2
```

### Message 3

As **alice** created the **x\_messages** topic, messages are produced to Kafka successfully.

4. Use the **team-b-client** to produce messages to the **x\_messages** topic.

```
bin/kafka-console-producer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--producer.config /tmp/team-b-client.properties  
Message 4  
Message 5
```

This request returns a **Not authorized to access topics: [x\_messages]** error.

5. Use the **team-b-client** to consume messages from the **x\_messages** topic:

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--from-beginning --consumer.config /tmp/team-b-client.properties --group  
x_consumer_group_b
```

The consumer receives all the messages from the **x\_messages** topic.

6. Use the **team-a-client** to consume messages from the **x\_messages** topic.

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--from-beginning --consumer.config /tmp/team-a-client.properties --group  
x_consumer_group_a
```

This request returns a **Not authorized to access topics: [x\_messages]** error.

7. Use the **team-a-client** to consume messages from a consumer group that begins with **a\_**.

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093  
--topic x_messages \  
--from-beginning --consumer.config /tmp/team-a-client.properties --group  
a_consumer_group_a
```

This request returns a **Not authorized to access topics: [x\_messages]** error.

**Dev Team A** has no **Read** access on topics that start with a **x\_**.

8. Use **alice** to produce messages to the **x\_messages** topic.

```
bin/kafka-console-consumer.sh --bootstrap-server my-cluster-kafka-bootstrap:9093
```

```
--topic x_messages \
--from-beginning --consumer.config /tmp/alice.properties
```

Messages are produced to Kafka successfully.

alice can read from or write to any topic.

9. Use alice to read the cluster configuration.

```
bin/kafka-configs.sh --bootstrap-server my-cluster-kafka-bootstrap:9093 --command
--config /tmp/alice.properties \
--entity-type brokers --describe --entity-default
```

The cluster configuration for this example is empty.

#### *Additional resources*

- [Installing the Keycloak Operator](#)
- [Map Keycloak Authorization Services to the Kafka authorization model](#)

# Chapter 7. Using Strimzi Operators

Use the Strimzi operators to manage your Kafka cluster, and Kafka topics and users.

## 7.1. Watching namespaces with Strimzi operators

Operators watch and manage Strimzi resources in namespaces. The Cluster Operator can watch a single namespace, multiple namespaces, or all namespaces in a Kubernetes cluster. The Topic Operator and User Operator can watch a single namespace.

- The Cluster Operator watches for [Kafka](#) resources
- The Topic Operator watches for [KafkaTopic](#) resources
- The User Operator watches for [KafkaUser](#) resources

The Topic Operator and the User Operator can only watch a single Kafka cluster in a namespace. And they can only be connected to a single Kafka cluster.

If multiple Topic Operators watch the same namespace, name collisions and topic deletion can occur. This is because each Kafka cluster uses Kafka topics that have the same name (such as [\\_consumer\\_offsets](#)). Make sure that only one Topic Operator watches a given namespace.

When using multiple User Operators with a single namespace, a user with a given username can exist in more than one Kafka cluster.

If you deploy the Topic Operator and User Operator using the Cluster Operator, they watch the Kafka cluster deployed by the Cluster Operator by default. You can also specify a namespace using [watchedNamespace](#) in the operator configuration.

For a standalone deployment of each operator, you specify a namespace and connection to the Kafka cluster to watch in the configuration.

## 7.2. Using the Cluster Operator

The Cluster Operator is used to deploy a Kafka cluster and other Kafka components.

For information on deploying the Cluster Operator, see [Deploying the Cluster Operator](#).

### 7.2.1. Role-Based Access Control (RBAC) resources

The Cluster Operator creates and manages RBAC resources for Strimzi components that need access to Kubernetes resources.

For the Cluster Operator to function, it needs permission within the Kubernetes cluster to interact with Kafka resources, such as [Kafka](#) and [KafkaConnect](#), as well as managed resources like [ConfigMap](#), [Pod](#), [Deployment](#), [StatefulSet](#), and [Service](#).

Permission is specified through Kubernetes role-based access control (RBAC) resources:

- `ServiceAccount`
- `Role` and `ClusterRole`
- `RoleBinding` and `ClusterRoleBinding`

## Delegating privileges to Strimzi components

The Cluster Operator runs under a service account called `strimzi-cluster-operator`. It is assigned cluster roles that give it permission to create the RBAC resources for Strimzi components. Role bindings associate the cluster roles with the service account.

Kubernetes prevents components operating under one `ServiceAccount` from granting another `ServiceAccount` privileges that the granting `ServiceAccount` does not have. Because the Cluster Operator creates the `RoleBinding` and `ClusterRoleBinding` RBAC resources needed by the resources it manages, it requires a role that gives it the same privileges.

The following tables describe the RBAC resources created by the Cluster Operator.

*Table 5. ServiceAccount resources*

Name	Used by
<code>&lt;cluster_name&gt;-kafka</code>	Kafka broker pods
<code>&lt;cluster_name&gt;-zookeeper</code>	ZooKeeper pods
<code>&lt;cluster_name&gt;-cluster-connect</code>	Kafka Connect pods
<code>&lt;cluster_name&gt;-mirror-maker</code>	MirrorMaker pods
<code>&lt;cluster_name&gt;-mirrormaker2</code>	MirrorMaker 2.0 pods
<code>&lt;cluster_name&gt;-bridge</code>	Kafka Bridge pods
<code>&lt;cluster_name&gt;-entity-operator</code>	Entity Operator

*Table 6. ClusterRole resources*

Name	Used by
<code>strimzi-cluster-operator-namespaced</code>	Cluster Operator
<code>strimzi-cluster-operator-global</code>	Cluster Operator
<code>strimzi-cluster-operator-leader-election</code>	Cluster Operator
<code>strimzi-kafka-broker</code>	Cluster Operator, rack feature (when used)
<code>strimzi-entity-operator</code>	Cluster Operator, Topic Operator, User Operator
<code>strimzi-kafka-client</code>	Cluster Operator, Kafka clients for rack awareness

*Table 7. ClusterRoleBinding resources*

Name	Used by
<code>strimzi-cluster-operator</code>	Cluster Operator

Name	Used by
<code>strimzi-cluster-operator-kafka-broker-delegation</code>	Cluster Operator, Kafka brokers for rack awareness
<code>strimzi-cluster-operator-kafka-client-delegation</code>	Cluster Operator, Kafka clients for rack awareness

Table 8. `RoleBinding` resources

Name	Used by
<code>strimzi-cluster-operator</code>	Cluster Operator
<code>strimzi-cluster-operator-kafka-broker-delegation</code>	Cluster Operator, Kafka brokers for rack awareness

## Running the Cluster Operator using a `ServiceAccount`

The Cluster Operator is best run using a `ServiceAccount`:

*Example `ServiceAccount` for the Cluster Operator*

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: strimzi-cluster-operator
  labels:
    app: strimzi
```

The `Deployment` of the operator then needs to specify this in its `spec.template.spec.serviceAccountName`:

*Partial example of `Deployment` for the Cluster Operator*

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: strimzi-cluster-operator
  labels:
    app: strimzi
spec:
  replicas: 1
  selector:
    matchLabels:
      name: strimzi-cluster-operator
      strimzi.io/kind: cluster-operator
  template:
    # ...
```

Note line 12, where `strimzi-cluster-operator` is specified as the `serviceAccountName`.

## ClusterRole resources

The Cluster Operator uses `ClusterRole` resources to provide the necessary access to resources. Depending on the Kubernetes cluster setup, a cluster administrator might be needed to create the cluster roles.

**NOTE**

Cluster administrator rights are only needed for the creation of `ClusterRole` resources. The Cluster Operator will not run under a cluster admin account.

`ClusterRole` resources follow the *principle of least privilege* and contain only those privileges needed by the Cluster Operator to operate the cluster of the Kafka component. The first set of assigned privileges allow the Cluster Operator to manage Kubernetes resources such as `StatefulSet`, `Deployment`, `Pod`, and `ConfigMap`.

All cluster roles are required by the Cluster Operator in order to delegate privileges.

The Cluster Operator uses the `strimzi-cluster-operator-namespaced` and `strimzi-cluster-operator-global` cluster roles to grant permission at the namespace-scoped resources level and cluster-scoped resources level.

### `ClusterRole` with namespaced resources for the Cluster Operator

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-cluster-operator-namespaced
  labels:
    app: strimzi
rules:
  # Resources in this role are used by the operator based on an operand being deployed
  # in some namespace. When needed, you
  # can deploy the operator as a cluster-wide operator. But grant the rights listed in
  # this role only on the namespaces
  # where the operands will be deployed. That way, you can limit the access the
  # operator has to other namespaces where it
  # does not manage any clusters.
  - apiGroups:
      - "rbac.authorization.k8s.io"
    resources:
      # The cluster operator needs to access and manage rolebindings to grant Strimzi
      # components cluster permissions
      - rolebindings
    verbs:
      - get
      - list
      - watch
      - create
      - delete
      - patch
      - update
  - apiGroups:
```

```

- "rbac.authorization.k8s.io"
resources:
  # The cluster operator needs to access and manage roles to grant the entity
operator permissions
  - roles
verbs:
  - get
  - list
  - watch
  - create
  - delete
  - patch
  - update
- apiGroups:
  - ""
resources:
  # The cluster operator needs to access and delete pods, this is to allow it to
monitor pod health and coordinate rolling updates
  - pods
  # The cluster operator needs to access and manage service accounts to grant
Stimzi components cluster permissions
  - serviceaccounts
  # The cluster operator needs to access and manage config maps for Stimzi
components configuration
  - configmaps
  # The cluster operator needs to access and manage services and endpoints to
expose Stimzi components to network traffic
  - services
  - endpoints
  # The cluster operator needs to access and manage secrets to handle credentials
  - secrets
  # The cluster operator needs to access and manage persistent volume claims to
bind them to Stimzi components for persistent data
  - persistentvolumeclaims
verbs:
  - get
  - list
  - watch
  - create
  - delete
  - patch
  - update
- apiGroups:
  # The cluster operator needs the extensions api as the operator supports
Kubernetes version 1.11+
  # apps/v1 was introduced in Kubernetes 1.14
  - "extensions"
resources:
  # The cluster operator needs to access and manage deployments to run deployment
based Stimzi components
  - deployments

```

```

    - deployments/scale
    # The cluster operator needs to access replica sets to manage Strimzi components
    and to determine error states
    - replicaset
    # The cluster operator needs to access and manage replication controllers to
    manage replicaset
    - replicationcontroller
    # The cluster operator needs to access and manage network policies to lock down
    communication between Strimzi components
    - networkpolicy
    # The cluster operator needs to access and manage ingresses which allow external
    access to the services in a cluster
    - ingress
  verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update
  - apiGroups:
    - "apps"
  resources:
    # The cluster operator needs to access and manage deployments to run deployment
    based Strimzi components
    - deployments
    - deployments/scale
    - deployments/status
    # The cluster operator needs to access and manage stateful sets to run stateful
    sets based Strimzi components
    - statefulsets
    # The cluster operator needs to access replica-sets to manage Strimzi components
    and to determine error states
    - replicaset
  verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update
  - apiGroups:
    - "" # legacy core events api, used by topic operator
    - "events.k8s.io" # new events api, used by cluster operator
  resources:
    # The cluster operator needs to be able to create events and delegate
    permissions to do so
    - events
  verbs:

```

```

    - create
- apiGroups:
    # Kafka Connect Build on OpenShift requirement
    - build.openshift.io
resources:
    - buildconfigs
    - buildconfigs/instantiate
    - builds
verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update
- apiGroups:
    - networking.k8s.io
resources:
    # The cluster operator needs to access and manage network policies to lock down
    communication between Strimzi components
    - networkpolicies
    # The cluster operator needs to access and manage ingresses which allow external
    access to the services in a cluster
    - ingresses
verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update
- apiGroups:
    - route.openshift.io
resources:
    # The cluster operator needs to access and manage routes to expose Strimzi
    components for external access
    - routes
    - routes/custom-host
verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update
- apiGroups:
    - policy
resources:

```

```

# The cluster operator needs to access and manage pod disruption budgets this
limits the number of concurrent disruptions
    # that a Strimzi component experiences, allowing for higher availability
    - poddisruptionbudgets
verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update

```

### **ClusterRole** with cluster-scoped resources for the Cluster Operator

```

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-cluster-operator-global
  labels:
    app: strimzi
rules:
  - apiGroups:
      - "rbac.authorization.k8s.io"
    resources:
      # The cluster operator needs to create and manage cluster role bindings in the
      case of an install where a user
        # has specified they want their cluster role bindings generated
        - clusterrolebindings
    verbs:
      - get
      - list
      - watch
      - create
      - delete
      - patch
      - update
  - apiGroups:
      - storage.k8s.io
    resources:
      # The cluster operator requires "get" permissions to view storage class details
      # This is because only a persistent volume of a supported storage class type can
      be resized
      - storageclasses
    verbs:
      - get
  - apiGroups:
      - ""
    resources:
      # The cluster operator requires "list" permissions to view all nodes in a

```

```

cluster
  # The listing is used to determine the node addresses when NodePort access is
  configured
    # These addresses are then exposed in the custom resource states
    - nodes
  verbs:
    - list

```

The **strimzi-cluster-operator-leader-election** cluster role represents the permissions needed for the leader election.

#### **ClusterRole with leader election permissions**

```

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-cluster-operator-leader-election
  labels:
    app: strimzi
rules:
  - apiGroups:
      - coordination.k8s.io
    resources:
      # The cluster operator needs to access and manage leases for leader election
      # The "create" verb cannot be used with "resourceNames"
      - leases
    verbs:
      - create
  - apiGroups:
      - coordination.k8s.io
    resources:
      # The cluster operator needs to access and manage leases for leader election
      - leases
    resourceNames:
      # The default RBAC files give the operator only access to the Lease resource
      names strimzi-cluster-operator
      # If you want to use another resource name or resource namespace, you have to
      configure the RBAC resources accordingly
      - strimzi-cluster-operator
    verbs:
      - get
      - list
      - watch
      - delete
      - patch
      - update

```

The **strimzi-kafka-broker** cluster role represents the access needed by the init container in Kafka pods that use rack awareness.

A role binding named `strimzi-<cluster_name>-kafka-init` grants the `<cluster_name>-kafka` service account access to nodes within a cluster using the `strimzi-kafka-broker` role. If the rack feature is not used and the cluster is not exposed through `nodeport`, no binding is created.

`ClusterRole` for the Cluster Operator allowing it to delegate access to Kubernetes nodes to the Kafka broker pods

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-kafka-broker
  labels:
    app: strimzi
rules:
  - apiGroups:
    - ""
      resources:
        # The Kafka Brokers require "get" permissions to view the node they are on
        # This information is used to generate a Rack ID that is used for High
        Availability configurations
        - nodes
      verbs:
        - get
```

The `strimzi-entity-operator` cluster role represents the access needed by the Topic Operator and User Operator.

The Topic Operator produces Kubernetes events with status information, so the `<cluster_name>-entity-operator` service account is bound to the `strimzi-entity-operator` role, which grants this access via the `strimzi-entity-operator` role binding.

`ClusterRole` for the Cluster Operator allowing it to delegate access to events to the Topic and User Operators

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-entity-operator
  labels:
    app: strimzi
rules:
  - apiGroups:
    - "kafka.strimzi.io"
      resources:
        # The entity operator runs the KafkaTopic assembly operator, which needs to
        # access and manage KafkaTopic resources
        - kafkatopics
        - kafkatopics/status
        # The entity operator runs the KafkaUser assembly operator, which needs to
        # access and manage KafkaUser resources
```

```

    - kafkausers
    - kafkausers/status
  verbs:
    - get
    - list
    - watch
    - create
    - patch
    - update
    - delete
- apiGroups:
    - ""
  resources:
    - events
  verbs:
    # The entity operator needs to be able to create events
    - create
- apiGroups:
    - ""
  resources:
    # The entity operator user-operator needs to access and manage secrets to store
generated credentials
    - secrets
  verbs:
    - get
    - list
    - watch
    - create
    - delete
    - patch
    - update

```

The **strimzi-kafka-client** cluster role represents the access needed by Kafka clients that use rack awareness.

**ClusterRole** for the Cluster Operator allowing it to delegate access to Kubernetes nodes to the Kafka client-based pods

```

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-kafka-client
  labels:
    app: strimzi
rules:
- apiGroups:
    - ""
  resources:
    # The Kafka clients (Connect, Mirror Maker, etc.) require "get" permissions to
view the node they are on

```

```

# This information is used to generate a Rack ID (client.rack option) that is
used for consuming from the closest
  # replicas when enabled
    - nodes
  verbs:
    - get

```

## ClusterRoleBinding resources

The Cluster Operator uses `ClusterRoleBinding` and `RoleBinding` resources to associate its `ClusterRole` with its `ServiceAccount`: Cluster role bindings are required by cluster roles containing cluster-scoped resources.

*Example `ClusterRoleBinding` for the Cluster Operator*

```

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: strimzi-cluster-operator
  labels:
    app: strimzi
subjects:
  - kind: ServiceAccount
    name: strimzi-cluster-operator
    namespace: myproject
roleRef:
  kind: ClusterRole
  name: strimzi-cluster-operator-global
  apiGroup: rbac.authorization.k8s.io

```

Cluster role bindings are also needed for the cluster roles used in delegating privileges:

*Example `ClusterRoleBinding` for the Cluster Operator and Kafka broker rack awareness*

```

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: strimzi-cluster-operator-kafka-broker-delegation
  labels:
    app: strimzi
  # The Kafka broker cluster role must be bound to the cluster operator service account
  # so that it can delegate the cluster role to the Kafka brokers.
  # This must be done to avoid escalating privileges which would be blocked by
  # Kubernetes.
subjects:
  - kind: ServiceAccount
    name: strimzi-cluster-operator
    namespace: myproject
roleRef:
  kind: ClusterRole

```

```
name: strimzi-kafka-broker
apiGroup: rbac.authorization.k8s.io
```

*Example ClusterRoleBinding for the Cluster Operator and Kafka client rack awareness*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: strimzi-cluster-operator-kafka-client-delegation
  labels:
    app: strimzi
  # The Kafka clients cluster role must be bound to the cluster operator service account
  # so that it can delegate the
  # cluster role to the Kafka clients using it for consuming from closest replica.
  # This must be done to avoid escalating privileges which would be blocked by
  # Kubernetes.
subjects:
  - kind: ServiceAccount
    name: strimzi-cluster-operator
    namespace: myproject
roleRef:
  kind: ClusterRole
  name: strimzi-kafka-client
  apiGroup: rbac.authorization.k8s.io
```

Cluster roles containing only namespaced resources are bound using role bindings only.

*Example RoleBinding for the Cluster Operator*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: strimzi-cluster-operator
  labels:
    app: strimzi
subjects:
  - kind: ServiceAccount
    name: strimzi-cluster-operator
    namespace: myproject
roleRef:
  kind: ClusterRole
  name: strimzi-cluster-operator-namespaced
  apiGroup: rbac.authorization.k8s.io
```

*Example RoleBinding for the Cluster Operator and Kafka broker rack awareness*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
```

```
name: strimzi-cluster-operator-entity-operator-delegation
labels:
  app: strimzi
# The Entity Operator cluster role must be bound to the cluster operator service
account so that it can delegate the cluster role to the Entity Operator.
# This must be done to avoid escalating privileges which would be blocked by
Kubernetes.
subjects:
  - kind: ServiceAccount
    name: strimzi-cluster-operator
    namespace: myproject
roleRef:
  kind: ClusterRole
  name: strimzi-entity-operator
  apiGroup: rbac.authorization.k8s.io
```

## 7.2.2. ConfigMap for Cluster Operator logging

Cluster Operator logging is configured through a [ConfigMap](#) named `strimzi-cluster-operator`.

A [ConfigMap](#) containing logging configuration is created when installing the Cluster Operator. This [ConfigMap](#) is described in the file `install/cluster-operator/050-ConfigMap-strimzi-cluster-operator.yaml`. You configure Cluster Operator logging by changing the data field `log4j2.properties` in this [ConfigMap](#).

To update the logging configuration, you can edit the `050-ConfigMap-strimzi-cluster-operator.yaml` file and then run the following command:

```
kubectl create -f install/cluster-operator/050-ConfigMap-strimzi-cluster-operator.yaml
```

Alternatively, edit the [ConfigMap](#) directly:

```
kubectl edit configmap strimzi-cluster-operator
```

To change the frequency of the reload interval, set a time in seconds in the `monitorInterval` option in the created [ConfigMap](#).

If the [ConfigMap](#) is missing when the Cluster Operator is deployed, the default logging values are used.

If the [ConfigMap](#) is accidentally deleted after the Cluster Operator is deployed, the most recently loaded logging configuration is used. Create a new [ConfigMap](#) to load a new logging configuration.

**NOTE**    Do not remove the `monitorInterval` option from the [ConfigMap](#).

### 7.2.3. Configuring the Cluster Operator with environment variables

You can configure the Cluster Operator using environment variables. The supported environment variables are listed here.

**NOTE** The environment variables relate to the container configuration for the deployment of the Cluster Operator image. For more information on [image](#) configuration, see, [image](#).

#### STRIMZI\_NAMESPACE

A comma-separated list of namespaces that the operator operates in. When not set, set to empty string, or set to `*`, the Cluster Operator operates in all namespaces.

The Cluster Operator deployment might use the downward API to set this automatically to the namespace the Cluster Operator is deployed in.

*Example configuration for Cluster Operator namespaces*

```
env:  
  - name: STRIMZI_NAMESPACE  
    valueFrom:  
      fieldRef:  
        fieldPath: metadata.namespace
```

#### STRIMZI\_FULL\_RECONCILIATION\_INTERVAL\_MS

Optional, default is 120000 ms. The interval between [periodic reconciliations](#), in milliseconds.

#### STRIMZI\_OPERATION\_TIMEOUT\_MS

Optional, default 300000 ms. The timeout for internal operations, in milliseconds. Increase this value when using Strimzi on clusters where regular Kubernetes operations take longer than usual (because of slow downloading of Docker images, for example).

#### STRIMZI\_ZOOKEEPER\_ADMIN\_SESSION\_TIMEOUT\_MS

Optional, default 10000 ms. The session timeout for the Cluster Operator's ZooKeeper admin client, in milliseconds. Increase the value if ZooKeeper requests from the Cluster Operator are regularly failing due to timeout issues. There is a maximum allowed session time set on the ZooKeeper server side via the `maxSessionTimeout` config. By default, the maximum session timeout value is 20 times the default `tickTime` (whose default is 2000) at 40000 ms. If you require a higher timeout, change the `maxSessionTimeout` ZooKeeper server configuration value.

#### STRIMZI\_OPERATIONS\_THREAD\_POOL\_SIZE

Optional, default 10. The worker thread pool size, which is used for various asynchronous and blocking operations that are run by the Cluster Operator.

#### STRIMZI\_OPERATOR\_NAME

Optional, defaults to the pod's hostname. The operator name identifies the Strimzi instance when [emitting Kubernetes events](#).

## **STRIMZI\_OPERATOR\_NAMESPACE**

The name of the namespace where the Cluster Operator is running. Do not configure this variable manually. Use the downward API.

```
env:  
  - name: STRIMZI_OPERATOR_NAMESPACE  
    valueFrom:  
      fieldRef:  
        fieldPath: metadata.namespace
```

## **STRIMZI\_OPERATOR\_NAMESPACE\_LABELS**

Optional. The labels of the namespace where the Strimzi Cluster Operator is running. Use namespace labels to configure the namespace selector in [network policies](#). Network policies allow the Strimzi Cluster Operator access only to the operands from the namespace with these labels. When not set, the namespace selector in network policies is configured to allow access to the Cluster Operator from any namespace in the Kubernetes cluster.

```
env:  
  - name: STRIMZI_OPERATOR_NAMESPACE_LABELS  
    value: label1=value1,label2=value2
```

## **STRIMZI\_LABELS\_EXCLUSION\_PATTERN**

Optional, default regex pattern is `^app.kubernetes.io/(?!part-of).*`. The regex exclusion pattern used to filter labels propagation from the main custom resource to its subresources. The labels exclusion filter is not applied to labels in template sections such as `spec.kafka.template.pod.metadata.labels`.

```
env:  
  - name: STRIMZI_LABELS_EXCLUSION_PATTERN  
    value: "^key1.*"
```

## **STRIMZI\_CUSTOM\_{COMPONENT\_NAME}\_LABELS**

Optional. One or more custom labels to apply to all the pods created by the `{COMPONENT_NAME}` custom resource. The Cluster Operator labels the pods when the custom resource is created or is next reconciled.

Labels can be applied to the following components:

- **KAFKA**
- **KAFKA\_CONNECT**
- **KAFKA\_CONNECT\_BUILD**
- **ZOOKEEPER**
- **ENTITY\_OPERATOR**

- KAFKA\_MIRROR MAKER2
- KAFKA\_MIRROR MAKER
- CRUISE\_CONTROL
- KAFKA\_BRIDGE
- KAFKA\_EXPORTER
- JMX\_TRANS

### **STRIMZI\_CUSTOM\_RESOURCE\_SELECTOR**

Optional. The label selector to filter the custom resources handled by the Cluster Operator. The operator will operate only on those custom resources that have the specified labels set. Resources without these labels will not be seen by the operator. The label selector applies to **Kafka**, **KafkaConnect**, **KafkaBridge**, **KafkaMirrorMaker**, and **KafkaMirrorMaker2** resources. **KafkaRebalance** and **KafkaConnector** resources are operated only when their corresponding Kafka and Kafka Connect clusters have the matching labels.

```
env:
  - name: STRIMZI_CUSTOM_RESOURCE_SELECTOR
    value: label1=value1,label2=value2
```

### **STRIMZI\_KAFKA\_IMAGES**

Required. The mapping from the Kafka version to the corresponding Docker image containing a Kafka broker for that version. The required syntax is whitespace or comma-separated <version>=<image> pairs. For example 3.2.1=quay.io/strimzi/kafka:0.32.0-kafka-3.2.1, 3.3.1=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1. This is used when a **Kafka.spec.kafka.version** property is specified but not the **Kafka.spec.kafka.image** in the **Kafka** resource.

### **STRIMZI\_DEFAULT\_KAFKA\_INIT\_IMAGE**

Optional, default **quay.io/strimzi/operator:0.32.0**. The image name to use as default for the init container if no image is specified as the **kafka-init-image** in the **Kafka** resource. The init container is started before the broker for initial configuration work, such as rack support.

### **STRIMZI\_KAFKA\_CONNECT\_IMAGES**

Required. The mapping from the Kafka version to the corresponding Docker image of Kafka Connect for that version. The required syntax is whitespace or comma-separated <version>=<image> pairs. For example 3.2.1=quay.io/strimzi/kafka:0.32.0-kafka-3.2.1, 3.3.1=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1. This is used when a **KafkaConnect.spec.version** property is specified but not the **KafkaConnect.spec.image**.

### **STRIMZI\_KAFKA\_MIRROR MAKER\_IMAGES**

Required. The mapping from the Kafka version to the corresponding Docker image of MirrorMaker for that version. The required syntax is whitespace or comma-separated <version>=<image> pairs. For example 3.2.1=quay.io/strimzi/kafka:0.32.0-kafka-3.2.1, 3.3.1=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1. This is used when a **KafkaMirrorMaker.spec.version** property is specified but not the **KafkaMirrorMaker.spec.image**.

## **STRIMZI\_DEFAULT\_TOPIC\_OPERATOR\_IMAGE**

Optional, default `quay.io/strimzi/operator:0.32.0`. The image name to use as the default when deploying the Topic Operator if no image is specified as the `Kafka.spec.entityOperator.topicOperator.image` in the `Kafka` resource.

## **STRIMZI\_DEFAULT\_USER\_OPERATOR\_IMAGE**

Optional, default `quay.io/strimzi/operator:0.32.0`. The image name to use as the default when deploying the User Operator if no image is specified as the `Kafka.spec.entityOperator.userOperator.image` in the `Kafka` resource.

## **STRIMZI\_DEFAULT\_TLS\_SIDECAR\_ENTITY\_OPERATOR\_IMAGE**

Optional, default `quay.io/strimzi/kafka:0.32.0-kafka-3.3.1`. The image name to use as the default when deploying the sidecar container for the Entity Operator if no image is specified as the `Kafka.spec.entityOperator.tlsSidecar.image` in the `Kafka` resource. The sidecar provides TLS support.

## **STRIMZI\_IMAGE\_PULL\_POLICY**

Optional. The `ImagePullPolicy` that is applied to containers in all pods managed by the Cluster Operator. The valid values are `Always`, `IfNotPresent`, and `Never`. If not specified, the Kubernetes defaults are used. Changing the policy will result in a rolling update of all your Kafka, Kafka Connect, and Kafka MirrorMaker clusters.

## **STRIMZI\_IMAGE\_PULL\_SECRETS**

Optional. A comma-separated list of `Secret` names. The secrets referenced here contain the credentials to the container registries where the container images are pulled from. The secrets are specified in the `imagePullSecrets` property for all pods created by the Cluster Operator. Changing this list results in a rolling update of all your Kafka, Kafka Connect, and Kafka MirrorMaker clusters.

## **STRIMZI\_KUBERNETES\_VERSION**

Optional. Overrides the Kubernetes version information detected from the API server.

*Example configuration for Kubernetes version override*

```
env:
  - name: STRIMZI_KUBERNETES_VERSION
    value: |
      major=1
      minor=16
      gitVersion=v1.16.2
      gitCommit=c97fe5036ef3df2967d086711e6c0c405941e14b
      gitTreeState=clean
      buildDate=2019-10-15T19:09:08Z
      goVersion=go1.12.10
      compiler=gc
      platform=linux/amd64
```

## KUBERNETES\_SERVICE\_DNS\_DOMAIN

Optional. Overrides the default Kubernetes DNS domain name suffix.

By default, services assigned in the Kubernetes cluster have a DNS domain name that uses the default suffix `cluster.local`.

For example, for broker `kafka-0`:

```
<cluster-name>-kafka-0.<cluster-name>-kafka-brokers.<namespace>.svc.cluster.local
```

The DNS domain name is added to the Kafka broker certificates used for hostname verification.

If you are using a different DNS domain name suffix in your cluster, change the `KUBERNETES_SERVICE_DNS_DOMAIN` environment variable from the default to the one you are using in order to establish a connection with the Kafka brokers.

## STRIMZI\_CONNECT\_BUILD\_TIMEOUT\_MS

Optional, default 300000 ms. The timeout for building new Kafka Connect images with additional connectors, in milliseconds. Consider increasing this value when using Strimzi to build container images containing many connectors or using a slow container registry.

## STRIMZI\_NETWORK\_POLICY\_GENERATION

Optional, default `true`. Network policy for resources. Network policies allow connections between Kafka components.

Set this environment variable to `false` to disable network policy generation. You might do this, for example, if you want to use custom network policies. Custom network policies allow more control over maintaining the connections between components.

## STRIMZI\_DNS\_CACHE\_TTL

Optional, default `30`. Number of seconds to cache successful name lookups in local DNS resolver. Any negative value means cache forever. Zero means do not cache, which can be useful for avoiding connection errors due to long caching policies being applied.

## STRIMZI\_POD\_SET\_RECONCILIATION\_ONLY

Optional, default `false`. When set to `true`, the Cluster Operator reconciles only the `StrimziPodSet` resources and any changes to the other custom resources (`Kafka`, `KafkaConnect`, and so on) are ignored. This mode is useful for ensuring that your pods are recreated if needed, but no other changes happen to the clusters.

## STRIMZI\_FEATURE\_GATES

Optional. Enables or disables the features and functionality controlled by [feature gates](#).

## STRIMZI\_POD\_SECURITY\_PROVIDER\_CLASS

Optional. Configuration for the pluggable `PodSecurityProvider` class, which can be used to provide the security context configuration for Pods and containers.

## Leader election environment variables

Use leader election environment variables when [running additional Cluster Operator replicas](#). You might run additional replicas to safeguard against disruption caused by major failure.

### STRIMZI\_LEADER\_ELECTION\_ENABLED

Optional, disabled (`false`) by default. Enables or disables leader election, which allows additional Cluster Operator replicas to run on standby.

**NOTE**

Leader election is disabled by default. It is only enabled when applying this environment variable on installation.

### STRIMZI\_LEADER\_ELECTIONLEASE\_NAME

Required when leader election is enabled. The name of the Kubernetes `Lease` resource that is used for the leader election.

### STRIMZI\_LEADER\_ELECTIONLEASE\_NAMESPACE

Required when leader election is enabled. The namespace where the Kubernetes `Lease` resource used for leader election is created. You can use the downward API to configure it to the namespace where the Cluster Operator is deployed.

```
env:  
- name: STRIMZI_LEADER_ELECTIONLEASE_NAMESPACE  
  valueFrom:  
    fieldRef:  
      fieldPath: metadata.namespace
```

### STRIMZI\_LEADER\_ELECTION\_IDENTITY

Required when leader election is enabled. Configures the identity of a given Cluster Operator instance used during the leader election. The identity must be unique for each operator instance. You can use the downward API to configure it to the name of the pod where the Cluster Operator is deployed.

```
env:  
- name: STRIMZI_LEADER_ELECTION_IDENTITY  
  valueFrom:  
    fieldRef:  
      fieldPath: metadata.name
```

### STRIMZI\_LEADER\_ELECTIONLEASE\_DURATION\_MS

Optional, default 15000 ms. Specifies the duration the acquired lease is valid.

### STRIMZI\_LEADER\_ELECTIONRENEW\_DEADLINE\_MS

Optional, default 10000 ms. Specifies the period the leader should try to maintain leadership.

## **STRIMZI\_LEADER\_ELECTION\_RETRY\_PERIOD\_MS**

Optional, default 2000 ms. Specifies the frequency of updates to the lease lock by the leader.

## **Restricting Cluster Operator access with network policy**

Use the **STRIMZI\_OPERATOR\_NAMESPACE\_LABELS** environment variable to establish network policy for the Cluster Operator using namespace labels.

The Cluster Operator can run in the same namespace as the resources it manages, or in a separate namespace. By default, the **STRIMZI\_OPERATOR\_NAMESPACE** environment variable is configured to use the downward API to find the namespace the Cluster Operator is running in. If the Cluster Operator is running in the same namespace as the resources, only local access is required and allowed by Strimzi.

If the Cluster Operator is running in a separate namespace to the resources it manages, any namespace in the Kubernetes cluster is allowed access to the Cluster Operator unless network policy is configured. By adding namespace labels, access to the Cluster Operator is restricted to the namespaces specified.

*Network policy configured for the Cluster Operator deployment*

```
#...
env:
# ...
- name: STRIMZI_OPERATOR_NAMESPACE_LABELS
  value: label1=value1,label2=value2
#...
```

## **Setting the time interval for periodic reconciliation**

Use the **STRIMZI\_FULL\_RECONCILIATION\_INTERVAL\_MS** variable to set the time interval for periodic reconciliations.

The Cluster Operator reacts to all notifications about applicable cluster resources received from the Kubernetes cluster. If the operator is not running, or if a notification is not received for any reason, resources will get out of sync with the state of the running Kubernetes cluster. In order to handle failovers properly, a periodic reconciliation process is executed by the Cluster Operator so that it can compare the state of the resources with the current cluster deployments in order to have a consistent state across all of them.

*Additional resources*

- [Downward API](#)

### **7.2.4. Configuring the Cluster Operator with default proxy settings**

If you are running a Kafka cluster behind a HTTP proxy, you can still pass data in and out of the cluster. For example, you can run Kafka Connect with connectors that push and pull data from outside the proxy. Or you can use a proxy to connect with an authorization server.

Configure the Cluster Operator deployment to specify the proxy environment variables. The Cluster Operator accepts standard proxy configuration (`HTTP_PROXY`, `HTTPS_PROXY` and `NO_PROXY`) as environment variables. The proxy settings are applied to all Strimzi containers.

The format for a proxy address is `http://IP-ADDRESS:PORT-NUMBER`. To set up a proxy with a name and password, the format is `http://USERNAME:PASSWORD@IP-ADDRESS:PORT-NUMBER`.

#### Prerequisites

- You need an account with permission to create and manage `CustomResourceDefinition` and RBAC (`ClusterRole`, and `RoleBinding`) resources.

#### Procedure

1. To add proxy environment variables to the Cluster Operator, update its `Deployment` configuration ([install/cluster-operator/060-Deployment-stimzi-cluster-operator.yaml](#)).

*Example proxy configuration for the Cluster Operator*

```
apiVersion: apps/v1
kind: Deployment
spec:
  # ...
  template:
    spec:
      serviceAccountName: stimzi-cluster-operator
      containers:
        # ...
        env:
          # ...
          - name: "HTTP_PROXY"
            value: "http://proxy.com" ①
          - name: "HTTPS_PROXY"
            value: "https://proxy.com" ②
          - name: "NO_PROXY"
            value: "internal.com, other.domain.com" ③
        # ...
```

① Address of the proxy server.

② Secure address of the proxy server.

③ Addresses for servers that are accessed directly as exceptions to the proxy server. The URLs are comma-separated.

Alternatively, edit the `Deployment` directly:

```
kubectl edit deployment stimzi-cluster-operator
```

2. If you updated the YAML file instead of editing the `Deployment` directly, apply the changes:

```
kubectl create -f install/cluster-operator/060-Deployment-stimzi-cluster-
```

#### *Additional resources*

- [Host aliases](#)
- [Designating Strimzi administrators](#)

### 7.2.5. Running multiple Cluster Operator replicas with leader election

The default Cluster Operator configuration enables [leader election](#). Use leader election to run multiple parallel replicas of the Cluster Operator. One replica is elected as the active leader and operates the deployed resources. The other replicas run in standby mode. When the leader stops or fails, one of the standby replicas is elected as the new leader and starts operating the deployed resources.

By default, Strimzi runs with a single Cluster Operator replica that is always the leader replica. When a single Cluster Operator replica stops or fails, Kubernetes starts a new replica.

Running the Cluster Operator with multiple replicas is not essential. But it's useful to have replicas on standby in case of large-scale disruptions. For example, suppose multiple worker nodes or an entire availability zone fails. This failure might cause the Cluster Operator pod and many Kafka pods to go down at the same time. If subsequent pod scheduling causes congestion through lack of resources, this can delay operations when running a single Cluster Operator.

#### Configuring Cluster Operator replicas

To run additional Cluster Operator replicas in standby mode, you will need to increase the number of replicas and enable leader election. To configure leader election, use the leader election environment variables.

To make the required changes, configure the following Cluster Operator installation files located in [install/cluster-operator/](#):

- 060-Deployment-stimzi-cluster-operator.yaml
- 022-ClusterRole-stimzi-cluster-operator-role.yaml
- 022-RoleBinding-stimzi-cluster-operator.yaml

Leader election has its own [ClusterRole](#) and [RoleBinding](#) RBAC resources that target the namespace where the Cluster Operator is running, rather than the namespace it is watching.

The default deployment configuration creates a [Lease](#) resource called [stimzi-cluster-operator](#) in the same namespace as the Cluster Operator. The Cluster Operator uses leases to manage leader election. The RBAC resources provide the permissions to use the [Lease](#) resource. If you use a different [Lease](#) name or namespace, update the [ClusterRole](#) and [RoleBinding](#) files accordingly.

#### *Prerequisites*

- You need an account with permission to create and manage [CustomResourceDefinition](#) and RBAC ([ClusterRole](#), and [RoleBinding](#)) resources.

## Procedure

Edit the `Deployment` resource that is used to deploy the Cluster Operator, which is defined in the `060-Deployment-stimzi-cluster-operator.yaml` file.

1. Change the `replicas` property from the default (1) to a value that matches the required number of replicas.

### *Increasing the number of Cluster Operator replicas*

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: stimzi-cluster-operator
  labels:
    app: stimzi
spec:
  replicas: 3
```

2. Check that the leader election `env` properties are set.

If they are not set, configure them.

To enable leader election, `STRIMZI_LEADER_ELECTION_ENABLED` must be set to `true` (default).

In this example, the name of the lease is changed to `my-stimzi-cluster-operator`.

### *Configuring leader election environment variables for the Cluster Operator*

```
# ...
spec
  containers:
    - name: stimzi-cluster-operator
      # ...
      env:
        - name: STRIMZI_LEADER_ELECTION_ENABLED
          value: "true"
        - name: STRIMZI_LEADER_ELECTIONLEASE_NAME
          value: "my-stimzi-cluster-operator"
        - name: STRIMZI_LEADER_ELECTIONLEASE_NAMESPACE
          valueFrom:
            fieldRef:
              fieldPath: metadata.namespace
        - name: STRIMZI_LEADER_ELECTION_IDENTITY
          valueFrom:
            fieldRef:
              fieldPath: metadata.name
```

For a description of the available environment variables, see [Leader election environment variables](#).

If you specified a different name or namespace for the `Lease` resource used in leader election, update the RBAC resources.

3. (optional) Edit the `ClusterRole` resource in the `022-ClusterRole-strimzi-cluster-operator-role.yaml` file.

Update `resourceNames` with the name of the `Lease` resource.

*Updating the ClusterRole references to the lease*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: strimzi-cluster-operator-leader-election
  labels:
    app: strimzi
rules:
- apiGroups:
  - coordination.k8s.io
  resourceNames:
  - my-strimzi-cluster-operator
# ...
```

4. (optional) Edit the the `RoleBinding` resource in the `022-RoleBinding-strimzi-cluster-operator.yaml` file.

Update `subjects.name` and `subjects.namespace` with the name of the `Lease` resource and the namespace where it was created.

*Updating the RoleBinding references to the lease*

```
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: strimzi-cluster-operator-leader-election
  labels:
    app: strimzi
subjects:
- kind: ServiceAccount
  name: my-strimzi-cluster-operator
  namespace: myproject
# ...
```

5. Deploy the Cluster Operator:

```
kubectl create -f install/cluster-operator -n myproject
```

6. Check the status of the deployment:

```
kubectl get deployments -n myproject
```

*Output shows the deployment name and readiness*

NAME	READY	UP-TO-DATE	AVAILABLE
strimzi-cluster-operator	3/3	3	3

**READY** shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows the correct number of replicas.

### 7.2.6. Configuring FIPS mode in the Cluster Operator

Federal Information Processing Standards (FIPS) are standards for computer security and interoperability. When running Strimzi on a FIPS-enabled Kubernetes cluster, the OpenJDK used in Strimzi container images will automatically switch to FIPS mode. This prevents Strimzi from running on the cluster. When you deploy Strimzi to the cluster, you will see errors similar to the following:

```
Exception in thread "main" io.fabric8.kubernetes.client.KubernetesClientException: An  
error has occurred.  
...  
Caused by: java.security.KeyStoreException:  
sun.security.pkcs11.wrapper.PKCS11Exception: CKR_SESSION_READ_ONLY  
...  
Caused by: sun.security.pkcs11.wrapper.PKCS11Exception: CKR_SESSION_READ_ONLY  
...
```

If you want to run Strimzi on your FIPS-enabled cluster, you can disable the OpenJDK FIPS mode by setting the **FIPS\_MODE** environment variable to **disabled** in the deployment configuration for the Cluster Operator. The Strimzi deployment won't be FIPS compliant, but the Strimzi operators as well as all of its operands will be able to run on the FIPS-enabled Kubernetes cluster.

#### Procedure

1. To disable the FIPS mode in the Cluster Operator, update its **Deployment** configuration ([install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml](#)) and add the **FIPS\_MODE** environment variable.

*Example FIPS configuration for the Cluster Operator*

```
apiVersion: apps/v1  
kind: Deployment  
spec:  
  # ...  
  template:  
    spec:  
      serviceAccountName: strimzi-cluster-operator  
      containers:
```

```
# ...
env:
# ...
- name: "FIPS_MODE"
  value: "disabled" ①
# ...
```

① Disables the FIPS mode.

Alternatively, edit the [Deployment](#) directly:

```
kubectl edit deployment strimzi-cluster-operator
```

2. If you updated the YAML file instead of editing the [Deployment](#) directly, apply the changes:

```
kubectl apply -f install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml
```

#### *Additional resources*

- [What are Federal Information Processing Standards \(FIPS\)](#)

## 7.3. Using the Topic Operator

When you create, modify or delete a topic using the [KafkaTopic](#) resource, the Topic Operator ensures those changes are reflected in the Kafka cluster.

For more information on the [KafkaTopic](#) resource, see the [KafkaTopic schema reference](#).

#### *Deploying the Topic Operator*

You can deploy the Topic Operator using the Cluster Operator or as a standalone operator. You would use a standalone Topic Operator with a Kafka cluster that is not managed by the Cluster Operator.

For deployment instructions, see the following:

- [Deploying the Topic Operator using the Cluster Operator \(recommended\)](#)
- [Deploying the standalone Topic Operator](#)

#### **IMPORTANT**

To deploy the standalone Topic Operator, you need to set environment variables to connect to a Kafka cluster. These environment variables do not need to be set if you are deploying the Topic Operator using the Cluster Operator as they will be set by the Cluster Operator.

### 7.3.1. Kafka topic resource

The [KafkaTopic](#) resource is used to configure topics, including the number of partitions and replicas.

The full schema for `KafkaTopic` is described in [KafkaTopic schema reference](#).

## Identifying a Kafka cluster for topic handling

A `KafkaTopic` resource includes a label that specifies the name of the Kafka cluster (derived from the name of the `Kafka` resource) to which it belongs.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: topic-name-1
  labels:
    strimzi.io/cluster: my-cluster
```

The label is used by the Topic Operator to identify the `KafkaTopic` resource and create a new topic, and also in subsequent handling of the topic.

If the label does not match the Kafka cluster, the Topic Operator cannot identify the `KafkaTopic` and the topic is not created.

## Kafka topic usage recommendations

When working with topics, be consistent. Always operate on either `KafkaTopic` resources or topics directly in Kubernetes. Avoid routinely switching between both methods for a given topic.

Use topic names that reflect the nature of the topic, and remember that names cannot be changed later.

If creating a topic in Kafka, use a name that is a valid Kubernetes resource name, otherwise the Topic Operator will need to create the corresponding `KafkaTopic` with a name that conforms to the Kubernetes rules.

**NOTE**

For information on the requirements for identifiers and names in Kubernetes, refer to [Object Names and IDs](#).

## Kafka topic naming conventions

Kafka and Kubernetes impose their own validation rules for the naming of topics in Kafka and `KafkaTopic.metadata.name` respectively. There are valid names for each which are invalid in the other.

Using the `spec.topicName` property, it is possible to create a valid topic in Kafka with a name that would be invalid for the Kafka topic in Kubernetes.

The `spec.topicName` property inherits Kafka naming validation rules:

- The name must not be longer than 249 characters.

- Valid characters for Kafka topics are ASCII alphanumerics, `.`, `_`, and `-`.
- The name cannot be `.` or `..`, though `.` can be used in a name, such as `exampleTopic.` or `.exampleTopic`.

`spec.topicName` must not be changed.

For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: topic-name-1
spec:
  topicName: topicName-1 ①
  # ...
```

① Upper case is invalid in Kubernetes.

cannot be changed to:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: topic-name-1
spec:
  topicName: name-2
  # ...
```

Some Kafka client applications, such as Kafka Streams, can create topics in Kafka programmatically. If those topics have names that are invalid Kubernetes resource names, the Topic Operator gives them a valid `metadata.name` based on the Kafka name. Invalid characters are replaced and a hash is appended to the name. For example:

#### NOTE

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: mytopic---c55e57fe2546a33f9e603caf57165db4072e827e
spec:
  topicName: myTopic
  # ...
```

### 7.3.2. Topic Operator topic store

The Topic Operator uses Kafka to store topic metadata describing topic configuration as key-value pairs. The *topic store* is based on the Kafka Streams key-value mechanism, which uses Kafka topics

to persist the state.

Topic metadata is cached in-memory and accessed locally within the Topic Operator. Updates from operations applied to the local in-memory cache are persisted to a backup topic store on disk. The topic store is continually synchronized with updates from Kafka topics or Kubernetes [KafkaTopic](#) custom resources. Operations are handled rapidly with the topic store set up this way, but should the in-memory cache crash it is automatically repopulated from the persistent storage.

## Internal topic store topics

Internal topics support the handling of topic metadata in the topic store.

### `_strimzi_store_topic`

Input topic for storing the topic metadata

### `_strimzi-topic-operator-kstreams-topic-store-changelog`

Retains a log of compacted topic store values

#### WARNING

Do not delete these topics, as they are essential to the running of the Topic Operator.

## Migrating topic metadata from ZooKeeper

In previous releases of Strimzi, topic metadata was stored in ZooKeeper. The new process removes this requirement, bringing the metadata into the Kafka cluster, and under the control of the Topic Operator.

When upgrading to Strimzi 0.32.0, the transition to Topic Operator control of the topic store is seamless. Metadata is found and migrated from ZooKeeper, and the old store is deleted.

## Downgrading to a Strimzi version that uses ZooKeeper to store topic metadata

If you are reverting back to a version of Strimzi earlier than 0.22, which uses ZooKeeper for the storage of topic metadata, you still downgrade your Cluster Operator to the previous version, then downgrade Kafka brokers and client applications to the previous Kafka version as standard.

However, you must also delete the topics that were created for the topic store using a [kafka-admin](#) command, specifying the bootstrap address of the Kafka cluster. For example:

```
kubectl run kafka-admin -ti --image=quay.io/strimzi/kafka:0.32.0-kafka-3.3.1 --rm=true  
--restart=Never -- ./bin/kafka-topics.sh --bootstrap-server localhost:9092 --topic  
_strimzi-topic-operator-kstreams-topic-store-changelog --delete && ./bin/kafka-  
topics.sh --bootstrap-server localhost:9092 --topic _strimzi_store_topic --delete
```

The command must correspond to the type of listener and authentication used to access the Kafka cluster.

The Topic Operator will reconstruct the ZooKeeper topic metadata from the state of the topics in Kafka.

## Topic Operator topic replication and scaling

The recommended configuration for topics managed by the Topic Operator is a topic replication factor of 3, and a minimum of 2 in-sync replicas.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: my-topic
  labels:
    strimzi.io/cluster: my-cluster
spec:
  partitions: 10 ①
  replicas: 3 ②
  config:
    min.insync.replicas: 2 ③
#...
```

① The number of partitions for the topic.

② The number of replica topic partitions. Currently, this cannot be changed in the [KafkaTopic](#) resource, but it can be changed using the [kafka-reassign-partitions.sh](#) tool.

③ The minimum number of replica partitions that a message must be successfully written to, or an exception is raised.

**NOTE**

In-sync replicas are used in conjunction with the `acks` configuration for producer applications. The `acks` configuration determines the number of follower partitions a message must be replicated to before the message is acknowledged as successfully received. The Topic Operator runs with `acks=all`, whereby messages must be acknowledged by all in-sync replicas.

When scaling Kafka clusters by adding or removing brokers, replication factor configuration is not changed and replicas are not reassigned automatically. However, you can use the [kafka-reassign-partitions.sh](#) tool to change the replication factor, and manually reassign replicas to brokers.

Alternatively, though the integration of Cruise Control for Strimzi cannot change the replication factor for topics, the optimization proposals it generates for rebalancing Kafka include commands that transfer partition replicas and change partition leadership.

## Handling changes to topics

A fundamental problem that the Topic Operator needs to solve is that there is no single source of truth: both the [KafkaTopic](#) resource and the Kafka topic can be modified independently of the Topic Operator. Complicating this, the Topic Operator might not always be able to observe changes at each end in real time. For example, when the Topic Operator is down.

To resolve this, the Topic Operator maintains information about each topic in the topic store. When a change happens in the Kafka cluster or Kubernetes, it looks at both the state of the other system and the topic store in order to determine what needs to change to keep everything in sync. The

same thing happens whenever the Topic Operator starts, and periodically while it is running.

For example, suppose the Topic Operator is not running, and a **KafkaTopic** called *my-topic* is created. When the Topic Operator starts, the topic store does not contain information on *my-topic*, so it can infer that the **KafkaTopic** was created after it was last running. The Topic Operator creates the topic corresponding to *my-topic*, and also stores metadata for *my-topic* in the topic store.

If you update Kafka topic configuration or apply a change through the **KafkaTopic** custom resource, the topic store is updated after the Kafka cluster is reconciled.

The topic store also allows the Topic Operator to manage scenarios where the topic configuration is changed in Kafka topics *and* updated through Kubernetes **KafkaTopic** custom resources, as long as the changes are not incompatible. For example, it is possible to make changes to the same topic config key, but to different values. For incompatible changes, the Kafka configuration takes priority, and the **KafkaTopic** is updated accordingly.

**NOTE** You can also use the **KafkaTopic** resource to delete topics using a `kubectl delete -f KAFKA-TOPIC-CONFIG-FILE` command. To be able to do this, `delete.topic.enable` must be set to `true` (default) in the `spec.kafka.config` of the Kafka resource.

#### *Additional resources*

- [Downgrading Strimzi](#)
- [Scaling cluster and partition reassignment](#)
- [Cruise Control for cluster rebalancing](#)

### 7.3.3. Configuring Kafka topics

Use the properties of the **KafkaTopic** resource to configure Kafka topics.

You can use `kubectl apply` to create or modify topics, and `kubectl delete` to delete existing topics.

For example:

- `kubectl apply -f <topic_config_file>`
- `kubectl delete KafkaTopic <topic_name>`

This procedure shows how to create a topic with 10 partitions and 2 replicas.

#### *Before you start*

It is important that you consider the following before making your changes:

- Kafka does not support decreasing the number of partitions.
- Increasing `spec.partitions` for topics with keys will change how records are partitioned, which can be particularly problematic when the topic uses *semantic partitioning*.
- Strimzi does not support making the following changes through the **KafkaTopic** resource:
  - Using `spec.replicas` to change the number of replicas that were initially specified
  - Changing topic names using `spec.topicName`

## Prerequisites

- A running Kafka cluster [configured with a Kafka broker listener using TLS authentication and encryption](#).
- A running Topic Operator (typically [deployed with the Entity Operator](#)).
- For deleting a topic, `delete.topic.enable=true` (default) in the `spec.kafka.config` of the [Kafka](#) resource.

## Procedure

1. Configure the [KafkaTopic](#) resource.

*Example Kafka topic configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: orders
  labels:
    strimzi.io/cluster: my-cluster
spec:
  partitions: 10
  replicas: 2
```

**TIP**

When modifying a topic, you can get the current version of the resource using `kubectl get kafkatopic orders -o yaml`.

2. Create the [KafkaTopic](#) resource in Kubernetes.

```
kubectl apply -f <topic_config_file>
```

3. Wait for the ready status of the topic to change to [True](#):

```
kubectl get kafkatopics -o wide -w -n <namespace>
```

*Kafka topic status*

NAME	CLUSTER	PARTITIONS	REPLICATION FACTOR	READY
my-topic-1	my-cluster	10	3	True
my-topic-2	my-cluster	10	3	
my-topic-3	my-cluster	10	3	True

Topic creation is successful when the [READY](#) output shows [True](#).

4. If the [READY](#) column stays blank, get more details on the status from the resource YAML or from the Topic Operator logs.

Messages provide details on the reason for the current status.

```
oc get kafkatopics my-topic-2 -o yaml
```

*Details on a topic with a NotReady status*

```
# ...
status:
  conditions:
  - lastTransitionTime: "2022-06-13T10:14:43.351550Z"
    message: Number of partitions cannot be decreased
    reason: PartitionDecreaseException
    status: "True"
    type: NotReady
```

In this example, the reason the topic is not ready is because the original number of partitions was reduced in the [KafkaTopic](#) configuration. Kafka does not support this.

After resetting the topic configuration, the status shows the topic is ready.

```
kubectl get kafkatopics my-topic-2 -o wide -w -n <namespace>
```

*Status update of the topic*

NAME	CLUSTER	PARTITIONS	REPLICATION FACTOR	READY
my-topic-2	my-cluster	10	3	True

Fetching the details shows no messages

```
kubectl get kafkatopics my-topic-2 -o yaml
```

*Details on a topic with a READY status*

```
# ...
status:
  conditions:
  - lastTransitionTime: '2022-06-13T10:15:03.761084Z'
    status: 'True'
    type: Ready
```

### 7.3.4. Configuring the Topic Operator with resource requests and limits

You can allocate resources, such as CPU and memory, to the Topic Operator and set a limit on the amount of resources it can consume.

*Prerequisites*

- The Cluster Operator is running.

### *Procedure*

1. Update the Kafka cluster configuration in an editor, as required:

```
kubectl edit kafka MY-CLUSTER
```

2. In the `spec.entityOperator.topicOperator.resources` property in the `Kafka` resource, set the resource requests and limits for the Topic Operator.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # Kafka and ZooKeeper sections...
  entityOperator:
    topicOperator:
      resources:
        requests:
          cpu: "1"
          memory: 500Mi
        limits:
          cpu: "1"
          memory: 500Mi
```

3. Apply the new configuration to create or update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

## 7.4. Using the User Operator

When you create, modify or delete a user using the `KafkaUser` resource, the User Operator ensures those changes are reflected in the Kafka cluster.

For more information on the `KafkaUser` resource, see the [KafkaUser schema reference](#).

### *Deploying the User Operator*

You can deploy the User Operator using the Cluster Operator or as a standalone operator. You would use a standalone User Operator with a Kafka cluster that is not managed by the Cluster Operator.

For deployment instructions, see the following:

- [Deploying the User Operator using the Cluster Operator \(recommended\)](#)
- [Deploying the standalone User Operator](#)

### **IMPORTANT**

To deploy the standalone User Operator, you need to set environment variables to connect to a Kafka cluster. These environment variables do not

need to be set if you are deploying the User Operator using the Cluster Operator as they will be set by the Cluster Operator.

### 7.4.1. Configuring Kafka users

Use the properties of the [KafkaUser](#) resource to configure Kafka users.

You can use `kubectl apply` to create or modify users, and `kubectl delete` to delete existing users.

For example:

- `kubectl apply -f <user_config_file>`
- `kubectl delete KafkaUser <user_name>`

Users represent Kafka clients. When you configure Kafka users, you enable the user authentication and authorization mechanisms required by clients to access Kafka. The mechanism used must match the equivalent [Kafka](#) configuration. For more information on using [Kafka](#) and [KafkaUser](#) resources to secure access to Kafka brokers, see [Securing access to Kafka brokers](#).

#### *Prerequisites*

- A running Kafka cluster [configured with a Kafka broker listener using TLS authentication and encryption](#).
- A running User Operator (typically [deployed with the Entity Operator](#)).

#### *Procedure*

1. Configure the [KafkaUser](#) resource.

This example specifies TLS authentication and simple authorization using ACLs.

#### *Example Kafka user configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication:
    type: tls
  authorization:
    type: simple
  acls:
    # Example consumer Acls for topic my-topic using consumer group my-group
    - resource:
        type: topic
        name: my-topic
        patternType: literal
      operations:
        - Describe
```

```

    - Read
  host: "*"
- resource:
    type: group
    name: my-group
    patternType: literal
  operations:
    - Read
  host: "*"
# Example Producer Acls for topic my-topic
- resource:
    type: topic
    name: my-topic
    patternType: literal
  operations:
    - Create
    - Describe
    - Write
  host: "*"

```

2. Create the `KafkaUser` resource in Kubernetes.

```
kubectl apply -f <user_config_file>
```

3. Wait for the ready status of the user to change to `True`:

```
kubectl get kafkausers -o wide -w -n <namespace>
```

*Kafka user status*

NAME	CLUSTER	AUTHENTICATION	AUTHORIZATION	READY
my-user-1	my-cluster	tls	simple	True
my-user-2	my-cluster	tls	simple	
my-user-3	my-cluster	tls	simple	True

User creation is successful when the `READY` output shows `True`.

4. If the `READY` column stays blank, get more details on the status from the resource YAML or User Operator logs.

Messages provide details on the reason for the current status.

```
kubectl get kafkausers my-user-2 -o yaml
```

#### *Details on a user with a NotReady status*

```
# ...
status:
  conditions:
    - lastTransitionTime: "2022-06-10T10:07:37.238065Z"
      message: Simple authorization ACL rules are configured but not supported in the
                Kafka cluster configuration.
      reason: InvalidResourceException
      status: "True"
    type: NotReady
```

In this example, the reason the user is not ready is because simple authorization is not enabled in the [Kafka](#) configuration.

#### *Kafka configuration for simple authorization*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    authorization:
      type: simple
```

After updating the Kafka configuration, the status shows the user is ready.

```
kubectl get kafkausers my-user-2 -o wide -w -n <namespace>
```

#### *Status update of the user*

NAME	CLUSTER	AUTHENTICATION	AUTHORIZATION	READY
my-user-2	my-cluster	tls	simple	True

Fetching the details shows no messages.

```
kubectl get kafkausers my-user-2 -o yaml
```

#### *Details on a user with a READY status*

```
# ...
status:
  conditions:
    - lastTransitionTime: "2022-06-10T10:33:40.166846Z"
      status: "True"
```

```
type: Ready
```

## 7.4.2. Configuring the User Operator with resource requests and limits

You can allocate resources, such as CPU and memory, to the User Operator and set a limit on the amount of resources it can consume.

### Prerequisites

- The Cluster Operator is running.

### Procedure

1. Update the Kafka cluster configuration in an editor, as required:

```
kubectl edit kafka MY-CLUSTER
```

2. In the `spec.entityOperator.userOperator.resources` property in the `Kafka` resource, set the resource requests and limits for the User Operator.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # Kafka and ZooKeeper sections...
  entityOperator:
    userOperator:
      resources:
        requests:
          cpu: "1"
          memory: 500Mi
        limits:
          cpu: "1"
          memory: 500Mi
```

Save the file and exit the editor. The Cluster Operator applies the changes automatically.

## 7.5. Configuring feature gates

Strimzi operators support *feature gates* to enable or disable certain features and functionality. Enabling a feature gate changes the behavior of the relevant operator and introduces the feature to your Strimzi deployment.

Feature gates have a default state of either *enabled* or *disabled*.

To modify a feature gate's default state, use the `STRIMZI_FEATURE_GATES` environment variable in the operator's configuration. You can modify multiple feature gates using this single environment variable. Specify a comma-separated list of feature gate names and prefixes. A `+` prefix enables the feature gate and a `-` prefix disables it.

*Example feature gate configuration that enables FeatureGate1 and disables FeatureGate2*

```
env:  
  - name: STRIMZI_FEATURE_GATES  
    value: +FeatureGate1,-FeatureGate2
```

### 7.5.1. ControlPlaneListener feature gate

The [ControlPlaneListener](#) feature gate has moved to GA, which means it is now permanently enabled and cannot be disabled. With [ControlPlaneListener](#) enabled, the connections between the Kafka controller and brokers use an internal *control plane listener* on port 9090. Replication of data between brokers, as well as internal connections from Strimzi operators, Cruise Control, or the Kafka Exporter use the *replication listener* on port 9091.

**IMPORTANT**

With the [ControlPlaneListener](#) feature gate permanently enabled, it is no longer possible to upgrade or downgrade directly between Strimzi 0.22 and earlier and Strimzi 0.32 and newer. You have to upgrade or downgrade through one of the Strimzi versions in between.

### 7.5.2. ServiceAccountPatching feature gate

The [ServiceAccountPatching](#) feature gate has moved to GA, which means it is now permanently enabled and cannot be disabled. With [ServiceAccountPatching](#) enabled, the Cluster Operator always reconciles service accounts and updates them when needed. For example, when you change service account labels or annotations using the [template](#) property of a custom resource, the operator automatically updates them on the existing service account resources.

### 7.5.3. UseStrimziPodSets feature gate

The [UseStrimziPodSets](#) feature gate has a default state of *enabled*.

The [UseStrimziPodSets](#) feature gate introduces a resource for managing pods called [StimziPodSet](#). When the feature gate is enabled, this resource is used instead of the StatefulSets. Strimzi handles the creation and management of pods instead of Kubernetes. Using StimziPodSets instead of StatefulSets provides more control over the functionality.

When this feature gate is disabled, Strimzi relies on StatefulSets to create and manage pods for the ZooKeeper and Kafka clusters. Strimzi creates the StatefulSet and Kubernetes creates the pods according to the StatefulSet definition. When a pod is deleted, Kubernetes is responsible for recreating it. The use of StatefulSets has the following limitations:

- Pods are always created or removed based on their index numbers
- All pods in the StatefulSet need to have a similar configuration
- Changing storage configuration for the Pods in the StatefulSet is complicated

*Disabling the UseStrimziPodSets feature gate*

To disable the [UseStrimziPodSets](#) feature gate, specify [-UseStrimziPodSets](#) in the

`STRIMZI_FEATURE_GATES` environment variable in the Cluster Operator configuration.

**IMPORTANT**

The `UseStrimziPodSets` feature gate must be disabled when downgrading to Strimzi 0.27 and earlier versions.

#### 7.5.4. (Preview) UseKRaft feature gate

The `UseKRaft` feature gate has a default state of *disabled*.

The `UseKRaft` feature gate deploys the Kafka cluster in the KRaft (Kafka Raft metadata) mode without ZooKeeper. This feature gate is currently intended only for development and testing.

**IMPORTANT**

**The KRaft mode is not ready for production in Apache Kafka or in Strimzi.**

When the `UseKRaft` feature gate is enabled, the Kafka cluster is deployed without ZooKeeper. **The `.spec.zookeeper` properties in the Kafka custom resource will be ignored, but still need to be present.** The `UseKRaft` feature gate provides an API that configures Kafka cluster nodes and their roles. The API is still in development and is expected to change before the KRaft mode is production-ready.

Currently, the KRaft mode in Strimzi has the following major limitations:

- Moving from Kafka clusters with ZooKeeper to KRaft clusters or the other way around is not supported.
- Upgrades and downgrades of Apache Kafka versions or the Strimzi operator are not supported. Users might need to delete the cluster, upgrade the operator and deploy a new Kafka cluster.
- The Topic Operator is not supported. The `spec.entityOperator.topicOperator` property **must be removed** from the `Kafka` custom resource.
- SCRAM-SHA-512 authentication is not supported.
- JBOD storage is not supported. The `type: jbod` storage can be used, but the JBOD array can contain only one disk.
- Liveness and readiness probes are disabled.
- All Kafka nodes have both the `controller` and `broker` KRaft roles. Kafka clusters with separate `controller` and `broker` nodes are not supported.

*Enabling the UseStrimziPodSets feature gate*

To enable the `UseKRaft` feature gate, specify `+UseKRaft` in the `STRIMZI_FEATURE_GATES` environment variable in the Cluster Operator configuration.

**IMPORTANT**

The `UseKRaft` feature gate depends on the `UseStrimziPodSets` feature gate. When enabling the `UseKRaft` feature gate, make sure that the `UseStrimziPodSets` feature gate is enabled as well.

### 7.5.5. Feature gate releases

Feature gates have three stages of maturity:

- Alpha — typically disabled by default
- Beta — typically enabled by default
- General Availability (GA) — typically always enabled

Alpha stage features might be experimental or unstable, subject to change, or not sufficiently tested for production use. Beta stage features are well tested and their functionality is not likely to change. GA stage features are stable and should not change in the future. Alpha and beta stage features are removed if they do not prove to be useful.

- The `ControlPlaneListener` feature gate moved to GA stage in Strimzi 0.32. It is now permanently enabled and cannot be disabled.
- The `ServiceAccountPatching` feature gate moved to GA stage in Strimzi 0.30. It is now permanently enabled and cannot be disabled.
- The `UseStrimziPodSets` feature gate moved to beta stage in Strimzi 0.30 and is expected to remain in the beta stage until Strimzi 0.33.
- The `UseKRaft` feature gate is available for development only and does not currently have a planned release for moving to the beta phase.

**NOTE**

Feature gates might be removed when they reach GA. This means that the feature was incorporated into the Strimzi core features and can no longer be disabled.

*Table 9. Feature gates and the Strimzi versions when they moved to alpha, beta, or GA*

Feature gate	Alpha	Beta	GA
<code>ControlPlaneListener</code>	0.23	0.27	0.32
<code>ServiceAccountPatching</code>	0.24	0.27	0.30
<code>UseStrimziPodSets</code>	0.28	0.30	-
<code>UseKRaft</code>	0.29	-	-

If a feature gate is enabled, you may need to disable it before upgrading or downgrading from a specific Strimzi version. The following table shows which feature gates you need to disable when upgrading or downgrading Strimzi versions.

*Table 10. Feature gates to disable when upgrading or downgrading Strimzi*

Disable Feature gate	Upgrading from Strimzi version	Downgrading to Strimzi version
<code>ControlPlaneListener</code>	0.22 and earlier	0.22 and earlier
<code>UseStrimziPodSets</code>	-	0.27 and earlier

## 7.6. Monitoring operators using Prometheus metrics

Strimzi operators expose Prometheus metrics. The metrics are automatically enabled and contain information about:

- Number of reconciliations
- Number of Custom Resources the operator is processing
- Duration of reconciliations
- JVM metrics from the operators

Additionally, we provide an example Grafana dashboard.

For more information about Prometheus, see the [Introducing Metrics to Kafka](#) in the *Deploying and Upgrading Strimzi* guide.

# Chapter 8. Cruise Control for cluster rebalancing

Cruise Control is an open source system for automating Kafka operations, such as monitoring cluster workload, rebalancing a cluster based on predefined constraints, and detecting and fixing anomalies. It consists of four main components—the Load Monitor, the Analyzer, the Anomaly Detector, and the Executor—and a REST API for client interactions.

You can deploy [Cruise Control](#) to your Strimzi cluster and use it to *rebalance* a Kafka cluster. You deploy Cruise Control through configuration of a [Kafka](#) resource. You perform rebalances through the [KafkaRebalance](#) resource, which generates and applies optimization proposals.

Strimzi utilizes the REST API to support the following Cruise Control features:

- Generating optimization proposals from optimization goals.
- Rebalancing a Kafka cluster based on an optimization proposal.

## Optimization goals

An optimization goal describes a specific objective to achieve from a rebalance. For example, a goal might be to distribute topic replicas across brokers more evenly. You can change what goals to include through configuration. A goal is defined as a hard goal or soft goal. You can add hard goals through Cruise Control deployment configuration. You also have main, default, and user-provided goals that fit into each of these categories.

- **Hard goals** are preset and must be satisfied for an optimization proposal to be successful.
- **Soft goals** do not need to be satisfied for an optimization proposal to be successful. They can be set aside if it means that all hard goals are met.
- **Main goals** are inherited from Cruise Control. Some are preset as hard goals. Main goals are used in optimization proposals by default.
- **Default goals** are the same as the main goals by default. You can specify your own set of default goals.
- **User-provided goals** are a subset of default goals that are configured for generating a specific optimization proposal.

## Optimization proposals

Optimization proposals comprise the goals you want to achieve from a rebalance. You generate an optimization proposal to create a summary of proposed changes and the results that are possible with the rebalance. The goals are assessed in a specific order of priority. You can then choose to approve or reject the proposal. You can reject the proposal to run it again with an adjusted set of goals.

You can generate an optimization proposal in one of three modes.

- **full** is the default mode and runs a full rebalance.

- **add-brokers** is the mode you use after adding brokers when scaling up a Kafka cluster.
- **remove-brokers** is the mode you use before removing brokers when scaling down a Kafka cluster.

Other Cruise Control features are not currently supported, including self healing, notifications, write-your-own goals, and changing the topic replication factor.

Strimzi provides [example configuration files](#). Example YAML configuration files for Cruise Control are provided in [examples/cruise-control/](#).

## 8.1. Why use Cruise Control?

Cruise Control reduces the time and effort involved in running an efficient and balanced Kafka cluster.

A typical cluster can become unevenly loaded over time. Partitions that handle large amounts of message traffic might be unevenly distributed across the available brokers. To rebalance the cluster, administrators must monitor the load on brokers and manually reassign busy partitions to brokers with spare capacity.

Cruise Control automates the cluster rebalancing process. It constructs a *workload model* of resource utilization for the cluster—based on CPU, disk, and network load—and generates optimization proposals (that you can approve or reject) for more balanced partition assignments. A set of configurable optimization goals is used to calculate these proposals.

When you approve an optimization proposal, Cruise Control applies it to your Kafka cluster. When the cluster rebalancing operation is complete, the broker pods are used more effectively and the Kafka cluster is more evenly balanced.

*Additional resources*

- [Cruise Control Wiki](#)

## 8.2. Optimization goals overview

Optimization goals are constraints on workload redistribution and resource utilization across a Kafka cluster. To rebalance a Kafka cluster, Cruise Control uses optimization goals to generate [optimization proposals](#), which you can approve or reject.

### 8.2.1. Goals order of priority

Strimzi supports most of the optimization goals developed in the Cruise Control project. The supported goals, in the default descending order of priority, are as follows:

1. Rack-awareness
2. Minimum number of leader replicas per broker for a set of topics
3. Replica capacity
4. Capacity goals

- Disk capacity
  - Network inbound capacity
  - Network outbound capacity
  - CPU capacity
5. Replica distribution
  6. Potential network output
  7. Resource distribution goals
    - Disk utilization distribution
    - Network inbound utilization distribution
    - Network outbound utilization distribution
    - CPU utilization distribution
  8. Leader bytes-in rate distribution
  9. Topic replica distribution
  10. Leader replica distribution
  11. Preferred leader election
  12. Intra-broker disk capacity
  13. Intra-broker disk usage distribution

For more information on each optimization goal, see [Goals](#) in the Cruise Control Wiki.

**NOTE** "Write your own" goals and Kafka assigner goals are not yet supported.

### 8.2.2. Goals configuration in Strimzi custom resources

You configure optimization goals in [Kafka](#) and [KafkaRebalance](#) custom resources. Cruise Control has configurations for hard optimization goals that must be satisfied, as well as main, default, and user-provided optimization goals.

You can specify optimization goals in the following configuration:

- **Main goals** — `Kafka.spec.cruiseControl.config.goals`
- **Hard goals** — `Kafka.spec.cruiseControl.config.hard.goals`
- **Default goals** — `Kafka.spec.cruiseControl.config.default.goals`
- **User-provided goals** — `KafkaRebalance.spec.goals`

**NOTE** Resource distribution goals are subject to [capacity limits](#) on broker resources.

### 8.2.3. Hard and soft optimization goals

Hard goals are goals that *must* be satisfied in optimization proposals. Goals that are not configured as hard goals are known as *soft goals*. You can think of soft goals as *best effort* goals: they do *not*

need to be satisfied in optimization proposals, but are included in optimization calculations. An optimization proposal that violates one or more soft goals, but satisfies all hard goals, is valid.

Cruise Control will calculate optimization proposals that satisfy all the hard goals and as many soft goals as possible (in their priority order). An optimization proposal that does *not* satisfy all the hard goals is rejected by Cruise Control and not sent to the user for approval.

**NOTE** For example, you might have a soft goal to distribute a topic's replicas evenly across the cluster (the topic replica distribution goal). Cruise Control will ignore this goal if doing so enables all the configured hard goals to be met.

In Cruise Control, the following [main optimization goals](#) are preset as hard goals:

```
RackAwareGoal; MinTopicLeadersPerBrokerGoal; ReplicaCapacityGoal; DiskCapacityGoal;  
NetworkInboundCapacityGoal; NetworkOutboundCapacityGoal; CpuCapacityGoal
```

You configure hard goals in the Cruise Control deployment configuration, by editing the [hard.goals](#) property in [Kafka.spec.cruiseControl.config](#).

- To inherit the preset hard goals from Cruise Control, do not specify the [hard.goals](#) property in [Kafka.spec.cruiseControl.config](#)
- To change the preset hard goals, specify the desired goals in the [hard.goals](#) property, using their fully-qualified domain names.

*Example Kafka configuration for hard optimization goals*

```
apiVersion: kafka.strimzi.io/v1beta2  
kind: Kafka  
metadata:  
  name: my-cluster  
spec:  
  kafka:  
    # ...  
  zookeeper:  
    # ...  
  entityOperator:  
    topicOperator: {}  
    userOperator: {}  
  cruiseControl:  
    brokerCapacity:  
      inboundNetwork: 10000KB/s  
      outboundNetwork: 10000KB/s  
    config:  
      hard.goals: >  
        com.linkedin.kafka.cruisecontrol.analyzer.goals.NetworkInboundCapacityGoal,  
        com.linkedin.kafka.cruisecontrol.analyzer.goals.NetworkOutboundCapacityGoal  
    # ...
```

Increasing the number of configured hard goals will reduce the likelihood of Cruise Control generating valid optimization proposals.

If `skipHardGoalCheck: true` is specified in the `KafkaRebalance` custom resource, Cruise Control does *not* check that the list of user-provided optimization goals (in `KafkaRebalance.spec.goals`) contains *all* the configured hard goals (`hard.goals`). Therefore, if some, but not all, of the user-provided optimization goals are in the `hard.goals` list, Cruise Control will still treat them as hard goals even if `skipHardGoalCheck: true` is specified.

## 8.2.4. Main optimization goals

The *main optimization goals* are available to all users. Goals that are not listed in the main optimization goals are not available for use in Cruise Control operations.

Unless you change the Cruise Control [deployment configuration](#), Strimzi will inherit the following main optimization goals from Cruise Control, in descending priority order:

```
RackAwareGoal; ReplicaCapacityGoal; DiskCapacityGoal; NetworkInboundCapacityGoal;  
NetworkOutboundCapacityGoal; CpuCapacityGoal; ReplicaDistributionGoal;  
PotentialNwOutGoal; DiskUsageDistributionGoal; NetworkInboundUsageDistributionGoal;  
NetworkOutboundUsageDistributionGoal; CpuUsageDistributionGoal;  
TopicReplicaDistributionGoal; LeaderReplicaDistributionGoal;  
LeaderBytesInDistributionGoal; PreferredLeaderElectionGoal
```

Some of these goals are preset as [hard goals](#).

To reduce complexity, we recommend that you use the inherited main optimization goals, unless you need to *completely* exclude one or more goals from use in `KafkaRebalance` resources. The priority order of the main optimization goals can be modified, if desired, in the configuration for [default optimization goals](#).

You configure main optimization goals, if necessary, in the Cruise Control deployment configuration: `Kafka.spec.cruiseControl.config.goals`

- To accept the inherited main optimization goals, do not specify the `goals` property in `Kafka.spec.cruiseControl.config`.
- If you need to modify the inherited main optimization goals, specify a list of goals, in descending priority order, in the `goals` configuration option.

**NOTE**

If you change the inherited main optimization goals, you must ensure that the hard goals, if configured in the `hard.goals` property in `Kafka.spec.cruiseControl.config`, are a subset of the main optimization goals that you configured. Otherwise, errors will occur when generating optimization proposals.

## 8.2.5. Default optimization goals

Cruise Control uses the *default optimization goals* to generate the *cached optimization proposal*. For more information about the cached optimization proposal, see [Optimization proposals overview](#).

You can override the default optimization goals by setting [user-provided optimization goals](#) in a [KafkaRebalance](#) custom resource.

Unless you specify `default.goals` in the Cruise Control [deployment configuration](#), the main optimization goals are used as the default optimization goals. In this case, the cached optimization proposal is generated using the main optimization goals.

- To use the main optimization goals as the default goals, do not specify the `default.goals` property in [Kafka.spec.cruiseControl.config](#).
- To modify the default optimization goals, edit the `default.goals` property in [Kafka.spec.cruiseControl.config](#). You must use a subset of the main optimization goals.

*Example Kafka configuration for default optimization goals*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    topicOperator: {}
    userOperator: {}
  cruiseControl:
    brokerCapacity:
      inboundNetwork: 10000KB/s
      outboundNetwork: 10000KB/s
  config:
    default.goals: >
      com.linkedin.kafka.cruisecontrol.analyzer.goals.RackAwareGoal,
      com.linkedin.kafka.cruisecontrol.analyzer.goals.ReplicaCapacityGoal,
      com.linkedin.kafka.cruisecontrol.analyzer.goals.DiskCapacityGoal
    # ...
```

If no default optimization goals are specified, the cached proposal is generated using the main optimization goals.

### 8.2.6. User-provided optimization goals

*User-provided optimization goals* narrow down the configured default goals for a particular optimization proposal. You can set them, as required, in `spec.goals` in a [KafkaRebalance](#) custom resource:

`KafkaRebalance.spec.goals`

User-provided optimization goals can generate optimization proposals for different scenarios. For example, you might want to optimize leader replica distribution across the Kafka cluster without considering disk capacity or disk utilization. So, you create a `KafkaRebalance` custom resource containing a single user-provided goal for leader replica distribution.

User-provided optimization goals must:

- Include all configured [hard goals](#), or an error occurs
- Be a subset of the main optimization goals

To ignore the configured hard goals when generating an optimization proposal, add the `skipHardGoalCheck: true` property to the `KafkaRebalance` custom resource. See [Generating optimization proposals](#).

*Additional resources*

- [Configuring and deploying Cruise Control with Kafka](#)
- [Configurations](#) in the Cruise Control Wiki.

## 8.3. Optimization proposals overview

You use the `KafkaRebalance` resource to generate and apply the changes suggested in optimization proposals. An *optimization proposal* is a summary of proposed changes that would produce a more balanced Kafka cluster, with partition workloads distributed more evenly among the brokers.

Each optimization proposal is based on the set of [optimization goals](#) that was used to generate it, subject to any configured [capacity limits on broker resources](#).

All optimization proposals are *estimates* of the impact of a proposed rebalance. You can approve or reject a proposal. You cannot approve a cluster rebalance without first generating the optimization proposal.

You can run optimization proposals in one of the following rebalancing modes:

- `full`
- `add-brokers`
- `remove-brokers`

### 8.3.1. Rebalancing modes

You specify a rebalancing mode using the `spec.mode` property of the `KafkaRebalance` custom resource.

#### `full`

The `full` mode runs a full rebalance by moving replicas across all the brokers in the cluster. This is the default mode if the `spec.mode` property is not defined in the `KafkaRebalance` custom resource.

## **add-brokers**

The **add-brokers** mode is used after scaling up a Kafka cluster by adding one or more brokers. Normally, after scaling up a Kafka cluster, new brokers are used to host only the partitions of newly created topics. If no new topics are created, the newly added brokers are not used and the existing brokers remain under the same load. By using the **add-brokers** mode immediately after adding brokers to the cluster, the rebalancing operation moves replicas from existing brokers to the newly added brokers. You specify the new brokers as a list using the **spec.brokers** property of the **KafkaRebalance** custom resource.

## **remove-brokers**

The **remove-brokers** mode is used before scaling down a Kafka cluster by removing one or more brokers. If you scale down a Kafka cluster, brokers are shut down even if they host replicas. This can lead to under-replicated partitions and possibly result in some partitions being under their minimum ISR (in-sync replicas). To avoid this potential problem, the **remove-brokers** mode moves replicas off the brokers that are going to be removed. When these brokers are not hosting replicas anymore, you can safely run the scaling down operation. You specify the brokers you're removing as a list in the **spec.brokers** property in the **KafkaRebalance** custom resource.

In general, use the **full** rebalance mode to rebalance a Kafka cluster by spreading the load across brokers. Use the **add-brokers** and **remove-brokers** modes only if you want to scale your cluster up or down and rebalance the replicas accordingly.

The procedure to run a rebalance is actually the same across the three different modes. The only difference is with specifying a mode through the **spec.mode** property and, if needed, listing brokers that have been added or will be removed through the **spec.brokers** property.

### **8.3.2. The results of an optimization proposal**

When an optimization proposal is generated, a summary and broker load is returned.

#### **Summary**

The summary is contained in the **KafkaRebalance** resource. The summary provides an overview of the proposed cluster rebalance and indicates the scale of the changes involved. A summary of a successfully generated optimization proposal is contained in the **Status.OptimizationResult** property of the **KafkaRebalance** resource. The information provided is a summary of the full optimization proposal.

#### **Broker load**

The broker load is stored in a ConfigMap that contains data as a JSON string. The broker load shows before and after values for the proposed rebalance, so you can see the impact on each of the brokers in the cluster.

### **8.3.3. Manually approving or rejecting an optimization proposal**

An optimization proposal summary shows the proposed scope of changes.

You can use the name of the **KafkaRebalance** resource to return a summary from the command line.

*Returning an optimization proposal summary*

```
kubectl describe kafka-rebalance <kafka_rebalance_resource_name> -n <namespace>
```

You can also use the `jq` command line JSON parser tool.

*Returning an optimization proposal summary using jq*

```
kubectl get kafka-rebalance -o json | jq <jq_query>.
```

Use the summary to decide whether to approve or reject an optimization proposal.

### Approving an optimization proposal

You approve the optimization proposal by setting the `strimzi.io/rebalance` annotation of the `KafkaRebalance` resource to `approve`. Cruise Control applies the proposal to the Kafka cluster and starts a cluster rebalance operation.

### Rejecting an optimization proposal

If you choose not to approve an optimization proposal, you can [change the optimization goals](#) or [update any of the rebalance performance tuning options](#), and then generate another proposal. You can use the `strimzi.io/refresh` annotation to generate a new optimization proposal for a `KafkaRebalance` resource.

Use optimization proposals to assess the movements required for a rebalance. For example, a summary describes inter-broker and intra-broker movements. Inter-broker rebalancing moves data between separate brokers. Intra-broker rebalancing moves data between disks on the same broker when you are using a JBOD storage configuration. Such information can be useful even if you don't go ahead and approve the proposal.

You might reject an optimization proposal, or delay its approval, because of the additional load on a Kafka cluster when rebalancing.

In the following example, the proposal suggests the rebalancing of data between separate brokers. The rebalance involves the movement of 55 partition replicas, totaling 12MB of data, across the brokers. Though the inter-broker movement of partition replicas has a high impact on performance, the total amount of data is not large. If the total data was much larger, you could reject the proposal, or time when to approve the rebalance to limit the impact on the performance of the Kafka cluster.

Rebalance performance tuning options can help reduce the impact of data movement. If you can extend the rebalance period, you can divide the rebalance into smaller batches. Fewer data movements at a single time reduces the load on the cluster.

*Example optimization proposal summary*

Name:	my-rebalance
Namespace:	myproject
Labels:	strimzi.io/cluster=my-cluster
Annotations:	API Version: kafka.strimzi.io/v1alpha1

```

Kind:           KafkaRebalance
Metadata:
# ...
Status:
Conditions:
  Last Transition Time: 2022-04-05T14:36:11.900Z
  Status:             ProposalReady
  Type:               State
Observed Generation: 1
Optimization Result:
  Data To Move MB: 0
  Excluded Brokers For Leadership:
  Excluded Brokers For Replica Move:
  Excluded Topics:
    Intra Broker Data To Move MB: 12
    Monitored Partitions Percentage: 100
    Num Intra Broker Replica Movements: 0
    Num Leader Movements: 24
    Num Replica Movements: 55
    On Demand Balancedness Score After: 82.91290759174306
    On Demand Balancedness Score Before: 78.01176356230222
    Recent Windows: 5
Session Id:          a4f833bd-2055-4213-bfdd-ad21f95bf184

```

The proposal will also move 24 partition leaders to different brokers. This requires a change to the ZooKeeper configuration, which has a low impact on performance.

The balancedness scores are measurements of the overall balance of the Kafka cluster before and after the optimization proposal is approved. A balancedness score is based on optimization goals. If all goals are satisfied, the score is 100. The score is reduced for each goal that will not be met. Compare the balancedness scores to see whether the Kafka cluster is less balanced than it could be following a rebalance.

### 8.3.4. Automatically approving an optimization proposal

To save time, you can automate the process of approving optimization proposals. With automation, when you generate an optimization proposal it goes straight into a cluster rebalance.

To enable the optimization proposal auto-approval mechanism, create the `KafkaRebalance` resource with the `strimzi.io/rebalance-auto-approval` annotation set to `true`. If the annotation is not set or set to `false`, the optimization proposal requires manual approval.

*Example rebalance request with auto-approval mechanism enabled*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster

```

```

annotations:
  strimzi.io/rebalance-auto-approval: true
spec:
  mode: # any mode
  # ...

```

You can still check the status when automatically approving an optimization proposal. The status of the [KafkaRebalance](#) resource moves to [Ready](#) when the rebalance is complete.

### 8.3.5. Optimization proposal summary properties

The following table explains the properties contained in the optimization proposal's summary section.

*Table 11. Properties contained in an optimization proposal summary*

JSON property	Description
<code>numIntraBrokerReplicaMovements</code>	<p>The total number of partition replicas that will be transferred between the disks of the cluster's brokers.</p> <p><b>Performance impact during rebalance operation:</b> Relatively high, but lower than <code>numReplicaMovements</code>.</p>
<code>excludedBrokersForLeadership</code>	Not yet supported. An empty list is returned.
<code>numReplicaMovements</code>	<p>The number of partition replicas that will be moved between separate brokers.</p> <p><b>Performance impact during rebalance operation:</b> Relatively high.</p>
<code>onDemandBalancednessScoreBefore</code> , <code>onDemandBalancednessScoreAfter</code>	<p>A measurement of the overall <i>balancedness</i> of a Kafka Cluster, before and after the optimization proposal was generated.</p> <p>The score is calculated by subtracting the sum of the <a href="#">BalancednessScore</a> of each violated soft goal from 100. Cruise Control assigns a <a href="#">BalancednessScore</a> to every optimization goal based on several factors, including priority—the goal's position in the list of <code>default.goals</code> or user-provided goals.</p> <p>The <a href="#">Before</a> score is based on the current configuration of the Kafka cluster. The <a href="#">After</a> score is based on the generated optimization proposal.</p>

JSON property	Description
<code>intraBrokerDataToMoveMB</code>	<p>The sum of the size of each partition replica that will be moved between disks on the same broker (see also <code>numIntraBrokerReplicaMovements</code>).</p> <p><b>Performance impact during rebalance operation:</b> Variable. The larger the number, the longer the cluster rebalance will take to complete. Moving a large amount of data between disks on the same broker has less impact than between separate brokers (see <code>dataToMoveMB</code>).</p>
<code>recentWindows</code>	The number of metrics windows upon which the optimization proposal is based.
<code>dataToMoveMB</code>	<p>The sum of the size of each partition replica that will be moved to a separate broker (see also <code>numReplicaMovements</code>).</p> <p><b>Performance impact during rebalance operation:</b> Variable. The larger the number, the longer the cluster rebalance will take to complete.</p>
<code>monitoredPartitionsPercentage</code>	The percentage of partitions in the Kafka cluster covered by the optimization proposal. Affected by the number of <code>excludedTopics</code> .
<code>excludedTopics</code>	If you specified a regular expression in the <code>spec.excludedTopicsRegex</code> property in the <code>KafkaRebalance</code> resource, all topic names matching that expression are listed here. These topics are excluded from the calculation of partition replica/leader movements in the optimization proposal.
<code>numLeaderMovements</code>	<p>The number of partitions whose leaders will be switched to different replicas. This involves a change to ZooKeeper configuration.</p> <p><b>Performance impact during rebalance operation:</b> Relatively low.</p>
<code>excludedBrokersForReplicaMove</code>	Not yet supported. An empty list is returned.

### 8.3.6. Broker load properties

The broker load is stored in a ConfigMap (with the same name as the `KafkaRebalance` custom resource) as a JSON formatted string. This JSON string consists of a JSON object with keys for each broker IDs linking to a number of metrics for each broker. Each metric consist of three values. The first is the metric value before the optimization proposal is applied, the second is the expected value of the metric after the proposal is applied, and the third is the difference between the first two values (after minus before).

**NOTE** The ConfigMap appears when the `KafkaRebalance` resource is in the `ProposalReady`

state and remains after the rebalance is complete.

You can use the name of the ConfigMap to view its data from the command line.

#### *Returning ConfigMap data*

```
kubectl describe configmaps <my_rebalance_configmap_name> -n <namespace>
```

You can also use the `jq` command line JSON parser tool to extract the JSON string from the ConfigMap.

#### *Extracting the JSON string from the ConfigMap using jq*

```
kubectl get configmaps <my_rebalance_configmap_name> -o json | jq  
'.["data"]["brokerLoad.json"]|fromjson|.'
```

The following table explains the properties contained in the optimization proposal's broker load ConfigMap:

JSON property	Description
<code>leaders</code>	The number of replicas on this broker that are partition leaders.
<code>replicas</code>	The number of replicas on this broker.
<code>cpuPercentage</code>	The CPU utilization as a percentage of the defined capacity.
<code>diskUsedPercentage</code>	The disk utilization as a percentage of the defined capacity.
<code>diskUsedMB</code>	The absolute disk usage in MB.
<code>networkOutRate</code>	The total network output rate for the broker.
<code>leaderNetworkInRate</code>	The network input rate for all partition leader replicas on this broker.
<code>followerNetworkInRate</code>	The network input rate for all follower replicas on this broker.
<code>potentialMaxNetworkOutRate</code>	The hypothetical maximum network output rate that would be realized if this broker became the leader of all the replicas it currently hosts.

### **8.3.7. Cached optimization proposal**

Cruise Control maintains a *cached optimization proposal* based on the configured default optimization goals. Generated from the workload model, the cached optimization proposal is updated every 15 minutes to reflect the current state of the Kafka cluster. If you generate an optimization proposal using the default optimization goals, Cruise Control returns the most recent cached proposal.

To change the cached optimization proposal refresh interval, edit the `proposal.expiration.ms` setting in the Cruise Control deployment configuration. Consider a shorter interval for fast

changing clusters, although this increases the load on the Cruise Control server.

#### *Additional resources*

- [Optimization goals overview](#)
- [Generating optimization proposals](#)
- [Approving an optimization proposal](#)

## 8.4. Rebalance performance tuning overview

You can adjust several performance tuning options for cluster rebalances. These options control how partition replica and leadership movements in a rebalance are executed, as well as the bandwidth that is allocated to a rebalance operation.

### 8.4.1. Partition reassignment commands

[Optimization proposals](#) are comprised of separate partition reassignment commands. When you [approve](#) a proposal, the Cruise Control server applies these commands to the Kafka cluster.

A partition reassignment command consists of either of the following types of operations:

- Partition movement: Involves transferring the partition replica and its data to a new location. Partition movements can take one of two forms:
  - Inter-broker movement: The partition replica is moved to a log directory on a different broker.
  - Intra-broker movement: The partition replica is moved to a different log directory on the same broker.
- Leadership movement: This involves switching the leader of the partition's replicas.

Cruise Control issues partition reassignment commands to the Kafka cluster in batches. The performance of the cluster during the rebalance is affected by the number of each type of movement contained in each batch.

### 8.4.2. Replica movement strategies

Cluster rebalance performance is also influenced by the *replica movement strategy* that is applied to the batches of partition reassignment commands. By default, Cruise Control uses the [BaseReplicaMovementStrategy](#), which simply applies the commands in the order they were generated. However, if there are some very large partition reassessments early in the proposal, this strategy can slow down the application of the other reassessments.

Cruise Control provides four alternative replica movement strategies that can be applied to optimization proposals:

- [PrioritizeSmallReplicaMovementStrategy](#): Order reassessments in order of ascending size.
- [PrioritizeLargeReplicaMovementStrategy](#): Order reassessments in order of descending size.
- [PostponeUrgReplicaMovementStrategy](#): Prioritize reassessments for replicas of partitions which

have no out-of-sync replicas.

- **PrioritizeMinIsrWithOfflineReplicasStrategy**: Prioritize reassessments with (At/Under)MinISR partitions with offline replicas. This strategy will only work if `cruiseControl.config.concurrency.adjuster.min_isr.check.enabled` is set to `true` in the `Kafka` custom resource's spec.

These strategies can be configured as a sequence. The first strategy attempts to compare two partition reassessments using its internal logic. If the reassessments are equivalent, then it passes them to the next strategy in the sequence to decide the order, and so on.

### 8.4.3. Intra-broker disk balancing

Moving a large amount of data between disks on the same broker has less impact than between separate brokers. If you are running a Kafka deployment that uses JBOD storage with multiple disks on the same broker, Cruise Control can balance partitions between the disks.

**NOTE** If you are using JBOD storage with a single disk, intra-broker disk balancing will result in a proposal with 0 partition movements since there are no disks to balance between.

To perform an intra-broker disk balance, set `rebalanceDisk` to `true` under the `KafkaRebalance.spec`. When setting `rebalanceDisk` to `true`, do not set a `goals` field in the `KafkaRebalance.spec`, as Cruise Control will automatically set the intra-broker goals and ignore the inter-broker goals. Cruise Control does not perform inter-broker and intra-broker balancing at the same time.

### 8.4.4. Rebalance tuning options

Cruise Control provides several configuration options for tuning the rebalance parameters discussed above. You can set these tuning options when [configuring and deploying Cruise Control with Kafka](#) or [optimization proposal](#) levels:

- The Cruise Control server setting can be set in the Kafka custom resource under `Kafka.spec.cruiseControl.config`.
- The individual rebalance performance configurations can be set under `KafkaRebalance.spec`.

The relevant configurations are summarized in the following table.

*Table 12. Rebalance performance tuning configuration*

Cruise Control properties	KafkaRebalance properties	Default	Description
<code>num.concurrent.partition.movements.per.broker</code>	<code>concurrentPartitionMovementsPerBroker</code>	5	The maximum number of inter-broker partition movements in each partition reassignment batch

Cruise Control properties	KafkaRebalance properties	Default	Description
<code>num.concurrent.intra.broker.partition.movements</code>	<code>concurrentIntraBrokerPartitionMovements</code>	2	The maximum number of intra-broker partition movements in each partition reassignment batch
<code>num.concurrent.leader.movements</code>	<code>concurrentLeaderMovements</code>	1000	The maximum number of partition leadership changes in each partition reassignment batch
<code>default.replication.throttle</code>	<code>replicationThrottle</code>	Null (no limit)	The bandwidth (in bytes per second) to assign to partition reassignment

Cruise Control properties	KafkaRebalance properties	Default	Description
<code>default.replica.movement.strategies</code>	<code>replicaMovementStrategies</code>	<code>BaseReplicaMovementStrategy</code>	The list of strategies (in priority order) used to determine the order in which partition reassignment commands are executed for generated proposals. For the server setting, use a comma separated string with the fully qualified names of the strategy class (add <code>com.linkedin.kafka.cruisecontrol.executor.strategy</code> . to the start of each class name). For the KafkaRebalance resource setting use a YAML array of strategy class names.
-	<code>rebalanceDisk</code>	false	Enables intra-broker disk balancing, which balances disk space utilization between disks on the same broker. Only applies to Kafka deployments that use JBOD storage with multiple disks.

Changing the default settings affects the length of time that the rebalance takes to complete, as well

as the load placed on the Kafka cluster during the rebalance. Using lower values reduces the load but increases the amount of time taken, and vice versa.

#### *Additional resources*

- [CruiseControlSpec schema reference](#).
- [KafkaRebalanceSpec schema reference](#).

## 8.5. Configuring and deploying Cruise Control with Kafka

Through `Kafka` resource configuration, the Cluster Operator can deploy Cruise Control when deploying a Kafka cluster. You can use the `cruiseControl` properties of the `Kafka` resource to configure the deployment. Deploy one instance of Cruise Control per Kafka cluster.

Use `goals` configuration in the Cruise Control `config` to specify optimization goals for generating optimization proposals. You can use `brokerCapacity` to change the default capacity limits for goals related to resource distribution. If brokers are running on nodes with heterogeneous network resources, you can use `overrides` to set network capacity limits for each broker.

If an empty object `({})` is used for the `cruiseControl` configuration, all properties use their default values.

#### *Prerequisites*

- A Kubernetes cluster
- A running Cluster Operator

#### *Procedure*

1. Edit the `cruiseControl` property for the `Kafka` resource.

The properties you can configure are shown in this example configuration:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  cruiseControl:
    brokerCapacity: ①
      inboundNetwork: 10000KB/s
      outboundNetwork: 10000KB/s
    overrides: ②
      - brokers: [0]
        inboundNetwork: 20000KiB/s
        outboundNetwork: 20000KiB/s
      - brokers: [1, 2]
        inboundNetwork: 30000KiB/s
```

```

    outboundNetwork: 30000KiB/s
# ...
config: ③
  default.goals: > ④
    com.linkedin.kafka.cruisecontrol.analyzer.goals.RackAwareGoal,
    com.linkedin.kafka.cruisecontrol.analyzer.goals.ReplicaCapacityGoal,
    com.linkedin.kafka.cruisecontrol.analyzer.goals.DiskCapacityGoal
# ...
  hard.goals: >
    com.linkedin.kafka.cruisecontrol.analyzer.goals.NetworkInboundCapacityGoal,
    com.linkedin.kafka.cruisecontrol.analyzer.goals.NetworkOutboundCapacityGoal
# ...
  cpu.balance.threshold: 1.1
  metadata.max.age.ms: 300000
  send.buffer.bytes: 131072
  webserver.http.cors.enabled: true ⑤
  webserver.http.cors.origin: "*"
  webserver.http.cors.exposeheaders: "User-Task-ID,Content-Type"
# ...
resources: ⑥
  requests:
    cpu: 1
    memory: 512Mi
  limits:
    cpu: 2
    memory: 2Gi
logging: ⑦
  type: inline
  loggers:
    rootLogger.level: "INFO"
template: ⑧
  pod:
    metadata:
      labels:
        label1: value1
    securityContext:
      runAsUser: 1000001
      fsGroup: 0
    terminationGracePeriodSeconds: 120
  readinessProbe: ⑨
    initialDelaySeconds: 15
    timeoutSeconds: 5
  livenessProbe:
    initialDelaySeconds: 15
    timeoutSeconds: 5
metricsConfig: ⑩
  type: jmxPrometheusExporter
  valueFrom:
    configMapKeyRef:
      name: cruise-control-metrics
      key: metrics-config.yml

```

```
# ...
```

- ① Capacity limits for broker resources.
- ② Overrides set network capacity limits for specific brokers when running on nodes with heterogeneous network resources.
- ③ Cruise Control configuration. Standard Cruise Control configuration may be provided, restricted to those properties not managed directly by Strimzi.
- ④ Optimization goals configuration, which can include configuration for default optimization goals (`default.goals`), main optimization goals (`goals`), and hard goals (`hard.goals`).
- ⑤ CORS enabled and configured for read-only access to the Cruise Control API.
- ⑥ Requests for reservation of supported resources, currently `cpu` and `memory`, and limits to specify the maximum resources that can be consumed.
- ⑦ Cruise Control loggers and log levels added directly (`inline`) or indirectly (`external`) through a ConfigMap. A custom ConfigMap must be placed under the `log4j.properties` key. Cruise Control has a single logger named `rootLogger.level`. You can set the log level to INFO, ERROR, WARN, TRACE, DEBUG, FATAL or OFF.
- ⑧ Template customization. Here a pod is scheduled with additional security attributes.
- ⑨ Healthchecks to know when to restart a container (liveness) and when a container can accept traffic (readiness).
- ⑩ Prometheus metrics enabled. In this example, metrics are configured for the Prometheus JMX Exporter (the default metrics exporter).

## 2. Create or update the resource:

```
kubectl apply -f <kafka_configuration_file>
```

## 3. Check the status of the deployment:

```
kubectl get deployments -n <my_cluster_operator_namespace>
```

*Output shows the deployment name and readiness*

NAME	READY	UP-TO-DATE	AVAILABLE
my-cluster-cruise-control	1/1	1	1

`my-cluster` is the name of the Kafka cluster.

`READY` shows the number of replicas that are ready/expected. The deployment is successful when the `AVAILABLE` output shows `1`.

## Auto-created topics

The following table shows the three topics that are automatically created when Cruise Control is

deployed. These topics are required for Cruise Control to work properly and must not be deleted or changed. You can change the name of the topic using the specified configuration option.

Table 13. Auto-created topics

Auto-created topic configuration	Default topic name	Created by	Function
<code>metric.reporter.topic</code>	<code>strimzi.cruisecontrol.metrics</code>	Strimzi Metrics Reporter	Stores the raw metrics from the Metrics Reporter in each Kafka broker.
<code>partition.metric.sample.store.topic</code>	<code>strimzi.cruisecontrol.partitionmetricsamples</code>	Cruise Control	Stores the derived metrics for each partition. These are created by the <a href="#">Metric Sample Aggregator</a> .
<code>broker.metric.sample.store.topic</code>	<code>strimzi.cruisecontrol.modeltrainingsamples</code>	Cruise Control	Stores the metrics samples used to create the <a href="#">Cluster Workload Model</a> .

To prevent the removal of records that are needed by Cruise Control, log compaction is disabled in the auto-created topics.

**NOTE** If the names of the auto-created topics are changed in a Kafka cluster that already has Cruise Control enabled, the old topics will not be deleted and should be manually removed.

#### What to do next

After configuring and deploying Cruise Control, you can [generate optimization proposals](#).

#### Additional resources

- [Optimization goals overview](#)
- [CruiseControlSpec schema reference](#)

## 8.6. Generating optimization proposals

When you create or update a `KafkaRebalance` resource, Cruise Control generates an [optimization proposal](#) for the Kafka cluster based on the configured [optimization goals](#). Analyze the information in the optimization proposal and decide whether to approve it. You can use the results of the optimization proposal to rebalance your Kafka cluster.

You can run the optimization proposal in one of the following modes:

- `full` (default)
- `add-brokers`
- `remove-brokers`

The mode you use depends on whether you are rebalancing across all the brokers already running in the Kafka cluster; or you want to rebalance after scaling up or before scaling down your Kafka

cluster. For more information, see [Rebalancing modes with broker scaling](#).

#### Prerequisites

- You have [deployed Cruise Control](#) to your Strimzi cluster.
- You have configured [optimization goals](#) and, optionally, [capacity limits on broker resources](#).

#### Procedure

1. Create a [KafkaRebalance](#) resource and specify the appropriate mode.

##### full mode (default)

To use the *default optimization goals* defined in the [Kafka](#) resource, leave the `spec` property empty. Cruise Control rebalances a Kafka cluster in `full` mode by default.

*Example configuration with full rebalancing by default*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
spec: {}
```

You can also run a full rebalance by specifying the `full` mode through the `spec.mode` property.

*Example configuration specifying full mode*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
spec:
  mode: full
```

##### add-brokers mode

If you want to rebalance a Kafka cluster after scaling up, specify the `add-brokers` mode.

In this mode, existing replicas are moved to the newly added brokers. You need to specify the brokers as a list.

*Example configuration specifying add-brokers mode*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
```

```
  strimzi.io/cluster: my-cluster
spec:
  mode: add-brokers
  brokers: [3, 4] ①
```

① List of newly added brokers added by the scale up operation. This property is mandatory.

### remove-brokers mode

If you want to rebalance a Kafka cluster before scaling down, specify the `remove-brokers` mode.

In this mode, replicas are moved off the brokers that are going to be removed. You need to specify the brokers that are being removed as a list.

*Example configuration specifying remove-brokers mode*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
spec:
  mode: remove-brokers
  brokers: [3, 4] ①
```

① List of brokers to be removed by the scale down operation. This property is mandatory.

**NOTE**

The following steps and the steps to approve or stop a rebalance are the same regardless of the rebalance mode you are using.

2. To configure *user-provided optimization goals* instead of using the default goals, add the `goals` property and enter one or more goals.

In the following example, rack awareness and replica capacity are configured as user-provided optimization goals:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
spec:
  goals:
    - RackAwareGoal
    - ReplicaCapacityGoal
```

3. To ignore the configured hard goals, add the `skipHardGoalCheck: true` property:

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
spec:
  goals:
    - RackAwareGoal
    - ReplicaCapacityGoal
  skipHardGoalCheck: true

```

4. (Optional) To approve the optimization proposal automatically, set the `strimzi.io/rebalance-auto-approval` annotation to `true`:

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaRebalance
metadata:
  name: my-rebalance
  labels:
    strimzi.io/cluster: my-cluster
  annotations:
    strimzi.io/rebalance-auto-approval: true
spec:
  goals:
    - RackAwareGoal
    - ReplicaCapacityGoal
  skipHardGoalCheck: true

```

5. Create or update the resource:

```
kubectl apply -f <kafka_rebalance_configuration_file>
```

The Cluster Operator requests the optimization proposal from Cruise Control. This might take a few minutes depending on the size of the Kafka cluster.

6. If you used the automatic approval mechanism, wait for the status of the optimization proposal to change to `Ready`. If you haven't enabled the automatic approval mechanism, wait for the status of the optimization proposal to change to `ProposalReady`:

```
kubectl get kafkarebalance -o wide -w -n <namespace>
```

### PendingProposal

A `PendingProposal` status means the rebalance operator is polling the Cruise Control API to check if the optimization proposal is ready.

## ProposalReady

A `ProposalReady` status means the optimization proposal is ready for review and approval.

When the status changes to `ProposalReady`, the optimization proposal is ready to approve.

### 7. Review the optimization proposal.

The optimization proposal is contained in the `Status.Optimization Result` property of the `KafkaRebalance` resource.

```
kubectl describe kafka_rebalance <kafka_rebalance_resource_name>
```

#### *Example optimization proposal*

```
Status:  
Conditions:  
  Last Transition Time: 2020-05-19T13:50:12.533Z  
  Status: ProposalReady  
  Type: State  
  Observed Generation: 1  
Optimization Result:  
  Data To Move MB: 0  
  Excluded Brokers For Leadership:  
  Excluded Brokers For Replica Move:  
  Excluded Topics:  
    Intra Broker Data To Move MB: 0  
    Monitored Partitions Percentage: 100  
    Num Intra Broker Replica Movements: 0  
    Num Leader Movements: 0  
    Num Replica Movements: 26  
    On Demand Balancedness Score After: 81.8666802863978  
    On Demand Balancedness Score Before: 78.01176356230222  
    Recent Windows: 1  
Session Id: 05539377-ca7b-45ef-b359-e13564f1458c
```

The properties in the `Optimization Result` section describe the pending cluster rebalance operation. For descriptions of each property, see [Contents of optimization proposals](#).

#### *Insufficient CPU capacity*

If a Kafka cluster is overloaded in terms of CPU utilization, you might see an insufficient CPU capacity error in the `KafkaRebalance` status. It's worth noting that this utilization value is unaffected by the `excludedTopics` configuration. Although optimization proposals will not reassign replicas of excluded topics, their load is still considered in the utilization calculation.

#### *Example CPU utilization error*

```
com.linkedin.kafka.cruisecontrol.exception.OptimizationFailureException:  
  [CpuCapacityGoal] Insufficient capacity for cpu (Utilization 615.21,  
  Allowed Capacity 420.00, Threshold: 0.70). Add at least 3 brokers with
```

the same CPU capacity (100.00) as broker-0. Add at least 3 brokers with the same CPU capacity (100.00) as broker-0.

**NOTE**

The error shows CPU capacity as a percentage rather than the number of CPU cores. For this reason, it does not directly map to the number of CPUs configured in the Kafka custom resource. It is like having a single *virtual* CPU per broker, which has the cycles of the CPUs configured in `Kafka.spec.kafka.resources.limits.cpu`. This has no effect on the rebalance behavior, since the ratio between CPU utilization and capacity remains the same.

*What to do next*

[Approving an optimization proposal](#)

*Additional resources*

- [Optimization proposals overview](#)

## 8.7. Approving an optimization proposal

You can approve an [optimization proposal](#) generated by Cruise Control, if its status is `ProposalReady`. Cruise Control will then apply the optimization proposal to the Kafka cluster, reassigning partitions to brokers and changing partition leadership.

**This is not a dry run.** Before you approve an optimization proposal, you must:

**CAUTION**

- Refresh the proposal in case it has become out of date.
- Carefully review the [contents of the proposal](#).

*Prerequisites*

- You have [generated an optimization proposal](#) from Cruise Control.
- The `KafkaRebalance` custom resource status is `ProposalReady`.

*Procedure*

Perform these steps for the optimization proposal that you want to approve.

1. Unless the optimization proposal is newly generated, check that it is based on current information about the state of the Kafka cluster. To do so, refresh the optimization proposal to make sure it uses the latest cluster metrics:

- a. Annotate the `KafkaRebalance` resource in Kubernetes with `strimzi.io/rebalance=refresh`:

```
kubectl annotate kafkaresource <kafka_rebalance_resource_name> strimzi.io/rebalance=refresh
```

2. Wait for the status of the optimization proposal to change to `ProposalReady`:

```
kubectl get kafka-rebalance -o wide -w -n <namespace>
```

### PendingProposal

A **PendingProposal** status means the rebalance operator is polling the Cruise Control API to check if the optimization proposal is ready.

### ProposalReady

A **ProposalReady** status means the optimization proposal is ready for review and approval.

When the status changes to **ProposalReady**, the optimization proposal is ready to approve.

3. Approve the optimization proposal that you want Cruise Control to apply.

Annotate the **KafkaRebalance** resource in Kubernetes with `strimzi.io/rebalance=approve`:

```
kubectl annotate kafka-rebalance <kafka_rebalance_resource_name>  
strimzi.io/rebalance=approve
```

4. The Cluster Operator detects the annotated resource and instructs Cruise Control to rebalance the Kafka cluster.
5. Wait for the status of the optimization proposal to change to **Ready**:

```
kubectl get kafka-rebalance -o wide -w -n <namespace>
```

### Rebalancing

A **Rebalancing** status means the rebalancing is in progress.

### Ready

A **Ready** status means the rebalance is complete.

### NotReady

A **NotReady** status means an error occurred—see [Fixing problems with a KafkaRebalance resource](#).

When the status changes to **Ready**, the rebalance is complete.

To use the same **KafkaRebalance** custom resource to generate another optimization proposal, apply the `refresh` annotation to the custom resource. This moves the custom resource to the **PendingProposal** or **ProposalReady** state. You can then review the optimization proposal and approve it, if desired.

### Additional resources

- [Optimization proposals overview](#)
- [Stopping a cluster rebalance](#)

## 8.8. Stopping a cluster rebalance

Once started, a cluster rebalance operation might take some time to complete and affect the overall performance of the Kafka cluster.

If you want to stop a cluster rebalance operation that is in progress, apply the `stop` annotation to the `KafkaRebalance` custom resource. This instructs Cruise Control to finish the current batch of partition reassessments and then stop the rebalance. When the rebalance has stopped, completed partition reassessments have already been applied; therefore, the state of the Kafka cluster is different when compared to prior to the start of the rebalance operation. If further rebalancing is required, you should generate a new optimization proposal.

**NOTE**

The performance of the Kafka cluster in the intermediate (stopped) state might be worse than in the initial state.

*Prerequisites*

- You have [approved the optimization proposal](#) by annotating the `KafkaRebalance` custom resource with `approve`.
- The status of the `KafkaRebalance` custom resource is `Rebalancing`.

*Procedure*

1. Annotate the `KafkaRebalance` resource in Kubernetes:

```
kubectl annotate kafka-rebalance rebalance-cr-name strimzi.io/rebalance=stop
```

2. Check the status of the `KafkaRebalance` resource:

```
kubectl describe kafka-rebalance rebalance-cr-name
```

3. Wait until the status changes to `Stopped`.

*Additional resources*

- [Optimization proposals overview](#)

## 8.9. Fixing problems with a `KafkaRebalance` resource

If an issue occurs when creating a `KafkaRebalance` resource or interacting with Cruise Control, the error is reported in the resource status, along with details of how to fix it. The resource also moves to the `NotReady` state.

To continue with the cluster rebalance operation, you must fix the problem in the `KafkaRebalance` resource itself or with the overall Cruise Control deployment. Problems might include the following:

- A misconfigured parameter in the `KafkaRebalance` resource.

- The `strimzi.io/cluster` label for specifying the Kafka cluster in the `KafkaRebalance` resource is missing.
- The Cruise Control server is not deployed as the `cruiseControl` property in the `Kafka` resource is missing.
- The Cruise Control server is not reachable.

After fixing the issue, you need to add the `refresh` annotation to the `KafkaRebalance` resource. During a “refresh”, a new optimization proposal is requested from the Cruise Control server.

#### *Prerequisites*

- You have [approved an optimization proposal](#).
- The status of the `KafkaRebalance` custom resource for the rebalance operation is `NotReady`.

#### *Procedure*

1. Get information about the error from the `KafkaRebalance` status:

```
kubectl describe kafka-rebalance-rebalance-cr-name
```

2. Attempt to resolve the issue in the `KafkaRebalance` resource.
3. Annotate the `KafkaRebalance` resource in Kubernetes:

```
kubectl annotate kafka-rebalance-rebalance-cr-name strimzi.io/rebalance=refresh
```

4. Check the status of the `KafkaRebalance` resource:

```
kubectl describe kafka-rebalance-rebalance-cr-name
```

5. Wait until the status changes to `PendingProposal`, or directly to `ProposalReady`.

#### *Additional resources*

- [Optimization proposals overview](#)

# Chapter 9. Managing TLS certificates

Strimzi supports TLS for encrypted communication between Kafka and Strimzi components.

Communication is always encrypted between the following components:

- Communication between Kafka and ZooKeeper
- Interbroker communication between Kafka brokers
- Internodal communication between ZooKeeper nodes
- Strimzi operator communication with Kafka brokers and ZooKeeper nodes

Communication between Kafka clients and Kafka brokers is encrypted according to how the cluster is configured. For the Kafka and Strimzi components, TLS certificates are also used for authentication.

The Cluster Operator automatically sets up and renews TLS certificates to enable encryption and authentication within your cluster. It also sets up other TLS certificates if you want to enable encryption or TLS authentication between Kafka brokers and clients.

Certificate Authority (CA) certificates are generated by the Cluster Operator to verify the identities of components and clients. If you don't want to use the CAs generated by the Cluster Operator, you can [install your own cluster and client CA certificates](#).

You can also [provide Kafka listener certificates](#) for TLS listeners or external listeners that have TLS encryption enabled. Use Kafka listener certificates to incorporate the security infrastructure you already have in place.

**NOTE** Any certificates you provide are not renewed by the Cluster Operator.

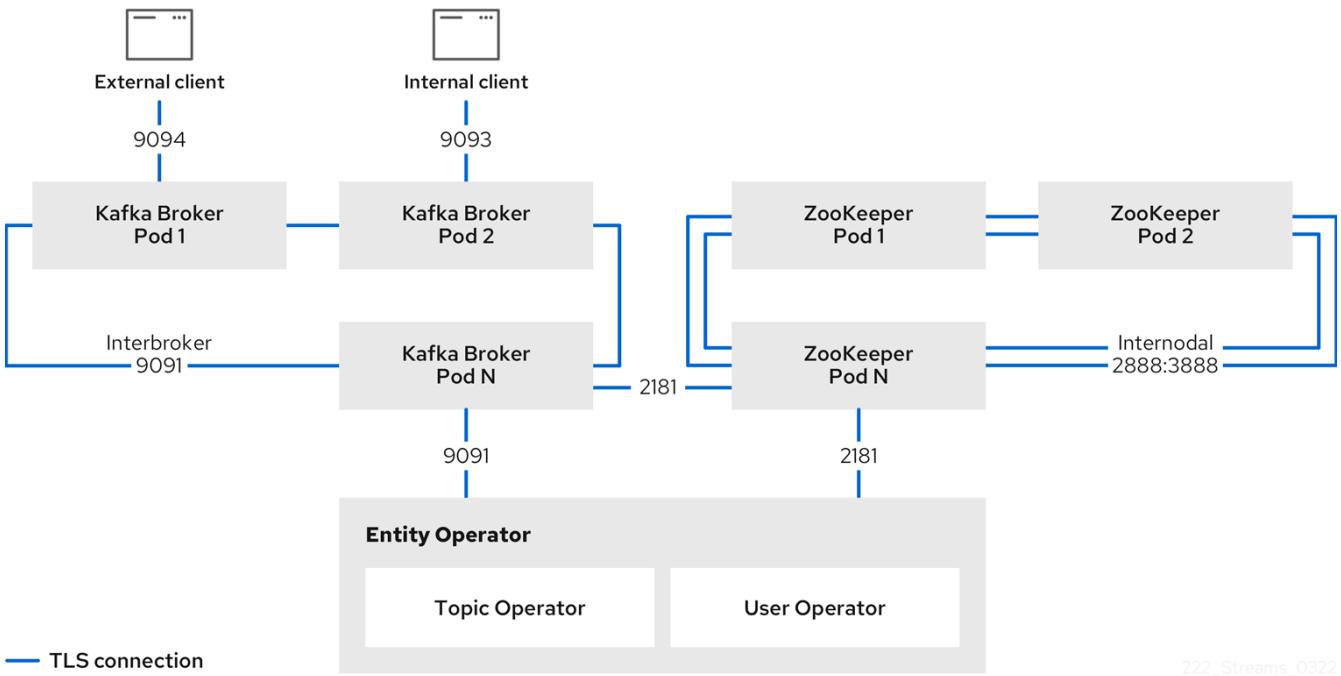


Figure 5. Example architecture of the communication secured by TLS

## 9.1. Certificate Authorities

To support encryption, each Strimzi component needs its own private keys and public key certificates. All component certificates are signed by an internal Certificate Authority (CA) called the *cluster CA*.

Similarly, each Kafka client application connecting to Strimzi using TLS client authentication needs to provide private keys and certificates. A second internal CA, named the *clients CA*, is used to sign certificates for the Kafka clients.

### 9.1.1. CA certificates

Both the cluster CA and clients CA have a self-signed public key certificate.

Kafka brokers are configured to trust certificates signed by either the cluster CA or clients CA. Components that clients do not need to connect to, such as ZooKeeper, only trust certificates signed by the cluster CA. Unless TLS encryption for external listeners is disabled, client applications must trust certificates signed by the cluster CA. This is also true for client applications that perform [mutual TLS authentication](#).

By default, Strimzi automatically generates and renews CA certificates issued by the cluster CA or clients CA. You can configure the management of these CA certificates in the `Kafka.spec.clusterCa` and `Kafka.spec.clientsCa` objects. Certificates provided by users are not renewed.

You can provide your own CA certificates for the cluster CA or clients CA. For more information, see [Installing your own CA certificates](#). If you provide your own certificates, you must manually renew them when needed.

## 9.1.2. Installing your own CA certificates

This procedure describes how to install your own CA certificates and keys instead of using the CA certificates and private keys generated by the Cluster Operator.

The Cluster Operator automatically generates and renews the following secrets:

### **CLUSTER-NAME-cluster-ca**

The cluster secret that contains the private key for the cluster CA.

### **CLUSTER-NAME-cluster-ca-cert**

The cluster secret that contains a cluster CA certificate. The certificate contains a public key to validate the identity of Kafka brokers.

### **CLUSTER-NAME-clients-ca**

The client secret that contains the private key for the client CA.

### **CLUSTER-NAME-clients-ca-cert**

The client secret that contains a client CA certificate. The certificate contains a public key to validate the identity of clients accessing the Kafka brokers.

Strimzi uses these secrets by default.

This procedure describes the steps to replace the secrets to use your own cluster or client CA certificates.

#### *Prerequisites*

- The Cluster Operator is running.
- A Kafka cluster is not yet deployed.
- Your own X.509 certificates and keys in PEM format for the cluster CA or clients CA.
  - If you want to use a cluster or clients CA which is not a Root CA, you have to include the whole chain in the certificate file. The chain should be in the following order:
    1. The cluster or clients CA
    2. One or more intermediate CAs
    3. The root CA
    - All CAs in the chain should be configured using the X509v3 Basic Constraints extension. Basic Constraints limit the path length of a certificate chain.
  - The OpenSSL TLS management tool for converting certificates.

#### *Before you begin*

The Cluster Operator generates the following files for the **CLUSTER-NAME-cluster-ca-cert** secret:

- **ca.crt** cluster certificate in PEM format
- **ca.p12** cluster certificate in PKCS #12 format
- **ca.password** to access the PKCS #12 file

Some applications cannot use PEM certificates and support only PKCS #12 certificates. You can also add your own cluster certificate in PKCS #12 format.

If you don't have a cluster certificate in PKCS #12 format, use the OpenSSL TLS management tool to generate one from your `ca.crt` file.

*Example certificate generation command*

```
openssl pkcs12 -export -in ca.crt -nokeys -out ca.p12 -password pass:P12-PASSWORD  
-caname ca.crt
```

Replace `P12-PASSWORD` with your own password.

You can do the same for the `CLUSTER-NAME-clients-ca-cert` secret, which also contains certificates in PEM and PKCS #12 format by default.

*Procedure*

1. Replace the CA certificate generated by the Cluster Operator.

a. Delete the existing secret.

```
kubectl delete secret CA-CERTIFICATE-SECRET
```

`CA-CERTIFICATE-SECRET` is the name of the `Secret`:

- `CLUSTER-NAME-cluster-ca-cert` for the cluster CA certificate
- `CLUSTER-NAME-clients-ca-cert` for the clients CA certificate

Replace `CLUSTER-NAME` with the name of your Kafka cluster.

Ignore any "Not Exists" errors.

b. Create the new secret.

*Client secret creation with a certificate in PEM format only*

```
kubectl create secret generic CLUSTER-NAME-clients-ca-cert --from  
-file=ca.crt=ca.crt
```

*Cluster secret creation with certificates in PEM and PKCS #12 format*

```
kubectl create secret generic CLUSTER-NAME-cluster-ca-cert \  
--from-file=ca.crt=ca.crt \  
--from-file=ca.p12=ca.p12 \  
--from-literal=password=P12-PASSWORD
```

2. Replace the private key generated by the Cluster Operator.

a. Delete the existing secret.

```
kubectl delete secret CA-KEY-SECRET
```

*CA-KEY-SECRET* is the name of CA key:

- **CLUSTER-NAME-cluster-ca** for the cluster CA key
- **CLUSTER-NAME-clients-ca** for the clients CA key

b. Create the new secret.

```
kubectl create secret generic CA-KEY-SECRET --from-file=ca.key=ca.key
```

3. Label the secrets.

```
kubectl label secret CA-CERTIFICATE-SECRET strimzi.io/kind=Kafka  
strimzi.io/cluster=CLUSTER-NAME
```

```
kubectl label secret CA-KEY-SECRET strimzi.io/kind=Kafka  
strimzi.io/cluster=CLUSTER-NAME
```

- Label **strimzi.io/kind=Kafka** identifies the Kafka custom resource.
- Label **strimzi.io/cluster=CLUSTER-NAME** identifies the Kafka cluster.

4. Annotate the secrets

```
kubectl annotate secret CA-CERTIFICATE-SECRET strimzi.io/ca-cert-generation=CA-  
CERTIFICATE-GENERATION
```

```
kubectl annotate secret CA-KEY-SECRET strimzi.io/ca-key-generation=CA-KEY-  
GENERATION
```

- Annotation **strimzi.io/ca-cert-generation=CA-CERTIFICATE-GENERATION** defines the generation of a new CA certificate.
- Annotation **strimzi.io/ca-key-generation=CA-KEY-GENERATION** defines the generation of a new CA key.

If you are replacing CA certificates automatically generated by the Cluster Operator, use the next higher incremental value from the existing annotation and follow the [replacing CA keys procedure](#). If there are no CA certificates automatically generated by the Cluster Operator, start from 0 (zero) as the incremental value (**strimzi.io/ca-cert-generation=0**) for your own CA certificate. Set a higher incremental value when you renew the certificates.

5. Create the **Kafka** resource for your cluster, configuring either the **Kafka.spec.clusterCa** or the **Kafka.spec.clientsCa** object to *not* use generated CAs.

Example fragment [Kafka](#) resource configuring the cluster CA to use certificates you supply for yourself

```
kind: Kafka
version: kafka.strimzi.io/v1beta2
spec:
  # ...
  clusterCa:
    generateCertificateAuthority: false
```

#### Additional resources

- To renew CA certificates you have previously installed, see [Renewing your own CA certificates](#).
- To replace the private keys of CA certificates you have previously installed, see [Replacing private keys used by your own CA certificates](#).
- [Providing your own Kafka listener certificates](#).

## 9.2. Secrets

Strimzi uses secrets to store private and public key certificates for Kafka clusters, clients, and users. Secrets are used for establishing TLS encrypted connections between Kafka brokers, and between brokers and clients. They are also used for mutual TLS authentication.

Cluster and clients secrets are always pairs: one contains the public key and one contains the private key.

### Cluster secret

A cluster secret contains the *cluster CA* to sign Kafka broker certificates. Connecting clients use the certificate to establish a TLS encrypted connection with a Kafka cluster. The certificate verifies broker identity.

### Client secret

A client secret contains the *clients CA* for a user to sign its own client certificate. This allows mutual authentication against the Kafka cluster. The broker validates a client's identity through the certificate.

### User secret

A user secret contains a private key and certificate. The secret is created and signed by the clients CA when a new user is created. The key and certificate are used to authenticate and authorize the user when accessing the cluster.

#### 9.2.1. Secrets in PEM and PKCS #12 formats

Secrets provide private keys and certificates in PEM and PKCS #12 formats. Use the format that's suitable for your client. Using private keys and certificates in PEM format means that users have to get them from the secrets, and generate a corresponding truststore or keystore to use in their applications. PKCS #12 storage provides a truststore or keystore that can be used directly.

PKCS #12 defines an archive file format ([.p12](#)) for storing cryptography objects into a single file with

password protection. You can use PKCS #12 to manage certificates and keys in one place.

Each secret contains fields specific to PKCS #12.

- The `.p12` field contains the certificates and keys.
- The `.password` field is the password that protects the archive.

All keys are 2048 bits in size and are valid by default for 365 days from initial generation. You can [change the validity period](#).

### 9.2.2. Secrets generated by the Cluster Operator

The Cluster Operator generates the following certificates, which are saved as secrets in the Kubernetes cluster. Strimzi uses these secrets by default.

The cluster CA and clients CA have separate secrets for the private key and public key.

#### `<cluster_name>-cluster-ca`

Contains the private key of the cluster CA. Strimzi and Kafka components use the private key to sign server certificates.

#### `<cluster_name>-cluster-ca-cert`

Contains the public key of the cluster CA. Kafka clients use the public key to verify the identity of the Kafka brokers they are connecting to with TLS server authentication.

#### `<cluster_name>-clients-ca`

Contains the private key of the clients CA. Kafka clients use the private key to sign new user certificates for TLS client authentication when connecting to Kafka brokers.

#### `<cluster_name>-clients-ca-cert`

Contains the public key of the client CA. Kafka brokers use the public key to verify the identity of clients accessing the Kafka brokers when TLS client authentication is used.

Secrets for communication between Strimzi components contain a private key and a public key certificate signed by the cluster CA.

#### `<cluster_name>-kafka-brokers`

Contains the private and public keys for Kafka brokers.

#### `<cluster_name>-zookeeper-nodes`

Contains the private and public keys for ZooKeeper nodes.

#### `<cluster_name>-cluster-operator-certs`

Contains the private and public keys for encrypting communication between the Cluster Operator and Kafka or ZooKeeper.

#### `<cluster_name>-entity-topic-operator-certs`

Contains the private and public keys for encrypting communication between the Topic Operator and Kafka or ZooKeeper.

#### <cluster\_name>-entity-user-operator-certs

Contains the private and public keys for encrypting communication between the User Operator and Kafka or ZooKeeper.

#### <cluster\_name>-cruise-control-certs

Contains the private and public keys for encrypting communication between Cruise Control and Kafka or ZooKeeper.

#### <cluster\_name>-kafka-exporter-certs

Contains the private and public keys for encrypting communication between Kafka Exporter and Kafka or ZooKeeper.

**NOTE** You can [provide your own server certificates and private keys](#) to connect to Kafka brokers using *Kafka listener certificates* rather than certificates signed by the cluster CA or clients CA.

### 9.2.3. Cluster CA secrets

Cluster CA secrets are managed by the Cluster Operator in a Kafka cluster.

Only the <cluster\_name>-cluster-ca-cert secret is required by clients. All other cluster secrets are accessed by Strimzi components. You can enforce this using Kubernetes role-based access controls, if necessary.

**NOTE** The CA certificates in <cluster\_name>-cluster-ca-cert must be trusted by Kafka client applications so that they validate the Kafka broker certificates when connecting to Kafka brokers over TLS.

Table 14. Fields in the <cluster\_name>-cluster-ca secret

Field	Description
ca.key	The current private key for the cluster CA.

Table 15. Fields in the <cluster\_name>-cluster-ca-cert secret

Field	Description
ca.p12	PKCS #12 archive file for storing certificates and keys.
ca.password	Password for protecting the PKCS #12 archive file.
ca.crt	The current certificate for the cluster CA.

Table 16. Fields in the <cluster\_name>-kafka-brokers secret

Field	Description
<cluster_name>-kafka-<num>.p12	PKCS #12 archive file for storing certificates and keys.
<cluster_name>-kafka-<num>.password	Password for protecting the PKCS #12 archive file.

Field	Description
<code>&lt;cluster_name&gt;-kafka-&lt;num&gt;.crt</code>	Certificate for a Kafka broker pod <code>&lt;num&gt;</code> . Signed by a current or former cluster CA private key in <code>&lt;cluster_name&gt;-cluster-ca</code> .
<code>&lt;cluster_name&gt;-kafka-&lt;num&gt;.key</code>	Private key for a Kafka broker pod <code>&lt;num&gt;</code> .

Table 17. Fields in the `<cluster_name>-zookeeper-nodes` secret

Field	Description
<code>&lt;cluster_name&gt;-zookeeper-&lt;num&gt;.p12</code>	PKCS #12 archive file for storing certificates and keys.
<code>&lt;cluster_name&gt;-zookeeper-&lt;num&gt;.password</code>	Password for protecting the PKCS #12 archive file.
<code>&lt;cluster_name&gt;-zookeeper-&lt;num&gt;.crt</code>	Certificate for ZooKeeper node <code>&lt;num&gt;</code> . Signed by a current or former cluster CA private key in <code>&lt;cluster_name&gt;-cluster-ca</code> .
<code>&lt;cluster_name&gt;-zookeeper-&lt;num&gt;.key</code>	Private key for ZooKeeper pod <code>&lt;num&gt;</code> .

Table 18. Fields in the `<cluster_name>-cluster-operator-certs` secret

Field	Description
<code>cluster-operator.p12</code>	PKCS #12 archive file for storing certificates and keys.
<code>cluster-operator.password</code>	Password for protecting the PKCS #12 archive file.
<code>cluster-operator.crt</code>	Certificate for TLS communication between the Cluster Operator and Kafka or ZooKeeper. Signed by a current or former cluster CA private key in <code>&lt;cluster_name&gt;-cluster-ca</code> .
<code>cluster-operator.key</code>	Private key for TLS communication between the Cluster Operator and Kafka or ZooKeeper.

Table 19. Fields in the `<cluster_name>-entity-topic-operator-certs` secret

Field	Description
<code>entity-operator.p12</code>	PKCS #12 archive file for storing certificates and keys.
<code>entity-operator.password</code>	Password for protecting the PKCS #12 archive file.
<code>entity-operator.crt</code>	Certificate for TLS communication between the Topic Operator and Kafka or ZooKeeper. Signed by a current or former cluster CA private key in <code>&lt;cluster_name&gt;-cluster-ca</code> .
<code>entity-operator.key</code>	Private key for TLS communication between the Topic Operator and Kafka or ZooKeeper.

Table 20. Fields in the `<cluster_name>-entity-user-operator-certs` secret

Field	Description
entity-operator.p12	PKCS #12 archive file for storing certificates and keys.
entity-operator.password	Password for protecting the PKCS #12 archive file.
entity-operator.crt	Certificate for TLS communication between the User Operator and Kafka or ZooKeeper. Signed by a current or former cluster CA private key in <cluster_name>-cluster-ca.
entity-operator.key	Private key for TLS communication between the User Operator and Kafka or ZooKeeper.

Table 21. Fields in the <cluster\_name>-cruise-control-certs secret

Field	Description
cruise-control.p12	PKCS #12 archive file for storing certificates and keys.
cruise-control.password	Password for protecting the PKCS #12 archive file.
cruise-control.crt	Certificate for TLS communication between Cruise Control and Kafka or ZooKeeper. Signed by a current or former cluster CA private key in <cluster_name>-cluster-ca.
cruise-control.key	Private key for TLS communication between the Cruise Control and Kafka or ZooKeeper.

Table 22. Fields in the <cluster\_name>-kafka-exporter-certs secret

Field	Description
kafka-exporter.p12	PKCS #12 archive file for storing certificates and keys.
kafka-exporter.password	Password for protecting the PKCS #12 archive file.
kafka-exporter.crt	Certificate for TLS communication between Kafka Exporter and Kafka or ZooKeeper. Signed by a current or former cluster CA private key in <cluster_name>-cluster-ca.
kafka-exporter.key	Private key for TLS communication between the Kafka Exporter and Kafka or ZooKeeper.

## 9.2.4. Client CA secrets

Clients CA secrets are managed by the Cluster Operator in a Kafka cluster.

The certificates in <cluster\_name>-clients-ca-cert are those which the Kafka brokers trust.

The <cluster\_name>-clients-ca secret is used to sign the certificates of client applications. This secret must be accessible to the Strimzi components and for administrative access if you are intending to issue application certificates without using the User Operator. You can enforce this using Kubernetes role-based access controls, if necessary.

Table 23. Fields in the <cluster\_name>-clients-ca secret

Field	Description
<code>ca.key</code>	The current private key for the clients CA.

Table 24. Fields in the `<cluster_name>-clients-ca-cert` secret

Field	Description
<code>ca.p12</code>	PKCS #12 archive file for storing certificates and keys.
<code>ca.password</code>	Password for protecting the PKCS #12 archive file.
<code>ca.crt</code>	The current certificate for the clients CA.

## 9.2.5. User secrets

User secrets are managed by the User Operator.

When a user is created using the User Operator, a secret is generated using the name of the user.

Table 25. Fields in the `user_name` secret

Secret name	Field within secret	Description
<code>&lt;user_name&gt;</code>	<code>user.p12</code>	PKCS #12 archive file for storing certificates and keys.
	<code>user.password</code>	Password for protecting the PKCS #12 archive file.
	<code>user.crt</code>	Certificate for the user, signed by the clients CA
	<code>user.key</code>	Private key for the user

## 9.2.6. Adding labels and annotations to cluster CA secrets

By configuring the `clusterCaCert` template property in the `Kafka` custom resource, you can add custom labels and annotations to the Cluster CA secrets created by the Cluster Operator. Labels and annotations are useful for identifying objects and adding contextual information. You configure template properties in Strimzi custom resources.

*Example template customization to add labels and annotations to secrets*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    template:
      clusterCaCert:
        metadata:
          labels:
```

```
label1: value1
label2: value2
annotations:
  annotation1: value1
  annotation2: value2
# ...
```

For more information on configuring template properties, see [Customizing Kubernetes resources](#).

### 9.2.7. Disabling `ownerReference` in the CA secrets

By default, the Cluster and Client CA secrets are created with an `ownerReference` property that is set to the `Kafka` custom resource. This means that, when the `Kafka` custom resource is deleted, the CA secrets are also deleted (garbage collected) by Kubernetes.

If you want to reuse the CA for a new cluster, you can disable the `ownerReference` by setting the `generateSecretOwnerReference` property for the Cluster and Client CA secrets to `false` in the `Kafka` configuration. When the `ownerReference` is disabled, CA secrets are not deleted by Kubernetes when the corresponding `Kafka` custom resource is deleted.

*Example Kafka configuration with disabled `ownerReference` for Cluster and Client CAs*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
# ...
spec:
# ...
  clusterCa:
    generateSecretOwnerReference: false
  clientsCa:
    generateSecretOwnerReference: false
# ...
```

*Additional resources*

- [CertificateAuthority schema reference](#)

## 9.3. Certificate renewal and validity periods

Cluster CA and clients CA certificates are only valid for a limited time period, known as the validity period. This is usually defined as a number of days since the certificate was generated.

For CA certificates automatically created by the Cluster Operator, you can configure the validity period of:

- Cluster CA certificates in `Kafka.spec.clusterCa.validityDays`
- Client CA certificates in `Kafka.spec.clientsCa.validityDays`

The default validity period for both certificates is 365 days. Manually-installed CA certificates

should have their own validity periods defined.

When a CA certificate expires, components and clients that still trust that certificate will not accept TLS connections from peers whose certificates were signed by the CA private key. The components and clients need to trust the *new* CA certificate instead.

To allow the renewal of CA certificates without a loss of service, the Cluster Operator initiates certificate renewal before the old CA certificates expire.

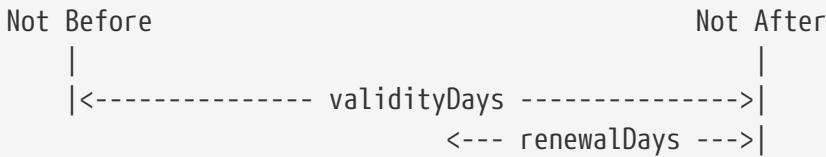
You can configure the renewal period of the certificates created by the Cluster Operator:

- Cluster CA certificates in `Kafka.spec.clusterCa.renewalDays`
- Client CA certificates in `Kafka.spec.clientsCa.renewalDays`

The default renewal period for both certificates is 30 days.

The renewal period is measured backwards, from the expiry date of the current certificate.

#### *Validity period against renewal period*



To make a change to the validity and renewal periods after creating the Kafka cluster, you configure and apply the `Kafka` custom resource, and [manually renew the CA certificates](#). If you do not manually renew the certificates, the new periods will be used the next time the certificate is renewed automatically.

#### *Example Kafka configuration for certificate validity and renewal periods*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
# ...
spec:
# ...
  clusterCa:
    renewalDays: 30
    validityDays: 365
    generateCertificateAuthority: true
  clientsCa:
    renewalDays: 30
    validityDays: 365
    generateCertificateAuthority: true
# ...
```

The behavior of the Cluster Operator during the renewal period depends on the settings for the `generateCertificateAuthority` certificate generation properties for the cluster CA and clients CA.

## true

If the properties are set to `true`, a CA certificate is generated automatically by the Cluster Operator, and renewed automatically within the renewal period.

## false

If the properties are set to `false`, a CA certificate is not generated by the Cluster Operator. Use this option if you are [installing your own certificates](#).

### 9.3.1. Renewal process with automatically generated CA certificates

The Cluster Operator performs the following processes in this order when renewing CA certificates:

1. Generates a new CA certificate, but retains the existing key.

The new certificate replaces the old one with the name `ca.crt` within the corresponding `Secret`.

2. Generates new client certificates (for ZooKeeper nodes, Kafka brokers, and the Entity Operator).

This is not strictly necessary because the signing key has not changed, but it keeps the validity period of the client certificate in sync with the CA certificate.

3. Restarts ZooKeeper nodes so that they will trust the new CA certificate and use the new client certificates.
4. Restarts Kafka brokers so that they will trust the new CA certificate and use the new client certificates.
5. Restarts the Topic and User Operators so that they will trust the new CA certificate and use the new client certificates.

User certificates are signed by the clients CA. User certificates generated by the User Operator are renewed when the clients CA is renewed.

### 9.3.2. Client certificate renewal

The Cluster Operator is not aware of the client applications using the Kafka cluster.

When connecting to the cluster, and to ensure they operate correctly, client applications must:

- Trust the cluster CA certificate published in the `<cluster>-cluster-ca-cert` Secret.
- Use the credentials published in their `<user-name>` Secret to connect to the cluster.

The User Secret provides credentials in PEM and PKCS #12 format, or it can provide a password when using SCRAM-SHA authentication. The User Operator creates the user credentials when a user is created.

You must ensure clients continue to work after certificate renewal. The renewal process depends on how the clients are configured.

If you are provisioning client certificates and keys manually, you must generate new client certificates and ensure the new certificates are used by clients within the renewal period. Failure to

do this by the end of the renewal period could result in client applications being unable to connect to the cluster.

**NOTE**

For workloads running inside the same Kubernetes cluster and namespace, Secrets can be mounted as a volume so the client Pods construct their keystores and truststores from the current state of the Secrets. For more details on this procedure, see [Configuring internal clients to trust the cluster CA](#).

### 9.3.3. Manually renewing the CA certificates generated by the Cluster Operator

Cluster and clients CA certificates generated by the Cluster Operator auto-renew at the start of their respective certificate renewal periods. However, you can use the `strimzi.io/force-renew` annotation to manually renew one or both of these certificates before the certificate renewal period starts. You might do this for security reasons, or if you have [changed the renewal or validity periods for the certificates](#).

A renewed certificate uses the same private key as the old certificate.

**NOTE**

If you are using your own CA certificates, the `force-renew` annotation cannot be used. Instead, follow the procedure for [renewing your own CA certificates](#).

#### Prerequisites

- The Cluster Operator is running.
- A Kafka cluster in which CA certificates and private keys are installed.

#### Procedure

1. Apply the `strimzi.io/force-renew` annotation to the `Secret` that contains the CA certificate that you want to renew.

*Table 26. Annotation for the Secret that forces renewal of certificates*

Certificate	Secret	Annotate command
Cluster CA	<code>KAFKA-CLUSTER-NAME-cluster-ca-cert</code>	<code>kubectl annotate secret KAFKA-CLUSTER-NAME-cluster-ca-cert strimzi.io/force-renew=true</code>
Clients CA	<code>KAFKA-CLUSTER-NAME-clients-ca-cert</code>	<code>kubectl annotate secret KAFKA-CLUSTER-NAME-clients-ca-cert strimzi.io/force-renew=true</code>

At the next reconciliation the Cluster Operator will generate a new CA certificate for the `Secret` that you annotated. If maintenance time windows are configured, the Cluster Operator will generate the new CA certificate at the first reconciliation within the next maintenance time window.

Client applications must reload the cluster and clients CA certificates that were renewed by the Cluster Operator.

## 2. Check the period the CA certificate is valid:

For example, using an `openssl` command:

```
kubectl get secret CA-CERTIFICATE-SECRET -o 'jsonpath={.data.CA-CERTIFICATE}' |  
base64 -d | openssl x509 -subject -issuer -startdate -enddate -noout
```

`CA-CERTIFICATE-SECRET` is the name of the `Secret`, which is `KAFKA-CLUSTER-NAME-cluster-ca-cert` for the cluster CA certificate and `KAFKA-CLUSTER-NAME-clients-ca-cert` for the clients CA certificate.

`CA-CERTIFICATE` is the name of the CA certificate, such as `jsonpath={.data.ca\ crt}`.

The command returns a `notBefore` and `notAfter` date, which is the validity period for the CA certificate.

For example, for a cluster CA certificate:

```
subject=O = io.strimzi, CN = cluster-ca v0  
issuer=O = io.strimzi, CN = cluster-ca v0  
notBefore=Jun 30 09:43:54 2020 GMT  
notAfter=Jun 30 09:43:54 2021 GMT
```

## 3. Delete old certificates from the Secret.

When components are using the new certificates, older certificates might still be active. Delete the old certificates to remove any potential security risk.

### Additional resources

- [Secrets](#)
- [Maintenance time windows for rolling updates](#)
- [CertificateAuthority schema reference](#)

### 9.3.4. Replacing private keys used by the CA certificates generated by the Cluster Operator

You can replace the private keys used by the cluster CA and clients CA certificates generated by the Cluster Operator. When a private key is replaced, the Cluster Operator generates a new CA certificate for the new private key.

#### NOTE

If you are using your own CA certificates, the `force-replace` annotation cannot be used. Instead, follow the procedure for [renewing your own CA certificates](#).

### Prerequisites

- The Cluster Operator is running.
- A Kafka cluster in which CA certificates and private keys are installed.

#### *Procedure*

- Apply the `strimzi.io/force-replace` annotation to the `Secret` that contains the private key that you want to renew.

*Table 27. Commands for replacing private keys*

Private key for	Secret	Annotate command
Cluster CA	<i>CLUSTER-NAME-cluster-ca</i>	<code>kubectl annotate secret CLUSTER-NAME-cluster-ca strimzi.io/force-replace=true</code>
Clients CA	<i>CLUSTER-NAME-clients-ca</i>	<code>kubectl annotate secret CLUSTER-NAME-clients-ca strimzi.io/force-replace=true</code>

At the next reconciliation the Cluster Operator will:

- Generate a new private key for the `Secret` that you annotated
- Generate a new CA certificate

If maintenance time windows are configured, the Cluster Operator will generate the new private key and CA certificate at the first reconciliation within the next maintenance time window.

Client applications must reload the cluster and clients CA certificates that were renewed by the Cluster Operator.

#### *Additional resources*

- [Secrets](#)
- [Maintenance time windows for rolling updates](#)

### **9.3.5. Renewing your own CA certificates**

This procedure describes how to renew CA certificates that you are using instead of the certificates generated by the Cluster Operator.

**If you are not changing the corresponding CA keys, perform the steps in this procedure. Otherwise, perform the steps to [replace private keys used by your own CA certificates](#).**

If you are using your own certificates, the Cluster Operator will not renew them automatically. Therefore, it is important that you follow this procedure during the renewal period of the certificate in order to replace CA certificates that will soon expire.

The procedure describes the renewal of CA certificates in PEM format.

#### *Prerequisites*

- The Cluster Operator is running.
- [Your own CA certificates and private keys are installed](#).
- You have new cluster or clients X.509 certificates in PEM format.

#### *Procedure*

## 1. Update the **Secret** for the CA certificate.

Edit the existing secret to add the new CA certificate and update the certificate generation annotation value.

```
kubectl edit secret <ca_certificate_secret_name>
```

<*ca\_certificate\_secret\_name*> is the name of the **Secret**, which is <*kafka\_cluster\_name*>-**cluster-ca-cert** for the cluster CA certificate and <*kafka\_cluster\_name*>-**clients-ca-cert** for the clients CA certificate.

The following example shows a secret for a cluster CA certificate that's associated with a Kafka cluster named **my-cluster**.

*Example secret configuration for a cluster CA certificate*

```
apiVersion: v1
kind: Secret
data:
  ca.crt: LS0tLS1CRUdJTiBDRVJUSUZJQ0F... ①
metadata:
  annotations:
    strimzi.io/ca-cert-generation: "0" ②
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
    name: my-cluster-cluster-ca-cert
  #...
type: Opaque
```

① Current base64-encoded CA certificate

② Current CA certificate generation annotation value

## 2. Encode your new CA certificate into base64.

```
cat <path_to_new_certificate> | base64
```

## 3. Update the CA certificate.

Copy the base64-encoded CA certificate from the previous step as the value for the **ca.crt** property under **data**.

## 4. Increase the value of the CA certificate generation annotation.

Update the **strimzi.io/ca-cert-generation** annotation with a higher incremental value. For example, change **strimzi.io/ca-cert-generation=0** to **strimzi.io/ca-cert-generation=1**. If the **Secret** is missing the annotation, the value is treated as **0**, so add the annotation with a value of **1**.

When Strimzi generates certificates, the certificate generation annotation is automatically incremented by the Cluster Operator. For manual renewal of your own CA certificates, set the annotations with a higher incremental value. The annotation needs a higher value than the one from the current secret so that the Cluster Operator can roll the pods and update the certificates. The `strimzi.io/ca-cert-generation` has to be incremented on each CA certificate renewal.

5. Save the secret with the new CA certificate and certificate generation annotation value.

*Example secret configuration updated with a new CA certificate*

```
apiVersion: v1
kind: Secret
data:
  ca.crt: GCa6LS3RTheKFfFDGBOUDYFAZ0F... ①
metadata:
  annotations:
    strimzi.io/ca-cert-generation: "1" ②
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
  name: my-cluster-cluster-ca-cert
  #...
type: Opaque
```

① New base64-encoded CA certificate

② New CA certificate generation annotation value

On the next reconciliation, the Cluster Operator performs a rolling update of ZooKeeper, Kafka, and other components to trust the new CA certificate.

If maintenance time windows are configured, the Cluster Operator will roll the pods at the first reconciliation within the next maintenance time window.

### 9.3.6. Replacing private keys used by your own CA certificates

This procedure describes how to renew CA certificates and private keys that you are using instead of the certificates and keys generated by the Cluster Operator.

**Perform the steps in this procedure when you are also changing the corresponding CA keys. Otherwise, perform the steps to [renew your own CA certificates](#).**

If you are using your own certificates, the Cluster Operator will not renew them automatically. Therefore, it is important that you follow this procedure during the renewal period of the certificate in order to replace CA certificates that will soon expire.

The procedure describes the renewal of CA certificates in PEM format.

Before going through the following steps, make sure that the CN (Common Name) of the new CA certificate is different from the current one. For example, when the Cluster Operator renews

certificates automatically it adds a `v<version_number>` suffix to identify a version. Do the same with your own CA certificate by adding a different suffix on each renewal. By using a different key to generate a new CA certificate, you retain the current CA certificate stored in the `Secret`.

#### Prerequisites

- The Cluster Operator is running.
- Your own CA certificates and private keys are installed.
- You have new cluster or clients X.509 certificates and keys in PEM format.

#### Procedure

1. Pause the reconciliation of the `Kafka` custom resource.
  - a. Annotate the custom resource in Kubernetes, setting the `pause-reconciliation` annotation to `true`:

```
kubectl annotate Kafka <name_of_custom_resource> strimzi.io/pause-reconciliation="true"
```

For example, for a `Kafka` custom resource named `my-cluster`:

```
kubectl annotate Kafka my-cluster strimzi.io/pause-reconciliation="true"
```

- b. Check that the status conditions of the custom resource show a change to `ReconciliationPaused`:

```
kubectl describe Kafka <name_of_custom_resource>
```

The `type` condition changes to `ReconciliationPaused` at the `lastTransitionTime`.

2. Update the `Secret` for the CA certificate.
  - a. Edit the existing secret to add the new CA certificate and update the certificate generation annotation value.

```
kubectl edit secret <ca_certificate_secret_name>
```

`<ca_certificate_secret_name>` is the name of the `Secret`, which is `KAFKA-CLUSTER-NAME-cluster-ca-cert` for the cluster CA certificate and `KAFKA-CLUSTER-NAME-clients-ca-cert` for the clients CA certificate.

The following example shows a secret for a cluster CA certificate that's associated with a Kafka cluster named `my-cluster`.

*Example secret configuration for a cluster CA certificate*

```
apiVersion: v1
```

```
kind: Secret
data:
  ca.crt: LS0tLS1CRUdJTiBDRVJUSUZJQ0F... ①
metadata:
  annotations:
    strimzi.io/ca-cert-generation: "0" ②
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
  name: my-cluster-cluster-ca-cert
  #...
type: Opaque
```

① Current base64-encoded CA certificate

② Current CA certificate generation annotation value

- b. Rename the current CA certificate to retain it.

Rename the current `ca.crt` property under `data` as `ca-<date>.crt`, where `<date>` is the certificate expiry date in the format `YEAR-MONTH-DAYTHOUR-MINUTE-SECONDZ`. For example `ca-2022-01-26T17-32-00Z.crt`:. Leave the value for the property as it is to retain the current CA certificate.

- c. Encode your new CA certificate into base64.

```
cat <path_to_new_certificate> | base64
```

- d. Update the CA certificate.

Create a new `ca.crt` property under `data` and copy the base64-encoded CA certificate from the previous step as the value for `ca.crt` property.

- e. Increase the value of the CA certificate generation annotation.

Update the `strimzi.io/ca-cert-generation` annotation with a higher incremental value. For example, change `strimzi.io/ca-cert-generation=0` to `strimzi.io/ca-cert-generation=1`. If the `Secret` is missing the annotation, the value is treated as `0`, so add the annotation with a value of `1`.

When Strimzi generates certificates, the certificate generation annotation is automatically incremented by the Cluster Operator. For manual renewal of your own CA certificates, set the annotations with a higher incremental value. The annotation needs a higher value than the one from the current secret so that the Cluster Operator can roll the pods and update the certificates. The `strimzi.io/ca-cert-generation` has to be incremented on each CA certificate renewal.

- f. Save the secret with the new CA certificate and certificate generation annotation value.

*Example secret configuration updated with a new CA certificate*

```
apiVersion: v1
kind: Secret
data:
  ca.crt: GCa6LS3RTHeKFiFDGBOUDYFAZ0F... ①
  ca-2022-01-26T17-32-00Z.crt: LS0tLS1CRUdJTiBDRVJUSUZJQ0F... ②
metadata:
  annotations:
    strimzi.io/ca-cert-generation: "1" ③
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
  name: my-cluster-cluster-ca-cert
  #...
type: Opaque
```

- ① New base64-encoded CA certificate
- ② Old base64-encoded CA certificate
- ③ New CA certificate generation annotation value

3. Update the **Secret** for the CA key used to sign your new CA certificate.

a. Edit the existing secret to add the new CA key and update the key generation annotation value.

```
kubectl edit secret <ca_key_name>
```

<*ca\_key\_name*> is the name of CA key, which is <*kafka\_cluster\_name*-cluster-ca for the cluster CA key and <*kafka\_cluster\_name*-clients-ca for the clients CA key.

The following example shows a secret for a cluster CA key that's associated with a Kafka cluster named **my-cluster**.

*Example secret configuration for a cluster CA key*

```
apiVersion: v1
kind: Secret
data:
  ca.key: SA1cKF1GFDz0IiPOIUQBHDNFGDFS... ①
metadata:
  annotations:
    strimzi.io/ca-key-generation: "0" ②
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
  name: my-cluster-cluster-ca
  #...
type: Opaque
```

- ① Current base64-encoded CA key
- ② Current CA key generation annotation value

b. Encode the CA key into base64.

```
cat <path_to_new_key> | base64
```

c. Update the CA key.

Copy the base64-encoded CA key from the previous step as the value for the `ca.key` property under `data`.

d. Increase the value of the CA key generation annotation.

Update the `strimzi.io/ca-key-generation` annotation with a higher incremental value. For example, change `strimzi.io/ca-key-generation=0` to `strimzi.io/ca-key-generation=1`. If the `Secret` is missing the annotation, it is treated as `0`, so add the annotation with a value of `1`.

When Strimzi generates certificates, the key generation annotation is automatically incremented by the Cluster Operator. For manual renewal of your own CA certificates together with a new CA key, set the annotation with a higher incremental value. The annotation needs a higher value than the one from the current secret so that the Cluster Operator can roll the pods and update the certificates and keys. The `strimzi.io/ca-key-generation` has to be incremented on each CA certificate renewal.

4. Save the secret with the new CA key and key generation annotation value.

*Example secret configuration updated with a new CA key*

```
apiVersion: v1
kind: Secret
data:
  ca.key: AB0cKF1GFDz0IiPOIUQWERZJQ0F... ①
metadata:
  annotations:
    strimzi.io/ca-key-generation: "1" ②
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/kind: Kafka
  name: my-cluster-cluster-ca
  #...
type: Opaque
```

① New base64-encoded CA key

② New CA key generation annotation value

5. Resume from the pause.

To resume the `Kafka` custom resource reconciliation, set the `pause-reconciliation` annotation to

false.

```
kubectl annotate --overwrite Kafka <name_of_custom_resource> strimzi.io/pause-reconciliation="false"
```

You can also do the same by removing the pause-reconciliation annotation.

```
kubectl annotate Kafka <name_of_custom_resource> strimzi.io/pause-reconciliation-
```

On the next reconciliation, the Cluster Operator performs a rolling update of ZooKeeper, Kafka, and other components to trust the new CA certificate. When the rolling update is complete, the Cluster Operator will start a new one to generate new server certificates signed by the new CA key.

If maintenance time windows are configured, the Cluster Operator will roll the pods at the first reconciliation within the next maintenance time window.

## 9.4. TLS connections

### 9.4.1. ZooKeeper communication

Communication between the ZooKeeper nodes on all ports, as well as between clients and ZooKeeper, is encrypted using TLS.

Communication between Kafka brokers and ZooKeeper nodes is also encrypted.

### 9.4.2. Kafka inter-broker communication

Communication between Kafka brokers is always encrypted using TLS. The connections between the Kafka controller and brokers use an internal *control plane listener* on port 9090. Replication of data between brokers, as well as internal connections from Strimzi operators, Cruise Control, or the Kafka Exporter use the *replication listener* on port 9091. These internal listeners are not available to Kafka clients.

### 9.4.3. Topic and User Operators

All Operators use encryption for communication with both Kafka and ZooKeeper. In Topic and User Operators, a TLS sidecar is used when communicating with ZooKeeper.

### 9.4.4. Cruise Control

Cruise Control uses encryption for communication with both Kafka and ZooKeeper. A TLS sidecar is used when communicating with ZooKeeper.

### 9.4.5. Kafka Client connections

Encrypted or unencrypted communication between Kafka brokers and clients is configured using the `tls` property for `spec.kafka.listeners`.

## 9.5. Configuring internal clients to trust the cluster CA

This procedure describes how to configure a Kafka client that resides inside the Kubernetes cluster — connecting to a TLS listener — to trust the cluster CA certificate.

The easiest way to achieve this for an internal client is to use a volume mount to access the [Secrets](#) containing the necessary certificates and keys.

Follow the steps to configure trust certificates that are signed by the cluster CA for Java-based Kafka Producer, Consumer, and Streams APIs.

Choose the steps to follow according to the certificate format of the cluster CA: PKCS #12 ([.p12](#)) or PEM ([.crt](#)).

The steps describe how to mount the Cluster Secret that verifies the identity of the Kafka cluster to the client pod.

### Prerequisites

- The Cluster Operator must be running.
- There needs to be a [Kafka](#) resource within the Kubernetes cluster.
- You need a Kafka client application inside the Kubernetes cluster that will connect using TLS, and needs to trust the cluster CA certificate.
- The client application must be running in the same namespace as the [Kafka](#) resource.

### Using PKCS #12 format (.p12)

1. Mount the cluster Secret as a volume when defining the client pod.

For example:

```
kind: Pod
apiVersion: v1
metadata:
  name: client-pod
spec:
  containers:
    - name: client-name
      image: client-name
      volumeMounts:
        - name: secret-volume
          mountPath: /data/p12
      env:
        - name: SECRET_PASSWORD
          valueFrom:
            secretKeyRef:
              name: my-secret
              key: my-password
      volumes:
        - name: secret-volume
```

```
secret:  
  secretName: my-cluster-cluster-ca-cert
```

Here we're mounting the following:

- The PKCS #12 file into an exact path, which can be configured
  - The password into an environment variable, where it can be used for Java configuration
2. Configure the Kafka client with the following properties:
- A security protocol option:
    - `security.protocol: SSL` when using TLS for encryption (with or without TLS authentication).
    - `security.protocol: SASL_SSL` when using SCRAM-SHA authentication over TLS.
  - `ssl.truststore.location` with the truststore location where the certificates were imported.
  - `ssl.truststore.password` with the password for accessing the truststore.
  - `ssl.truststore.type=PKCS12` to identify the truststore type.

*Using PEM format (.crt)*

1. Mount the cluster Secret as a volume when defining the client pod.

For example:

```
kind: Pod  
apiVersion: v1  
metadata:  
  name: client-pod  
spec:  
  containers:  
    - name: client-name  
      image: client-name  
      volumeMounts:  
        - name: secret-volume  
          mountPath: /data/crt  
  volumes:  
    - name: secret-volume  
      secret:  
        secretName: my-cluster-cluster-ca-cert
```

2. Use the extracted certificate to configure TLS connection in clients that use certificates in X.509 format.

## 9.6. Configuring external clients to trust the cluster CA

This procedure describes how to configure a Kafka client that resides outside the Kubernetes cluster – connecting to an `external` listener – to trust the cluster CA certificate. Follow this

procedure when setting up the client and during the renewal period, when the old clients CA certificate is replaced.

Follow the steps to configure trust certificates that are signed by the cluster CA for Java-based Kafka Producer, Consumer, and Streams APIs.

Choose the steps to follow according to the certificate format of the cluster CA: PKCS #12 ([.p12](#)) or PEM ([.crt](#)).

The steps describe how to obtain the certificate from the Cluster Secret that verifies the identity of the Kafka cluster.

**IMPORTANT**

The `<cluster_name>-cluster-ca-cert` secret contains more than one CA certificate during the CA certificate renewal period. Clients must add *all* of them to their truststores.

*Prerequisites*

- The Cluster Operator must be running.
- There needs to be a [Kafka](#) resource within the Kubernetes cluster.
- You need a Kafka client application outside the Kubernetes cluster that will connect using TLS, and needs to trust the cluster CA certificate.

*Using PKCS #12 format (.p12)*

1. Extract the cluster CA certificate and password from the `<cluster_name>-cluster-ca-cert` Secret of the Kafka cluster.

```
kubectl get secret <cluster_name>-cluster-ca-cert -o jsonpath='{.data.ca\.p12}' |  
base64 -d > ca.p12
```

```
kubectl get secret <cluster_name>-cluster-ca-cert -o  
jsonpath='{.data.ca\.password}' | base64 -d > ca.password
```

Replace `<cluster_name>` with the name of the Kafka cluster.

2. Configure the Kafka client with the following properties:
  - A security protocol option:
    - `security.protocol: SSL` when using TLS for encryption (with or without TLS authentication).
    - `security.protocol: SASL_SSL` when using SCRAM-SHA authentication over TLS.
  - `ssl.truststore.location` with the truststore location where the certificates were imported.
  - `ssl.truststore.password` with the password for accessing the truststore. This property can be omitted if it is not needed by the truststore.
  - `ssl.truststore.type=PKCS12` to identify the truststore type.

### Using PEM format (.crt)

1. Extract the cluster CA certificate from the <cluster\_name>-cluster-ca-cert secret of the Kafka cluster.

```
kubectl get secret <cluster_name>-cluster-ca-cert -o jsonpath='{.data.ca\.crt}' |  
base64 -d > ca.crt
```

2. Use the extracted certificate to configure TLS connection in clients that use certificates in X.509 format.

## 9.7. Kafka listener certificates

You can provide your own server certificates and private keys for any listener with TLS encryption enabled. These user-provided certificates are called *Kafka listener certificates*.

Providing Kafka listener certificates allows you to leverage existing security infrastructure, such as your organization's private CA or a public CA. Kafka clients will need to trust the CA which was used to sign the listener certificate.

You must manually renew Kafka listener certificates when needed.

### 9.7.1. Providing your own Kafka listener certificates

This procedure shows how to configure a listener to use your own private key and server certificate, called a [Kafka listener certificate](#).

Your client applications should use the CA public key as a trusted certificate in order to verify the identity of the Kafka broker.

#### Prerequisites

- A Kubernetes cluster.
- The Cluster Operator is running.
- For each listener, a compatible server certificate signed by an external CA.
  - Provide an X.509 certificate in PEM format.
  - Specify the correct Subject Alternative Names (SANS) for each listener. For more information, see [Alternative subjects in server certificates for Kafka listeners](#).
  - You can provide a certificate that includes the whole CA chain in the certificate file.

#### Procedure

1. Create a [Secret](#) containing your private key and server certificate:

```
kubectl create secret generic my-secret --from-file=my-listener-key.key --from  
-file=my-listener-certificate.crt
```

2. Edit the [Kafka](#) resource for your cluster. Configure the listener to use your [Secret](#), certificate file,

and private key file in the `configuration.brokerCertChainAndKey` property.

*Example configuration for a `loadbalancer` external listener with TLS encryption enabled*

```
# ...
listeners:
  - name: plain
    port: 9092
    type: internal
    tls: false
  - name: external
    port: 9094
    type: loadbalancer
    tls: true
    authentication:
      type: tls
    configuration:
      brokerCertChainAndKey:
        secretName: my-secret
        certificate: my-listener-certificate.crt
        key: my-listener-key.key
# ...
```

*Example configuration for a TLS listener*

```
# ...
listeners:
  - name: plain
    port: 9092
    type: internal
    tls: false
  - name: tls
    port: 9093
    type: internal
    tls: true
    authentication:
      type: tls
    configuration:
      brokerCertChainAndKey:
        secretName: my-secret
        certificate: my-listener-certificate.crt
        key: my-listener-key.key
# ...
```

3. Apply the new configuration to create or update the resource:

```
kubectl apply -f kafka.yaml
```

The Cluster Operator starts a rolling update of the Kafka cluster, which updates the

configuration of the listeners.

**NOTE**

A rolling update is also started if you update a Kafka listener certificate in a [Secret](#) that is already used by a TLS or external listener.

*Additional resources*

- [Alternative subjects in server certificates for Kafka listeners](#)
- [GenericKafkaListener schema reference](#)
- [Kafka listener certificates](#)

## 9.7.2. Alternative subjects in server certificates for Kafka listeners

In order to use TLS hostname verification with your own [Kafka listener certificates](#), you must use the correct Subject Alternative Names (SANs) for each listener. The certificate SANs must specify hostnames for:

- All of the Kafka brokers in your cluster
- The Kafka cluster bootstrap service

You can use wildcard certificates if they are supported by your CA.

### TLS listener SAN examples

Use the following examples to help you specify hostnames of the SANs in your certificates for TLS listeners.

#### *Wildcards example*

```
//Kafka brokers
*.<cluster-name>-kafka-brokers
*.<cluster-name>-kafka-brokers.<namespace>.svc

// Bootstrap service
<cluster-name>-kafka-bootstrap
<cluster-name>-kafka-bootstrap.<namespace>.svc
```

#### *Non-wildcards example*

```
// Kafka brokers
<cluster-name>-kafka-0.<cluster-name>-kafka-brokers
<cluster-name>-kafka-0.<cluster-name>-kafka-brokers.<namespace>.svc
<cluster-name>-kafka-1.<cluster-name>-kafka-brokers
<cluster-name>-kafka-1.<cluster-name>-kafka-brokers.<namespace>.svc
# ...

// Bootstrap service
<cluster-name>-kafka-bootstrap
<cluster-name>-kafka-bootstrap.<namespace>.svc
```

## External listener SAN examples

For external listeners which have TLS encryption enabled, the hostnames you need to specify in certificates depends on the external listener [type](#).

*Table 28. SANs for each type of external listener*

External listener type	In the SANs, specify...
<code>Route</code>	Addresses of all Kafka broker <code>Routes</code> and the address of the bootstrap <code>Route</code> .  You can use a matching wildcard name.
<code>loadbalancer</code>	Addresses of all Kafka broker <code>loadbalancers</code> and the bootstrap <code>loadbalancer</code> address.  You can use a matching wildcard name.
<code>NodePort</code>	Addresses of all Kubernetes worker nodes that the Kafka broker pods might be scheduled to.  You can use a matching wildcard name.

### Additional resources

- [Providing your own Kafka listener certificates](#)

# Chapter 10. Managing Strimzi

This chapter covers tasks to maintain a deployment of Strimzi.

## 10.1. Working with custom resources

You can use `kubectl` commands to retrieve information and perform other operations on Strimzi custom resources.

Using `kubectl` with the `status` subresource of a custom resource allows you to get the information about the resource.

### 10.1.1. Performing `kubectl` operations on custom resources

Use `kubectl` commands, such as `get`, `describe`, `edit`, or `delete`, to perform operations on resource types. For example, `kubectl get kafkatopics` retrieves a list of all Kafka topics and `kubectl get kafkas` retrieves all deployed Kafka clusters.

When referencing resource types, you can use both singular and plural names: `kubectl get kafkas` gets the same results as `kubectl get kafka`.

You can also use the *short name* of the resource. Learning short names can save you time when managing Strimzi. The short name for `Kafka` is `k`, so you can also run `kubectl get k` to list all Kafka clusters.

```
kubectl get k

NAME      DESIRED KAFKA REPLICAS  DESIRED ZK REPLICAS
my-cluster  3                      3
```

Table 29. Long and short names for each Strimzi resource

Strimzi resource	Long name	Short name
Kafka	kafka	k
Kafka Topic	kafkatopic	kt
Kafka User	kafkauser	ku
Kafka Connect	kafkaconnect	kc
Kafka Connector	kafkaconnector	kctr
Kafka Mirror Maker	kafkamirrormaker	kmm
Kafka Mirror Maker 2	kafkamirrormaker2	kmm2
Kafka Bridge	kafkabridge	kb
Kafka Rebalance	kafkarebalance	kr

## Resource categories

Categories of custom resources can also be used in `kubectl` commands.

All Strimzi custom resources belong to the category `strimzi`, so you can use `strimzi` to get all the Strimzi resources with one command.

For example, running `kubectl get strimzi` lists all Strimzi custom resources in a given namespace.

```
kubectl get strimzi

NAME                                     DESIRED KAFKA REPLICAS DESIRED ZK REPLICAS
kafka.kafka.strimzi.io/my-cluster         3                      3

NAME                                     PARTITIONS REPLICATION FACTOR
kafkatopic.kafka.strimzi.io/kafka-apps   3                      3

NAME                                     AUTHENTICATION AUTHORIZATION
kafkauser.kafka.strimzi.io/my-user       tls                     simple
```

The `kubectl get strimzi -o name` command returns all resource types and resource names. The `-o name` option fetches the output in the *type/name* format

```
kubectl get strimzi -o name

kafka.kafka.strimzi.io/my-cluster
kafkatopic.kafka.strimzi.io/kafka-apps
kafkauser.kafka.strimzi.io/my-user
```

You can combine this `strimzi` command with other commands. For example, you can pass it into a `kubectl delete` command to delete all resources in a single command.

```
kubectl delete $(kubectl get strimzi -o name)

kafka.kafka.strimzi.io "my-cluster" deleted
kafkatopic.kafka.strimzi.io "kafka-apps" deleted
kafkauser.kafka.strimzi.io "my-user" deleted
```

Deleting all resources in a single operation might be useful, for example, when you are testing new Strimzi features.

## Querying the status of sub-resources

There are other values you can pass to the `-o` option. For example, by using `-o yaml` you get the output in YAML format. Using `-o json` will return it as JSON.

You can see all the options in `kubectl get --help`.

One of the most useful options is the [JSONPath support](#), which allows you to pass JSONPath expressions to query the Kubernetes API. A JSONPath expression can extract or navigate specific parts of any resource.

For example, you can use the JSONPath expression `{.status.listeners[?(@.name=="tls")].bootstrapServers}` to get the bootstrap address from the status of the Kafka custom resource and use it in your Kafka clients.

Here, the command finds the `bootstrapServers` value of the listener named `tls`:

```
kubectl get kafka my-cluster  
-o=jsonpath='{.status.listeners[?(@.name=="tls")].bootstrapServers}{"\n"}'  
  
my-cluster-kafka-bootstrap.myproject.svc:9093
```

By changing the name condition you can also get the address of the other Kafka listeners.

You can use `jsonpath` to extract any other property or group of properties from any custom resource.

### 10.1.2. Strimzi custom resource status information

Several resources have a `status` property, as described in the following table.

*Table 30. Custom resource status properties*

Strimzi resource	Schema reference	Publishes status information on...
Kafka	<a href="#">KafkaStatus schema reference</a>	The Kafka cluster.
KafkaConnect	<a href="#">KafkaConnectStatus schema reference</a>	The Kafka Connect cluster, if deployed.
KafkaConnector	<a href="#">KafkaConnectorStatus schema reference</a>	KafkaConnector resources, if deployed.
KafkaMirrorMaker	<a href="#">KafkaMirrorMakerStatus schema reference</a>	The Kafka MirrorMaker tool, if deployed.
KafkaTopic	<a href="#">KafkaTopicStatus schema reference</a>	Kafka topics in your Kafka cluster.
KafkaUser	<a href="#">KafkaUserStatus schema reference</a>	Kafka users in your Kafka cluster.
KafkaBridge	<a href="#">KafkaBridgeStatus schema reference</a>	The Strimzi Kafka Bridge, if deployed.

The `status` property of a resource provides information on the resource's:

- *Current state*, in the `status.conditions` property
- *Last observed generation*, in the `status.observedGeneration` property

The `status` property also provides resource-specific information. For example:

- `KafkaStatus` provides information on listener addresses, and the id of the Kafka cluster.
- `KafkaConnectStatus` provides the REST API endpoint for Kafka Connect connectors.
- `KafkaUserStatus` provides the user name of the Kafka user and the `Secret` in which their credentials are stored.
- `KafkaBridgeStatus` provides the HTTP address at which external client applications can access the Bridge service.

A resource's *current state* is useful for tracking progress related to the resource achieving its *desired state*, as defined by the `spec` property. The status conditions provide the time and reason the state of the resource changed and details of events preventing or delaying the operator from realizing the resource's desired state.

The *last observed generation* is the generation of the resource that was last reconciled by the Cluster Operator. If the value of `observedGeneration` is different from the value of `metadata.generation`, the operator has not yet processed the latest update to the resource. If these values are the same, the status information reflects the most recent changes to the resource.

Strimzi creates and maintains the status of custom resources, periodically evaluating the current state of the custom resource and updating its status accordingly. When performing an update on a custom resource using `kubectl edit`, for example, its `status` is not editable. Moreover, changing the `status` would not affect the configuration of the Kafka cluster.

Here we see the `status` property specified for a Kafka custom resource.

#### *Kafka custom resource with status*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
spec:
  # ...
status:
  conditions: ①
  - lastTransitionTime: 2021-07-23T23:46:57+0000
    status: "True"
    type: Ready ②
  observedGeneration: 4 ③
  listeners: ④
  - addresses:
    - host: my-cluster-kafka-bootstrap.myproject.svc
      port: 9092
    type: plain
  - addresses:
    - host: my-cluster-kafka-bootstrap.myproject.svc
      port: 9093
    certificates:
    - |
```

```

-----BEGIN CERTIFICATE-----
...
-----END CERTIFICATE-----
type: tls
- addresses:
  - host: 172.29.49.180
    port: 9094
  certificates:
  - |
    -----BEGIN CERTIFICATE-----
    ...
    -----END CERTIFICATE-----
type: external
clusterId: CLUSTER-ID ⑤
# ...

```

- ① Status **conditions** describe criteria related to the status that cannot be deduced from the existing resource information, or are specific to the instance of a resource.
- ② The **Ready** condition indicates whether the Cluster Operator currently considers the Kafka cluster able to handle traffic.
- ③ The **observedGeneration** indicates the generation of the **Kafka** custom resource that was last reconciled by the Cluster Operator.
- ④ The **listeners** describe the current Kafka bootstrap addresses by type.
- ⑤ The Kafka cluster id.

**IMPORTANT**

The address in the custom resource status for external listeners with type **nodeport** is currently not supported.

**NOTE**

The Kafka bootstrap addresses listed in the status do not signify that those endpoints or the Kafka cluster is in a ready state.

#### *Accessing status information*

You can access status information for a resource from the command line. For more information, see [Finding the status of a custom resource](#).

### 10.1.3. Finding the status of a custom resource

This procedure describes how to find the status of a custom resource.

#### *Prerequisites*

- A Kubernetes cluster.
- The Cluster Operator is running.

#### *Procedure*

- Specify the custom resource and use the **-o jsonpath** option to apply a standard JSONPath expression to select the **status** property:

```
kubectl get kafka <kafka_resource_name> -o jsonpath='{.status}'
```

This expression returns all the status information for the specified custom resource. You can use dot notation, such as `status.listeners` or `status.observedGeneration`, to fine-tune the status information you wish to see.

#### *Additional resources*

- [Strimzi custom resource status information](#)
- For more information about using JSONPath, see [JSONPath support](#).

## 10.2. Pausing reconciliation of custom resources

Sometimes it is useful to pause the reconciliation of custom resources managed by Strimzi Operators, so that you can perform fixes or make updates. If reconciliations are paused, any changes made to custom resources are ignored by the Operators until the pause ends.

If you want to pause reconciliation of a custom resource, set the `strimzi.io/pause-reconciliation` annotation to `true` in its configuration. This instructs the appropriate Operator to pause reconciliation of the custom resource. For example, you can apply the annotation to the `KafkaConnect` resource so that reconciliation by the Cluster Operator is paused.

You can also create a custom resource with the pause annotation enabled. The custom resource is created, but it is ignored.

#### *Prerequisites*

- The Strimzi Operator that manages the custom resource is running.

#### *Procedure*

1. Annotate the custom resource in Kubernetes, setting `pause-reconciliation` to `true`:

```
kubectl annotate <kind_of_custom_resource> <name_of_custom_resource>  
strimzi.io/pause-reconciliation="true"
```

For example, for the `KafkaConnect` custom resource:

```
kubectl annotate KafkaConnect my-connect strimzi.io/pause-reconciliation="true"
```

2. Check that the status conditions of the custom resource show a change to `ReconciliationPaused`:

```
kubectl describe <kind_of_custom_resource> <name_of_custom_resource>
```

The `type` condition changes to `ReconciliationPaused` at the `lastTransitionTime`.

*Example custom resource with a paused reconciliation condition type*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  annotations:
    strimzi.io/pause-reconciliation: "true"
    strimzi.io/use-connector-resources: "true"
  creationTimestamp: 2021-03-12T10:47:11Z
  #...
spec:
  # ...
status:
  conditions:
  - lastTransitionTime: 2021-03-12T10:47:41.689249Z
    status: "True"
    type: ReconciliationPaused
```

*Resuming from pause*

- To resume reconciliation, you can set the annotation to `false`, or remove the annotation.

*Additional resources*

- [Customizing Kubernetes resources](#)
- [Finding the status of a custom resource](#)

## 10.3. Evicting pods with Strimzi Drain Cleaner

Kafka and ZooKeeper pods might be evicted during Kubernetes upgrades, maintenance or pod rescheduling. If your Kafka broker and ZooKeeper pods were deployed by Strimzi, you can use the Strimzi Drain Cleaner tool to handle the pod evictions. Since the Strimzi Drain Cleaner will handle the eviction instead of Kubernetes, you need to set the `podDisruptionBudget` for your Kafka deployment to `0` (zero). Kubernetes will then no longer be allowed to evict the pod automatically.

By deploying the Strimzi Drain Cleaner, you can use the Cluster Operator to move Kafka pods instead of Kubernetes. The Cluster Operator ensures that topics are never under-replicated. Kafka can remain operational during the eviction process. The Cluster Operator waits for topics to synchronize, as the Kubernetes worker nodes drain consecutively.

An admission webhook notifies the Strimzi Drain Cleaner of pod eviction requests to the Kubernetes API. The Strimzi Drain Cleaner then adds a rolling update annotation to the pods to be drained. This informs the Cluster Operator to perform a rolling update of an evicted pod.

**NOTE**

If you are not using the Strimzi Drain Cleaner, you can [add pod annotations to perform rolling updates manually](#).

*Webhook configuration*

The Strimzi Drain Cleaner deployment files include a `ValidatingWebhookConfiguration` resource file. The resource provides the configuration for registering the webhook with the Kubernetes API.

The configuration defines the `rules` for the Kubernetes API to follow in the event of a pod eviction request. The rules specify that only `CREATE` operations related to `pods/eviction` sub-resources are intercepted. If these rules are met, the API forwards the notification.

The `clientConfig` points to the Strimzi Drain Cleaner service and `/drainer` endpoint that exposes the webhook. The webhook uses a secure TLS connection, which requires authentication. The `caBundle` property specifies the certificate chain to validate HTTPS communication. Certificates are encoded in Base64.

#### *Webhook configuration for pod eviction notifications*

```
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
# ...
webhooks:
- name: strimzi-drain-cleaner.strimzi.io
  rules:
    - apiGroups: [""]
      apiVersions: ["v1"]
      operations: ["CREATE"]
      resources: ["pods/eviction"]
      scope: "Namespaced"
  clientConfig:
    service:
      namespace: "strimzi-drain-cleaner"
      name: "strimzi-drain-cleaner"
      path: /drainer
      port: 443
      caBundle: Cg==
# ...
```

### 10.3.1. Prerequisites

To deploy and use the Strimzi Drain Cleaner, you need to download the deployment files.

The Strimzi Drain Cleaner deployment files are available from the [GitHub releases page](#).

### 10.3.2. Deploying the Strimzi Drain Cleaner

Deploy the Strimzi Drain Cleaner to the Kubernetes cluster where the Cluster Operator and Kafka cluster are running.

#### *Prerequisites*

- You have [downloaded the Strimzi Drain Cleaner deployment files](#).
- You have a highly available Kafka cluster deployment running with Kubernetes worker nodes that you would like to update.
- Topics are replicated for high availability.

Topic configuration specifies a replication factor of at least 3 and a minimum number of in-sync

replicas to 1 less than the replication factor.

#### *Kafka topic replicated for high availability*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: my-topic
  labels:
    strimzi.io/cluster: my-cluster
spec:
  partitions: 1
  replicas: 3
  config:
    # ...
    min.insync.replicas: 2
    # ...
```

#### *Excluding ZooKeeper*

If you don't want to include ZooKeeper, you can remove the `--zookeeper` command option from the Strimzi Drain Cleaner [Deployment](#) configuration file.

```
apiVersion: apps/v1
kind: Deployment
spec:
  # ...
  template:
    spec:
      serviceAccountName: strimzi-drain-cleaner
      containers:
        - name: strimzi-drain-cleaner
          # ...
          command:
            - "/application"
            - "-Dquarkus.http.host=0.0.0.0"
            - "--kafka"
            - "--zookeeper" ①
          # ...
```

① Remove this option to exclude ZooKeeper from Strimzi Drain Cleaner operations.

#### *Procedure*

1. Configure a pod disruption budget of **0** (zero) for your Kafka deployment using `template` settings in the [Kafka](#) resource.

#### *Specifying a pod disruption budget*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
```

```
metadata:  
  name: my-cluster  
  namespace: myproject  
spec:  
  kafka:  
    template:  
      podDisruptionBudget:  
        maxUnavailable: 0  
  
    # ...  
  zookeeper:  
    template:  
      podDisruptionBudget:  
        maxUnavailable: 0  
    # ...
```

Reducing the maximum pod disruption budget to zero prevents Kubernetes from automatically evicting the pods in case of voluntary disruptions, leaving the Strimzi Drain Cleaner and Strimzi Cluster Operator to roll the pod which will be scheduled by Kubernetes on a different worker node.

Add the same configuration for ZooKeeper if you want to use Strimzi Drain Cleaner to drain ZooKeeper nodes.

## 2. Update the **Kafka** resource:

```
kubectl apply -f <kafka-configuration-file>
```

## 3. Deploy the Strimzi Drain Cleaner.

You can use **cert-manager** in the deployment process.

- If you are using **cert-manager** with Kubernetes, apply the resources in the [/install/drain-cleaner/certmanager](#) directory.

```
kubectl apply -f ./install/drain-cleaner/certmanager
```

The TLS certificates for the webhook are generated automatically and injected into the webhook configuration.

- If you are not using **cert-manager** with Kubernetes, apply the resources in the [/install/drain-cleaner/kubernetes](#) directory.

```
kubectl apply -f ./install/drain-cleaner/kubernetes
```

The resources are configured with TLS certificates that have already been generated. Use these certificates if you are not changing any configuration for the Strimzi Drain Cleaner,

such as namespaces, service names, or pod names. Otherwise, you can generate and use your own certificates.

**NOTE**

You can use the build script and files provided in [webhook-certificates](#) to generate your own certificates. The script uses the [CFSSL](#) and [openSSL](#) tools to generate the certificates. After you have generated the certificates, you need to add them to the [040-Secret.yaml](#) and [070-ValidatingWebhookConfiguration.yaml](#) files.

- To run the Drain Cleaner on OpenShift, apply the resources in the [/install/drain-cleaner/openshift](#) directory.

```
kubectl apply -f ./install/drain-cleaner/openshift
```

### 10.3.3. Using the Strimzi Drain Cleaner

Use the Strimzi Drain Cleaner in combination with the Cluster Operator to move Kafka broker or ZooKeeper pods from nodes that are being drained. When you run the Strimzi Drain Cleaner, it annotates pods with a rolling update pod annotation. The Cluster Operator performs rolling updates based on the annotation.

#### *Prerequisites*

- You have [deployed the Strimzi Drain Cleaner](#).

#### *Procedure*

1. Drain a specified Kubernetes node hosting the Kafka broker or ZooKeeper pods.

```
kubectl get nodes  
kubectl drain <name-of-node> --delete-emptydir-data --ignore-daemonsets  
--timeout=600s --force
```

2. Check the eviction events in the Strimzi Drain Cleaner log to verify that the pods have been annotated for restart.

#### *Strimzi Drain Cleaner log show annotations of pods*

```
INFO ... Received eviction webhook for Pod my-cluster-zookeeper-2 in namespace my-project  
INFO ... Pod my-cluster-zookeeper-2 in namespace my-project will be annotated for restart  
INFO ... Pod my-cluster-zookeeper-2 in namespace my-project found and annotated for restart  
  
INFO ... Received eviction webhook for Pod my-cluster-kafka-0 in namespace my-project  
INFO ... Pod my-cluster-kafka-0 in namespace my-project will be annotated for restart
```

```
INFO ... Pod my-cluster-kafka-0 in namespace my-project found and annotated for restart
```

3. Check the reconciliation events in the Cluster Operator log to verify the rolling updates.

*Cluster Operator log shows rolling updates*

```
INFO PodOperator:68 - Reconciliation #13(timer) Kafka(my-project/my-cluster): Rolling Pod my-cluster-zookeeper-2
INFO PodOperator:68 - Reconciliation #13(timer) Kafka(my-project/my-cluster): Rolling Pod my-cluster-kafka-0
INFO AbstractOperator:500 - Reconciliation #13(timer) Kafka(my-project/my-cluster): reconciled
```

## 10.4. Manually starting rolling updates of Kafka and ZooKeeper clusters

Strimzi supports the use of annotations on resources to manually trigger a rolling update of Kafka and ZooKeeper clusters through the Cluster Operator. Rolling updates restart the pods of the resource with new ones.

Manually performing a rolling update on a specific pod or set of pods is usually only required in exceptional circumstances. However, rather than deleting the pods directly, if you perform the rolling update through the Cluster Operator you ensure the following:

- The manual deletion of the pod does not conflict with simultaneous Cluster Operator operations, such as deleting other pods in parallel.
- The Cluster Operator logic handles the Kafka configuration specifications, such as the number of in-sync replicas.

### 10.4.1. Prerequisites

To perform a manual rolling update, you need a running Cluster Operator and Kafka cluster.

See the *Deploying and Upgrading Strimzi* guide for instructions on running a:

- [Cluster Operator](#)
- [Kafka cluster](#)

### 10.4.2. Performing a rolling update using a pod management annotation

This procedure describes how to trigger a rolling update of a Kafka cluster or ZooKeeper cluster.

To trigger the update, you add an annotation to the resource you are using to manage the pods running on the cluster. You annotate the [StatefulSet](#) or [StrimziPodSet](#) resource (if you enabled the [UseStrimziPodSets feature gate](#)).

#### *Procedure*

1. Find the name of the resource that controls the Kafka or ZooKeeper pods you want to manually update.

For example, if your Kafka cluster is named *my-cluster*, the corresponding names are *my-cluster-kafka* and *my-cluster-zookeeper*.

2. Use `kubectl annotate` to annotate the appropriate resource in Kubernetes.

#### *Annotating a StatefulSet*

```
kubectl annotate statefulset <cluster_name>-kafka strimzi.io/manual-rolling-
update=true

kubectl annotate statefulset <cluster_name>-zookeeper strimzi.io/manual-rolling-
update=true
```

#### *Annotating a StrimziPodSet*

```
kubectl annotate strimzipodset <cluster_name>-kafka strimzi.io/manual-rolling-
update=true

kubectl annotate strimzipodset <cluster_name>-zookeeper strimzi.io/manual-rolling-
update=true
```

3. Wait for the next reconciliation to occur (every two minutes by default). A rolling update of all pods within the annotated resource is triggered, as long as the annotation was detected by the reconciliation process. When the rolling update of all the pods is complete, the annotation is removed from the resource.

### **10.4.3. Performing a rolling update using a Pod annotation**

This procedure describes how to manually trigger a rolling update of an existing Kafka cluster or ZooKeeper cluster using a Kubernetes `Pod` annotation. When multiple pods are annotated, consecutive rolling updates are performed within the same reconciliation run.

#### *Prerequisites*

You can perform a rolling update on a Kafka cluster regardless of the topic replication factor used. But for Kafka to stay operational during the update, you'll need the following:

- A highly available Kafka cluster deployment running with nodes that you wish to update.
- Topics replicated for high availability.

Topic configuration specifies a replication factor of at least 3 and a minimum number of in-sync replicas to 1 less than the replication factor.

#### *Kafka topic replicated for high availability*

```
apiVersion: kafka.strimzi.io/v1beta2
```

```
kind: KafkaTopic
metadata:
  name: my-topic
  labels:
    strimzi.io/cluster: my-cluster
spec:
  partitions: 1
  replicas: 3
  config:
    # ...
    min.insync.replicas: 2
    # ...
```

#### Procedure

1. Find the name of the Kafka or ZooKeeper **Pod** you want to manually update.

For example, if your Kafka cluster is named *my-cluster*, the corresponding **Pod** names are *my-cluster-kafka-index* and *my-cluster-zookeeper-index*. The *index* starts at zero and ends at the total number of replicas minus one.

2. Annotate the **Pod** resource in Kubernetes.

Use `kubectl annotate`:

```
kubectl annotate pod cluster-name-kafka-index strimzi.io/manual-rolling-update=true

kubectl annotate pod cluster-name-zookeeper-index strimzi.io/manual-rolling-
update=true
```

3. Wait for the next reconciliation to occur (every two minutes by default). A rolling update of the annotated **Pod** is triggered, as long as the annotation was detected by the reconciliation process. When the rolling update of a pod is complete, the annotation is removed from the **Pod**.

## 10.5. Discovering services using labels and annotations

Service discovery makes it easier for client applications running in the same Kubernetes cluster as Strimzi to interact with a Kafka cluster.

A *service discovery* label and annotation is generated for services used to access the Kafka cluster:

- Internal Kafka bootstrap service
- HTTP Bridge service

The label helps to make the service discoverable, and the annotation provides connection details that a client application can use to make the connection.

The service discovery label, `strimzi.io/discovery`, is set as `true` for the **Service** resources. The service discovery annotation has the same key, providing connection details in JSON format for

each service.

## Example internal Kafka bootstrap service

```
apiVersion: v1
kind: Service
metadata:
  annotations:
    strimzi.io/discovery: |-
      [ {
        "port" : 9092,
        "tls" : false,
        "protocol" : "kafka",
        "auth" : "scram-sha-512"
      }, {
        "port" : 9093,
        "tls" : true,
        "protocol" : "kafka",
        "auth" : "tls"
      } ]
  labels:
    strimzi.io/cluster: my-cluster
    strimzi.io/discovery: "true"
    strimzi.io/kind: Kafka
    strimzi.io/name: my-cluster-kafka-bootstrap
  name: my-cluster-kafka-bootstrap
spec:
  #...
```

## Example HTTP Bridge service

```
apiVersion: v1
kind: Service
metadata:
  annotations:
    strimzi.io/discovery: |-
      [ {
        "port" : 8080,
        "tls" : false,
        "auth" : "none",
        "protocol" : "http"
      } ]
  labels:
    strimzi.io/cluster: my-bridge
    strimzi.io/discovery: "true"
    strimzi.io/kind: KafkaBridge
    strimzi.io/name: my-bridge-bridge-service
```

### 10.5.1. Returning connection details on services

You can find the services by specifying the discovery label when fetching services from the command line or a corresponding API call.

```
kubectl get service -l strimzi.io/discovery=true
```

The connection details are returned when retrieving the service discovery label.

## 10.6. Recovering a cluster from persistent volumes

You can recover a Kafka cluster from persistent volumes (PVs) if they are still present.

You might want to do this, for example, after:

- A namespace was deleted unintentionally
- A whole Kubernetes cluster is lost, but the PVs remain in the infrastructure

### 10.6.1. Recovery from namespace deletion

Recovery from namespace deletion is possible because of the relationship between persistent volumes and namespaces. A **PersistentVolume** (PV) is a storage resource that lives outside of a namespace. A PV is mounted into a Kafka pod using a **PersistentVolumeClaim** (PVC), which lives inside a namespace.

The reclaim policy for a PV tells a cluster how to act when a namespace is deleted. If the reclaim policy is set as:

- *Delete* (default), PVs are deleted when PVCs are deleted within a namespace
- *Retain*, PVs are not deleted when a namespace is deleted

To ensure that you can recover from a PV if a namespace is deleted unintentionally, the policy must be reset from *Delete* to *Retain* in the PV specification using the **persistentVolumeReclaimPolicy** property:

```
apiVersion: v1
kind: PersistentVolume
# ...
spec:
  # ...
  persistentVolumeReclaimPolicy: Retain
```

Alternatively, PVs can inherit the reclaim policy of an associated storage class. Storage classes are used for dynamic volume allocation.

By configuring the **reclaimPolicy** property for the storage class, PVs that use the storage class are created with the appropriate reclaim policy. The storage class is configured for the PV using the

`storageClassName` property.

```
apiVersion: v1
kind: StorageClass
metadata:
  name: gp2-retain
parameters:
  # ...
# ...
reclaimPolicy: Retain
```

```
apiVersion: v1
kind: PersistentVolume
# ...
spec:
  # ...
storageClassName: gp2-retain
```

**NOTE** If you are using *Retain* as the reclaim policy, but you want to delete an entire cluster, you need to delete the PVs manually. Otherwise they will not be deleted, and may cause unnecessary expenditure on resources.

### 10.6.2. Recovery from loss of a Kubernetes cluster

When a cluster is lost, you can use the data from disks/volumes to recover the cluster if they were preserved within the infrastructure. The recovery procedure is the same as with namespace deletion, assuming PVs can be recovered and they were created manually.

### 10.6.3. Recovering a deleted cluster from persistent volumes

This procedure describes how to recover a deleted cluster from persistent volumes (PVs).

In this situation, the Topic Operator identifies that topics exist in Kafka, but the [KafkaTopic](#) resources do not exist.

When you get to the step to recreate your cluster, you have two options:

1. Use *Option 1* when you can recover all [KafkaTopic](#) resources.

The [KafkaTopic](#) resources must therefore be recovered before the cluster is started so that the corresponding topics are not deleted by the Topic Operator.

2. Use *Option 2* when you are unable to recover all [KafkaTopic](#) resources.

In this case, you deploy your cluster without the Topic Operator, delete the Topic Operator topic store metadata, and then redeploy the Kafka cluster with the Topic Operator so it can recreate the [KafkaTopic](#) resources from the corresponding topics.

**NOTE** If the Topic Operator is not deployed, you only need to recover the **PersistentVolumeClaim** (PVC) resources.

### Before you begin

In this procedure, it is essential that PVs are mounted into the correct PVC to avoid data corruption. A **volumeName** is specified for the PVC and this must match the name of the PV.

For more information, see:

- [Persistent Volume Claim naming](#)
- [JBOD and Persistent Volume Claims](#)

**NOTE** The procedure does not include recovery of **KafkaUser** resources, which must be recreated manually. If passwords and certificates need to be retained, secrets must be recreated before creating the **KafkaUser** resources.

### Procedure

1. Check information on the PVs in the cluster:

```
kubectl get pv
```

Information is presented for PVs with data.

Example output showing columns important to this procedure:

NAME	RECLAIMPOLICY	CLAIM
pvc-5e9c5c7f-3317-11ea-a650-06e1eadd9a4c	... Retain ...	myproject/data-my-cluster-zookeeper-1
pvc-5e9cc72d-3317-11ea-97b0-0aef8816c7ea	... Retain ...	myproject/data-my-cluster-zookeeper-0
pvc-5ead43d1-3317-11ea-97b0-0aef8816c7ea	... Retain ...	myproject/data-my-cluster-zookeeper-2
pvc-7e1f67f9-3317-11ea-a650-06e1eadd9a4c	... Retain ...	myproject/data-0-my-cluster-kafka-0
pvc-7e21042e-3317-11ea-9786-02deaf9aa87e	... Retain ...	myproject/data-0-my-cluster-kafka-1
pvc-7e226978-3317-11ea-97b0-0aef8816c7ea	... Retain ...	myproject/data-0-my-cluster-kafka-2

- *NAME* shows the name of each PV.
- *RECLAIM POLICY* shows that PVs are *retained*.
- *CLAIM* shows the link to the original PVCs.

2. Recreate the original namespace:

```
kubectl create namespace myproject
```

3. Recreate the original PVC resource specifications, linking the PVCs to the appropriate PV:

For example:

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: data-0-my-cluster-kafka-0
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 100Gi
  storageClassName: gp2-retain
  volumeMode: Filesystem
  volumeName: pvc-7e1f67f9-3317-11ea-a650-06e1eadd9a4c
```

4. Edit the PV specifications to delete the **claimRef** properties that bound the original PVC.

For example:

```
apiVersion: v1
kind: PersistentVolume
metadata:
  annotations:
    kubernetes.io/createdby: aws-ebs-dynamic-provisioner
    pv.kubernetes.io/bound-by-controller: "yes"
    pv.kubernetes.io/provisioned-by: kubernetes.io/aws-ebs
  creationTimestamp: "<date>"
  finalizers:
    - kubernetes.io/pv-protection
  labels:
    failure-domain.beta.kubernetes.io/region: eu-west-1
    failure-domain.beta.kubernetes.io/zone: eu-west-1c
  name: pvc-7e226978-3317-11ea-97b0-0aef8816c7ea
  resourceVersion: "39431"
  selfLink: /api/v1/persistentvolumes/pvc-7e226978-3317-11ea-97b0-0aef8816c7ea
  uid: 7efe6b0d-3317-11ea-a650-06e1eadd9a4c
spec:
  accessModes:
    - ReadWriteOnce
  awsElasticBlockStore:
    fsType: xfs
    volumeID: aws://eu-west-1c/vol-09db3141656d1c258
  capacity:
```

```
storage: 100Gi
claimRef:
  apiVersion: v1
  kind: PersistentVolumeClaim
  name: data-0-my-cluster-kafka-2
  namespace: myproject
  resourceVersion: "39113"
  uid: 54be1c60-3319-11ea-97b0-0aef8816c7ea
nodeAffinity:
  required:
    nodeSelectorTerms:
      - matchExpressions:
          - key: failure-domain.beta.kubernetes.io/zone
            operator: In
            values:
              - eu-west-1c
          - key: failure-domain.beta.kubernetes.io/region
            operator: In
            values:
              - eu-west-1
persistentVolumeReclaimPolicy: Retain
storageClassName: gp2-retain
volumeMode: Filesystem
```

In the example, the following properties are deleted:

```
claimRef:
  apiVersion: v1
  kind: PersistentVolumeClaim
  name: data-0-my-cluster-kafka-2
  namespace: myproject
  resourceVersion: "39113"
  uid: 54be1c60-3319-11ea-97b0-0aef8816c7ea
```

## 5. Deploy the Cluster Operator.

```
kubectl create -f install/cluster-operator -n my-project
```

## 6. Recreate your cluster.

Follow the steps depending on whether or not you have all the **KafkaTopic** resources needed to recreate your cluster.

**Option 1:** If you have **all** the **KafkaTopic** resources that existed before you lost your cluster, including internal topics such as committed offsets from **\_consumer\_offsets**:

1. Recreate all **KafkaTopic** resources.

It is essential that you recreate the resources before deploying the cluster, or the Topic Operator will delete the topics.

2. Deploy the Kafka cluster.

For example:

```
kubectl apply -f kafka.yaml
```

**Option 2:** If you do not have all the `KafkaTopic` resources that existed before you lost your cluster:

1. Deploy the Kafka cluster, as with the first option, but without the Topic Operator by removing the `topicOperator` property from the Kafka resource before deploying.

If you include the Topic Operator in the deployment, the Topic Operator will delete all the topics.

2. Delete the internal topic store topics from the Kafka cluster:

```
kubectl run kafka-admin -ti --image=quay.io/stimzi/kafka:0.32.0-kafka-3.3.1
--rm=true --restart=Never -- ./bin/kafka-topics.sh --bootstrap-server
localhost:9092 --topic __stimzi-topic-operator-kstreams-topic-store-changelog
--delete && ./bin/kafka-topics.sh --bootstrap-server localhost:9092 --topic
__stimzi_store_topic --delete
```

The command must correspond to the type of listener and authentication used to access the Kafka cluster.

3. Enable the Topic Operator by redeploying the Kafka cluster with the `topicOperator` property to recreate the `KafkaTopic` resources.

For example:

```
apiVersion: kafka.stimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  #...
  entityOperator:
    topicOperator: {} ①
  #...
```

① Here we show the default configuration, which has no additional properties. You specify the required configuration using the properties described in [EntityTopicOperatorSpec schema reference](#).

7. Verify the recovery by listing the **KafkaTopic** resources:

```
kubectl get KafkaTopic
```

## 10.7. Setting limits on brokers using the Kafka Static Quota plugin

Use the *Kafka Static Quota* plugin to set throughput and storage limits on brokers in your Kafka cluster. You enable the plugin and set limits by configuring the **Kafka** resource. You can set a byte-rate threshold and storage quotas to put limits on the clients interacting with your brokers.

You can set byte-rate thresholds for producer and consumer bandwidth. The total limit is distributed across all clients accessing the broker. For example, you can set a byte-rate threshold of 40 MBps for producers. If two producers are running, they are each limited to a throughput of 20 MBps.

Storage quotas throttle Kafka disk storage limits between a soft limit and hard limit. The limits apply to all available disk space. Producers are slowed gradually between the soft and hard limit. The limits prevent disks filling up too quickly and exceeding their capacity. Full disks can lead to issues that are hard to rectify. The hard limit is the maximum storage limit.

**NOTE** For JBOD storage, the limit applies across all disks. If a broker is using two 1 TB disks and the quota is 1.1 TB, one disk might fill and the other disk will be almost empty.

### Prerequisites

- The Cluster Operator that manages the Kafka cluster is running.

### Procedure

1. Add the plugin properties to the **config** of the **Kafka** resource.

The plugin properties are shown in this example configuration.

#### Example Kafka Static Quota plugin configuration

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    config:
      client.quota.callback.class: io.strimzi.kafka.quotas.StaticQuotaCallback ①
      client.quota.callback.static.produce: 1000000 ②
      client.quota.callback.static.fetch: 1000000 ③
      client.quota.callback.static.storage.soft: 400000000000 ④
```

```
client.quota.callback.static.storage.hard: 5000000000000 ⑤
client.quota.callback.static.storage.check-interval: 5 ⑥
```

- ① Loads the Kafka Static Quota plugin.
- ② Sets the producer byte-rate threshold. 1 MBps in this example.
- ③ Sets the consumer byte-rate threshold. 1 MBps in this example.
- ④ Sets the lower soft limit for storage. 400 GB in this example.
- ⑤ Sets the higher hard limit for storage. 500 GB in this example.
- ⑥ Sets the interval in seconds between checks on storage. 5 seconds in this example. You can set this to 0 to disable the check.

## 2. Update the resource.

```
kubectl apply -f <kafka_configuration_file>
```

### *Additional resources*

- [Setting user quotas](#)

## 10.8. Frequently asked questions

### 10.8.1. Questions related to the Cluster Operator

#### **Why do I need cluster administrator privileges to install Strimzi?**

To install Strimzi, you need to be able to create the following cluster-scoped resources:

- Custom Resource Definitions (CRDs) to instruct Kubernetes about resources that are specific to Strimzi, such as [Kafka](#) and [KafkaConnect](#)
- [ClusterRoles](#) and [ClusterRoleBindings](#)

Cluster-scoped resources, which are not scoped to a particular Kubernetes namespace, typically require *cluster administrator* privileges to install.

As a cluster administrator, you can inspect all the resources being installed (in the [/install/](#) directory) to ensure that the [ClusterRoles](#) do not grant unnecessary privileges.

After installation, the Cluster Operator runs as a regular [Deployment](#), so any standard (non-admin) Kubernetes user with privileges to access the [Deployment](#) can configure it. The cluster administrator can grant standard users the privileges necessary to manage [Kafka](#) custom resources.

See also:

- [Why does the Cluster Operator need to create ClusterRoleBindings?](#)
- [Can standard Kubernetes users create Kafka custom resources?](#)

## Why does the Cluster Operator need to create `ClusterRoleBindings`?

Kubernetes has built-in [privilege escalation prevention](#), which means that the Cluster Operator cannot grant privileges it does not have itself, specifically, it cannot grant such privileges in a namespace it cannot access. Therefore, the Cluster Operator must have the privileges necessary for *all* the components it orchestrates.

The Cluster Operator needs to be able to grant access so that:

- The Topic Operator can manage `KafkaTopics`, by creating `Roles` and `RoleBindings` in the namespace that the operator runs in
- The User Operator can manage `KafkaUsers`, by creating `Roles` and `RoleBindings` in the namespace that the operator runs in
- The failure domain of a `Node` is discovered by Strimzi, by creating a `ClusterRoleBinding`

When using rack-aware partition assignment, the broker pod needs to be able to get information about the `Node` it is running on, for example, the Availability Zone in Amazon AWS. A `Node` is a cluster-scoped resource, so access to it can only be granted through a `ClusterRoleBinding`, not a namespace-scoped `RoleBinding`.

## Can standard Kubernetes users create Kafka custom resources?

By default, standard Kubernetes users will not have the privileges necessary to manage the custom resources handled by the Cluster Operator. The cluster administrator can grant a user the necessary privileges using Kubernetes RBAC resources.

For more information, see [Designating Strimzi administrators](#) in the *Deploying and Upgrading Strimzi* guide.

## What do the *failed to acquire lock* warnings in the log mean?

For each cluster, the Cluster Operator executes only one operation at a time. The Cluster Operator uses locks to make sure that there are never two parallel operations running for the same cluster. Other operations must wait until the current operation completes before the lock is released.

### INFO

Examples of cluster operations include *cluster creation*, *rolling update*, *scale down*, and *scale up*.

If the waiting time for the lock takes too long, the operation times out and the following warning message is printed to the log:

```
2018-03-04 17:09:24 WARNING AbstractClusterOperations:290 - Failed to acquire lock for
kafka cluster lock::kafka::myproject::my-cluster
```

Depending on the exact configuration of `STRIMZI_FULL_RECONCILIATION_INTERVAL_MS` and `STRIMZI_OPERATION_TIMEOUT_MS`, this warning message might appear occasionally without indicating any underlying issues. Operations that time out are picked up in the next periodic reconciliation, so that the operation can acquire the lock and execute again.

Should this message appear periodically, even in situations when there should be no other operations running for a given cluster, it might indicate that the lock was not properly released due to an error. If this is the case, try restarting the Cluster Operator.

## Why is hostname verification failing when connecting to NodePorts using TLS?

Currently, off-cluster access using NodePorts with TLS encryption enabled does not support TLS hostname verification. As a result, the clients that verify the hostname will fail to connect. For example, the Java client will fail with the following exception:

```
Caused by: java.security.cert.CertificateException: No subject alternative names matching IP address 168.72.15.231 found
at sun.security.util.HostnameChecker.matchIP(HostnameChecker.java:168)
at sun.security.util.HostnameChecker.match(HostnameChecker.java:94)
at sun.security.ssl.X509TrustManagerImpl.checkIdentity(X509TrustManagerImpl.java:455)
at sun.security.ssl.X509TrustManagerImpl.checkIdentity(X509TrustManagerImpl.java:436)
at sun.security.ssl.X509TrustManagerImpl.checkTrusted(X509TrustManagerImpl.java:252)
at
sun.security.ssl.X509TrustManagerImpl.checkServerTrusted(X509TrustManagerImpl.java:136
)
at sun.security.ssl.ClientHandshaker.serverCertificate(ClientHandshaker.java:1501)
... 17 more
```

To connect, you must disable hostname verification. In the Java client, you can do this by setting the configuration option `ssl.endpoint.identification.algorithm` to an empty string.

When configuring the client using a properties file, you can do it this way:

```
ssl.endpoint.identification.algorithm=
```

When configuring the client directly in Java, set the configuration option to an empty string:

```
props.put("ssl.endpoint.identification.algorithm", "");
```

# Chapter 11. Tuning Kafka configuration

Use configuration properties to optimize the performance of Kafka brokers, producers and consumers.

A minimum set of configuration properties is required, but you can add or adjust properties to change how producers and consumers interact with Kafka brokers. For example, you can tune latency and throughput of messages so that clients can respond to data in real time.

You might start by analyzing metrics to gauge where to make your initial configurations, then make incremental changes and further comparisons of metrics until you have the configuration you need.

For more information about Apache Kafka configuration properties, see the [Apache Kafka documentation](#).

## 11.1. Tools that help with tuning

The following tools help with Kafka tuning:

- [Cruise Control](#) generates optimization proposals that you can use to assess and implement a cluster rebalance
- [Kafka Static Quota plugin](#) sets limits on brokers
- [Rack configuration](#) spreads broker partitions across racks and allows consumers to fetch data from the nearest replica

## 11.2. Managed broker configurations

When you deploy Strimzi on Kubernetes, you can specify broker configuration through the `config` property of the [Kafka](#) custom resource. However, certain broker configuration options are managed directly by Strimzi.

As such, you cannot configure the following options:

- `broker.id` to specify the ID of the Kafka broker
- `log.dirs` directories for log data
- `zookeeper.connect` configuration to connect Kafka with ZooKeeper
- `listeners` to expose the Kafka cluster to clients
- `authorization` mechanisms to allow or decline actions executed by users
- `authentication` mechanisms to prove the identity of users requiring access to Kafka

Broker IDs start from 0 (zero) and correspond to the number of broker replicas. Log directories are mounted to `/var/lib/kafka/data/kafka-log $\text{IDX}$`  based on the `spec.kafka.storage` configuration in the [Kafka](#) custom resource.  $\text{IDX}$  is the Kafka broker pod index.

For a list of exclusions, see the [KafkaClusterSpec schema reference](#).

## 11.3. Kafka broker configuration tuning

Use configuration properties to optimize the performance of Kafka brokers. You can use standard Kafka broker configuration options, except for properties managed directly by Strimzi.

### 11.3.1. Basic broker configuration

A typical broker configuration will include settings for properties related to topics, threads and logs.

*Basic broker configuration properties*

```
# ...
num.partitions=1
default.replication.factor=3
offsets.topic.replication.factor=3
transaction.state.log.replication.factor=3
transaction.state.log.min_isr=2
log.retention.hours=168
log.segment.bytes=1073741824
log.retention.check.interval.ms=300000
num.network.threads=3
num.io.threads=8
num.recovery.threads.per.data.dir=1
socket.send.buffer.bytes=102400
socket.receive.buffer.bytes=102400
socket.request.max.bytes=104857600
group.initial.rebalance.delay.ms=0
zookeeper.connection.timeout.ms=6000
# ...
```

### 11.3.2. Replicating topics for high availability

Basic topic properties set the default number of partitions and replication factor for topics, which will apply to topics that are created without these properties being explicitly set, including when topics are created automatically.

```
# ...
num.partitions=1
auto.create.topics.enable=false
default.replication.factor=3
min.insync.replicas=2
replica.fetch.max.bytes=1048576
# ...
```

For high availability environments, it is advisable to increase the replication factor to at least 3 for topics and set the minimum number of in-sync replicas required to 1 less than the replication factor.

The `auto.create.topics.enable` property is enabled by default so that topics that do not already exist are created automatically when needed by producers and consumers. If you are using automatic topic creation, you can set the default number of partitions for topics using `num.partitions`. Generally, however, this property is disabled so that more control is provided over topics through explicit topic creation.

For `data durability`, you should also set `min.insync.replicas` in your `topic` configuration and message delivery acknowledgments using `acks=all` in your `producer` configuration.

Use `replica.fetch.max.bytes` to set the maximum size, in bytes, of messages fetched by each follower that replicates the leader partition. Change this value according to the average message size and throughput. When considering the total memory allocation required for read/write buffering, the memory available must also be able to accommodate the maximum replicated message size when multiplied by all followers.

The `delete.topic.enable` property is enabled by default to allow topics to be deleted. In a production environment, you should disable this property to avoid accidental topic deletion, resulting in data loss. You can, however, temporarily enable it and delete topics and then disable it again.

When running Strimzi on Kubernetes, the Topic Operator can provide operator-style topic management. You can use the `KafkaTopic` resource to create topics. For topics created using the `KafkaTopic` resource, the replication factor is set using `spec.replicas`. If `delete.topic.enable` is enabled, you can also delete topics using the `KafkaTopic` resource.

```
# ...
auto.create.topics.enable=false
delete.topic.enable=true
# ...
```

### 11.3.3. Internal topic settings for transactions and commits

If you are `using transactions` to enable atomic writes to partitions from producers, the state of the transactions is stored in the internal `__transaction_state` topic. By default, the brokers are configured with a replication factor of 3 and a minimum of 2 in-sync replicas for this topic, which means that a minimum of three brokers are required in your Kafka cluster.

```
# ...
transaction.state.log.replication.factor=3
transaction.state.log.min_isr=2
# ...
```

Similarly, the internal `__consumer_offsets` topic, which stores consumer state, has default settings for the number of partitions and replication factor.

```
# ...
offsets.topic.num.partitions=50
offsets.topic.replication.factor=3
# ...
```

**Do not reduce these settings in production.** You can increase the settings in a *production* environment. As an exception, you might want to reduce the settings in a single-broker *test* environment.

### 11.3.4. Improving request handling throughput by increasing I/O threads

Network threads handle requests to the Kafka cluster, such as produce and fetch requests from client applications. Produce requests are placed in a request queue. Responses are placed in a response queue.

The number of network threads per listener should reflect the replication factor and the levels of activity from client producers and consumers interacting with the Kafka cluster. If you are going to have a lot of requests, you can increase the number of threads, using the amount of time threads are idle to determine when to add more threads.

To reduce congestion and regulate the request traffic, you can limit the number of requests allowed in the request queue. When the request queue is full, all incoming traffic is blocked.

I/O threads pick up requests from the request queue to process them. Adding more threads can improve throughput, but the number of CPU cores and disk bandwidth imposes a practical upper limit. At a minimum, the number of I/O threads should equal the number of storage volumes.

```
# ...
num.network.threads=3 ①
queued.max.requests=500 ②
num.io.threads=8 ③
num.recovery.threads.per.data.dir=4 ④
# ...
```

① The number of network threads for the Kafka cluster.

② The number of requests allowed in the request queue.

③ The number of I/O threads for a Kafka broker.

④ The number of threads used for log loading at startup and flushing at shutdown. Try setting to a value of at least the number of cores.

Configuration updates to the thread pools for all brokers might occur dynamically at the cluster level. These updates are restricted to between half the current size and twice the current size.

**TIP** The following Kafka broker metrics can help with working out the number of threads required:

- `kafka.network:type=SocketServer, name=NetworkProcessorAvgIdlePercent` provides

metrics on the average time network threads are idle as a percentage.

- `kafka.server:type=KafkaRequestHandlerPool, name=RequestHandlerAvgIdlePercent` provides metrics on the average time I/O threads are idle as a percentage.

If there is 0% idle time, all resources are in use, which means that adding more threads might be beneficial. When idle time goes below 30%, performance may start to suffer.

If threads are slow or limited due to the number of disks, you can try increasing the size of the buffers for network requests to improve throughput:

```
# ...
replica.socket.receive.buffer.bytes=65536
# ...
```

And also increase the maximum number of bytes Kafka can receive:

```
# ...
socket.request.max.bytes=104857600
# ...
```

### 11.3.5. Increasing bandwidth for high latency connections

Kafka batches data to achieve reasonable throughput over high-latency connections from Kafka to clients, such as connections between datacenters. However, if high latency is a problem, you can increase the size of the buffers for sending and receiving messages.

```
# ...
socket.send.buffer.bytes=1048576
socket.receive.buffer.bytes=1048576
# ...
```

You can estimate the optimal size of your buffers using a *bandwidth-delay product* calculation, which multiplies the maximum bandwidth of the link (in bytes/s) with the round-trip delay (in seconds) to give an estimate of how large a buffer is required to sustain maximum throughput.

### 11.3.6. Managing logs with data retention policies

Kafka uses logs to store message data. Logs are a series of segments associated with various indexes. New messages are written to an *active* segment, and never subsequently modified. Segments are read when serving fetch requests from consumers. Periodically, the active segment is *rolled* to become read-only and a new active segment is created to replace it. There is only a single segment active at a time. Older segments are retained until they are eligible for deletion.

Configuration at the broker level sets the maximum size in bytes of a log segment and the amount of time in milliseconds before an active segment is rolled:

```
# ...
log.segment.bytes=1073741824
log.roll.ms=604800000
# ...
```

You can override these settings at the topic level using `segment.bytes` and `segment.ms`. Whether you need to lower or raise these values depends on the policy for segment deletion. A larger size means the active segment contains more messages and is rolled less often. Segments also become eligible for deletion less often.

You can set time-based or size-based log retention and cleanup policies so that logs are kept manageable. Depending on your requirements, you can use log retention configuration to delete old segments. If log retention policies are used, non-active log segments are removed when retention limits are reached. Deleting old segments bounds the storage space required for the log so you do not exceed disk capacity.

For time-based log retention, you set a retention period based on hours, minutes and milliseconds. The retention period is based on the time messages were appended to the segment.

The milliseconds configuration has priority over minutes, which has priority over hours. The minutes and milliseconds configuration is null by default, but the three options provide a substantial level of control over the data you wish to retain. Preference should be given to the milliseconds configuration, as it is the only one of the three properties that is dynamically updateable.

```
# ...
log.retention.ms=1680000
# ...
```

If `log.retention.ms` is set to -1, no time limit is applied to log retention, so all logs are retained. Disk usage should always be monitored, but the -1 setting is not generally recommended as it can lead to issues with full disks, which can be hard to rectify.

For size-based log retention, you set a maximum log size (of all segments in the log) in bytes:

```
# ...
log.retention.bytes=1073741824
# ...
```

In other words, a log will typically have approximately  $\text{log.retention.bytes}/\text{log.segment.bytes}$  segments once it reaches a steady state. When the maximum log size is reached, older segments are removed.

A potential issue with using a maximum log size is that it does not take into account the time messages were appended to a segment. You can use time-based and size-based log retention for your cleanup policy to get the balance you need. Whichever threshold is reached first triggers the

cleanup.

If you wish to add a time delay before a segment file is deleted from the system, you can add the delay using `log.segment.delete.delay.ms` for all topics at the broker level or `file.delete.delay.ms` for specific topics in the topic configuration.

```
# ...
log.segment.delete.delay.ms=60000
# ...
```

### 11.3.7. Removing log data with cleanup policies

The method of removing older log data is determined by the *log cleaner* configuration.

The log cleaner is enabled for the broker by default:

```
# ...
log.cleaner.enable=true
# ...
```

The log cleaner needs to be enabled if you are using log compaction cleanup policy. You can set the cleanup policy at the topic or broker level. Broker-level configuration is the default for topics that do not have policy set.

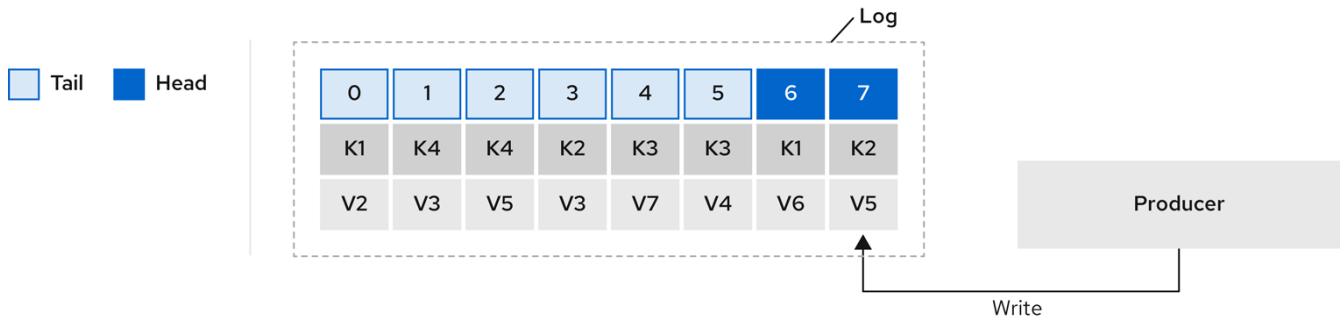
You can set policy to delete logs, compact logs, or do both:

```
# ...
log.cleanup.policy=compact,delete
# ...
```

The `delete` policy corresponds to managing logs with data retention policies. It is suitable when data does not need to be retained forever. The `compact` policy guarantees to keep the most recent message for each message key. Log compaction is suitable where message values are changeable, and you want to retain the latest update.

If cleanup policy is set to delete logs, older segments are deleted based on log retention limits. Otherwise, if the log cleaner is not enabled, and there are no log retention limits, the log will continue to grow.

If cleanup policy is set for log compaction, the *head* of the log operates as a standard Kafka log, with writes for new messages appended in order. In the *tail* of a compacted log, where the log cleaner operates, records will be deleted if another record with the same key occurs later in the log. Messages with null values are also deleted. If you're not using keys, you can't use compaction because keys are needed to identify related messages. While Kafka guarantees that the latest messages for each key will be retained, it does not guarantee that the whole compacted log will not contain duplicates.

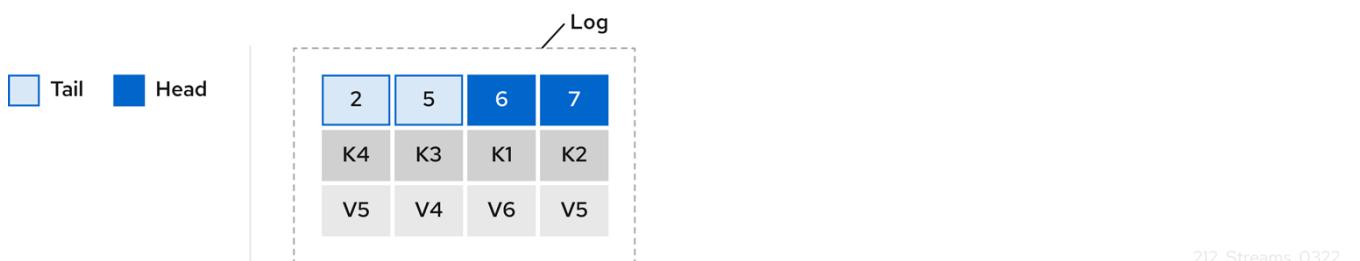


212\_Streams\_0322

Figure 6. Log showing key value writes with offset positions before compaction

Using keys to identify messages, Kafka compaction keeps the latest message (with the highest offset) for a specific message key, eventually discarding earlier messages that have the same key. In other words, the message in its latest state is always available and any out-of-date records of that particular message are eventually removed when the log cleaner runs. You can restore a message back to a previous state.

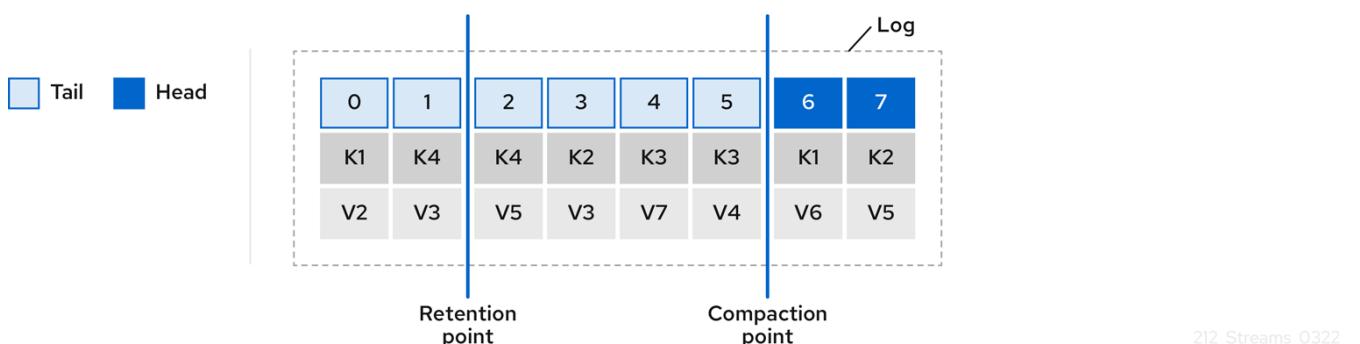
Records retain their original offsets even when surrounding records get deleted. Consequently, the tail can have non-contiguous offsets. When consuming an offset that's no longer available in the tail, the record with the next higher offset is found.



212\_Streams\_0322

Figure 7. Log after compaction

If you choose only a compact policy, your log can still become arbitrarily large. In which case, you can set policy to compact *and* delete logs. If you choose to compact and delete, first the log data is compacted, removing records with a key in the head of the log. After which, data that falls before the log retention threshold is deleted.



212\_Streams\_0322

Figure 8. Log retention point and compaction point

You set the frequency the log is checked for cleanup in milliseconds:

```
# ...
log.retention.check.interval.ms=300000
# ...
```

Adjust the log retention check interval in relation to the log retention settings. Smaller retention sizes might require more frequent checks.

The frequency of cleanup should be often enough to manage the disk space, but not so often it affects performance on a topic.

You can also set a time in milliseconds to put the cleaner on standby if there are no logs to clean:

```
# ...
log.cleaner.backoff.ms=15000
# ...
```

If you choose to delete older log data, you can set a period in milliseconds to retain the deleted data before it is purged:

```
# ...
log.cleaner.delete.retention.ms=86400000
# ...
```

The deleted data retention period gives time to notice the data is gone before it is irretrievably deleted.

To delete all messages related to a specific key, a producer can send a *tombstone* message. A *tombstone* has a null value and acts as a marker to tell a consumer the value is deleted. After compaction, only the tombstone is retained, which must be for a long enough period for the consumer to know that the message is deleted. When older messages are deleted, having no value, the tombstone key is also deleted from the partition.

### 11.3.8. Managing disk utilization

There are many other configuration settings related to log cleanup, but of particular importance is memory allocation.

The deduplication property specifies the total memory for cleanup across all log cleaner threads. You can set an upper limit on the percentage of memory used through the buffer load factor.

```
# ...
log.cleaner.dedupe.buffer.size=134217728
log.cleaner.io.buffer.load.factor=0.9
# ...
```

Each log entry uses exactly 24 bytes, so you can work out how many log entries the buffer can

handle in a single run and adjust the setting accordingly.

If possible, consider increasing the number of log cleaner threads if you are looking to reduce the log cleaning time:

```
# ...
log.cleaner.threads=8
# ...
```

If you are experiencing issues with 100% disk bandwidth usage, you can throttle the log cleaner I/O so that the sum of the read/write operations is less than a specified double value based on the capabilities of the disks performing the operations:

```
# ...
log.cleaner.io.max.bytes.per.second=1.7976931348623157E308
# ...
```

### 11.3.9. Handling large message sizes

The default batch size for messages is 1MB, which is optimal for maximum throughput in most use cases. Kafka can accommodate larger batches at a reduced throughput, assuming adequate disk capacity.

Large message sizes are handled in four ways:

1. [Producer-side message compression](#) writes compressed messages to the log.
2. Reference-based messaging sends only a reference to data stored in some other system in the message's value.
3. Inline messaging splits messages into chunks that use the same key, which are then combined on output using a stream-processor like Kafka Streams.
4. Broker and producer/consumer client application configuration built to handle larger message sizes.

The reference-based messaging and message compression options are recommended and cover most situations. With any of these options, care must be taken to avoid introducing performance issues.

#### *Producer-side compression*

For producer configuration, you specify a `compression.type`, such as Gzip, which is then applied to batches of data generated by the producer. Using the broker configuration `compression.type=producer`, the broker retains whatever compression the producer used. Whenever producer and topic compression do not match, the broker has to compress batches again prior to appending them to the log, which impacts broker performance.

Compression also adds additional processing overhead on the producer and decompression overhead on the consumer, but includes more data in a batch, so is often beneficial to throughput

when message data compresses well.

Combine producer-side compression with fine-tuning of the batch size to facilitate optimum throughput. Using metrics helps to gauge the average batch size needed.

#### *Reference-based messaging*

Reference-based messaging is useful for data replication when you do not know how big a message will be. The external data store must be fast, durable, and highly available for this configuration to work. Data is written to the data store and a reference to the data is returned. The producer sends a message containing the reference to Kafka. The consumer gets the reference from the message and uses it to fetch the data from the data store.

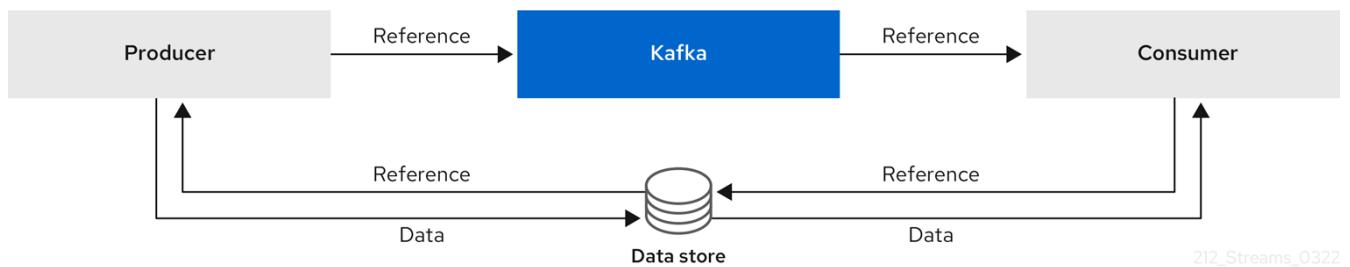


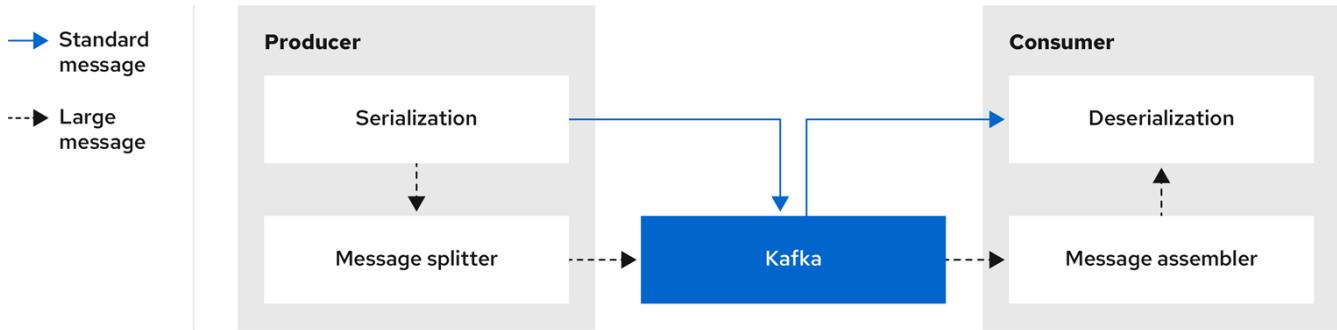
Figure 9. Reference-based messaging flow

As the message passing requires more trips, end-to-end latency will increase. Another significant drawback of this approach is there is no automatic clean up of the data in the external system when the Kafka message gets cleaned up. A hybrid approach would be to only send large messages to the data store and process standard-sized messages directly.

#### *Inline messaging*

Inline messaging is complex, but it does not have the overhead of depending on external systems like reference-based messaging.

The producing client application has to serialize and then chunk the data if the message is too big. The producer then uses the Kafka `ByteArraySerializer` or similar to serialize each chunk again before sending it. The consumer tracks messages and buffers chunks until it has a complete message. The consuming client application receives the chunks, which are assembled before deserialization. Complete messages are delivered to the rest of the consuming application in order according to the offset of the first or last chunk for each set of chunked messages. Successful delivery of the complete message is checked against offset metadata to avoid duplicates during a rebalance.



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Figure 10. Inline messaging flow

Inline messaging has a performance overhead on the consumer side because of the buffering required, particularly when handling a series of large messages in parallel. The chunks of large messages can become interleaved, so that it is not always possible to commit when all the chunks of a message have been consumed if the chunks of another large message in the buffer are incomplete. For this reason, the buffering is usually supported by persisting message chunks or by implementing commit logic.

#### *Configuration to handle larger messages*

If larger messages cannot be avoided, and to avoid blocks at any point of the message flow, you can increase message limits. To do this, configure `message.max.bytes` at the topic level to set the maximum record batch size for individual topics. If you set `message.max.bytes` at the broker level, larger messages are allowed for all topics.

The broker will reject any message that is greater than the limit set with `message.max.bytes`. The buffer size for the producers (`max.request.size`) and consumers (`message.max.bytes`) must be able to accommodate the larger messages.

#### **11.3.10. Controlling the log flush of message data**

Generally, the recommendation is to not set explicit flush thresholds and let the operating system perform background flush using its default settings. Partition replication provides greater data durability than writes to any single disk, as a failed broker can recover from its in-sync replicas.

Log flush properties control the periodic writes of cached message data to disk. The scheduler specifies the frequency of checks on the log cache in milliseconds:

```
# ...
log.flush.scheduler.interval.ms=2000
# ...
```

You can control the frequency of the flush based on the maximum amount of time that a message is kept in-memory and the maximum number of messages in the log before writing to disk:

```
# ...
log.flush.interval.ms=50000
```

```
log.flush.interval.messages=100000  
# ...
```

The wait between flushes includes the time to make the check and the specified interval before the flush is carried out. Increasing the frequency of flushes can affect throughput.

If you are using application flush management, setting lower flush thresholds might be appropriate if you are using faster disks.

### 11.3.11. Partition rebalancing for availability

Partitions can be replicated across brokers for fault tolerance. For a given partition, one broker is elected leader and handles all produce requests (writes to the log). Partition followers on other brokers replicate the partition data of the partition leader for data reliability in the event of the leader failing.

Followers do not normally serve clients, though `rack` configuration allows a consumer to consume messages from the closest replica when a Kafka cluster spans multiple datacenters. Followers operate only to replicate messages from the partition leader and allow recovery should the leader fail. Recovery requires an in-sync follower. Followers stay in sync by sending fetch requests to the leader, which returns messages to the follower in order. The follower is considered to be in sync if it has caught up with the most recently committed message on the leader. The leader checks this by looking at the last offset requested by the follower. An out-of-sync follower is usually not eligible as a leader should the current leader fail, unless [unclean leader election is allowed](#).

You can adjust the lag time before a follower is considered out of sync:

```
# ...  
replica.lag.time.max.ms=30000  
# ...
```

Lag time puts an upper limit on the time to replicate a message to all in-sync replicas and how long a producer has to wait for an acknowledgment. If a follower fails to make a fetch request and catch up with the latest message within the specified lag time, it is removed from in-sync replicas. You can reduce the lag time to detect failed replicas sooner, but by doing so you might increase the number of followers that fall out of sync needlessly. The right lag time value depends on both network latency and broker disk bandwidth.

When a leader partition is no longer available, one of the in-sync replicas is chosen as the new leader. The first broker in a partition's list of replicas is known as the *preferred* leader. By default, Kafka is enabled for automatic partition leader rebalancing based on a periodic check of leader distribution. That is, Kafka checks to see if the preferred leader is the *current* leader. A rebalance ensures that leaders are evenly distributed across brokers and brokers are not overloaded.

You can use Cruise Control for Strimzi to figure out replica assignments to brokers that balance load evenly across the cluster. Its calculation takes into account the differing load experienced by leaders and followers. A failed leader affects the balance of a Kafka cluster because the remaining brokers get the extra work of leading additional partitions.

For the assignment found by Cruise Control to actually be balanced it is necessary that partitions are lead by the preferred leader. Kafka can automatically ensure that the preferred leader is being used (where possible), changing the current leader if necessary. This ensures that the cluster remains in the balanced state found by Cruise Control.

You can control the frequency, in seconds, of the rebalance check and the maximum percentage of imbalance allowed for a broker before a rebalance is triggered.

```
#...
auto.leader.rebalance.enable=true
leader.imbalance.check.interval.seconds=300
leader.imbalance.per.broker.percentage=10
#...
```

The percentage leader imbalance for a broker is the ratio between the current number of partitions for which the broker is the current leader and the number of partitions for which it is the preferred leader. You can set the percentage to zero to ensure that preferred leaders are always elected, assuming they are in sync.

If the checks for rebalances need more control, you can disable automated rebalances. You can then choose when to trigger a rebalance using the [kafka-leader-election.sh](#) command line tool.

**NOTE**

The Grafana dashboards provided with Strimzi show metrics for under-replicated partitions and partitions that do not have an active leader.

### 11.3.12. Unclean leader election

Leader election to an in-sync replica is considered clean because it guarantees no loss of data. And this is what happens by default. But what if there is no in-sync replica to take on leadership? Perhaps the ISR (in-sync replica) only contained the leader when the leader's disk died. If a minimum number of in-sync replicas is not set, and there are no followers in sync with the partition leader when its hard drive fails irrevocably, data is already lost. Not only that, but *a new leader cannot be elected* because there are no in-sync followers.

You can configure how Kafka handles leader failure:

```
# ...
unclean.leader.election.enable=false
# ...
```

Unclean leader election is disabled by default, which means that out-of-sync replicas cannot become leaders. With clean leader election, if no other broker was in the ISR when the old leader was lost, Kafka waits until that leader is back online before messages can be written or read. Unclean leader election means out-of-sync replicas can become leaders, but you risk losing messages. The choice you make depends on whether your requirements favor availability or durability.

You can override the default configuration for specific topics at the topic level. If you cannot afford the risk of data loss, then leave the default configuration.

### 11.3.13. Avoiding unnecessary consumer group rebalances

For consumers joining a new consumer group, you can add a delay so that unnecessary rebalances to the broker are avoided:

```
# ...
group.initial.rebalance.delay.ms=3000
# ...
```

The delay is the amount of time that the coordinator waits for members to join. The longer the delay, the more likely it is that all the members will join in time and avoid a rebalance. But the delay also prevents the group from consuming until the period has ended.

## 11.4. Kafka producer configuration tuning

Use a basic producer configuration with optional properties that are tailored to specific use cases.

Adjusting your configuration to maximize throughput might increase latency or vice versa. You will need to experiment and tune your producer configuration to get the balance you need.

### 11.4.1. Basic producer configuration

Connection and serializer properties are required for every producer. Generally, it is good practice to add a client id for tracking, and use compression on the producer to reduce batch sizes in requests.

In a basic producer configuration:

- The order of messages in a partition is not guaranteed.
- The acknowledgment of messages reaching the broker does not guarantee durability.

*Basic producer configuration properties*

```
# ...
bootstrap.servers=localhost:9092 ①
key.serializer=org.apache.kafka.common.serialization.StringSerializer ②
value.serializer=org.apache.kafka.common.serialization.StringSerializer ③
client.id=my-client ④
compression.type=gzip ⑤
# ...
```

① (Required) Tells the producer to connect to a Kafka cluster using a *host:port* bootstrap server address for a Kafka broker. The producer uses the address to discover and connect to all brokers in the cluster. Use a comma-separated list to specify two or three addresses in case a server is down, but it's not necessary to provide a list of all the brokers in the cluster.

- ② (Required) Serializer to transform the key of each message to bytes prior to them being sent to a broker.
- ③ (Required) Serializer to transform the value of each message to bytes prior to them being sent to a broker.
- ④ (Optional) The logical name for the client, which is used in logs and metrics to identify the source of a request.
- ⑤ (Optional) The codec for compressing messages, which are sent and might be stored in compressed format and then decompressed when reaching a consumer. Compression is useful for improving throughput and reducing the load on storage, but might not be suitable for low latency applications where the cost of compression or decompression could be prohibitive.

## 11.4.2. Data durability

Message delivery acknowledgments minimize the likelihood that messages are lost. Acknowledgments are enabled by default with the `acks` property set at `acks=all`.

### *Acknowledging message delivery*

```
# ...
acks=all ①
# ...
```

- ① `acks=all` forces a leader replica to replicate messages to a certain number of followers before acknowledging that the message request was successfully received.

The `acks=all` setting offers the strongest guarantee of delivery, but it will increase the latency between the producer sending a message and receiving acknowledgment. If you don't require such strong guarantees, a setting of `acks=0` or `acks=1` provides either no delivery guarantees or only acknowledgment that the leader replica has written the record to its log.

With `acks=all`, the leader waits for all in-sync replicas to acknowledge message delivery. A topic's `min.insync.replicas` configuration sets the minimum required number of in-sync replica acknowledgements. The number of acknowledgements include that of the leader and followers.

A typical starting point is to use the following configuration:

- Producer configuration:
  - `acks=all` (default)
- Broker configuration for topic replication:
  - `default.replication.factor=3` (default = `1`)
  - `min.insync.replicas=2` (default = `1`)

When you create a topic, you can override the default replication factor. You can also override `min.insync.replicas` at the topic level in the topic configuration.

Strimzi uses this configuration in the example configuration files for multi-node deployment of Kafka.

The following table describes how this configuration operates depending on the availability of followers that replicate the leader replica.

Table 31. Follower availability

Number of followers available and in-sync	Acknowledgements	Producer can send messages?
2	The leader waits for 2 follower acknowledgements	Yes
1	The leader waits for 1 follower acknowledgement	Yes
0	The leader raises an exception	No

A topic replication factor of 3 creates one leader replica and two followers. In this configuration, the producer can continue if a single follower is unavailable. Some delay can occur whilst removing a failed broker from the in-sync replicas or a creating a new leader. If the second follower is also unavailable, message delivery will not be successful. Instead of acknowledging successful message delivery, the leader sends an error (*not enough replicas*) to the producer. The producer raises an equivalent exception. With `retries` configuration, the producer can resend the failed message request.

**NOTE** If the system fails, there is a risk of unsent data in the buffer being lost.

### 11.4.3. Ordered delivery

Idempotent producers avoid duplicates as messages are delivered exactly once. IDs and sequence numbers are assigned to messages to ensure the order of delivery, even in the event of failure. If you are using `acks=all` for data consistency, using idempotency makes sense for ordered delivery. Idempotency is enabled for producers by default. With idempotency enabled, you can set the number of concurrent in-flight requests to a maximum of 5 for message ordering to be preserved.

*Ordered delivery with idempotency*

```
# ...
enable.idempotence=true ①
max.in.flight.requests.per.connection=5 ②
acks=all ③
retries=2147483647 ④
# ...
```

① Set to `true` to enable the idempotent producer.

② With idempotent delivery the number of in-flight requests may be greater than 1 while still providing the message ordering guarantee. The default is 5 in-flight requests.

③ Set `acks` to `all`.

④ Set the number of attempts to resend a failed message request.

If you choose not to use `acks=all` and disable idempotency because of the performance cost, set the

number of in-flight (unacknowledged) requests to 1 to preserve ordering. Otherwise, a situation is possible where *Message-A* fails only to succeed after *Message-B* was already written to the broker.

#### *Ordered delivery without idempotency*

```
# ...
enable.idempotence=false ①
max.in.flight.requests.per.connection=1 ②
retries=2147483647
# ...
```

① Set to `false` to disable the idempotent producer.

② Set the number of in-flight requests to exactly 1.

#### **11.4.4. Reliability guarantees**

Idempotence is useful for exactly once writes to a single partition. Transactions, when used with idempotence, allow exactly once writes across multiple partitions.

Transactions guarantee that messages using the same transactional ID are produced once, and either *all* are successfully written to the respective logs or *none* of them are.

```
# ...
enable.idempotence=true
max.in.flight.requests.per.connection=5
acks=all
retries=2147483647
transactional.id=UNIQUE-ID ①
transaction.timeout.ms=900000 ②
# ...
```

① Specify a unique transactional ID.

② Set the maximum allowed time for transactions in milliseconds before a timeout error is returned. The default is `900000` or 15 minutes.

The choice of `transactional.id` is important in order that the transactional guarantee is maintained. Each transactional id should be used for a unique set of topic partitions. For example, this can be achieved using an external mapping of topic partition names to transactional ids, or by computing the transactional id from the topic partition names using a function that avoids collisions.

#### **11.4.5. Optimizing producers for throughput and latency**

Usually, the requirement of a system is to satisfy a particular throughput target for a proportion of messages within a given latency. For example, targeting 500,000 messages per second with 95% of messages being acknowledged within 2 seconds.

It's likely that the messaging semantics (message ordering and durability) of your producer are defined by the requirements for your application. For instance, it's possible that you don't have the

option of using `acks=0` or `acks=1` without breaking some important property or guarantee provided by your application.

Broker restarts have a significant impact on high percentile statistics. For example, over a long period the 99th percentile latency is dominated by behavior around broker restarts. This is worth considering when designing benchmarks or comparing performance numbers from benchmarking with performance numbers seen in production.

Depending on your objective, Kafka offers a number of configuration parameters and techniques for tuning producer performance for throughput and latency.

### Message batching (`linger.ms` and `batch.size`)

Message batching delays sending messages in the hope that more messages destined for the same broker will be sent, allowing them to be batched into a single produce request. Batching is a compromise between higher latency in return for higher throughput. Time-based batching is configured using `linger.ms`, and size-based batching is configured using `batch.size`.

### Compression (`compression.type`)

Message compression adds latency in the producer (CPU time spent compressing the messages), but makes requests (and potentially disk writes) smaller, which can increase throughput. Whether compression is worthwhile, and the best compression to use, will depend on the messages being sent. Compression happens on the thread which calls `KafkaProducer.send()`, so if the latency of this method matters for your application you should consider using more threads.

### Pipelining (`max.in.flight.requests.per.connection`)

Pipelining means sending more requests before the response to a previous request has been received. In general more pipelining means better throughput, up to a threshold at which other effects, such as worse batching, start to counteract the effect on throughput.

#### *Lowering latency*

When your application calls `KafkaProducer.send()` the messages are:

- Processed by any interceptors
- Serialized
- Assigned to a partition
- Compressed
- Added to a batch of messages in a per-partition queue

At which point the `send()` method returns. So the time `send()` is blocked is determined by:

- The time spent in the interceptors, serializers and partitioner
- The compression algorithm used
- The time spent waiting for a buffer to use for compression

Batches will remain in the queue until one of the following occurs:

- The batch is full (according to `batch.size`)

- The delay introduced by `linger.ms` has passed
- The sender is about to send message batches for other partitions to the same broker, and it is possible to add this batch too
- The producer is being flushed or closed

Look at the configuration for batching and buffering to mitigate the impact of `send()` blocking on latency.

```
# ...
linger.ms=100 ①
batch.size=16384 ②
buffer.memory=33554432 ③
# ...
```

- ① The `linger` property adds a delay in milliseconds so that larger batches of messages are accumulated and sent in a request. The default is `0`.
- ② If a maximum `batch.size` in bytes is used, a request is sent when the maximum is reached, or messages have been queued for longer than `linger.ms` (whichever comes sooner). Adding the delay allows batches to accumulate messages up to the batch size.
- ③ The buffer size must be at least as big as the batch size, and be able to accommodate buffering, compression and in-flight requests.

#### *Increasing throughput*

Improve throughput of your message requests by adjusting the maximum time to wait before a message is delivered and completes a send request.

You can also direct messages to a specified partition by writing a custom partitioner to replace the default.

```
# ...
delivery.timeout.ms=120000 ①
partitioner.class=my-custom-partitioner ②
# ...
```

- ① The maximum time in milliseconds to wait for a complete send request. You can set the value to `MAX_LONG` to delegate to Kafka an indefinite number of retries. The default is `120000` or 2 minutes.
- ② Specify the class name of the custom partitioner.

## 11.5. Kafka consumer configuration tuning

Use a basic consumer configuration with optional properties that are tailored to specific use cases.

When tuning your consumers your primary concern will be ensuring that they cope efficiently with the amount of data ingested. As with the producer tuning, be prepared to make incremental changes until the consumers operate as expected.

### 11.5.1. Basic consumer configuration

Connection and deserializer properties are required for every consumer. Generally, it is good practice to add a client id for tracking.

In a consumer configuration, irrespective of any subsequent configuration:

- The consumer fetches from a given offset and consumes the messages in order, unless the offset is changed to skip or re-read messages.
- The broker does not know if the consumer processed the responses, even when committing offsets to Kafka, because the offsets might be sent to a different broker in the cluster.

*Basic consumer configuration properties*

```
# ...
bootstrap.servers=localhost:9092 ①
key.deserializer=org.apache.kafka.common.serialization.StringDeserializer ②
value.deserializer=org.apache.kafka.common.serialization.StringDeserializer ③
client.id=my-client ④
group.id=my-group-id ⑤
# ...
```

① (Required) Tells the consumer to connect to a Kafka cluster using a *host:port* bootstrap server address for a Kafka broker. The consumer uses the address to discover and connect to all brokers in the cluster. Use a comma-separated list to specify two or three addresses in case a server is down, but it is not necessary to provide a list of all the brokers in the cluster. If you are using a loadbalancer service to expose the Kafka cluster, you only need the address for the service because the availability is handled by the loadbalancer.

② (Required) Deserializer to transform the bytes fetched from the Kafka broker into message keys.

③ (Required) Deserializer to transform the bytes fetched from the Kafka broker into message values.

④ (Optional) The logical name for the client, which is used in logs and metrics to identify the source of a request. The id can also be used to throttle consumers based on processing time quotas.

⑤ (Conditional) A group id is *required* for a consumer to be able to join a consumer group.

### 11.5.2. Scaling data consumption using consumer groups

Consumer groups share a typically large data stream generated by one or multiple producers from a given topic. Consumers are grouped using a `group.id` property, allowing messages to be spread across the members. One of the consumers in the group is elected leader and decides how the partitions are assigned to the consumers in the group. Each partition can only be assigned to a single consumer.

If you do not already have as many consumers as partitions, you can scale data consumption by adding more consumer instances with the same `group.id`. Adding more consumers to a group than there are partitions will not help throughput, but it does mean that there are consumers on standby

should one stop functioning. If you can meet throughput goals with fewer consumers, you save on resources.

Consumers within the same consumer group send offset commits and heartbeats to the same broker. So the greater the number of consumers in the group, the higher the request load on the broker.

```
# ...
group.id=my-group-id ①
# ...
```

① Add a consumer to a consumer group using a group id.

### 11.5.3. Message ordering guarantees

Kafka brokers receive fetch requests from consumers that ask the broker to send messages from a list of topics, partitions and offset positions.

A consumer observes messages in a single partition in the same order that they were committed to the broker, which means that Kafka **only** provides ordering guarantees for messages in a single partition. Conversely, if a consumer is consuming messages from multiple partitions, the order of messages in different partitions as observed by the consumer does not necessarily reflect the order in which they were sent.

If you want a strict ordering of messages from one topic, use one partition per consumer.

### 11.5.4. Optimizing consumers for throughput and latency

Control the number of messages returned when your client application calls `KafkaConsumer.poll()`.

Use the `fetch.max.wait.ms` and `fetch.min.bytes` properties to increase the minimum amount of data fetched by the consumer from the Kafka broker. Time-based batching is configured using `fetch.max.wait.ms`, and size-based batching is configured using `fetch.min.bytes`.

If CPU utilization in the consumer or broker is high, it might be because there are too many requests from the consumer. You can adjust `fetch.max.wait.ms` and `fetch.min.bytes` properties higher so that there are fewer requests and messages are delivered in bigger batches. By adjusting higher, throughput is improved with some cost to latency. You can also adjust higher if the amount of data being produced is low.

For example, if you set `fetch.max.wait.ms` to 500ms and `fetch.min.bytes` to 16384 bytes, when Kafka receives a fetch request from the consumer it will respond when the first of either threshold is reached.

Conversely, you can adjust the `fetch.max.wait.ms` and `fetch.min.bytes` properties lower to improve end-to-end latency.

```
# ...
fetch.max.wait.ms=500 ①
```

```
fetch.min.bytes=16384 ②  
# ...
```

① The maximum time in milliseconds the broker will wait before completing fetch requests. The default is **500** milliseconds.

② If a minimum batch size in bytes is used, a request is sent when the minimum is reached, or messages have been queued for longer than **fetch.max.wait.ms** (whichever comes sooner). Adding the delay allows batches to accumulate messages up to the batch size.

*Lowering latency by increasing the fetch request size*

Use the **fetch.max.bytes** and **max.partition.fetch.bytes** properties to increase the maximum amount of data fetched by the consumer from the Kafka broker.

The **fetch.max.bytes** property sets a maximum limit in bytes on the amount of data fetched from the broker at one time.

The **max.partition.fetch.bytes** sets a maximum limit in bytes on how much data is returned for each partition, which must always be larger than the number of bytes set in the broker or topic configuration for **max.message.bytes**.

The maximum amount of memory a client can consume is calculated approximately as:

```
NUMBER-OF-BROKERS * fetch.max.bytes and NUMBER-OF-PARTITIONS *  
max.partition.fetch.bytes
```

If memory usage can accommodate it, you can increase the values of these two properties. By allowing more data in each request, latency is improved as there are fewer fetch requests.

```
# ...  
fetch.max.bytes=52428800 ①  
max.partition.fetch.bytes=1048576 ②  
# ...
```

① The maximum amount of data in bytes returned for a fetch request.

② The maximum amount of data in bytes returned for each partition.

### 11.5.5. Avoiding data loss or duplication when committing offsets

The Kafka *auto-commit mechanism* allows a consumer to commit the offsets of messages automatically. If enabled, the consumer will commit offsets received from polling the broker at 5000ms intervals.

The auto-commit mechanism is convenient, but it introduces a risk of data loss and duplication. If a consumer has fetched and transformed a number of messages, but the system crashes with processed messages in the consumer buffer when performing an auto-commit, that data is lost. If the system crashes after processing the messages, but before performing the auto-commit, the data is duplicated on another consumer instance after rebalancing.

Auto-committing can avoid data loss only when all messages are processed before the next poll to the broker, or the consumer closes.

To minimize the likelihood of data loss or duplication, you can set `enable.auto.commit` to `false` and develop your client application to have more control over committing offsets. Or you can use `auto.commit.interval.ms` to decrease the intervals between commits.

```
# ...
enable.auto.commit=false ①
# ...
```

① Auto commit is set to false to provide more control over committing offsets.

By setting to `enable.auto.commit` to `false`, you can commit offsets after **all** processing has been performed and the message has been consumed. For example, you can set up your application to call the Kafka `commitSync` and `commitAsync` commit APIs.

The `commitSync` API commits the offsets in a message batch returned from polling. You call the API when you are finished processing all the messages in the batch. If you use the `commitSync` API, the application will not poll for new messages until the last offset in the batch is committed. If this negatively affects throughput, you can commit less frequently, or you can use the `commitAsync` API. The `commitAsync` API does not wait for the broker to respond to a commit request, but risks creating more duplicates when rebalancing. A common approach is to combine both commit APIs in an application, with the `commitSync` API used just before shutting the consumer down or rebalancing to make sure the final commit is successful.

## Controlling transactional messages

Consider using transactional ids and enabling idempotence (`enable.idempotence=true`) on the producer side to guarantee exactly-once delivery. On the consumer side, you can then use the `isolation.level` property to control how transactional messages are read by the consumer.

The `isolation.level` property has two valid values:

- `read_committed`
- `read_uncommitted` (default)

Use `read_committed` to ensure that only transactional messages that have been committed are read by the consumer. However, this will cause an increase in end-to-end latency, because the consumer will not be able to return a message until the brokers have written the transaction markers that record the result of the transaction (*committed* or *aborted*).

```
# ...
enable.auto.commit=false
isolation.level=read_committed ①
# ...
```

① Set to `read_committed` so that only committed messages are read by the consumer.

## 11.5.6. Recovering from failure to avoid data loss

Use the `session.timeout.ms` and `heartbeat.interval.ms` properties to configure the time taken to check and recover from consumer failure within a consumer group.

The `session.timeout.ms` property specifies the maximum amount of time in milliseconds a consumer within a consumer group can be out of contact with a broker before being considered inactive and a *rebalancing* is triggered between the active consumers in the group. When the group rebalances, the partitions are reassigned to the members of the group.

The `heartbeat.interval.ms` property specifies the interval in milliseconds between *heartbeat* checks to the consumer group coordinator to indicate that the consumer is active and connected. The heartbeat interval must be lower, usually by a third, than the session timeout interval.

If you set the `session.timeout.ms` property lower, failing consumers are detected earlier, and rebalancing can take place quicker. However, take care not to set the timeout so low that the broker fails to receive a heartbeat in time and triggers an unnecessary rebalance.

Decreasing the heartbeat interval reduces the chance of accidental rebalancing, but more frequent heartbeats increases the overhead on broker resources.

## 11.5.7. Managing offset policy

Use the `auto.offset.reset` property to control how a consumer behaves when no offsets have been committed, or a committed offset is no longer valid or deleted.

Suppose you deploy a consumer application for the first time, and it reads messages from an existing topic. Because this is the first time the `group.id` is used, the `_consumer_offsets` topic does not contain any offset information for this application. The new application can start processing all existing messages from the start of the log or only new messages. The default reset value is `latest`, which starts at the end of the partition, and consequently means some messages are missed. To avoid data loss, but increase the amount of processing, set `auto.offset.reset` to `earliest` to start at the beginning of the partition.

Also consider using the `earliest` option to avoid messages being lost when the offsets retention period (`offsets.retention.minutes`) configured for a broker has ended. If a consumer group or standalone consumer is inactive and commits no offsets during the retention period, previously committed offsets are deleted from `_consumer_offsets`.

```
# ...
heartbeat.interval.ms=3000 ①
session.timeout.ms=45000 ②
auto.offset.reset=earliest ③
# ...
```

① Adjust the heartbeat interval lower according to anticipated rebalances.

② If no heartbeats are received by the Kafka broker before the timeout duration expires, the consumer is removed from the consumer group and a rebalance is initiated. If the broker configuration has a `group.min.session.timeout.ms` and `group.max.session.timeout.ms`, the session

timeout value must be within that range.

- ③ Set to `earliest` to return to the start of a partition and avoid data loss if offsets were not committed.

If the amount of data returned in a single fetch request is large, a timeout might occur before the consumer has processed it. In this case, you can lower `max.partition.fetch.bytes` or increase `session.timeout.ms`.

### 11.5.8. Minimizing the impact of rebalances

The rebalancing of a partition between active consumers in a group is the time it takes for:

- Consumers to commit their offsets
- The new consumer group to be formed
- The group leader to assign partitions to group members
- The consumers in the group to receive their assignments and start fetching

Clearly, the process increases the downtime of a service, particularly when it happens repeatedly during a rolling restart of a consumer group cluster.

In this situation, you can use the concept of *static membership* to reduce the number of rebalances. Rebalancing assigns topic partitions evenly among consumer group members. Static membership uses persistence so that a consumer instance is recognized during a restart after a session timeout.

The consumer group coordinator can identify a new consumer instance using a unique id that is specified using the `group.instance.id` property. During a restart, the consumer is assigned a new member id, but as a static member it continues with the same instance id, and the same assignment of topic partitions is made.

If the consumer application does not make a call to poll at least every `max.poll.interval.ms` milliseconds, the consumer is considered to be failed, causing a rebalance. If the application cannot process all the records returned from poll in time, you can avoid a rebalance by using the `max.poll.interval.ms` property to specify the interval in milliseconds between polls for new messages from a consumer. Or you can use the `max.poll.records` property to set a maximum limit on the number of records returned from the consumer buffer, allowing your application to process fewer records within the `max.poll.interval.ms` limit.

```
# ...
group.instance.id=UNIQUE-ID ①
max.poll.interval.ms=300000 ②
max.poll.records=500 ③
# ...
```

① The unique instance id ensures that a new consumer instance receives the same assignment of topic partitions.

② Set the interval to check the consumer is continuing to process messages.

③ Sets the number of processed records returned from the consumer.

## 11.6. Handling high volumes of messages

If your Strimzi deployment needs to handle a high volume of messages, you can use configuration options to optimize for throughput and latency.

Producer and consumer configuration can help control the size and frequency of requests to Kafka brokers. For more information on the configuration options, see the following:

- [Apache Kafka configuration documentation for producers](#)
- [Apache Kafka configuration documentation for consumers](#)

You can also use the same configuration options with the producers and consumers used by the Kafka Connect runtime source connectors (including MirrorMaker 2.0) and sink connectors.

### Source connectors

- Producers from the Kafka Connect runtime send messages to the Kafka cluster.
- For MirrorMaker 2.0, since the source system is Kafka, consumers retrieve messages from a source Kafka cluster.

### Sink connectors

- Consumers from the Kafka Connect runtime retrieve messages from the Kafka cluster.

For consumers, you might increase the amount of data fetched in a single fetch request to reduce latency. You increase the fetch request size using the `fetch.max.bytes` and `max.partition.fetch.bytes` properties. You can also set a maximum limit on the number of messages returned from the consumer buffer using the `max.poll.records` property.

For MirrorMaker 2.0, configure the `fetch.max.bytes`, `max.partition.fetch.bytes`, and `max.poll.records` values at the source connector level (`consumer.*`), as they relate to the specific consumer that fetches messages from the source.

For producers, you might increase the size of the message batches sent in a single produce request. You increase the batch size using the `batch.size` property. A larger batch size reduces the number of outstanding messages ready to be sent and the size of the backlog in the message queue. Messages being sent to the same partition are batched together. A produce request is sent to the target cluster when the batch size is reached. By increasing the batch size, produce requests are delayed and more messages are added to the batch and sent to brokers at the same time. This can improve throughput when you have just a few topic partitions that handle large numbers of messages.

Consider the number and size of the records that the producer handles for a suitable producer batch size.

Use `linger.ms` to add a wait time in milliseconds to delay produce requests when producer load decreases. The delay means that more records can be added to batches if they are under the maximum batch size.

Configure the `batch.size` and `linger.ms` values at the source connector level (`producer.override.*`),

as they relate to the specific producer that sends messages to the target Kafka cluster.

For Kafka Connect source connectors, the data streaming pipeline to the target Kafka cluster is as follows:

*Data streaming pipeline for Kafka Connect source connector*

**external data source → (Kafka Connect tasks) source message queue → producer buffer → target Kafka topic**

For Kafka Connect sink connectors, the data streaming pipeline to the target external data source is as follows:

*Data streaming pipeline for Kafka Connect sink connector*

**source Kafka topic → (Kafka Connect tasks) sink message queue → consumer buffer → external data source**

For MirrorMaker 2.0, the data mirroring pipeline to the target Kafka cluster is as follows:

*Data mirroring pipeline for MirrorMaker 2.0*

**source Kafka topic → (Kafka Connect tasks) source message queue → producer buffer → target Kafka topic**

The producer sends messages in its buffer to topics in the target Kafka cluster. While this is happening, Kafka Connect tasks continue to poll the data source to add messages to the source message queue.

The size of the producer buffer for the source connector is set using the `producer.override.buffer.memory` property. Tasks wait for a specified timeout period (`offset.flush.timeout.ms`) before the buffer is flushed. This should be enough time for the sent messages to be acknowledged by the brokers and offset data committed. The source task does not wait for the producer to empty the message queue before committing offsets, except during shutdown.

If the producer is unable to keep up with the throughput of messages in the source message queue, buffering is blocked until there is space available in the buffer within a time period bounded by `max.block.ms`. Any unacknowledged messages still in the buffer are sent during this period. New messages are not added to the buffer until these messages are acknowledged and flushed.

You can try the following configuration changes to keep the underlying source message queue of outstanding messages at a manageable size:

- Increasing the default value in milliseconds of the `offset.flush.timeout.ms`
- Ensuring that there are enough [CPU and memory resources](#)
- Increasing the number of tasks that run in parallel by doing the following:
  - Increasing the number of tasks that run in parallel using the `tasksMax` property
  - Increasing the number of worker nodes that run tasks using the `replicas` property

Consider the number of tasks that can run in parallel according to the available CPU and memory

resources and number of worker nodes. You might need to keep adjusting the configuration values until they have the desired effect.

### 11.6.1. Configuring Kafka Connect for high-volume messages

Kafka Connect fetches data from the source external data system and hands it to the Kafka Connect runtime producers so that it's replicated to the target cluster.

The following example shows configuration for Kafka Connect using the [KafkaConnect](#) custom resource.

*Example Kafka Connect configuration for handling high volumes of messages*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
  annotations:
    strimzi.io/use-connector-resources: "true"
spec:
  replicas: 3
  config:
    offset.flush.timeout.ms: 10000
    # ...
  resources:
    requests:
      cpu: "1"
      memory: 2Gi
    limits:
      cpu: "2"
      memory: 2Gi
  # ...
```

Producer configuration is added for the source connector, which is managed using the [KafkaConnector](#) custom resource.

*Example source connector configuration for handling high volumes of messages*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-source-connector
  labels:
    strimzi.io/cluster: my-connect-cluster
spec:
  class: org.apache.kafka.connect.file.FileStreamSourceConnector
  tasksMax: 2
  config:
    producer.override.batch.size: 327680
    producer.override.linger.ms: 100
```

```
# ...
```

**NOTE** [FileStreamSourceConnector](#) and [FileStreamSinkConnector](#) are provided as example connectors. For information on deploying them as [KafkaConnector](#) resources, see [Deploying example KafkaConnector resources](#).

Consumer configuration is added for the sink connector.

*Example sink connector configuration for handling high volumes of messages*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-sink-connector
  labels:
    strimzi.io/cluster: my-connect-cluster
spec:
  class: org.apache.kafka.connect.file FileStreamSinkConnector
  tasksMax: 2
  config:
    consumer.fetch.max.bytes: 52428800
    consumer.max.partition.fetch.bytes: 1048576
    consumer.max.poll.records: 500
    # ...
```

If you are using the Kafka Connect API instead of the [KafkaConnector](#) custom resource to manage your connectors, you can add the connector configuration as a JSON object.

*Example curl request to add source connector configuration for handling high volumes of messages*

```
curl -X POST \
  http://my-connect-cluster-connect-api:8083/connectors \
  -H 'Content-Type: application/json' \
  -d '{ "name": "my-source-connector",
  "config":
  {
    "connector.class": "org.apache.kafka.connect.file FileStreamSourceConnector",
    "file": "/opt/kafka/LICENSE",
    "topic": "my-topic",
    "tasksMax": "4",
    "type": "source"
    "producer.override.batch.size": 327680
    "producer.override.linger.ms": 100
  }
}'
```

## 11.6.2. Configuring MirrorMaker 2.0 for high-volume messages

MirrorMaker 2.0 fetches data from the source cluster and hands it to the Kafka Connect runtime producers so that it's replicated to the target cluster.

The following example shows the configuration for MirrorMaker 2.0 using the [KafkaMirrorMaker2](#) custom resource.

*Example MirrorMaker 2.0 configuration for handling high volumes of messages*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker2
metadata:
  name: my-mirror-maker2
spec:
  version: 3.3.1
  replicas: 1
  connectCluster: "my-cluster-target"
  clusters:
    - alias: "my-cluster-source"
      bootstrapServers: my-cluster-source-kafka-bootstrap:9092
    - alias: "my-cluster-target"
      config:
        offset.flush.timeout.ms: 10000
      bootstrapServers: my-cluster-target-kafka-bootstrap:9092
  mirrors:
    - sourceCluster: "my-cluster-source"
      targetCluster: "my-cluster-target"
      sourceConnector:
        tasksMax: 2
        config:
          producer.override.batch.size: 327680
          producer.override.linger.ms: 100
          consumer.fetch.max.bytes: 52428800
          consumer.max.partition.fetch.bytes: 1048576
          consumer.max.poll.records: 500
      # ...
  resources:
    requests:
      cpu: "1"
      memory: Gi
    limits:
      cpu: "2"
      memory: 4Gi
```

## 11.6.3. Checking the MirrorMaker 2.0 message flow

If you are using Prometheus and Grafana to monitor your deployment, you can check the MirrorMaker 2.0 message flow.

The example MirrorMaker 2.0 Grafana dashboards provided with Strimzi show the following metrics related to the flush pipeline.

- The number of messages in Kafka Connect's outstanding messages queue
- The available bytes of the producer buffer
- The offset commit timeout in milliseconds

You can use these metrics to gauge whether or not you need to tune your configuration based on the volume of messages.

*Additional resources*

- [Grafana dashboards](#)
- [Creating and managing connectors](#)

# Chapter 12. Custom resource API reference

## 12.1. Common configuration properties

Common configuration properties apply to more than one resource.

### 12.1.1. `replicas`

Use the `replicas` property to configure replicas.

The type of replication depends on the resource.

- `KafkaTopic` uses a replication factor to configure the number of replicas of each partition within a Kafka cluster.
- Kafka components use replicas to configure the number of pods in a deployment to provide better availability and scalability.

**NOTE** When running a Kafka component on Kubernetes it may not be necessary to run multiple replicas for high availability. When the node where the component is deployed crashes, Kubernetes will automatically reschedule the Kafka component pod to a different node. However, running Kafka components with multiple replicas can provide faster failover times as the other nodes will be up and running.

### 12.1.2. `bootstrapServers`

Use the `bootstrapServers` property to configure a list of bootstrap servers.

The bootstrap server lists can refer to Kafka clusters that are not deployed in the same Kubernetes cluster. They can also refer to a Kafka cluster not deployed by Strimzi.

If on the same Kubernetes cluster, each list must ideally contain the Kafka cluster bootstrap service which is named `CLUSTER-NAME-kafka-bootstrap` and a port number. If deployed by Strimzi but on different Kubernetes clusters, the list content depends on the approach used for exposing the clusters (routes, ingress, nodeports or loadbalancers).

When using Kafka with a Kafka cluster not managed by Strimzi, you can specify the bootstrap servers list according to the configuration of the given cluster.

### 12.1.3. `ssl`

Use the three allowed `ssl` configuration options for client connection using a specific *cipher suite* for a TLS version. A cipher suite combines algorithms for secure connection and data transfer.

You can also configure the `ssl.endpoint.identification.algorithm` property to enable or disable hostname verification.

### *Example SSL configuration*

```
# ...
spec:
  config:
    ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384" ①
    ssl.enabled.protocols: "TLSv1.2" ②
    ssl.protocol: "TLSv1.2" ③
    ssl.endpoint.identification.algorithm: HTTPS ④
# ...
```

- ① The cipher suite for TLS using a combination of `ECDHE` key exchange mechanism, `RSA` authentication algorithm, `AES` bulk encryption algorithm and `SHA384` MAC algorithm.
- ② The SSL protocol `TLSv1.2` is enabled.
- ③ Specifies the `TLSv1.2` protocol to generate the SSL context. Allowed values are `TLSv1.1` and `TLSv1.2`.
- ④ Hostname verification is enabled by setting to `HTTPS`. An empty string disables the verification.

#### **12.1.4. `trustedCertificates`**

Having set `tls` to configure TLS encryption, use the `trustedCertificates` property to provide a list of secrets with key names under which the certificates are stored in X.509 format.

You can use the secrets created by the Cluster Operator for the Kafka cluster, or you can create your own TLS certificate file, then create a `Secret` from the file:

```
kubectl create secret generic MY-SECRET \
--from-file=MY-TLS-CERTIFICATE-FILE.crt
```

### *Example TLS encryption configuration*

```
tls:
  trustedCertificates:
    - secretName: my-cluster-cluster-cert
      certificate: ca.crt
    - secretName: my-cluster-cluster-cert
      certificate: ca2.crt
```

If certificates are stored in the same secret, it can be listed multiple times.

If you want to enable TLS, but use the default set of public certification authorities shipped with Java, you can specify `trustedCertificates` as an empty array:

### *Example of enabling TLS with the default Java certificates*

```
tls:
  trustedCertificates: []
```

For information on configuring TLS client authentication, see the [KafkaClientAuthenticationTls schema reference](#).

### 12.1.5. resources

Configure resource *requests* and *limits* to control resources for Strimzi containers. You can specify requests and limits for `memory` and `cpu` resources. The requests should be enough to ensure a stable performance of Kafka.

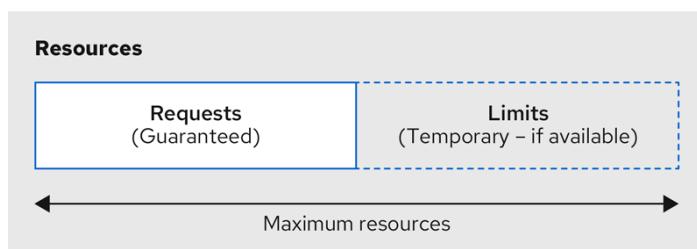
How you configure resources in a production environment depends on a number of factors. For example, applications are likely to be sharing resources in your Kubernetes cluster.

For Kafka, the following aspects of a deployment can impact the resources you need:

- Throughput and size of messages
- The number of network threads handling messages
- The number of producers and consumers
- The number of topics and partitions

The values specified for resource requests are reserved and always available to the container. Resource limits specify the maximum resources that can be consumed by a given container. The amount between the request and limit is not reserved and might not be always available. A container can use the resources up to the limit only when they are available. Resource limits are temporary and can be reallocated.

#### *Resource requests and limits*



212\_Streams\_0322

If you set limits without requests or vice versa, Kubernetes uses the same value for both. Setting equal requests and limits for resources guarantees quality of service, as Kubernetes will not kill containers unless they exceed their limits.

You can configure resource requests and limits for one or more supported resources.

#### *Example resource configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    #...
```

```
resources:
  requests:
    memory: 64Gi
    cpu: "8"
  limits:
    memory: 64Gi
    cpu: "12"
entityOperator:
  #...
topicOperator:
  #...
  resources:
    requests:
      memory: 512Mi
      cpu: "1"
    limits:
      memory: 512Mi
      cpu: "1"
```

Resource requests and limits for the Topic Operator and User Operator are set in the [Kafka](#) resource.

If the resource request is for more than the available free resources in the Kubernetes cluster, the pod is not scheduled.

**NOTE** Strimzi uses the Kubernetes syntax for specifying [memory](#) and [cpu](#) resources. For more information about managing computing resources on Kubernetes, see [Managing Compute Resources for Containers](#).

## Memory resources

When configuring memory resources, consider the total requirements of the components.

Kafka runs inside a JVM and uses an operating system page cache to store message data before writing to disk. The memory request for Kafka should fit the JVM heap and page cache. You can [configure the `jvmOptions` property](#) to control the minimum and maximum heap size.

Other components don't rely on the page cache. You can configure memory resources without configuring the [jvmOptions](#) to control the heap size.

Memory requests and limits are specified in megabytes, gigabytes, mebibytes, and gibibytes. Use the following suffixes in the specification:

- [M](#) for megabytes
- [G](#) for gigabytes
- [Mi](#) for mebibytes
- [Gi](#) for gibibytes

*Example resources using different memory units*

```
# ...
```

```
resources:  
  requests:  
    memory: 512Mi  
  limits:  
    memory: 2Gi  
# ...
```

For more details about memory specification and additional supported units, see [Meaning of memory](#).

## CPU resources

A CPU request should be enough to give a reliable performance at any time. CPU requests and limits are specified as *cores* or *millicpus/millicores*.

CPU cores are specified as integers (5 CPU core) or decimals (2.5 CPU core). 1000 *millicores* is the same as 1 CPU core.

*Example CPU units*

```
# ...  
resources:  
  requests:  
    cpu: 500m  
  limits:  
    cpu: 2.5  
# ...
```

The computing power of 1 CPU core may differ depending on the platform where Kubernetes is deployed.

For more information on CPU specification, see [Meaning of CPU](#).

## 12.1.6. **image**

Use the **image** property to configure the container image used by the component.

Overriding container images is recommended only in special situations where you need to use a different container registry or a customized image.

For example, if your network does not allow access to the container repository used by Strimzi, you can copy the Strimzi images or build them from the source. However, if the configured image is not compatible with Strimzi images, it might not work properly.

A copy of the container image might also be customized and used for debugging.

You can specify which container image to use for a component using the **image** property in the following resources:

- `Kafka.spec.kafka`

- `Kafka.spec.zookeeper`
- `Kafka.spec.entityOperator.topicOperator`
- `Kafka.spec.entityOperator.userOperator`
- `Kafka.spec.entityOperator.tlsSidecar`
- `Kafka.spec.jmxTrans`
- `KafkaConnect.spec`
- `KafkaMirrorMaker.spec`
- `KafkaMirrorMaker2.spec`
- `KafkaBridge.spec`

## Configuring the `image` property for Kafka, Kafka Connect, and Kafka MirrorMaker

Kafka, Kafka Connect, and Kafka MirrorMaker support multiple versions of Kafka. Each component requires its own image. The default images for the different Kafka versions are configured in the following environment variables:

- `STRIMZI_KAFKA_IMAGES`
- `STRIMZI_KAFKA_CONNECT_IMAGES`
- `STRIMZI_KAFKA_MIRROR MAKER_IMAGES`

These environment variables contain mappings between the Kafka versions and their corresponding images. The mappings are used together with the `image` and `version` properties:

- If neither `image` nor `version` are given in the custom resource then the `version` will default to the Cluster Operator's default Kafka version, and the image will be the one corresponding to this version in the environment variable.
- If `image` is given but `version` is not, then the given image is used and the `version` is assumed to be the Cluster Operator's default Kafka version.
- If `version` is given but `image` is not, then the image that corresponds to the given version in the environment variable is used.
- If both `version` and `image` are given, then the given image is used. The image is assumed to contain a Kafka image with the given version.

The `image` and `version` for the different components can be configured in the following properties:

- For Kafka in `spec.kafka.image` and `spec.kafka.version`.
- For Kafka Connect and Kafka MirrorMaker in `spec.image` and `spec.version`.

### WARNING

It is recommended to provide only the `version` and leave the `image` property unspecified. This reduces the chance of making a mistake when configuring the custom resource. If you need to change the images used for different versions of Kafka, it is preferable to configure the Cluster Operator's environment variables.

## Configuring the `image` property in other resources

For the `image` property in the other custom resources, the given value will be used during deployment. If the `image` property is missing, the `image` specified in the Cluster Operator configuration will be used. If the `image` name is not defined in the Cluster Operator configuration, then the default value will be used.

- For Topic Operator:
  1. Container image specified in the `STRIMZI_DEFAULT_TOPIC_OPERATOR_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/operator:0.32.0` container image.
- For User Operator:
  1. Container image specified in the `STRIMZI_DEFAULT_USER_OPERATOR_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/operator:0.32.0` container image.
- For Entity Operator TLS sidecar:
  1. Container image specified in the `STRIMZI_DEFAULT_TLS_SIDECAR_ENTITY_OPERATOR_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/kafka:0.32.0-kafka-3.3.1` container image.
- For Kafka Exporter:
  1. Container image specified in the `STRIMZI_DEFAULT_KAFKA_EXPORTER_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/kafka:0.32.0-kafka-3.3.1` container image.
- For Kafka Bridge:
  1. Container image specified in the `STRIMZI_DEFAULT_KAFKA_BRIDGE_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/kafka-bridge:0.22.3` container image.
- For Kafka broker initializer:
  1. Container image specified in the `STRIMZI_DEFAULT_KAFKA_INIT_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/operator:0.32.0` container image.
- For Kafka jmxTrans:
  1. Container image specified in the `STRIMZI_DEFAULT_JMXTRANS_IMAGE` environment variable from the Cluster Operator configuration.
  2. `quay.io/strimzi/jmxtrans:0.32.0` container image.

*Example container image configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
```

```
name: my-cluster
spec:
  kafka:
    # ...
    image: my-org/my-image:latest
    # ...
  zookeeper:
    # ...
```

### 12.1.7. `livenessProbe` and `readinessProbe` healthchecks

Use the `livenessProbe` and `readinessProbe` properties to configure healthcheck probes supported in Strimzi.

Healthchecks are periodical tests which verify the health of an application. When a Healthcheck probe fails, Kubernetes assumes that the application is not healthy and attempts to fix it.

For more details about the probes, see [Configure Liveness and Readiness Probes](#).

Both `livenessProbe` and `readinessProbe` support the following options:

- `initialDelaySeconds`
- `timeoutSeconds`
- `periodSeconds`
- `successThreshold`
- `failureThreshold`

*Example of liveness and readiness probe configuration*

```
# ...
readinessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
livenessProbe:
  initialDelaySeconds: 15
  timeoutSeconds: 5
# ...
```

For more information about the `livenessProbe` and `readinessProbe` options, see the [Probe schema reference](#).

### 12.1.8. `metricsConfig`

Use the `metricsConfig` property to enable and configure Prometheus metrics.

The `metricsConfig` property contains a reference to a ConfigMap that has additional configurations for the [Prometheus JMX Exporter](#). Strimzi supports Prometheus metrics using Prometheus JMX exporter to convert the JMX metrics supported by Apache Kafka and ZooKeeper to Prometheus

metrics.

To enable Prometheus metrics export without further configuration, you can reference a ConfigMap containing an empty file under `metricsConfig.valueFrom.configMapKeyRef.key`. When referencing an empty file, all metrics are exposed as long as they have not been renamed.

#### *Example ConfigMap with metrics configuration for Kafka*

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: my-configmap
data:
  my-key: |
    lowercaseOutputName: true
    rules:
      # Special cases and very specific rules
      - pattern: kafka.server<type=(.+), name=(.+), clientId=(.+), topic=(.+),
        partition=(.+)><>Value
        name: kafka_server_$1_$2
        type: GAUGE
        labels:
          clientId: "$3"
          topic: "$4"
          partition: "$5"
      # further configuration
```

#### *Example metrics configuration for Kafka*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    metricsConfig:
      type: jmxPrometheusExporter
      valueFrom:
        configMapKeyRef:
          name: my-config-map
          key: my-key
    # ...
  zookeeper:
    # ...
```

When metrics are enabled, they are exposed on port 9404.

When the `metricsConfig` (or deprecated `metrics`) property is not defined in the resource, the Prometheus metrics are disabled.

For more information about setting up and deploying Prometheus and Grafana, see [Introducing Metrics to Kafka](#) in the *Deploying and Upgrading Strimzi* guide.

## 12.1.9. `jvmOptions`

The following Strimzi components run inside a Java Virtual Machine (JVM):

- Apache Kafka
- Apache ZooKeeper
- Apache Kafka Connect
- Apache Kafka MirrorMaker
- Strimzi Kafka Bridge

To optimize their performance on different platforms and architectures, you configure the `jvmOptions` property in the following resources:

- `Kafka.spec.kafka`
- `Kafka.spec.zookeeper`
- `Kafka.spec.entityOperator.userOperator`
- `Kafka.spec.entityOperator.topicOperator`
- `Kafka.spec.cruiseControl`
- `KafkaConnect.spec`
- `KafkaMirrorMaker.spec`
- `KafkaMirrorMaker2.spec`
- `KafkaBridge.spec`

You can specify the following options in your configuration:

### `-Xms`

Minimum initial allocation heap size when the JVM starts

### `-Xmx`

Maximum heap size

### `-XX`

Advanced runtime options for the JVM

### `javaSystemProperties`

Additional system properties

### `gcLoggingEnabled`

[Enables garbage collector logging](#)

#### **NOTE**

The units accepted by JVM settings, such as `-Xmx` and `-Xms`, are the same units

accepted by the JDK `java` binary in the corresponding image. Therefore, `1g` or `1G` means 1,073,741,824 bytes, and `Gi` is not a valid unit suffix. This is different from the units used for [memory requests and limits](#), which follow the Kubernetes convention where `1G` means 1,000,000,000 bytes, and `1Gi` means 1,073,741,824 bytes.

#### `-Xms` and `-Xmx` options

In addition to setting memory request and limit values for your containers, you can use the `-Xms` and `-Xmx` JVM options to set specific heap sizes for your JVM. Use the `-Xms` option to set an initial heap size and the `-Xmx` option to set a maximum heap size.

Specify heap size to have more control over the memory allocated to your JVM. Heap sizes should make the best use of a container's [memory limit \(and request\)](#) without exceeding it. Heap size and any other memory requirements need to fit within a specified memory limit. If you don't specify heap size in your configuration, but you configure a memory resource limit (and request), the Cluster Operator imposes default heap sizes automatically. The Cluster Operator sets default maximum and minimum heap values based on a percentage of the memory resource configuration.

The following table shows the default heap values.

*Table 32. Default heap settings for components*

Component	Percent of available memory allocated to the heap	Maximum limit
Kafka	50%	5 GB
ZooKeeper	75%	2 GB
Kafka Connect	75%	None
MirrorMaker 2.0	75%	None
MirrorMaker	75%	None
Cruise Control	75%	None
Kafka Bridge	50%	31 Gi

If a memory limit (and request) is not specified, a JVM's minimum heap size is set to `128M`. The JVM's maximum heap size is not defined to allow the memory to increase as needed. This is ideal for single node environments in test and development.

Setting an appropriate memory request can prevent the following:

- Kubernetes killing a container if there is pressure on memory from other pods running on the node.
- Kubernetes scheduling a container to a node with insufficient memory. If `-Xms` is set to `-Xmx`, the container will crash immediately; if not, the container will crash at a later time.

In this example, the JVM uses 2 GiB (=2,147,483,648 bytes) for its heap. Total JVM memory usage can be a lot more than the maximum heap size.

### *Example -Xmx and -Xms configuration*

```
# ...
jvmOptions:
  "-Xmx": "2g"
  "-Xms": "2g"
# ...
```

Setting the same value for initial (`-Xms`) and maximum (`-Xmx`) heap sizes avoids the JVM having to allocate memory after startup, at the cost of possibly allocating more heap than is really needed.

#### **IMPORTANT**

Containers performing lots of disk I/O, such as Kafka broker containers, require available memory for use as an operating system page cache. For such containers, the requested memory should be significantly higher than the memory used by the JVM.

### *-XX option*

`-XX` options are used to configure the `KAFKA_JVM_PERFORMANCE_OPTS` option of Apache Kafka.

### *Example -XX configuration*

```
jvmOptions:
  "-XX":
    "UseG1GC": true
    "MaxGCPauseMillis": 20
    "InitiatingHeapOccupancyPercent": 35
    "ExplicitGCInvokesConcurrent": true
```

### *JVM options resulting from the -XX configuration*

```
-XX:+UseG1GC -XX:MaxGCPauseMillis=20 -XX:InitiatingHeapOccupancyPercent=35
-XX:+ExplicitGCInvokesConcurrent -XX:-UseParNewGC
```

#### **NOTE**

When no `-XX` options are specified, the default Apache Kafka configuration of `KAFKA_JVM_PERFORMANCE_OPTS` is used.

### *javaSystemProperties*

`javaSystemProperties` are used to configure additional Java system properties, such as debugging utilities.

### *Example javaSystemProperties configuration*

```
jvmOptions:
  javaSystemProperties:
    - name: javax.net.debug
      value: ssl
```

For more information about the `jvmOptions`, see the [JvmOptions schema reference](#).

## 12.1.10. Garbage collector logging

The `jvmOptions` property also allows you to enable and disable garbage collector (GC) logging. GC logging is disabled by default. To enable it, set the `gcLoggingEnabled` property as follows:

*Example GC logging configuration*

```
# ...
jvmOptions:
  gcLoggingEnabled: true
# ...
```

# 12.2. Schema properties

## 12.2.1. Kafka schema reference

Property	Description
<code>spec</code>	The specification of the Kafka and ZooKeeper clusters, and Topic Operator.
<code>KafkaSpec</code>	
<code>status</code>	The status of the Kafka and ZooKeeper clusters, and Topic Operator.
<code>KafkaStatus</code>	

## 12.2.2. KafkaSpec schema reference

Used in: [Kafka](#)

Property	Description
<code>kafka</code>	Configuration of the Kafka cluster.
<code>KafkaClusterSpec</code>	
<code>zookeeper</code>	Configuration of the ZooKeeper cluster.
<code>ZookeeperClusterSpec</code>	
<code>entityOperator</code>	Configuration of the Entity Operator.
<code>EntityOperatorSpec</code>	
<code>clusterCa</code>	Configuration of the cluster certificate authority.
<code>CertificateAuthority</code>	
<code>clientsCa</code>	Configuration of the clients certificate authority.
<code>CertificateAuthority</code>	
<code>cruiseControl</code>	Configuration for Cruise Control deployment.
<code>CruiseControlSpec</code>	Deploys a Cruise Control instance when specified.

Property	Description
jmxTrans	Configuration for JmxTrans. When the property is present a JmxTrans deployment is created for gathering JMX metrics from each Kafka broker. For more information see <a href="#">JmxTrans GitHub</a> .
JmxTransSpec	
kafkaExporter	Configuration of the Kafka Exporter. Kafka Exporter can provide additional metrics, for example lag of consumer group at topic/partition.
KafkaExporterSpec	
maintenanceTimeWindows	A list of time windows for maintenance tasks (that is, certificates renewal). Each time window is defined by a cron expression.
string array	

### 12.2.3. KafkaClusterSpec schema reference

Used in: [KafkaSpec](#)

[Full list of KafkaClusterSpec schema properties](#)

Configures a Kafka cluster.

#### listeners

Use the `listeners` property to configure listeners to provide access to Kafka brokers.

*Example configuration of a plain (unencrypted) listener without authentication*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
    listeners:
      - name: plain
        port: 9092
        type: internal
        tls: false
    # ...
  zookeeper:
    # ...
```

#### config

Use the `config` properties to configure Kafka broker options as keys.

Standard Apache Kafka configuration may be provided, restricted to those properties not managed directly by Strimzi.

Configuration options that cannot be configured relate to:

- Security (Encryption, Authentication, and Authorization)
- Listener configuration
- Broker ID configuration
- Configuration of log data directories
- Inter-broker communication
- ZooKeeper connectivity

The values can be one of the following JSON types:

- String
- Number
- Boolean

You can specify and configure the options listed in the [Apache Kafka documentation](#) with the exception of those options that are managed directly by Strimzi. Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `listeners`
- `advertised.`
- `broker.`
- `listener.`
- `host.name`
- `port`
- `inter.broker.listener.name`
- `sasl.`
- `ssl.`
- `security.`
- `password.`
- `principal.builder.class`
- `log.dir`
- `zookeeper.connect`
- `zookeeper.set.acl`
- `authorizer.`
- `super.user`

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other supported options are passed to Kafka.

There are exceptions to the forbidden options. For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed `ssl` properties](#). You can also configure the

`zookeeper.connection.timeout.ms` property to set the maximum time allowed for establishing a ZooKeeper connection.

*Example Kafka broker configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    config:
      num.partitions: 1
      num.recovery.threads.per.data.dir: 1
      default.replication.factor: 3
      offsets.topic.replication.factor: 3
      transaction.state.log.replication.factor: 3
      transaction.state.log.min.isr: 1
      log.retention.hours: 168
      log.segment.bytes: 1073741824
      log.retention.check.interval.ms: 300000
      num.network.threads: 3
      num.io.threads: 8
      socket.send.buffer.bytes: 102400
      socket.receive.buffer.bytes: 102400
      socket.request.max.bytes: 104857600
      group.initial.rebalance.delay.ms: 0
      ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384"
      ssl.enabled.protocols: "TLSv1.2"
      ssl.protocol: "TLSv1.2"
      zookeeper.connection.timeout.ms: 6000
    # ...
```

## **brokerRackInitImage**

When rack awareness is enabled, Kafka broker pods use init container to collect the labels from the Kubernetes cluster nodes. The container image used for this container can be configured using the `brokerRackInitImage` property. When the `brokerRackInitImage` field is missing, the following images are used in order of priority:

1. Container image specified in `STRIMZI_DEFAULT_KAFKA_INIT_IMAGE` environment variable in the Cluster Operator configuration.
2. `quay.io/strimzi/operator:0.32.0` container image.

*Example brokerRackInitImage configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
```

```
name: my-cluster
spec:
  kafka:
    # ...
    rack:
      topologyKey: topology.kubernetes.io/zone
    brokerRackInitImage: my-org/my-image:latest
    # ...
```

**NOTE** Overriding container images is recommended only in special situations, where you need to use a different container registry. For example, because your network does not allow access to the container registry used by Strimzi. In this case, you should either copy the Strimzi images or build them from the source. If the configured image is not compatible with Strimzi images, it might not work properly.

## logging

Kafka has its own configurable loggers:

- `log4j.logger.org.I0Itec.zkclient.ZkClient`
- `log4j.logger.org.apache.zookeeper`
- `log4j.logger.kafka`
- `log4j.logger.org.apache.kafka`
- `log4j.logger.kafka.request.logger`
- `log4j.logger.kafka.network.Processor`
- `log4j.logger.kafka.server.KafkaApis`
- `log4j.logger.kafka.network.RequestChannel$`
- `log4j.logger.kafka.controller`
- `log4j.logger.kafka.log.LogCleaner`
- `log4j.logger.state.change.logger`
- `log4j.logger.kafka.authorizer.logger`

Kafka uses the Apache `log4j` logger implementation.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not

set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  kafka:
    # ...
    logging:
      type: inline
      loggers:
        kafka.root.logger.level: "INFO"
  # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  logging:
    type: external
    valueFrom:
      configMapKeyRef:
        name: customConfigMap
        key: kafka-log4j.properties
  # ...
```

Any available loggers that are not configured have their level set to `OFF`.

If Kafka was deployed using the Cluster Operator, changes to Kafka logging levels are applied dynamically.

If you use external logging, a rolling update is triggered when logging appenders are changed.

#### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the `jvmOptions` property.

#### **KafkaClusterSpec schema properties**

Property	Description
version	The kafka broker version. Defaults to 3.3.1. Consult the user documentation to understand the process required to upgrade or downgrade the version.
string	
replicas	The number of pods in the cluster.
integer	
image	The docker image for the pods. The default value depends on the configured <code>Kafka.spec.kafka.version</code> .
string	
listeners	Configures listeners of Kafka brokers.
<code>GenericKafkaListener</code> array	
config	Kafka broker config properties with the following prefixes cannot be set: listeners, advertised., broker., listener., host.name, port, inter.broker.listener.name, sasl., ssl., security., password., log.dir, zookeeper.connect, zookeeper.set.acl, zookeeper.ssl, zookeeper.clientCnxnSocket, authorizer., super.user, cruise.control.metrics.topic, cruise.control.metrics.reporter.bootstrap.servers.node.id, process.roles, controller. (with the exception of: zookeeper.connection.timeout.ms, ssl.cipher.suites, ssl.protocol, ssl.enabled.protocols, sasl.server.max.receive.size, cruise.control.metrics.topic.num.partitions, cruise.control.metrics.topic.replication.factor, cruise.control.metrics.topic.retention.ms, cruise.control.metrics.topic.auto.create.retries, cruise.control.metrics.topic.auto.create.timeout.ms, cruise.control.metrics.topic.min.insync.replicas, controller.quorum.election.backoff.max.ms, controller.quorum.election.timeout.ms, controller.quorum.fetch.timeout.ms).
map	
storage	Storage configuration (disk). Cannot be updated. The type depends on the value of the <code>storage.type</code> property within the given object, which must be one of [ephemeral, persistent-claim, jbos].
<code>EphemeralStorage</code> , <code>PersistentClaimStorage</code> , <code>JbosStorage</code>	

Property	Description
authorization	Authorization configuration for Kafka brokers. The type depends on the value of the <code>authorization.type</code> property within the given object, which must be one of [simple, opa, keycloak, custom].
KafkaAuthorizationSimple, KafkaAuthorizationOpa, KafkaAuthorizationKeycloak, KafkaAuthorizationCustom	
rack	Configuration of the <code>broker.rack</code> broker config.
Rack	
brokerRackInitImage	The image of the init container used for initializing the <code>broker.rack</code> .
string	
livenessProbe	Pod liveness checking.
Probe	
readinessProbe	Pod readiness checking.
Probe	
jvmOptions	JVM Options for pods.
JvmOptions	
jmxOptions	JMX Options for Kafka brokers.
KafkaJmxOptions	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resource requirements</a> .
ResourceRequirements	
metricsConfig	Metrics configuration. The type depends on the value of the <code>metricsConfig.type</code> property within the given object, which must be one of [jmxPrometheusExporter].
JmxPrometheusExporterMetrics	
logging	Logging configuration for Kafka. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
InlineLogging, ExternalLogging	
template	Template for Kafka cluster resources. The template allows users to specify how the <code>StatefulSet</code> , <code>Pods</code> , and <code>Services</code> are generated.
KafkaClusterTemplate	

#### 12.2.4. `GenericKafkaListener` schema reference

Used in: `KafkaClusterSpec`

[Full list of `GenericKafkaListener` schema properties](#)

Configures listeners to connect to Kafka brokers within and outside Kubernetes.

You configure the listeners in the `Kafka` resource.

*Example Kafka resource showing listener configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    #...
    listeners:
      - name: plain
        port: 9092
        type: internal
        tls: false
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: tls
      - name: external1
        port: 9094
        type: route
        tls: true
      - name: external2
        port: 9095
        type: ingress
        tls: true
        authentication:
          type: tls
    configuration:
      bootstrap:
        host: bootstrap.myingress.com
      brokers:
        - broker: 0
          host: broker-0.myingress.com
        - broker: 1
          host: broker-1.myingress.com
        - broker: 2
          host: broker-2.myingress.com
    #...
```

## listeners

You configure Kafka broker listeners using the `listeners` property in the `Kafka` resource. Listeners are defined as an array.

*Example listener configuration*

```
listeners:
  - name: plain
```

```
port: 9092
type: internal
tls: false
```

The name and port must be unique within the Kafka cluster. The name can be up to 25 characters long, comprising lower-case letters and numbers. Allowed port numbers are 9092 and higher with the exception of ports 9404 and 9999, which are already used for Prometheus and JMX.

By specifying a unique name and port for each listener, you can configure multiple listeners.

## type

The type is set as `internal`, or for external listeners, as `route`, `loadbalancer`, `nodeport`, `ingress` or `cluster-ip`.

## internal

You can configure internal listeners with or without encryption using the `tls` property.

*Example `internal` listener configuration*

```
#...
spec:
  kafka:
    #...
    listeners:
      #...
      - name: plain
        port: 9092
        type: internal
        tls: false
      - name: tls
        port: 9093
        type: internal
        tls: true
        authentication:
          type: tls
#...
```

## route

Configures an external listener to expose Kafka using OpenShift `Routes` and the HAProxy router.

A dedicated `Route` is created for every Kafka broker pod. An additional `Route` is created to serve as a Kafka bootstrap address. Kafka clients can use these `Routes` to connect to Kafka on port 443. The client connects on port 443, the default router port, but traffic is then routed to the port you configure, which is `9094` in this example.

*Example `route` listener configuration*

```
#...
spec:
```

```
kafka:  
  #...  
  listeners:  
    #...  
    - name: external1  
      port: 9094  
      type: route  
      tls: true  
    #...
```

## ingress

Configures an external listener to expose Kafka using Kubernetes [Ingress](#) and the [NGINX Ingress Controller for Kubernetes](#).

A dedicated [Ingress](#) resource is created for every Kafka broker pod. An additional [Ingress](#) resource is created to serve as a Kafka bootstrap address. Kafka clients can use these [Ingress](#) resources to connect to Kafka on port 443. The client connects on port 443, the default controller port, but traffic is then routed to the port you configure, which is [9095](#) in the following example.

You must specify the hostnames used by the bootstrap and per-broker services using [GenericKafkaListenerConfigurationBootstrap](#) and [GenericKafkaListenerConfigurationBroker](#) properties.

*Example [ingress](#) listener configuration*

```
#...  
spec:  
  kafka:  
    #...  
    listeners:  
      #...  
      - name: external2  
        port: 9095  
        type: ingress  
        tls: true  
        authentication:  
          type: tls  
        configuration:  
          bootstrap:  
            host: bootstrap.myingress.com  
        brokers:  
          - broker: 0  
            host: broker-0.myingress.com  
          - broker: 1  
            host: broker-1.myingress.com  
          - broker: 2  
            host: broker-2.myingress.com  
    #...
```

**NOTE**

External listeners using [Ingress](#) are currently only tested with the [NGINX Ingress Controller for Kubernetes](#).

## loadbalancer

Configures an external listener to expose Kafka [Loadbalancer](#) type [Services](#).

A new loadbalancer service is created for every Kafka broker pod. An additional loadbalancer is created to serve as a Kafka *bootstrap* address. Loadbalancers listen to the specified port number, which is port [9094](#) in the following example.

You can use the [loadBalancerSourceRanges](#) property to configure [source ranges](#) to restrict access to the specified IP addresses.

*Example loadbalancer listener configuration*

```
#...
spec:
  kafka:
    #...
    listeners:
      - name: external3
        port: 9094
        type: loadbalancer
        tls: true
        configuration:
          loadBalancerSourceRanges:
            - 10.0.0.0/8
            - 88.208.76.87/32
    #...
```

## nodeport

Configures an external listener to expose Kafka using [NodePort](#) type [Services](#).

Kafka clients connect directly to the nodes of Kubernetes. An additional [NodePort](#) type of service is created to serve as a Kafka bootstrap address.

When configuring the advertised addresses for the Kafka broker pods, Strimzi uses the address of the node on which the given pod is running. You can use [preferredNodePortAddressType](#) property to configure the [first address type checked as the node address](#).

*Example nodeport listener configuration*

```
#...
spec:
  kafka:
    #...
    listeners:
      #...
      - name: external4
        port: 9095
```

```
type: nodeport
tls: false
configuration:
  preferredNodePortAddressType: InternalDNS
#...
```

**NOTE** TLS hostname verification is not currently supported when exposing Kafka clusters using node ports.

## cluster-ip

Create a listener which uses per-broker [Services](#) instead of the headless Service.

This listener type can be useful to expose the cluster outside of Kubernetes with some custom mechanisms such as TCP Ingress or other Ingress controllers etc

A new clusterIP service is created for each Kafka broker pod. An additional clusterIP is created to serve as a Kafka *bootstrap* address.

*Example cluster-ip listener configuration*

```
#...
spec:
  kafka:
    #...
    listeners:
      - name: external-cluster-ip
        type: cluster-ip
        tls: false
        port: 9096
#...
```

## port

The port number is the port used in the Kafka cluster, which might not be the same port used for access by a client.

- [loadbalancer](#) listeners use the specified port number, as do [internal](#) listeners
- [ingress](#) and [route](#) listeners use port 443 for access
- [nodeport](#) listeners use the port number assigned by Kubernetes

For client connection, use the address and port for the bootstrap service of the listener. You can retrieve this from the status of the [Kafka](#) resource.

*Example command to retrieve the address and port for client connection*

```
kubectl get kafka <kafka_cluster_name> -
o=jsonpath='{.status.listeners[?(@.name=="<listener_name>")].bootstrapServers}{"\n"}'
```

**NOTE**

Listeners cannot be configured to use the ports set aside for interbroker communication (9090 and 9091) and metrics (9404).

## tls

The TLS property is required.

By default, TLS encryption is not enabled. To enable it, set the `tls` property to `true`.

TLS encryption is always used with `route` listeners.

## authentication

Authentication for the listener can be specified as:

- Mutual TLS (`tls`)
- SCRAM-SHA-512 (`scram-sha-512`)
- Token-based OAuth 2.0 (`oauth`)
- Custom (`custom`)

## networkPolicyPeers

Use `networkPolicyPeers` to configure network policies that restrict access to a listener at the network level. The following example shows a `networkPolicyPeers` configuration for a `plain` and a `tls` listener.

```
listeners:  
  #...  
  - name: plain  
    port: 9092  
    type: internal  
    tls: true  
    authentication:  
      type: scram-sha-512  
    networkPolicyPeers:  
      - podSelector:  
          matchLabels:  
            app: kafka-sasl-consumer  
      - podSelector:  
          matchLabels:  
            app: kafka-sasl-producer  
  - name: tls  
    port: 9093  
    type: internal  
    tls: true  
    authentication:  
      type: tls  
    networkPolicyPeers:  
      - namespaceSelector:  
          matchLabels:
```

```

project: myproject
- namespaceSelector:
  matchLabels:
    project: myproject2
# ...

```

In the example:

- Only application pods matching the labels `app: kafka-sasl-consumer` and `app: kafka-sasl-producer` can connect to the `plain` listener. The application pods must be running in the same namespace as the Kafka broker.
- Only application pods running in namespaces matching the labels `project: myproject` and `project: myproject2` can connect to the `tls` listener.

The syntax of the `networkPolicyPeers` field is the same as the `from` field in `NetworkPolicy` resources.

### `GenericKafkaListener` schema properties

Property	Description
<code>name</code>	Name of the listener. The name will be used to identify the listener and the related Kubernetes objects. The name has to be unique within given a Kafka cluster. The name can consist of lowercase characters and numbers and be up to 11 characters long.
<code>string</code>	
<code>port</code>	Port number used by the listener inside Kafka. The port number has to be unique within a given Kafka cluster. Allowed port numbers are 9092 and higher with the exception of ports 9404 and 9999, which are already used for Prometheus and JMX. Depending on the listener type, the port number might not be the same as the port number that connects Kafka clients.
<code>integer</code>	

Property	Description
type	<p>Type of the listener. Currently the supported types are <code>internal</code>, <code>route</code>, <code>loadbalancer</code>, <code>nodeport</code> and <code>ingress</code>.</p> <ul style="list-style-type: none"> <li>• <code>internal</code> type exposes Kafka internally only within the Kubernetes cluster.</li> <li>• <code>route</code> type uses OpenShift Routes to expose Kafka.</li> <li>• <code>loadbalancer</code> type uses LoadBalancer type services to expose Kafka.</li> <li>• <code>nodeport</code> type uses NodePort type services to expose Kafka.</li> <li>• <code>ingress</code> type uses Kubernetes Nginx Ingress to expose Kafka with TLS passthrough.</li> <li>• <code>cluster-ip</code> type uses ClusterIP service with per broker port number. Can be exposed over Nginx Ingress Controller with tcp port config.</li> </ul>
string (one of [ingress, internal, route, loadbalancer, cluster-ip, nodeport])	
tls	Enables TLS encryption on the listener. This is a required property.
boolean	
authentication	Authentication configuration for this listener. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [tls, scram-sha-512, oauth, custom].
KafkaListenerAuthenticationTls, KafkaListenerAuthenticationScramSha512, KafkaListenerAuthenticationOAuth, KafkaListenerAuthenticationCustom	
configuration	Additional listener configuration.
<code>GenericKafkaListenerConfiguration</code>	
networkPolicyPeers	List of peers which should be able to connect to this listener. Peers in this list are combined using a logical OR operation. If this field is empty or missing, all connections will be allowed for this listener. If this field is present and contains at least one item, the listener only allows the traffic which matches at least one item in this list. For more information, see the <a href="#">external documentation for networking.k8s.io/v1 networkpolicypeer</a> .
NetworkPolicyPeer array	

## 12.2.5. `KafkaListenerAuthenticationTls` schema reference

Used in: `GenericKafkaListener`

The `type` property is a discriminator that distinguishes use of the `KafkaListenerAuthenticationTls` type from `KafkaListenerAuthenticationScramSha512`, `KafkaListenerAuthenticationOAuth`, `KafkaListenerAuthenticationCustom`. It must have the value `tls` for the type `KafkaListenerAuthenticationTls`.

Property	Description
<code>type</code>	Must be <code>tls</code> .
<code>string</code>	

## 12.2.6. `KafkaListenerAuthenticationScramSha512` schema reference

Used in: `GenericKafkaListener`

The `type` property is a discriminator that distinguishes use of the `KafkaListenerAuthenticationScramSha512` type from `KafkaListenerAuthenticationTls`, `KafkaListenerAuthenticationOAuth`, `KafkaListenerAuthenticationCustom`. It must have the value `scram-sha-512` for the type `KafkaListenerAuthenticationScramSha512`.

Property	Description
<code>type</code>	Must be <code>scram-sha-512</code> .
<code>string</code>	

## 12.2.7. `KafkaListenerAuthenticationOAuth` schema reference

Used in: `GenericKafkaListener`

The `type` property is a discriminator that distinguishes use of the `KafkaListenerAuthenticationOAuth` type from `KafkaListenerAuthenticationTls`, `KafkaListenerAuthenticationScramSha512`, `KafkaListenerAuthenticationCustom`. It must have the value `oauth` for the type `KafkaListenerAuthenticationOAuth`.

Property	Description
<code>accessTokenIsJwt</code>	Configure whether the access token is treated as JWT. This must be set to <code>false</code> if the authorization server returns opaque tokens. Defaults to <code>true</code> .
<code>boolean</code>	
<code>checkAccessTokenType</code>	Configure whether the access token type check is performed or not. This should be set to <code>false</code> if the authorization server does not include 'typ' claim in JWT token. Defaults to <code>true</code> .
<code>boolean</code>	

Property	Description
checkAudience	Enable or disable audience checking. Audience checks identify the recipients of tokens. If audience checking is enabled, the OAuth Client ID also has to be configured using the <code>clientId</code> property. The Kafka broker will reject tokens that do not have its <code>clientId</code> in their <code>aud</code> (audience) claim. Default value is <code>false</code> .
boolean	
checkIssuer	Enable or disable issuer checking. By default issuer is checked using the value configured by <code>validIssuerUri</code> . Default value is <code>true</code> .
boolean	
clientAudience	The audience to use when making requests to the authorization server's token endpoint. Used for inter-broker authentication and for configuring OAuth 2.0 over PLAIN using the <code>clientId</code> and <code>secret</code> method.
string	
clientId	OAuth Client ID which the Kafka broker can use to authenticate against the authorization server and use the introspect endpoint URI.
string	
clientScope	The scope to use when making requests to the authorization server's token endpoint. Used for inter-broker authentication and for configuring OAuth 2.0 over PLAIN using the <code>clientId</code> and <code>secret</code> method.
string	
clientSecret	Link to Kubernetes Secret containing the OAuth client secret which the Kafka broker can use to authenticate against the authorization server and use the introspect endpoint URI.
<code>GenericSecretSource</code>	
connectTimeoutSeconds	The connect timeout in seconds when connecting to authorization server. If not set, the effective connect timeout is 60 seconds.
integer	
customClaimCheck	JsonPath filter query to be applied to the JWT token or to the response of the introspection endpoint for additional token validation. Not set by default.
string	
disableTlsHostnameVerification	Enable or disable TLS hostname verification. Default value is <code>false</code> .
boolean	
enableECDSA	The <code>enableECDSA</code> property has been <b>deprecated</b> . Enable or disable ECDSA support by installing BouncyCastle crypto provider. ECDSA support is always enabled. The BouncyCastle libraries are no longer packaged with Strimzi. Value is ignored.
boolean	

Property	Description
enableMetrics boolean	Enable or disable OAuth metrics. Default value is <code>false</code> .
enableOauthBearer boolean	Enable or disable OAuth authentication over SASL_OAUTHBEARER. Default value is <code>true</code> .
enablePlain boolean	Enable or disable OAuth authentication over SASL_PLAIN. There is no re-authentication support when this mechanism is used. Default value is <code>false</code> .
failFast boolean	Enable or disable termination of Kafka broker processes due to potentially recoverable runtime errors during startup. Default value is <code>true</code> .
fallbackUserNameClaim string	The fallback username claim to be used for the user id if the claim specified by <code>userNameClaim</code> is not present. This is useful when <code>client_credentials</code> authentication only results in the client id being provided in another claim. It only takes effect if <code>userNameClaim</code> is set.
fallbackUserNamePrefix string	The prefix to use with the value of <code>fallbackUserNameClaim</code> to construct the user id. This only takes effect if <code>fallbackUserNameClaim</code> is true, and the value is present for the claim. Mapping usernames and client ids into the same user id space is useful in preventing name collisions.
groupsClaim string	JsonPath query used to extract groups for the user during authentication. Extracted groups can be used by a custom authorizer. By default no groups are extracted.
groupsClaimDelimiter string	A delimiter used to parse groups when they are extracted as a single String value rather than a JSON array. Default value is ',' (comma).
introspectionEndpointUri string	URI of the token introspection endpoint which can be used to validate opaque non-JWT tokens.
jwksEndpointUri string	URI of the JWKS certificate endpoint, which can be used for local JWT validation.

Property	Description
jwksExpirySeconds integer	Configures how often are the JWKS certificates considered valid. The expiry interval has to be at least 60 seconds longer then the refresh interval specified in <code>jwksRefreshSeconds</code> . Defaults to 360 seconds.
jwksIgnoreKeyUse boolean	Flag to ignore the 'use' attribute of <code>key</code> declarations in a JWKS endpoint response. Default value is <code>false</code> .
jwksMinRefreshPauseSeconds integer	The minimum pause between two consecutive refreshes. When an unknown signing key is encountered the refresh is scheduled immediately, but will always wait for this minimum pause. Defaults to 1 second.
jwksRefreshSeconds integer	Configures how often are the JWKS certificates refreshed. The refresh interval has to be at least 60 seconds shorter then the expiry interval specified in <code>jwksExpirySeconds</code> . Defaults to 300 seconds.
maxSecondsWithoutReauthentication integer	Maximum number of seconds the authenticated session remains valid without re-authentication. This enables Apache Kafka re-authentication feature, and causes sessions to expire when the access token expires. If the access token expires before max time or if max time is reached, the client has to re-authenticate, otherwise the server will drop the connection. Not set by default - the authenticated session does not expire when the access token expires. This option only applies to SASL_OAUTHBEARER authentication mechanism (when <code>enableOauthBearer</code> is <code>true</code> ).
readTimeoutSeconds integer	The read timeout in seconds when connecting to authorization server. If not set, the effective read timeout is 60 seconds.
tlsTrustedCertificates <code>CertSecretSource</code> array	Trusted certificates for TLS connection to the OAuth server.

Property	Description
tokenEndpointUri string	URI of the Token Endpoint to use with SASL_PLAIN mechanism when the client authenticates with <code>clientId</code> and a <code>secret</code> . If set, the client can authenticate over SASL_PLAIN by either setting <code>username</code> to <code>clientId</code> , and setting <code>password</code> to client <code>secret</code> , or by setting <code>username</code> to account <code>username</code> , and <code>password</code> to access token prefixed with <code>\$accessToken:</code> . If this option is not set, the <code>password</code> is always interpreted as an access token (without a prefix), and <code>username</code> as the account <code>username</code> (a so called 'no-client-credentials' mode).
type string	Must be <code>oauth</code> .
userInfoEndpointUri string	URI of the User Info Endpoint to use as a fallback to obtaining the user id when the Introspection Endpoint does not return information that can be used for the user id.
userNameClaim string	Name of the claim from the JWT authentication token, Introspection Endpoint response or User Info Endpoint response which will be used to extract the user id. Defaults to <code>sub</code> .
validIssuerUri string	URI of the token issuer used for authentication.
validTokenType string	Valid value for the <code>token_type</code> attribute returned by the Introspection Endpoint. No default value, and not checked by default.

### 12.2.8. `GenericSecretSource` schema reference

Used in: `KafkaClientAuthenticationOAuth`, `KafkaListenerAuthenticationCustom`, `KafkaListenerAuthenticationOAuth`

Property	Description
key string	The key under which the secret value is stored in the Kubernetes Secret.
secretName string	The name of the Kubernetes Secret containing the secret value.

### 12.2.9. `CertSecretSource` schema reference

Used in: `ClientTls`, `KafkaAuthorizationKeycloak`, `KafkaClientAuthenticationOAuth`,

## KafkaListenerAuthenticationOAuth

Property	Description
certificate	The name of the file certificate in the Secret.
string	
secretName	The name of the Secret containing the certificate.
string	

### 12.2.10. KafkaListenerAuthenticationCustom schema reference

Used in: [GenericKafkaListener](#)

[Full list of KafkaListenerAuthenticationCustom schema properties](#)

To configure custom authentication, set the `type` property to `custom`.

Custom authentication allows for any type of kafka-supported authentication to be used.

*Example custom OAuth authentication configuration*

```
spec:  
  kafka:  
    config:  
      principal.builder.class: SimplePrincipal.class  
    listeners:  
      - name: oauth-bespoke  
        port: 9093  
        type: internal  
        tls: true  
        authentication:  
          type: custom  
          sasl: true  
          listenerConfig:  
            oauthbearer.sasl.client.callback.handler.class: client.class  
            oauthbearer.sasl.server.callback.handler.class: server.class  
            oauthbearer.sasl.login.callback.handler.class: login.class  
            oauthbearer.connections.max.reauth.ms: 999999999  
            sasl.enabled.mechanisms: oauthbearer  
            oauthbearer.sasl.jaas.config: |  
              org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule  
required ;  
secrets:  
  - name: example
```

A protocol map is generated that uses the `sasl` and `tls` values to determine which protocol to map to the listener.

- SASL = True, TLS = True → SASL\_SSL

- SASL = False, TLS = True → SSL
- SASL = True, TLS = False → SASL\_PLAINTEXT
- SASL = False, TLS = False → PLAINTEXT

## listenerConfig

Listener configuration specified using `listenerConfig` is prefixed with `listener.name.<listener_name>-<port>`. For example, `sasl.enabled.mechanisms` becomes `listener.name.<listener_name>-<port>.sasl.enabled.mechanisms`.

## secrets

Secrets are mounted to `/opt/kafka/custom-authn-secrets/custom-listener-<listener_name>-<port>/<secret_name>` in the Kafka broker nodes' containers.

For example, the mounted secret ([example](#)) in the example configuration would be located at `/opt/kafka/custom-authn-secrets/custom-listener-oauth-bespoke-9093/example`.

## Principal builder

You can set a custom principal builder in the Kafka cluster configuration. However, the principal builder is subject to the following requirements:

- The specified principal builder class must exist on the image. *Before* building your own, check if one already exists. You'll need to rebuild the Strimzi images with the required classes.
- No other listener is using `oauth` type authentication. This is because an OAuth listener appends its own principle builder to the Kafka configuration.
- The specified principal builder is compatible with Strimzi.

Custom principal builders must support peer certificates for authentication, as Strimzi uses these to manage the Kafka cluster.

A custom OAuth principal builder might be identical or very similar to the Strimzi [OAuth principal builder](#).

### NOTE

[Kafka's default principal builder class](#) supports the building of principals based on the names of peer certificates. The custom principal builder should provide a principal of type `user` using the name of the SSL peer certificate.

The following example shows a custom principal builder that satisfies the OAuth requirements of Strimzi.

*Example principal builder for custom OAuth configuration*

```
public final class CustomKafkaPrincipalBuilder implements KafkaPrincipalBuilder {
    public KafkaPrincipalBuilder() {}

    @Override
```

```

public KafkaPrincipal build(AuthenticationContext context) {
    if (context instanceof SslAuthenticationContext) {
        SSLSession sslSession = ((SslAuthenticationContext) context).session();
        try {
            return new KafkaPrincipal(
                KafkaPrincipal.USER_TYPE,
                sslSession.getPeerPrincipal().getName());
        } catch (SSLPeerUnverifiedException e) {
            throw new IllegalArgumentException("Cannot use an unverified peer for authentication", e);
        }
    }

    // Create your own KafkaPrincipal here
    ...
}

```

### KafkaListenerAuthenticationCustom schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaListenerAuthenticationCustom` type from `KafkaListenerAuthenticationTls`, `KafkaListenerAuthenticationScramSha512`, `KafkaListenerAuthenticationOAuth`. It must have the value `custom` for the type `KafkaListenerAuthenticationCustom`.

Property	Description
listenerConfig	Configuration to be used for a specific listener. All values are prefixed with <code>listener.name.&lt;listener_name&gt;</code> .
map	
sasl	Enable or disable SASL on this listener.
boolean	
secrets	Secrets to be mounted to <code>/opt/kafka/custom-authn-secrets/custom-listener-&lt;listener_name&gt;-&lt;port&gt;/&lt;secret_name&gt;</code> .
GenericSecretSource array	
type	Must be <code>custom</code> .
string	

### 12.2.11. GenericKafkaListenerConfiguration schema reference

Used in: `GenericKafkaListener`

[Full list of `GenericKafkaListenerConfiguration` schema properties](#)

Configuration for Kafka listeners.

## brokerCertChainAndKey

The `brokerCertChainAndKey` property is only used with listeners that have TLS encryption enabled. You can use the property to provide your own Kafka listener certificates.

*Example configuration for a `loadbalancer` external listener with TLS encryption enabled*

```
listeners:  
#...  
- name: external  
  port: 9094  
  type: loadbalancer  
  tls: true  
  authentication:  
    type: tls  
  configuration:  
    brokerCertChainAndKey:  
      secretName: my-secret  
      certificate: my-listener-certificate.crt  
      key: my-listener-key.key  
# ...
```

## externalTrafficPolicy

The `externalTrafficPolicy` property is used with `loadbalancer` and `nodeport` listeners. When exposing Kafka outside of Kubernetes you can choose `Local` or `Cluster`. `Local` avoids hops to other nodes and preserves the client IP, whereas `Cluster` does neither. The default is `Cluster`.

## loadBalancerSourceRanges

The `loadBalancerSourceRanges` property is only used with `loadbalancer` listeners. When exposing Kafka outside of Kubernetes use source ranges, in addition to labels and annotations, to customize how a service is created.

*Example source ranges configured for a loadbalancer listener*

```
listeners:  
#...  
- name: external  
  port: 9094  
  type: loadbalancer  
  tls: false  
  configuration:  
    externalTrafficPolicy: Local  
    loadBalancerSourceRanges:  
      - 10.0.0.0/8  
      - 88.208.76.87/32  
    # ...  
# ...
```

## class

The `class` property is only used with `ingress` listeners. You can configure the `Ingress` class using the `class` property.

*Example of an external listener of type `ingress` using Ingress class `nginx-internal`*

```
listeners:  
#...  
- name: external  
  port: 9094  
  type: ingress  
  tls: true  
  configuration:  
    class: nginx-internal  
  # ...  
# ...
```

## preferredNodePortAddressType

The `preferredNodePortAddressType` property is only used with `nodeport` listeners.

Use the `preferredNodePortAddressType` property in your listener configuration to specify the first address type checked as the node address. This property is useful, for example, if your deployment does not have DNS support, or you only want to expose a broker internally through an internal DNS or IP address. If an address of this type is found, it is used. If the preferred address type is not found, Strimzi proceeds through the types in the standard order of priority:

1. ExternalDNS
2. ExternalIP
3. Hostname
4. InternalDNS
5. InternalIP

*Example of an external listener configured with a preferred node port address type*

```
listeners:  
#...  
- name: external  
  port: 9094  
  type: nodeport  
  tls: false  
  configuration:  
    preferredNodePortAddressType: InternalDNS  
    # ...  
# ...
```

## useServiceDnsDomain

The `useServiceDnsDomain` property is only used with `internal` listeners. It defines whether the fully-qualified DNS names that include the cluster service suffix (usually `.cluster.local`) are used. With `useServiceDnsDomain` set as `false`, the advertised addresses are generated without the service suffix; for example, `my-cluster-kafka-0.my-cluster-kafka-brokers.myproject.svc`. With `useServiceDnsDomain` set as `true`, the advertised addresses are generated with the service suffix; for example, `my-cluster-kafka-0.my-cluster-kafka-brokers.myproject.svc.cluster.local`. Default is `false`.

*Example of an internal listener configured to use the Service DNS domain*

```
listeners:  
#...  
- name: plain  
  port: 9092  
  type: internal  
  tls: false  
  configuration:  
    useServiceDnsDomain: true  
    # ...  
# ...
```

If your Kubernetes cluster uses a different service suffix than `.cluster.local`, you can configure the suffix using the `KUBERNETES_SERVICE_DNS_DOMAIN` environment variable in the Cluster Operator configuration. See [Configuring the Cluster Operator with environment variables](#) for more details.

## GenericKafkaListenerConfiguration schema properties

Property	Description
<code>brokerCertChainAndKey</code>	Reference to the <code>Secret</code> which holds the certificate and private key pair which will be used for this listener. The certificate can optionally contain the whole chain. This field can be used only with listeners with enabled TLS encryption.
<code>CertAndKeySecretSource</code>	
<code>externalTrafficPolicy</code>	Specifies whether the service routes external traffic to node-local or cluster-wide endpoints. <code>Cluster</code> may cause a second hop to another node and obscures the client source IP. <code>Local</code> avoids a second hop for LoadBalancer and Nodeport type services and preserves the client source IP (when supported by the infrastructure). If unspecified, Kubernetes will use <code>Cluster</code> as the default. This field can be used only with <code>loadbalancer</code> or <code>nodeport</code> type listener.
<code>string (one of [Local, Cluster])</code>	

Property	Description
loadBalancerSourceRanges  string array	A list of CIDR ranges (for example <code>10.0.0.0/8</code> or <code>130.211.204.1/32</code> ) from which clients can connect to load balancer type listeners. If supported by the platform, traffic through the loadbalancer is restricted to the specified CIDR ranges. This field is applicable only for loadbalancer type services and is ignored if the cloud provider does not support the feature. This field can be used only with <code>loadbalancer</code> type listener.
bootstrap  <code>GenericKafkaListenerConfigurationBootstrap</code>	Bootstrap configuration.
brokers  <code>GenericKafkaListenerConfigurationBroker</code> array	Per-broker configurations.
ipFamilyPolicy  string (one of [RequireDualStack, SingleStack, PreferDualStack])	Specifies the IP Family Policy used by the service. Available options are <code>SingleStack</code> , <code>PreferDualStack</code> and <code>RequireDualStack</code> . <code>SingleStack</code> is for a single IP family. <code>PreferDualStack</code> is for two IP families on dual-stack configured clusters or a single IP family on single-stack clusters. <code>RequireDualStack</code> fails unless there are two IP families on dual-stack configured clusters. If unspecified, Kubernetes will choose the default value based on the service type. Available on Kubernetes 1.20 and newer.
ipFamilies  string (one or more of [IPv6, IPv4]) array	Specifies the IP Families used by the service. Available options are <code>IPv4</code> and <code>IPv6</code> . If <code>unspecified</code> , Kubernetes will choose the default value based on the <code>'ipFamilyPolicy'</code> setting. Available on Kubernetes 1.20 and newer.
createBootstrapService  boolean	Whether to create the bootstrap service or not. The bootstrap service is created by default (if not specified differently). This field can be used with the <code>loadBalancer</code> type listener.
class  string	Configures the <code>Ingress</code> class that defines which <code>Ingress</code> controller will be used. This field can be used only with <code>ingress</code> type listener. If not specified, the default Ingress controller will be used.

Property	Description
finalizers string array	A list of finalizers which will be configured for the <code>LoadBalancer</code> type Services created for this listener. If supported by the platform, the finalizer <code>service.kubernetes.io/load-balancer-cleanup</code> to make sure that the external load balancer is deleted together with the service. For more information, see <a href="https://kubernetes.io/docs/tasks/access-application-cluster/create-external-load-balancer/#garbage-collecting-load-balancers">https://kubernetes.io/docs/tasks/access-application-cluster/create-external-load-balancer/#garbage-collecting-load-balancers</a> . This field can be used only with <code>loadbalancer</code> type listeners.
maxConnectionCreationRate integer	The maximum connection creation rate we allow in this listener at any time. New connections will be throttled if the limit is reached.
maxConnections integer	The maximum number of connections we allow for this listener in the broker at any time. New connections are blocked if the limit is reached.
preferredNodePortAddressType string (one of [ExternalDNS, ExternalIP, Hostname, InternalIP, InternalDNS])	<p>Defines which address type should be used as the node address. Available types are: <code>ExternalDNS</code>, <code>ExternalIP</code>, <code>InternalDNS</code>, <code>InternalIP</code> and <code>Hostname</code>. By default, the addresses will be used in the following order (the first one found will be used):</p> <ul style="list-style-type: none"> <li>• <code>ExternalDNS</code></li> <li>• <code>ExternalIP</code></li> <li>• <code>InternalDNS</code></li> <li>• <code>InternalIP</code></li> <li>• <code>Hostname</code></li> </ul>
	This field is used to select the preferred address type, which is checked first. If no address is found for this address type, the other types are checked in the default order. This field can only be used with <code>nodeport</code> type listener.

Property	Description
useServiceDnsDomain boolean	Configures whether the Kubernetes service DNS domain should be used or not. If set to <code>true</code> , the generated addresses will contain the service DNS domain suffix (by default <code>.cluster.local</code> , can be configured using environment variable <code>KUBERNETES_SERVICE_DNS_DOMAIN</code> ). Defaults to <code>false</code> . This field can be used only with <code>internal</code> type listener.

## 12.2.12. `CertAndKeySecretSource` schema reference

Used in: [GenericKafkaListenerConfiguration](#), [KafkaClientAuthenticationTls](#)

Property	Description
certificate string	The name of the file certificate in the Secret.
key string	The name of the private key in the Secret.
secretName string	The name of the Secret containing the certificate.

## 12.2.13. `GenericKafkaListenerConfigurationBootstrap` schema reference

Used in: [GenericKafkaListenerConfiguration](#)

[Full list of GenericKafkaListenerConfigurationBootstrap schema properties](#)

Broker service equivalents of `nodePort`, `host`, `loadBalancerIP` and `annotations` properties are configured in the [GenericKafkaListenerConfigurationBroker schema](#).

### alternativeNames

You can specify alternative names for the bootstrap service. The names are added to the broker certificates and can be used for TLS hostname verification. The `alternativeNames` property is applicable to all types of listeners.

*Example of an external `route` listener configured with an additional bootstrap address*

```
listeners:
  #...
  - name: external
    port: 9094
    type: route
    tls: true
    authentication:
      type: tls
```

```
configuration:  
  bootstrap:  
    alternativeNames:  
      - example.hostname1  
      - example.hostname2  
# ...
```

## host

The `host` property is used with `route` and `ingress` listeners to specify the hostnames used by the bootstrap and per-broker services.

A `host` property value is mandatory for `ingress` listener configuration, as the Ingress controller does not assign any hostnames automatically. Make sure that the hostnames resolve to the Ingress endpoints. Strimzi will not perform any validation that the requested hosts are available and properly routed to the Ingress endpoints.

*Example of host configuration for an ingress listener*

```
listeners:  
#...  
- name: external  
  port: 9094  
  type: ingress  
  tls: true  
  authentication:  
    type: tls  
  configuration:  
    bootstrap:  
      host: bootstrap.myingress.com  
    brokers:  
      - broker: 0  
        host: broker-0.myingress.com  
      - broker: 1  
        host: broker-1.myingress.com  
      - broker: 2  
        host: broker-2.myingress.com  
# ...
```

By default, `route` listener hosts are automatically assigned by OpenShift. However, you can override the assigned route hosts by specifying hosts.

Strimzi does not perform any validation that the requested hosts are available. You must ensure that they are free and can be used.

*Example of host configuration for a route listener*

```
# ...  
listeners:  
#...
```

```
- name: external
  port: 9094
  type: route
  tls: true
  authentication:
    type: tls
  configuration:
    bootstrap:
      host: bootstrap.myrouter.com
  brokers:
    - broker: 0
      host: broker-0.myrouter.com
    - broker: 1
      host: broker-1.myrouter.com
    - broker: 2
      host: broker-2.myrouter.com
# ...
```

## nodePort

By default, the port numbers used for the bootstrap and broker services are automatically assigned by Kubernetes. You can override the assigned node ports for `nodeport` listeners by specifying the requested port numbers.

Strimzi does not perform any validation on the requested ports. You must ensure that they are free and available for use.

*Example of an external listener configured with overrides for node ports*

```
# ...
listeners:
  #...
  - name: external
    port: 9094
    type: nodeport
    tls: true
    authentication:
      type: tls
    configuration:
      bootstrap:
        nodePort: 32100
    brokers:
      - broker: 0
        nodePort: 32000
      - broker: 1
        nodePort: 32001
      - broker: 2
        nodePort: 32002
# ...
```

## loadBalancerIP

Use the `loadBalancerIP` property to request a specific IP address when creating a loadbalancer. Use this property when you need to use a loadbalancer with a specific IP address. The `loadBalancerIP` field is ignored if the cloud provider does not support the feature.

*Example of an external listener of type `loadbalancer` with specific loadbalancer IP address requests*

```
# ...
listeners:
#...
- name: external
  port: 9094
  type: loadbalancer
  tls: true
  authentication:
    type: tls
  configuration:
    bootstrap:
      loadBalancerIP: 172.29.3.10
    brokers:
      - broker: 0
        loadBalancerIP: 172.29.3.1
      - broker: 1
        loadBalancerIP: 172.29.3.2
      - broker: 2
        loadBalancerIP: 172.29.3.3
# ...
```

## annotations

Use the `annotations` property to add annotations to Kubernetes resources related to the listeners. You can use these annotations, for example, to instrument DNS tooling such as [External DNS](#), which automatically assigns DNS names to the loadbalancer services.

*Example of an external listener of type `loadbalancer` using `annotations`*

```
# ...
listeners:
#...
- name: external
  port: 9094
  type: loadbalancer
  tls: true
  authentication:
    type: tls
  configuration:
    bootstrap:
      annotations:
        external-dns.alpha.kubernetes.io/hostname: kafka-bootstrap.mydomain.com.
        external-dns.alpha.kubernetes.io/ttl: "60"
```

```

brokers:
- broker: 0
  annotations:
    external-dns.alpha.kubernetes.io/hostname: kafka-broker-0.mydomain.com.
    external-dns.alpha.kubernetes.io/ttl: "60"
- broker: 1
  annotations:
    external-dns.alpha.kubernetes.io/hostname: kafka-broker-1.mydomain.com.
    external-dns.alpha.kubernetes.io/ttl: "60"
- broker: 2
  annotations:
    external-dns.alpha.kubernetes.io/hostname: kafka-broker-2.mydomain.com.
    external-dns.alpha.kubernetes.io/ttl: "60"
# ...

```

## GenericKafkaListenerConfigurationBootstrap schema properties

Property	Description
alternativeNames	Additional alternative names for the bootstrap service. The alternative names will be added to the list of subject alternative names of the TLS certificates.
host	The bootstrap host. This field will be used in the Ingress resource or in the Route resource to specify the desired hostname. This field can be used only with <code>route</code> (optional) or <code>ingress</code> (required) type listeners.
nodePort	Node port for the bootstrap service. This field can be used only with <code>nodeport</code> type listener.
loadBalancerIP	The loadbalancer is requested with the IP address specified in this field. This feature depends on whether the underlying cloud provider supports specifying the <code>loadBalancerIP</code> when a load balancer is created. This field is ignored if the cloud provider does not support the feature. This field can be used only with <code>loadbalancer</code> type listener.
annotations	Annotations that will be added to the <code>Ingress</code> , <code>Route</code> , or <code>Service</code> resource. You can use this field to configure DNS providers such as External DNS. This field can be used only with <code>loadbalancer</code> , <code>nodeport</code> , <code>route</code> , or <code>ingress</code> type listeners.
map	

Property	Description
labels	
map	Labels that will be added to the <a href="#">Ingress</a> , <a href="#">Route</a> , or <a href="#">Service</a> resource. This field can be used only with <a href="#">loadbalancer</a> , <a href="#">nodeport</a> , <a href="#">route</a> , or <a href="#">ingress</a> type listeners.

## 12.2.14. [GenericKafkaListenerConfigurationBroker](#) schema reference

Used in: [GenericKafkaListenerConfiguration](#)

[Full list of GenericKafkaListenerConfigurationBroker schema properties](#)

You can see example configuration for the [nodePort](#), [host](#), [loadBalancerIP](#) and [annotations](#) properties in the [GenericKafkaListenerConfigurationBootstrap schema](#), which configures bootstrap service overrides.

### *Advertised addresses for brokers*

By default, Strimzi tries to automatically determine the hostnames and ports that your Kafka cluster advertises to its clients. This is not sufficient in all situations, because the infrastructure on which Strimzi is running might not provide the right hostname or port through which Kafka can be accessed.

You can specify a broker ID and customize the advertised hostname and port in the [configuration](#) property of the listener. Strimzi will then automatically configure the advertised address in the Kafka brokers and add it to the broker certificates so it can be used for TLS hostname verification. Overriding the advertised host and ports is available for all types of listeners.

*Example of an external [route](#) listener configured with overrides for advertised addresses*

```
listeners:
#...
- name: external
  port: 9094
  type: route
  tls: true
  authentication:
    type: tls
  configuration:
    brokers:
      - broker: 0
        advertisedHost: example.hostname.0
        advertisedPort: 12340
      - broker: 1
        advertisedHost: example.hostname.1
        advertisedPort: 12341
      - broker: 2
        advertisedHost: example.hostname.2
        advertisedPort: 12342
# ...
```

## GenericKafkaListenerConfigurationBroker schema properties

Property	Description
broker	ID of the kafka broker (broker identifier). Broker IDs start from 0 and correspond to the number of broker replicas.
integer	
advertisedHost	The host name which will be used in the brokers' <code>advertised.brokers</code> .
string	
advertisedPort	The port number which will be used in the brokers' <code>advertised.brokers</code> .
integer	
host	The broker host. This field will be used in the Ingress resource or in the Route resource to specify the desired hostname. This field can be used only with <code>route</code> (optional) or <code>ingress</code> (required) type listeners.
string	
nodePort	Node port for the per-broker service. This field can be used only with <code>nodeport</code> type listener.
integer	
loadBalancerIP	The loadbalancer is requested with the IP address specified in this field. This feature depends on whether the underlying cloud provider supports specifying the <code>loadBalancerIP</code> when a load balancer is created. This field is ignored if the cloud provider does not support the feature. This field can be used only with <code>loadbalancer</code> type listener.
string	
annotations	Annotations that will be added to the <code>Ingress</code> or <code>Service</code> resource. You can use this field to configure DNS providers such as External DNS. This field can be used only with <code>loadbalancer</code> , <code>nodeport</code> , or <code>ingress</code> type listeners.
map	
labels	Labels that will be added to the <code>Ingress</code> , <code>Route</code> , or <code>Service</code> resource. This field can be used only with <code>loadbalancer</code> , <code>nodeport</code> , <code>route</code> , or <code>ingress</code> type listeners.
map	

### 12.2.15. EphemeralStorage schema reference

Used in: `JbosStorage`, `KafkaClusterSpec`, `ZookeeperClusterSpec`

The `type` property is a discriminator that distinguishes use of the `EphemeralStorage` type from `PersistentClaimStorage`. It must have the value `ephemeral` for the type `EphemeralStorage`.

Property	Description
id	Storage identification number. It is mandatory only for storage volumes defined in a storage of type 'jbod'.
integer	
sizeLimit	When type=ephemeral, defines the total amount of local storage required for this EmptyDir volume (for example 1Gi).
string	
type	Must be <b>ephemeral</b> .
string	

## 12.2.16. **PersistentClaimStorage** schema reference

Used in: [JbodStorage](#), [KafkaClusterSpec](#), [ZookeeperClusterSpec](#)

The **type** property is a discriminator that distinguishes use of the **PersistentClaimStorage** type from **EphemeralStorage**. It must have the value **persistent-claim** for the type **PersistentClaimStorage**.

Property	Description
type	Must be <b>persistent-claim</b> .
string	
size	When type=persistent-claim, defines the size of the persistent volume claim (i.e 1Gi). Mandatory when type=persistent-claim.
string	
selector	Specifies a specific persistent volume to use. It contains key:value pairs representing labels for selecting such a volume.
map	
deleteClaim	Specifies if the persistent volume claim has to be deleted when the cluster is un-deployed.
boolean	
class	The storage class to use for dynamic volume allocation.
string	
id	Storage identification number. It is mandatory only for storage volumes defined in a storage of type 'jbod'.
integer	
overrides	Overrides for individual brokers. The <b>overrides</b> field allows to specify a different configuration for different brokers.
<b>PersistentClaimStorageOverride</b> array	

## 12.2.17. **PersistentClaimStorageOverride** schema reference

Used in: [PersistentClaimStorage](#)

Property	Description
class	The storage class to use for dynamic volume allocation for this broker.
string	
broker	Id of the kafka broker (broker identifier).
integer	

## 12.2.18. `JbodStorage` schema reference

Used in: [KafkaClusterSpec](#)

The `type` property is a discriminator that distinguishes use of the `JbodStorage` type from `EphemeralStorage`, `PersistentClaimStorage`. It must have the value `jvod` for the type `JbodStorage`.

Property	Description
type	Must be <code>jvod</code> .
string	
volumes	List of volumes as Storage objects representing the JBOD disks array.
<code>EphemeralStorage</code> , <code>PersistentClaimStorage</code> array	

## 12.2.19. `KafkaAuthorizationSimple` schema reference

Used in: [KafkaClusterSpec](#)

[Full list of KafkaAuthorizationSimple schema properties](#)

Simple authorization in Strimzi uses the `AclAuthorizer` plugin, the default Access Control Lists (ACLs) authorization plugin provided with Apache Kafka. ACLs allow you to define which users have access to which resources at a granular level.

Configure the `Kafka` custom resource to use simple authorization. Set the `type` property in the `authorization` section to the value `simple`, and configure a list of super users.

Access rules are configured for the `KafkaUser`, as described in the [ACLRule schema reference](#).

### superUsers

A list of user principals treated as super users, so that they are always allowed without querying ACL rules. For more information see [Kafka authorization](#).

*An example of simple authorization configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
```

```

kafka:
  # ...
  authorization:
    type: simple
    superUsers:
      - CN=client_1
      - user_2
      - CN=client_3
  # ...

```

**NOTE** The `super.user` configuration option in the `config` property in `Kafka.spec.kafka` is ignored. Designate super users in the `authorization` property instead. For more information, see [Kafka broker configuration](#).

### KafkaAuthorizationSimple schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaAuthorizationSimple` type from `KafkaAuthorizationOpa`, `KafkaAuthorizationKeycloak`, `KafkaAuthorizationCustom`. It must have the value `simple` for the type `KafkaAuthorizationSimple`.

Property	Description
type	Must be <code>simple</code> .
string	
superUsers	List of super users. Should contain list of user principals which should get unlimited access rights.
string array	

### 12.2.20. KafkaAuthorizationOpa schema reference

Used in: `KafkaClusterSpec`

#### Full list of KafkaAuthorizationOpa schema properties

To use Open Policy Agent authorization, set the `type` property in the `authorization` section to the value `opa`, and configure OPA properties as required. Strimzi uses Open Policy Agent plugin for Kafka authorization as the authorizer. For more information about the format of the input data and policy examples, see [Open Policy Agent plugin for Kafka authorization](#).

#### url

The URL used to connect to the Open Policy Agent server. The URL has to include the policy which will be queried by the authorizer. **Required**.

#### allowOnError

Defines whether a Kafka client should be allowed or denied by default when the authorizer fails to query the Open Policy Agent, for example, when it is temporarily unavailable. Defaults to `false` - all actions will be denied.

## initialCacheCapacity

Initial capacity of the local cache used by the authorizer to avoid querying the Open Policy Agent for every request. Defaults to **5000**.

## maximumCacheSize

Maximum capacity of the local cache used by the authorizer to avoid querying the Open Policy Agent for every request. Defaults to **50000**.

## expireAfterMs

The expiration of the records kept in the local cache to avoid querying the Open Policy Agent for every request. Defines how often the cached authorization decisions are reloaded from the Open Policy Agent server. In milliseconds. Defaults to **3600000** milliseconds (1 hour).

## superUsers

A list of user principals treated as super users, so that they are always allowed without querying the open Policy Agent policy. For more information see [Kafka authorization](#).

*An example of Open Policy Agent authorizer configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
  kafka:
    # ...
    authorization:
      type: opa
      url: http://opa:8181/v1/data/kafka/allow
      allowOnError: false
      initialCacheCapacity: 1000
      maximumCacheSize: 10000
      expireAfterMs: 60000
      superUsers:
        - CN=fred
        - sam
        - CN=edward
    # ...
```

## KafkaAuthorizationOpa schema properties

The **type** property is a discriminator that distinguishes use of the **KafkaAuthorizationOpa** type from **KafkaAuthorizationSimple**, **KafkaAuthorizationKeycloak**, **KafkaAuthorizationCustom**. It must have the value **opa** for the type **KafkaAuthorizationOpa**.

Property	Description
type	Must be <code>opa</code> .
string	
url	The URL used to connect to the Open Policy Agent server. The URL has to include the policy which will be queried by the authorizer. This option is required.
string	
allowOnError	Defines whether a Kafka client should be allowed or denied by default when the authorizer fails to query the Open Policy Agent, for example, when it is temporarily unavailable). Defaults to <code>false</code> - all actions will be denied.
boolean	
initialCacheCapacity	Initial capacity of the local cache used by the authorizer to avoid querying the Open Policy Agent for every request. Defaults to <code>5000</code> .
integer	
maximumCacheSize	Maximum capacity of the local cache used by the authorizer to avoid querying the Open Policy Agent for every request. Defaults to <code>50000</code> .
integer	
expireAfterMs	The expiration of the records kept in the local cache to avoid querying the Open Policy Agent for every request. Defines how often the cached authorization decisions are reloaded from the Open Policy Agent server. In milliseconds. Defaults to <code>360000</code> .
integer	
superUsers	List of super users, which is specifically a list of user principals that have unlimited access rights.
string array	
enableMetrics	Defines whether the Open Policy Agent authorizer plugin should provide metrics. Defaults to <code>false</code> .
boolean	

## 12.2.21. `KafkaAuthorizationKeycloak` schema reference

Used in: `KafkaClusterSpec`

The `type` property is a discriminator that distinguishes use of the `KafkaAuthorizationKeycloak` type from `KafkaAuthorizationSimple`, `KafkaAuthorizationOpa`, `KafkaAuthorizationCustom`. It must have the value `keycloak` for the type `KafkaAuthorizationKeycloak`.

Property	Description
type	Must be <code>keycloak</code> .
string	

Property	Description
clientId string	OAuth Client ID which the Kafka client can use to authenticate against the OAuth server and use the token endpoint URI.
tokenEndpointUri string	Authorization server token endpoint URI.
tlsTrustedCertificates <i>CertSecretSource</i> array	Trusted certificates for TLS connection to the OAuth server.
disableTlsHostnameVerification boolean	Enable or disable TLS hostname verification. Default value is <b>false</b> .
delegateToKafkaAcls boolean	Whether authorization decision should be delegated to the 'Simple' authorizer if DENIED by Keycloak Authorization Services policies. Default value is <b>false</b> .
grantsRefreshPeriodSeconds integer	The time between two consecutive grants refresh runs in seconds. The default value is 60.
grantsRefreshPoolSize integer	The number of threads to use to refresh grants for active sessions. The more threads, the more parallelism, so the sooner the job completes. However, using more threads places a heavier load on the authorization server. The default value is 5.
superUsers string array	List of super users. Should contain list of user principals which should get unlimited access rights.
connectTimeoutSeconds integer	The connect timeout in seconds when connecting to authorization server. If not set, the effective connect timeout is 60 seconds.
readTimeoutSeconds integer	The read timeout in seconds when connecting to authorization server. If not set, the effective read timeout is 60 seconds.
enableMetrics boolean	Enable or disable OAuth metrics. Default value is <b>false</b> .

## 12.2.22. KafkaAuthorizationCustom schema reference

Used in: [KafkaClusterSpec](#)

[Full list of KafkaAuthorizationCustom schema properties](#)

To use custom authorization in Strimzi, you can configure your own [Authorizer](#) plugin to define Access Control Lists (ACLs).

ACLs allow you to define which users have access to which resources at a granular level.

Configure the [Kafka](#) custom resource to use custom authorization. Set the `type` property in the `authorization` section to the value `custom`, and the set following properties.

**IMPORTANT**

The custom authorizer must implement the `org.apache.kafka.server.authorizer.Authorizer` interface, and support configuration of `super.users` using the `super.users` configuration property.

### **authorizerClass**

(Required) Java class that implements the `org.apache.kafka.server.authorizer.Authorizer` interface to support custom ACLs.

### **superUsers**

A list of user principals treated as super users, so that they are always allowed without querying ACL rules. For more information see [Kafka authorization](#).

You can add configuration for initializing the custom authorizer using [Kafka.spec.kafka.config](#).

*An example of custom authorization configuration under Kafka.spec*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
  kafka:
    # ...
    authorization:
      type: custom
      authorizerClass: io.mycompany.CustomAuthorizer
      superUsers:
        - CN=client_1
        - user_2
        - CN=client_3
    # ...
    config:
      authorization.custom.property1=value1
      authorization.custom.property2=value2
    # ...
```

In addition to the [Kafka](#) custom resource configuration, the JAR file containing the custom authorizer class along with its dependencies must be available on the classpath of the Kafka broker.

The Strimzi Maven build process provides a mechanism to add custom third-party libraries to the generated Kafka broker container image by adding them as dependencies in the `pom.xml` file under the `docker-images/kafka/kafka-thirdparty-libs` directory. The directory contains different folders

for different Kafka versions. Choose the appropriate folder. Before modifying the `pom.xml` file, the third-party library must be available in a Maven repository, and that Maven repository must be accessible to the Strimzi build process.

**NOTE** The `super.user` configuration option in the `config` property in `Kafka.spec.kafka` is ignored. Designate super users in the `authorization` property instead. For more information, see [Kafka broker configuration](#).

Custom authorization can make use of group membership information extracted from the JWT token during authentication when using `oauth` authentication and configuring `groupsClaim` configuration attribute. Groups are available on the `OAuthKafkaPrincipal` object during `authorize()` call as follows:

```
public List<AuthorizationResult> authorize(AuthorizableRequestContext
requestContext, List<Action> actions) {

    KafkaPrincipal principal = requestContext.principal();
    if (principal instanceof OAuthKafkaPrincipal) {
        OAuthKafkaPrincipal p = (OAuthKafkaPrincipal) principal;

        for (String group: p.getGroups()) {
            System.out.println("Group: " + group);
        }
    }
}
```

## **KafkaAuthorizationCustom** schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaAuthorizationCustom` type from `KafkaAuthorizationSimple`, `KafkaAuthorizationOpa`, `KafkaAuthorizationKeycloak`. It must have the value `custom` for the type `KafkaAuthorizationCustom`.

Property	Description
<code>type</code>	Must be <code>custom</code> .
<code>string</code>	
<code>authorizerClass</code>	Authorization implementation class, which must be available in classpath.
<code>string</code>	
<code>superUsers</code>	List of super users, which are user principals with unlimited access rights.
<code>string array</code>	
<code>supportsAdminApi</code>	Indicates whether the custom authorizer supports the APIs for managing ACLs using the Kafka Admin API. Defaults to <code>false</code> .
<code>boolean</code>	

## 12.2.23. Rack schema reference

Used in: [KafkaBridgeSpec](#), [KafkaClusterSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#)

[Full list of Rack schema properties](#)

The `rack` option configures rack awareness. A `rack` can represent an availability zone, data center, or an actual rack in your data center. The `rack` is configured through a `topologyKey`. `topologyKey` identifies a label on Kubernetes nodes that contains the name of the topology in its value. An example of such a label is `topology.kubernetes.io/zone` (or `failure-domain.beta.kubernetes.io/zone` on older Kubernetes versions), which contains the name of the availability zone in which the Kubernetes node runs. You can configure your Kafka cluster to be aware of the `rack` in which it runs, and enable additional features such as spreading partition replicas across different racks or consuming messages from the closest replicas.

For more information about Kubernetes node labels, see [Well-Known Labels, Annotations and Taints](#). Consult your Kubernetes administrator regarding the node label that represents the zone or rack into which the node is deployed.

### Spreading partition replicas across racks

When rack awareness is configured, Strimzi will set `broker.rack` configuration for each Kafka broker. The `broker.rack` configuration assigns a rack ID to each broker. When `broker.rack` is configured, Kafka brokers will spread partition replicas across as many different racks as possible. When replicas are spread across multiple racks, the probability that multiple replicas will fail at the same time is lower than if they would be in the same rack. Spreading replicas improves resiliency, and is important for availability and reliability. To enable rack awareness in Kafka, add the `rack` option to the `.spec.kafka` section of the `Kafka` custom resource as shown in the example below.

*Example rack configuration for Kafka*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    rack:
      topologyKey: topology.kubernetes.io/zone
    # ...
```

**NOTE**

The `rack` in which brokers are running can change in some cases when the pods are deleted or restarted. As a result, the replicas running in different racks might then share the same rack. Use Cruise Control and the `KafkaRebalance` resource with the `RackAwareGoal` to make sure that replicas remain distributed across different racks.

When rack awareness is enabled in the `Kafka` custom resource, Strimzi will automatically add the Kubernetes `preferredDuringSchedulingIgnoredDuringExecution` affinity rule to distribute the Kafka

brokers across the different racks. However, the *preferred* rule does not guarantee that the brokers will be spread. Depending on your exact Kubernetes and Kafka configurations, you should add additional `affinity` rules or configure `topologySpreadConstraints` for both ZooKeeper and Kafka to make sure the nodes are properly distributed accross as many racks as possible. For more information see [Configuring pod scheduling](#).

## Consuming messages from the closest replicas

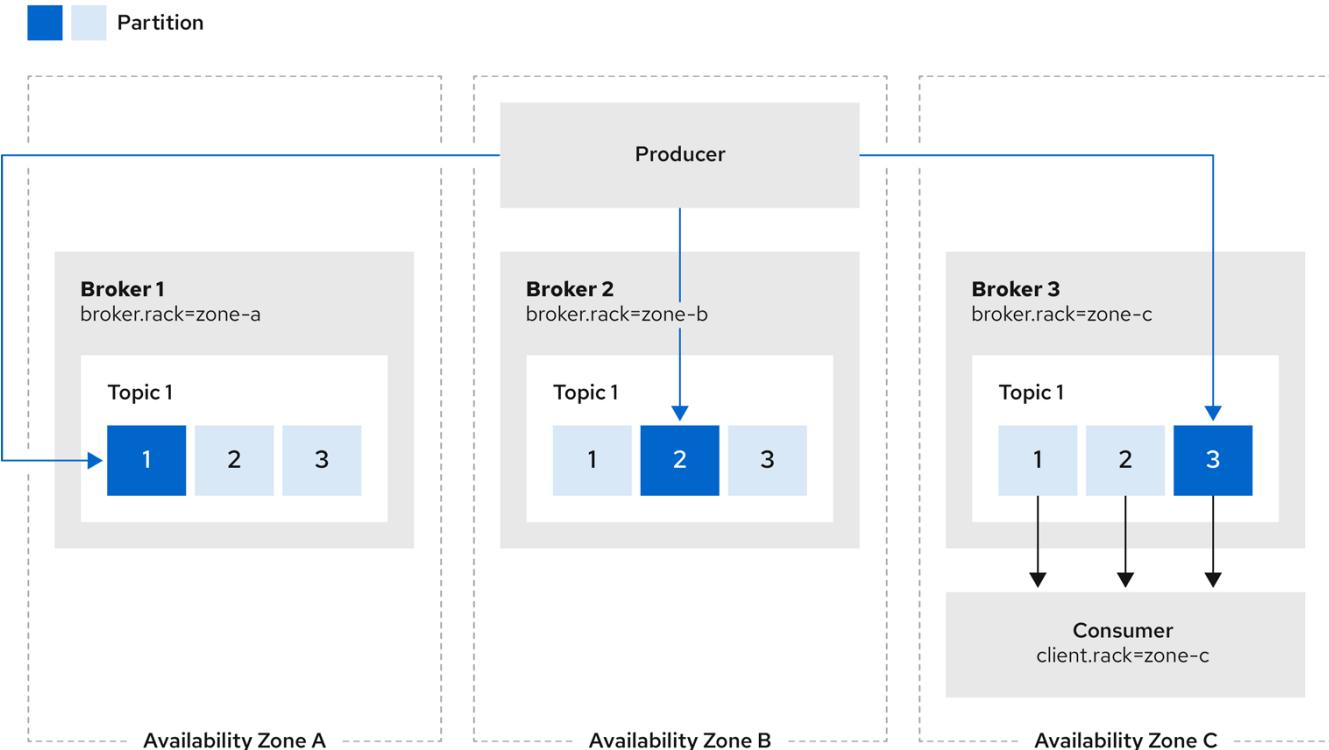
Rack awareness can also be used in consumers to fetch data from the closest replica. This is useful for reducing the load on your network when a Kafka cluster spans multiple datacenters and can also reduce costs when running Kafka in public clouds. However, it can lead to increased latency.

In order to be able to consume from the closest replica, rack awareness has to be configured in the Kafka cluster, and the `RackAwareReplicaSelector` has to be enabled. The replica selector plugin provides the logic that enables clients to consume from the nearest replica. The default implementation uses `LeaderSelector` to always select the leader replica for the client. Specify `RackAwareReplicaSelector` for the `replica.selector.class` to switch from the default implementation.

Example `rack` configuration with enabled replica-aware selector

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    rack:
      topologyKey: topology.kubernetes.io/zone
    config:
      # ...
      replica.selector.class: org.apache.kafka.common.replica.RackAwareReplicaSelector
    # ...
```

In addition to the Kafka broker configuration, you also need to specify the `client.rack` option in your consumers. The `client.rack` option should specify the *rack ID* in which the consumer is running. `RackAwareReplicaSelector` associates matching `broker.rack` and `client.rack` IDs, to find the nearest replica and consume from it. If there are multiple replicas in the same rack, `RackAwareReplicaSelector` always selects the most up-to-date replica. If the rack ID is not specified, or if it cannot find a replica with the same rack ID, it will fall back to the leader replica.



222\_Streams\_0322

Figure 11. Example showing client consuming from replicas in the same availability zone

You can also configure Kafka Connect, MirrorMaker 2.0 and Kafka Bridge so that connectors consume messages from the closest replicas. You enable rack awareness in the [KafkaConnect](#), [KafkaMirrorMaker2](#) and [KafkaBridge](#) custom resources. The configuration does not set affinity rules, but you can also configure [affinity](#) or [topologySpreadConstraints](#). For more information see [Configuring pod scheduling](#).

When deploying Kafka Connect using Strimzi, you can use the `rack` section in the [KafkaConnect](#) custom resource to automatically configure the `client.rack` option.

#### Example `rack` configuration for Kafka Connect

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
# ...
spec:
  # ...
  rack:
    topologyKey: topology.kubernetes.io/zone
    # ...
```

When deploying MirrorMaker 2 using Strimzi, you can use the `rack` section in the [KafkaMirrorMaker2](#) custom resource to automatically configure the `client.rack` option.

#### Example `rack` configuration for MirrorMaker 2.0

```
apiVersion: kafka.strimzi.io/v1beta2
```

```

kind: KafkaMirrorMaker2
# ...
spec:
# ...
rack:
  topologyKey: topology.kubernetes.io/zone
# ...

```

When deploying Kafka Bridge using Strimzi, you can use the `rack` section in the `KafkaBridge` custom resource to automatically configure the `client.rack` option.

*Example rack configuration for Kafka Bridge*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
# ...
spec:
# ...
rack:
  topologyKey: topology.kubernetes.io/zone
# ...

```

## Rack schema properties

Property	Description
topologyKey	A key that matches labels assigned to the Kubernetes cluster nodes. The value of the label is used to set a broker's <code>broker.rack</code> config, and the <code>client.rack</code> config for Kafka Connect or MirrorMaker 2.0.

### 12.2.24. Probe schema reference

Used in: `CruiseControlSpec`, `EntityTopicOperatorSpec`, `EntityUserOperatorSpec`, `KafkaBridgeSpec`, `KafkaClusterSpec`, `KafkaConnectSpec`, `KafkaExporterSpec`, `KafkaMirrorMaker2Spec`, `KafkaMirrorMakerSpec`, `TlsSidecar`, `ZookeeperClusterSpec`

Property	Description
failureThreshold	Minimum consecutive failures for the probe to be considered failed after having succeeded. Defaults to 3. Minimum value is 1.
initialDelaySeconds	The initial delay before first the health is first checked. Default to 15 seconds. Minimum value is 0.
periodSeconds	How often (in seconds) to perform the probe. Default to 10 seconds. Minimum value is 1.
integer	

Property	Description
successThreshold	Minimum consecutive successes for the probe to be considered successful after having failed. Defaults to 1. Must be 1 for liveness. Minimum value is 1.
integer	
timeoutSeconds	The timeout for each attempted health check. Default to 5 seconds. Minimum value is 1.
integer	

## 12.2.25. `JvmOptions` schema reference

Used in: `CruiseControlSpec`, `EntityTopicOperatorSpec`, `EntityUserOperatorSpec`, `KafkaBridgeSpec`, `KafkaClusterSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2Spec`, `KafkaMirrorMakerSpec`, `ZookeeperClusterSpec`

Property	Description
-XX	A map of -XX options to the JVM.
map	
-Xms	-Xms option to to the JVM.
string	
-Xmx	-Xmx option to to the JVM.
string	
gcLoggingEnabled	Specifies whether the Garbage Collection logging is enabled. The default is false.
boolean	
javaSystemProperties	A map of additional system properties which will be passed using the -D option to the JVM.
<code>SystemProperty</code> array	

## 12.2.26. `SystemProperty` schema reference

Used in: `JvmOptions`

Property	Description
name	The system property name.
string	
value	The system property value.
string	

## 12.2.27. `KafkaJmxOptions` schema reference

Used in: `KafkaClusterSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2Spec`, `ZookeeperClusterSpec`

[Full list of `KafkaJmxOptions` schema properties](#)

Configures JMX connection options.

Get JMX metrics from Kafka brokers, ZooKeeper nodes, Kafka Connect, and MirrorMaker 2.0. by connecting to port 9999. Use the `jmxOptions` property to configure a password-protected or an unprotected JMX port. Using password protection prevents unauthorized pods from accessing the port.

You can then obtain metrics about the component.

For example, for each Kafka broker you can obtain bytes-per-second usage data from clients, or the request rate of the network of the broker.

To enable security for the JMX port, set the `type` parameter in the `authentication` field to `password`.

*Example password-protected JMX configuration for Kafka brokers and ZooKeeper nodes*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    jmxOptions:
      authentication:
        type: "password"
    # ...
  zookeeper:
    # ...
    jmxOptions:
      authentication:
        type: "password"
    #...
```

You can then deploy a pod into a cluster and obtain JMX metrics using the headless service by specifying which broker you want to address.

For example, to get JMX metrics from broker `0` you specify:

```
"CLUSTER-NAME-kafka-0.CLUSTER-NAME-kafka-brokers"
```

`CLUSTER-NAME-kafka-0` is name of the broker pod, and `CLUSTER-NAME-kafka-brokers` is the name of the headless service to return the IPs of the broker pods.

If the JMX port is secured, you can get the username and password by referencing them from the JMX Secret in the deployment of your pod.

For an unprotected JMX port, use an empty object `{}` to open the JMX port on the headless service. You deploy a pod and obtain metrics in the same way as for the protected port, but in this case any

pod can read from the JMX port.

*Example open port JMX configuration for Kafka brokers and ZooKeeper nodes*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
    jmxOptions: {}
    # ...
  zookeeper:
    # ...
    jmxOptions: {}
    # ...
```

#### *Additional resources*

- For more information on the Kafka component metrics exposed using JMX, see the [Apache Kafka documentation](#).

### **KafkaJmxOptions schema properties**

Property	Description
authentication	Authentication configuration for connecting to the JMX port. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [password].
<code>KafkaJmxAuthenticationPassword</code>	

### **12.2.28. KafkaJmxAuthenticationPassword schema reference**

Used in: [KafkaJmxOptions](#)

The `type` property is a discriminator that distinguishes use of the [KafkaJmxAuthenticationPassword](#) type from other subtypes which may be added in the future. It must have the value `password` for the type [KafkaJmxAuthenticationPassword](#).

Property	Description
type	Must be <code>password</code> .
string	

### **12.2.29. JmxPrometheusExporterMetrics schema reference**

Used in: [CruiseControlSpec](#), [KafkaClusterSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#), [KafkaMirrorSpec](#), [ZookeeperClusterSpec](#)

The `type` property is a discriminator that distinguishes use of the [JmxPrometheusExporterMetrics](#) type

from other subtypes which may be added in the future. It must have the value `jmxPrometheusExporter` for the type `JmxPrometheusExporterMetrics`.

Property	Description
type	Must be <code>jmxPrometheusExporter</code> .
string	
valueFrom	ConfigMap entry where the Prometheus JMX Exporter configuration is stored. For details of the structure of this configuration, see the <a href="#">Prometheus JMX Exporter</a> .
<code>ExternalConfigurationReference</code>	

### 12.2.30. `ExternalConfigurationReference` schema reference

Used in: `ExternalLogging`, `JmxPrometheusExporterMetrics`

Property	Description
<code>configMapKeyRef</code>	Reference to the key in the ConfigMap containing the configuration. For more information, see the <a href="#">external documentation for core/v1 configmapkeyselector</a> .
<code>ConfigMapKeySelector</code>	

### 12.2.31. `InlineLogging` schema reference

Used in: `CruiseControlSpec`, `EntityTopicOperatorSpec`, `EntityUserOperatorSpec`, `KafkaBridgeSpec`, `KafkaClusterSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2Spec`, `KafkaMirrorMakerSpec`, `ZookeeperClusterSpec`

The `type` property is a discriminator that distinguishes use of the `InlineLogging` type from `ExternalLogging`. It must have the value `inline` for the type `InlineLogging`.

Property	Description
type	Must be <code>inline</code> .
string	
loggers	A Map from logger name to logger level.
map	

### 12.2.32. `ExternalLogging` schema reference

Used in: `CruiseControlSpec`, `EntityTopicOperatorSpec`, `EntityUserOperatorSpec`, `KafkaBridgeSpec`, `KafkaClusterSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2Spec`, `KafkaMirrorMakerSpec`, `ZookeeperClusterSpec`

The `type` property is a discriminator that distinguishes use of the `ExternalLogging` type from `InlineLogging`. It must have the value `external` for the type `ExternalLogging`.

Property	Description
type	Must be <a href="#">external</a> .
string	
valueFrom	
<a href="#">ExternalConfigurationReference</a>	<a href="#">ConfigMap</a> entry where the logging configuration is stored.

### 12.2.33. KafkaClusterTemplate schema reference

Used in: [KafkaClusterSpec](#)

Property	Description
statefulset	Template for Kafka <a href="#">StatefulSet</a> .
<a href="#">StatefulSetTemplate</a>	
pod	Template for Kafka <a href="#">Pods</a> .
<a href="#">PodTemplate</a>	
bootstrapService	Template for Kafka bootstrap <a href="#">Service</a> .
<a href="#">InternalServiceTemplate</a>	
brokersService	Template for Kafka broker <a href="#">Service</a> .
<a href="#">InternalServiceTemplate</a>	
externalBootstrapService	Template for Kafka external bootstrap <a href="#">Service</a> .
<a href="#">ResourceTemplate</a>	
perPodService	Template for Kafka per-pod <a href="#">Services</a> used for access from outside of Kubernetes.
<a href="#">ResourceTemplate</a>	
externalBootstrapRoute	Template for Kafka external bootstrap <a href="#">Route</a> .
<a href="#">ResourceTemplate</a>	
perPodRoute	Template for Kafka per-pod <a href="#">Routes</a> used for access from outside of OpenShift.
<a href="#">ResourceTemplate</a>	
externalBootstrapIngress	Template for Kafka external bootstrap <a href="#">Ingress</a> .
<a href="#">ResourceTemplate</a>	
perPodIngress	Template for Kafka per-pod <a href="#">Ingress</a> used for access from outside of Kubernetes.
<a href="#">ResourceTemplate</a>	
persistentVolumeClaim	Template for all Kafka <a href="#">PersistentVolumeClaims</a> .
<a href="#">ResourceTemplate</a>	
podDisruptionBudget	Template for Kafka <a href="#">PodDisruptionBudget</a> .
<a href="#">PodDisruptionBudgetTemplate</a>	
kafkaContainer	Template for the Kafka broker container.
<a href="#">ContainerTemplate</a>	

Property	Description
initContainer	Template for the Kafka init container.
<a href="#">ContainerTemplate</a>	
clusterCaCert	Template for Secret with Kafka Cluster certificate public key.
<a href="#">ResourceTemplate</a>	
serviceAccount	Template for the Kafka service account.
<a href="#">ResourceTemplate</a>	
jmxSecret	Template for Secret of the Kafka Cluster JMX authentication.
<a href="#">ResourceTemplate</a>	
clusterRoleBinding	Template for the Kafka ClusterRoleBinding.
<a href="#">ResourceTemplate</a>	
podSet	Template for Kafka <a href="#">StrimziPodSet</a> resource.
<a href="#">ResourceTemplate</a>	

## 12.2.34. [StatefulSetTemplate](#) schema reference

Used in: [KafkaClusterTemplate](#), [ZookeeperClusterTemplate](#)

Property	Description
metadata	Metadata applied to the resource.
<a href="#">MetadataTemplate</a>	
podManagementPolicy	PodManagementPolicy which will be used for this StatefulSet. Valid values are <a href="#">Parallel</a> and <a href="#">OrderedReady</a> . Defaults to <a href="#">Parallel</a> .
string (one of [OrderedReady, Parallel])	

## 12.2.35. [MetadataTemplate](#) schema reference

Used in: [BuildConfigTemplate](#), [DeploymentTemplate](#), [InternalServiceTemplate](#), [PodDisruptionBudgetTemplate](#), [PodTemplate](#), [ResourceTemplate](#), [StatefulSetTemplate](#)

[Full list of MetadataTemplate schema properties](#)

Labels and Annotations are used to identify and organize resources, and are configured in the `metadata` property.

For example:

```
# ...
template:
  pod:
    metadata:
      labels:
        label1: value1
        label2: value2
```

```

annotations:
  annotation1: value1
  annotation2: value2
# ...

```

The `labels` and `annotations` fields can contain any labels or annotations that do not contain the reserved string `strimzi.io`. Labels and annotations containing `strimzi.io` are used internally by Strimzi and cannot be configured.

### **MetadataTemplate schema properties**

Property	Description
labels	Labels added to the resource template. Can be applied to different resources such as <a href="#">StatefulSets</a> , <a href="#">Deployments</a> , <a href="#">Pods</a> , and <a href="#">Services</a> .
map	
annotations	Annotations added to the resource template. Can be applied to different resources such as <a href="#">StatefulSets</a> , <a href="#">Deployments</a> , <a href="#">Pods</a> , and <a href="#">Services</a> .
map	

### **12.2.36. PodTemplate schema reference**

Used in: `CruiseControlTemplate`, `EntityOperatorTemplate`, `JmxTransTemplate`, `KafkaBridgeTemplate`, `KafkaClusterTemplate`, `KafkaConnectTemplate`, `KafkaExporterTemplate`, `KafkaMirrorMakerTemplate`, `ZookeeperClusterTemplate`

[Full list of PodTemplate schema properties](#)

Configures the template for Kafka pods.

*Example PodTemplate configuration*

```

# ...
template:
  pod:
    metadata:
      labels:
        label1: value1
      annotations:
        anno1: value1
    imagePullSecrets:
      - name: my-docker-credentials
    securityContext:
      runAsUser: 1000001
      fsGroup: 0
    terminationGracePeriodSeconds: 120
# ...

```

## hostAliases

Use the `hostAliases` property to specify a list of hosts and IP addresses, which are injected into the `/etc/hosts` file of the pod.

This configuration is especially useful for Kafka Connect or MirrorMaker when a connection outside of the cluster is also requested by users.

*Example hostAliases configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
#...
spec:
  # ...
  template:
    pod:
      hostAliases:
        - ip: "192.168.1.86"
          hostnames:
            - "my-host-1"
            - "my-host-2"
      #...
```

## PodTemplate schema properties

Property	Description
metadata	Metadata applied to the resource.
<a href="#">MetadataTemplate</a>	
imagePullSecrets	List of references to secrets in the same namespace to use for pulling any of the images used by this Pod. When the <code>STRIMZI_IMAGE_PULL_SECRETS</code> environment variable in Cluster Operator and the <code>imagePullSecrets</code> option are specified, only the <code>imagePullSecrets</code> variable is used and the <code>STRIMZI_IMAGE_PULL_SECRETS</code> variable is ignored. For more information, see the <a href="#">external documentation for core/v1 localobjectreference</a> .
<a href="#">LocalObjectReference</a> array	
securityContext	Configures pod-level security attributes and common container settings. For more information, see the <a href="#">external documentation for core/v1 podsecuritycontext</a> .
<a href="#">PodSecurityContext</a>	

Property	Description
terminationGracePeriodSeconds  integer	The grace period is the duration in seconds after the processes running in the pod are sent a termination signal, and the time when the processes are forcibly halted with a kill signal. Set this value to longer than the expected cleanup time for your process. Value must be a non-negative integer. A zero value indicates delete immediately. You might need to increase the grace period for very large Kafka clusters, so that the Kafka brokers have enough time to transfer their work to another broker before they are terminated. Defaults to 30 seconds.
affinity  <a href="#">Affinity</a>	The pod's affinity rules. For more information, see the <a href="#">external documentation for core/v1 affinity</a> .
tolerations  <a href="#">Toleration array</a>	The pod's tolerations. For more information, see the <a href="#">external documentation for core/v1 toleration</a> .
priorityClassName  string	The name of the priority class used to assign priority to the pods. For more information about priority classes, see <a href="#">Pod Priority and Preemption</a> .
schedulerName  string	The name of the scheduler used to dispatch this <a href="#">Pod</a> . If not specified, the default scheduler will be used.
hostAliases  <a href="#">HostAlias array</a>	The pod's HostAliases. HostAliases is an optional list of hosts and IPs that will be injected into the Pod's hosts file if specified. For more information, see the <a href="#">external documentation for core/v1 hostalias</a> .
tmpDirSizeLimit  string	Defines the total amount (for example <a href="#">1Gi</a> ) of local storage required for temporary EmptyDir volume ( <a href="#">/tmp</a> ). Default value is <a href="#">5Mi</a> .
enableServiceLinks  boolean	Indicates whether information about services should be injected into Pod's environment variables.
topologySpreadConstraints  <a href="#">TopologySpreadConstraint array</a>	The pod's topology spread constraints. For more information, see the <a href="#">external documentation for core/v1 topologyspreadconstraint</a> .

### 12.2.37. InternalServiceTemplate schema reference

Used in: [CruiseControlTemplate](#), [KafkaBridgeTemplate](#), [KafkaClusterTemplate](#), [KafkaConnectTemplate](#),

## ZookeeperClusterTemplate

Property	Description
metadata	Metadata applied to the resource.
MetadataTemplate	
ipFamilyPolicy	Specifies the IP Family Policy used by the service. Available options are <code>SingleStack</code> , <code>PreferDualStack</code> and <code>RequireDualStack</code> . <code>SingleStack</code> is for a single IP family. <code>PreferDualStack</code> is for two IP families on dual-stack configured clusters or a single IP family on single-stack clusters. <code>RequireDualStack</code> fails unless there are two IP families on dual-stack configured clusters. If unspecified, Kubernetes will choose the default value based on the service type. Available on Kubernetes 1.20 and newer.
string (one of [RequireDualStack, SingleStack, PreferDualStack])	
ipFamilies	Specifies the IP Families used by the service. Available options are <code>IPv4</code> and <code>IPv6</code> . If unspecified, Kubernetes will choose the default value based on the 'ipFamilyPolicy' setting. Available on Kubernetes 1.20 and newer.
string (one or more of [IPv6, IPv4]) array	

### 12.2.38. ResourceTemplate schema reference

Used in: `CruiseControlTemplate`, `EntityOperatorTemplate`, `JmxTransTemplate`, `KafkaBridgeTemplate`, `KafkaClusterTemplate`, `KafkaConnectTemplate`, `KafkaExporterTemplate`, `KafkaMirrorMakerTemplate`, `KafkaUserTemplate`, `ZookeeperClusterTemplate`

Property	Description
metadata	Metadata applied to the resource.
MetadataTemplate	

### 12.2.39. PodDisruptionBudgetTemplate schema reference

Used in: `CruiseControlTemplate`, `KafkaBridgeTemplate`, `KafkaClusterTemplate`, `KafkaConnectTemplate`, `KafkaMirrorMakerTemplate`, `ZookeeperClusterTemplate`

[Full list of PodDisruptionBudgetTemplate schema properties](#)

Strimzi creates a `PodDisruptionBudget` for every new `StatefulSet` or `Deployment`. By default, pod disruption budgets only allow a single pod to be unavailable at a given time. You can increase the amount of unavailable pods allowed by changing the default value of the `maxUnavailable` property.

*An example of PodDisruptionBudget template*

```
# ...
```

```

template:
  podDisruptionBudget:
    metadata:
      labels:
        key1: label1
        key2: label2
      annotations:
        key1: label1
        key2: label2
    maxUnavailable: 1
# ...

```

### PodDisruptionBudgetTemplate schema properties

Property	Description
metadata	Metadata to apply to the PodDisruptionBudgetTemplate resource.
MetadataTemplate	
maxUnavailable	Maximum number of unavailable pods to allow automatic Pod eviction. A Pod eviction is allowed when the <code>maxUnavailable</code> number of pods or fewer are unavailable after the eviction. Setting this value to 0 prevents all voluntary evictions, so the pods must be evicted manually. Defaults to 1.
integer	

### 12.2.40. ContainerTemplate schema reference

Used in: `CruiseControlTemplate`, `EntityOperatorTemplate`, `JmxTransTemplate`, `KafkaBridgeTemplate`, `KafkaClusterTemplate`, `KafkaConnectTemplate`, `KafkaExporterTemplate`, `KafkaMirrorMakerTemplate`, `ZookeeperClusterTemplate`

#### Full list of ContainerTemplate schema properties

You can set custom security context and environment variables for a container.

The environment variables are defined under the `env` property as a list of objects with `name` and `value` fields. The following example shows two custom environment variables and a custom security context set for the Kafka broker containers:

```

# ...
template:
  kafkaContainer:
    env:
      - name: EXAMPLE_ENV_1
        value: example.env.one
      - name: EXAMPLE_ENV_2
        value: example.env.two
    securityContext:

```

```
runAsUser: 2000  
# ...
```

Environment variables prefixed with `KAFKA_` are internal to Strimzi and should be avoided. If you set a custom environment variable that is already in use by Strimzi, it is ignored and a warning is recorded in the log.

### ContainerTemplate schema properties

Property	Description
env	Environment variables which should be applied to the container.
ContainerEnvVar array	
securityContext	Security context for the container. For more information, see the <a href="#">external documentation for core/v1 securitycontext</a> .
SecurityContext	

#### 12.2.41. ContainerEnvVar schema reference

Used in: [ContainerTemplate](#)

Property	Description
name	The environment variable key.
string	
value	The environment variable value.
string	

#### 12.2.42. ZookeeperClusterSpec schema reference

Used in: [KafkaSpec](#)

[Full list of ZookeeperClusterSpec schema properties](#)

Configures a ZooKeeper cluster.

##### config

Use the `config` properties to configure ZooKeeper options as keys.

Standard Apache ZooKeeper configuration may be provided, restricted to those properties not managed directly by Strimzi.

Configuration options that cannot be configured relate to:

- Security (Encryption, Authentication, and Authorization)
- Listener configuration
- Configuration of data directories

- ZooKeeper cluster composition

The values can be one of the following JSON types:

- String
- Number
- Boolean

You can specify and configure the options listed in the [ZooKeeper documentation](#) with the exception of those managed directly by Strimzi. Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `server.`
- `dataDir`
- `dataLogDir`
- `clientPort`
- `authProvider`
- `quorum.auth`
- `requireClientAuthScheme`

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other supported options are passed to ZooKeeper.

There are exceptions to the forbidden options. For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed `ssl` properties](#).

#### *Example ZooKeeper configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  config:
    autopurge.snapRetainCount: 3
    autopurge.purgeInterval: 1
    ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384"
    ssl.enabled.protocols: "TLSv1.2"
    ssl.protocol: "TLSv1.2"
    # ...
```

#### **logging**

ZooKeeper has a configurable logger:

- `zookeeper.root.logger`

ZooKeeper uses the Apache `log4j` logger implementation.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  zookeeper:
    # ...
    logging:
      type: inline
      loggers:
        zookeeper.root.logger: "INFO"
  # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  zookeeper:
    # ...
    logging:
      type: external
      valueFrom:
        configMapKeyRef:
          name: customConfigMap
          key: zookeeper-log4j.properties
  # ...
```

#### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the [jvmOptions](#) property.

## ZookeeperClusterSpec schema properties

Property	Description
replicas	The number of pods in the cluster.
integer	
image	The docker image for the pods.
string	
storage	Storage configuration (disk). Cannot be updated. The type depends on the value of the <a href="#">storage.type</a> property within the given object, which must be one of [ephemeral, persistent-claim].
EphemeralStorage, PersistentClaimStorage	
config	The ZooKeeper broker config. Properties with the following prefixes cannot be set: server., dataDir, dataLogDir, clientPort, authProvider, quorum.auth, requireClientAuthScheme, snapshot.trust.empty, standaloneEnabled, reconfigEnabled, 4lw.commands.whitelist, secureClientPort, ssl., serverCnxnFactory, sslQuorum (with the exception of: ssl.protocol, ssl.quorum.protocol, ssl.enabledProtocols, ssl.quorum.enabledProtocols, ssl.ciphersuites, ssl.quorum.ciphersuites, ssl.hostnameVerification, ssl.quorum.hostnameVerification).
map	
livenessProbe	Pod liveness checking.
Probe	
readinessProbe	Pod readiness checking.
Probe	
jvmOptions	JVM Options for pods.
JvmOptions	
jmxOptions	JMX Options for Zookeeper nodes.
KafkaJmxOptions	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resource requirements</a> .
ResourceRequirements	
metricsConfig	Metrics configuration. The type depends on the value of the <a href="#">metricsConfig.type</a> property within the given object, which must be one of [jmxPrometheusExporter].
JmxPrometheusExporterMetrics	

Property	Description
logging	Logging configuration for ZooKeeper. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
template	Template for ZooKeeper cluster resources. The template allows users to specify how the <code>StatefulSet</code> , <code>Pods</code> , and <code>Services</code> are generated.
ZookeeperClusterTemplate	

### 12.2.43. ZookeeperClusterTemplate schema reference

Used in: `ZookeeperClusterSpec`

Property	Description
statefulset	Template for ZooKeeper <code>StatefulSet</code> .
StatefulSetTemplate	
pod	Template for ZooKeeper <code>Pods</code> .
PodTemplate	
clientService	Template for ZooKeeper client <code>Service</code> .
InternalServiceTemplate	
nodesService	Template for ZooKeeper nodes <code>Service</code> .
InternalServiceTemplate	
persistentVolumeClaim	Template for all ZooKeeper <code>PersistentVolumeClaims</code> .
ResourceTemplate	
podDisruptionBudget	Template for ZooKeeper <code>PodDisruptionBudget</code> .
PodDisruptionBudgetTemplate	
zookeeperContainer	Template for the ZooKeeper container.
ContainerTemplate	
serviceAccount	Template for the ZooKeeper service account.
ResourceTemplate	
jmxSecret	Template for Secret of the Zookeeper Cluster JMX authentication.
ResourceTemplate	
podSet	Template for ZooKeeper <code>StrimziPodSet</code> resource.
ResourceTemplate	

### 12.2.44. EntityOperatorSpec schema reference

Used in: `KafkaSpec`

Property	Description
topicOperator	Configuration of the Topic Operator.
<a href="#">EntityTopicOperatorSpec</a>	
userOperator	Configuration of the User Operator.
<a href="#">EntityUserOperatorSpec</a>	
tlsSidecar	TLS sidecar configuration.
<a href="#">TlsSidecar</a>	
template	Template for Entity Operator resources. The template allows users to specify how a <a href="#">Deployment</a> and <a href="#">Pod</a> is generated.
<a href="#">EntityOperatorTemplate</a>	

## 12.2.45. [EntityTopicOperatorSpec](#) schema reference

Used in: [EntityOperatorSpec](#)

[Full list of EntityTopicOperatorSpec schema properties](#)

Configures the Topic Operator.

### logging

The Topic Operator has a configurable logger:

- `rootLogger.level`

The Topic Operator uses the Apache [log4j2](#) logger implementation.

Use the `logging` property in the `entityOperator.topicOperator` field of the Kafka resource [Kafka](#) resource to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j2.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of [inline](#) and [external](#) logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
```

```

name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    # ...
  topicOperator:
    watchedNamespace: my-topic-namespace
    reconciliationIntervalSeconds: 60
    logging:
      type: inline
      loggers:
        rootLogger.level: INFO
# ...

```

### *External logging*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    # ...
  topicOperator:
    watchedNamespace: my-topic-namespace
    reconciliationIntervalSeconds: 60
    logging:
      type: external
      valueFrom:
        configMapKeyRef:
          name: customConfigMap
          key: topic-operator-log4j2.properties
# ...

```

### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the [JvmOptions](#) property.

### **EntityTopicOperatorSpec schema properties**

Property	Description
watchedNamespace string	The namespace the Topic Operator should watch.
image string	The image to use for the Topic Operator.
reconciliationIntervalSeconds integer	Interval between periodic reconciliations.
zookeeperSessionTimeoutSeconds integer	Timeout for the ZooKeeper session.
startupProbe <b>Probe</b>	Pod startup checking.
livenessProbe <b>Probe</b>	Pod liveness checking.
readinessProbe <b>Probe</b>	Pod readiness checking.
resources <b>ResourceRequirements</b>	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
topicMetadataMaxAttempts integer	The number of attempts at getting topic metadata.
logging <b>InlineLogging, ExternalLogging</b>	Logging configuration. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
jvmOptions <b>JvmOptions</b>	JVM Options for pods.

## 12.2.46. EntityUserOperatorSpec schema reference

Used in: [EntityOperatorSpec](#)

[Full list of EntityUserOperatorSpec schema properties](#)

Configures the User Operator.

### logging

The User Operator has a configurable logger:

- `rootLogger.level`

The User Operator uses the Apache `log4j2` logger implementation.

Use the `logging` property in the `entityOperator.userOperator` field of the `Kafka` resource to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j2.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
    # ...
  userOperator:
    watchedNamespace: my-topic-namespace
    reconciliationIntervalSeconds: 60
    logging:
      type: inline
      loggers:
        rootLogger.level: INFO
    # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    # ...
  zookeeper:
    # ...
  entityOperator:
```

```

# ...
userOperator:
  watchedNamespace: my-topic-namespace
  reconciliationIntervalSeconds: 60
  logging:
    type: external
    valueFrom:
      configMapKeyRef:
        name: customConfigMap
        key: user-operator-log4j2.properties
# ...

```

### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the [jvmOptions property](#).

### [EntityUserOperatorSpec schema properties](#)

Property	Description
watchedNamespace	The namespace the User Operator should watch.
string	
image	The image to use for the User Operator.
string	
reconciliationIntervalSeconds	Interval between periodic reconciliations.
integer	
zookeeperSessionTimeoutSeconds	<b>The <code>zookeeperSessionTimeoutSeconds</code> property has been deprecated.</b> This property has been deprecated because ZooKeeper is not used anymore by the User Operator. Timeout for the ZooKeeper session.
integer	
secretPrefix	The prefix that will be added to the KafkaUser name to be used as the Secret name.
string	
livenessProbe	Pod liveness checking.
<b>Probe</b>	
readinessProbe	Pod readiness checking.
<b>Probe</b>	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
<a href="#">ResourceRequirements</a>	
logging	Logging configuration. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
<a href="#">InlineLogging</a> , <a href="#">ExternalLogging</a>	

Property	Description
jvmOptions	JVM Options for pods.
JvmOptions	

## 12.2.47. `TlsSidecar` schema reference

Used in: [CruiseControlSpec](#), [EntityOperatorSpec](#)

[Full list of `TlsSidecar` schema properties](#)

Configures a TLS sidecar, which is a container that runs in a pod, but serves a supporting purpose. In Strimzi, the TLS sidecar uses TLS to encrypt and decrypt communication between components and ZooKeeper.

The TLS sidecar is used in the Entity Operator.

The TLS sidecar is configured using the `tlsSidecar` property in [Kafka.spec.entityOperator](#).

The TLS sidecar supports the following additional options:

- `image`
- `resources`
- `logLevel`
- `readinessProbe`
- `livenessProbe`

The `resources` property specifies the [memory](#) and [CPU resources](#) allocated for the TLS sidecar.

The `image` property configures the [container image](#) which will be used.

The `readinessProbe` and `livenessProbe` properties configure [healthcheck probes](#) for the TLS sidecar.

The `logLevel` property specifies the logging level. The following logging levels are supported:

- emerg
- alert
- crit
- err
- warning
- notice
- info
- debug

The default value is `notice`.

### Example TLS sidecar configuration

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  entityOperator:
    # ...
    tlsSidecar:
      resources:
        requests:
          cpu: 200m
          memory: 64Mi
        limits:
          cpu: 500m
          memory: 128Mi
  # ...
```

### TlsSidecar schema properties

Property	Description
image	The docker image for the container.
string	
livenessProbe	Pod liveness checking.
Probe	
logLevel	The log level for the TLS sidecar. Default value is <a href="#">notice</a> .
string (one of [emerg, debug, crit, err, alert, warning, notice, info])	
readinessProbe	Pod readiness checking.
Probe	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
ResourceRequirements	

### 12.2.48. EntityOperatorTemplate schema reference

Used in: [EntityOperatorSpec](#)

Property	Description
deployment	Template for Entity Operator <a href="#">Deployment</a> .
ResourceTemplate	

Property	Description
pod	Template for Entity Operator <a href="#">Pods</a> .
<a href="#">PodTemplate</a>	
topicOperatorContainer	Template for the Entity Topic Operator container.
<a href="#">ContainerTemplate</a>	
userOperatorContainer	Template for the Entity User Operator container.
<a href="#">ContainerTemplate</a>	
tlsSidecarContainer	Template for the Entity Operator TLS sidecar container.
<a href="#">ContainerTemplate</a>	
serviceAccount	Template for the Entity Operator service account.
<a href="#">ResourceTemplate</a>	

## 12.2.49. [CertificateAuthority](#) schema reference

Used in: [KafkaSpec](#)

Configuration of how TLS certificates are used within the cluster. This applies to certificates used for both internal communication within the cluster and to certificates used for client access via [Kafka.spec.kafka.listeners.tls](#).

Property	Description
generateCertificateAuthority	If true then Certificate Authority certificates will be generated automatically. Otherwise the user will need to provide a Secret with the CA certificate. Default is true.
boolean	
generateSecretOwnerReference	If <a href="#">true</a> , the Cluster and Client CA Secrets are configured with the <a href="#">ownerReference</a> set to the <a href="#">Kafka</a> resource. If the <a href="#">Kafka</a> resource is deleted when <a href="#">true</a> , the CA Secrets are also deleted. If <a href="#">false</a> , the <a href="#">ownerReference</a> is disabled. If the <a href="#">Kafka</a> resource is deleted when <a href="#">false</a> , the CA Secrets are retained and available for reuse. Default is <a href="#">true</a> .
boolean	
validityDays	The number of days generated certificates should be valid for. The default is 365.
integer	

Property	Description
renewalDays integer	The number of days in the certificate renewal period. This is the number of days before the a certificate expires during which renewal actions may be performed. When <code>generateCertificateAuthority</code> is true, this will cause the generation of a new certificate. When <code>generateCertificateAuthority</code> is true, this will cause extra logging at WARN level about the pending certificate expiry. Default is 30.
certificateExpirationPolicy string (one of [replace-key, renew-certificate])	How should CA certificate expiration be handled when <code>generateCertificateAuthority=true</code> . The default is for a new CA certificate to be generated reusing the existing private key.

## 12.2.50. `CruiseControlSpec` schema reference

Used in: [KafkaSpec](#)

[Full list of `CruiseControlSpec` schema properties](#)

Configures a Cruise Control cluster.

Configuration options relate to:

- Goals configuration
- Capacity limits for resource distribution goals

### `config`

Use the `config` properties to configure Cruise Control options as keys.

Standard Cruise Control configuration may be provided, restricted to those properties not managed directly by Strimzi.

Configuration options that cannot be configured relate to the following:

- Security (Encryption, Authentication, and Authorization)
- Connection to the Kafka cluster
- Client ID configuration
- ZooKeeper connectivity
- Web server configuration
- Self healing

The values can be one of the following JSON types:

- String

- Number
- Boolean

You can specify and configure the options listed in the [Cruise Control documentation](#) with the exception of those options that are managed directly by Strimzi. See the description of the `config` property for a list of forbidden prefixes.

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other supported options are passed to Cruise Control.

There are exceptions to the forbidden options. For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed ssl properties](#). You can also configure `webserver` properties to enable Cross-Origin Resource Sharing (CORS).

#### *Example Cruise Control configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  cruiseControl:
    # ...
    config:
      default.goals: >
        com.linkedin.kafka.cruisecontrol.analyzer.goals.RackAwareGoal,
        com.linkedin.kafka.cruisecontrol.analyzer.goals.ReplicaCapacityGoal
      cpu.balance.threshold: 1.1
      metadata.max.age.ms: 300000
      send.buffer.bytes: 131072
      webserver.http.cors.enabled: true
      webserver.http.cors.origin: "*"
      webserver.http.cors.exposeheaders: "User-Task-ID,Content-Type"
    # ...
```

## Cross-Origin Resource Sharing (CORS)

Cross-Origin Resource Sharing (CORS) is a HTTP mechanism for controlling access to REST APIs. Restrictions can be on access methods or originating URLs of client applications. You can enable CORS with Cruise Control using the `webserver.http.cors.enabled` property in the `config`. When enabled, CORS permits read access to the Cruise Control REST API from applications that have different originating URLs than Strimzi. This allows applications from specified origins to use `GET` requests to fetch information about the Kafka cluster through the Cruise Control API. For example, applications can fetch information on the current cluster load or the most recent optimization proposal. `POST` requests are not permitted.

### NOTE

For more information on using CORS with Cruise Control, see [REST APIs in the Cruise Control Wiki](#).

## Enabling CORS for Cruise Control

You enable and configure CORS in `Kafka.spec.cruiseControl.config`.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  cruiseControl:
    # ...
    config:
      webserver.http.cors.enabled: true ①
      webserver.http.cors.origin: "*" ②
      webserver.http.cors.exposeheaders: "User-Task-ID,Content-Type" ③
      # ...
```

① Enables CORS.

② Specifies permitted origins for the `Access-Control-Allow-Origin` HTTP response header. You can use a wildcard or specify a single origin as a URL. If you use a wildcard, a response is returned following requests from any origin.

③ Exposes specified header names for the `Access-Control-Expose-Headers` HTTP response header. Applications in permitted origins can read responses with the specified headers.

## Cruise Control REST API security

The Cruise Control REST API is secured with HTTP Basic authentication and SSL to protect the cluster against potentially destructive Cruise Control operations, such as decommissioning Kafka brokers. We recommend that Cruise Control in Strimzi is **only used with these settings enabled**.

However, it is possible to disable these settings by specifying the following Cruise Control configuration:

- To disable the built-in HTTP Basic authentication, set `webserver.security.enable` to `false`.
- To disable the built-in SSL, set `webserver.ssl.enable` to `false`.

*Cruise Control configuration to disable API authorization, authentication, and SSL*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  cruiseControl:
    config:
      webserver.security.enable: false
```

```
webserver.ssl.enable: false  
# ...
```

## brokerCapacity

Cruise Control uses capacity limits to determine if optimization goals for resource distribution are being broken. There are four goals of this type:

- [DiskUsageDistributionGoal](#) - Disk utilization distribution
- [CpuUsageDistributionGoal](#) - CPU utilization distribution
- [NetworkInboundUsageDistributionGoal](#) - Network inbound utilization distribution
- [NetworkOutboundUsageDistributionGoal](#) - Network outbound utilization distribution

You specify capacity limits for Kafka broker resources in the [brokerCapacity](#) property in [Kafka.spec.cruiseControl](#). They are enabled by default and you can change their default values. Capacity limits can be set for the following broker resources:

- [cpu](#) - CPU resource in millicores or CPU cores (Default: 1)
- [inboundNetwork](#) - Inbound network throughput in byte units per second (Default: 10000KiB/s)
- [outboundNetwork](#) - Outbound network throughput in byte units per second (Default: 10000KiB/s)

For network throughput, use an integer value with standard Kubernetes byte units (K, M, G) or their bbyte (power of two) equivalents (Ki, Mi, Gi) per second.

**NOTE**

Disk and CPU capacity limits are automatically generated by Strimzi, so you do not need to set them. In order to guarantee accurate rebalance proposals when using CPU goals, you can set CPU requests equal to CPU limits in [Kafka.spec.kafka.resources](#). That way, all CPU resources are reserved upfront and are always available. This configuration allows Cruise Control to properly evaluate the CPU utilization when preparing the rebalance proposals based on CPU goals. In cases where you cannot set CPU requests equal to CPU limits in [Kafka.spec.kafka.resources](#), you can set the CPU capacity manually for the same accuracy.

*Example Cruise Control brokerCapacity configuration using bbyte units*

```
apiVersion: kafka.strimzi.io/v1beta2  
kind: Kafka  
metadata:  
  name: my-cluster  
spec:  
  # ...  
  cruiseControl:  
    # ...  
    brokerCapacity:  
      cpu: "2"  
      inboundNetwork: 10000KiB/s
```

```
outboundNetwork: 10000KiB/s  
# ...
```

## Capacity overrides

Brokers might be running on nodes with heterogeneous network or CPU resources. If that's the case, specify `overrides` that set the network capacity and CPU limits for each broker. The overrides ensure an accurate rebalance between the brokers. Override capacity limits can be set for the following broker resources:

- `cpu` - CPU resource in millicores or CPU cores (Default: 1)
- `inboundNetwork` - Inbound network throughput in byte units per second (Default: 10000KiB/s)
- `outboundNetwork` - Outbound network throughput in byte units per second (Default: 10000KiB/s)

*An example of Cruise Control capacity overrides configuration using bbyte units*

```
apiVersion: kafka.strimzi.io/v1beta2  
kind: Kafka  
metadata:  
  name: my-cluster  
spec:  
  # ...  
  cruiseControl:  
    # ...  
    brokerCapacity:  
      cpu: "1"  
      inboundNetwork: 10000KiB/s  
      outboundNetwork: 10000KiB/s  
      overrides:  
        - brokers: [0]  
          cpu: "2.755"  
          inboundNetwork: 20000KiB/s  
          outboundNetwork: 20000KiB/s  
        - brokers: [1, 2]  
          cpu: 3000m  
          inboundNetwork: 30000KiB/s  
          outboundNetwork: 30000KiB/s
```

For more information, refer to the [BrokerCapacity schema reference](#).

## Logging configuration

Cruise Control has its own configurable logger:

- `rootLogger.level`

Cruise Control uses the Apache `log4j2` logger implementation.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
# ...
spec:
  cruiseControl:
    # ...
    logging:
      type: inline
      loggers:
        rootLogger.level: "INFO"
    # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
# ...
spec:
  cruiseControl:
    # ...
    logging:
      type: external
      valueFrom:
        configMapKeyRef:
          name: customConfigMap
          key: cruise-control-log4j.properties
    # ...
```

#### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the `jvmOptions` property.

#### `CruiseControlSpec` schema properties

Property	Description
image	The docker image for the pods.
string	
tlsSidecar	<b>The <code>tlsSidecar</code> property has been deprecated.</b>
<code>TlsSidecar</code>	TLS sidecar configuration.
resources	CPU and memory resources to reserve for the Cruise Control container. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
<code>ResourceRequirements</code>	
livenessProbe	Pod liveness checking for the Cruise Control container.
<code>Probe</code>	
readinessProbe	Pod readiness checking for the Cruise Control container.
<code>Probe</code>	
jvmOptions	JVM Options for the Cruise Control container.
<code>JvmOptions</code>	
logging	Logging configuration (Log4j 2) for Cruise Control. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
<code>InlineLogging, ExternalLogging</code>	
template	Template to specify how Cruise Control resources, <a href="#">Deployments</a> and <a href="#">Pods</a> , are generated.
<code>CruiseControlTemplate</code>	
brokerCapacity	The Cruise Control <code>brokerCapacity</code> configuration.
<code>BrokerCapacity</code>	

Property	Description
config	The Cruise Control configuration. For a full list of configuration options refer to <a href="https://github.com/linkedin/cruise-control/wiki/Configurations">https://github.com/linkedin/cruise-control/wiki/Configurations</a> . Note that properties with the following prefixes cannot be set: bootstrap.servers, client.id, zookeeper., network., security, failed.brokers.zk.path, webserver.http., webserver.api.urlprefix, webserver.session.path, webserver.accesslog, two.step., request.reason.required, metric.reporter.sample.r.bootstrap.servers, capacity.config.file, self.healing., ssl, kafka.broker.failure.detection.enable, topic.config.provider.class (with the exception of: ssl.cipher.suites, ssl.protocol, ssl.enabled.protocols, webserver.http.cors.enabled, webserver.http.cors.origin, webserver.http.cors.exposeheaders, webserver.security.enable, webserver.ssl.enable).
map	
metricsConfig	Metrics configuration. The type depends on the value of the <code>metricsConfig.type</code> property within the given object, which must be one of [jmxPrometheusExporter].
JmxPrometheusExporterMetrics	

### 12.2.51. `CruiseControlTemplate` schema reference

Used in: `CruiseControlSpec`

Property	Description
deployment	Template for Cruise Control <code>Deployment</code> .
ResourceTemplate	
pod	Template for Cruise Control <code>Pods</code> .
PodTemplate	
apiService	Template for Cruise Control <code>API Service</code> .
InternalServiceTemplate	
podDisruptionBudget	Template for Cruise Control <code>PodDisruptionBudget</code> .
PodDisruptionBudgetTemplate	

Property	Description
cruiseControlContainer	Template for the Cruise Control container.
<b>ContainerTemplate</b>	
tlsSidecarContainer	The <b>tlsSidecarContainer</b> property has been <b>deprecated</b> . Template for the Cruise Control TLS sidecar container.
<b>ContainerTemplate</b>	
serviceAccount	Template for the Cruise Control service account.
<b>ResourceTemplate</b>	

## 12.2.52. **BrokerCapacity** schema reference

Used in: [CruiseControlSpec](#)

Property	Description
disk	The <b>disk</b> property has been <b>deprecated</b> . The Cruise Control disk capacity setting has been deprecated, is ignored, and will be removed in the future Broker capacity for disk in bytes. Use a number value with either standard Kubernetes byte units (K, M, G, or T), their bibyte (power of two) equivalents (Ki, Mi, Gi, or Ti), or a byte value with or without E notation. For example, 100000M, 100000Mi, 104857600000, or 1e+11.
string	
cpuUtilization	The <b>cpuUtilization</b> property has been <b>deprecated</b> . The Cruise Control CPU capacity setting has been deprecated, is ignored, and will be removed in the future Broker capacity for CPU resource utilization as a percentage (0 - 100).
integer	
cpu	Broker capacity for CPU resource in cores or millicores. For example, 1, 1.500, 1500m. For more information on valid CPU resource units see <a href="https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/#meaning-of-cpu">https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/#meaning-of-cpu</a> .
string	
inboundNetwork	Broker capacity for inbound network throughput in bytes per second. Use an integer value with standard Kubernetes byte units (K, M, G) or their bibyte (power of two) equivalents (Ki, Mi, Gi) per second. For example, 10000KiB/s.
string	

Property	Description
outboundNetwork string	Broker capacity for outbound network throughput in bytes per second. Use an integer value with standard Kubernetes byte units (K, M, G) or their bibyte (power of two) equivalents (Ki, Mi, Gi) per second. For example, 10000KiB/s.
overrides <b>BrokerCapacityOverride</b> array	Overrides for individual brokers. The <b>overrides</b> property lets you specify a different capacity configuration for different brokers.

## 12.2.53. **BrokerCapacityOverride** schema reference

Used in: [BrokerCapacity](#)

Property	Description
brokers integer array	List of Kafka brokers (broker identifiers).
cpu string	Broker capacity for CPU resource in cores or millicores. For example, 1, 1.500, 1500m. For more information on valid CPU resource units see <a href="https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/#meaning-of-cpu">https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/#meaning-of-cpu</a> .
inboundNetwork string	Broker capacity for inbound network throughput in bytes per second. Use an integer value with standard Kubernetes byte units (K, M, G) or their bibyte (power of two) equivalents (Ki, Mi, Gi) per second. For example, 10000KiB/s.
outboundNetwork string	Broker capacity for outbound network throughput in bytes per second. Use an integer value with standard Kubernetes byte units (K, M, G) or their bibyte (power of two) equivalents (Ki, Mi, Gi) per second. For example, 10000KiB/s.

## 12.2.54. **JmxTransSpec** schema reference

Used in: [KafkaSpec](#)

Property	Description
image string	The image to use for the JmxTrans.

Property	Description
outputDefinitions	Defines the output hosts that will be referenced later on. For more information on these properties see, <a href="#">JmxTransOutputDefinitionTemplate schema reference</a> .
JmxTransOutputDefinitionTemplate array	
logLevel	Sets the logging level of the JmxTrans deployment. For more information see, <a href="#">JmxTrans Logging Level</a> .
string	
kafkaQueries	Queries to send to the Kafka brokers to define what data should be read from each broker. For more information on these properties see, <a href="#">JmxTransQueryTemplate schema reference</a> .
JmxTransQueryTemplate array	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
ResourceRequirements	
template	Template for JmxTrans resources.
JmxTransTemplate	

## 12.2.55. JmxTransOutputDefinitionTemplate schema reference

Used in: [JmxTransSpec](#)

Property	Description
outputType	Template for setting the format of the data that will be pushed. For more information see <a href="#">JmxTrans OutputWriters</a> .
string	
host	The DNS/hostname of the remote host that the data is pushed to.
string	
port	The port of the remote host that the data is pushed to.
integer	
flushDelayInSeconds	How many seconds the JmxTrans waits before pushing a new set of data out.
integer	
typeNames	Template for filtering data to be included in response to a wildcard query. For more information see <a href="#">JmxTrans queries</a> .
string array	
name	Template for setting the name of the output definition. This is used to identify where to send the results of queries should be sent.
string	

## 12.2.56. [JmxTransQueryTemplate](#) schema reference

Used in: [JmxTransSpec](#)

Property	Description
targetMBean	If using wildcards instead of a specific MBean then the data is gathered from multiple MBeans. Otherwise if specifying an MBean then data is gathered from that specified MBean.
string	
attributes	Determine which attributes of the targeted MBean should be included.
string array	
outputs	List of the names of output definitions specified in the spec.kafka.jmxTrans.outputDefinitions that have defined where JMX metrics are pushed to, and in which data format.
string array	

## 12.2.57. [JmxTransTemplate](#) schema reference

Used in: [JmxTransSpec](#)

Property	Description
deployment	Template for JmxTrans Deployment.
<a href="#">ResourceTemplate</a>	
pod	Template for JmxTrans Pods.
<a href="#">PodTemplate</a>	
container	Template for JmxTrans container.
<a href="#">ContainerTemplate</a>	
serviceAccount	Template for the JMX Trans service account.
<a href="#">ResourceTemplate</a>	

## 12.2.58. [KafkaExporterSpec](#) schema reference

Used in: [KafkaSpec](#)

Property	Description
image	The docker image for the pods.
string	
groupRegex	Regular expression to specify which consumer groups to collect. Default value is <code>.*</code> .
string	
topicRegex	Regular expression to specify which topics to collect. Default value is <code>.*</code> .
string	

Property	Description
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resource requirements</a> .
ResourceRequirements	
logging	Only log messages with the given severity or above. Valid levels: [ <a href="#">info</a> , <a href="#">debug</a> , <a href="#">trace</a> ]. Default log level is <a href="#">info</a> .
string	
enableSaramaLogging	Enable Sarama logging, a Go client library used by the Kafka Exporter.
boolean	
template	Customization of deployment templates and pods.
KafkaExporterTemplate	
livenessProbe	Pod liveness check.
Probe	
readinessProbe	Pod readiness check.
Probe	

## 12.2.59. KafkaExporterTemplate schema reference

Used in: [KafkaExporterSpec](#)

Property	Description
deployment	Template for Kafka Exporter <a href="#">Deployment</a> .
ResourceTemplate	
pod	Template for Kafka Exporter <a href="#">Pods</a> .
PodTemplate	
service	<b>The <code>service</code> property has been deprecated.</b> The Kafka Exporter service has been removed.
ResourceTemplate	Template for Kafka Exporter <a href="#">Service</a> .
container	Template for the Kafka Exporter container.
ContainerTemplate	
serviceAccount	Template for the Kafka Exporter service account.
ResourceTemplate	

## 12.2.60. KafkaStatus schema reference

Used in: [Kafka](#)

Property	Description
conditions	List of status conditions.
Condition array	

Property	Description
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
listeners	Addresses of the internal and external listeners.
ListenerStatus array	
clusterId	Kafka cluster Id.
string	

## 12.2.61. Condition schema reference

Used in: [KafkaBridgeStatus](#), [KafkaConnectorStatus](#), [KafkaConnectStatus](#), [KafkaMirrorMaker2Status](#), [KafkaMirrorMakerStatus](#), [KafkaRebalanceStatus](#), [KafkaStatus](#), [KafkaTopicStatus](#), [KafkaUserStatus](#)

Property	Description
type	The unique identifier of a condition, used to distinguish between other conditions in the resource.
string	
status	The status of the condition, either True, False or Unknown.
string	
lastTransitionTime	Last time the condition of a type changed from one status to another. The required format is 'yyyy-MM-ddTHH:mm:ssZ', in the UTC time zone.
string	
reason	The reason for the condition's last transition (a single word in CamelCase).
string	
message	Human-readable message indicating details about the condition's last transition.
string	

## 12.2.62. ListenerStatus schema reference

Used in: [KafkaStatus](#)

Property	Description
type	The <b>type</b> property has been deprecated, and should now be configured using <b>name</b> . The name of the listener.
string	
name	The name of the listener.
string	
addresses	A list of the addresses for this listener.
ListenerAddress array	

Property	Description
bootstrapServers string	A comma-separated list of <code>host:port</code> pairs for connecting to the Kafka cluster using this listener.
certificates string array	A list of TLS certificates which can be used to verify the identity of the server when connecting to the given listener. Set only for <code>tls</code> and <code>external</code> listeners.

## 12.2.63. `ListenerAddress` schema reference

Used in: [ListenerStatus](#)

Property	Description
host string	The DNS name or IP address of the Kafka bootstrap service.
port integer	The port of the Kafka bootstrap service.

## 12.2.64. `KafkaConnect` schema reference

Property	Description
spec <a href="#">KafkaConnectSpec</a>	The specification of the Kafka Connect cluster.
status <a href="#">KafkaConnectStatus</a>	The status of the Kafka Connect cluster.

## 12.2.65. `KafkaConnectSpec` schema reference

Used in: [KafkaConnect](#)

[Full list of KafkaConnectSpec schema properties](#)

Configures a Kafka Connect cluster.

### config

Use the `config` properties to configure Kafka options as keys.

Standard Apache Kafka Connect configuration may be provided, restricted to those properties not managed directly by Strimzi.

Configuration options that cannot be configured relate to:

- Kafka cluster bootstrap address

- Security (Encryption, Authentication, and Authorization)
- Listener / REST interface configuration
- Plugin path configuration

The values can be one of the following JSON types:

- String
- Number
- Boolean

You can specify and configure the options listed in the [Apache Kafka documentation](#) with the exception of those options that are managed directly by Strimzi. Specifically, configuration options with keys equal to or starting with one of the following strings are forbidden:

- `ssl.`
- `sasl.`
- `security.`
- `listeners`
- `plugin.path`
- `rest.`
- `bootstrap.servers`

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other options are passed to Kafka Connect.

**IMPORTANT**

The Cluster Operator does not validate keys or values in the `config` object provided. When an invalid configuration is provided, the Kafka Connect cluster might not start or might become unstable. In this circumstance, fix the configuration in the `KafkaConnect.spec.config` object, then the Cluster Operator can roll out the new configuration to all Kafka Connect nodes.

Certain options have default values:

- `group.id` with default value `connect-cluster`
- `offset.storage.topic` with default value `connect-cluster-offsets`
- `config.storage.topic` with default value `connect-cluster-configs`
- `status.storage.topic` with default value `connect-cluster-status`
- `key.converter` with default value `org.apache.kafka.connect.json.JsonConverter`
- `value.converter` with default value `org.apache.kafka.connect.json.JsonConverter`

These options are automatically configured in case they are not present in the `KafkaConnect.spec.config` properties.

There are exceptions to the forbidden options. You can use three allowed `ssl` configuration options

for client connection using a specific *cipher suite* for a TLS version. A cipher suite combines algorithms for secure connection and data transfer. You can also configure the `ssl.endpoint.identification.algorithm` property to enable or disable hostname verification.

#### Example Kafka Connect configuration

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  config:
    group.id: my-connect-cluster
    offset.storage.topic: my-connect-cluster-offsets
    config.storage.topic: my-connect-cluster-configs
    status.storage.topic: my-connect-cluster-status
    key.converter: org.apache.kafka.connect.json.JsonConverter
    value.converter: org.apache.kafka.connect.json.JsonConverter
    key.converter.schemas.enable: true
    value.converter.schemas.enable: true
    config.storage.replication.factor: 3
    offset.storage.replication.factor: 3
    status.storage.replication.factor: 3
    ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384"
    ssl.enabled.protocols: "TLSv1.2"
    ssl.protocol: "TLSv1.2"
    ssl.endpoint.identification.algorithm: HTTPS
  # ...
```

For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed SSL properties](#). You can also [configure the `ssl.endpoint.identification.algorithm` property](#) to enable or disable hostname verification.

## logging

Kafka Connect has its own configurable loggers:

- `connect.root.logger.level`
- `log4j.logger.org.reflections`

Further loggers are added depending on the Kafka Connect plugins running.

Use a curl request to get a complete list of Kafka Connect loggers running from any Kafka broker pod:

```
curl -s http://<connect-cluster-name>-connect-api:8083/admin/loggers/
```

Kafka Connect uses the Apache [log4j](#) logger implementation.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
spec:
  # ...
  logging:
    type: inline
    loggers:
      connect.root.logger.level: "INFO"
  # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
spec:
  # ...
  logging:
    type: external
    valueFrom:
      configMapKeyRef:
        name: customConfigMap
        key: connect-logging.log4j
  # ...
```

Any available loggers that are not configured have their level set to `OFF`.

If Kafka Connect was deployed using the Cluster Operator, changes to Kafka Connect logging levels are applied dynamically.

If you use external logging, a rolling update is triggered when logging appenders are changed.

#### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the [jvmOptions](#) property.

## KafkaConnectSpec schema properties

Property	Description
version	The Kafka Connect version. Defaults to 3.3.1. Consult the user documentation to understand the process required to upgrade or downgrade the version.
string	
replicas	The number of pods in the Kafka Connect group.
integer	
image	The docker image for the pods.
string	
bootstrapServers	Bootstrap servers to connect to. This should be given as a comma separated list of <hostname>:_<port>_ pairs.
string	
tls	TLS configuration.
<a href="#">ClientTls</a>	
authentication	Authentication configuration for Kafka Connect. The type depends on the value of the <a href="#">authentication.type</a> property within the given object, which must be one of [tls, scram-sha-256, scram-sha-512, plain, oauth].
<a href="#">KafkaClientAuthenticationTls</a> , <a href="#">KafkaClientAuthenticationScramSha256</a> , <a href="#">KafkaClientAuthenticationScramSha512</a> , <a href="#">KafkaClientAuthenticationPlain</a> , <a href="#">KafkaClientAuthenticationOAuth</a>	
config	The Kafka Connect configuration. Properties with the following prefixes cannot be set: ssl, sasl., security., listeners, plugin.path, rest., bootstrap.servers, consumer.interceptor.classes, producer.interceptor.classes (with the exception of: ssl.endpoint.identification.algorithm, ssl.cipher.suites, ssl.protocol, ssl.enabled.protocols).
map	
resources	The maximum limits for CPU and memory resources and the requested initial resources. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
<a href="#">ResourceRequirements</a>	
livenessProbe	Pod liveness checking.
<a href="#">Probe</a>	
readinessProbe	Pod readiness checking.
<a href="#">Probe</a>	

Property	Description
jvmOptions	JVM Options for pods.
<a href="#">JvmOptions</a>	
jmxOptions	JMX Options.
<a href="#">KafkaJmxOptions</a>	
logging	Logging configuration for Kafka Connect. The type depends on the value of the <a href="#">logging.type</a> property within the given object, which must be one of [inline, external].
<a href="#">InlineLogging</a> , <a href="#">ExternalLogging</a>	
clientRackInitImage	The image of the init container used for initializing the <a href="#">client.rack</a> .
string	
rack	Configuration of the node label which will be used as the <a href="#">client.rack</a> consumer configuration.
<a href="#">Rack</a>	
tracing	The configuration of tracing in Kafka Connect. The type depends on the value of the <a href="#">tracing.type</a> property within the given object, which must be one of [jaeger, opentelemetry].
<a href="#">JaegerTracing</a> , <a href="#">OpenTelemetryTracing</a>	
template	Template for Kafka Connect and Kafka Mirror Maker 2 resources. The template allows users to specify how the <a href="#">Deployment</a> , <a href="#">Pods</a> and <a href="#">Service</a> are generated.
<a href="#">KafkaConnectTemplate</a>	
externalConfiguration	Pass data from Secrets or ConfigMaps to the Kafka Connect pods and use them to configure connectors.
<a href="#">ExternalConfiguration</a>	
build	Configures how the Connect container image should be built. Optional.
<a href="#">Build</a>	
metricsConfig	Metrics configuration. The type depends on the value of the <a href="#">metricsConfig.type</a> property within the given object, which must be one of [jmxPrometheusExporter].
<a href="#">JmxPrometheusExporterMetrics</a>	

## 12.2.66. [ClientTls](#) schema reference

Used in: [KafkaBridgeSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2ClusterSpec](#), [KafkaMirrorMakerConsumerSpec](#), [KafkaMirrorMakerProducerSpec](#)

[Full list of ClientTls schema properties](#)

Configures TLS trusted certificates for connecting KafkaConnect, KafkaBridge, KafkaMirror, KafkaMirrorMaker2 to the cluster.

## trustedCertificates

Provide a list of secrets using the `trustedCertificates` property.

### ClientTls schema properties

Property	Description
<code>trustedCertificates</code>	Trusted certificates for TLS connection.
<code>CertSecretSource</code> array	

## 12.2.67. KafkaClientAuthenticationTls schema reference

Used in: `KafkaBridgeSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2ClusterSpec`, `KafkaMirrorMakerConsumerSpec`, `KafkaMirrorMakerProducerSpec`

[Full list of KafkaClientAuthenticationTls schema properties](#)

To configure TLS client authentication, set the `type` property to the value `tls`. TLS client authentication uses a TLS certificate to authenticate.

### certificateAndKey

The certificate is specified in the `certificateAndKey` property and is always loaded from a Kubernetes secret. In the secret, the certificate must be stored in X509 format under two different keys: public and private.

You can use the secrets created by the User Operator, or you can create your own TLS certificate file, with the keys used for authentication, then create a `Secret` from the file:

```
kubectl create secret generic MY-SECRET \
--from-file=MY-PUBLIC-TLS-CERTIFICATE-FILE.crt \
--from-file=MY-PRIVATE.key
```

**NOTE** TLS client authentication can only be used with TLS connections.

*Example TLS client authentication configuration*

```
authentication:
  type: tls
  certificateAndKey:
    secretName: my-secret
    certificate: my-public-tls-certificate-file.crt
    key: private.key
```

### KafkaClientAuthenticationTls schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaClientAuthenticationTls` type from `KafkaClientAuthenticationScramSha256`, `KafkaClientAuthenticationScramSha512`,

`KafkaClientAuthenticationPlain`, `KafkaClientAuthenticationOAuth`. It must have the value `tls` for the type `KafkaClientAuthenticationTls`.

Property	Description
<code>certificateAndKey</code>	Reference to the <code>Secret</code> which holds the certificate and private key pair.
<code>CertAndKeySecretSource</code>	
<code>type</code>	Must be <code>tls</code> .
<code>string</code>	

## 12.2.68. `KafkaClientAuthenticationScramSha256` schema reference

Used in: `KafkaBridgeSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2ClusterSpec`, `KafkaMirrorMakerConsumerSpec`, `KafkaMirrorMakerProducerSpec`

[Full list of `KafkaClientAuthenticationScramSha256` schema properties](#)

To configure SASL-based SCRAM-SHA-256 authentication, set the `type` property to `scram-sha-256`. The SCRAM-SHA-256 authentication mechanism requires a username and password.

### `username`

Specify the username in the `username` property.

### `passwordSecret`

In the `passwordSecret` property, specify a link to a `Secret` containing the password.

You can use the secrets created by the User Operator.

If required, you can create a text file that contains the password, in cleartext, to use for authentication:

```
echo -n PASSWORD > MY-PASSWORD.txt
```

You can then create a `Secret` from the text file, setting your own field name (key) for the password:

```
kubectl create secret generic MY-CONNECT-SECRET-NAME --from-file=MY-PASSWORD-FIELD-NAME=./MY-PASSWORD.txt
```

*Example Secret for SCRAM-SHA-256 client authentication for Kafka Connect*

```
apiVersion: v1
kind: Secret
metadata:
  name: my-connect-secret-name
type: Opaque
data:
```

```
my-connect-password-field: LFTIyFRFLMmU2N2Tm
```

The `secretName` property contains the name of the `Secret`, and the `password` property contains the name of the key under which the password is stored inside the `Secret`.

**IMPORTANT** Do not specify the actual password in the `password` property.

*Example SASL-based SCRAM-SHA-256 client authentication configuration for Kafka Connect*

```
authentication:  
  type: scram-sha-256  
  username: my-connect-username  
  passwordSecret:  
    secretName: my-connect-secret-name  
    password: my-connect-password-field
```

### KafkaClientAuthenticationScramSha256 schema properties

Property	Description
passwordSecret	Reference to the <code>Secret</code> which holds the password.
PasswordSecretSource	
type	Must be <code>scram-sha-256</code> .
string	
username	Username used for the authentication.
string	

### 12.2.69. PasswordSecretSource schema reference

Used in: `KafkaClientAuthenticationOAuth`, `KafkaClientAuthenticationPlain`, `KafkaClientAuthenticationScramSha256`, `KafkaClientAuthenticationScramSha512`

Property	Description
password	The name of the key in the Secret under which the password is stored.
string	
secretName	The name of the Secret containing the password.
string	

### 12.2.70. KafkaClientAuthenticationScramSha512 schema reference

Used in: `KafkaBridgeSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2ClusterSpec`, `KafkaMirrorMakerConsumerSpec`, `KafkaMirrorMakerProducerSpec`

[Full list of KafkaClientAuthenticationScramSha512 schema properties](#)

To configure SASL-based SCRAM-SHA-512 authentication, set the `type` property to `scram-sha-512`. The SCRAM-SHA-512 authentication mechanism requires a username and password.

#### username

Specify the username in the `username` property.

#### passwordSecret

In the `passwordSecret` property, specify a link to a `Secret` containing the password.

You can use the secrets created by the User Operator.

If required, you can create a text file that contains the password, in cleartext, to use for authentication:

```
echo -n PASSWORD > MY-PASSWORD.txt
```

You can then create a `Secret` from the text file, setting your own field name (key) for the password:

```
kubectl create secret generic MY-CONNECT-SECRET-NAME --from-file=MY-PASSWORD-FIELD-  
NAME=./MY-PASSWORD.txt
```

*Example Secret for SCRAM-SHA-512 client authentication for Kafka Connect*

```
apiVersion: v1  
kind: Secret  
metadata:  
  name: my-connect-secret-name  
type: Opaque  
data:  
  my-connect-password-field: LFTIyFRF1MmU2N2Tm
```

The `secretName` property contains the name of the `Secret`, and the `password` property contains the name of the key under which the password is stored inside the `Secret`.

**IMPORTANT** Do not specify the actual password in the `password` property.

*Example SASL-based SCRAM-SHA-512 client authentication configuration for Kafka Connect*

```
authentication:  
  type: scram-sha-512  
  username: my-connect-username  
  passwordSecret:  
    secretName: my-connect-secret-name  
    password: my-connect-password-field
```

## KafkaClientAuthenticationScramSha512 schema properties

Property	Description
passwordSecret	Reference to the <a href="#">Secret</a> which holds the password.
PasswordSecretSource	
type	Must be <code>scram-sha-512</code> .
string	
username	Username used for the authentication.
string	

### 12.2.71. KafkaClientAuthenticationPlain schema reference

Used in: [KafkaBridgeSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2ClusterSpec](#), [KafkaMirrorMakerConsumerSpec](#), [KafkaMirrorMakerProducerSpec](#)

[Full list of KafkaClientAuthenticationPlain schema properties](#)

To configure SASL-based PLAIN authentication, set the `type` property to `plain`. SASL PLAIN authentication mechanism requires a username and password.

**WARNING**

The SASL PLAIN mechanism will transfer the username and password across the network in cleartext. Only use SASL PLAIN authentication if TLS encryption is enabled.

#### username

Specify the username in the `username` property.

#### passwordSecret

In the `passwordSecret` property, specify a link to a [Secret](#) containing the password.

You can use the secrets created by the User Operator.

If required, create a text file that contains the password, in cleartext, to use for authentication:

```
echo -n PASSWORD > MY-PASSWORD.txt
```

You can then create a [Secret](#) from the text file, setting your own field name (key) for the password:

```
kubectl create secret generic MY-CONNECT-SECRET-NAME --from-file=MY-PASSWORD-FIELD-NAME=./MY-PASSWORD.txt
```

*Example Secret for PLAIN client authentication for Kafka Connect*

```
apiVersion: v1
```

```

kind: Secret
metadata:
  name: my-connect-secret-name
type: Opaque
data:
  my-password-field-name: LFTIyFRF1MmU2N2Tm

```

The `secretName` property contains the name of the `Secret` and the `password` property contains the name of the key under which the password is stored inside the `Secret`.

**IMPORTANT** Do not specify the actual password in the `password` property.

*An example SASL based PLAIN client authentication configuration*

```

authentication:
  type: plain
  username: my-connect-username
  passwordSecret:
    secretName: my-connect-secret-name
    password: my-password-field-name

```

### KafkaClientAuthenticationPlain schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaClientAuthenticationPlain` type from `KafkaClientAuthenticationTls`, `KafkaClientAuthenticationScramSha256`, `KafkaClientAuthenticationScramSha512`, `KafkaClientAuthenticationOAuth`. It must have the value `plain` for the type `KafkaClientAuthenticationPlain`.

Property	Description
<code>passwordSecret</code>	Reference to the <code>Secret</code> which holds the password.
<code>PasswordSecretSource</code>	
<code>type</code>	Must be <code>plain</code> .
<code>string</code>	
<code>username</code>	Username used for the authentication.
<code>string</code>	

### 12.2.72. KafkaClientAuthenticationOAuth schema reference

Used in: `KafkaBridgeSpec`, `KafkaConnectSpec`, `KafkaMirrorMaker2ClusterSpec`, `KafkaMirrorMakerConsumerSpec`, `KafkaMirrorMakerProducerSpec`

[Full list of KafkaClientAuthenticationOAuth schema properties](#)

To configure OAuth client authentication, set the `type` property to `oauth`.

OAuth authentication can be configured using one of the following options:

- Client ID and secret
- Client ID and refresh token
- Access token
- Username and password
- TLS

#### *Client ID and secret*

You can configure the address of your authorization server in the `tokenEndpointUri` property together with the client ID and client secret used in authentication. The OAuth client will connect to the OAuth server, authenticate using the client ID and secret and get an access token which it will use to authenticate with the Kafka broker. In the `clientSecret` property, specify a link to a `Secret` containing the client secret.

*An example of OAuth client authentication using client ID and client secret*

```
authentication:
  type: oauth
  tokenEndpointUri:
    https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token
    clientId: my-client-id
    clientSecret:
      secretName: my-client-oauth-secret
      key: client-secret
```

Optionally, `scope` and `audience` can be specified if needed.

#### *Client ID and refresh token*

You can configure the address of your OAuth server in the `tokenEndpointUri` property together with the OAuth client ID and refresh token. The OAuth client will connect to the OAuth server, authenticate using the client ID and refresh token and get an access token which it will use to authenticate with the Kafka broker. In the `refreshToken` property, specify a link to a `Secret` containing the refresh token.

+ .An example of OAuth client authentication using client ID and refresh token

```
authentication:
  type: oauth
  tokenEndpointUri:
    https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token
    clientId: my-client-id
    refreshToken:
      secretName: my-refresh-token-secret
      key: refresh-token
```

#### *Access token*

You can configure the access token used for authentication with the Kafka broker directly. In this

case, you do not specify the `tokenEndpointUri`. In the `accessToken` property, specify a link to a `Secret` containing the access token.

*An example of OAuth client authentication using only an access token*

```
authentication:  
  type: oauth  
  accessToken:  
    secretName: my-access-token-secret  
    key: access-token
```

#### *Username and password*

OAuth username and password configuration uses the OAuth *Resource Owner Password Grant* mechanism. The mechanism is deprecated, and is only supported to enable integration in environments where client credentials (ID and secret) cannot be used. You might need to use user accounts if your access management system does not support another approach or user accounts are required for authentication.

A typical approach is to create a special user account in your authorization server that represents your client application. You then give the account a long randomly generated password and a very limited set of permissions. For example, the account can only connect to your Kafka cluster, but is not allowed to use any other services or login to the user interface.

Consider using a refresh token mechanism first.

You can configure the address of your authorization server in the `tokenEndpointUri` property together with the client ID, username and the password used in authentication. The OAuth client will connect to the OAuth server, authenticate using the username, the password, the client ID, and optionally even the client secret to obtain an access token which it will use to authenticate with the Kafka broker.

In the `passwordSecret` property, specify a link to a `Secret` containing the password.

Normally, you also have to configure a `clientId` using a public OAuth client. If you are using a confidential OAuth client, you also have to configure a `clientSecret`.

*An example of OAuth client authentication using username and a password with a public client*

```
authentication:  
  type: oauth  
  tokenEndpointUri:  
    https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token  
  username: my-username  
  passwordSecret:  
    secretName: my-password-secret-name  
    password: my-password-field-name  
  clientId: my-public-client-id
```

*An example of OAuth client authentication using a username and a password with a confidential client*

```
authentication:  
  type: oauth  
  tokenEndpointUri:  
    https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token  
  username: my-username  
  passwordSecret:  
    secretName: my-password-secret-name  
    password: my-password-field-name  
  clientId: my-confidential-client-id  
  clientSecret:  
    secretName: my-confidential-client-oauth-secret  
    key: client-secret
```

Optionally, **scope** and **audience** can be specified if needed.

#### TLS

Accessing the OAuth server using the HTTPS protocol does not require any additional configuration as long as the TLS certificates used by it are signed by a trusted certification authority and its hostname is listed in the certificate.

If your OAuth server is using certificates which are self-signed or are signed by a certification authority which is not trusted, you can configure a list of trusted certificates in the custom resource. The **tlsTrustedCertificates** property contains a list of secrets with key names under which the certificates are stored. The certificates must be stored in X509 format.

*An example of TLS certificates provided*

```
authentication:  
  type: oauth  
  tokenEndpointUri:  
    https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token  
  clientId: my-client-id  
  refreshToken:  
    secretName: my-refresh-token-secret  
    key: refresh-token  
  tlsTrustedCertificates:  
    - secretName: oauth-server-ca  
      certificate: tls.crt
```

The OAuth client will by default verify that the hostname of your OAuth server matches either the certificate subject or one of the alternative DNS names. If it is not required, you can disable the hostname verification.

*An example of disabled TLS hostname verification*

```
authentication:  
  type: oauth
```

```

tokenEndpointUri:
https://sso.myproject.svc:8443/auth/realms/internal/protocol/openid-connect/token
clientId: my-client-id
refreshToken:
  secretName: my-refresh-token-secret
  key: refresh-token
disableTlsHostnameVerification: true

```

## KafkaClientAuthenticationOAuth schema properties

The `type` property is a discriminator that distinguishes use of the `KafkaClientAuthenticationOAuth` type from `KafkaClientAuthenticationTls`, `KafkaClientAuthenticationScramSha256`, `KafkaClientAuthenticationScramSha512`, `KafkaClientAuthenticationPlain`. It must have the value `oauth` for the type `KafkaClientAuthenticationOAuth`.

Property	Description
accessToken	Link to Kubernetes Secret containing the access token which was obtained from the authorization server.
GenericSecretSource	
accessTokenIsJwt	Configure whether access token should be treated as JWT. This should be set to <code>false</code> if the authorization server returns opaque tokens. Defaults to <code>true</code> .
boolean	
audience	OAuth audience to use when authenticating against the authorization server. Some authorization servers require the audience to be explicitly set. The possible values depend on how the authorization server is configured. By default, <code>audience</code> is not specified when performing the token endpoint request.
string	
clientId	OAuth Client ID which the Kafka client can use to authenticate against the OAuth server and use the token endpoint URI.
string	
clientSecret	Link to Kubernetes Secret containing the OAuth client secret which the Kafka client can use to authenticate against the OAuth server and use the token endpoint URI.
GenericSecretSource	
connectTimeoutSeconds	The connect timeout in seconds when connecting to authorization server. If not set, the effective connect timeout is 60 seconds.
integer	
disableTlsHostnameVerification	Enable or disable TLS hostname verification. Default value is <code>false</code> .
boolean	
enableMetrics	Enable or disable OAuth metrics. Default value is <code>false</code> .
boolean	

Property	Description
maxTokenExpirySeconds	Set or limit time-to-live of the access tokens to the specified number of seconds. This should be set if the authorization server returns opaque tokens.
integer	
passwordSecret	Reference to the <a href="#">Secret</a> which holds the password.
<a href="#">PasswordSecretSource</a>	
readTimeoutSeconds	The read timeout in seconds when connecting to authorization server. If not set, the effective read timeout is 60 seconds.
integer	
refreshToken	Link to Kubernetes Secret containing the refresh token which can be used to obtain access token from the authorization server.
<a href="#">GenericSecretSource</a>	
scope	OAuth scope to use when authenticating against the authorization server. Some authorization servers require this to be set. The possible values depend on how authorization server is configured. By default <a href="#">scope</a> is not specified when doing the token endpoint request.
string	
tlsTrustedCertificates	Trusted certificates for TLS connection to the OAuth server.
<a href="#">CertSecretSource</a> array	
tokenEndpointUri	Authorization server token endpoint URI.
string	
type	Must be <a href="#">oauth</a> .
string	
username	Username used for the authentication.
string	

### 12.2.73. [JaegerTracing](#) schema reference

The type [JaegerTracing](#) has been deprecated.

Used in: [KafkaBridgeSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#), [KafkaMirrorMakerSpec](#)

The [type](#) property is a discriminator that distinguishes use of the [JaegerTracing](#) type from [OpenTelemetryTracing](#). It must have the value [jaeger](#) for the type [JaegerTracing](#).

Property	Description
type	Must be <a href="#">jaeger</a> .
string	

## 12.2.74. OpenTelemetryTracing schema reference

Used in: [KafkaBridgeSpec](#), [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#), [KafkaMirrorMakerSpec](#)

The `type` property is a discriminator that distinguishes use of the [OpenTelemetryTracing](#) type from [JaegerTracing](#). It must have the value `opentelemetry` for the type [OpenTelemetryTracing](#).

Property	Description
type	Must be <code>opentelemetry</code> .
string	

## 12.2.75. KafkaConnectTemplate schema reference

Used in: [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#)

Property	Description
deployment	Template for Kafka Connect <a href="#">Deployment</a> .
<a href="#">DeploymentTemplate</a>	
pod	Template for Kafka Connect <a href="#">Pods</a> .
<a href="#">PodTemplate</a>	
apiService	Template for Kafka Connect <a href="#">API Service</a> .
<a href="#">InternalServiceTemplate</a>	
connectContainer	Template for the Kafka Connect container.
<a href="#">ContainerTemplate</a>	
initContainer	Template for the Kafka init container.
<a href="#">ContainerTemplate</a>	
podDisruptionBudget	Template for Kafka Connect <a href="#">PodDisruptionBudget</a> .
<a href="#">PodDisruptionBudgetTemplate</a>	
serviceAccount	Template for the Kafka Connect service account.
<a href="#">ResourceTemplate</a>	
clusterRoleBinding	Template for the Kafka Connect <a href="#">ClusterRoleBinding</a> .
<a href="#">ResourceTemplate</a>	
buildPod	Template for Kafka Connect Build <a href="#">Pods</a> . The build pod is used only on Kubernetes.
<a href="#">PodTemplate</a>	
buildContainer	Template for the Kafka Connect Build container. The build container is used only on Kubernetes.
<a href="#">ContainerTemplate</a>	
buildConfig	Template for the Kafka Connect <a href="#">BuildConfig</a> used to build new container images. The <a href="#">BuildConfig</a> is used only on OpenShift.
<a href="#">BuildConfigTemplate</a>	

Property	Description
buildServiceAccount	Template for the Kafka Connect Build service account.
<a href="#">ResourceTemplate</a>	
jmxSecret	Template for Secret of the Kafka Connect Cluster JMX authentication.
<a href="#">ResourceTemplate</a>	

## 12.2.76. [DeploymentTemplate](#) schema reference

Used in: [KafkaBridgeTemplate](#), [KafkaConnectTemplate](#), [KafkaMirrorMakerTemplate](#)

Property	Description
metadata	Metadata applied to the resource.
<a href="#">MetadataTemplate</a>	
deploymentStrategy	DeploymentStrategy which will be used for this Deployment. Valid values are <a href="#">RollingUpdate</a> and <a href="#">Recreate</a> . Defaults to <a href="#">RollingUpdate</a> .
string (one of [RollingUpdate, Recreate])	

## 12.2.77. [BuildConfigTemplate](#) schema reference

Used in: [KafkaConnectTemplate](#)

Property	Description
metadata	Metadata to apply to the <a href="#">PodDisruptionBudgetTemplate</a> resource.
<a href="#">MetadataTemplate</a>	
pullSecret	Container Registry Secret with the credentials for pulling the base image.
string	

## 12.2.78. [ExternalConfiguration](#) schema reference

Used in: [KafkaConnectSpec](#), [KafkaMirrorMaker2Spec](#)

[Full list of ExternalConfiguration schema properties](#)

Configures external storage properties that define configuration options for Kafka Connect connectors.

You can mount ConfigMaps or Secrets into a Kafka Connect pod as environment variables or volumes. Volumes and environment variables are configured in the `externalConfiguration` property in [KafkaConnect.spec](#).

When applied, the environment variables and volumes are available for use when developing your connectors.

## env

Use the `env` property to specify one or more environment variables. These variables can contain a value from either a ConfigMap or a Secret.

*Example Secret containing values for environment variables*

```
apiVersion: v1
kind: Secret
metadata:
  name: aws-creds
type: Opaque
data:
  awsAccessKey: QUtJQVhYWFnYWFnYWFnYWFn=
  awsSecretAccessKey: Ylhsd1lYTnpkMj15WkE=
```

**NOTE**

The names of user-defined environment variables cannot start with `KAFKA_` or `STRIMZI_`.

To mount a value from a Secret to an environment variable, use the `valueFrom` property and the `secretKeyRef`.

*Example environment variables set to values from a Secret*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  externalConfiguration:
    env:
      - name: AWS_ACCESS_KEY_ID
        valueFrom:
          secretKeyRef:
            name: aws-creds
            key: awsAccessKey
      - name: AWS_SECRET_ACCESS_KEY
        valueFrom:
          secretKeyRef:
            name: aws-creds
            key: awsSecretAccessKey
```

A common use case for mounting Secrets is for a connector to communicate with Amazon AWS. The connector needs to be able to read the `AWS_ACCESS_KEY_ID` and `AWS_SECRET_ACCESS_KEY`.

To mount a value from a ConfigMap to an environment variable, use `configMapKeyRef` in the `valueFrom` property as shown in the following example.

*Example environment variables set to values from a ConfigMap*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  externalConfiguration:
    env:
      - name: MY_ENVIRONMENT_VARIABLE
        valueFrom:
          configMapKeyRef:
            name: my-config-map
            key: my-key
```

## volumes

Use volumes to mount ConfigMaps or Secrets to a Kafka Connect pod.

Using volumes instead of environment variables is useful in the following scenarios:

- Mounting a properties file that is used to configure Kafka Connect connectors
- Mounting truststores or keystores with TLS certificates

Volumes are mounted inside the Kafka Connect containers on the path `/opt/kafka/external-configuration/<volume-name>`. For example, the files from a volume named `connector-config` will appear in the directory `/opt/kafka/external-configuration/connector-config`.

Configuration *providers* load values from outside the configuration. Use a provider mechanism to avoid passing restricted information over the Kafka Connect REST interface.

- `FileConfigProvider` loads configuration values from properties in a file.
- `DirectoryConfigProvider` loads configuration values from separate files within a directory structure.

Use a comma-separated list if you want to add more than one provider, including custom providers. You can use custom providers to load values from other file locations.

*Using `FileConfigProvider` to load property values*

In this example, a Secret named `mysecret` contains connector properties that specify a database name and password:

*Example Secret with database properties*

```
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
type: Opaque
```

```

stringData:
  connector.properties: |- ①
    dbUsername: my-username ②
    dbPassword: my-password

```

- ① The connector configuration in properties file format.
- ② Database username and password properties used in the configuration.

The Secret and the `FileConfigProvider` configuration provider are specified in the Kafka Connect configuration.

- The Secret is mounted to a volume named `connector-config`.
- `FileConfigProvider` is given the alias `file`.

*Example external volumes set to values from a Secret*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  config:
    config.providers: file ①
    config.providers.file.class:
      org.apache.kafka.common.config.provider.FileConfigProvider ②
      #...
    externalConfiguration:
      volumes:
        - name: connector-config ③
          secret:
            secretName: mysecret ④

```

- ① The alias for the configuration provider is used to define other configuration parameters.
- ② `FileConfigProvider` provides values from properties files. The parameter uses the alias from `config.providers`, taking the form `config.providers.${alias}.class`.
- ③ The name of the volume containing the Secret. Each volume must specify a name in the `name` property and a reference to a ConfigMap or Secret.
- ④ The name of the Secret.

Placeholders for the property values in the Secret are referenced in the connector configuration. The placeholder structure is `file:PATH-AND-FILE-NAME:PROPERTY`. `FileConfigProvider` reads and extracts the database `username` and `password` property values from the mounted Secret in connector configurations.

*Example connector configuration showing placeholders for external values*

```

apiVersion: kafka.strimzi.io/v1beta2

```

```

kind: KafkaConnector
metadata:
  name: my-source-connector
  labels:
    strimzi.io/cluster: my-connect-cluster
spec:
  class: io.debezium.connector.mysql.MySqlConnector
  tasksMax: 2
  config:
    database.hostname: 192.168.99.1
    database.port: "3306"
    database.user: "${file:/opt/kafka/external-configuration/connector-
config/mysecret:dbUsername}"
    database.password: "${file:/opt/kafka/external-configuration/connector-
config/mysecret:dbPassword}"
    database.server.id: "184054"
    #...

```

*Using [DirectoryConfigProvider](#) to load property values from separate files*

In this example, a [Secret](#) contains TLS truststore and keystore user credentials in separate files.

*Example Secret with user credentials*

```

apiVersion: v1
kind: Secret
metadata:
  name: my-user
  labels:
    strimzi.io/kind: KafkaUser
    strimzi.io/cluster: my-cluster
type: Opaque
data: ①
  ca.crt: # Public key of the client CA
  user.crt: # User certificate that contains the public key of the user
  user.key: # Private key of the user
  user.p12: # PKCS #12 archive file for storing certificates and keys
  user.password: # Password for protecting the PKCS #12 archive file

```

The Secret and the [DirectoryConfigProvider](#) configuration provider are specified in the Kafka Connect configuration.

- The Secret is mounted to a volume named [connector-config](#).
- [DirectoryConfigProvider](#) is given the alias [directory](#).

*Example external volumes set for user credentials files*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:

```

```

name: my-connect
spec:
  # ...
  config:
    config.providers: directory
    config.providers.directory.class:
      org.apache.kafka.common.config.provider.DirectoryConfigProvider ①
      #...
    externalConfiguration:
      volumes:
        - name: cluster-ca
          secret:
            secretName: my-cluster-cluster-ca-cert
        - name: my-user
          secret:
            secretName: my-user

```

- ① The `DirectoryConfigProvider` provides values from files in a directory. The parameter uses the alias from `config.providers`, taking the form `config.providers.${alias}.class`.

Placeholders for the credentials are referenced in the connector configuration. The placeholder structure is `directory:PATH:FILE-NAME`. `DirectoryConfigProvider` reads and extracts the credentials from the mounted Secret in connector configurations.

*Example connector configuration showing placeholders for external values*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-source-connector
  labels:
    strimzi.io/cluster: my-connect-cluster
spec:
  class: io.debezium.connector.mysql.MySqlConnector
  tasksMax: 2
  config:
    # ...
    database.history.producer.security.protocol: SSL
    database.history.producer.ssl.truststore.type: PEM
    database.history.producer.ssl.truststore.certificates:
      "${directory:/opt/kafka/external-configuration/cluster-ca:ca.crt}"
      database.history.producer.ssl.keystore.type: PEM
      database.history.producer.ssl.keystore.certificate.chain:
        "${directory:/opt/kafka/external-configuration/my-user:user.crt}"
        database.history.producer.ssl.keystore.key: "${directory:/opt/kafka/external-configuration/my-user:user.key}"
    #...

```

## ExternalConfiguration schema properties

Property	Description
env	Makes data from a Secret or ConfigMap available in the Kafka Connect pods as environment variables.
ExternalConfigurationEnv array	
volumes	Makes data from a Secret or ConfigMap available in the Kafka Connect pods as volumes.
ExternalConfigurationVolumeSource array	

### 12.2.79. ExternalConfigurationEnv schema reference

Used in: [ExternalConfiguration](#)

Property	Description
name	Name of the environment variable which will be passed to the Kafka Connect pods. The name of the environment variable cannot start with KAFKA_ or STRIMZI_.
string	
valueFrom	
ExternalConfigurationEnvVarSource	Value of the environment variable which will be passed to the Kafka Connect pods. It can be passed either as a reference to Secret or ConfigMap field. The field has to specify exactly one Secret or ConfigMap.

### 12.2.80. ExternalConfigurationEnvVarSource schema reference

Used in: [ExternalConfigurationEnv](#)

Property	Description
configMapKeyRef	Reference to a key in a ConfigMap. For more information, see the <a href="#">external documentation for core/v1 configmapkeyselector</a> .
ConfigMapKeySelector	
secretKeyRef	Reference to a key in a Secret. For more information, see the <a href="#">external documentation for core/v1 secretkeyselector</a> .
SecretKeySelector	

### 12.2.81. ExternalConfigurationVolumeSource schema reference

Used in: [ExternalConfiguration](#)

Property	Description
configMap	Reference to a key in a ConfigMap. Exactly one Secret or ConfigMap has to be specified. For more information, see the <a href="#">external documentation for core/v1 configmapvolumesource</a> .
ConfigMapVolumeSource	
name	Name of the volume which will be added to the Kafka Connect pods.
string	
secret	Reference to a key in a Secret. Exactly one Secret or ConfigMap has to be specified. For more information, see the <a href="#">external documentation for core/v1 secretvolumesource</a> .
SecretVolumeSource	

## 12.2.82. Build schema reference

Used in: [KafkaConnectSpec](#)

[Full list of Build schema properties](#)

Configures additional connectors for Kafka Connect deployments.

### output

To build new container images with additional connector plugins, Strimzi requires a container registry where the images can be pushed to, stored, and pulled from. Strimzi does not run its own container registry, so a registry must be provided. Strimzi supports private container registries as well as public registries such as [Quay](#) or [Docker Hub](#). The container registry is configured in the `.spec.build.output` section of the [KafkaConnect](#) custom resource. The `output` configuration, which is required, supports two types: `docker` and `imagestream`.

#### Using Docker registry

To use a Docker registry, you have to specify the `type` as `docker`, and the `image` field with the full name of the new container image. The full name must include:

- The address of the registry
- Port number (if listening on a non-standard port)
- The tag of the new container image

Example valid container image names:

- `docker.io/my-org/my-image/my-tag`
- `quay.io/my-org/my-image/my-tag`
- `image-registry.image-registry.svc:5000/myproject/kafka-connect-build:latest`

Each Kafka Connect deployment must use a separate image, which can mean different tags at the most basic level.

If the registry requires authentication, use the `pushSecret` to set a name of the Secret with the registry credentials. For the Secret, use the `kubernetes.io/dockerconfigjson` type and a `.dockerconfigjson` file to contain the Docker credentials. For more information on pulling an image from a private registry, see [Create a Secret based on existing Docker credentials](#).

#### *Example output configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      type: docker ①
      image: my-registry.io/my-org/my-connect-cluster:latest ②
      pushSecret: my-registry-credentials ③
  #...
```

① (Required) Type of output used by Strimzi.

② (Required) Full name of the image used, including the repository and tag.

③ (Optional) Name of the secret with the container registry credentials.

#### *Using OpenShift ImageStream*

Instead of Docker, you can use OpenShift ImageStream to store a new container image. The ImageStream has to be created manually before deploying Kafka Connect. To use ImageStream, set the `type` to `imagestream`, and use the `image` property to specify the name of the ImageStream and the tag used. For example, `my-connect-image-stream:latest`.

#### *Example output configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      type: imagestream ①
      image: my-connect-build:latest ②
  #...
```

① (Required) Type of output used by Strimzi.

② (Required) Name of the ImageStream and tag.

## plugins

Connector plugins are a set of files that define the implementation required to connect to certain types of external system. The connector plugins required for a container image must be configured using the `.spec.build.plugins` property of the `KafkaConnect` custom resource. Each connector plugin must have a name which is unique within the Kafka Connect deployment. Additionally, the plugin artifacts must be listed. These artifacts are downloaded by Strimzi, added to the new container image, and used in the Kafka Connect deployment. The connector plugin artifacts can also include additional components, such as (de)serializers. Each connector plugin is downloaded into a separate directory so that the different connectors and their dependencies are properly *sandboxed*. Each plugin must be configured with at least one `artifact`.

*Example `plugins` configuration with two connector plugins*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      #...
    plugins: ①
      - name: debezium-postgres-connector
        artifacts:
          - type: tgz
            url: https://repo1.maven.org/maven2/io/debezium/debezium-connector-
                  postgres/1.3.1.Final/debezium-connector-postgres-1.3.1.Final-plugin.tar.gz
            sha512sum:
962a12151bdf9a5a30627eebac739955a4fd95a08d373b86bdcea2b4d0c27dd6e1edd5cb548045e115e33a
9e69b1b2a352bee24df035a0447cb820077af00c03
          - name: camel-telegram
            artifacts:
              - type: tgz
                url:
https://repo.maven.apache.org/maven2/org/apache/camel/kafkaconnector/camel-telegram-
kafka-connector/0.7.0/camel-telegram-kafka-connector-0.7.0-package.tar.gz
            sha512sum:
a9b1ac63e3284bea7836d7d24d84208c49cdf5600070e6bd1535de654f6920b74ad950d51733e8020bf418
7870699819f54ef5859c7846ee4081507f48873479
  #...
```

① (Required) List of connector plugins and their artifacts.

Strimzi supports the following types of artifacts:

- JAR files, which are downloaded and used directly
- TGZ archives, which are downloaded and unpacked
- ZIP archives, which are downloaded and unpacked

- Maven artifacts, which uses Maven coordinates
- Other artifacts, which are downloaded and used directly

## IMPORTANT

Strimzi does not perform any security scanning of the downloaded artifacts. For security reasons, you should first verify the artifacts manually, and configure the checksum verification to make sure the same artifact is used in the automated build and in the Kafka Connect deployment.

### Using JAR artifacts

JAR artifacts represent a JAR file that is downloaded and added to a container image. To use a JAR artifacts, set the `type` property to `jar`, and specify the download location using the `url` property.

Additionally, you can specify a SHA-512 checksum of the artifact. If specified, Strimzi will verify the checksum of the artifact while building the new container image.

#### Example JAR artifact

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      #...
  plugins:
    - name: my-plugin
      artifacts:
        - type: jar ①
          url: https://my-domain.tld/my-jar.jar ②
          sha512sum: 589...ab4 ③
        - type: jar
          url: https://my-domain.tld/my-jar2.jar
  #...
```

① (Required) Type of artifact.

② (Required) URL from which the artifact is downloaded.

③ (Optional) SHA-512 checksum to verify the artifact.

### Using TGZ artifacts

TGZ artifacts are used to download TAR archives that have been compressed using Gzip compression. The TGZ artifact can contain the whole Kafka Connect connector, even when comprising multiple different files. The TGZ artifact is automatically downloaded and unpacked by Strimzi while building the new container image. To use TGZ artifacts, set the `type` property to `tgz`, and specify the download location using the `url` property.

Additionally, you can specify a SHA-512 checksum of the artifact. If specified, Strimzi will verify the

checksum before unpacking it and building the new container image.

#### Example TGZ artifact

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      #...
  plugins:
    - name: my-plugin
      artifacts:
        - type: tgz ①
          url: https://my-domain.tld/my-connector-archive.tgz ②
          sha512sum: 158...jg10 ③
  #...
```

① (Required) Type of artifact.

② (Required) URL from which the archive is downloaded.

③ (Optional) SHA-512 checksum to verify the artifact.

#### Using ZIP artifacts

ZIP artifacts are used to download ZIP compressed archives. Use ZIP artifacts in the same way as the TGZ artifacts described in the previous section. The only difference is you specify `type: zip` instead of `type: tgz`.

#### Using Maven artifacts

`maven` artifacts are used to specify connector plugin artifacts as Maven coordinates. The Maven coordinates identify plugin artifacts and dependencies so that they can be located and fetched from a Maven repository.

**NOTE**

The Maven repository must be accessible for the connector build process to add the artifacts to the container image.

#### Example Maven artifact

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      #...
```

```

plugins:
  - name: my-plugin
    artifacts:
      - type: maven ①
        repository: https://mvnrepository.com ②
        group: org.apache.camel.kafkaconnector ③
        artifact: camel-kafka-connector ④
        version: 0.11.0 ⑤
    #...

```

① (Required) Type of artifact.

② (Optional) Maven repository to download the artifacts from. If you do not specify a repository, [Maven Central repository](#) is used by default.

③ (Required) Maven group ID.

④ (Required) Maven artifact type.

⑤ (Required) Maven version number.

#### *Using other artifacts*

**other** artifacts represent any kind of file that is downloaded and added to a container image. If you want to use a specific name for the artifact in the resulting container image, use the `fileName` field. If a file name is not specified, the file is named based on the URL hash.

Additionally, you can specify a SHA-512 checksum of the artifact. If specified, Strimzi will verify the checksum of the artifact while building the new container image.

#### *Example other artifact*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec:
  #...
  build:
    output:
      #...
  plugins:
    - name: my-plugin
      artifacts:
        - type: other ①
          url: https://my-domain.tld/my-other-file.ext ②
          sha512sum: 589...ab4 ③
          fileName: name-the-file.ext ④
    #...

```

① (Required) Type of artifact.

② (Required) URL from which the artifact is downloaded.

③ (Optional) SHA-512 checksum to verify the artifact.

④ (Optional) The name under which the file is stored in the resulting container image.

## Build schema properties

Property	Description
output	Configures where should the newly built image be stored. Required. The type depends on the value of the <code>output.type</code> property within the given object, which must be one of [docker, imagestream].
<code>DockerOutput</code> , <code>ImageStreamOutput</code>	
resources	CPU and memory resources to reserve for the build. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
<code>ResourceRequirements</code>	
plugins	List of connector plugins which should be added to the Kafka Connect. Required.
<code>Plugin array</code>	

### 12.2.83. `DockerOutput` schema reference

Used in: `Build`

The `type` property is a discriminator that distinguishes use of the `DockerOutput` type from `ImageStreamOutput`. It must have the value `docker` for the type `DockerOutput`.

Property	Description
image	The full name which should be used for tagging and pushing the newly built image. For example <code>quay.io/my-organization/my-custom-connect:latest</code> . Required.
string	
pushSecret	Container Registry Secret with the credentials for pushing the newly built image.
string	

Property	Description
additionalKanikoOptions string array	Configures additional options which will be passed to the Kaniko executor when building the new Connect image. Allowed options are: --customPlatform, --insecure, --insecure-pull, --insecure-registry, --log-format, --log-timestamp, --registry-mirror, --reproducible, --single-snapshot, --skip-tls-verify, --skip-tls-verify-pull, --skip-tls-verify-registry, --verbosity, --snapshotMode, --use-new-run. These options will be used only on Kubernetes where the Kaniko executor is used. They will be ignored on OpenShift. The options are described in the <a href="#">Kaniko GitHub repository</a> . Changing this field does not trigger new build of the Kafka Connect image.
type string	Must be <code>docker</code> .

## 12.2.84. `ImageStreamOutput` schema reference

Used in: [Build](#)

The `type` property is a discriminator that distinguishes use of the `ImageStreamOutput` type from `DockerOutput`. It must have the value `imagestream` for the type `ImageStreamOutput`.

Property	Description
image string	The name and tag of the ImageStream where the newly built image will be pushed. For example <code>my-custom-connect:latest</code> . Required.
type string	Must be <code>imagestream</code> .

## 12.2.85. `Plugin` schema reference

Used in: [Build](#)

Property	Description
name string	The unique name of the connector plugin. Will be used to generate the path where the connector artifacts will be stored. The name has to be unique within the KafkaConnect resource. The name has to follow the following pattern: <code>^[a-z][-_a-zA-Z0-9]*[a-zA-Z]\$</code> . Required.

Property	Description
artifacts <code>JarArtifact</code> , <code>TgzArtifact</code> , <code>ZipArtifact</code> , <code>MavenArtifact</code> , <code>OtherArtifact</code> array	List of artifacts which belong to this connector plugin. Required.

## 12.2.86. `JarArtifact` schema reference

Used in: [Plugin](#)

Property	Description
url	URL of the artifact which will be downloaded. Strimzi does not do any security scanning of the downloaded artifacts. For security reasons, you should first verify the artifacts manually and configure the checksum verification to make sure the same artifact is used in the automated build. Required for <code>jar</code> , <code>zip</code> , <code>tgz</code> and <code>other</code> artifacts. Not applicable to the <code>maven</code> artifact type.
string	SHA512 checksum of the artifact. Optional. If specified, the checksum will be verified while building the new container. If not specified, the downloaded artifact will not be verified. Not applicable to the <code>maven</code> artifact type.
sha512sum	
insecure	By default, connections using TLS are verified to check they are secure. The server certificate used must be valid, trusted, and contain the server name. By setting this option to <code>true</code> , all TLS verification is disabled and the artifact will be downloaded, even when the server is considered insecure.
boolean	
type	Must be <code>jar</code> .
string	

## 12.2.87. `TgzArtifact` schema reference

Used in: [Plugin](#)

Property	Description
url string	URL of the artifact which will be downloaded. Strimzi does not do any security scanning of the downloaded artifacts. For security reasons, you should first verify the artifacts manually and configure the checksum verification to make sure the same artifact is used in the automated build. Required for <code>jar</code> , <code>zip</code> , <code>tgz</code> and <code>other</code> artifacts. Not applicable to the <code>maven</code> artifact type.
sha512sum string	SHA512 checksum of the artifact. Optional. If specified, the checksum will be verified while building the new container. If not specified, the downloaded artifact will not be verified. Not applicable to the <code>maven</code> artifact type.
insecure boolean	By default, connections using TLS are verified to check they are secure. The server certificate used must be valid, trusted, and contain the server name. By setting this option to <code>true</code> , all TLS verification is disabled and the artifact will be downloaded, even when the server is considered insecure.
type string	Must be <code>tgz</code> .

## 12.2.88. ZipArtifact schema reference

Used in: [Plugin](#)

Property	Description
url string	URL of the artifact which will be downloaded. Strimzi does not do any security scanning of the downloaded artifacts. For security reasons, you should first verify the artifacts manually and configure the checksum verification to make sure the same artifact is used in the automated build. Required for <code>jar</code> , <code>zip</code> , <code>tgz</code> and <code>other</code> artifacts. Not applicable to the <code>maven</code> artifact type.
sha512sum string	SHA512 checksum of the artifact. Optional. If specified, the checksum will be verified while building the new container. If not specified, the downloaded artifact will not be verified. Not applicable to the <code>maven</code> artifact type.

Property	Description
insecure	By default, connections using TLS are verified to check they are secure. The server certificate used must be valid, trusted, and contain the server name. By setting this option to <code>true</code> , all TLS verification is disabled and the artifact will be downloaded, even when the server is considered insecure.
boolean	
type	Must be <code>zip</code> .
string	

## 12.2.89. `MavenArtifact` schema reference

Used in: [Plugin](#)

The `type` property is a discriminator that distinguishes use of the `MavenArtifact` type from `JarArtifact`, `TgzArtifact`, `ZipArtifact`, `OtherArtifact`. It must have the value `maven` for the type `MavenArtifact`.

Property	Description
repository	Maven repository to download the artifact from. Applicable to the <code>maven</code> artifact type only.
string	
group	Maven group id. Applicable to the <code>maven</code> artifact type only.
string	
artifact	Maven artifact id. Applicable to the <code>maven</code> artifact type only.
string	
version	Maven version number. Applicable to the <code>maven</code> artifact type only.
string	
type	Must be <code>maven</code> .
string	

## 12.2.90. `OtherArtifact` schema reference

Used in: [Plugin](#)

Property	Description
url string	URL of the artifact which will be downloaded. Strimzi does not do any security scanning of the downloaded artifacts. For security reasons, you should first verify the artifacts manually and configure the checksum verification to make sure the same artifact is used in the automated build. Required for <code>jar</code> , <code>zip</code> , <code>tgz</code> and <code>other</code> artifacts. Not applicable to the <code>maven</code> artifact type.
sha512sum string	SHA512 checksum of the artifact. Optional. If specified, the checksum will be verified while building the new container. If not specified, the downloaded artifact will not be verified. Not applicable to the <code>maven</code> artifact type.
fileName string	Name under which the artifact will be stored.
insecure boolean	By default, connections using TLS are verified to check they are secure. The server certificate used must be valid, trusted, and contain the server name. By setting this option to <code>true</code> , all TLS verification is disabled and the artifact will be downloaded, even when the server is considered insecure.
type string	Must be <code>other</code> .

## 12.2.91. KafkaConnectStatus schema reference

Used in: [KafkaConnect](#)

Property	Description
conditions <code>Condition</code> array	List of status conditions.
observedGeneration integer	The generation of the CRD that was last reconciled by the operator.
url string	The URL of the REST API endpoint for managing and monitoring Kafka Connect connectors.
connectorPlugins <code>ConnectorPlugin</code> array	The list of connector plugins available in this Kafka Connect deployment.

Property	Description
labelSelector	Label selector for pods providing this resource.
string	
replicas	The current number of pods being used to provide this resource.
integer	

## 12.2.92. [ConnectorPlugin](#) schema reference

Used in: [KafkaConnectStatus](#), [KafkaMirrorMaker2Status](#)

Property	Description
type	The type of the connector plugin. The available types are <a href="#">sink</a> and <a href="#">source</a> .
string	
version	The version of the connector plugin.
string	
class	The class of the connector plugin.
string	

## 12.2.93. [KafkaTopic](#) schema reference

Property	Description
spec	The specification of the topic.
<a href="#">KafkaTopicSpec</a>	
status	The status of the topic.
<a href="#">KafkaTopicStatus</a>	

## 12.2.94. [KafkaTopicSpec](#) schema reference

Used in: [KafkaTopic](#)

Property	Description
partitions	The number of partitions the topic should have. This cannot be decreased after topic creation. It can be increased after topic creation, but it is important to understand the consequences that has, especially for topics with semantic partitioning. When absent this will default to the broker configuration for <a href="#">num.partitions</a> .
integer	
replicas	The number of replicas the topic should have. When absent this will default to the broker configuration for <a href="#">default.replication.factor</a> .
integer	

Property	Description
config	The topic configuration.
map	
topicName	The name of the topic. When absent this will default to the metadata.name of the topic. It is recommended to not set this unless the topic name is not a valid Kubernetes resource name.
string	

## 12.2.95. KafkaTopicStatus schema reference

Used in: [KafkaTopic](#)

Property	Description
conditions	List of status conditions.
<a href="#">Condition</a> array	
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
topicName	Topic name.
string	

## 12.2.96. KafkaUser schema reference

Property	Description
spec	The specification of the user.
<a href="#">KafkaUserSpec</a>	
status	The status of the Kafka User.
<a href="#">KafkaUserStatus</a>	

## 12.2.97. KafkaUserSpec schema reference

Used in: [KafkaUser](#)

Property	Description
authentication	<p>Authentication mechanism enabled for this Kafka user. The supported authentication mechanisms are <code>scram-sha-512</code>, <code>tls</code>, and <code>tls-external</code>.</p> <ul style="list-style-type: none"> <li>• <code>scram-sha-512</code> generates a secret with SASL SCRAM-SHA-512 credentials.</li> <li>• <code>tls</code> generates a secret with user certificate for mutual TLS authentication.</li> <li>• <code>tls-external</code> does not generate a user certificate. But prepares the user for using mutual TLS authentication using a user certificate generated outside the User Operator. ACLs and quotas set for this user are configured in the <code>CN=&lt;username&gt;</code> format.</li> </ul>
<code>KafkaUserTlsClientAuthentication</code> , <code>KafkaUserTlsExternalClientAuthentication</code> , <code>KafkaUserScramSha512ClientAuthentication</code>	<p>Authentication is optional. If authentication is not configured, no credentials are generated. ACLs and quotas set for the user are configured in the <code>&lt;username&gt;</code> format suitable for SASL authentication. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [tls, tls-external, scram-sha-512].</p>
authorization	<p>Authorization rules for this Kafka user. The type depends on the value of the <code>authorization.type</code> property within the given object, which must be one of [simple].</p>
quotas	<p>Quotas on requests to control the broker resources used by clients. Network bandwidth and request rate quotas can be enforced. Kafka documentation for Kafka User quotas can be found at <a href="http://kafka.apache.org/documentation/#design_quotas">http://kafka.apache.org/documentation/#design_quotas</a>.</p>
<code>KafkaUserQuotas</code>	
template	<p>Template to specify how Kafka User <code>Secrets</code> are generated.</p>
<code>KafkaUserTemplate</code>	

## 12.2.98. `KafkaUserTlsClientAuthentication` schema reference

Used in: `KafkaUserSpec`

The `type` property is a discriminator that distinguishes use of the `KafkaUserTlsClientAuthentication` type from `KafkaUserTlsExternalClientAuthentication`, `KafkaUserScramSha512ClientAuthentication`. It must have the value `tls` for the type `KafkaUserTlsClientAuthentication`.

Property	Description
type	Must be <code>tls</code> .
string	

## 12.2.99. KafkaUserTlsExternalClientAuthentication schema reference

Used in: [KafkaUserSpec](#)

The `type` property is a discriminator that distinguishes use of the `KafkaUserTlsExternalClientAuthentication` type from `KafkaUserTlsClientAuthentication`, `KafkaUserScramSha512ClientAuthentication`. It must have the value `tls-external` for the type `KafkaUserTlsExternalClientAuthentication`.

Property	Description
type	Must be <code>tls-external</code> .
string	

## 12.2.100. KafkaUserScramSha512ClientAuthentication schema reference

Used in: [KafkaUserSpec](#)

The `type` property is a discriminator that distinguishes use of the `KafkaUserScramSha512ClientAuthentication` type from `KafkaUserTlsClientAuthentication`, `KafkaUserTlsExternalClientAuthentication`. It must have the value `scram-sha-512` for the type `KafkaUserScramSha512ClientAuthentication`.

Property	Description
password	Specify the password for the user. If not set, a new password is generated by the User Operator.
Password	
type	Must be <code>scram-sha-512</code> .
string	

## 12.2.101. Password schema reference

Used in: [KafkaUserScramSha512ClientAuthentication](#)

Property	Description
valueFrom	Secret from which the password should be read.
PasswordSource	

## 12.2.102. PasswordSource schema reference

Used in: [Password](#)

Property	Description
secretKeyRef	
SecretKeySelector	Selects a key of a Secret in the resource's namespace. For more information, see the <a href="#">external documentation for core/v1 secretkeyselector</a> .

## 12.2.103. KafkaUserAuthorizationSimple schema reference

Used in: [KafkaUserSpec](#)

The `type` property is a discriminator that distinguishes use of the `KafkaUserAuthorizationSimple` type from other subtypes which may be added in the future. It must have the value `simple` for the type `KafkaUserAuthorizationSimple`.

Property	Description
type	Must be <code>simple</code> .
string	
acls	List of ACL rules which should be applied to this user.
AclRule array	

## 12.2.104. AclRule schema reference

Used in: [KafkaUserAuthorizationSimple](#)

[Full list of AclRule schema properties](#)

Configures access control rules for a `KafkaUser` when brokers are using the `AclAuthorizer`.

*Example KafkaUser configuration with authorization*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  # ...
  authorization:
    type: simple
    acls:
      - resource:
          type: topic
          name: my-topic
          patternType: literal
        operations:
          - Read
          - Describe
```

```
- resource:  
  type: group  
  name: my-group  
  patternType: prefix  
operations:  
  - Read
```

## resource

Use the `resource` property to specify the resource that the rule applies to.

Simple authorization supports four resource types, which are specified in the `type` property:

- Topics (`topic`)
- Consumer Groups (`group`)
- Clusters (`cluster`)
- Transactional IDs (`transactionalId`)

For Topic, Group, and Transactional ID resources you can specify the name of the resource the rule applies to in the `name` property.

Cluster type resources have no name.

A name is specified as a `literal` or a `prefix` using the `patternType` property.

- Literal names are taken exactly as they are specified in the `name` field.
- Prefix names use the `name` value as a prefix and then apply the rule to all resources with names starting with that value.

When `patternType` is set as `literal`, you can set the name to `*` to indicate that the rule applies to all resources.

*Example ACL rule that allows the user to read messages from all topics*

```
acls:  
  - resource:  
    type: topic  
    name: "*"  
    patternType: literal  
operations:  
  - Read
```

## type

The `type` of rule, which is to `allow` or `deny` (not currently supported) an operations.

The `type` field is optional. If `type` is unspecified, the ACL rule is treated as an `allow` rule.

## operations

Specify a list of `operations` for the rule to allow or deny.

The following operations are supported:

- Read
- Write
- Delete
- Alter
- Describe
- All
- IdempotentWrite
- ClusterAction
- Create
- AlterConfigs
- DescribeConfigs

Only certain operations work with each resource.

For more details about `AclAuthorizer`, ACLs and supported combinations of resources and operations, see [Authorization and ACLs](#).

## host

Use the `host` property to specify a remote host from which the rule is allowed or denied.

Use an asterisk (\*) to allow or deny the operation from all hosts. The `host` field is optional. If `host` is unspecified, the \* value is used by default.

## AclRule schema properties

Property	Description
host	The host from which the action described in the ACL rule is allowed or denied.
string	
operation	<p><b>The <code>operation</code> property has been deprecated, and should now be configured using <code>spec.authorization.acls[*].operations</code>.</b></p> <p>Operation which will be allowed or denied. Supported operations are: Read, Write, Create, Delete, Alter, Describe, ClusterAction, AlterConfigs, DescribeConfigs, IdempotentWrite and All.</p>
string (one of [Read, Write, Delete, Alter, Describe, All, IdempotentWrite, ClusterAction, Create, AlterConfigs, DescribeConfigs])	

Property	Description
operations	List of operations which will be allowed or denied. Supported operations are: Read, Write, Create, Delete, Alter, Describe, ClusterAction, AlterConfigs, DescribeConfigs, IdempotentWrite and All.
resource	Indicates the resource for which given ACL rule applies. The type depends on the value of the <code>resource.type</code> property within the given object, which must be one of [topic, group, cluster, transactionalId].
type	The type of the rule. Currently the only supported type is <code>allow</code> . ACL rules with type <code>allow</code> are used to allow user to execute the specified operations. Default value is <code>allow</code> .
string (one of [allow, deny])	

## 12.2.105. `AclRuleTopicResource` schema reference

Used in: `AclRule`

The `type` property is a discriminator that distinguishes use of the `AclRuleTopicResource` type from `AclRuleGroupResource`, `AclRuleClusterResource`, `AclRuleTransactionalIdResource`. It must have the value `topic` for the type `AclRuleTopicResource`.

Property	Description
type	Must be <code>topic</code> .
string	
name	Name of resource for which given ACL rule applies. Can be combined with <code>patternType</code> field to use prefix pattern.
string	
patternType	Describes the pattern used in the resource field. The supported types are <code>literal</code> and <code>prefix</code> . With <code>literal</code> pattern type, the resource field will be used as a definition of a full topic name. With <code>prefix</code> pattern type, the resource name will be used only as a prefix. Default value is <code>literal</code> .
string (one of [prefix, literal])	

## 12.2.106. `AclRuleGroupResource` schema reference

Used in: `AclRule`

The `type` property is a discriminator that distinguishes use of the `AclRuleGroupResource` type from `AclRuleTopicResource`, `AclRuleClusterResource`, `AclRuleTransactionalIdResource`. It must have the

value `group` for the type `AclRuleGroupResource`.

Property	Description
type	Must be <code>group</code> .
string	
name	Name of resource for which given ACL rule applies. Can be combined with <code>patternType</code> field to use prefix pattern.
string	
patternType	Describes the pattern used in the resource field. The supported types are <code>literal</code> and <code>prefix</code> . With <code>literal</code> pattern type, the resource field will be used as a definition of a full topic name. With <code>prefix</code> pattern type, the resource name will be used only as a prefix. Default value is <code>literal</code> .
string (one of [prefix, literal])	

## 12.2.107. `AclRuleClusterResource` schema reference

Used in: `AclRule`

The `type` property is a discriminator that distinguishes use of the `AclRuleClusterResource` type from `AclRuleTopicResource`, `AclRuleGroupResource`, `AclRuleTransactionalIdResource`. It must have the value `cluster` for the type `AclRuleClusterResource`.

Property	Description
type	Must be <code>cluster</code> .
string	

## 12.2.108. `AclRuleTransactionalIdResource` schema reference

Used in: `AclRule`

The `type` property is a discriminator that distinguishes use of the `AclRuleTransactionalIdResource` type from `AclRuleTopicResource`, `AclRuleGroupResource`, `AclRuleClusterResource`. It must have the value `transactionalId` for the type `AclRuleTransactionalIdResource`.

Property	Description
type	Must be <code>transactionalId</code> .
string	
name	Name of resource for which given ACL rule applies. Can be combined with <code>patternType</code> field to use prefix pattern.
string	

Property	Description
patternType	Describes the pattern used in the resource field. The supported types are <code>literal</code> and <code>prefix</code> . With <code>literal</code> pattern type, the resource field will be used as a definition of a full name. With <code>prefix</code> pattern type, the resource name will be used only as a prefix. Default value is <code>literal</code> .
string (one of [prefix, literal])	

## 12.2.109. KafkaUserQuotas schema reference

Used in: [KafkaUserSpec](#)

[Full list of KafkaUserQuotas schema properties](#)

Kafka allows a user to set `quotas` to control the use of resources by clients.

### quotas

You can configure your clients to use the following types of quotas:

- *Network usage* quotas specify the byte rate threshold for each group of clients sharing a quota.
- *CPU utilization* quotas specify a window for broker requests from clients. The window is the percentage of time for clients to make requests. A client makes requests on the I/O threads and network threads of the broker.
- *Partition mutation* quotas limit the number of partition mutations which clients are allowed to make per second.

A partition mutation quota prevents Kafka clusters from being overwhelmed by concurrent topic operations. Partition mutations occur in response to the following types of user requests:

- Creating partitions for a new topic
- Adding partitions to an existing topic
- Deleting partitions from a topic

You can configure a partition mutation quota to control the rate at which mutations are accepted for user requests.

Using quotas for Kafka clients might be useful in a number of situations. Consider a wrongly configured Kafka producer which is sending requests at too high a rate. Such misconfiguration can cause a denial of service to other clients, so the problematic client ought to be blocked. By using a network limiting quota, it is possible to prevent this situation from significantly impacting other clients.

Strimzi supports user-level quotas, but not client-level quotas.

*Example Kafka user quota configuration*

spec:

```

quotas:
  producerByteRate: 1048576
  consumerByteRate: 2097152
  requestPercentage: 55
  controllerMutationRate: 10

```

For more information about Kafka user quotas, refer to the [Apache Kafka documentation](#).

### KafkaUserQuotas schema properties

Property	Description
consumerByteRate	A quota on the maximum bytes per-second that each client group can fetch from a broker before the clients in the group are throttled. Defined on a per-broker basis.
controllerMutationRate	A quota on the rate at which mutations are accepted for the create topics request, the create partitions request and the delete topics request. The rate is accumulated by the number of partitions created or deleted.
producerByteRate	A quota on the maximum bytes per-second that each client group can publish to a broker before the clients in the group are throttled. Defined on a per-broker basis.
requestPercentage	A quota on the maximum CPU utilization of each client group as a percentage of network and I/O threads.
integer	

### 12.2.110. KafkaUserTemplate schema reference

Used in: [KafkaUserSpec](#)

[Full list of KafkaUserTemplate schema properties](#)

Specify additional labels and annotations for the secret created by the User Operator.

*An example showing the KafkaUserTemplate*

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster
spec:
  authentication:
    type: tls
  template:

```

```

secret:
  metadata:
    labels:
      label1: value1
    annotations:
      anno1: value1
  # ...

```

### KafkaUserTemplate schema properties

Property	Description
secret	Template for KafkaUser resources. The template allows users to specify how the <a href="#">Secret</a> with password or TLS certificates is generated.
ResourceTemplate	

### 12.2.111. KafkaUserStatus schema reference

Used in: [KafkaUser](#)

Property	Description
conditions	List of status conditions.
<a href="#">Condition</a> array	
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
username	Username.
string	
secret	The name of <a href="#">Secret</a> where the credentials are stored.
string	

### 12.2.112. KafkaMirrorMaker schema reference

The type [KafkaMirrorMaker](#) has been deprecated. Please use [KafkaMirrorMaker2](#) instead.

Property	Description
spec	The specification of Kafka MirrorMaker.
<a href="#">KafkaMirrorMakerSpec</a>	
status	The status of Kafka MirrorMaker.
<a href="#">KafkaMirrorMakerStatus</a>	

### 12.2.113. KafkaMirrorMakerSpec schema reference

Used in: [KafkaMirrorMaker](#)

## Full list of KafkaMirrorMakerSpec schema properties

Configures Kafka MirrorMaker.

### include

Use the `include` property to configure a list of topics that Kafka MirrorMaker mirrors from the source to the target Kafka cluster.

The property allows any regular expression from the simplest case with a single topic name to complex patterns. For example, you can mirror topics A and B using `A|B` or all topics using `*`. You can also pass multiple regular expressions separated by commas to the Kafka MirrorMaker.

### KafkaMirrorMakerConsumerSpec and KafkaMirrorMakerProducerSpec

Use the `KafkaMirrorMakerConsumerSpec` and `KafkaMirrorMakerProducerSpec` to configure source (consumer) and target (producer) clusters.

Kafka MirrorMaker always works together with two Kafka clusters (source and target). To establish a connection, the bootstrap servers for the source and the target Kafka clusters are specified as comma-separated lists of `HOSTNAME:PORT` pairs. Each comma-separated list contains one or more Kafka brokers or a `Service` pointing to Kafka brokers specified as a `HOSTNAME:PORT` pair.

### logging

Kafka MirrorMaker has its own configurable logger:

- `mirrormaker.root.logger`

MirrorMaker uses the Apache `log4j` logger implementation.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. Inside the ConfigMap, the logging configuration is described using `log4j.properties`. Both `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. A ConfigMap using the exact logging configuration specified is created with the custom resource when the Cluster Operator is running, then recreated after each reconciliation. If you do not specify a custom ConfigMap, default logging settings are used. If a specific logger value is not set, upper-level logger settings are inherited for that logger. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker
spec:
  # ...
  logging:
```

```

type: inline
loggers:
  mirrormaker.root.logger: "INFO"
# ...

```

```

apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaMirrorMaker
spec:
# ...
logging:
  type: external
  valueFrom:
    configMapKeyRef:
      name: customConfigMap
      key: mirror-maker-log4j.properties
# ...

```

### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the [JvmOptions](#) property.

### KafkaMirrorMakerSpec schema properties

Property	Description
version	The Kafka MirrorMaker version. Defaults to 3.3.1. Consult the documentation to understand the process required to upgrade or downgrade the version.
string	
replicas	The number of pods in the <a href="#">Deployment</a> .
integer	
image	The docker image for the pods.
string	
consumer	Configuration of source cluster.
<a href="#">KafkaMirrorMakerConsumerSpec</a>	
producer	Configuration of target cluster.
<a href="#">KafkaMirrorMakerProducerSpec</a>	
resources	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
<a href="#">ResourceRequirements</a>	

Property	Description
whitelist	The <code>whitelist</code> property has been deprecated, and should now be configured using <code>spec.include</code> . List of topics which are included for mirroring. This option allows any regular expression using Java-style regular expressions. Mirroring two topics named A and B is achieved by using the expression <code>A B</code> . Or, as a special case, you can mirror all topics using the regular expression <code>*</code> . You can also specify multiple regular expressions separated by commas.
string	Mirroring two topics named A and B is achieved by using the expression <code>A B</code> . Or, as a special case, you can mirror all topics using the regular expression <code>*</code> . You can also specify multiple regular expressions separated by commas.
include	List of topics which are included for mirroring. This option allows any regular expression using Java-style regular expressions. Mirroring two topics named A and B is achieved by using the expression <code>A B</code> . Or, as a special case, you can mirror all topics using the regular expression <code>*</code> . You can also specify multiple regular expressions separated by commas.
string	Mirroring two topics named A and B is achieved by using the expression <code>A B</code> . Or, as a special case, you can mirror all topics using the regular expression <code>*</code> . You can also specify multiple regular expressions separated by commas.
jvmOptions  <code>JvmOptions</code>	JVM Options for pods.
logging  <code>InlineLogging, ExternalLogging</code>	Logging configuration for MirrorMaker. The type depends on the value of the <code>logging.type</code> property within the given object, which must be one of [inline, external].
metricsConfig  <code>JmxPrometheusExporterMetrics</code>	Metrics configuration. The type depends on the value of the <code>metricsConfig.type</code> property within the given object, which must be one of [jmxPrometheusExporter].
tracing  <code>JaegerTracing, OpenTelemetryTracing</code>	The configuration of tracing in Kafka MirrorMaker. The type depends on the value of the <code>tracing.type</code> property within the given object, which must be one of [jaeger, opentelemetry].
template  <code>KafkaMirrorMakerTemplate</code>	Template to specify how Kafka MirrorMaker resources, <code>Deployments</code> and <code>Pods</code> , are generated.
livenessProbe  <code>Probe</code>	Pod liveness checking.
readinessProbe  <code>Probe</code>	Pod readiness checking.

## 12.2.114. KafkaMirrorMakerConsumerSpec schema reference

Used in: [KafkaMirrorMakerSpec](#)

[Full list of KafkaMirrorMakerConsumerSpec schema properties](#)

Configures a MirrorMaker consumer.

### numStreams

Use the `consumer.numStreams` property to configure the number of streams for the consumer.

You can increase the throughput in mirroring topics by increasing the number of consumer threads. Consumer threads belong to the consumer group specified for Kafka MirrorMaker. Topic partitions are assigned across the consumer threads, which consume messages in parallel.

### offsetCommitInterval

Use the `consumer.offsetCommitInterval` property to configure an offset auto-commit interval for the consumer.

You can specify the regular time interval at which an offset is committed after Kafka MirrorMaker has consumed data from the source Kafka cluster. The time interval is set in milliseconds, with a default value of 60,000.

### config

Use the `consumer.config` properties to configure Kafka options for the consumer.

The `config` property contains the Kafka MirrorMaker consumer configuration options as keys, with values set in one of the following JSON types:

- String
- Number
- Boolean

For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed ssl properties](#). You can also [configure the ssl.endpoint.identification.algorithm property](#) to enable or disable hostname verification.

### Exceptions

You can specify and configure the options listed in the [Apache Kafka configuration documentation for consumers](#).

However, there are exceptions for options automatically configured and managed directly by Strimzi related to:

- Kafka cluster bootstrap address
- Security (encryption, authentication, and authorization)
- Consumer group identifier

- Interceptors

Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `bootstrap.servers`
- `group.id`
- `interceptor.classes`
- `ssl.` (not including specific exceptions)
- `sasl.`
- `security.`

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other options are passed to Kafka MirrorMaker.

#### IMPORTANT

The Cluster Operator does not validate keys or values in the provided `config` object. When an invalid configuration is provided, the Kafka MirrorMaker might not start or might become unstable. In such cases, the configuration in the `KafkaMirrorMaker.spec.consumer.config` object should be fixed and the Cluster Operator will roll out the new configuration for Kafka MirrorMaker.

#### `groupId`

Use the `consumer.groupId` property to configure a consumer group identifier for the consumer.

Kafka MirrorMaker uses a Kafka consumer to consume messages, behaving like any other Kafka consumer client. Messages consumed from the source Kafka cluster are mirrored to a target Kafka cluster. A group identifier is required, as the consumer needs to be part of a consumer group for the assignment of partitions.

#### `KafkaMirrorMakerConsumerSpec` schema properties

Property	Description
<code>numStreams</code> integer	Specifies the number of consumer stream threads to create.
<code>offsetCommitInterval</code> integer	Specifies the offset auto-commit interval in ms. Default value is 60000.
<code>bootstrapServers</code> string	A list of host:port pairs for establishing the initial connection to the Kafka cluster.
<code>groupId</code> string	A unique string that identifies the consumer group this consumer belongs to.

Property	Description
authentication	Authentication configuration for connecting to the cluster. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [tls, scram-sha-256, scram-sha-512, plain, oauth].
<code>KafkaClientAuthenticationTls</code> , <code>KafkaClientAuthenticationScramSha256</code> , <code>KafkaClientAuthenticationScramSha512</code> , <code>KafkaClientAuthenticationPlain</code> , <code>KafkaClientAuthenticationOAuth</code>	
config	The MirrorMaker consumer config. Properties with the following prefixes cannot be set: ssl., bootstrap.servers, group.id, sasl., security., interceptor.classes (with the exception of: ssl.endpoint.identification.algorithm, ssl.cipher.suites, ssl.protocol, ssl.enabled.protocols).
map	
tls	TLS configuration for connecting MirrorMaker to the cluster.
<code>ClientTls</code>	

## 12.2.115. `KafkaMirrorMakerProducerSpec` schema reference

Used in: `KafkaMirrorMakerSpec`

[Full list of `KafkaMirrorMakerProducerSpec` schema properties](#)

Configures a MirrorMaker producer.

### `abortOnSendFailure`

Use the `producer.abortOnSendFailure` property to configure how to handle message send failure from the producer.

By default, if an error occurs when sending a message from Kafka MirrorMaker to a Kafka cluster:

- The Kafka MirrorMaker container is terminated in Kubernetes.
- The container is then recreated.

If the `abortOnSendFailure` option is set to `false`, message sending errors are ignored.

### `config`

Use the `producer.config` properties to configure Kafka options for the producer.

The `config` property contains the Kafka MirrorMaker producer configuration options as keys, with values set in one of the following JSON types:

- String
- Number

- Boolean

For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed ssl properties](#). You can also [configure the `ssl.endpoint.identification.algorithm` property](#) to enable or disable hostname verification.

## Exceptions

You can specify and configure the options listed in the [Apache Kafka configuration documentation for producers](#).

However, there are exceptions for options automatically configured and managed directly by Strimzi related to:

- Kafka cluster bootstrap address
- Security (encryption, authentication, and authorization)
- Interceptors

Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `bootstrap.servers`
- `interceptor.classes`
- `ssl.` ([not including specific exceptions](#))
- `sasl.`
- `security.`

When a forbidden option is present in the `config` property, it is ignored and a warning message is printed to the Cluster Operator log file. All other options are passed to Kafka MirrorMaker.

### IMPORTANT

The Cluster Operator does not validate keys or values in the provided `config` object. When an invalid configuration is provided, the Kafka MirrorMaker might not start or might become unstable. In such cases, the configuration in the `KafkaMirrorMaker.spec.producer.config` object should be fixed and the Cluster Operator will roll out the new configuration for Kafka MirrorMaker.

## KafkaMirrorMakerProducerSpec schema properties

Property	Description
<code>bootstrapServers</code>	A list of host:port pairs for establishing the initial connection to the Kafka cluster.
<code>string</code>	
<code>abortOnSendFailure</code>	Flag to set the MirrorMaker to exit on a failed send. Default value is <code>true</code> .
<code>boolean</code>	

Property	Description
authentication	Authentication configuration for connecting to the cluster. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [tls, scram-sha-256, scram-sha-512, plain, oauth].
<code>KafkaClientAuthenticationTls</code> , <code>KafkaClientAuthenticationScramSha256</code> , <code>KafkaClientAuthenticationScramSha512</code> , <code>KafkaClientAuthenticationPlain</code> , <code>KafkaClientAuthenticationOAuth</code>	
config	The MirrorMaker producer config. Properties with the following prefixes cannot be set: ssl., bootstrap.servers, sasl., security., interceptor.classes (with the exception of: ssl.endpoint.identification.algorithm, ssl.cipher.suites, ssl.protocol, ssl.enabled.protocols).
map	
tls	TLS configuration for connecting MirrorMaker to the cluster.
<code>ClientTls</code>	

## 12.2.116. `KafkaMirrorMakerTemplate` schema reference

Used in: `KafkaMirrorMakerSpec`

Property	Description
deployment	Template for Kafka MirrorMaker <a href="#">Deployment</a> .
<code>DeploymentTemplate</code>	
pod	Template for Kafka MirrorMaker <a href="#">Pods</a> .
<code>PodTemplate</code>	
podDisruptionBudget	Template for Kafka MirrorMaker <a href="#">PodDisruptionBudget</a> .
<code>PodDisruptionBudgetTemplate</code>	
mirrorMakerContainer	Template for Kafka MirrorMaker container.
<code>ContainerTemplate</code>	
serviceAccount	Template for the Kafka MirrorMaker service account.
<code>ResourceTemplate</code>	

## 12.2.117. `KafkaMirrorMakerStatus` schema reference

Used in: `KafkaMirrorMaker`

Property	Description
conditions	List of status conditions.
<code>Condition</code> array	

Property	Description
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
labelSelector	Label selector for pods providing this resource.
string	
replicas	The current number of pods being used to provide this resource.
integer	

## 12.2.118. KafkaBridge schema reference

Property	Description
spec	The specification of the Kafka Bridge.
KafkaBridgeSpec	
status	The status of the Kafka Bridge.
KafkaBridgeStatus	

## 12.2.119. KafkaBridgeSpec schema reference

Used in: [KafkaBridge](#)

[Full list of KafkaBridgeSpec schema properties](#)

Configures a Kafka Bridge cluster.

Configuration options relate to:

- Kafka cluster bootstrap address
- Security (Encryption, Authentication, and Authorization)
- Consumer configuration
- Producer configuration
- HTTP configuration

### logging

Kafka Bridge has its own configurable loggers:

- `logger.bridge`
- `logger.<operation-id>`

You can replace `<operation-id>` in the `logger.<operation-id>` logger to set log levels for specific operations:

- `createConsumer`
- `deleteConsumer`

- `subscribe`
- `unsubscribe`
- `poll`
- `assign`
- `commit`
- `send`
- `sendToPartition`
- `seekToBeginning`
- `seekToEnd`
- `seek`
- `healthy`
- `ready`
- `openapi`

Each operation is defined according OpenAPI specification, and has a corresponding API endpoint through which the bridge receives requests from HTTP clients. You can change the log level on each endpoint to create fine-grained logging information about the incoming and outgoing HTTP requests.

Each logger has to be configured assigning it a `name` as `http.openapi.operation.<operation-id>`. For example, configuring the logging level for the `send` operation logger means defining the following:

```
logger.send.name = http.openapi.operation.send
logger.send.level = DEBUG
```

Kafka Bridge uses the Apache `log4j2` logger implementation. Loggers are defined in the `log4j2.properties` file, which has the following default configuration for `healthy` and `ready` endpoints:

```
logger.healthy.name = http.openapi.operation.healthy
logger.healthy.level = WARN
logger.ready.name = http.openapi.operation.ready
logger.ready.level = WARN
```

The log level of all other operations is set to `INFO` by default.

Use the `logging` property to configure loggers and logger levels.

You can set the log levels by specifying the logger and level directly (inline) or use a custom (external) ConfigMap. If a ConfigMap is used, you set `logging.valueFrom.configMapKeyRef.name` property to the name of the ConfigMap containing the external logging configuration. The `logging.valueFrom.configMapKeyRef.name` and `logging.valueFrom.configMapKeyRef.key` properties are mandatory. Default logging is used if the `name` or `key` is not set. Inside the ConfigMap, the logging

configuration is described using `log4j.properties`. For more information about log levels, see [Apache logging services](#).

Here we see examples of `inline` and `external` logging.

#### *Inline logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
spec:
  # ...
  logging:
    type: inline
    loggers:
      logger.bridge.level: "INFO"
      # enabling DEBUG just for send operation
      logger.send.name: "http.openapi.operation.send"
      logger.send.level: "DEBUG"
  # ...
```

#### *External logging*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
spec:
  # ...
  logging:
    type: external
    valueFrom:
      configMapKeyRef:
        name: customConfigMap
        key: bridge-log4j2.properties
  # ...
```

Any available loggers that are not configured have their level set to `OFF`.

If the Kafka Bridge was deployed using the Cluster Operator, changes to Kafka Bridge logging levels are applied dynamically.

If you use external logging, a rolling update is triggered when logging appenders are changed.

#### *Garbage collector (GC)*

Garbage collector logging can also be enabled (or disabled) using the `jvmOptions` property.

#### **KafkaBridgeSpec schema properties**

Property	Description
replicas	The number of pods in the <code>Deployment</code> .
integer	

Property	Description
image string	The docker image for the pods.
bootstrapServers string	A list of host:port pairs for establishing the initial connection to the Kafka cluster.
tls <b>ClientTls</b>	TLS configuration for connecting Kafka Bridge to the cluster.
authentication  <b>KafkaClientAuthenticationTls</b> , <b>KafkaClientAuthenticationScramSha256</b> , <b>KafkaClientAuthenticationScramSha512</b> , <b>KafkaClientAuthenticationPlain</b> , <b>KafkaClientAuthenticationOAuth</b>	Authentication configuration for connecting to the cluster. The type depends on the value of the <b>authentication.type</b> property within the given object, which must be one of [tls, scram-sha-256, scram-sha-512, plain, oauth].
http  <b>KafkaBridgeHttpConfig</b>	The HTTP related configuration.
adminClient  <b>KafkaBridgeAdminClientSpec</b>	Kafka AdminClient related configuration.
consumer  <b>KafkaBridgeConsumerSpec</b>	Kafka consumer related configuration.
producer  <b>KafkaBridgeProducerSpec</b>	Kafka producer related configuration.
resources  <b>ResourceRequirements</b>	CPU and memory resources to reserve. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
jvmOptions  <b>JvmOptions</b>	<b>Currently not supported</b> JVM Options for pods.
logging  <b>InlineLogging</b> , <b>ExternalLogging</b>	Logging configuration for Kafka Bridge. The type depends on the value of the <b>logging.type</b> property within the given object, which must be one of [inline, external].
clientRackInitImage string	The image of the init container used for initializing the <b>client.rack</b> .
rack  <b>Rack</b>	Configuration of the node label which will be used as the <b>client.rack</b> consumer configuration.
enableMetrics boolean	Enable the metrics for the Kafka Bridge. Default is false.

Property	Description
livenessProbe	Pod liveness checking.
<b>Probe</b>	
readinessProbe	Pod readiness checking.
<b>Probe</b>	
template	Template for Kafka Bridge resources. The template allows users to specify how a <a href="#">Deployment</a> and <a href="#">Pod</a> is generated.
<b>KafkaBridgeTemplate</b>	
tracing	The configuration of tracing in Kafka Bridge. The type depends on the value of the <a href="#">tracing.type</a> property within the given object, which must be one of [jaeger, opentelemetry].
<a href="#">JaegerTracing</a> , <a href="#">OpenTelemetryTracing</a>	

## 12.2.120. [KafkaBridgeHttpConfig](#) schema reference

Used in: [KafkaBridgeSpec](#)

[Full list of KafkaBridgeHttpConfig schema properties](#)

Configures HTTP access to a Kafka cluster for the Kafka Bridge.

The default HTTP configuration is for the Kafka Bridge to listen on port 8080.

### **cors**

As well as enabling HTTP access to a Kafka cluster, HTTP properties provide the capability to enable and define access control for the Kafka Bridge through Cross-Origin Resource Sharing (CORS). CORS is a HTTP mechanism that allows browser access to selected resources from more than one origin. To configure CORS, you define a list of allowed resource origins and HTTP access methods. For the origins, you can use a URL or a Java regular expression.

*Example Kafka Bridge HTTP configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  # ...
  http:
    port: 8080
    cors:
      allowedOrigins: "https://strimzi.io"
      allowedMethods: "GET,POST,PUT,DELETE,OPTIONS,PATCH"
  # ...
```

## KafkaBridgeHttpConfig schema properties

Property	Description
port	The port which is the server listening on.
integer	
cors	CORS configuration for the HTTP Bridge.
KafkaBridgeHttpCors	

## 12.2.121. KafkaBridgeHttpCors schema reference

Used in: [KafkaBridgeHttpConfig](#)

Property	Description
allowedOrigins	List of allowed origins. Java regular expressions can be used.
string array	
allowedMethods	List of allowed HTTP methods.
string array	

## 12.2.122. KafkaBridgeAdminClientSpec schema reference

Used in: [KafkaBridgeSpec](#)

Property	Description
config	The Kafka AdminClient configuration used for AdminClient instances created by the bridge.
map	

## 12.2.123. KafkaBridgeConsumerSpec schema reference

Used in: [KafkaBridgeSpec](#)

[Full list of KafkaBridgeConsumerSpec schema properties](#)

Configures consumer options for the Kafka Bridge as keys.

The values can be one of the following JSON types:

- String
- Number
- Boolean

You can specify and configure the options listed in the [Apache Kafka configuration documentation for consumers](#) with the exception of those options which are managed directly by Strimzi. Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `ssl`.
- `sasl`.
- `security`.
- `bootstrap.servers`
- `group.id`

When one of the forbidden options is present in the `config` property, it is ignored and a warning message will be printed to the Cluster Operator log file. All other options will be passed to Kafka

#### IMPORTANT

The Cluster Operator does not validate keys or values in the `config` object. If an invalid configuration is provided, the Kafka Bridge cluster might not start or might become unstable. Fix the configuration so that the Cluster Operator can roll out the new configuration to all Kafka Bridge nodes.

There are exceptions to the forbidden options. For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed `ssl` properties](#).

*Example Kafka Bridge consumer configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  # ...
  consumer:
    config:
      auto.offset.reset: earliest
      enable.auto.commit: true
      ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384"
      ssl.enabled.protocols: "TLSv1.2"
      ssl.protocol: "TLSv1.2"
      ssl.endpoint.identification.algorithm: HTTPS
  # ...
```

#### KafkaBridgeConsumerSpec schema properties

Property	Description
<code>config</code>	The Kafka consumer configuration used for consumer instances created by the bridge. Properties with the following prefixes cannot be set: <code>ssl</code> ., <code>bootstrap.servers</code> , <code>group.id</code> , <code>sasl</code> , <code>security</code> . (with the exception of: <code>ssl.endpoint.identification.algorithm</code> , <code>ssl.cipher.suites</code> , <code>ssl.protocol</code> , <code>ssl.enabled.protocols</code> ).
<code>map</code>	

## 12.2.124. KafkaBridgeProducerSpec schema reference

Used in: [KafkaBridgeSpec](#)

[Full list of KafkaBridgeProducerSpec schema properties](#)

Configures producer options for the Kafka Bridge as keys.

The values can be one of the following JSON types:

- String
- Number
- Boolean

You can specify and configure the options listed in the [Apache Kafka configuration documentation for producers](#) with the exception of those options which are managed directly by Strimzi. Specifically, all configuration options with keys equal to or starting with one of the following strings are forbidden:

- `ssl.`
- `sasl.`
- `security.`
- `bootstrap.servers`

When one of the forbidden options is present in the `config` property, it is ignored and a warning message will be printed to the Cluster Operator log file. All other options will be passed to Kafka

**IMPORTANT**

The Cluster Operator does not validate keys or values in the `config` object. If an invalid configuration is provided, the Kafka Bridge cluster might not start or might become unstable. Fix the configuration so that the Cluster Operator can roll out the new configuration to all Kafka Bridge nodes.

There are exceptions to the forbidden options. For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed `ssl` properties](#).

*Example Kafka Bridge producer configuration*

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  # ...
  producer:
    config:
      acks: 1
      delivery.timeout.ms: 300000
      ssl.cipher.suites: "TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384"
      ssl.enabled.protocols: "TLSv1.2"
```

```

    ssl.protocol: "TLSv1.2"
    ssl.endpoint.identification.algorithm: HTTPS
    # ...

```

### KafkaBridgeProducerSpec schema properties

Property	Description
config	The Kafka producer configuration used for producer instances created by the bridge. Properties with the following prefixes cannot be set: ssl., bootstrap.servers, sasl., security. (with the exception of: ssl.endpoint.identification.algorithm, ssl.cipher.suites, ssl.enabled.protocols).
map	

### 12.2.125. KafkaBridgeTemplate schema reference

Used in: [KafkaBridgeSpec](#)

Property	Description
deployment	Template for Kafka Bridge <a href="#">Deployment</a> .
<a href="#">DeploymentTemplate</a>	
pod	Template for Kafka Bridge <a href="#">Pods</a> .
<a href="#">PodTemplate</a>	
apiService	Template for Kafka Bridge <a href="#">API Service</a> .
<a href="#">InternalServiceTemplate</a>	
podDisruptionBudget	Template for Kafka Bridge <a href="#">PodDisruptionBudget</a> .
<a href="#">PodDisruptionBudgetTemplate</a>	
bridgeContainer	Template for the Kafka Bridge container.
<a href="#">ContainerTemplate</a>	
serviceAccount	Template for the Kafka Bridge service account.
<a href="#">ResourceTemplate</a>	
initContainer	Template for the Kafka Bridge init container.
<a href="#">ContainerTemplate</a>	

### 12.2.126. KafkaBridgeStatus schema reference

Used in: [KafkaBridge](#)

Property	Description
conditions	List of status conditions.
Condition array	
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
url	The URL at which external client applications can access the Kafka Bridge.
string	
labelSelector	Label selector for pods providing this resource.
string	
replicas	The current number of pods being used to provide this resource.
integer	

## 12.2.127. [KafkaConnector](#) schema reference

Property	Description
spec	The specification of the Kafka Connector.
<a href="#">KafkaConnectorSpec</a>	
status	The status of the Kafka Connector.
<a href="#">KafkaConnectorStatus</a>	

## 12.2.128. [KafkaConnectorSpec](#) schema reference

Used in: [KafkaConnector](#)

Property	Description
class	The Class for the Kafka Connector.
string	
tasksMax	The maximum number of tasks for the Kafka Connector.
integer	
config	The Kafka Connector configuration. The following properties cannot be set: connector.class, tasks.max.
map	
pause	Whether the connector should be paused. Defaults to false.
boolean	

## 12.2.129. [KafkaConnectorStatus](#) schema reference

Used in: [KafkaConnector](#)

Property	Description
conditions	List of status conditions.
Condition array	
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
connectorStatus	The connector status, as reported by the Kafka Connect REST API.
map	
tasksMax	The maximum number of tasks for the Kafka Connector.
integer	
topics	The list of topics used by the Kafka Connector.
string array	

## 12.2.130. KafkaMirrorMaker2 schema reference

Property	Description
spec	
KafkaMirrorMaker2Spec	The specification of the Kafka MirrorMaker 2.0 cluster.
status	
KafkaMirrorMaker2Status	The status of the Kafka MirrorMaker 2.0 cluster.

## 12.2.131. KafkaMirrorMaker2Spec schema reference

Used in: [KafkaMirrorMaker2](#)

Property	Description
version	The Kafka Connect version. Defaults to 3.3.1. Consult the user documentation to understand the process required to upgrade or downgrade the version.
string	
replicas	The number of pods in the Kafka Connect group.
integer	
image	The docker image for the pods.
string	
connectCluster	The cluster alias used for Kafka Connect. The alias must match a cluster in the list at <a href="#">spec.clusters</a> .
string	
clusters	Kafka clusters for mirroring.
KafkaMirrorMaker2ClusterSpec array	

Property	Description
mirrors  <a href="#">KafkaMirrorMaker2MirrorSpec</a> array	Configuration of the MirrorMaker 2.0 connectors.
resources  <a href="#">ResourceRequirements</a>	The maximum limits for CPU and memory resources and the requested initial resources. For more information, see the <a href="#">external documentation for core/v1 resourcerequirements</a> .
livenessProbe  <a href="#">Probe</a>	Pod liveness checking.
readinessProbe  <a href="#">Probe</a>	Pod readiness checking.
jvmOptions  <a href="#">JvmOptions</a>	JVM Options for pods.
jmxOptions  <a href="#">KafkaJmxOptions</a>	JMX Options.
logging  <a href="#">InlineLogging</a> , <a href="#">ExternalLogging</a>	Logging configuration for Kafka Connect. The type depends on the value of the <a href="#">logging.type</a> property within the given object, which must be one of [inline, external].
clientRackInitImage	The image of the init container used for initializing the <a href="#">client.rack</a> .
string	
rack  <a href="#">Rack</a>	Configuration of the node label which will be used as the <a href="#">client.rack</a> consumer configuration.
tracing  <a href="#">JaegerTracing</a> , <a href="#">OpenTelemetryTracing</a>	The configuration of tracing in Kafka Connect. The type depends on the value of the <a href="#">tracing.type</a> property within the given object, which must be one of [jaeger, opentelemetry].
template  <a href="#">KafkaConnectTemplate</a>	Template for Kafka Connect and Kafka Mirror Maker 2 resources. The template allows users to specify how the <a href="#">Deployment</a> , <a href="#">Pods</a> and <a href="#">Service</a> are generated.
externalConfiguration  <a href="#">ExternalConfiguration</a>	Pass data from Secrets or ConfigMaps to the Kafka Connect pods and use them to configure connectors.
metricsConfig  <a href="#">JmxPrometheusExporterMetrics</a>	Metrics configuration. The type depends on the value of the <a href="#">metricsConfig.type</a> property within the given object, which must be one of [jmxPrometheusExporter].

## 12.2.132. KafkaMirrorMaker2ClusterSpec schema reference

Used in: [KafkaMirrorMaker2Spec](#)

[Full list of KafkaMirrorMaker2ClusterSpec schema properties](#)

Configures Kafka clusters for mirroring.

### config

Use the `config` properties to configure Kafka options.

Standard Apache Kafka configuration may be provided, restricted to those properties not managed directly by Strimzi.

For client connection using a specific *cipher suite* for a TLS version, you can [configure allowed ssl properties](#). You can also [configure the ssl.endpoint.identification.algorithm property](#) to enable or disable hostname verification.

### KafkaMirrorMaker2ClusterSpec schema properties

Property	Description
alias	Alias used to reference the Kafka cluster.
string	
bootstrapServers	A comma-separated list of <code>host:port</code> pairs for establishing the connection to the Kafka cluster.
string	
tls	TLS configuration for connecting MirrorMaker 2.0 connectors to a cluster.
<code>ClientTls</code>	
authentication	Authentication configuration for connecting to the cluster. The type depends on the value of the <code>authentication.type</code> property within the given object, which must be one of [tls, scram-sha-256, scram-sha-512, plain, oauth].
<code>KafkaClientAuthenticationTls</code> , <code>KafkaClientAuthenticationScramSha256</code> , <code>KafkaClientAuthenticationScramSha512</code> , <code>KafkaClientAuthenticationPlain</code> , <code>KafkaClientAuthenticationOAuth</code>	
config	The MirrorMaker 2.0 cluster config. Properties with the following prefixes cannot be set: <code>ssl.</code> , <code>sasl.</code> , <code>security.</code> , <code>listeners.</code> , <code>plugin.path.</code> , <code>rest.</code> , <code>bootstrap.servers.</code> , <code>consumer.interceptor.classes.</code> , <code>producer.interceptor.classes.</code> (with the exception of: <code>ssl.endpoint.identification.algorithm</code> , <code>ssl.cipher.suites</code> , <code>ssl.protocol</code> , <code>ssl.enabled.protocols</code> ).
map	

### 12.2.133. KafkaMirrorMaker2MirrorSpec schema reference

Used in: [KafkaMirrorMaker2Spec](#)

Property	Description
sourceCluster	The alias of the source cluster used by the Kafka MirrorMaker 2.0 connectors. The alias must match a cluster in the list at <a href="#">spec.clusters</a> .
targetCluster	The alias of the target cluster used by the Kafka MirrorMaker 2.0 connectors. The alias must match a cluster in the list at <a href="#">spec.clusters</a> .
sourceConnector	The specification of the Kafka MirrorMaker 2.0 source connector.
heartbeatConnector	The specification of the Kafka MirrorMaker 2.0 heartbeat connector.
checkpointConnector	The specification of the Kafka MirrorMaker 2.0 checkpoint connector.
topicsPattern	A regular expression matching the topics to be mirrored, for example, "topic1 topic2 topic3". Comma-separated lists are also supported.
topicsBlacklistPattern	<b>The <code>topicsBlacklistPattern</code> property has been deprecated, and should now be configured using <code>.spec.mirrors.topicsExcludePattern</code>.</b> A regular expression matching the topics to exclude from mirroring. Comma-separated lists are also supported.
topicsExcludePattern	A regular expression matching the topics to exclude from mirroring. Comma-separated lists are also supported.
string	
groupsPattern	A regular expression matching the consumer groups to be mirrored. Comma-separated lists are also supported.
string	
groupsBlacklistPattern	<b>The <code>groupsBlacklistPattern</code> property has been deprecated, and should now be configured using <code>.spec.mirrors.groupsExcludePattern</code>.</b> A regular expression matching the consumer groups to exclude from mirroring. Comma-separated lists are also supported.
string	
groupsExcludePattern	A regular expression matching the consumer groups to exclude from mirroring. Comma-separated lists are also supported.
string	

## 12.2.134. `KafkaMirrorMaker2ConnectorSpec` schema reference

Used in: `KafkaMirrorMaker2MirrorSpec`

Property	Description
tasksMax	The maximum number of tasks for the Kafka Connector.
integer	
config	The Kafka Connector configuration. The following properties cannot be set: connector.class, tasks.max.
map	
pause	Whether the connector should be paused. Defaults to false.
boolean	

## 12.2.135. `KafkaMirrorMaker2Status` schema reference

Used in: `KafkaMirrorMaker2`

Property	Description
conditions	List of status conditions.
Condition array	
observedGeneration	The generation of the CRD that was last reconciled by the operator.
integer	
url	The URL of the REST API endpoint for managing and monitoring Kafka Connect connectors.
string	
connectorPlugins	The list of connector plugins available in this Kafka Connect deployment.
ConnectorPlugin array	
connectors	List of MirrorMaker 2.0 connector statuses, as reported by the Kafka Connect REST API.
map array	
labelSelector	Label selector for pods providing this resource.
string	
replicas	The current number of pods being used to provide this resource.
integer	

## 12.2.136. `KafkaRebalance` schema reference

Property	Description
spec	The specification of the Kafka rebalance.
<code>KafkaRebalanceSpec</code>	

Property	Description
status	The status of the Kafka rebalance.
KafkaRebalanceStatus	

## 12.2.137. KafkaRebalanceSpec schema reference

Used in: KafkaRebalance

Property	Description
mode	Mode to run the rebalancing. The supported modes are <code>full</code> , <code>add-brokers</code> , <code>remove-brokers</code> . If not specified, the <code>full</code> mode is used by default. <ul style="list-style-type: none"> <li>• <code>full</code> mode runs the rebalancing across all the brokers in the cluster.</li> <li>• <code>add-brokers</code> mode can be used after scaling up the cluster to move some replicas to the newly added brokers.</li> <li>• <code>remove-brokers</code> mode can be used before scaling down the cluster to move replicas out of the brokers to be removed.</li> </ul>
string (one of [remove-brokers, full, add-brokers])	
brokers	The list of newly added brokers in case of scaling up or the ones to be removed in case of scaling down to use for rebalancing. This list can be used only with rebalancing mode <code>add-brokers</code> and <code>removed-brokers</code> . It is ignored with <code>full</code> mode.
integer array	
goals	A list of goals, ordered by decreasing priority, to use for generating and executing the rebalance proposal. The supported goals are available at <a href="https://github.com/linkedin/cruise-control#goals">https://github.com/linkedin/cruise-control#goals</a> . If an empty goals list is provided, the goals declared in the default.goals Cruise Control configuration parameter are used.
string array	
skipHardGoalCheck	Whether to allow the hard goals specified in the Kafka CR to be skipped in optimization proposal generation. This can be useful when some of those hard goals are preventing a balance solution being found. Default is false.
boolean	

Property	Description
rebalanceDisk boolean	Enables intra-broker disk balancing, which balances disk space utilization between disks on the same broker. Only applies to Kafka deployments that use JBOD storage with multiple disks. When enabled, inter-broker balancing is disabled. Default is false.
excludedTopics string	A regular expression where any matching topics will be excluded from the calculation of optimization proposals. This expression will be parsed by the java.util.regex.Pattern class; for more information on the supported format consult the documentation for that class.
concurrentPartitionMovementsPerBroker integer	The upper bound of ongoing partition replica movements going into/out of each broker. Default is 5.
concurrentIntraBrokerPartitionMovements integer	The upper bound of ongoing partition replica movements between disks within each broker. Default is 2.
concurrentLeaderMovements integer	The upper bound of ongoing partition leadership movements. Default is 1000.
replicationThrottle integer	The upper bound, in bytes per second, on the bandwidth used to move replicas. There is no limit by default.
replicaMovementStrategies string array	A list of strategy class names used to determine the execution order for the replica movements in the generated optimization proposal. By default BaseReplicaMovementStrategy is used, which will execute the replica movements in the order that they were generated.

### 12.2.138. **KafkaRebalanceStatus** schema reference

Used in: [KafkaRebalance](#)

Property	Description
conditions <b>Condition</b> array	List of status conditions.
observedGeneration integer	The generation of the CRD that was last reconciled by the operator.

<b>Property</b>	<b>Description</b>
sessionId string	The session identifier for requests to Cruise Control pertaining to this KafkaRebalance resource. This is used by the Kafka Rebalance operator to track the status of ongoing rebalancing operations.
optimizationResult map	A JSON object describing the optimization result.