CONFLUENT
Developer

Introduction to Kafka Security

Data Flow in Kafka

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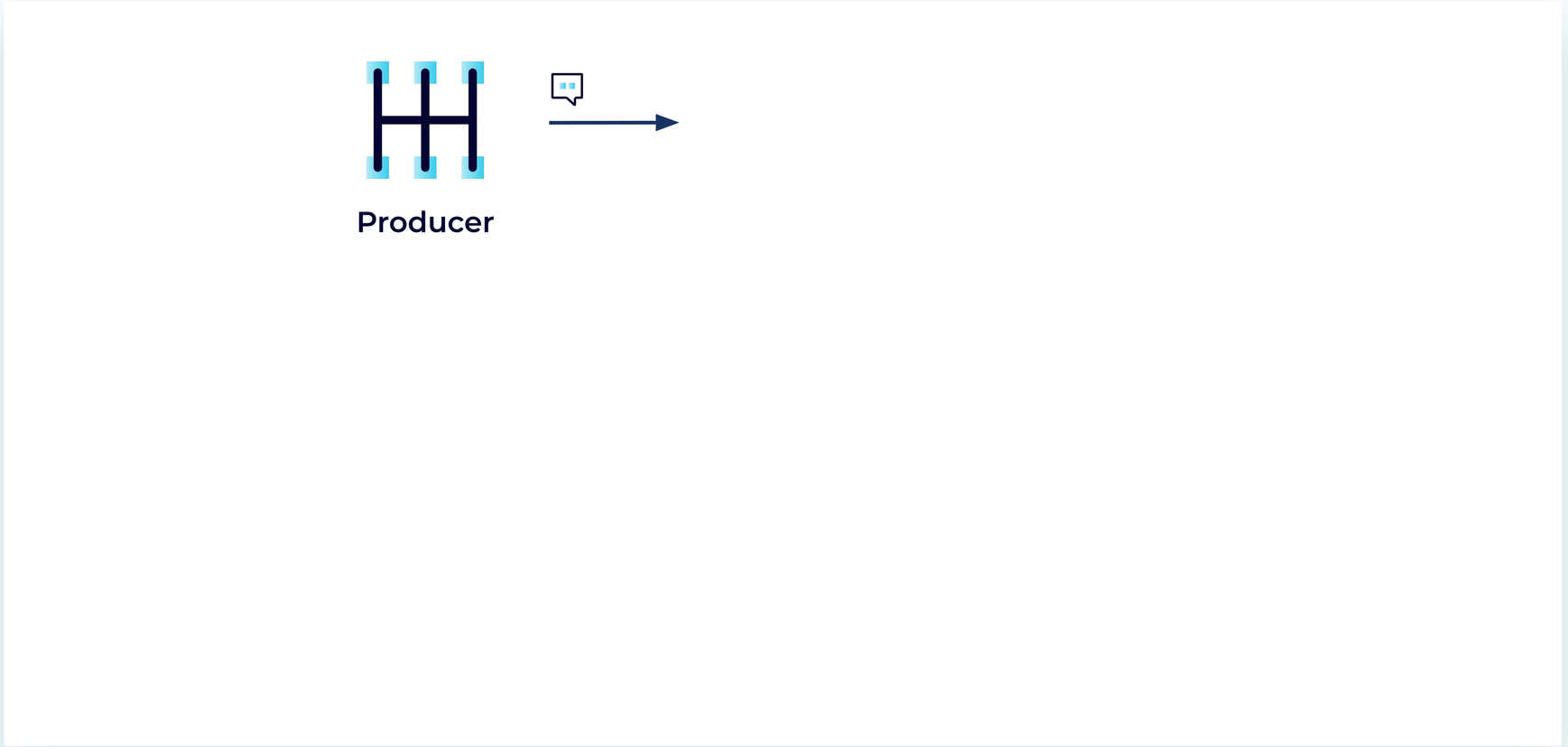

Data Flow in Kafka

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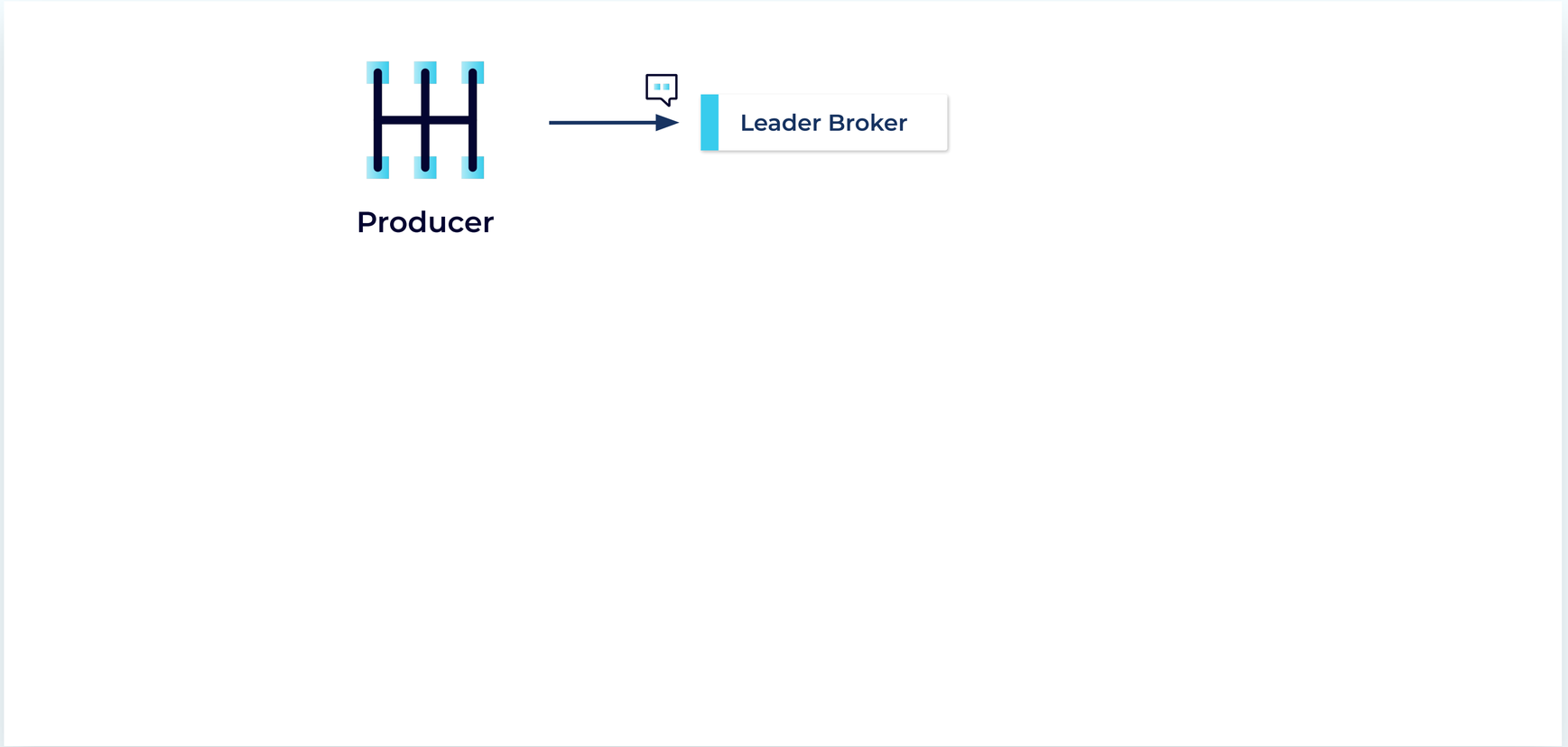

Data Flow in Kafka

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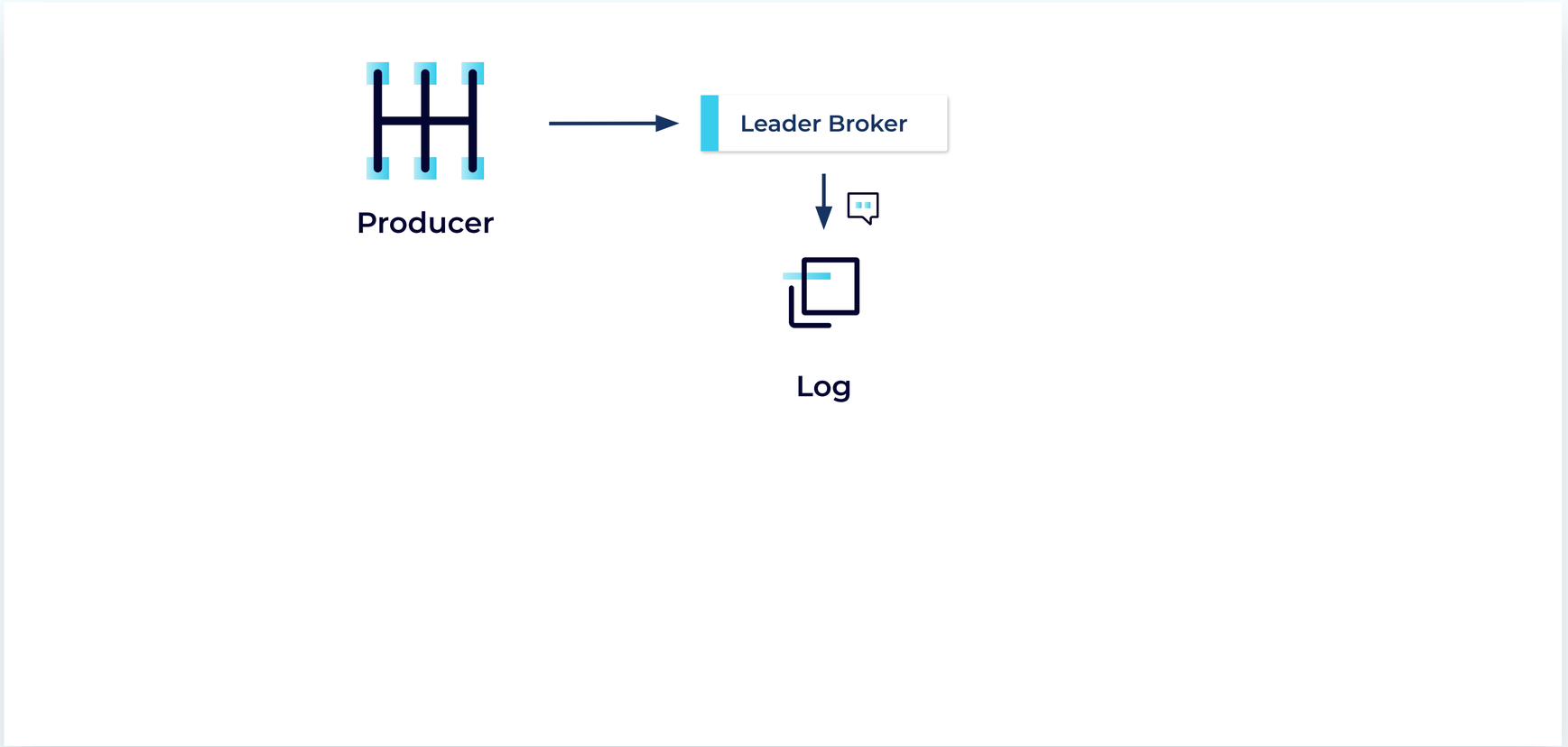

Data Flow in Kafka

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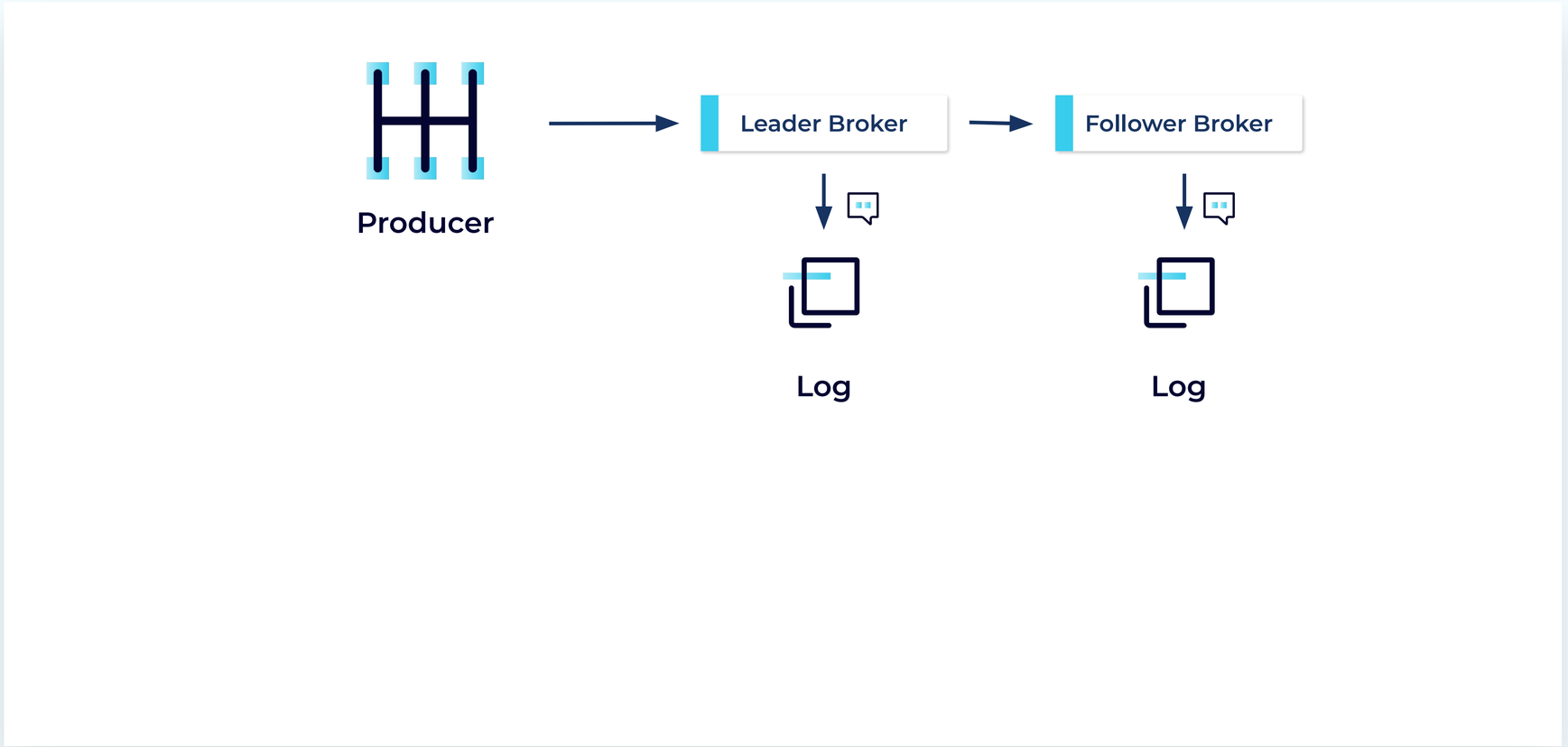

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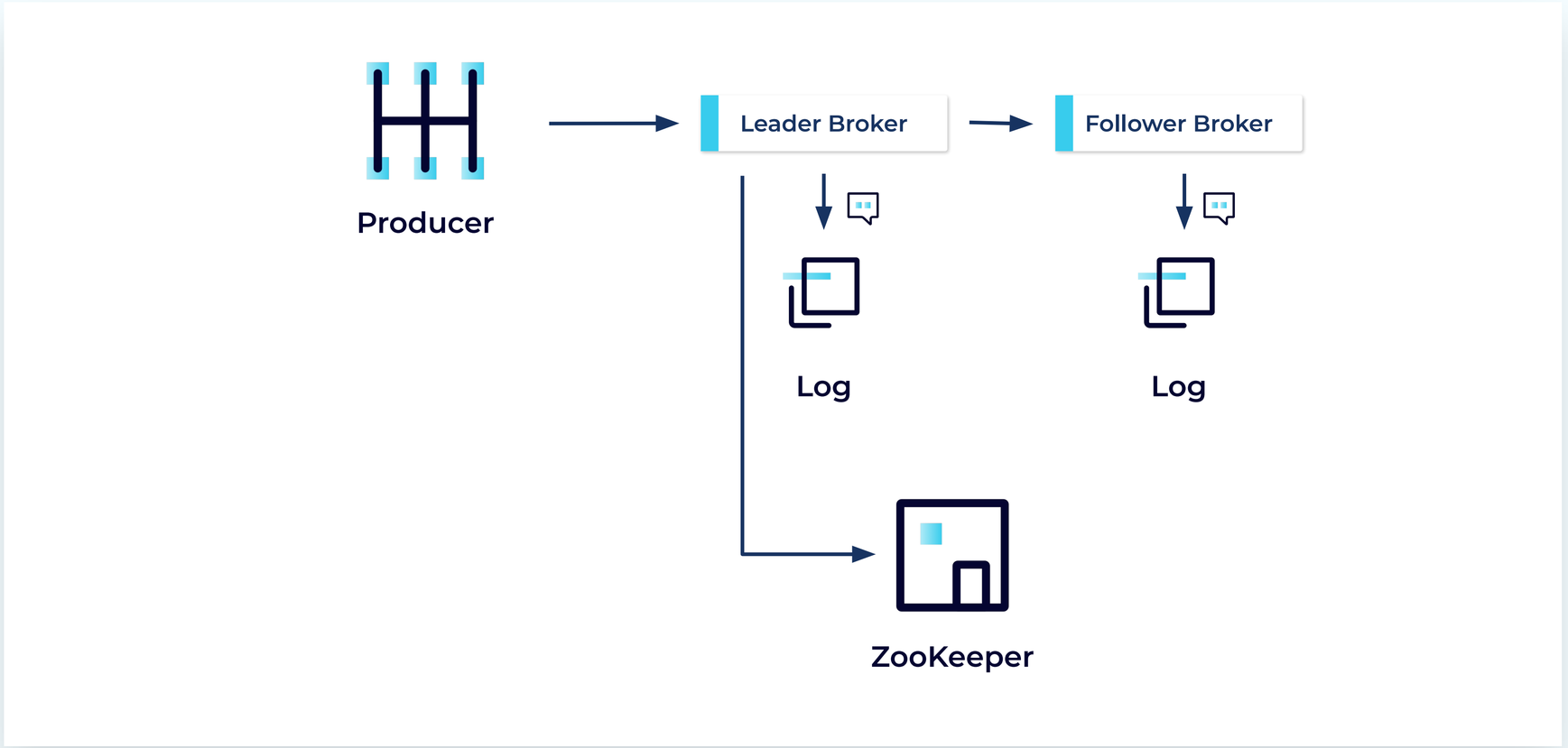

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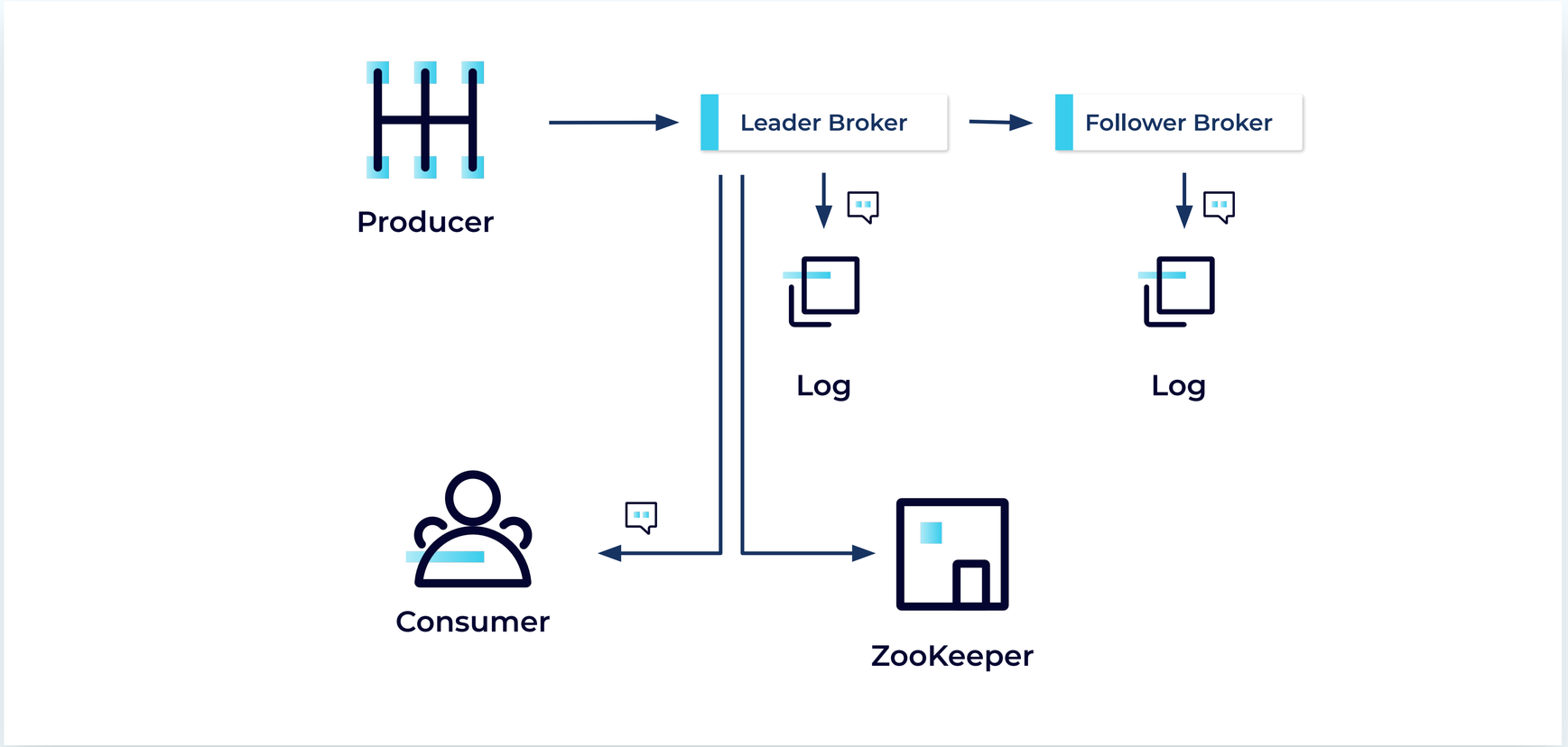

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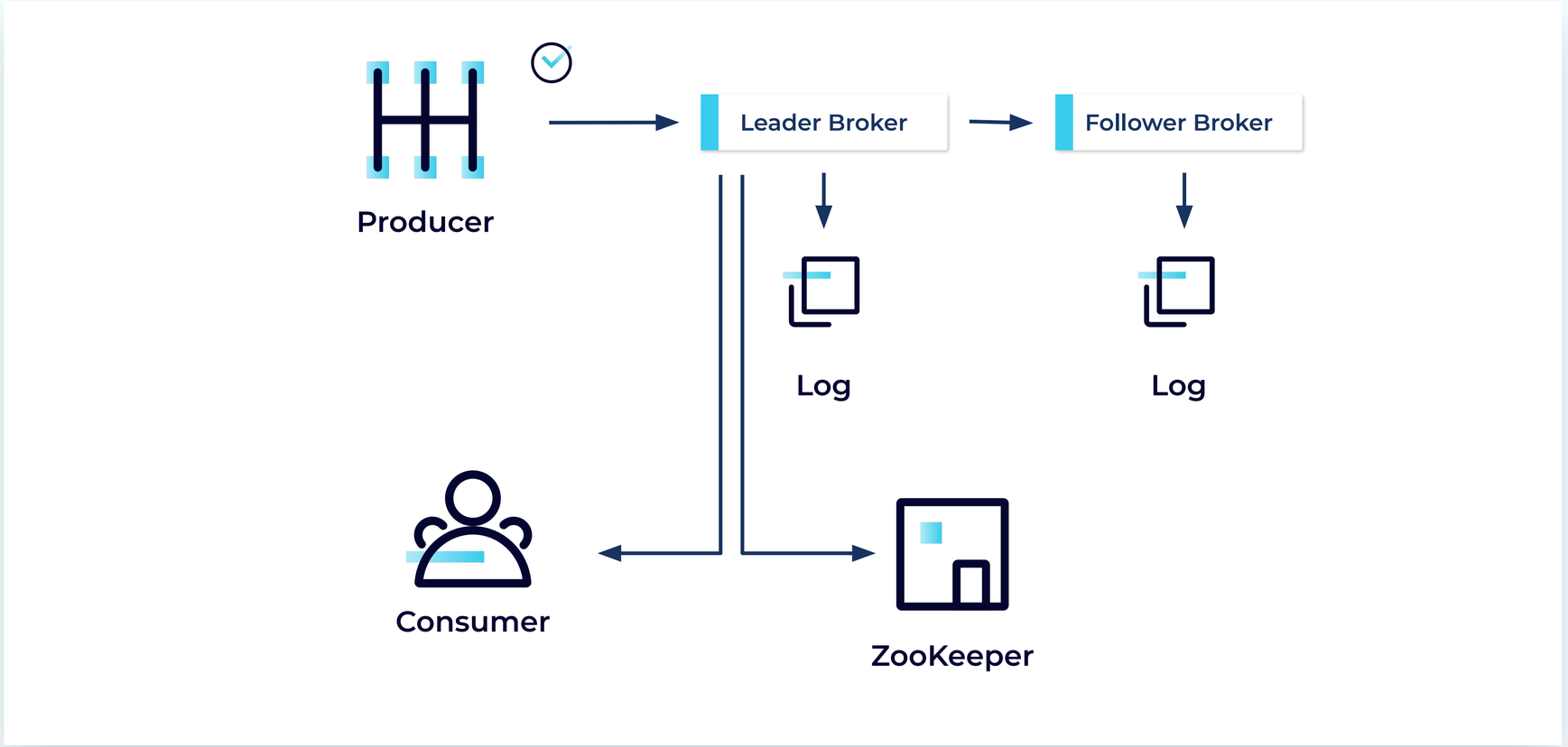

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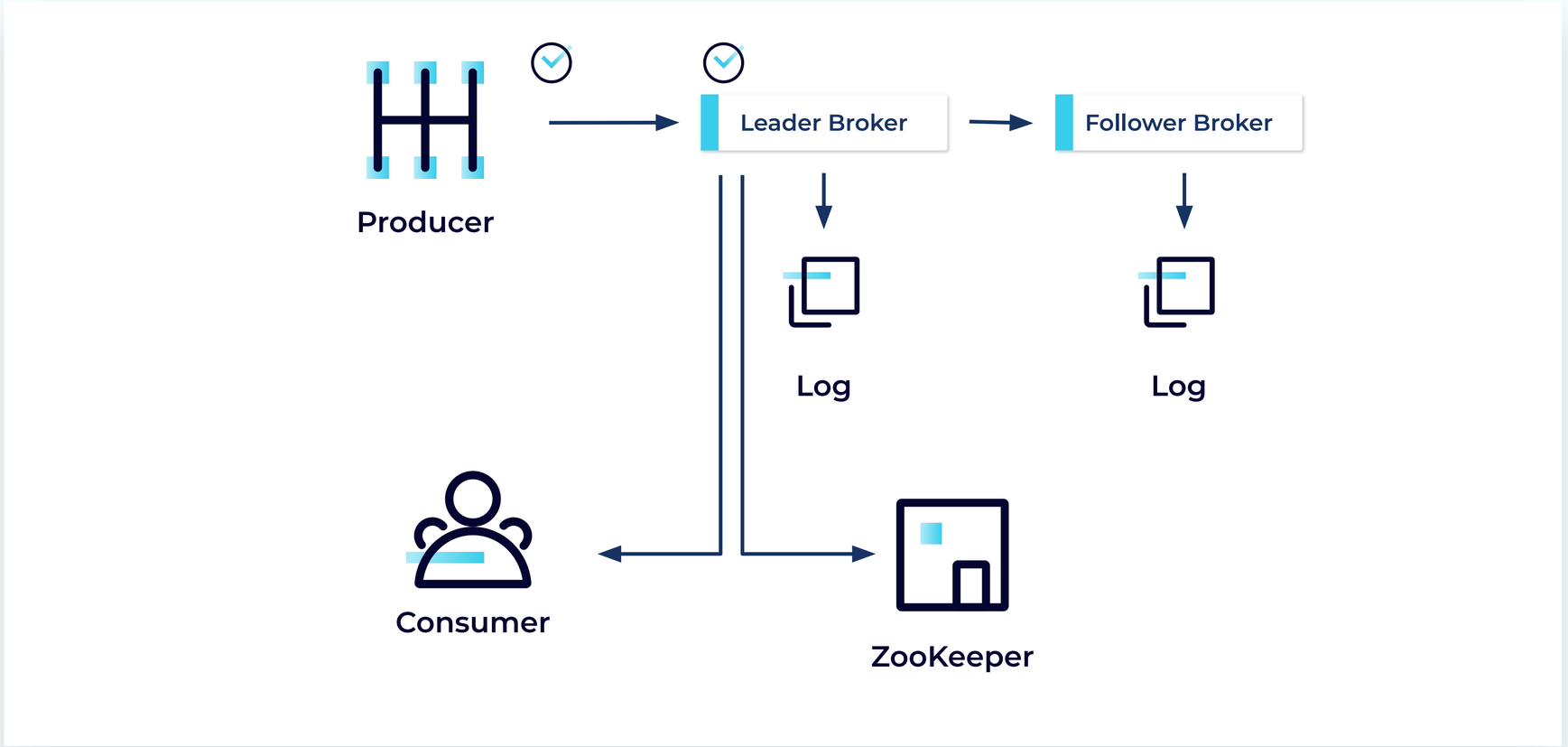

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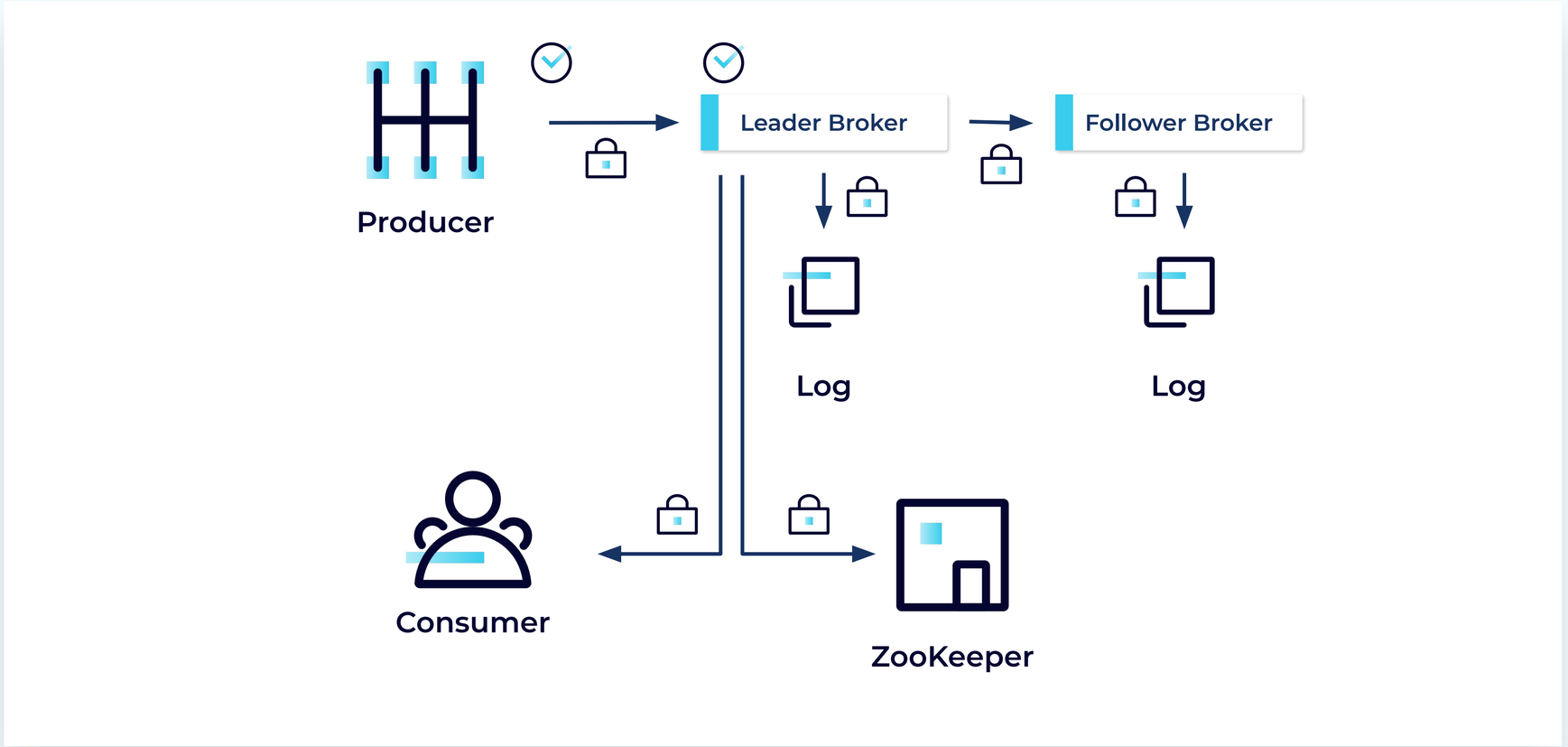

Data Flow in Kafka

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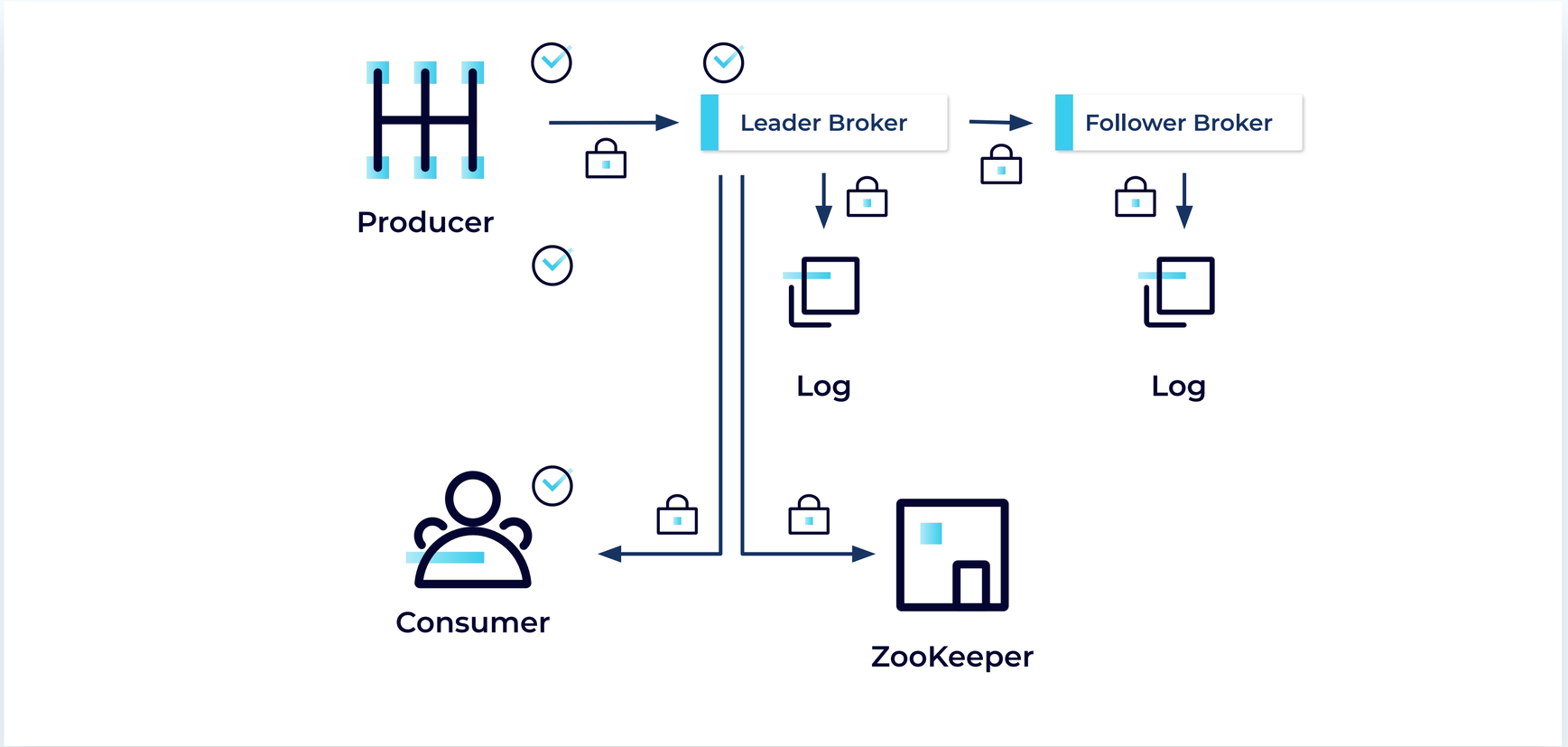

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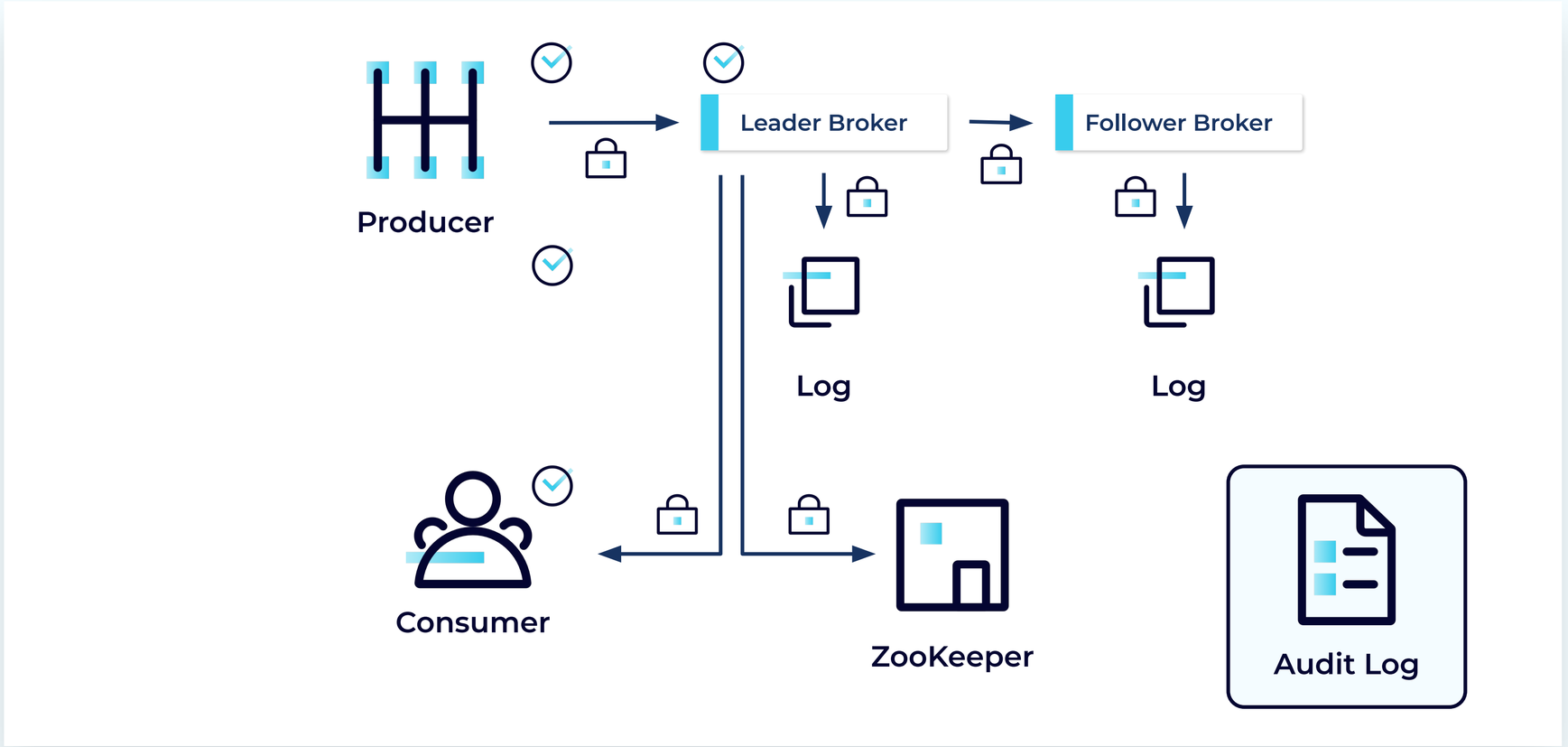

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Kafka Authentication Basics

Data Flow in Kafka

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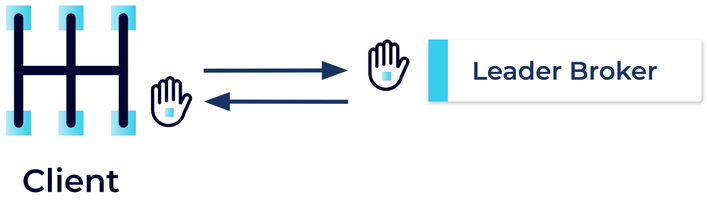

Data Flow in Kafka

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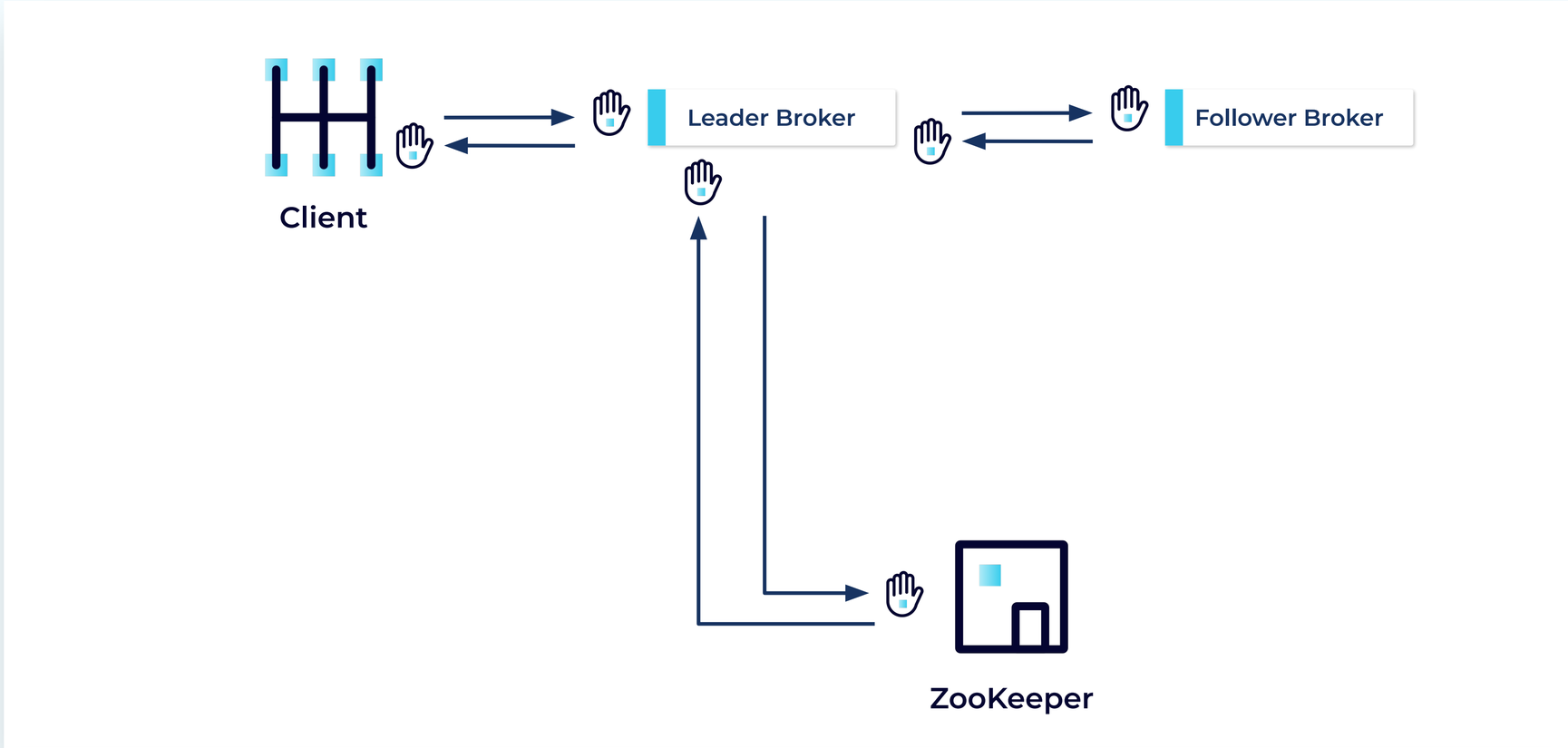

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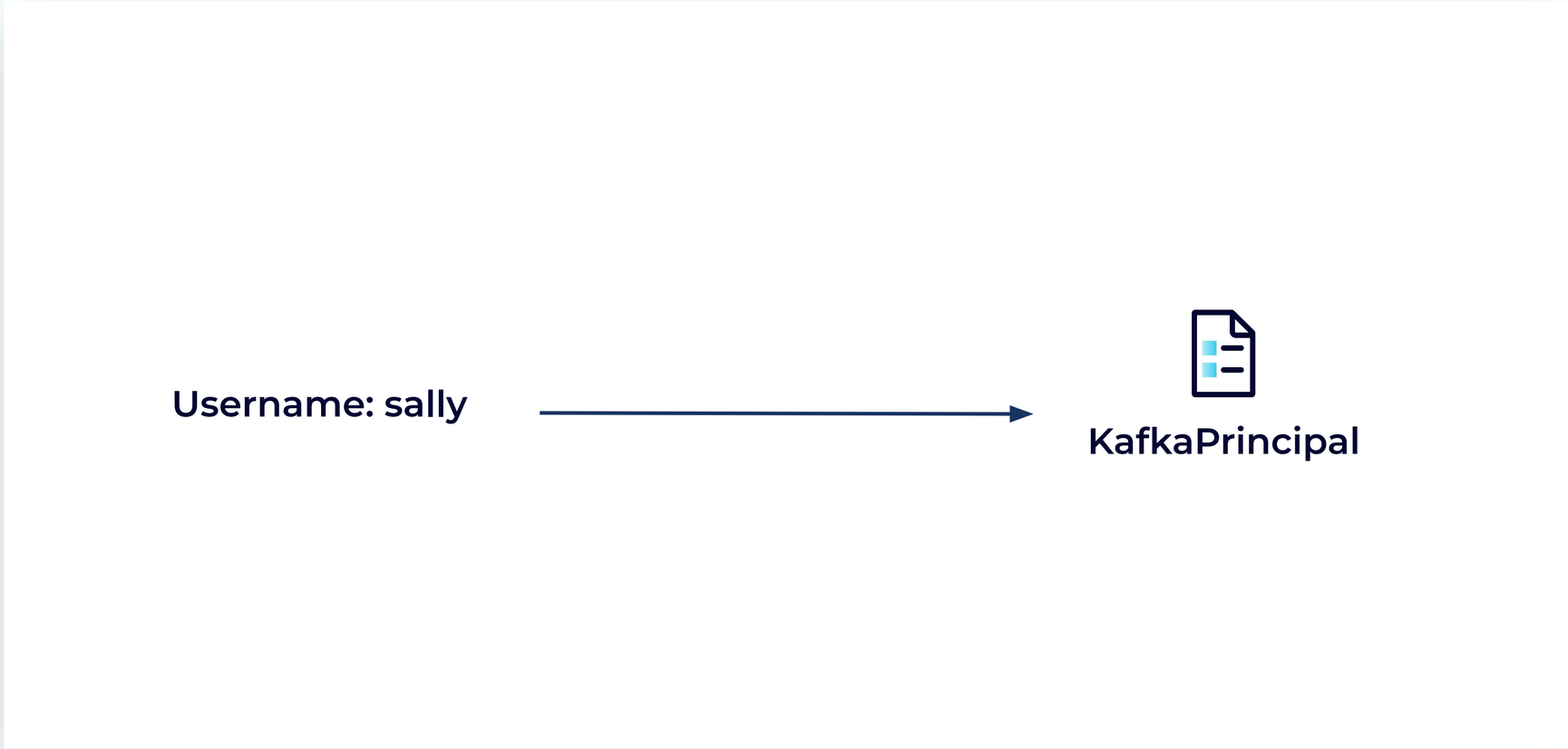

Interaction Types

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Clients

- Users
- Applications
- Services

Brokers

- Broker-to-Broker communication

Listeners and Security Protocols

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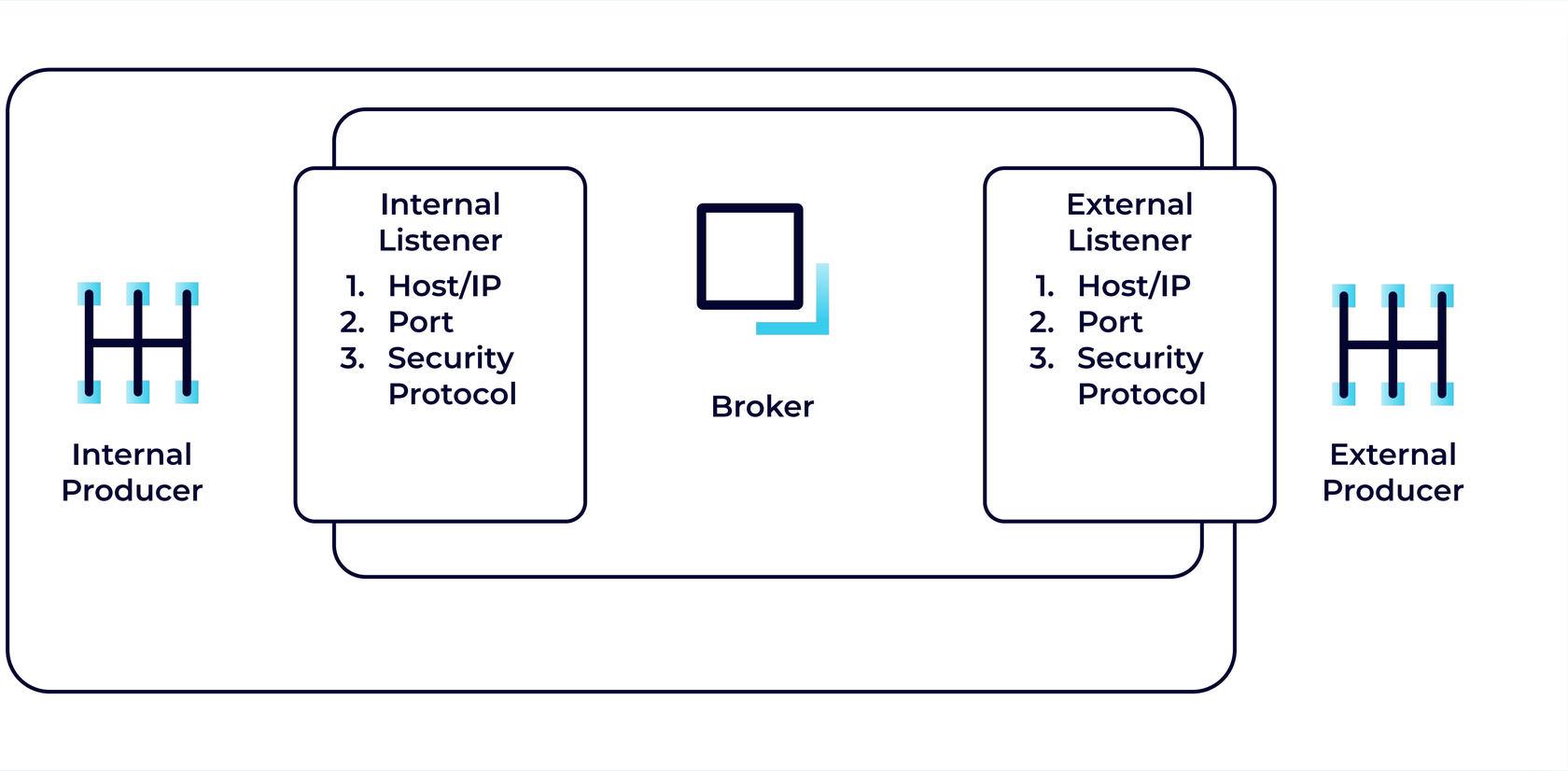

Securing Kafka

Security Protocols

- PLAINTEXT - not secure
- SASL_PLAINTEXT - not secure
- SSL - secure
- SASL_SSL - secure

Listeners and Security Protocols

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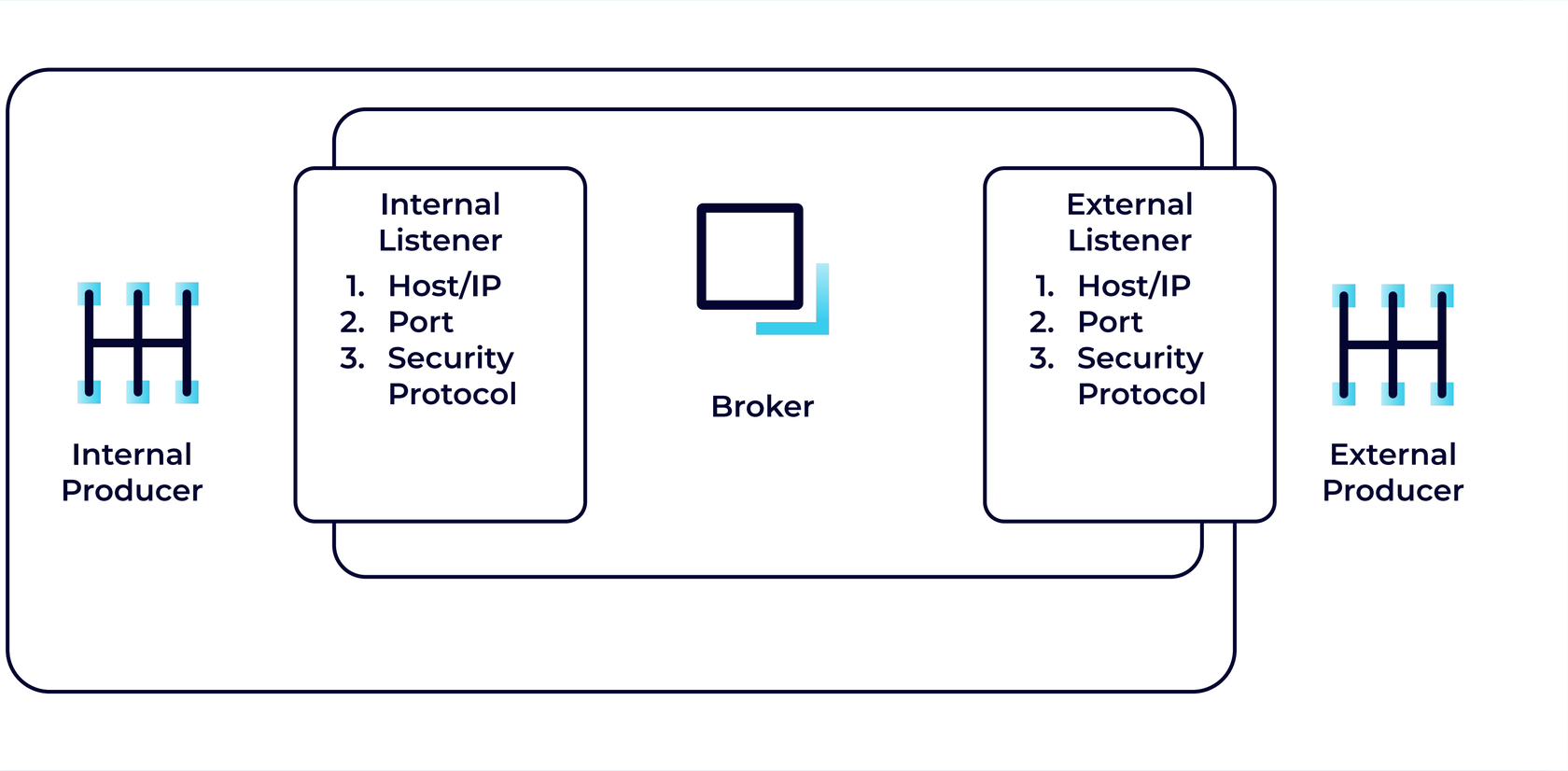

Configuring listeners on the broker

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Broker configuration

listeners=EXTERNAL://:9092,INTERNAL://10.0.0.2:9093,BROKER://10.0.0.2:9094
advertised.listeners=EXTERNAL://broker1.example.com:9092,INTERNAL://
broker1.local:9093,BROKER://broker1.local:9094

listener.security.protocol.map=EXTERNAL:SASL_SSL,INTERNAL:SSL,BROKER:SSL

inter.broker.listener.name=BROKER

Configuring the client

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Client configuration

security.protocol=SASL_SSL

bootstrap.servers=broker1.example.com:9092,broker2.example.com:9092

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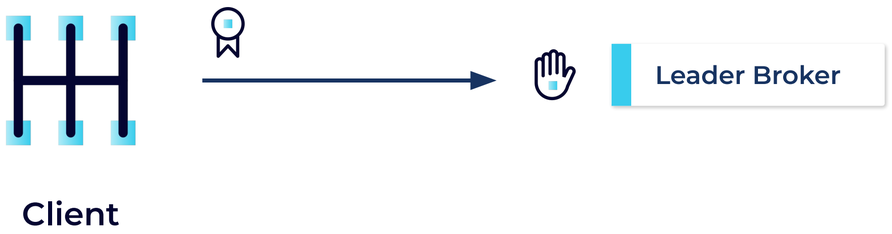
Kafka Authentication with SSL and SASL_SSL

SSL



SSL

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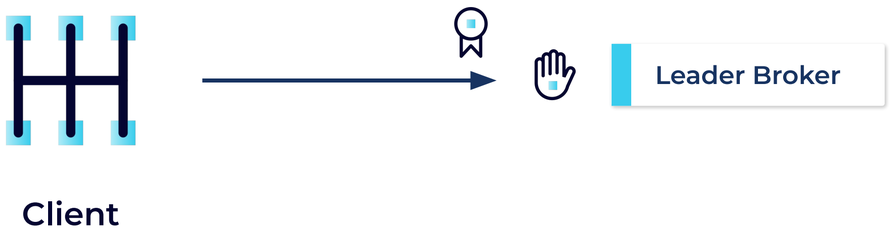

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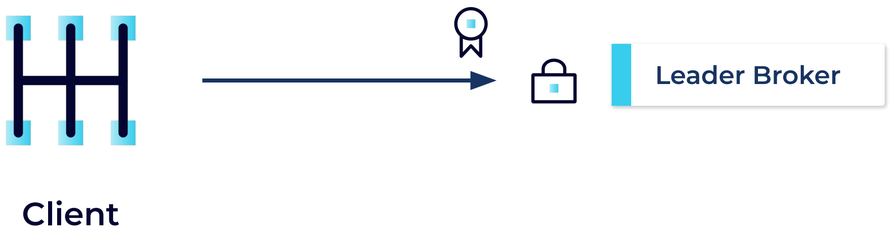

SSL

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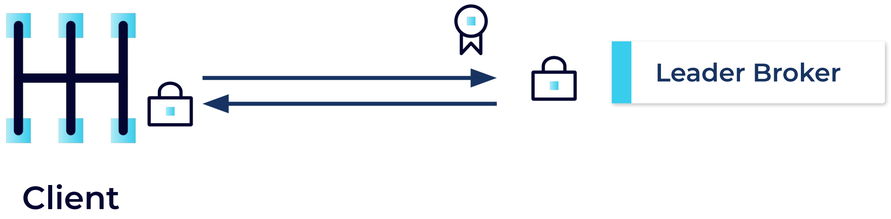
Broker configuration

ssl.client.auth=required



Inter-broker Authentication

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inter.broker.listener.name

security.inter.broker.protocol

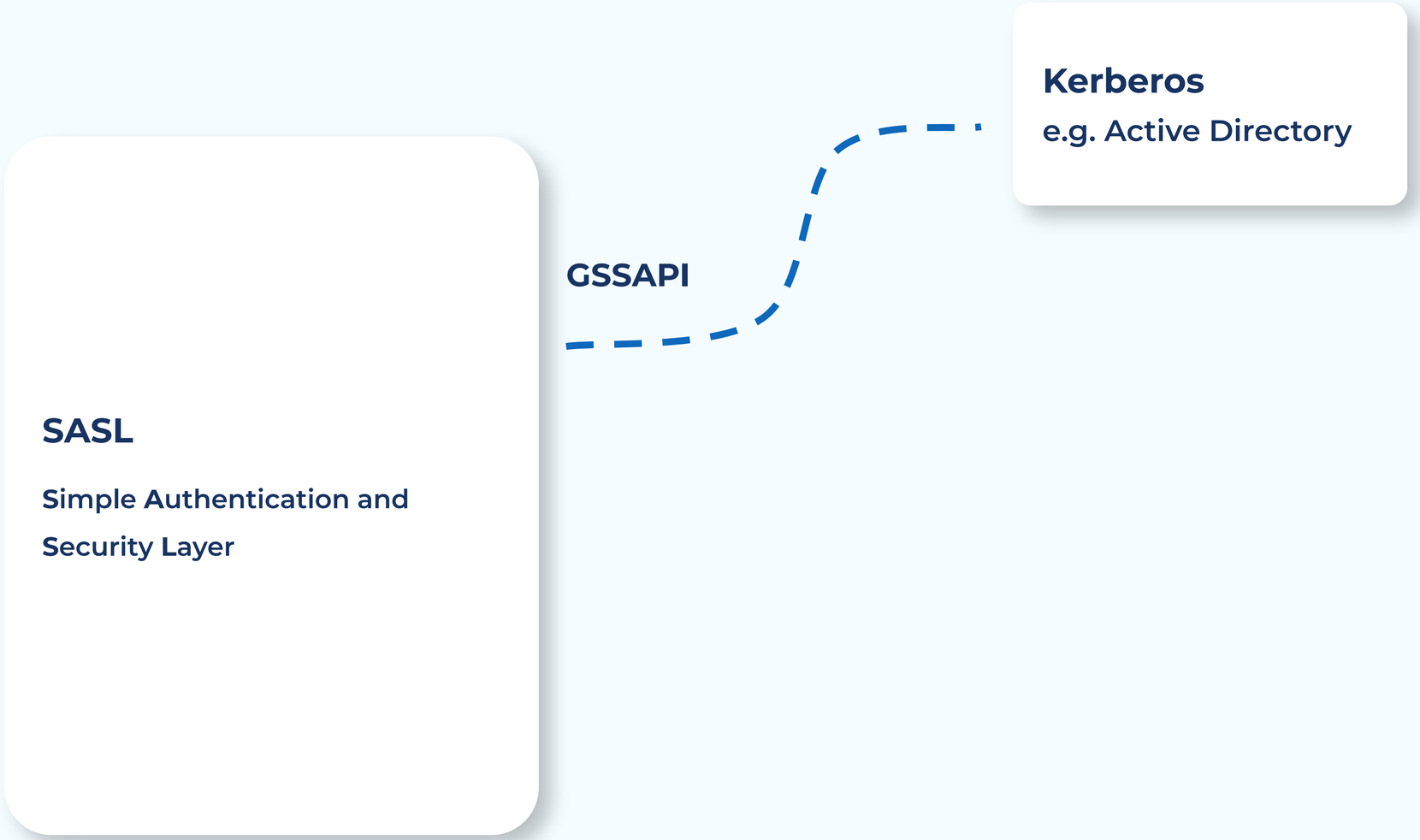
SASL_SSL

SASL

Simple Authentication and Security Layer

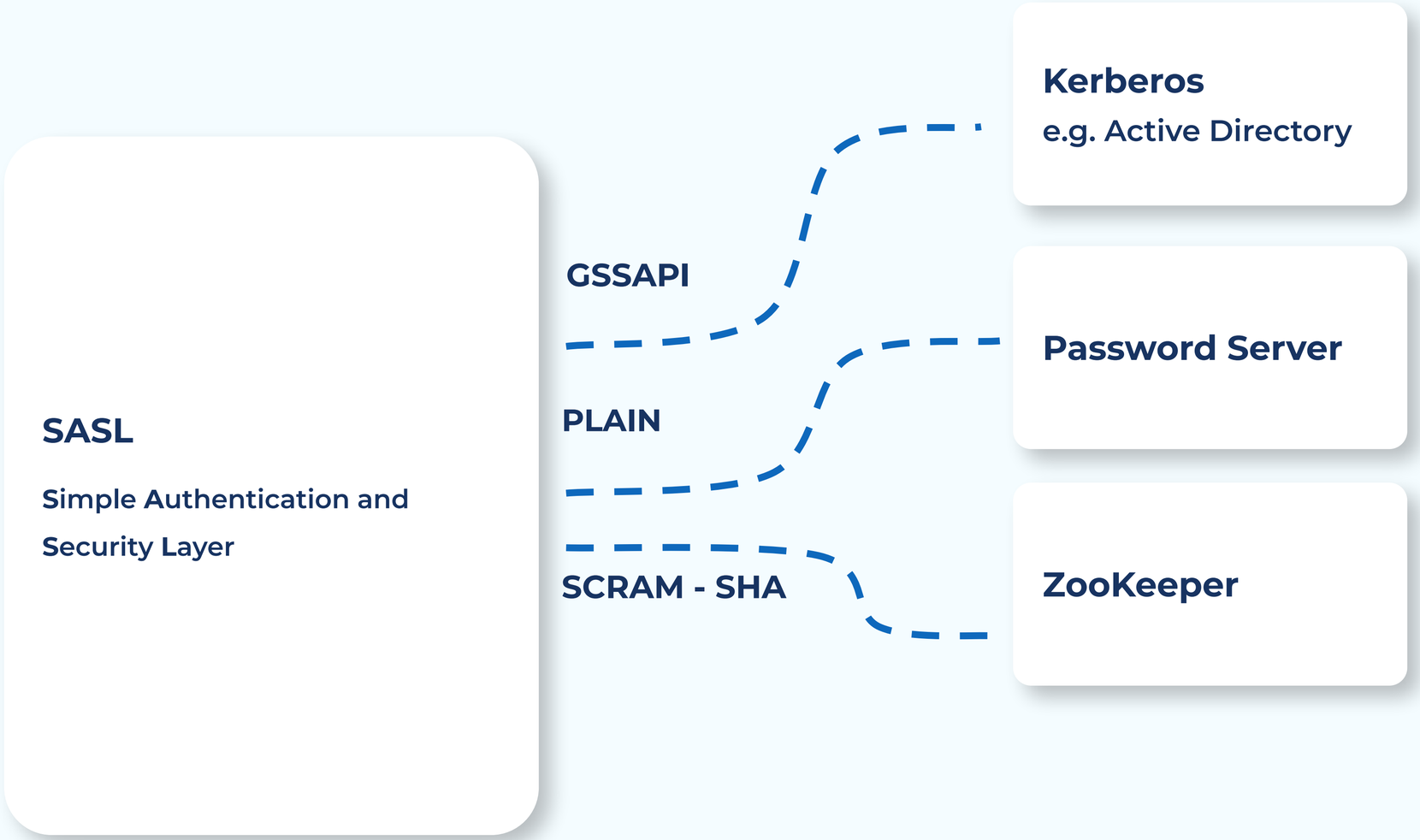
SASL_SSL

CONFLUENT Developer



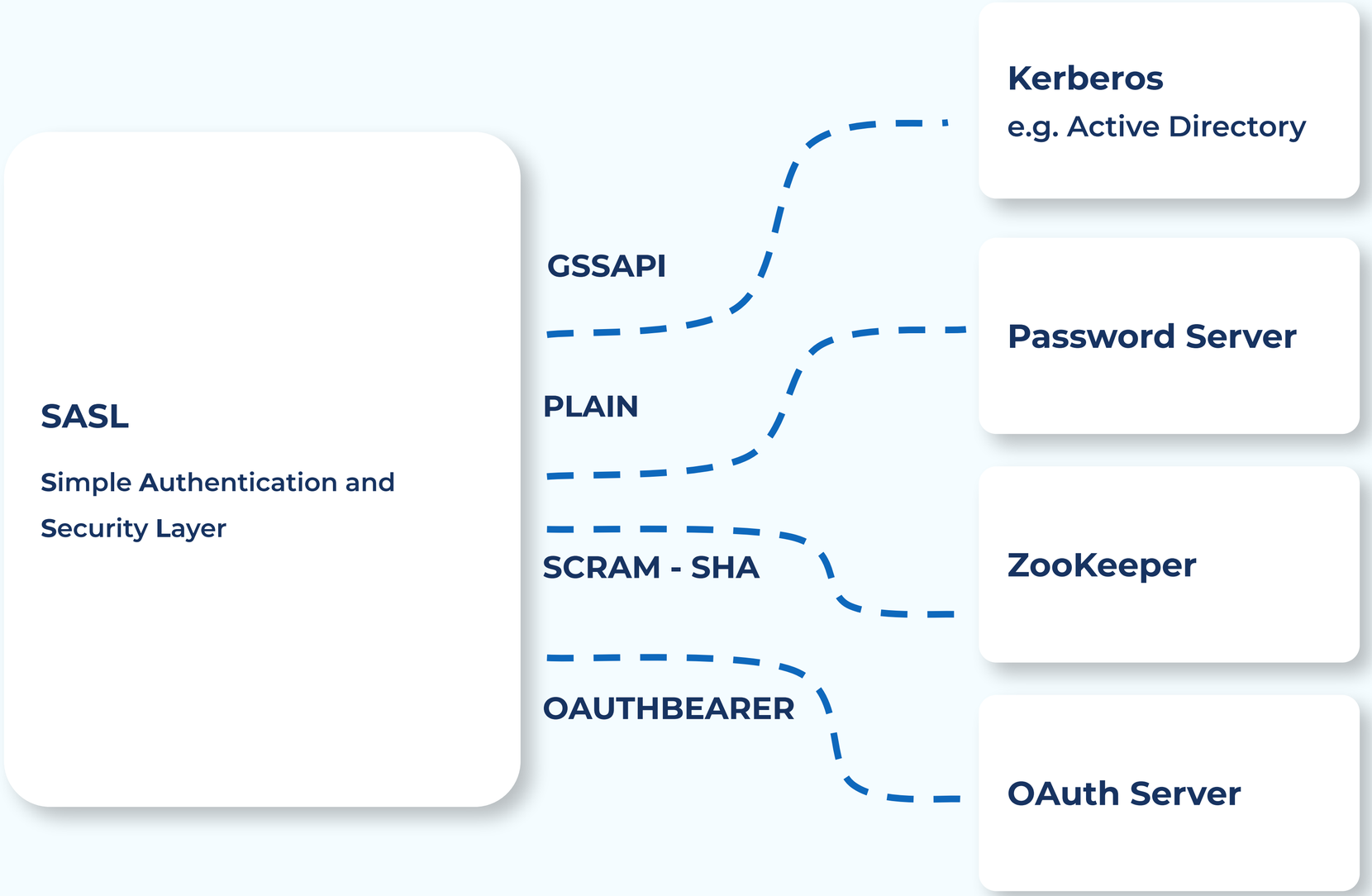
SASL_SSL

CONFLUENT Developer



SASL_SSL

CONFLUENT Developer



Considerations

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- Use filesystem permissions to restrict access to files containing security information

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- Avoid storing passwords in plaintext anywhere on the system
- Use disk encryption or a secure credential store
- Use quotas to limit the impact of malicious client behaviours
- Apply change control to configuration

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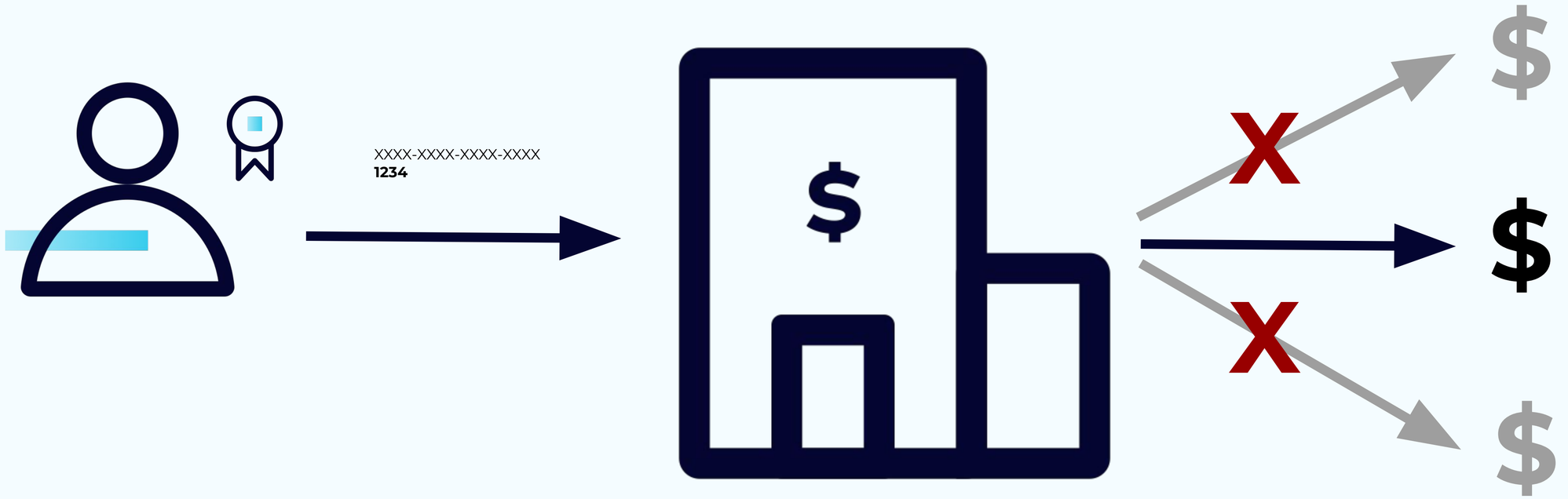
Authorization


XXXX-XXXX-XXXX-XXXX
1234
$
X
$
X
$
$

Access control lists (ACLs)

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Access control lists (ACLs)

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Pattern type: Literal or Prefixed
Resource name: Supports *
Principal: Supports User:*
Host: Source IP or *

Creating ACLs


```
kafka-acls --bootstrap-server localhost:9092 \
  --command-config adminclient-configs.conf  \
  --add \
  --allow-principal User:alice \
  --allow-principal User:fred \
  --operation read
  --operation write \
  --topic finance
```

Real-world principal names

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SSL certificate subject name

User:CN=tracking.example.org,OU=TEST,O=Sales,L=PaloAlto,ST=Ca,C=US

Kerberos

User:tracking

SSL subject names to principals

ssl.principal.mapping.rules

Kerberos identities to preferred principal format

sasl.kerberos.principal.to.local.rules

ACLs

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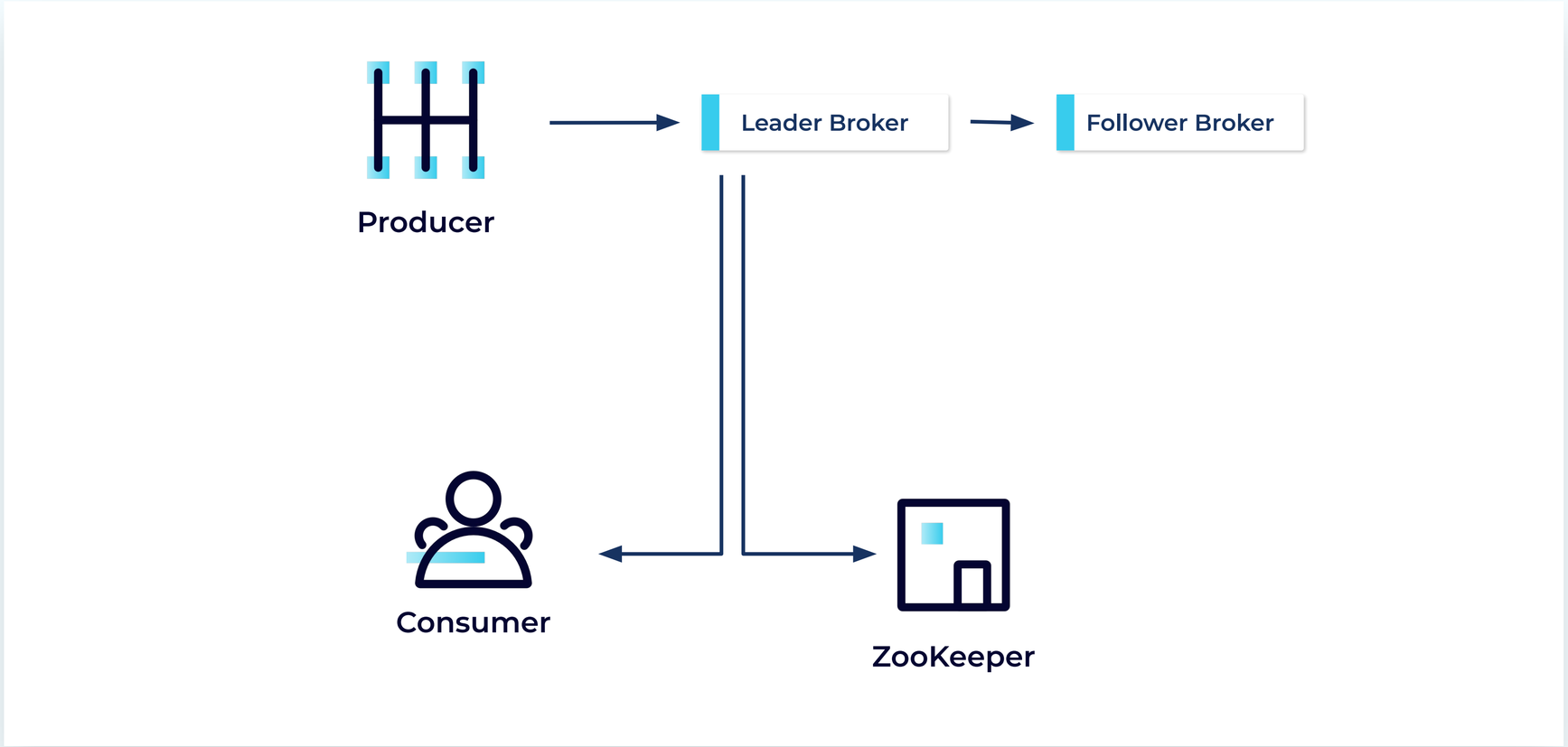
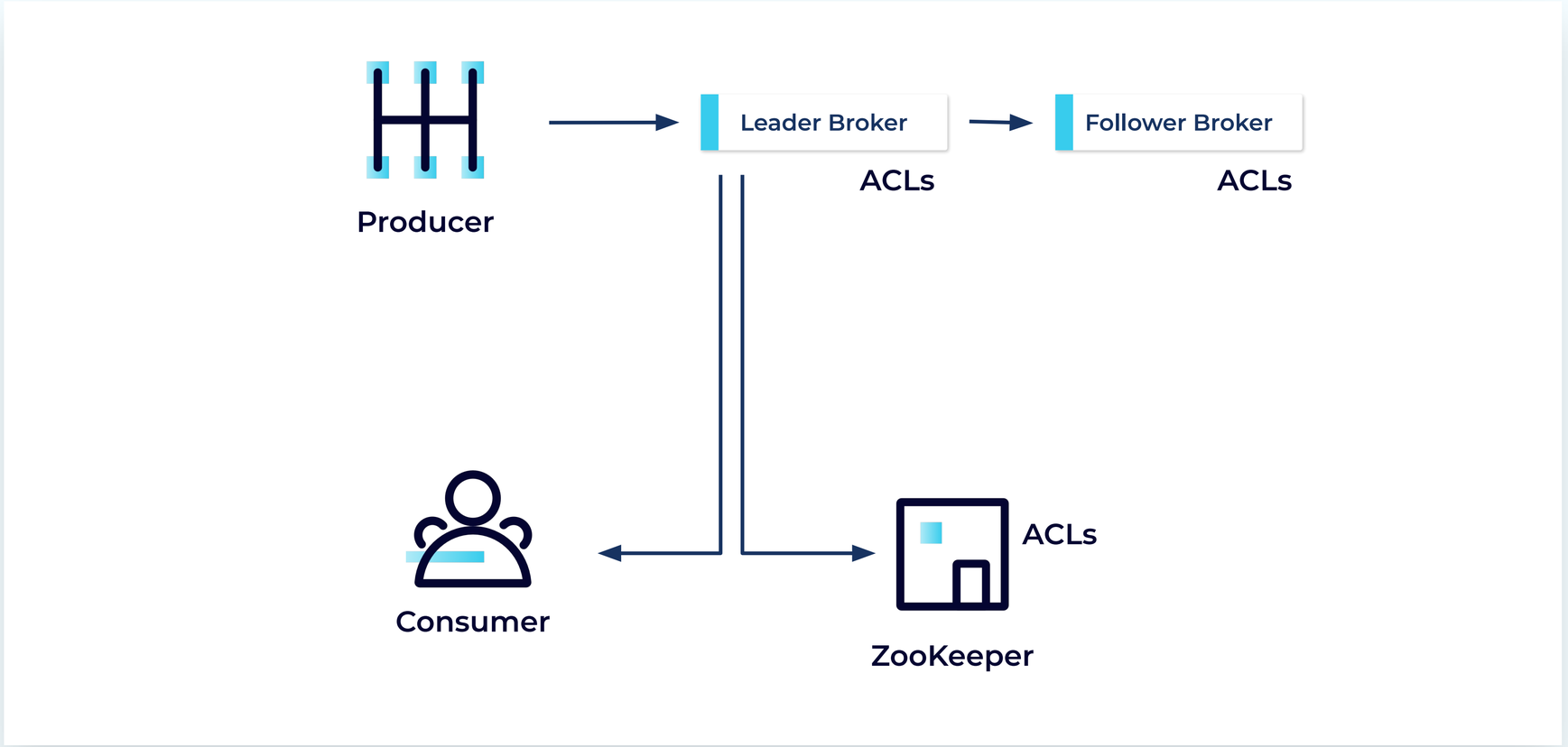


ACLs

CONFLUENT Developer



How Kafka applies ACLs

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Broker configuration (with ZooKeeper)

authorizer.class.name=kafka.security.authorizer.AclAuthorizer

How Kafka applies ACLs

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KRaft (no ZooKeeper)

Uses StandardAuthorizer by default

ACLs stored in __cluster_metadata topic

How Kafka applies ACLs

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Deny > Allow

Customizing access control

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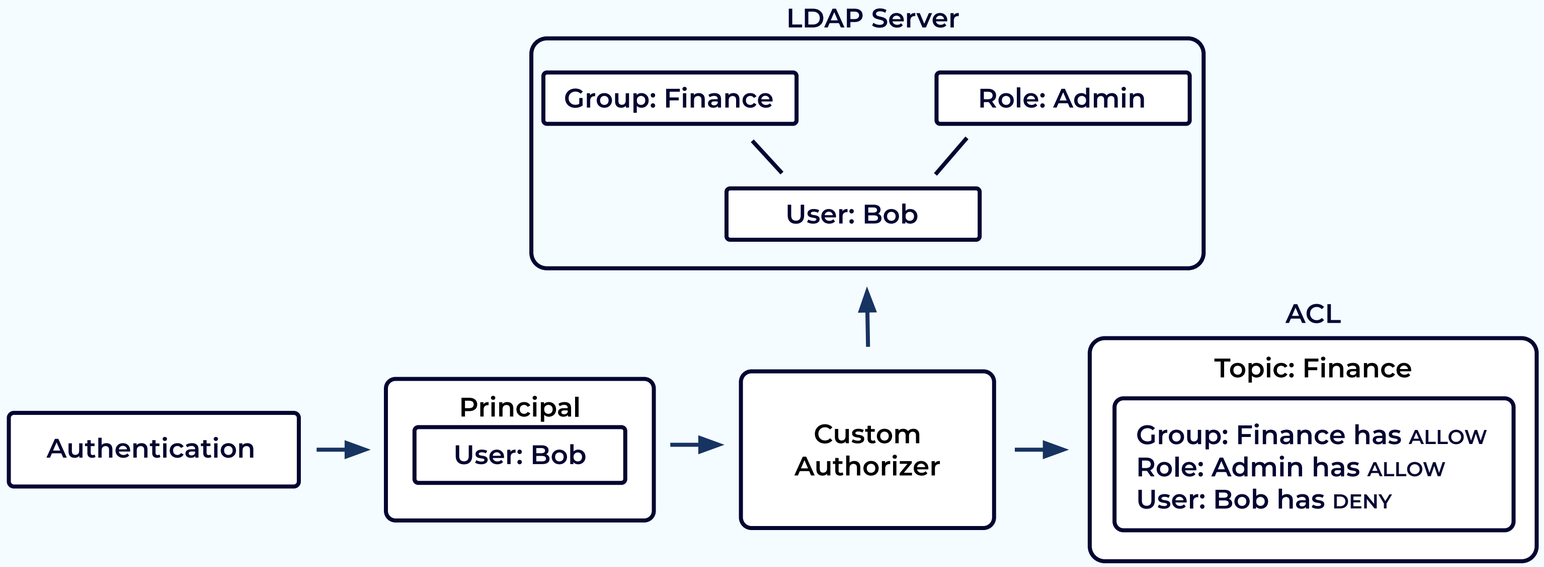
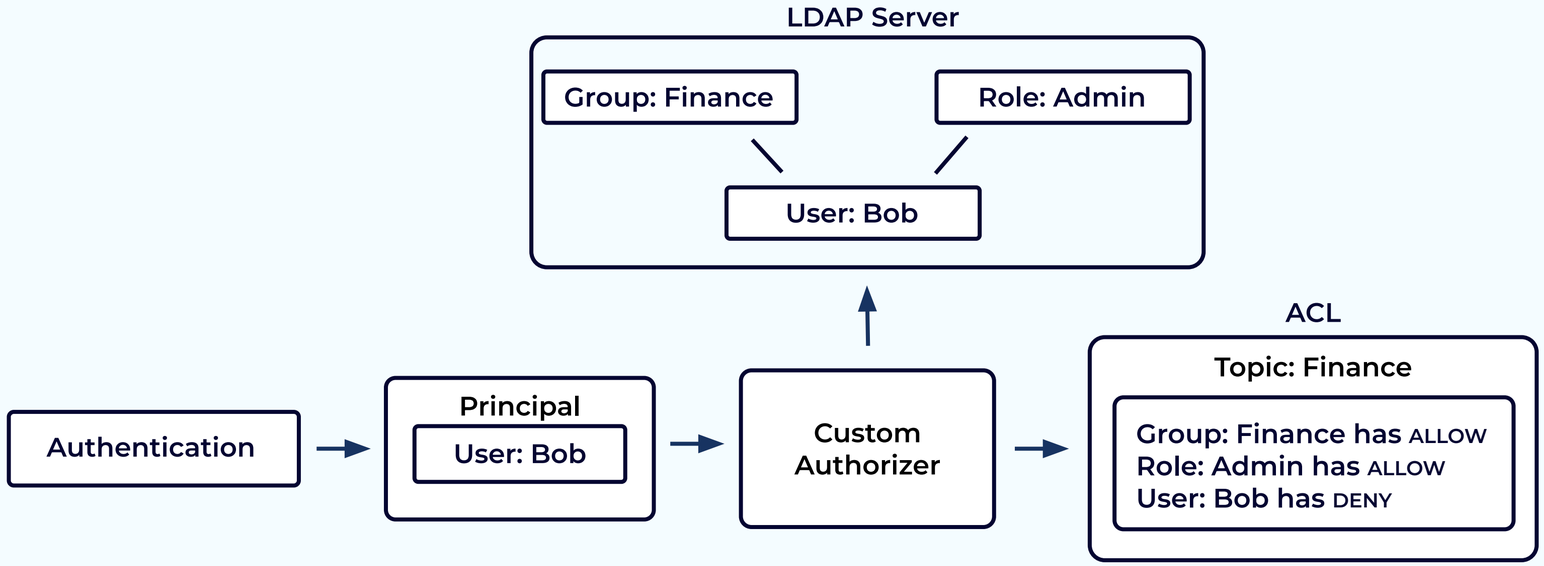


Customizing access control

CONFLUENT Developer

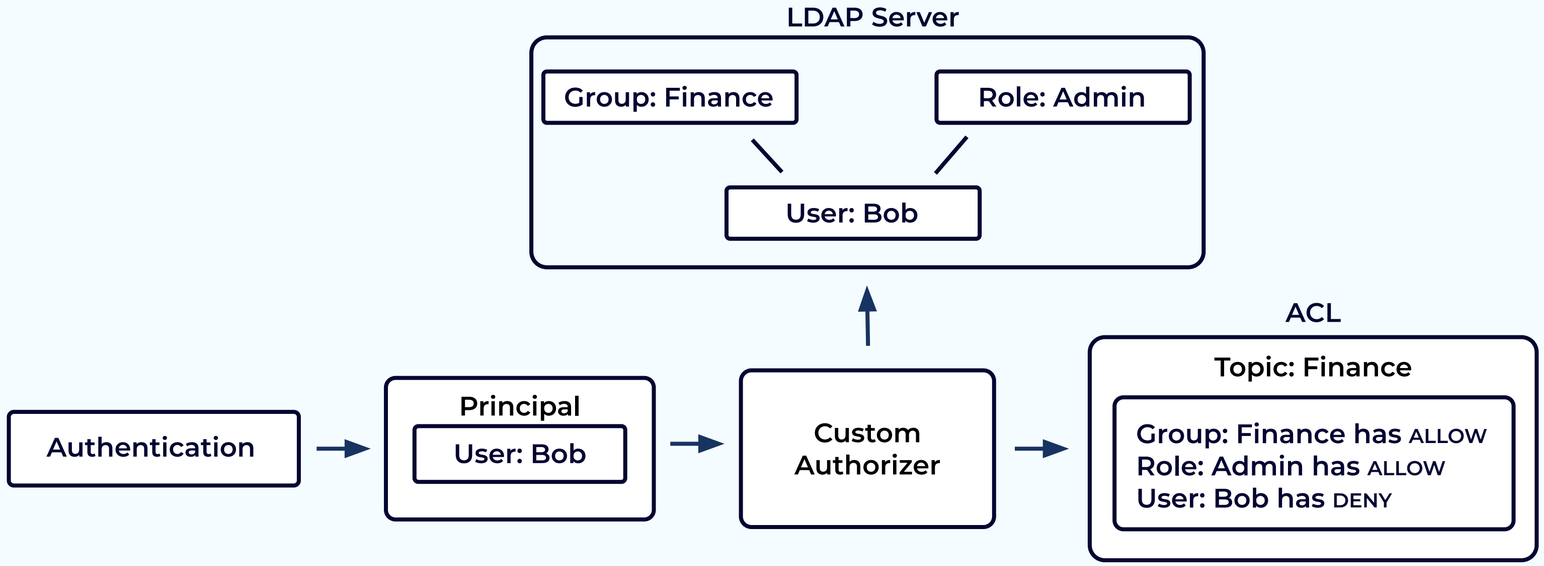
- Store user, group and role associations in e.g. an external LDAP server



Customizing access control

CONFLUENT Developer

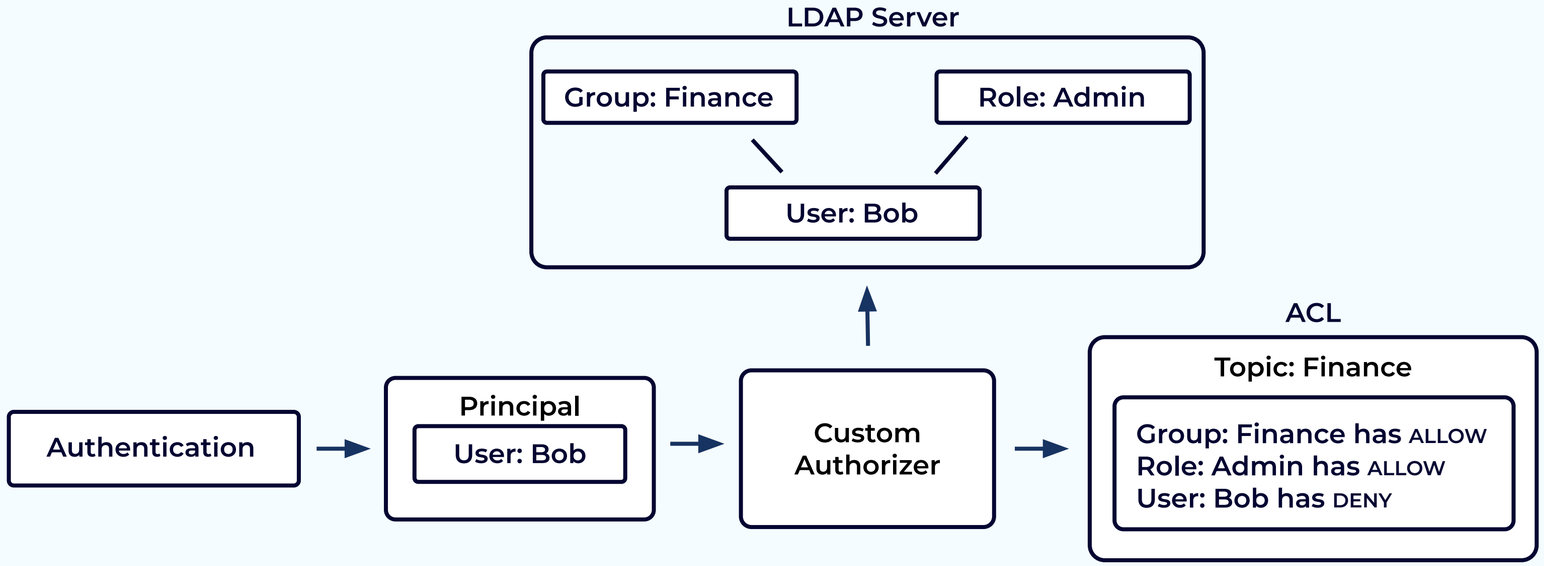
- Store user, group and role associations in e.g. an external LDAP server
- Add user, group and role permissions to the ACLs stored in ZooKeeper



Customizing access control

CONFLUENT Developer

- Store user, group and role associations in e.g. an external LDAP server
- Add user, group and role permissions to the ACLs stored in ZooKeeper
- Implement custom Authorizer that fetches a user's groups and roles from LDAP, and resolves against a resource's ACLs.



Considerations

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- Automate the process of creating user credentials and assigning ACLs for all environments
- Adjust connections.max.reauth.ms to force connection to reauthenticate at intervals
- Use Deny ACLs to prevent actions from compromised users

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Encryption

Encryption

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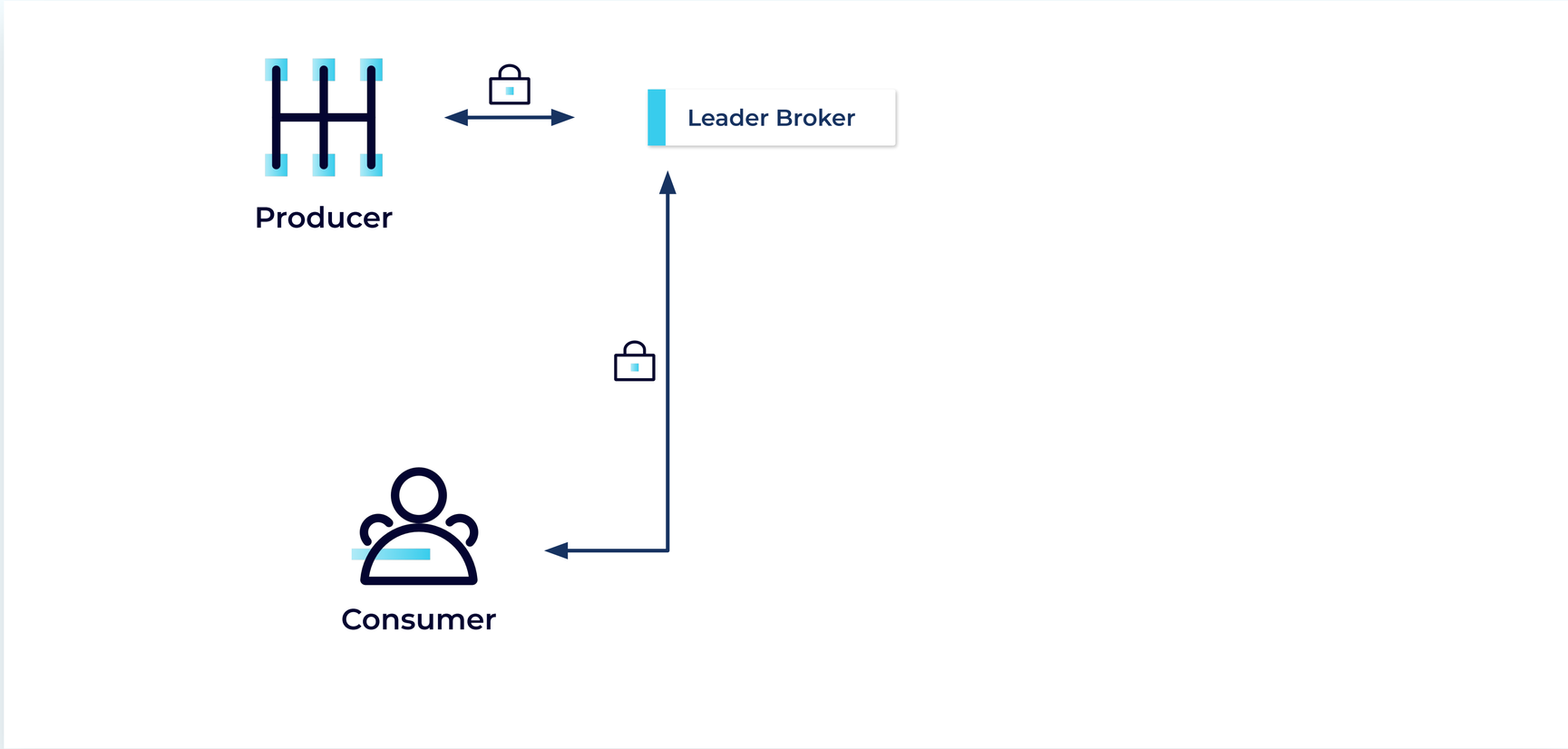

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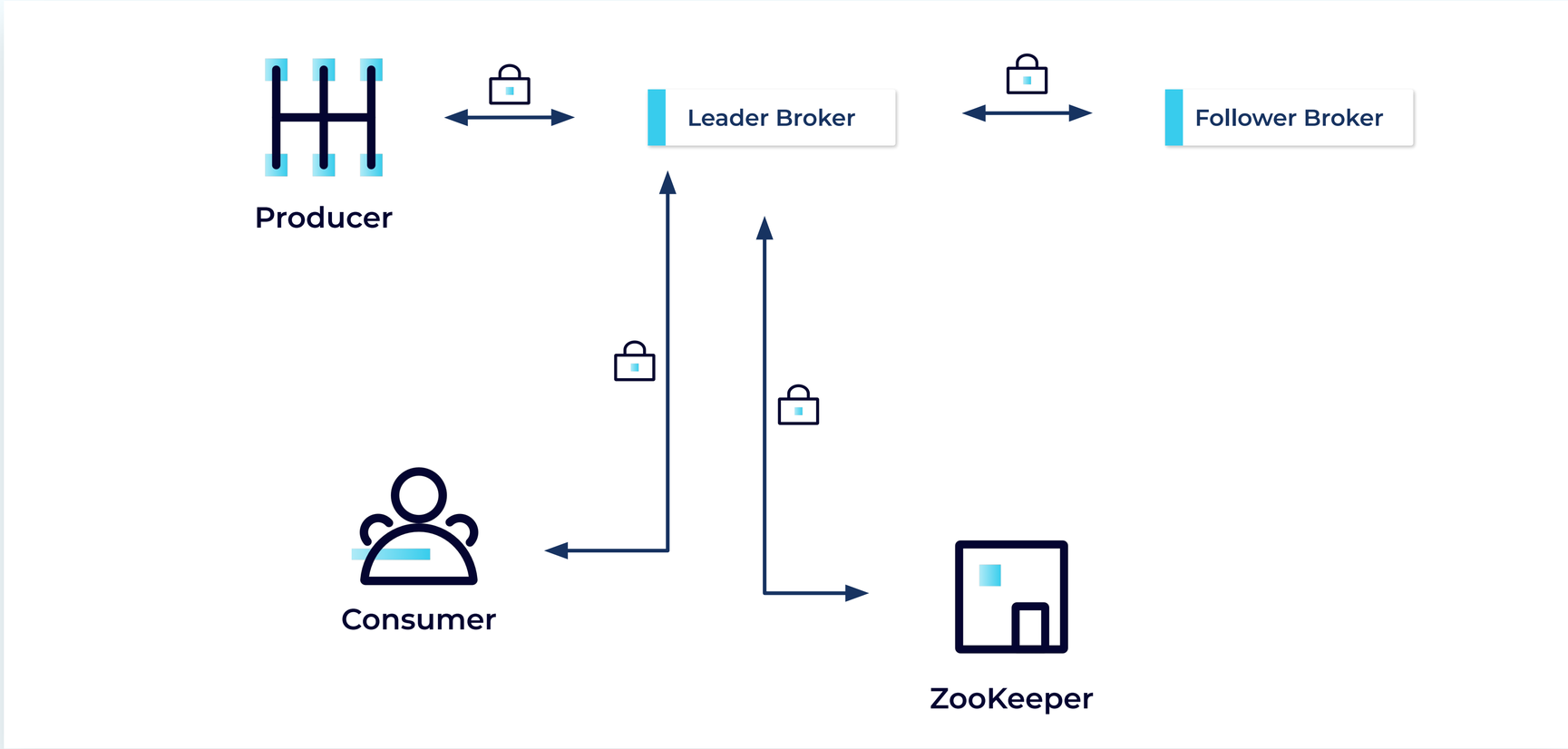

Encryption

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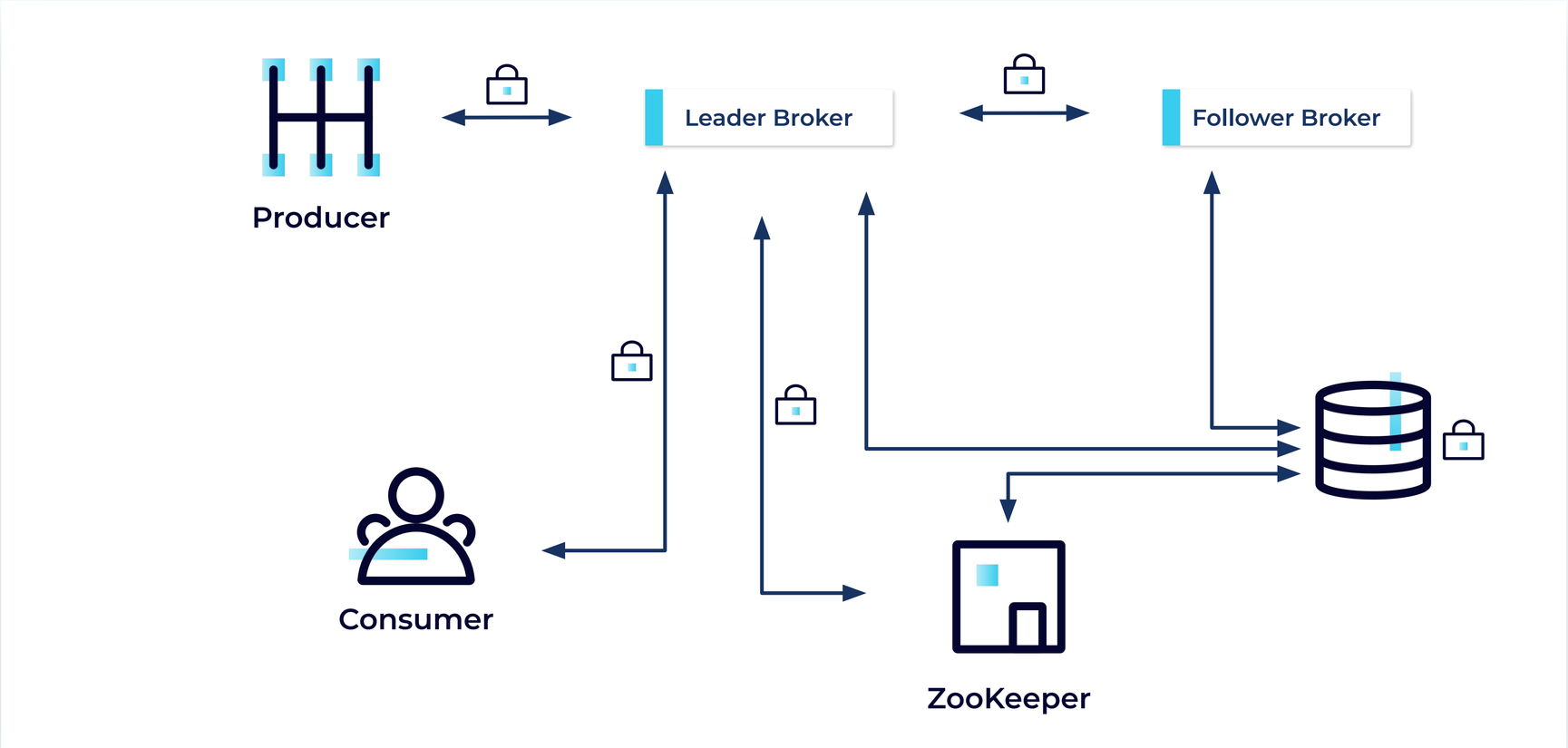

SSL

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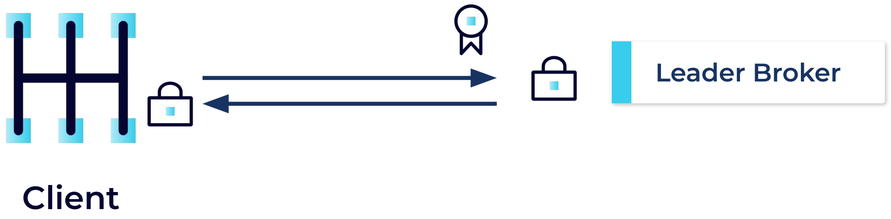
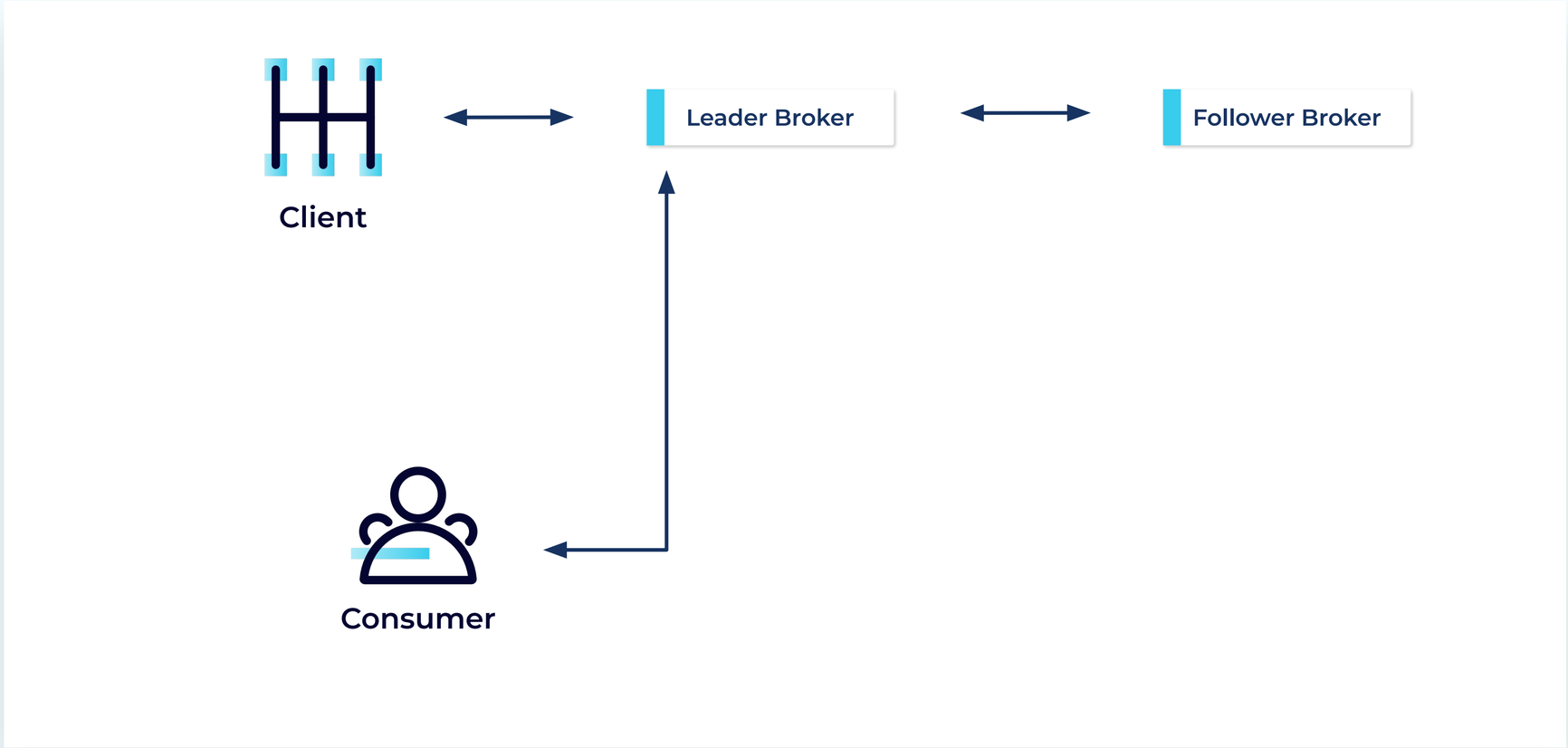
Broker configuration

ssl.client.auth=required



TLS



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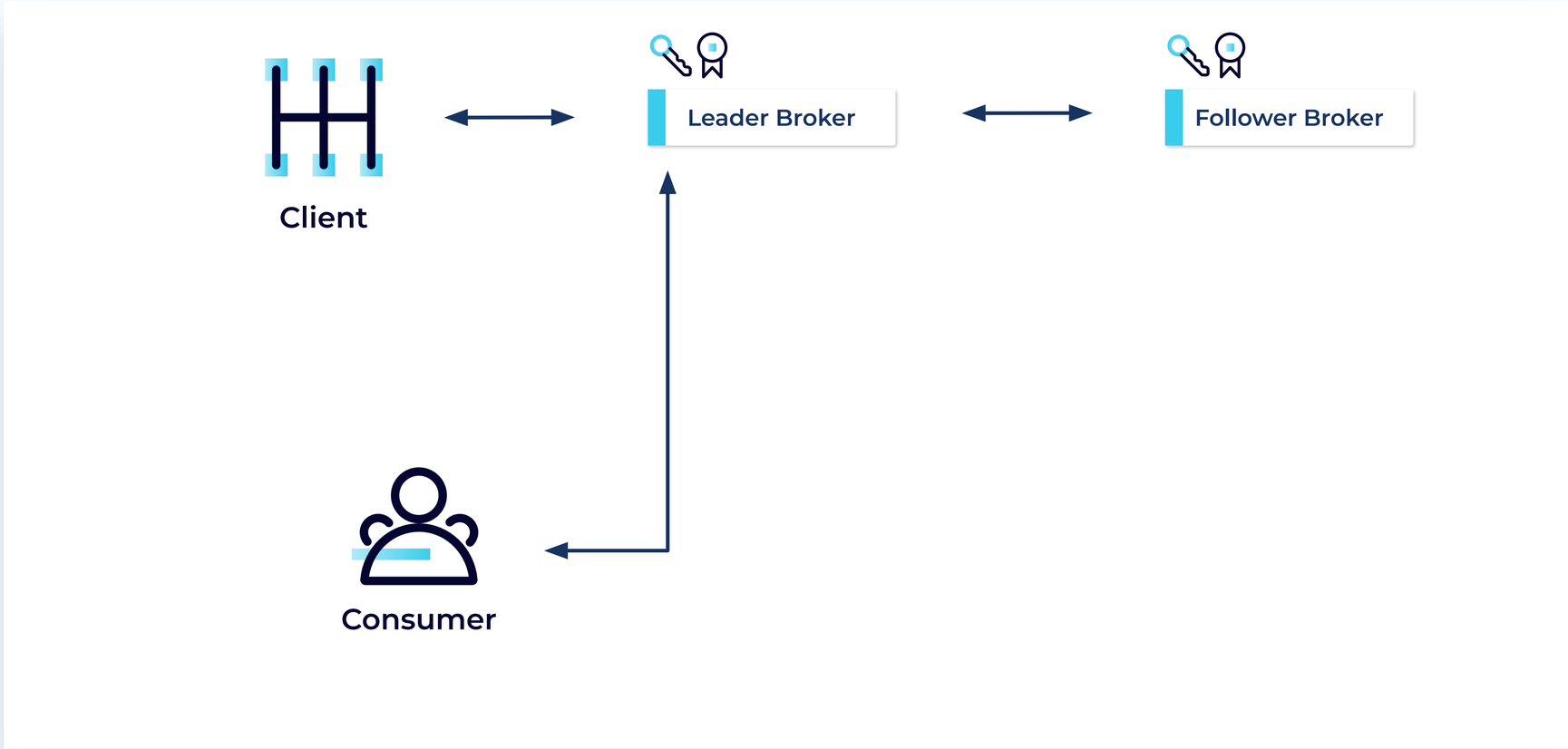

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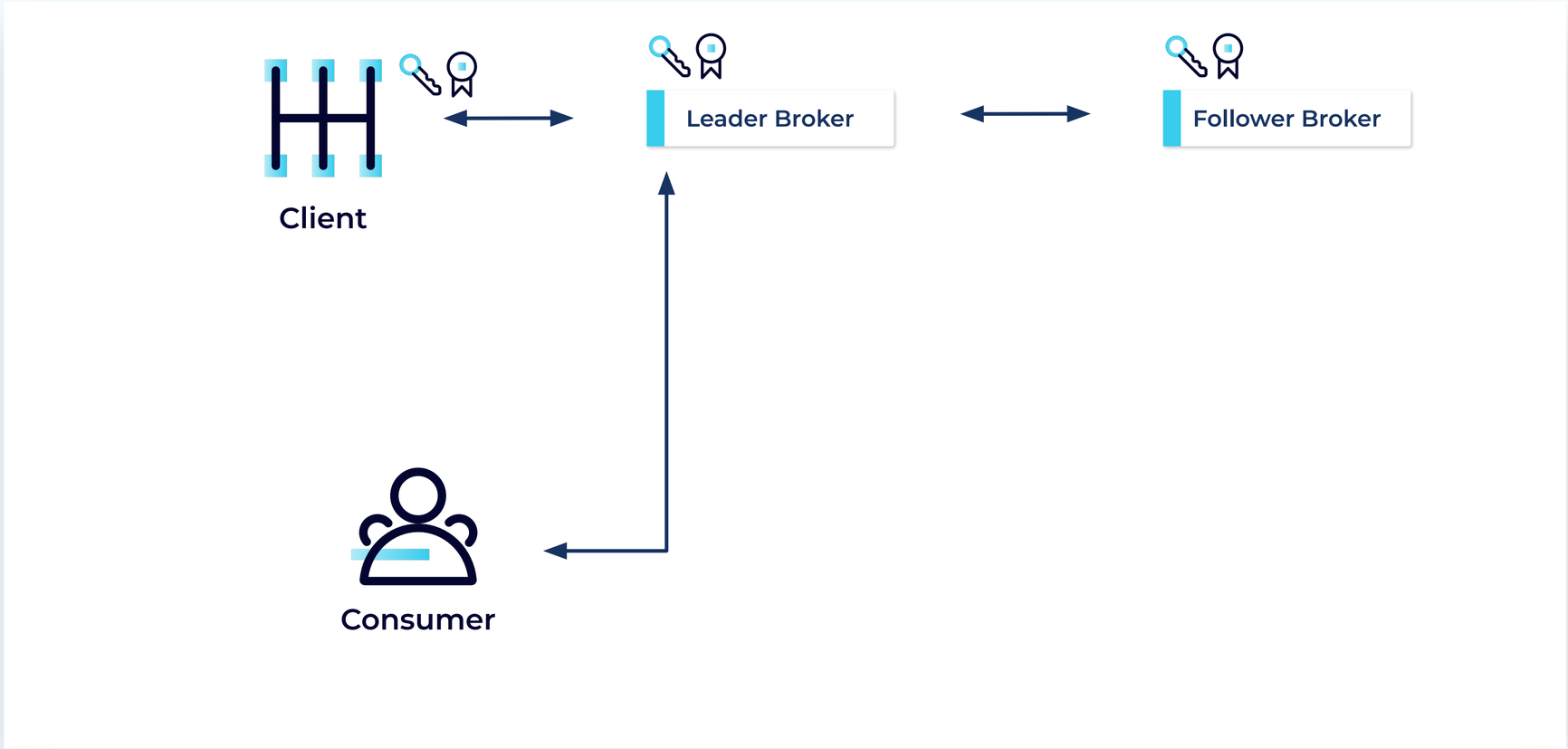

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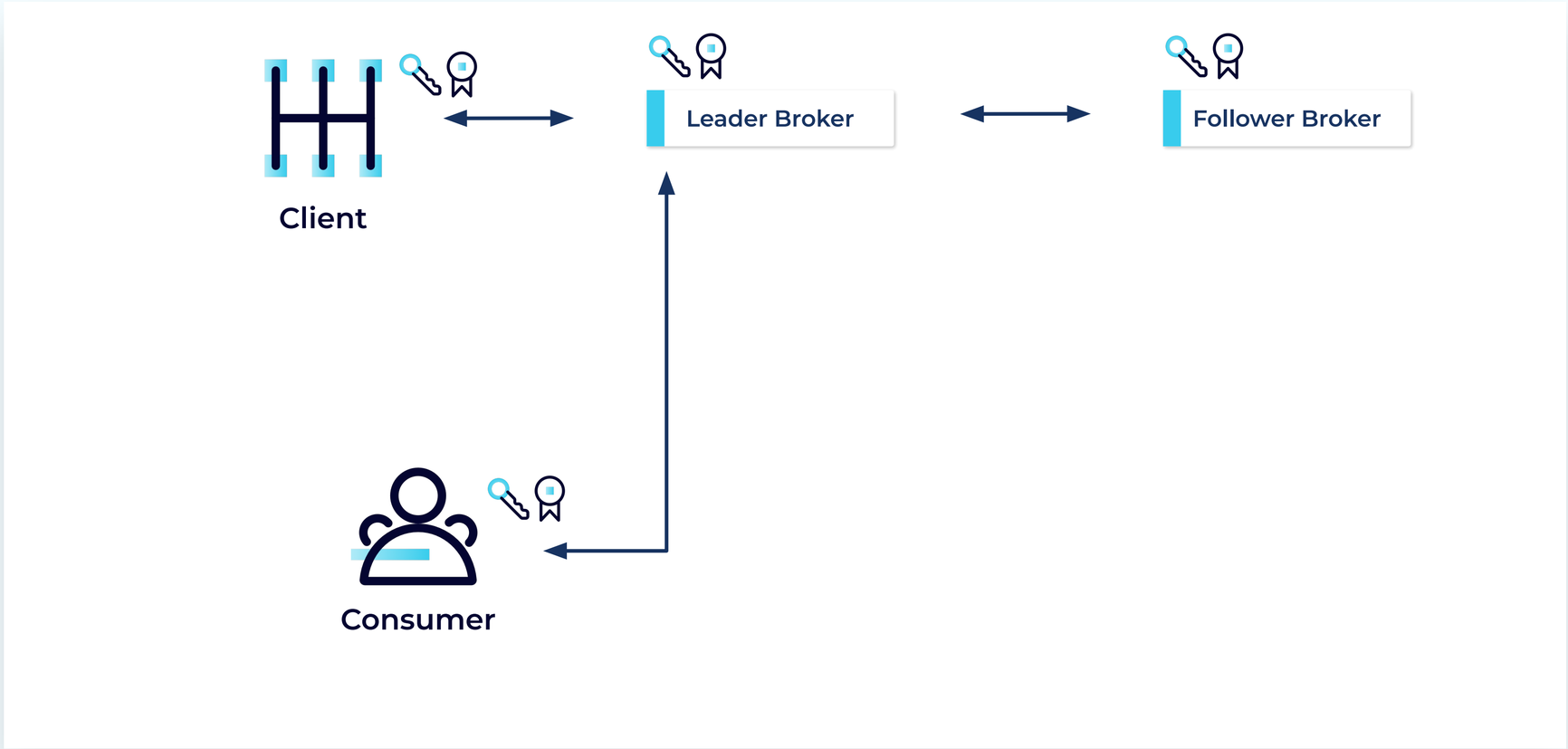


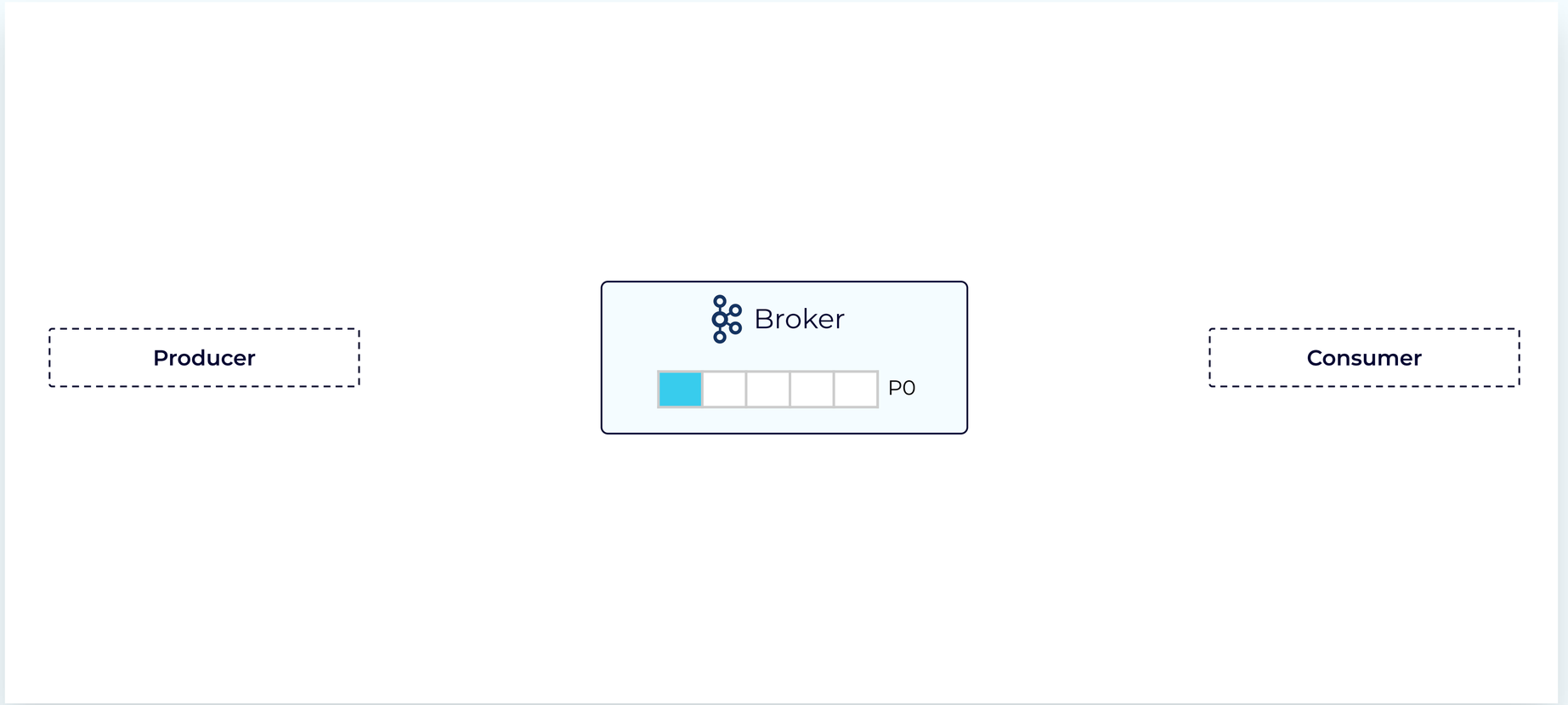
Inter-broker TLS Communication

security.inter.broker.protocol=SSL

Encrypting data at rest

- Whole disk or volume encryption
  - Filesystem ACLs to restrict access
- Platform capabilities
  - E.g. Encrypted AWS EBS volumes
- Appliances
  - E.g. Vormetric, Gemalto

End-to-End Encryption



End-to-End Encryption

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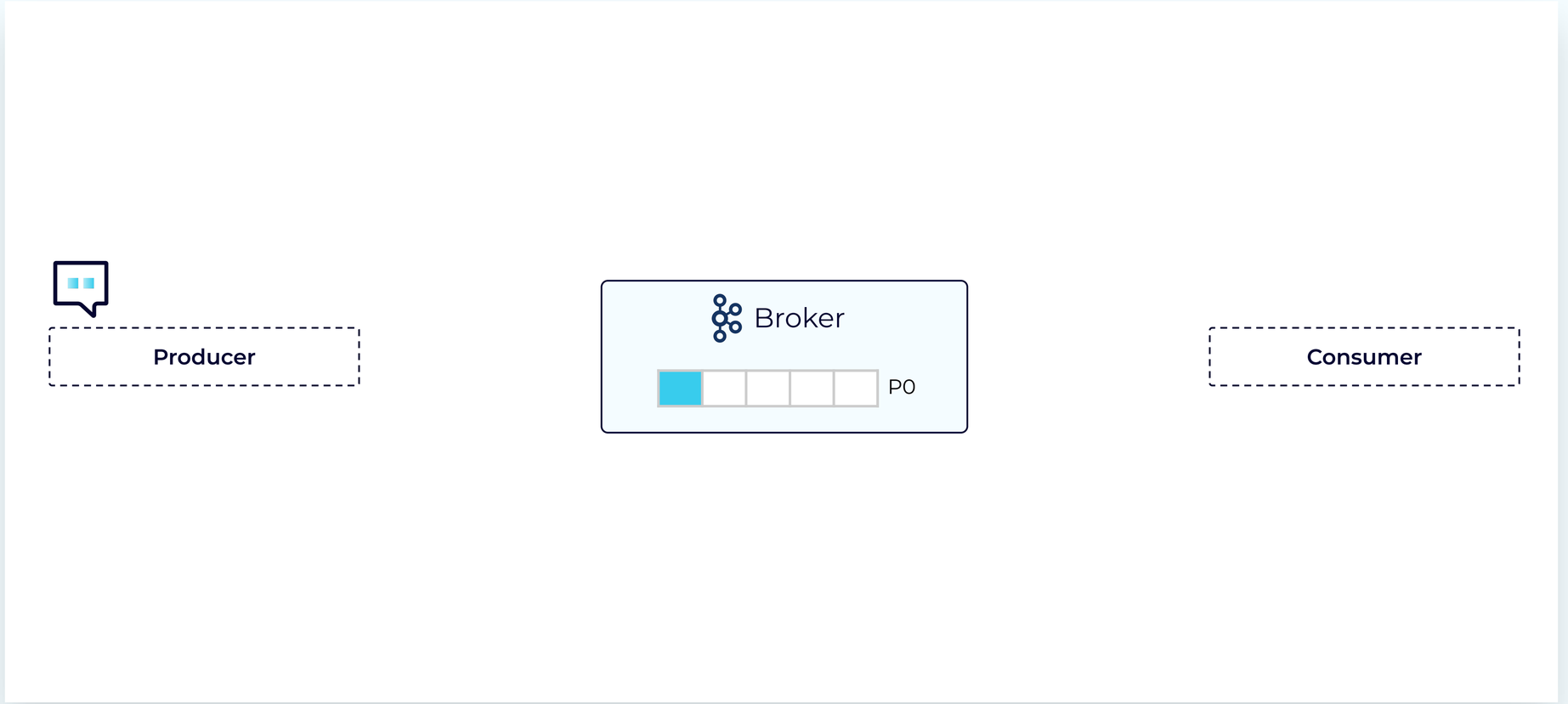

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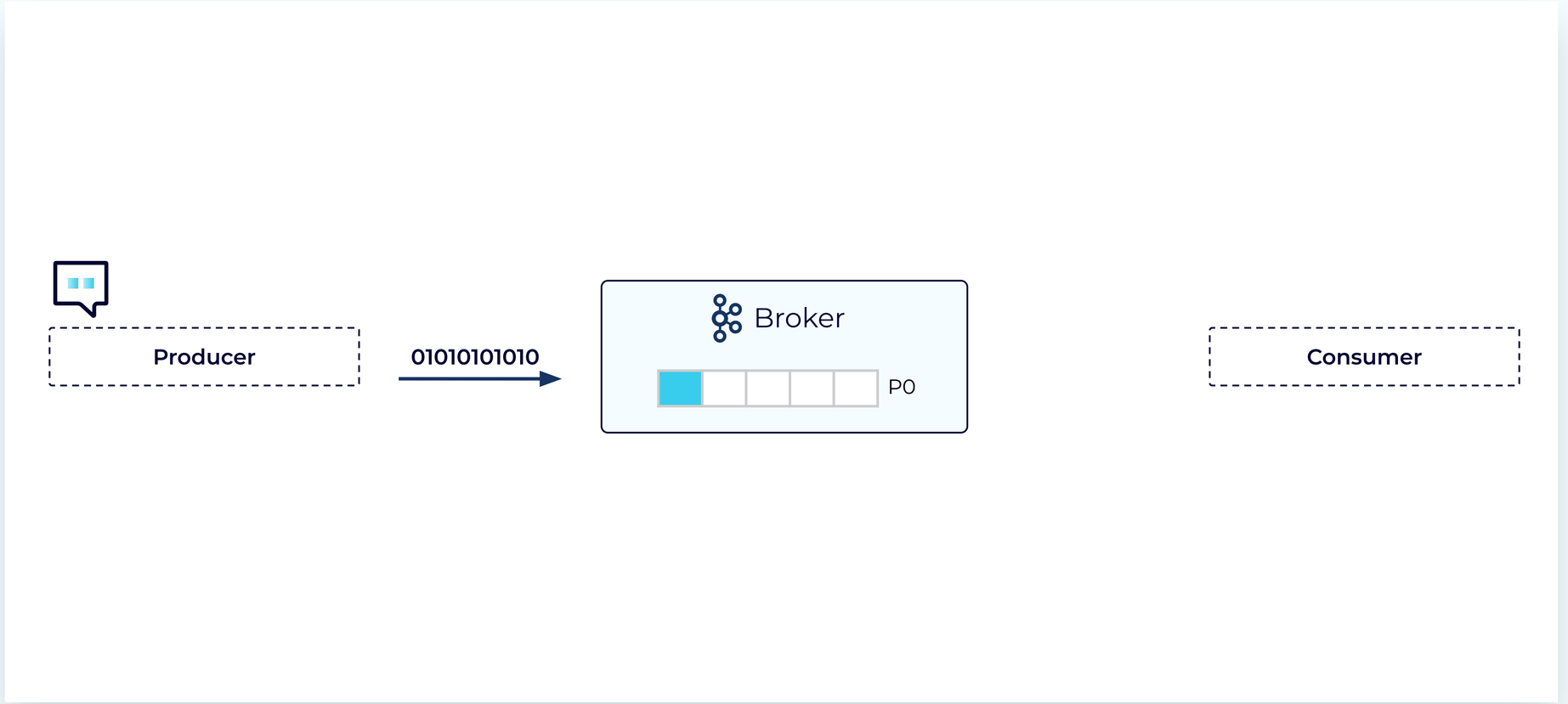

End-to-End Encryption

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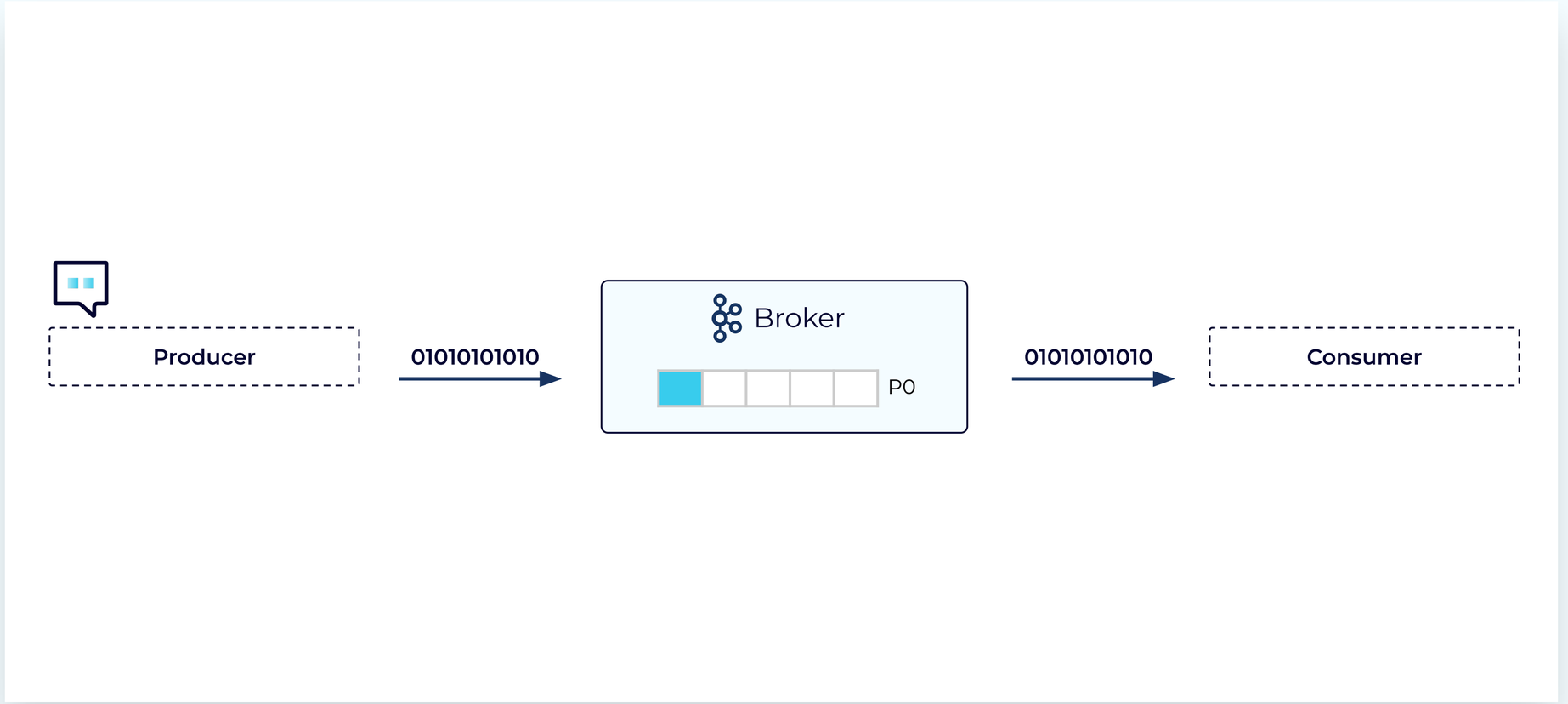

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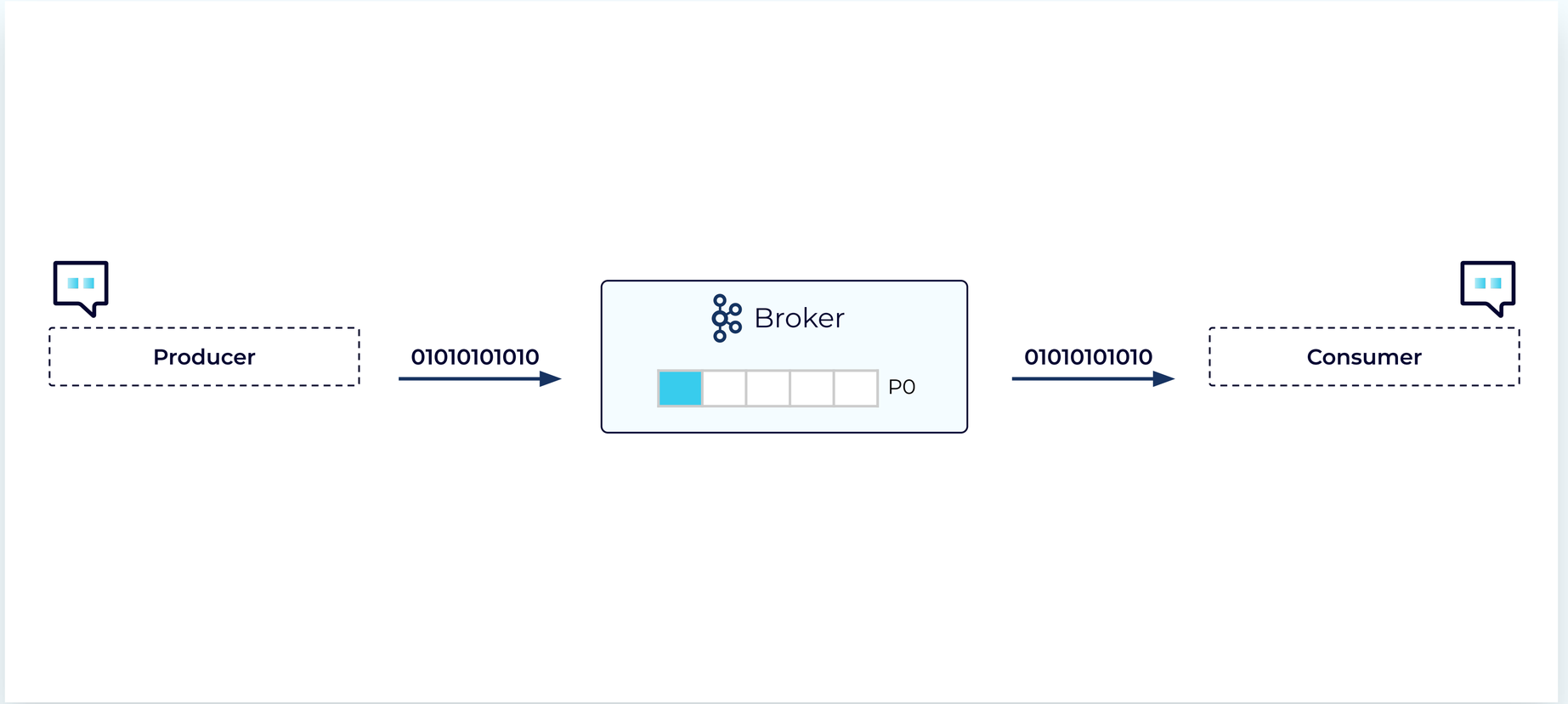

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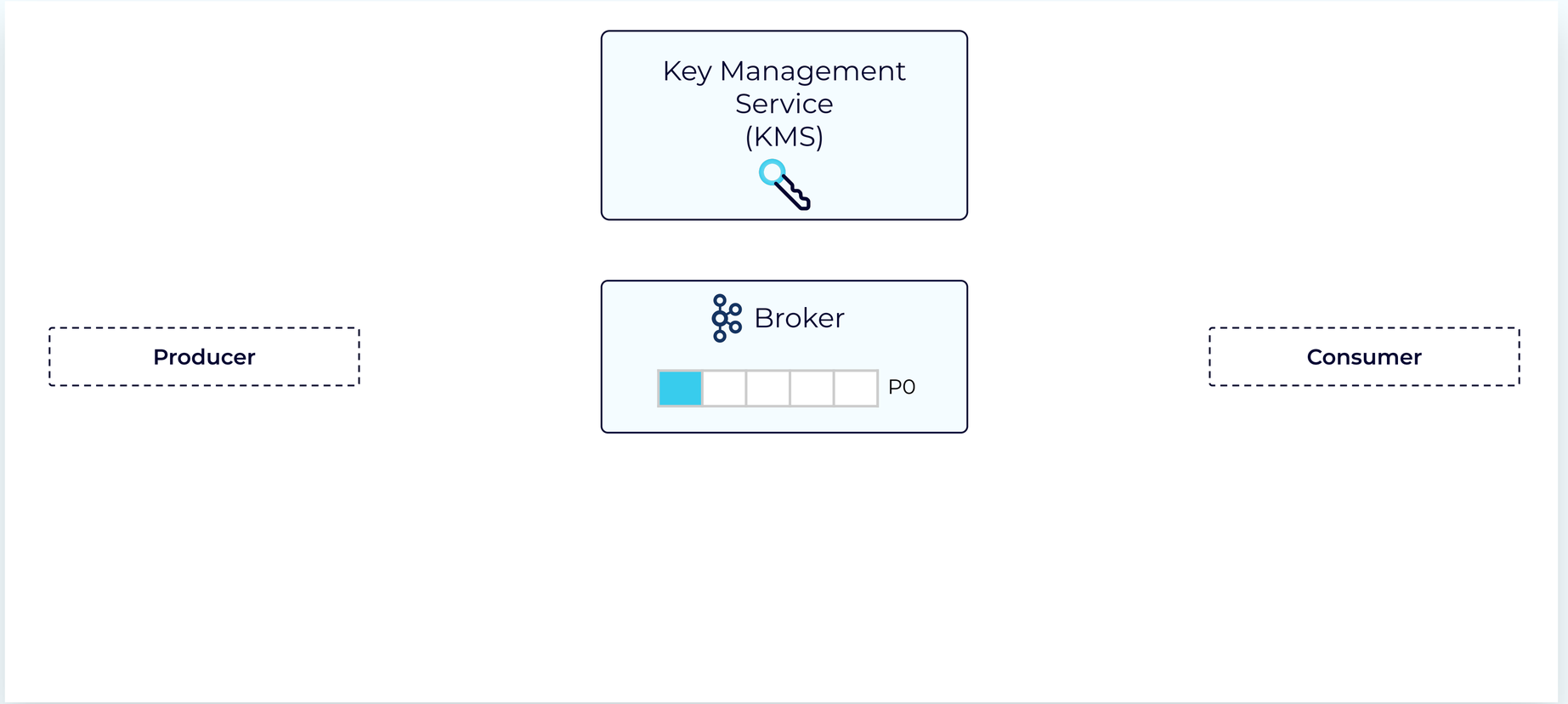

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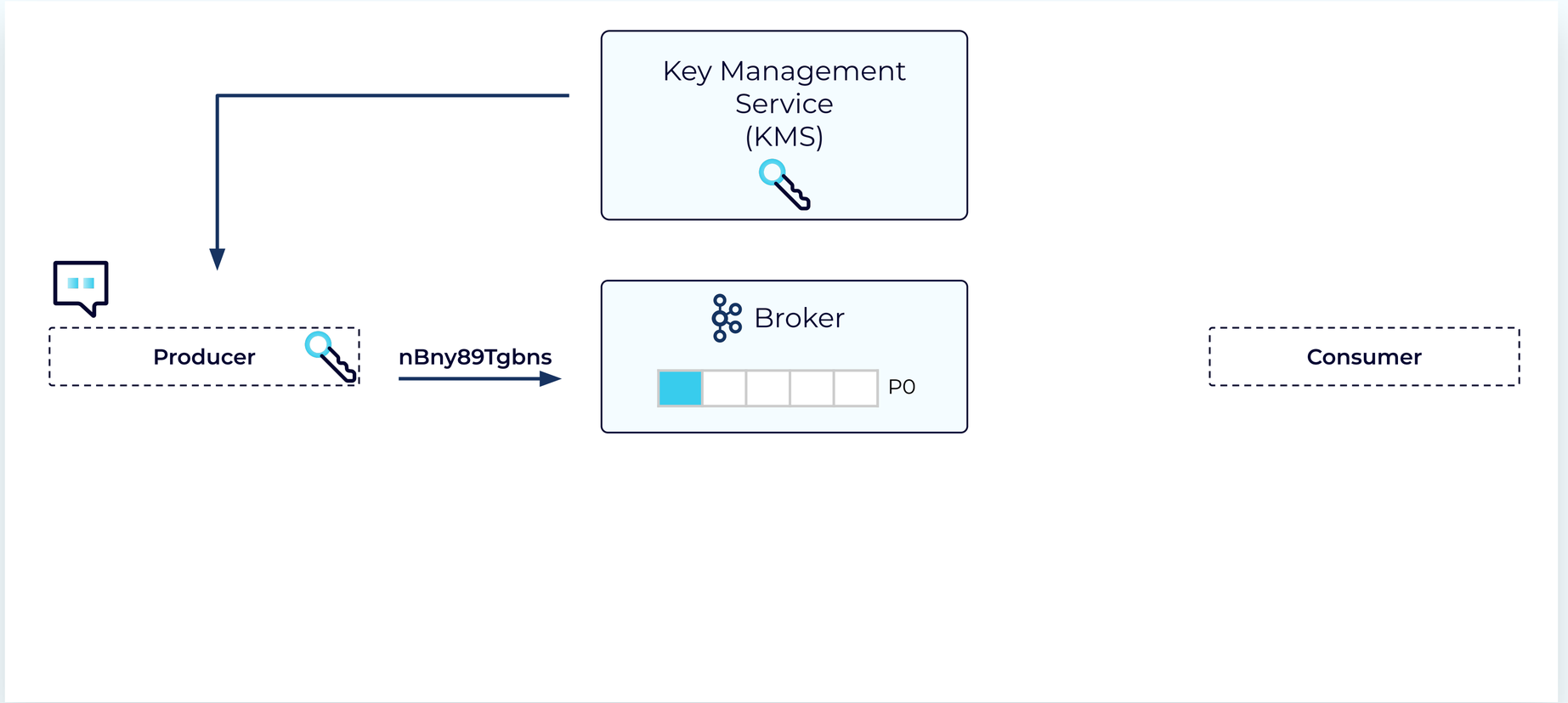

End-to-End Encryption

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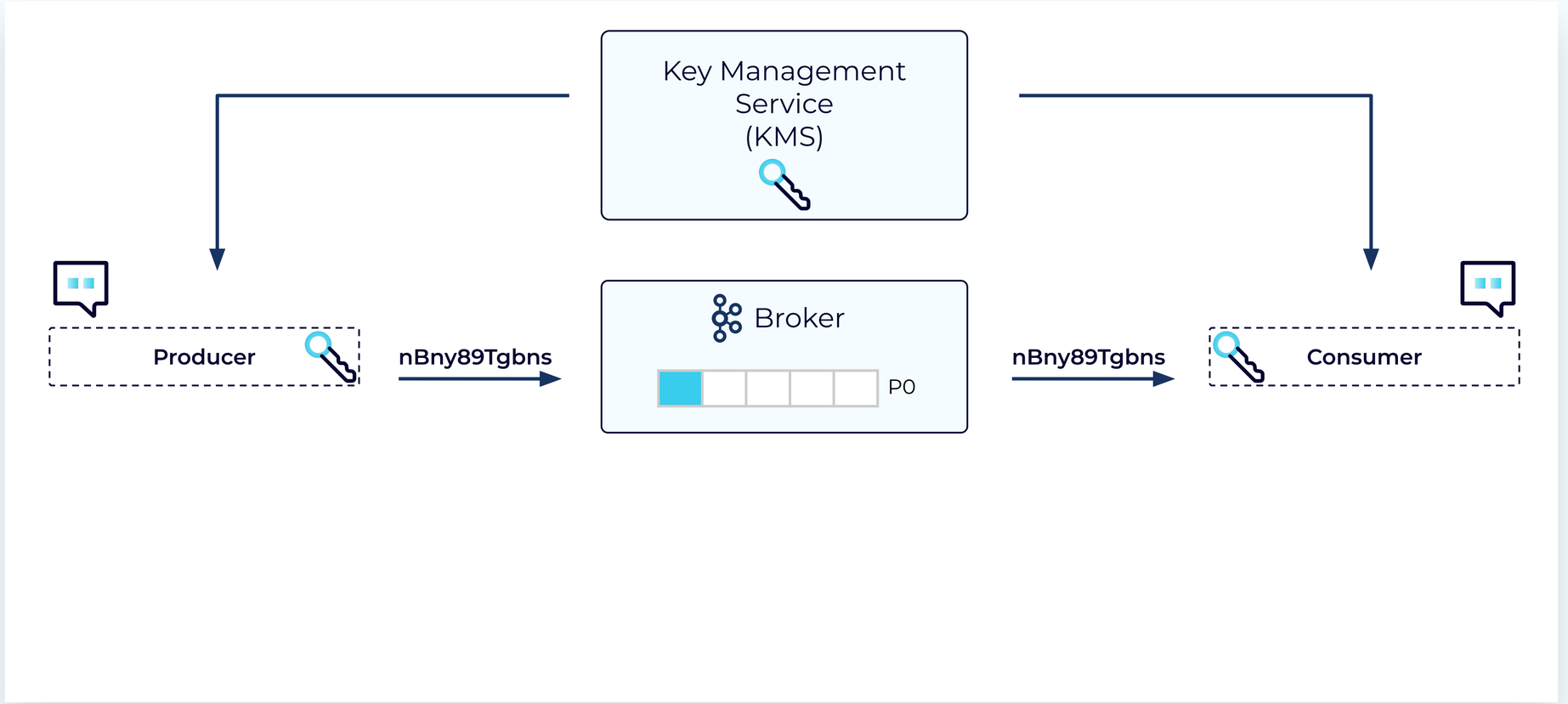

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Securing ZooKeeper

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Set `zookeeper.set.acl` to `true`

SSL client authentication

SASL

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- Integrate with Kerberos

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SASL

- Integrate with Kerberos
- Use TLS encryption
  - `ssl.clientAuth=none` in the ZooKeeper configuration

Securing ZooKeeper

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SSL client authentication

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- Use wildcard certificates OR Subject Alternative Name with list of broker hostnames

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SASL

- Integrate with Kerberos
- Use TLS encryption
  - `ssl.clientAuth=none` in the ZooKeeper configuration
- Configure each broker with same Kerberos principal

Securing ZooKeeper

SSL + SASL

- **Able to use either identity**
- **No need to use same distinguished name**
- **Ability to use hostnames in the distinguished name**

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Audit Logs

Audit Logs

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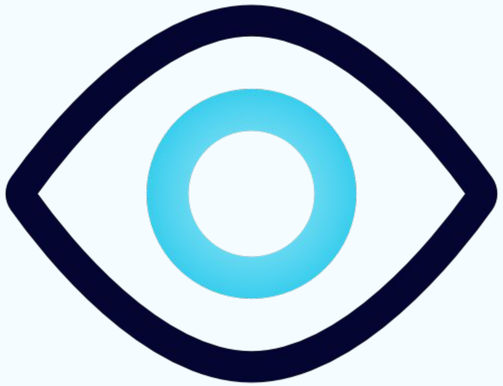
1. **Insight** – Logging every attempted operation



Audit Logs

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1. **Insight** – Logging every attempted operation
2. **Security** – Monitoring and validating operations

Audit Logs

CONFLUENT Developer

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Audit Logs

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1. **Insight** – Logging every attempted operation
2. **Security** – Monitoring and validating operations
3. **Impact** – Debugging client interactions
4. **Compliance** – Generating audit reports

Audit Logs

- kafka.authorizer.logger
  - Used for authorization logs
- kafka.request.logger
  - Used for request logs

Log4j authorization logger

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log4j.properties

log4j.logger.kafka.authorizer.logger=DEBUG

output

DEBUG Principal = User:Alice is Allowed Operation = Write from host = 127.0.0.1 on resource = Topic:LITERAL:customerOrders for request = Produce with resourceRefCount = 1 (kafka.authorizer.logger)

INFO Principal = User:Mallory is Denied Operation = Describe from host = 10.0.0.13 on resource = Topic:LITERAL:customerOrders for request = Metadata with resourceRefCount = 1 (kafka.authorizer.logger)

Log4j request logger

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log4j.properties

log4j.logger.kafka.request.logger=DEBUG

output

DEBUG Completed request:RequestHeader(apiKey=PRODUCE, apiVersion=8, clientId=producer-1, correlationId=6) -- {acks=-1,timeout=30000,partitionSizes=[customerOrders-0=15514]},response: {responses=[{topic=customerOrders,partition_responses=[{partition=0,error_code=0 ,base_offset=13,log_append_time=-1,log_start_offset=0,record_errors=[],error_mes sage=null}]}],throttle_time_ms=0} **from connection 127.0.0.1:9094-127.0.0.1:61040-0**;totalTime:2.42,requestQueueTime:0.112,local-Time:2.15,re moteTime:0.0,throttleTime:0,responseQueueTime:0.04,sendTime: 0.118,securityProtocol:SASL_SSL,**principal:User:Alice**,listener:SASL_SSL,clientInf ormation:ClientInformation(softwareName=apache-kafka-java, softwareVersion=2.7.0-SNAPSHOT) (kafka.request.logger)

Considerations

- Ensure you have sufficient disk space for each broker

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- Set a retention policy for logs
- Capture and consolidate logs to view holistic issues
- Use a visualization tool (e.g., ELK stack, Elasticsearch, Logstash, and Kibana)

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Security Recommendations

Education

Start with security in mind

Encrypt the filesystem

Secure data in transit

Set up a system for administering ACLs

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Rotate your keys

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Dynamically update certificates

Enable Reauthentication

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Protect ZooKeeper

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Set up and monitor audit logs

Play, tinker, break things

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Your Apache Kafka journey begins here

developer.confluent.io