

Advanced topics

1. Messaging systems

Intro

- Messaging provides a mechanism for loosely-coupled integration of systems
- The central unit of processing in a message is a message which typically contains a **body** and a **header**
- Use cases include:
 - Log aggregation between systems
 - Event propagation between systems - никакви събития се fire-ват
 - Offloading log-running tasks to worker nodes - the result of the task then to be sent to a third systems for example
- Messaging solutions implement different protocols for transferring of messages such as **AMQP** (binary protocol), XMPP, MQTT and many more like XML, JSON, etc.
- The variety of protocols implies vendor lock-in when using a particular messaging solution (also called a messaging broker) - ако е специфичен протокола лошо. Т.е. протокола е добре да е такъв, че да може да се използва от различни message broker systems
- Message brokers
 - ActiveMQ - using JMS (Java Messaging System) Java EE
 - RabbitMQ
 - Qpid
 - TIBCO
 - WebSphere MQ
 - Msmq
- Messaging solutions provide means for:
 - Securing message transfer, authenticating and authorizing messaging endpoints
 - Routing messages between endpoints
 - Subscribing to the broker
- An **enterprise service bus (ESB)** is one layer of abstraction above a messaging solution that further provides:
 - Adapters for different messaging protocols
 - Translation of messages between the different types of protocols

I. RabbitMQ

Info

- An open source message broker written in Erlang
 - Заема малко памет и процесор
 - при Erlang няма context switching като при JVM
 - reliability - дете ако не се изпълни, то родителят му го пуска за изпълнение наново
- **Implements the AMQP protocol** (Advanced Message Queueing Protocol)
- Has a pluggable architecture and provides extension for other protocols such as HTTP, STOMP and MQTT

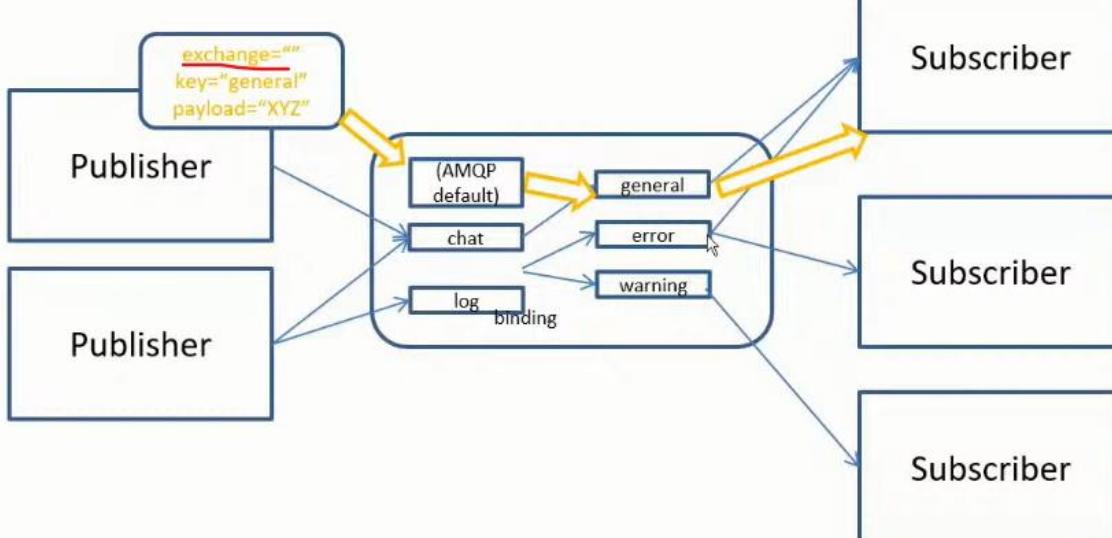
- AMQP is a binary protocol that aims to standardize middleware communication
- The AMQP protocol derives its origins from the financial industry - processing of large volumes of financial data between different systems is a classic use case of messaging
- The AMQP protocol defines:
 - **Exchanges** - the message broker endpoints that receive messages
 - **Queues** - the message broker endpoints that store messages from exchanges and are used by subscribers for retrieval of messages. The Queue can also be persistent - messages can be saved.
 - **Bindings** - rules that bind exchanges and queues
- The AMQP protocol is programmable - which means that the above entities can be created/ modified/ deleted by applications
- The AMQP protocol defines multiple connection channels inside a single TCP connection in order to remove the overhead of opening a large number of TCP connections to the message broker
- Each message can be published with a **routing key**
- Each binding between an exchange and a queue has a **binding key**
- Routing of messages is determined based on matching between the **routing key** and the **binding key**

Messaging patterns with RabbitMQ

- Different types of messaging patterns are implemented by means of different types of exchanges
- RabbitMQ provides the following types of exchanges:
 - default - без име като търси съвпадение на **routing key** с **binding key**
 - direct - има име като търси съвпадение на **routing key** с **binding key**
 - fanout
 - topic
 - headers- на база мачинг по хедъри също

Default exchange

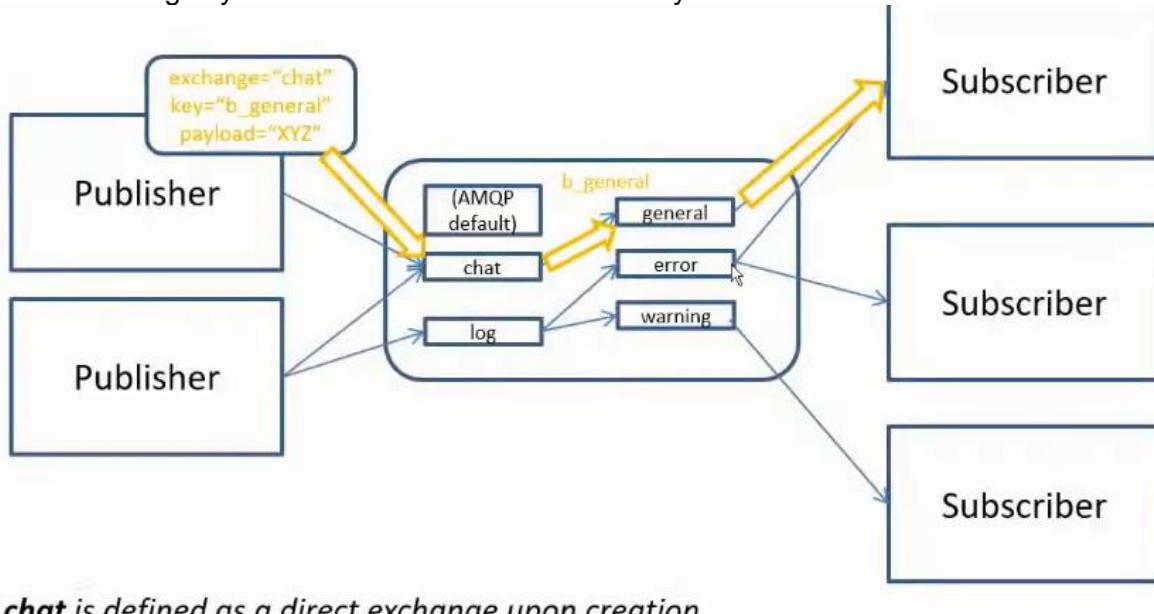
- A default exchange has **the empty string as a name** and routes messages to a queue if the routing key of the message matches the queue name (no binding needs to be declared between a default exchange and a queue)
- Default exchanges are suitable for point-to-point communication between endpoints



(AMQP default) is a system exchange

Direct exchange

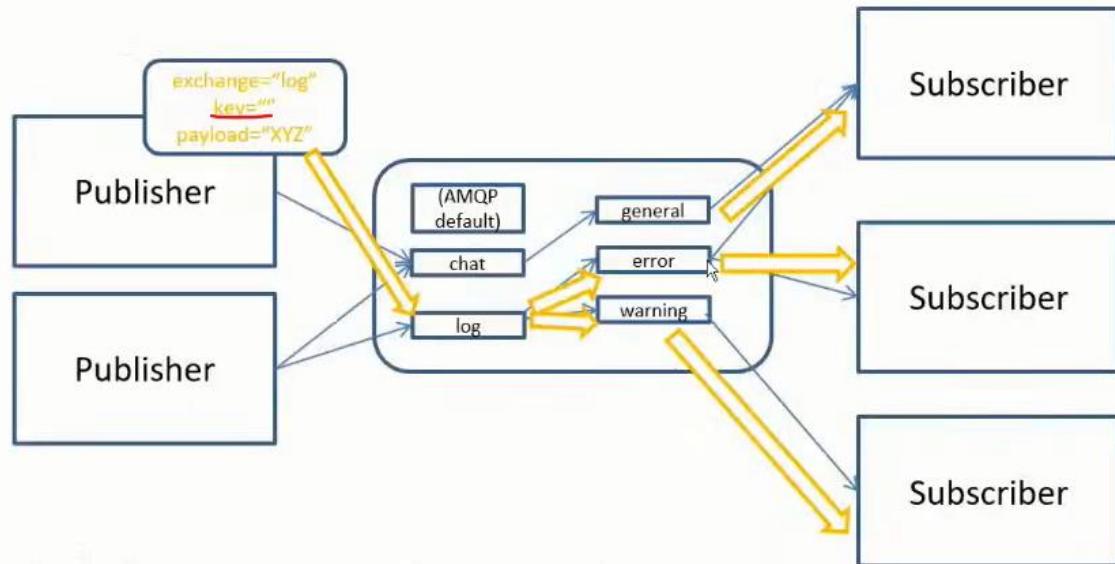
- A direct exchange routes messages to a queue if the routing key of the message matches the binding key between the direct exchange and the queue
- Direct exchanges are suitable for point-to-point communication between endpoints
- Binding key should be defined here mandatory



chat is defined as a direct exchange upon creation

Fanout exchange

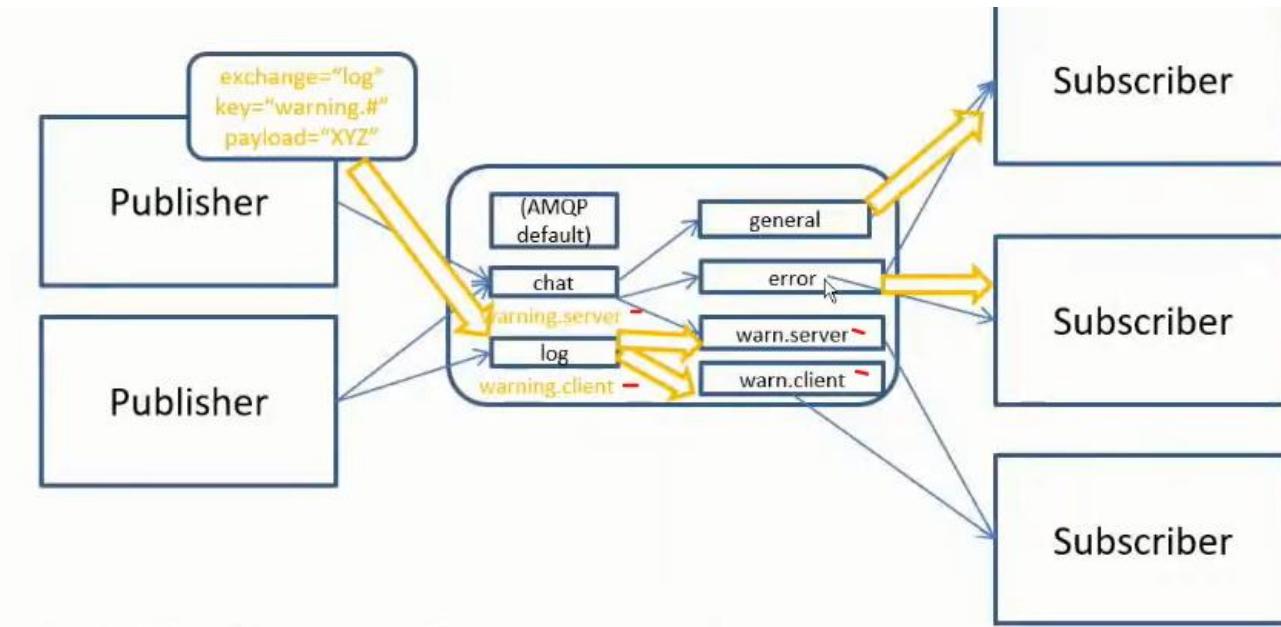
- A fanout exchange routes (broadcasts) messages to all queues that are bound to it (the binding key is not used)
- Fanout exchanges are suitable for publish-subscribe communication between endpoints



log is defined as a fanout exchange upon creation

Topic exchange

- A topic exchange routes (multicasts) messages to all queues that have a binding key (can be a pattern) that matches the routing key of the message
- Topic exchanges are suitable for routing messages to different queues based on the type of message
- Диеса след `warning` може да е всякаква дума



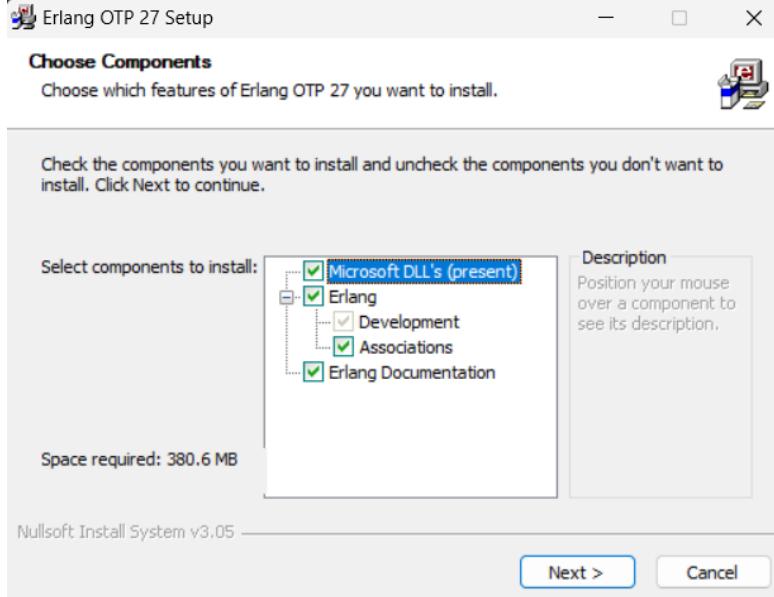
log is defined as a topic exchange upon creation

Headers exchange

- A headers exchange routes messages based on a custom message header
- Header exchanges are suitable for routing messages to different queues based on more than one attribute

Installation of the RabbitMQ server

First install the Erlang - <https://www.erlang.org/downloads>



Then install the RabbitMQ server - https://www.rabbitmq.com/docs/download_rabbitmq-service.bat
[rabbitmq-service.bat](https://www.rabbitmq.com/docs/download_rabbitmq-service.bat)

C:\Program Files\RabbitMQ Server\rabbitmq_server-3.13.6\sbin

Name	Date modified	Type	Size
rabbitmqctl.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-defaults.bat	7/23/2024 23:33	Windows Batch File	1 KB
rabbitmq-diagnostics.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-echopid.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-env.bat	7/23/2024 23:33	Windows Batch File	6 KB
rabbitmq-plugins.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-queues.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-server.bat	7/23/2024 23:33	Windows Batch File	3 KB
rabbitmq-service.bat	7/23/2024 23:33	Windows Batch File	9 KB
rabbitmq-streams.bat	7/23/2024 23:33	Windows Batch File	2 KB
rabbitmq-upgrade.bat	7/23/2024 23:33	Windows Batch File	2 KB
vmware-rabbitmq.bat	7/23/2024 23:33	Windows Batch File	2 KB

C:\Program Files\RabbitMQ Server\rabbitmq_server-3.13.6\sbin>**rabbitmq-plugins.bat enable**

rabbitmq_management

Enabling plugins on node rabbit@SVILKATA:

rabbitmq_management

The following plugins have been configured:

rabbitmq_management

rabbitmq_management_agent

rabbitmq_web_dispatch

Applying plugin configuration to rabbit@SVILKATA...

The following plugins have been enabled:

rabbitmq_management

rabbitmq_management_agent

rabbitmq_web_dispatch

set 3 plugins.

Offline change; changes will take effect at broker restart.

През CommandPrompt като администратор:

C:\Program Files\RabbitMQ Server\rabbitmq_server-3.13.6\sbin>rabbitmq-plugins.bat list

Listing plugins with pattern ".*" ...

Configured: E = explicitly enabled; e = implicitly enabled

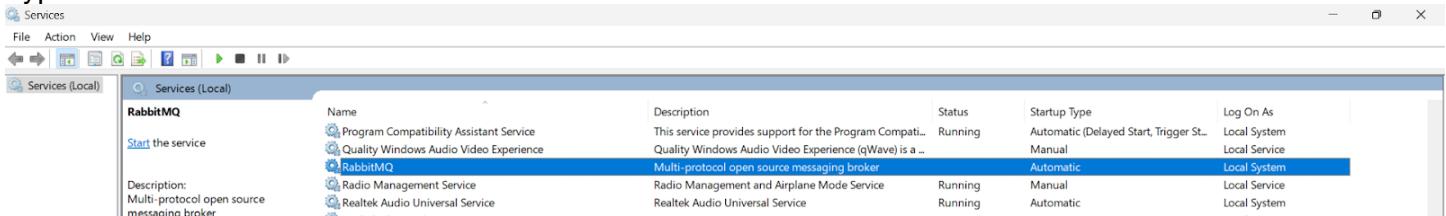
| Status: [failed to contact rabbit@SVILKATA - status not shown]

/

[] rabbitmq_amqp1_0	3.13.6
[] rabbitmq_auth_backend_cache	3.13.6
[] rabbitmq_auth_backend_http	3.13.6
[] rabbitmq_auth_backend_ldap	3.13.6
[] rabbitmq_auth_backend_oauth2	3.13.6
[] rabbitmq_auth_mechanism_ssl	3.13.6
[] rabbitmq_consistent_hash_exchange	3.13.6
[] rabbitmq_event_exchange	3.13.6
[] rabbitmq_federation	3.13.6
[] rabbitmq_federation_management	3.13.6
[] rabbitmq_jms_topic_exchange	3.13.6
[*] rabbitmq_management	3.13.6
[*] rabbitmq_management_agent	3.13.6
[] rabbitmq_mqtt	3.13.6

```
[ ] rabbitmq_peer_discovery_aws      3.13.6
[ ] rabbitmq_peer_discovery_common   3.13.6
[ ] rabbitmq_peer_discovery_consul  3.13.6
[ ] rabbitmq_peer_discovery_etcd    3.13.6
[ ] rabbitmq_peer_discovery_k8s     3.13.6
[ ] rabbitmq_prometheus            3.13.6
[ ] rabbitmq_random_exchange       3.13.6
[ ] rabbitmq_recent_history_exchange 3.13.6
[ ] rabbitmq_sharding              3.13.6
[ ] rabbitmq_shovel                3.13.6
[ ] rabbitmq_shovel_management     3.13.6
[ ] rabbitmq_stomp                 3.13.6
[ ] rabbitmq_stream                3.13.6
[ ] rabbitmq_stream_management     3.13.6
[ ] rabbitmq_top                   3.13.6
[ ] rabbitmq_tracing              3.13.6
[ ] rabbitmq_trust_store          3.13.6
[*] rabbitmq_web_dispatch         3.13.6
[ ] rabbitmq_web_mqtt             3.13.6
[ ] rabbitmq_web_mqtt_examples    3.13.6
[ ] rabbitmq_web_stomp            3.13.6
[ ] rabbitmq_web_stomp_examples   3.13.6
```

Type services.msc



C:\Program Files\RabbitMQ Server\rabbitmq_server-3.13.6\sbin>**rabbitmq-server.bat**

2024-07-31 11:52:47.571000+03:00 [warning] <0.134.0> Using RABBITMQ_ADVANCED_CONFIG_FILE: c:/Users/svilk/AppData/Roaming/RabbitMQ/advanced.config

2024-07-31 11:52:52.145000+03:00 [notice] <0.45.0> Application syslog exited with reason: stopped

2024-07-31 11:52:52.145000+03:00 [notice] <0.213.0> Logging: switching to configured handler(s); following messages may not be visible in this log output

```
## ##
      RabbitMQ 3.13.6
## ##
##### Copyright (c) 2007-2024 Broadcom Inc and/or its subsidiaries
##### ##
##### Licensed under the MPL 2.0. Website: https://rabbitmq.com
```

Erlang: 27.0.1 [jit]

TLS Library: OpenSSL - OpenSSL 3.1.0 14 Mar 2023

Release series support status: see <https://www.rabbitmq.com/release-information>

Doc guides: <https://www.rabbitmq.com/docs>

Support: <https://www.rabbitmq.com/docs/contact>

Tutorials: <https://www.rabbitmq.com/tutorials>

Monitoring: <https://www.rabbitmq.com/docs/monitoring>

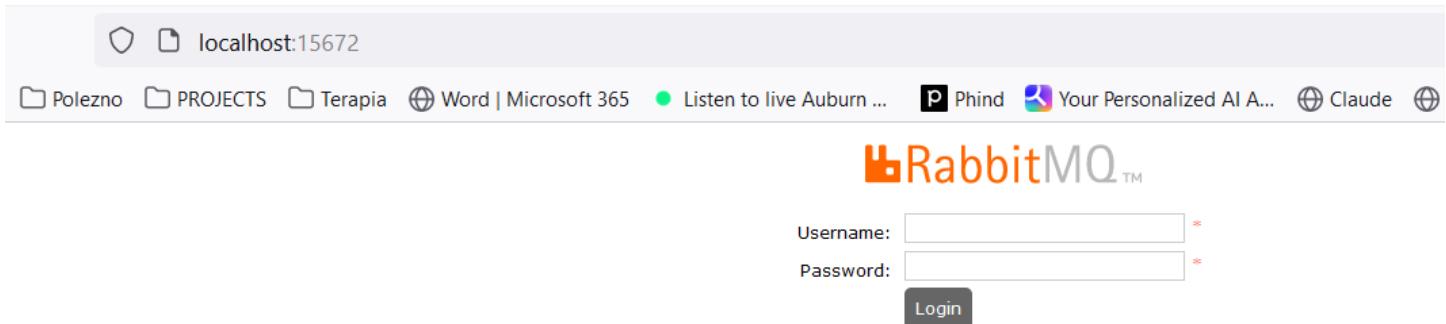
Upgrading: <https://www.rabbitmq.com/docs/upgrade>

Logs: <stdout>

c:/Users/svilk/AppData/Roaming/RabbitMQ/log/rabbit@SVILKATA.log

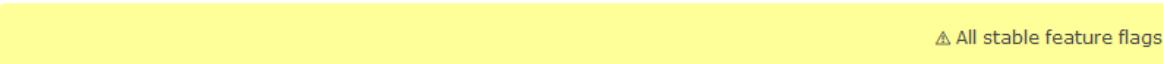
Config file(s): c:/Users/svilk/AppData/Roaming/RabbitMQ/advanced.config

Starting broker... completed with 3 plugins.



username: guest
password: guest

The screenshot shows the RabbitMQ management interface's "Overview" page. At the top, there are navigation links: Overview, Connections, Channels, Exchanges, Queues and Streams, and Admin. On the right, there are refresh settings ("Refresh every 5 seconds"), a virtual host dropdown set to "All", and a user dropdown for "guest" with a "Log out" button. The main content area starts with an "Overview" section containing "Totals" and "Global counts" tables. Below this is a "Nodes" section showing resource usage for the node "rabbit@SVILKATA". The table includes columns for Name, File descriptors, Socket descriptors, Erlang processes, Memory, Disk space, Uptime, Cores, Info, and Reset stats. The "File descriptors" and "Socket descriptors" rows show 0 available. The "Erlang processes" row shows 440. The "Memory" row shows 89 MB used of 118 GB total. The "Disk space" row shows 13 GB high watermark and 48 MiB low watermark. The "Uptime" row shows 2m 8s. The "Cores" row shows 20. The "Info" row shows basic 1 rss. Buttons for "This node" and "All nodes" are present. Below the nodes table are sections for "Churn statistics", "Ports and contexts", "Export definitions", and "Import definitions".

 All stable feature flags[Overview](#) [Connections](#) [Channels](#) [Exchanges](#) [Queues and Streams](#) [Admin](#)

Exchanges

[▼ All exchanges \(7\)](#)

Pagination

Page [1](#) of 1 - Filter: Regex ?

Virtual host	Name	Type	Features	Message rate in	Message rate out	+/-
/	(AMQP default)	direct	D			
/	amq.direct	direct	D			
/	amq.fanout	fanout	D			
/	amq.headers	headers	D			
/	amq.match	headers	D			
/	amq.rabbitmq.trace	topic	D I			
/	amq.topic	topic	D			

[► Add a new exchange](#)[HTTP API](#) [Documentation](#) [Tutorials](#) [New releases](#) [Commercial edition](#) [Commercial support](#) [Discussion](#)

Using the Java Client

```
<dependency>
<groupId>com.rabbitmq</groupId>
<artifactId>amqp-client</artifactId>
<version>5.20.0</version>
</dependency>

import com.rabbitmq.client.Channel;
import com.rabbitmq.client.Connection;
import com.rabbitmq.client.ConnectionFactory;

import java.io.IOException;
import java.nio.charset.StandardCharsets;
import java.util.concurrent.TimeoutException;

public class Publisher {
    public static void main(String[] args) throws IOException, TimeoutException {
        Connection connection = null;
        Channel channel = null;

        try {
            ConnectionFactory connectionFactory = new ConnectionFactory();
            connectionFactory.setHost("localhost"); //by default on port 15672
            connection = connectionFactory.newConnection();
            channel = connection.createChannel();
```

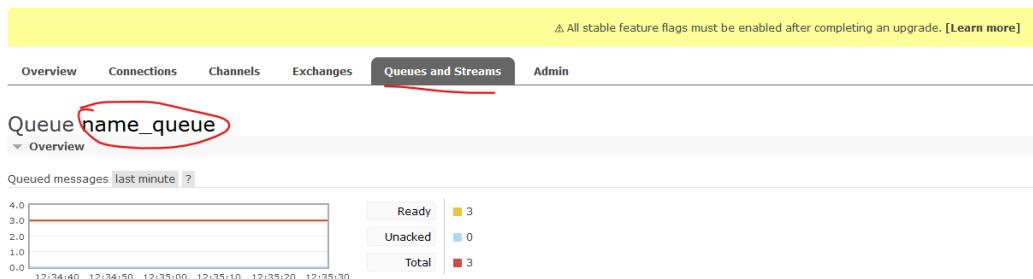
```

        channel.exchangeDeclare("name_exchange", "direct"); //created only once on
the RabbitMQ server
        channel.queueDeclare("name_queue", false, false, false, null); //created
only once on the RabbitMQ server
        channel.queueBind("name_queue", "name_exchange", "routing_key_test");

        channel.basicPublish("name_exchange", "routing_key_test", null,
                "Hello RabbitMQ from Java
client".getBytes(StandardCharsets.UTF_8));
    } finally {
        if (channel != null) {
            channel.close();
        }
        if (connection != null) {
            connection.close();
        }
    }
}
}
}

```

 RabbitMQ™ RabbitMQ 3.13.6 Erlang 27.0.1



All stable feature flags must be enabled

Overview Connections Channels Exchanges Queues and Streams Admin

▶ Bindings (2)

▶ Publish message

▼ Get messages

Warning: getting messages from a queue is a destructive action. [?](#)

Ack Mode:

Encoding: [?](#)

Messages:

Message 1

The server reported 2 messages remaining.

Exchange	name_exchange
Routing Key	routing_key_test
Redelivered	•
Properties	
Payload 31 bytes Encoding: string	Hello RabbitMQ from Java client

Message 2

The server reported 1 messages remaining.

Exchange	name_exchange
Routing Key	routing_key_test
Redelivered	◦
Properties	
Payload 31 bytes Encoding: string	Hello RabbitMQ from Java client

Message 3

```
import com.rabbitmq.client.AMQP;
import com.rabbitmq.client.Channel;
import com.rabbitmq.client.Connection;
import com.rabbitmq.client.ConnectionFactory;
import com.rabbitmq.client.DefaultConsumer;
import com.rabbitmq.client.Envelope;

import java.io.IOException;
import java.util.concurrent.TimeoutException;

public class Subscriber {
    public static void main(String[] args) throws IOException, TimeoutException, InterruptedException {
        Connection connection = null;
        Channel channel = null;

        try {
            ConnectionFactory connectionFactory = new ConnectionFactory();
            connectionFactory.setHost("localhost"); //by default on port 15672
            connection = connectionFactory.newConnection();
            channel = connection.createChannel();
```

```
channel.exchangeDeclare("name_exchange", "direct"); //created only once on
the RabbitMQ server
    channel.queueDeclare("name_queue", false, false, false, null); //created
only once on the RabbitMQ server
    channel.queueBind("name_queue", "name_exchange", "routing_key_test");

    while (true) {
        channel.basicConsume("name_queue", true, new DefaultConsumer(channel)
{
            @Override
            public void handleDelivery(String consumerTag, Envelope envelope,
AMQP.BasicProperties properties, byte[] body) throws IOException {
                // super.handleDelivery(consumerTag, envelope, properties,
body); no-op no work to do
                System.out.println(new String(body));
            }
        });
    }

    Thread.sleep(3000);
}
} finally {
    if (channel != null) {
        channel.close();
    }
    if (connection != null) {
        connection.close();
    }
}
}
```

Administration

- Administration of the broker includes a number of activities such as:
 - Updating the broker
 - Backing up the broker database
 - installing/uninstalling and configuring plug-ins
 - Configuring the various components of the broker
 - Apart from queues, exchanges and bindings we can also manage the following types of components:
 - vhosts (virtual hosts) - for logical separation of broker components
 - users
 - Parameters - defining upstream links to another brokers
 - Policies - for queue mirroring
 - Administration of single instance or an entire cluster can be performed in several ways:
 - Using the management Web interface

The screenshot shows the RabbitMQ Management UI with the Admin tab selected. The main area displays a table of users, including 'guest' and 'administrator'. A red circle highlights the 'Admin' tab in the top navigation bar. To the right, there's a sidebar with status indicators for various features like 'Users', 'Virtual Hosts', 'Feature Flags', etc., each marked with a red checkmark.

- Using the management HTTP API - rest API
- Using the **rabbitmq-admin.py** / **rabbitmqadmin.py** script - written on Python
- Using the **rabbitmqctl** utility

Scalability and High Availability in RabbitMQ

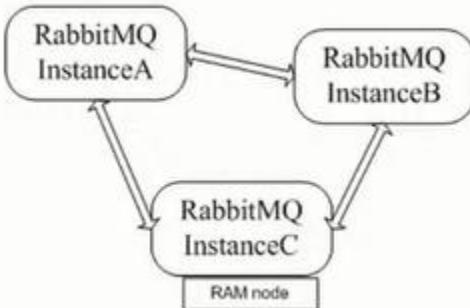
Basic default configuration

- RabbitMQ provides clustering support that allows new RabbitMQ nodes to be added on the fly
- Clustering by default does not guarantee that message loss may or may not occur - ако дадена инстанция примерно падне

- Nodes in a RabbitMQ cluster can be:
 - DISK - data is persisted in the node database
 - RAM - data is buffered only in-memory - когато не е критично да се запазват данните след рестарт например
- **Nodes share only broker metadata - messages are not replicated among nodes!! - съобщението не се реплицира в останалите node-ве**

Example:

A и B са DISK nodes, a C е Ram node.



Instance A node DISK

```

set RABBITMQ_NODENAME=instanceA &
set RABBITMQ_NODE_PORT=5770 &
set RABBITMQ_SERVER_START_ARGS=
    -rabbitmq_management listener [{port,33333}] &
rabbitmq-server.bat -detached
  
```

Instance B node DISK

Пускаме инстанция В, спираме я, присъединяваме я след това

```
set RABBITMQ_NODENAME=instanceB &
set RABBITMQ_NODE_PORT=5771 &
rabbitmq-server.bat -detached
rabbitmqctl.bat -n instanceB stop_app
rabbitmqctl.bat -n instanceB join_cluster instanceA@MARTIN
rabbitmqctl.bat -n instanceB start_app
```

Instance C node RAM

Пускаме инстанция С, спираме я, присъединяваме я след това

```
set RABBITMQ_NODENAME=instanceC &
set RABBITMQ_NODE_PORT=5772 &
rabbitmq-server.bat -detached
rabbitmqctl.bat -n instanceC stop_app
rabbitmqctl.bat -n instanceC join_cluster -ram instanceA@MARTIN
rabbitmqctl.bat -n instanceC start_app
```

- If a node that hosts a queue buffers unprocessed messages goes down, then messages are lost
- Default clustering mechanism provides scalability in terms of queues rather than high availability

Mirrored queues

- **Mirrored queues** are an extension to the default clustering mechanism that can be used to establish **high availability** at the broker level
- Mirrored queues provide queue replication over different nodes that allows a message to survive node failure
- Queue mirroring is establishing by means of a mirroring policy that specifies:
 - Number of nodes to use for queue replication
 - Particular nodes designated by name for queue replication
 - All nodes for queue replication

- The node where the queue is created is the master node - all other nodes are slaves
- A new master node can be promoted in case the original one goes down
- A slave node is promoted to/as the new master in case it is fully synchronized with the old master

Example:

Let's define the test queue in the cluster and mirror it over all other nodes:

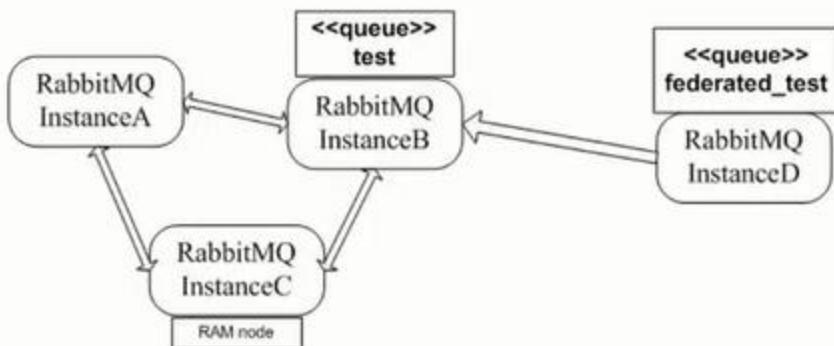
```
rabbitmqadmin.py -N instanceA declare queue name=test
durable=false
rabbitmqctl -n instanceA set_policy ha-all "test" "{\"ha-
mode\":\"all\"}"
```

Federation and Shovel plugins

- The RabbitMQ clustering mechanism uses Erlang message passing along with a message cookie in order to establish communication between the nodes..... which is **not reliable** over the Wide Area Networks!!
- In order to establish high availability among nodes in different geographic locations you can use the **federation**, **federation_management** and **shovel** plug-ins
- The shovel plug-in works at a lower level than the federation plug-in

Federation

- Ако искаме да репликираме опашката на отдалечена инстанция D:



```
set RABBITMQ_NODENAME=instanceD &
set RABBITMQ_NODE_PORT=6001 &
set RABBITMQ_SERVER_START_ARGS=
    -rabbitmq_management listener [{port,4444}] &
rabbitmq-server.bat -detached

rabbitmq-plugins -n instanceD enable rabbitmq_federation
rabbitmq-plugins -n instanceD enable
rabbitmq_federation_management
```

- Declare the **federated_test** queue

```
rabbitmqadmin.py -N instanceD -P 44444 declare queue
name=federated_test durable=false
```

Declare the upstream to the initial cluster and set a federation link to the **test** queue:

```
rabbitmqctl -n instanceD set_parameter federation-upstream
upstream
"{"uri":"amqp://localhost:5770","expires":3600000,
"queue":"test"}"

rabbitmqctl -n instanceD set_policy federate-queue
--apply-to queues "federated_test"
"{"federation-upstream":"upstream"}"
```

Shovel

The shovel plug-in provides two variants:

- **static** - all links between the source/destination nodes/clusters are defined statically in the RabbitMQ configuration file
- **dynamic** - all links between the source/destination nodes/clusters are defined dynamically via the RabbitMQ parameters

source	destination	exchange	queue
exchange		federation dynamic shovel	dynamic shovel
queue		static shovel dynamic shovel	federation dynamic shovel

Integrations

Info

- RabbitMQ provides integrations with other protocols such as STOMP, MQTT and LDAP by means of RabbitMQ plug-ins
- Using the Java Client - already discussed above
- The Spring framework provides integration with AMQP protocol and RabbitMQ in particular
- The **Spring AMQP framework** provides:
 - **RabbitAdmin** class for automatically declaring queues, exchanges and bindings
 - **Listener container** for asynchronous processing of inbound messages
 - **RabbitTemplate** class for sending and receiving messages
- Utilities of the Spring AMQP framework can be used directly in Java or preconfigured in the Spring configuration
- The **Spring Integration framework to Spring Boot** provides adapters for the AMQP protocol
- Integration with Quarkus framework

Spring AMQP framework

```
<dependencies>
    <dependency>
        <groupId>org.springframework.amqp</groupId>
        <artifactId>spring-rabbit</artifactId>
        <version>1.4.5.RELEASE</version>
    </dependency>
</dependencies>
```

The **RabbitAdmin** class:

```
CachingConnectionFactory factory = new
    CachingConnectionFactory("localhost");
RabbitAdmin admin = new RabbitAdmin(factory);
Queue queue = new Queue("sample-queue");
admin.declareQueue(queue);
TopicExchange exchange = new TopicExchange("sample-topic-
    exchange");
admin.declareExchange(exchange);
admin.declareBinding(BindingBuilder.bind(queue).to(exchange)
    .with("sample-key"));
factory.destroy();
```

Listener container

```

CachingConnectionFactory factory =
    new CachingConnectionFactory(
"localhost");
SimpleMessageListenerContainer container = new
SimpleMessageListenerContainer(
    factory);
Object listener = new Object() {
    public void handleMessage(String message) {
        System.out.println("Message received: " +
message);
    }};
MessageListenerAdapter adapter = new
    MessageListenerAdapter(listener);
container.setMessageListener(adapter);
container.setQueueNames("sample-queue");
container.start();

```

The RabbitTemplate class:

```

CachingConnectionFactory factory =
    new CachingConnectionFactory("localhost");
RabbitTemplate template = new
RabbitTemplate(factory);
template.convertAndSend("", "sample-queue",
    "sample-queue test message!");

```

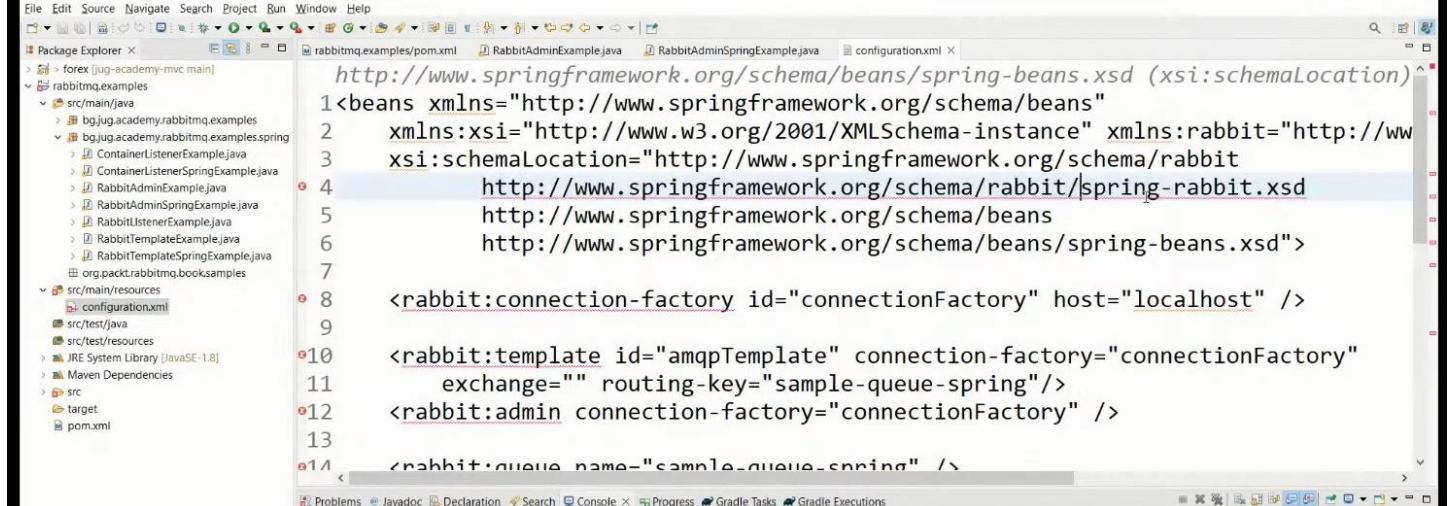
- All of the above Spring AMQP framework examples can be configured using the Spring configuration - so that to be cleaner and to decouple RabbitMQ configuration from the business logic/Java code

For example within a **configuration.xml** file:

```

7 public class RabbitAdminSpringExample {
8
9     public static void main(String[] args) {
10
11         AbstractApplicationContext context = new ClassPathXmlApplicationContext(
12             "configuration.xml");
13         RabbitAdmin admin = context.getBean(RabbitAdmin.class);
14     }
15
16 }

```



[Spring Boot Starter AMQP - Spring Integration framework](#)

In gradle

implementation 'org.springframework.boot:spring-boot-starter-amqp'

Предоставя ни бийнове за **RabbitAdmin** class, **Listener container** and **RabbitTemplate** class.

Посредством дефиниране на бийнове - можем да си декларирате **exchange**, **queue** или **queueBinding**

```
10 @Component
11 public class EventingServiceImpl implements EventingService {
12
13     private final RabbitTemplate template;
14
15     public EventingServiceImpl(RabbitTemplate template) {
16         this.template = template;
17     }
18
19     @Bean
20     public Queue createExchangeQueue() {
21         return new Queue("exchange_rate_queue");
22     }
23
24     @Override
25     public void publish(String message) {
26         template.convertAndSend("exchange_rate_queue", message);
27     }
28
29 }
```

Quarkus framework

```
<dependency>
<groupId>io.quarkus</groupId>
<artifactId>quarkus-smallrye-reactive-messaging-rabbitmq</artifactId>
</dependency>
```

In application.properties file

```
mp.messaging.outgoing.bi.use-ssl=true
mp.messaging.outgoing.bi.connector=smallrye-rabbitmq
mp.messaging.outgoing.bi.exchange.type=direct
mp.messaging.outgoing.bi.port=5672
```

```
import io.smallrye.reactive.messaging.rabbitmq.OutgoingRabbitMQMetadata;

@.Inject
@Channel("asd") //from Microprofile
Emitter<String> emitter; //from Microprofile

public void emmitMessage(RabbitMqPayload payload) {
    String messagePayload = JsonUtils.toJsonString(List.of(payload));
    LOGGER.debugf("Emitting Bi message to RabbitMQ %s", messagePayload);
    OutgoingRabbitMQMetadata metadata = new OutgoingRabbitMQMetadata.Builder()
        .withRoutingKey(payload.routingKey())
        .build();

    Message<String> message = Message.of(messagePayload, Metadata.of(metadata));
    biEmitter.send(message); //from Microprofile
    LOGGER.infof("Bi message emitted to route %s", payload.routingKey());
}
```

Security

- RabbitMQ uses SASL Simple Authentication Security Layer for authentication (SASL PLAIN used by default)
- RabbitMQ uses access control lists (permissions) for authorization
- SSL/TLS support can be enabled for the AMQP communication channels
- SSL/TLS support can be enabled for node communication between nodes in a cluster
- SSL/TLS support can be enabled for the federation and shovel plug-ins

II. Apache Kafka

Book

Kafka – The Definitive Guide – Real-Time Data and Stream Processing at Scale

Use cases

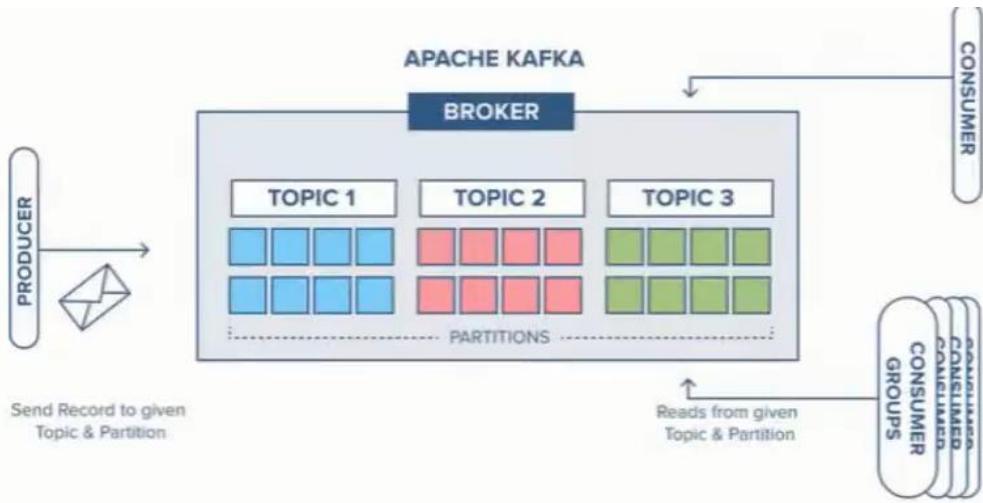
- For activity tracking – например LinkedIn да знае кой профил гледате/се гледа най-много
- Messaging
- Metrics and logging
- Commit log
- Stream processing – data pipeline – за един ден колко човека са кликнали на моята страница



Brokers and Clusters

A single Kafka server-instance is called a **broker**. The broker receives messages from producers, assigns offsets to them, and writes the messages to storage on disk. It also services consumers, responding to fetch requests for partitions and responding with the messages that have been published. Depending on the specific hardware and its performance characteristics, a single broker can easily handle thousands and millions of messages per second.

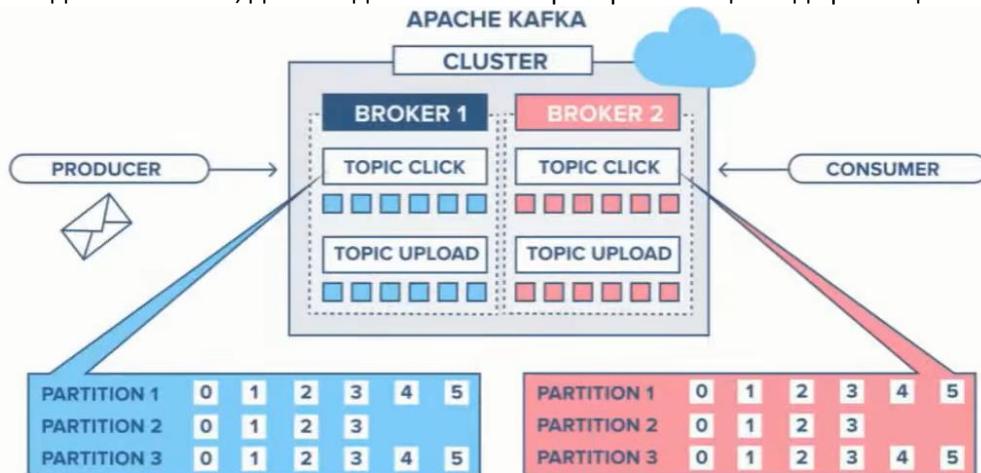
В един Kafka инстанция може да има 1 или повече топици, а във всеки топик има определен брой partitions.



Cluster – комбинация от няколко брокера (поне 3), т.е. няколко брокера които работят заедно и се координират заедно.

С други думи да има Fault tolerance, и когато един broker instance падне/или целият cluster падне, то да има опция да се репликират данните.

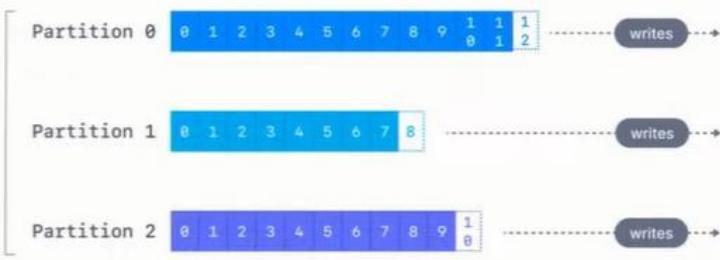
Като си правим cluster, то самите broker instances да бъдат географски на различни места – че ако падне нета на единния instance, да не паднат всичките брокер инстанции и дефакто целия клъстер.



Topics and Partitions

- With key – Messages are appended in the same partition if they have the same key
- Without key – messages are appended to the next partition in a round-robin fashion
- The order is guaranteed only in a partition and only if we have/use **key**

Kafka topic – основната единица



Колкото partitions има в даден топик, то толкова паралелни consumers може да имаме.

Ако имаме повече от 1 partition в даден топик, то нямаме гаранция за подредба. Освен разбира се ако не използваме key!

Partition представлява множество съобщения/елементи едно след друго, с определен индекс който наричаме offset!

Topic replication

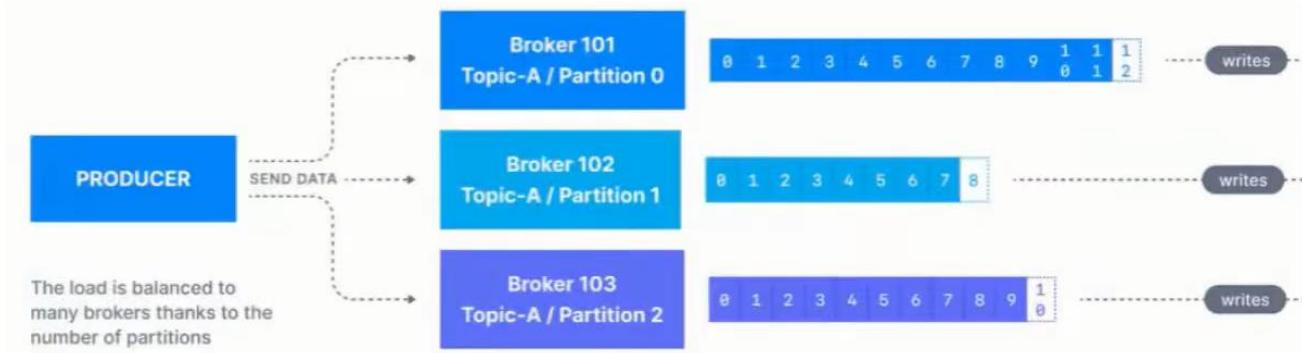
- **min.insync.replicas** – how many brokers (including the leader) should have the data before it is considered stored and ready to serve. Recommended is **replication.factor -1** (можем да настроим да я има тази информация на само 1 брокер, на още 2 брокера, и т.н. – зависи от use case-а и от наличните брокери)

Each partition is replicated separately, has its own broker leader and ISR.

Обикновено единия брокер се води Leader на partition-а.



Когато изпращаме данни, ние изпращаме данни към съответния Leader на съответния partition.



What is a Kafka message

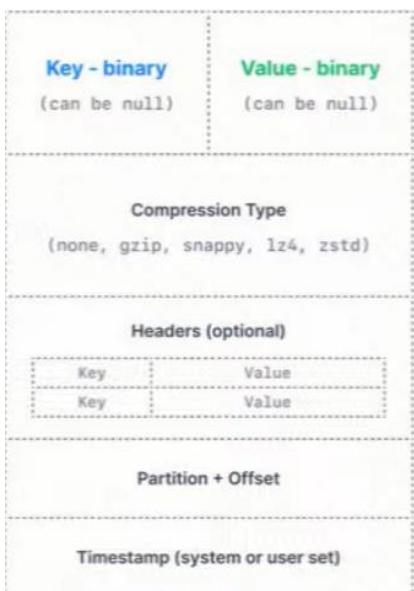
И key и value са **binary**! За Кафка всичко е byte-ове.

Възможност за компресия. Запазват се sequential – на следващия сегмент на диска.

Headers – например информация през кои сървиши е минало

Информация на кой partition е, и на кой offset индекс е даденото съобщение.

Timestamp by default се слага от producer-а, а не вътрешно от Кафка брокера!



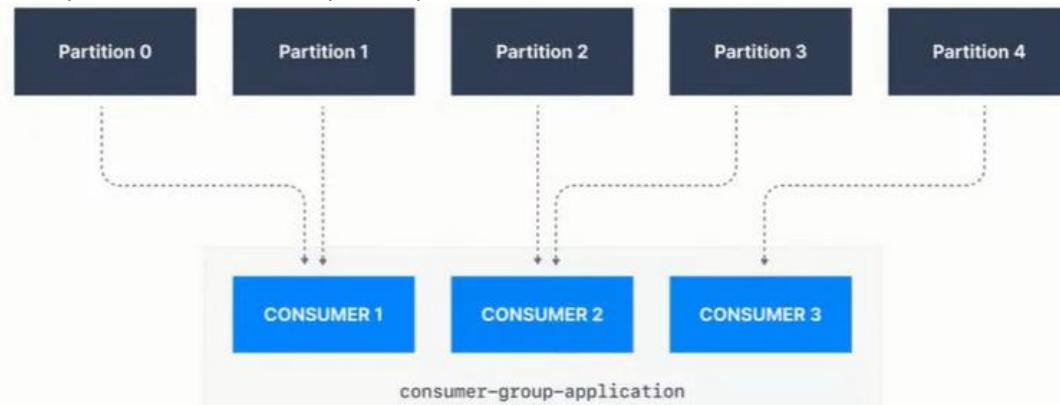
Consumers

Kafka скалира не на базата на топици, а на базата на partitions!!!

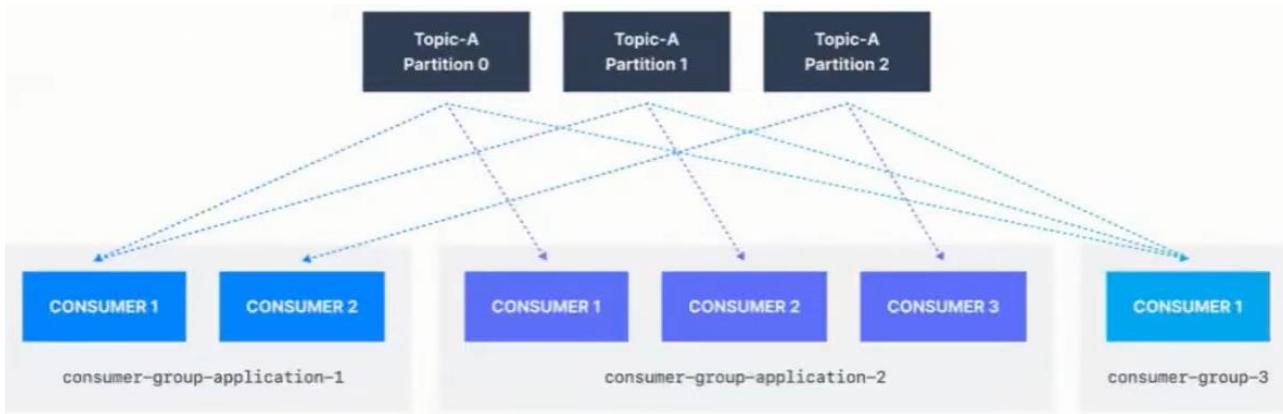
Consumer group

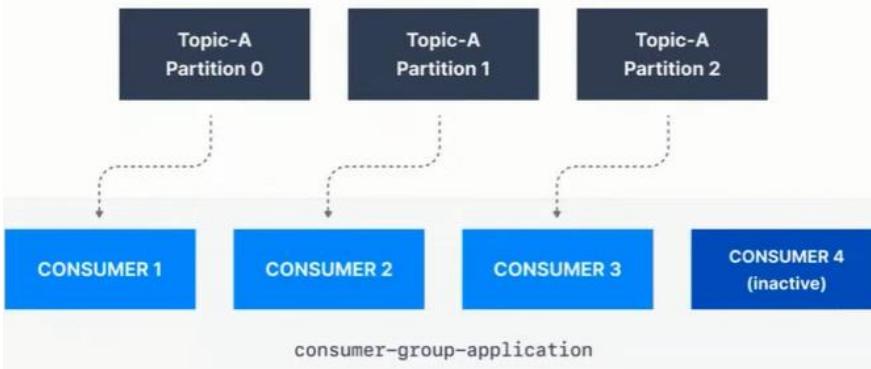
Пример: Имаме 5 партишъни. И разпределяме партишъните на различни consumers.

В текущият пример можем да сложим общо макс 5 consumers!!! Или с други думи правилото е че можем да скалираме consumers до броя на partitions!



Many consumers groups

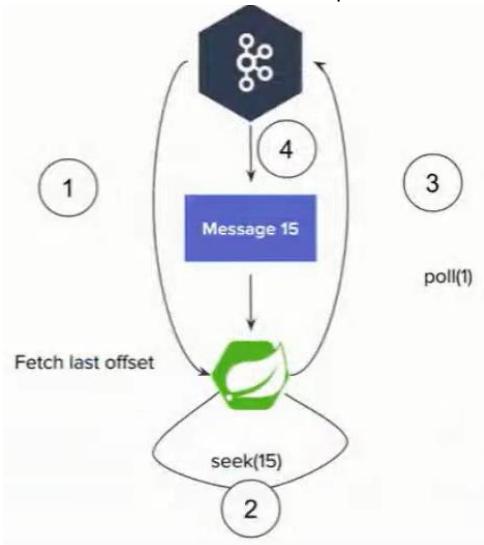




Commit

- Commit is the process of telling Kafka to remember that you have processed (**both produced and consumed**) the messages of a partition to a specific offset
- When first started, the consumer looks up where it left off via the kafka commit facility
- A call to **seek()** is made to initialize an internal counter which determines the messages that will be poll()-ed for the lifetime of the **consumer**

Poll означава вземи съобщението от брокера, и го процесни при теб (при Spring framework-а например)



Producer

Batching

spring.kafka.producer.batch-size=100

Sets the maximum number of records to be sent on one request. Sends the batch as soon as it is filled.

spring.kafka.producer.properties[linger.ms]

Gives the batch that much ms to be filled and sent automatically (see above). After the duration, if the batch is still not filled, sends it as it is.

spring.kafka.producer.buffer-memory

If a batch cannot be sent due to broker being down or whatever other recoverable issue, fills new batches in the buffer. After the buffer is filled, the **send()** method blocks for **spring.kafka.producer.properties[max.block.ms]**. This buffer **must be large enough** to contain at least one full batch or such batches will be lost.

spring.kafka.producer.compression-type=lz4 avro gzip snappy

The batch will be compressed before sending. This directly increases throughput and latency (not much latency)

Следните неща ни интересуват като изпращаме съобщения:

- **acks=0**

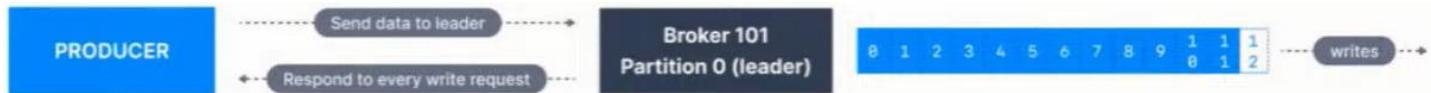
Does not wait for a response to consider the sent successful



- **acks=1**

Wait for the leader to commit the message/s but do not wait for the replicas to commit!!

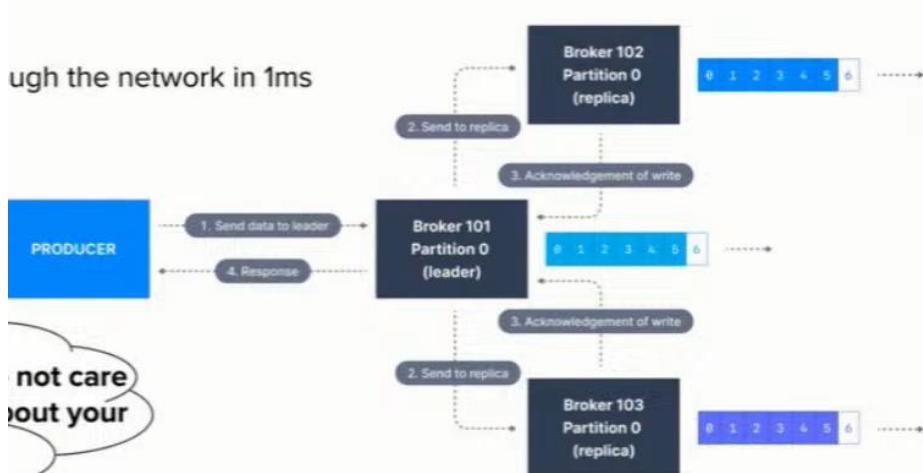
Изчакай поне Leader да ти върне, че е записано съобщението, но не чакаме да се случи репликацията. Проблем би бил ако leader-а умре/падне, и тогава съобщението се губи



- **acks=all**

Wait for the leader and all replicas(или еди колко си на брой реплики) to commit, so that to consider the message/s sent.

Note: all == -1



x2 slower – докато се получат повържденията за репликите, и се забавя

Assuming that a message/s is sent through the network in 1ms. This leads to 2.5ms latency.

1000 / 2ms = 2micro s per message

Consumer

Batching again

spring.kafka.consumer.max-poll-records=500

Sets the maximum number of records that will be returned by a poll()

spring.kafka.listener.ack-mode=batch

Auto commit is mostly evil. Don't use it by default unless actually verifiably ok for your data

Като процеснеш batch-а, то commit-ни ръчно тогава offset-а. Ако се закача наново, то да не го процесна същото съобщение.

spring.kafka.consumer.enable-auto-commit=false

max.poll.interval.ms=5min

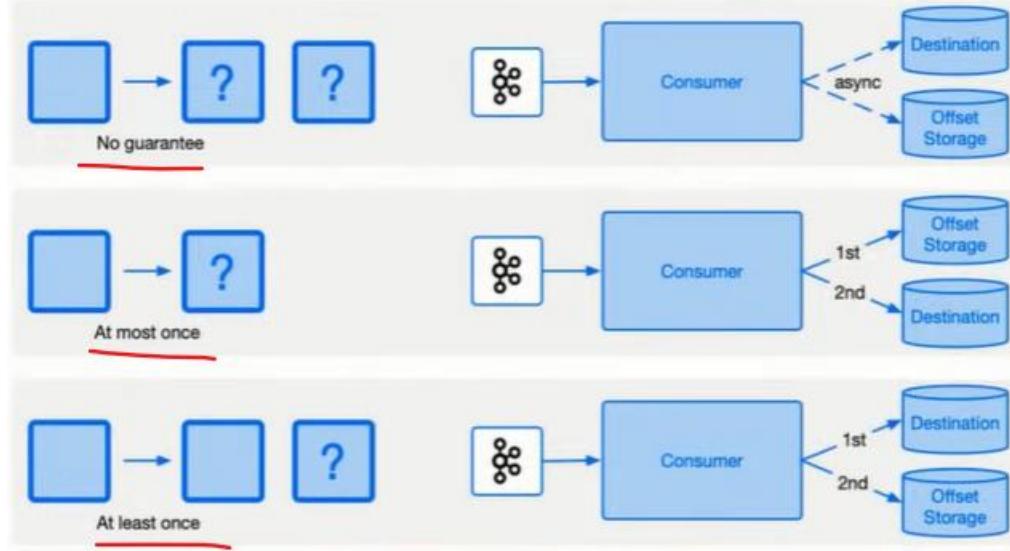
You must be able to process a full batch in that time or a rebalance will be triggered. На колко време да вземаме съобщенията обратно.

Delivery guarantees

Това съобщение защо сме го процеснали 2 пъти.

Или това съобщение защо изобщо не сме го процеснали.

At least once means not that a single message might be duplicated but a whole batch it is scary with big batches 😊



Idempotent producer – получаване на дуплицирани съобщения

Поради network проблем може Кафка брокера да е приел съобщението и да не отговори, и ние да изпратим съобщението наново.

Idempotent producer

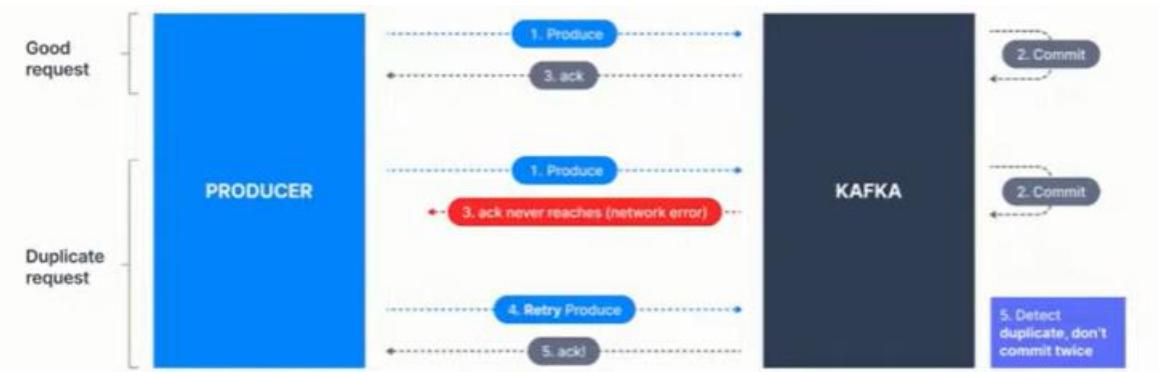


Idempotent producer

`spring.kafka.producer.properties[max.in.flight.requests.per.connection]=5`

`spring.kafka.producer.properties[enable.idempotence]=true`

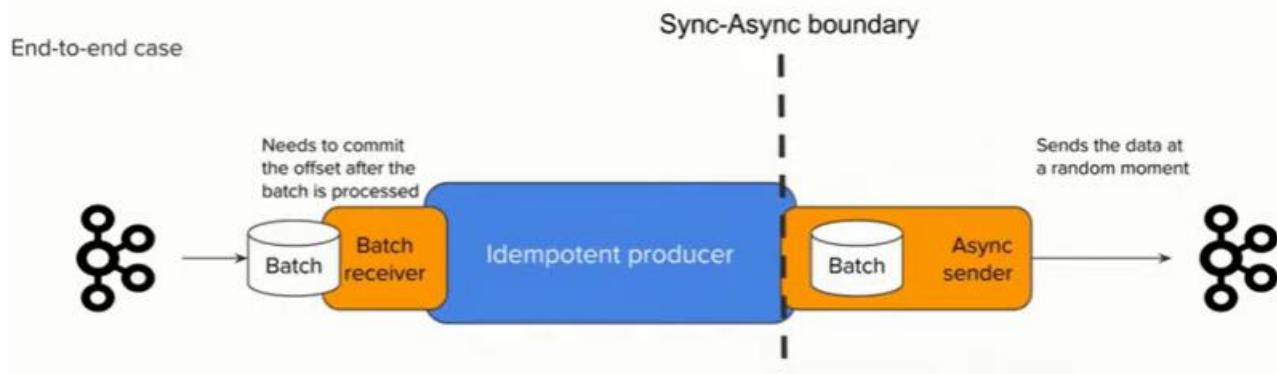
It works for the lifespan of the producer. Required but not enough for proper idempotency across restarts.



Ако е Network проблем, това решава дуплицирането.

Consumer – producer problem

Ако чета в Кафка, и пиша в Кафка – имам проблем. Защото трябва да имаме/използваме нещо, което се казва трансакции (трансакции в Кафка).



kafkaTemplate.send(msg)

This is fully async. You don't know when the data is actually going to be sent. The method returns a future that can be waited but to do it for each message breaks the batching and is extremely slow.

Demo with kafka-clients

Docker-compose file for Zookeeper, Kafka and RedPanda and also logback.xml configuration. – see BGJUG public repo.

build.gradle – Groovy style

```
dependencies {
    implementation group: 'org.apache.kafka', name: 'kafka-clients', version: '3.6.1'
    //SLF4J Api
    implementation 'org.slf4j:slf4j-api:1.7.32' //Use the latest version available

    //Logback (SLF$J implementation)
    implementation 'ch.qos.logback:logback-classic:1.2.6' //Use the latest version available
}
```

```
import org.apache.kafka.clients.producer.KafkaProducer;
import org.apache.kafka.clients.producer.Producer;
import org.apache.kafka.clients.producer.ProducerRecord;

import java.util.Properties;
```

```

public class ProducerExample {
    public static void main(String[] args) {
        Properties properties = new Properties();
        properties.put("bootstrap.servers", "localhost:29092");
        properties.put("key.serializer", "org.apache.kafka.common.serialization.StringSerializer");
        properties.put("value.serializer",
        "org.apache.kafka.common.serialization.StringSerializer");

        Producer<String, String> producer = new KafkaProducer<>(properties);

        producer.send(new ProducerRecord<>("bgjug", "KAFKA", "Welcome to RabbitMQ"), (metadata,
exception) -> {
            if (exception == null) {
                System.out.println("Message sent successfully - Topic: " +
                    metadata.topic() + ", Partition: " + metadata.partition() +
                    ", Offset: " + metadata.offset());
            } else {
                System.err.println("Error sending message: " + exception.getMessage());
            }
        });

        producer.close();
    }
}

```

След като пуснем Producer-а, получаваме следния лог:

13:19:15.064 [main] INFO o.a.k.c.producer.ProducerConfig - ProducerConfig values:

```

acks = -1
auto.include.jmx.reporter = true
batch.size = 16384
bootstrap.servers = [localhost:29092]
buffer.memory = 33554432
client.dns.lookup = use_all_dns_ips
client.id = producer-1
compression.type = none
connections.max.idle.ms = 540000
delivery.timeout.ms = 120000
enable.idempotence = true
interceptor.classes = []
key.serializer = class org.apache.kafka.common.serialization.StringSerializer
linger.ms = 0
max.block.ms = 60000
max.in.flight.requests.per.connection = 5
max.request.size = 1048576
metadata.max.age.ms = 300000
metadata.max.idle.ms = 300000
metric.reporters = []
metrics.num.samples = 2
metrics.recording.level = INFO
metrics.sample.window.ms = 30000
partitioner.adaptive.partitioning.enable = true
partitioner.availability.timeout.ms = 0
partitioner.class = null
partitioner.ignore.keys = false
receive.buffer.bytes = 32768
reconnect.backoff.max.ms = 1000
reconnect.backoff.ms = 50
request.timeout.ms = 30000
retries = 2147483647
retry.backoff.ms = 100
sasl.client.callback.handler.class = null
sasl.jaas.config = null
sasl.kerberos.kinit.cmd = /usr/bin/kinit
sasl.kerberos.min.time.before.relogin = 60000
sasl.kerberos.service.name = null
sasl.kerberos.ticket.renew.jitter = 0.05
sasl.kerberos.ticket.renew.window.factor = 0.8
sasl.login.callback.handler.class = null
sasl.login.class = null

```

```

sasl.login.connect.timeout.ms = null
sasl.login.read.timeout.ms = null
sasl.login.refresh.buffer.seconds = 300
sasl.login.refresh.min.period.seconds = 60
sasl.login.refresh.window.factor = 0.8
sasl.login.refresh.window.jitter = 0.05
sasl.login.retry.backoff.max.ms = 10000
sasl.login.retry.backoff.ms = 100
sasl.mechanism = GSSAPI
sasl.oauthbearer.clock.skew.seconds = 30
sasl.oauthbearer.expected.audience = null
sasl.oauthbearer.expected.issuer = null
sasl.oauthbearer.jwks.endpoint.refresh.ms = 3600000
sasl.oauthbearer.jwks.endpoint.retry.backoff.max.ms = 10000
sasl.oauthbearer.jwks.endpoint.retry.backoff.ms = 100
sasl.oauthbearer.jwks.endpoint.url = null
sasl.oauthbearer.scope.claim.name = scope
sasl.oauthbearer.sub.claim.name = sub
sasl.oauthbearer.token.endpoint.url = null
security.protocol = PLAINTEXT
security.providers = null
send.buffer.bytes = 131072
socket.connection.setup.timeout.max.ms = 30000
socket.connection.setup.timeout.ms = 10000
ssl.cipher.suites = null
ssl.enabled.protocols = [TLSv1.2, TLSv1.3]
ssl.endpoint.identification.algorithm = https
ssl.engine.factory.class = null
ssl.key.password = null
ssl.keymanager.algorithm = SunX509
ssl.keystore.certificate.chain = null
ssl.keystore.key = null
ssl.keystore.location = null
ssl.keystore.password = null
ssl.keystore.type = JKS
ssl.protocol = TLSv1.3
ssl.provider = null
ssl.secure.random.implementation = null
ssl.trustmanager.algorithm = PKIX
ssl.truststore.certificates = null
ssl.truststore.location = null
ssl.truststore.password = null
ssl.truststore.type = JKS
transaction.timeout.ms = 60000
transactional.id = null
value.serializer = class org.apache.kafka.common.serialization.StringSerializer

```

```

import org.apache.kafka.clients.consumer.Consumer;
import org.apache.kafka.clients.consumer.ConsumerConfig;
import org.apache.kafka.clients.consumer.ConsumerRecords;
import org.apache.kafka.clients.consumer.KafkaConsumer;
import org.apache.kafka.common.serialization.StringDeserializer;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import java.time.Duration;
import java.util.Collections;
import java.util.Properties;

public class ConsumerExample {

    private static final Logger logger = LoggerFactory.getLogger(ConsumerExample.class);

    public static void main(String[] args) {
        Properties properties = new Properties();
        properties.put(ConsumerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");
        properties.put(ConsumerConfig.GROUP_ID_CONFIG, "your.group.id");
        properties.put(ConsumerConfig.GROUP_ID_CONFIG, "svilen");
    }
}

```

```

        properties.put(ConsumerConfig.KEY_DESERIALIZER_CLASS_CONFIG,
StringDeserializer.class.getName());
        properties.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
StringDeserializer.class.getName());
        properties.put(ConsumerConfig.AUTO_OFFSET_RESET_CONFIG, "earliest");

    Consumer<String, String> consumer = new KafkaConsumer<>(properties);
    consumer.subscribe(Collections.singletonList("bgjug"));

    while (true) {
        ConsumerRecords<String, String> records = consumer.poll(Duration.ofMillis(100));

        records.forEach( record -> {
            logger.info("Consumed message - Topic: {}, Partition: {}, Offset: {}, Key: {}, Value: {}",
record.topic(), record.partition(), record.offset(), record.key(),
record.value());
        });
    }
}
}

```

The screenshot shows the Redpanda UI at localhost:9080/topics. The left sidebar has 'Topics' selected. The main area displays '1 Total Topics' and '1 Total Partitions'. A table lists the topic 'bgjug' with 1 partition, 1 replica, and a size of 92 B. The 'Name' column for 'bgjug' is circled in red.

Name	Partitions	Replicas	CleanupPolicy	Size
bgjug	1	1	delete	92 B

Demo with Spring

The screenshot shows the Spring Initializr at <https://start.spring.io>. In the search bar, 'kafka' is typed. Below the search bar, a green button says 'Spring for Apache Kafka MESSAGING'. A red underline is placed under the text 'Publish, subscribe, store, and process streams of records.'.

```

dependencies {
    implementation 'org.springframework.boot:spring-boot-starter-web'
    implementation 'org.springframework.kafka:spring-kafka'

    testImplementation 'org.springframework.boot:spring-boot-starter-test'
    testImplementation 'org.springframework.kafka:spring-kafka-test'
    testRuntimeOnly 'org.junit.platform:junit-platform-launcher'
}

```

<https://spring.io/projects/spring-kafka>

<https://spring.io/projects/spring-kafka#learn>

<https://docs.spring.io/spring-kafka/reference/index.html>

<https://docs.spring.io/spring-kafka/reference/kafka/receiving-messages/listener-annotation.html>

<https://docs.spring.io/spring-kafka/reference/kafka/sending-messages.html>

Не е добре на production Кафка сама да си прави топиците – тази опция трябва да бъде настроена подходящо!!!

2024-08-12T13:36:36.054+03:00 INFO 9752 --- [live-demo] [main] o.a.k.clients.consumer.ConsumerConfig :

ConsumerConfig values:

```
allow.auto.create.topics = true
auto.commit.interval.ms = 5000
auto.include.jmx.reporter = true
auto.offset.reset = earliest
bootstrap.servers = [localhost:29092]
check.crcs = true
client.dns.lookup = use_all_dns_ips
client.id = consumer-application-3
client.rack =
connections.max.idle.ms = 540000
default.api.timeout.ms = 60000
enable.auto.commit = false
exclude.internal.topics = true
fetch.max.bytes = 52428800
fetch.max.wait.ms = 500
fetch.min.bytes = 1
group.id = application
group.instance.id = null
heartbeat.interval.ms = 3000
interceptor.classes = []
internal.leave.group.on.close = true
internal.throw.on.fetch.stable.offset.unsupported = false
isolation.level = read_uncommitted
key.deserializer = class org.apache.kafka.common.serialization.StringDeserializer
max.partition.fetch.bytes = 1048576
max.poll.interval.ms = 300000
max.poll.records = 500
metadata.max.age.ms = 300000
metric.reporters = []
metrics.num.samples = 2
metrics.recording.level = INFO
metrics.sample.window.ms = 30000
partition.assignment.strategy = [class org.apache.kafka.clients.consumer.RangeAssignor, class org.apache.kafka.clients.consumer.CooperativeStickyAssignor]
receive.buffer.bytes = 65536
reconnect.backoff.max.ms = 1000
reconnect.backoff.ms = 50
request.timeout.ms = 30000
retry.backoff.ms = 100
sasl.client.callback.handler.class = null
sasl.jaas.config = null
sasl.kerberos.kinit.cmd = /usr/bin/kinit
sasl.kerberos.min.time.before.relogin = 60000
sasl.kerberos.service.name = null
```

```
sasl.kerberos.ticket.renew.jitter = 0.05
sasl.kerberos.ticket.renew.window.factor = 0.8
sasl.login.callback.handler.class = null
sasl.login.class = null
sasl.login.connect.timeout.ms = null
sasl.login.read.timeout.ms = null
sasl.login.refresh.buffer.seconds = 300
sasl.login.refresh.min.period.seconds = 60
sasl.login.refresh.window.factor = 0.8
sasl.login.refresh.window.jitter = 0.05
sasl.login.retry.backoff.max.ms = 10000
sasl.login.retry.backoff.ms = 100
sasl.mechanism = GSSAPI
sasl.oauthbearer.clock.skew.seconds = 30
sasl.oauthbearer.expected.audience = null
sasl.oauthbearer.expected.issuer = null
sasl.oauthbearer.jwks.endpoint.refresh.ms = 3600000
sasl.oauthbearer.jwks.endpoint.retry.backoff.max.ms = 10000
sasl.oauthbearer.jwks.endpoint.retry.backoff.ms = 100
sasl.oauthbearer.jwks.endpoint.url = null
sasl.oauthbearer.scope.claim.name = scope
sasl.oauthbearer.sub.claim.name = sub
sasl.oauthbearer.token.endpoint.url = null
security.protocol = PLAINTEXT
security.providers = null
send.buffer.bytes = 131072
session.timeout.ms = 45000
socket.connection.setup.timeout.max.ms = 30000
socket.connection.setup.timeout.ms = 10000
ssl.cipher.suites = null
ssl.enabled.protocols = [TLSv1.2, TLSv1.3]
ssl.endpoint.identification.algorithm = https
ssl.engine.factory.class = null
ssl.key.password = null
ssl.keymanager.algorithm = SunX509
ssl.keystore.certificate.chain = null
ssl.keystore.key = null
ssl.keystore.location = null
ssl.keystore.password = null
ssl.keystore.type = JKS
ssl.protocol = TLSv1.3
ssl.provider = null
ssl.secure.random.implementation = null
ssl.trustmanager.algorithm = PKIX
ssl.truststore.certificates = null
ssl.truststore.location = null
ssl.truststore.password = null
ssl.truststore.type = JKS
value.deserializer = class org.apache.kafka.common.serialization.StringDeserializer
```

```
import lombok.RequiredArgsConstructor;
import org.springframework.boot.CommandLineRunner;
```

```

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.kafka.config.KafkaListenerEndpointRegistry;
import org.springframework.kafka.core.KafkaTemplate;

@SpringBootApplication
@RequiredArgsConstructor
public class LiveDemoApplication implements CommandLineRunner {

    private final KafkaTemplate<String, String> kafkaTemplate; //injecting it
    private final KafkaListenerEndpointRegistry kafkaListenerEndpointRegistry; //injecting it

    public static void main(String[] args) {
        SpringApplication.run(LiveDemoApplication.class, args);
    }

    @Override
    public void run(String... args) throws Exception {
        //    for (int i = 0; i < 25_000_000; i++) {
        //        kafkaTemplate.send("welcometokafka", "When is next Java beer in Plovdiv?");
        //    }
        kafkaListenerEndpointRegistry.getListenerContainer("bgjug").start(); //How to dynamically
        start/stop Kafka Listener
    }
}

-----
import lombok.extern.slf4j.Slf4j;
import org.springframework.kafka.annotation.KafkaListener;
import org.springframework.stereotype.Component;

@Slf4j
@Component
public class KafkaConsumer {

    //    @KafkaListener(topics = "welcometokafka", groupId = "application", concurrency = "3")
    //    @KafkaListener(topics = "welcometokafka", groupId = "application")
    @KafkaListener(id = "bgjug", topics = "welcometokafka", groupId = "application", autoStartup =
    "false")
    public void listen(String data) {
        log.info(data);
    }
}

-----
import org.apache.kafka.clients.consumer.ConsumerConfig;
import org.apache.kafka.common.serialization.StringDeserializer;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.kafka.config.ConcurrentKafkaListenerContainerFactory;
import org.springframework.kafka.core.ConsumerFactory;
import org.springframework.kafka.core.DefaultKafkaConsumerFactory;

import java.util.HashMap;
import java.util.Map;

@Configuration
public class KafkaConsumerConfig {

    @Bean
    public ConsumerFactory<String, String> consumerFactory() {
        return new DefaultKafkaConsumerFactory<>(consumerConfigs());
    }

    @Bean
    public Map<String, Object> consumerConfigs() {
        Map<String, Object> props = new HashMap<>();

```

```

        props.put(ConsumerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");
        props.put(ConsumerConfig.KEY_DESERIALIZER_CLASS_CONFIG, StringDeserializer.class);
        props.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG, StringDeserializer.class);

        props.put(ConsumerConfig.AUTO_OFFSET_RESET_CONFIG, "earliest"); //when app goes down and
then restart

        props.put(ConsumerConfig.MAX_POLL_INTERVAL_MS_CONFIG, 1); //
props.put(ConsumerConfig.MAX_POLL_RECORDS_CONFIG, 100_000); //

        return props;
    }

    @Bean
    ConcurrentKafkaListenerContainerFactory<String, String>
kafkaListenerContainerFactory(ConsumerFactory<String, String> consumerFactory) {
    ConcurrentKafkaListenerContainerFactory<String, String> factory = new
ConcurrentKafkaListenerContainerFactory<>();
    factory.setConsumerFactory(consumerFactory);

    return factory;
}
}

-----
import org.apache.kafka.clients.producer.ProducerConfig;
import org.apache.kafka.common.serialization.StringSerializer;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.kafka.core.DefaultKafkaProducerFactory;
import org.springframework.kafka.core.KafkaTemplate;
import org.springframework.kafka.core.ProducerFactory;

import java.util.HashMap;
import java.util.Map;

@Configuration
public class KafkaProducerConfig {
    @Bean
    public KafkaTemplate<String, String> kafkaTemplate(ProducerFactory<String, String>
producerFactory) { //Injecting the producer factory
        return new KafkaTemplate<String, String>(producerFactory);
    }

    @Bean
    public ProducerFactory<String, String> producerFactory() {
        return new DefaultKafkaProducerFactory<>(producerConfigs());
    }

    @Bean
    public Map<String, Object> producerConfigs() {
        Map<String, Object> props = new HashMap<>();
        props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");
        props.put(ProducerConfig.KEY_SERIALIZER_CLASS_CONFIG, StringSerializer.class);
        props.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG, StringSerializer.class);
        props.put(ProducerConfig.COMPRESSION_TYPE_CONFIG, "gzip");
        // See https://kafka.apache.org/documentation/#producerconfigs for more properties

        return props;
    }
}

```

Quarkus integration

```

<dependency>
<groupId>io.quarkus</groupId>

```

```
<artifactId>quarkus-smallrye-reactive-messaging-kafka</artifactId>
</dependency>
```

application.properties

```
#####
## Logging configuration
#####
quarkus.log.category."io.zerodt.service.KafkaEventLogProducer".level=INFO
%dev.quarkus.log.category."io.zerodt.service.KafkaEventLogProducer".level=DEBUG
%dev.quarkus.log.category."org.apache.kafka.clients".level=ERROR

#####
## Kafka configuration
#####
%dev.kafka.bootstrap.servers=localhost:9092
%prod.kafka.sasl.config=org.apache.kafka.common.security.scram.ScramLoginModule
required username="${KAFKA_USER}" password="${KAFKA_PASSWORD}";

mp.messaging.incoming.analytics-in.connector=smallrye-kafka
mp.messaging.incoming.analytics-in.topic=analytics
mp.messaging.incoming.analytics-
in.key.serializer=org.apache.kafka.common.serialization.StringSerializer
mp.messaging.incoming.analytics-
in.value.serializer=org.apache.kafka.common.serialization.StringSerializer
mp.messaging.incoming.analytics-in.group.id=wallet-service

mp.messaging.outgoing.analytics.connector=smallrye-kafka
mp.messaging.outgoing.analytics.topic=analytics
mp.messaging.outgoing.analytics.key.serializer=org.apache.kafka.common.serialization.
StringSerializer
mp.messaging.outgoing.analytics.value.serializer=org.apache.kafka.common.serializatio
n.StringSerializer
```

```
import io.smallrye.reactive.messaging.annotations.Blocking;
import io.smallrye.reactive.messaging.kafka.KafkaRecord;
import io.zerodt.bonus.dto.CancelBonusDTO;
import io.zerodt.dto.AccountStatusChangedDTO;
import io.zerodt.dto.UserProfileDTO;
import io.zerodt.exception.BadDataException;
import io.zerodt.service.WalletService;
import io.zerodt.util.ExcludeCodeCoverageGenerated;
import io.zerodt.util.JsonUtils;
import org.apache.kafka.common.header.Header;
import org.eclipse.microprofile.reactive.messaging.Incoming;
import org.jboss.logging.Logger;
import org.jboss.logging.MDC;

import jakarta.enterprise.context.ApplicationScoped;
import jakarta.inject.Inject;
import jakarta.transaction.Transactional;
import java.nio.charset.StandardCharsets;
import java.util.concurrent.CompletionStage;

@ApplicationScoped
public class KafkaEventListener {

    private static final Logger LOGGER = Logger.getLogger(KafkaEventListener.class);

    @Inject
```

```

WalletService walletService;

@Incoming("analytics-in")
@Blocking
@Transactional
public CompletionStage<Void> updateProfileStatus(KafkaRecord<String, String> message) {
    final String eventType = getHeaderAsString(message, "eventType");
    if (!"ACCOUNT_STATUS_CHANGED".equals(eventType)) {
        LOGGER.debugf("Received different type of event - %s. Skipping", eventType);
        return message.ack();
    }

    LOGGER.infof("Received new user status changed event. Updating wallet status");
    final AccountStatusChangedDTO statusChange =
JsonUtils.readJsonFromString(message.getPayload(), AccountStatusChangedDTO.class);
    if (statusChange == null) {
        LOGGER.warnf("Received invalid profile JSON: %s", message.getPayload());
        return message.ack();
    }

    MDC.put("profileId", statusChange.playerId());
    try {
        walletService.updateProfileWalletsStatus(statusChange.playerId(),
statusChange.newStatus(), statusChange.previousStatus());
    } finally {
        MDC.clear();
    }
    return message.ack();
}
}
-----
```

```

import io.smallrye.reactive.messaging.kafka.OutgoingKafkaRecord;
import org.eclipse.microprofile.reactive.messaging.Channel;
import org.eclipse.microprofile.reactive.messaging.Emitter;

import jakarta.enterprise.context.ApplicationScoped;
import jakarta.inject.Inject;

@ApplicationScoped
public class KafkaEventLogEmitter {

    @Inject
    @Channel("analytics")
    Emitter<String> analyticsEmitter;

    public void emmitAnalyticsEvent(OutgoingKafkaRecord<String, String> message) {
        analyticsEmitter.send(message);
    }
}
```

```

-----
```

```

public class OutgoingKafkaRecord<K, T> implements KafkaRecord<K, T>

public interface KafkaRecord<K, T> extends Message<T>, ContextAwareMessage<T> {

    static <K, T> OutgoingKafkaRecord<K, T> from(Message<T> message) {
        return OutgoingKafkaRecord.from(message);
    }

    /**
     * Creates a new outgoing Kafka record.
     *
     * @param key the key, can be {@code null}
     * @param value the value / payload, must not be {@code null}
     */

```

```

* @param <K> the type of the key
* @param <T> the type of the value
* @return the new outgoing Kafka record
*/
static <K, T> OutgoingKafkaRecord<K, T> of(K key, T value)

```

```

-----
import io.smallrye.reactive.messaging.kafka.KafkaRecord;
import io.smallrye.reactive.messaging.kafka.OutgoingKafkaRecord;
import jakarta.enterprise.context.ApplicationScoped;
import jakarta.enterprise.event.Oberves;

import jakarta.inject.Inject;
import static jakarta.enterprise.event.TransactionPhase.AFTER_COMPLETION;

@ApplicationScoped
@ExcludeCodeCoverageGenerated
public class KafkaEventLogProducer {

    private static final Logger LOGGER = Logger.getLogger(KafkaEventLogProducer.class);

    @Inject
    KafkaEventLogEmitter emitter;

    public void publishLoyaltyLevelChangeEvent(@Oberves(during = AFTER_COMPLETION)
LoyaltyStatusChangeDTO loyaltyStatusChange) {
        Long profileId = loyaltyStatusChange.profileId();

        final String loyaltyStatusChangeMessage = JsonUtils.toJsonString(loyaltyStatusChange);
        final var loyaltyStatusChangeRecord = KafkaRecord.of(profileId.toString(),
loyaltyStatusChangeMessage)
            .withHeader("id", UUID.randomUUID().toString())
            .withHeader("eventType", "LOYALTY_STATUS_CHANGE");

        LOGGER.debugf("Publishing the following message to analytics topic: %s",
loyaltyStatusChangeRecord);
        emitter.emmitAnalyticsEvent(loyaltyStatusChangeRecord);
    }
}

```

Conclusion

Всеки път/за всяка задача трябват да настройваме ръчно Kafka producer и kafka consumer настройките! Никога да не разчитаме на дефолтните конфигурации!

2. Docker and containerization

2.1. Containers, Docker, Images

Containerization and images

OS-level virtualization refers to an operating system paradigm in which the kernel allows the existence of **multiple isolated user space instances** known as **containers, zones, jails, ...**

Работят в изолация /Standalone/.

Не може единия апп да източи паметта на другия апп. Ако единия апп му свърши паметта, то другия апп продължава да работи.

Цял сървър е доста скъпо също.
Затова използваме контейнеризация.

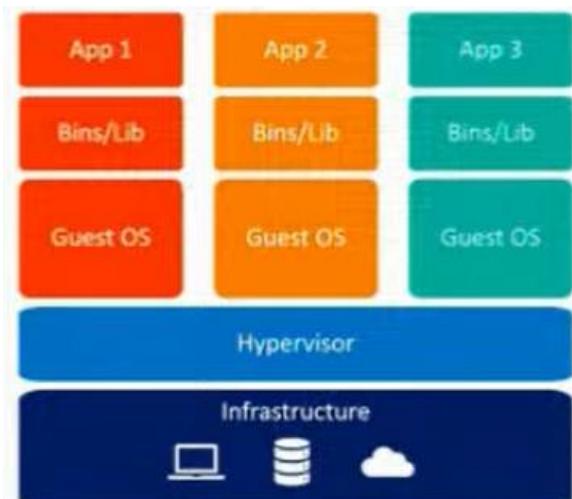
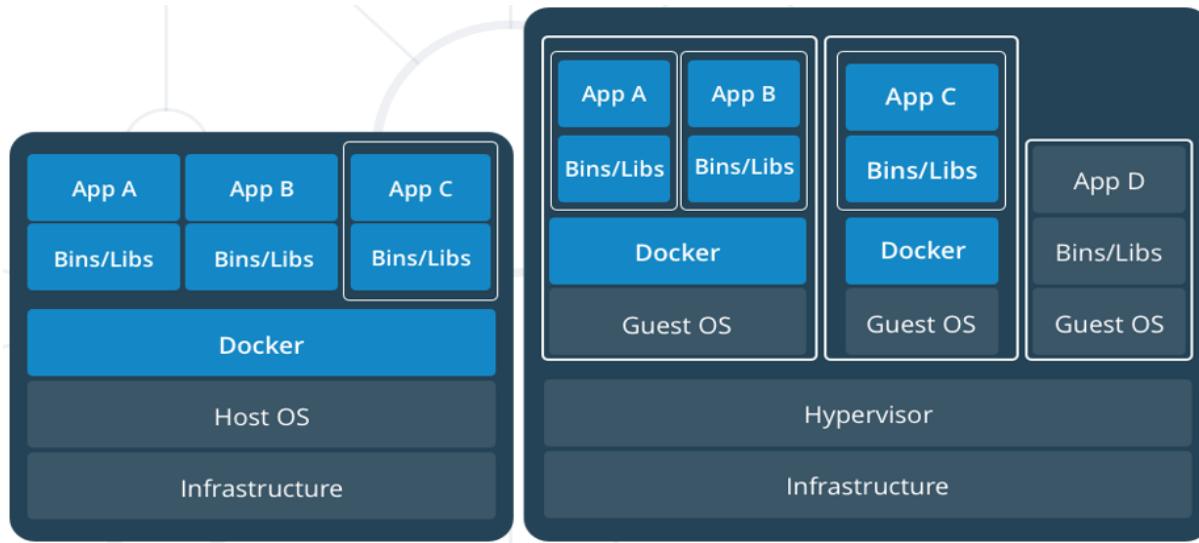
Container:

- A sandboxed process that is isolated from all other processes on a host machine
- Should contain only a single application and its dependencies
- **Portable and lightweight**

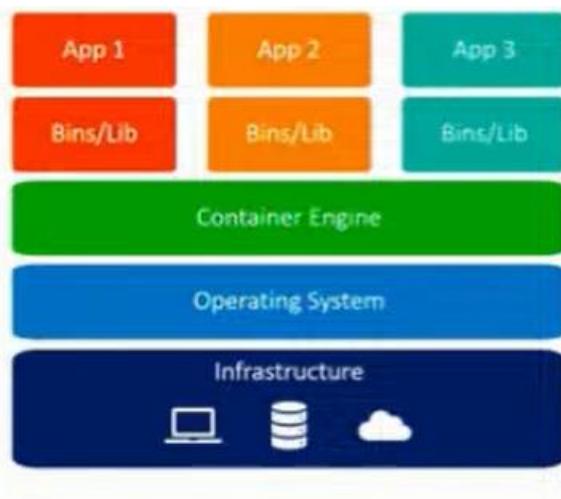
Image:

- Standalone executable package
- The specification of a container

VMs (виртуални машини) vs Containers



Virtual Machines



Containers

Първоначално е имало само виртуални машини.

Виртуална машина означава на даден хост машина/сървър да има изолирана операционна система, която можем да я ползваме без достъп до някакви други неща.

Идеята, ако има тази хост машина достатъчно ресурси, то да пуснем две независими изолирани виртуално операционни системи. Идеята е на всяка виртуална машина да се пуска един application.

Hypervisor – да дистрибуира и менъджира всички виртуални операционни системи и техните ресурси.

Един Docker container е процес, а не цяла виртуална машина! Една хост машина, една операционна система, различни процеси като един от тях е Docker container!

В самият Docker container се казва също че има инсталрирана малка операционна система – това всъщност не е съвсем вярно! Има файлова операционна система.

Docker Daemon(Docker engine) менъджира отделните контейнери.

- VMs virtualize the hardware
 - Complete isolation
 - Complete OS installation. Requires more resources
 - Runs almost any OS
-
- Containers virtualize the OS
 - Lightweight isolation
 - Shared kernel among all the containers. Requires fewer resources
 - Runs on the same OS == Linux

Solutions

- **rkt** by CoreOS
 - Application container engine
 - <https://coreos.com/rkt>
- **Docker** by Docker Inc
 - Application container engine
 - <https://www.docker.com/>

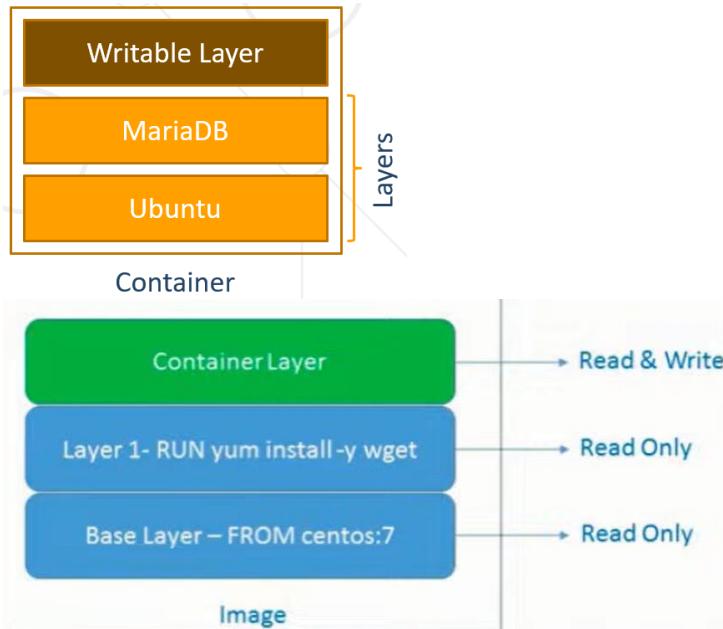
Containers Concepts (Docker View)

- **Container image** shows the state of a container, including registry or file system changes = все едно **container image** е нещо клас, а самия **контейнер** е нещо като клас. Самият container image е работещ container.
- **Container OS image** is the first layer of potentially many image layers that make up a container = основния image, върху който се гради контейнера
- **Container repository** stores container images and their dependencies = мястото, където се пазят тези container images

Definitions

- Container
 - Containers are processes with much more isolation
- Image
 - Images provide a way for simpler software distribution

Container layers



```
docker pull nginx
```

```
> docker pull nginx
Using default tag: latest
latest: Pulling from library/nginx
25d3892798f8: Pull complete
42de7275c085: Pull complete
c459a9332e03: Pull complete
48882f13d668: Pull complete
49180167b771: Pull complete
da4abc2b066c: Pull complete
20dc44ab57ab: Pull complete
Digest: sha256:84c52dfd55c467e12ef85cad6a252c0990564f03c4850799bf41dd738738691f
Status: Downloaded newer image for nginx:latest
docker.io/library/nginx:latest
```

Като дръпнем един докер image, той сваля няколко слоя/layers с няколко id-та, като всеки layer е една от следните команди: FROM, MAINTAINER, RUN, COPY, ADD, EXPOSE, ENTRYPOINT, CMD.

Ако имаме едно и също начало на два докер файла за изпичане на image то при pull-ване на 2 различни Image-а, то те ще се преизползват – няма да ги дърпа два пъти! Т.е. всеки един layer се кешира поотделно и представлява определена част от тази lightweight файлова система. Това също означава, че image-те се оптимизират. Всички layer-и се кешират, с изключение на последния Read & Write layer-a.

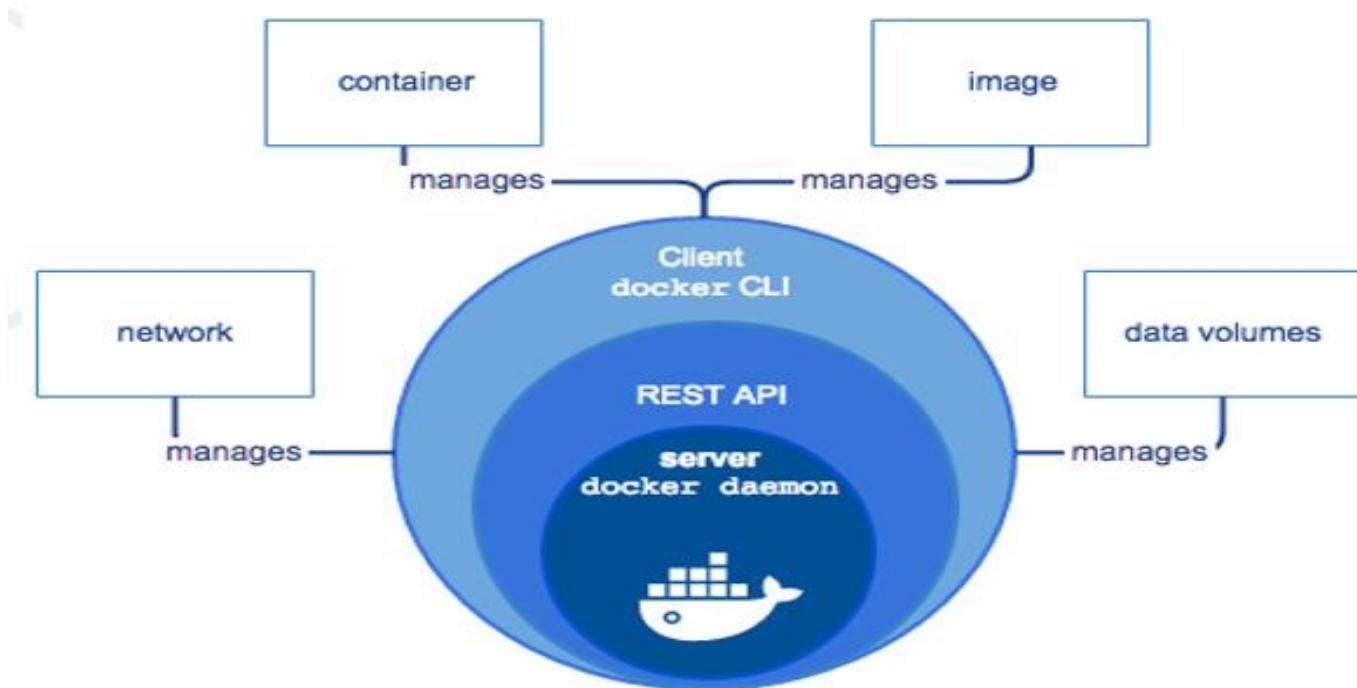
Когато създадем нов контейнер от image, то само тогава се създава и то **наново Read & Write layer-a**.

```
> docker pull httpd
Using default tag: latest
latest: Pulling from library/httpd
25d3892798f8: Already exists
7a5857226826: Pull complete
4f4fb700ef54: Pull complete
ec9858119e90: Pull complete
54e79f99f33b: Pull complete
e6520ad62ebbb: Pull complete
Digest: sha256:5ee9ec089bab71ffcb85734e2f7018171bcb2d6707f402779d3f5b28190bb1af
Status: Downloaded newer image for httpd:latest
docker.io/library/httpd:latest
```

2.2. Docker

Docker Engine

- Docker Mission – **Build, Ship, Deploy**
- Client-server application
- Components
 - dockerd daemon
 - REST API
 - docker CLI



Registries – мястото, където се пазят тези images

- Provided by Docker
 - Cloud
 - Docker Hub (<https://hub.docker.com/explore/>)
 - Docker Store (<https://store.docker.com/>)
 - On-premise
- Provided by 3rd parties
 - Quay.io, Artifactory, Google Container Registry

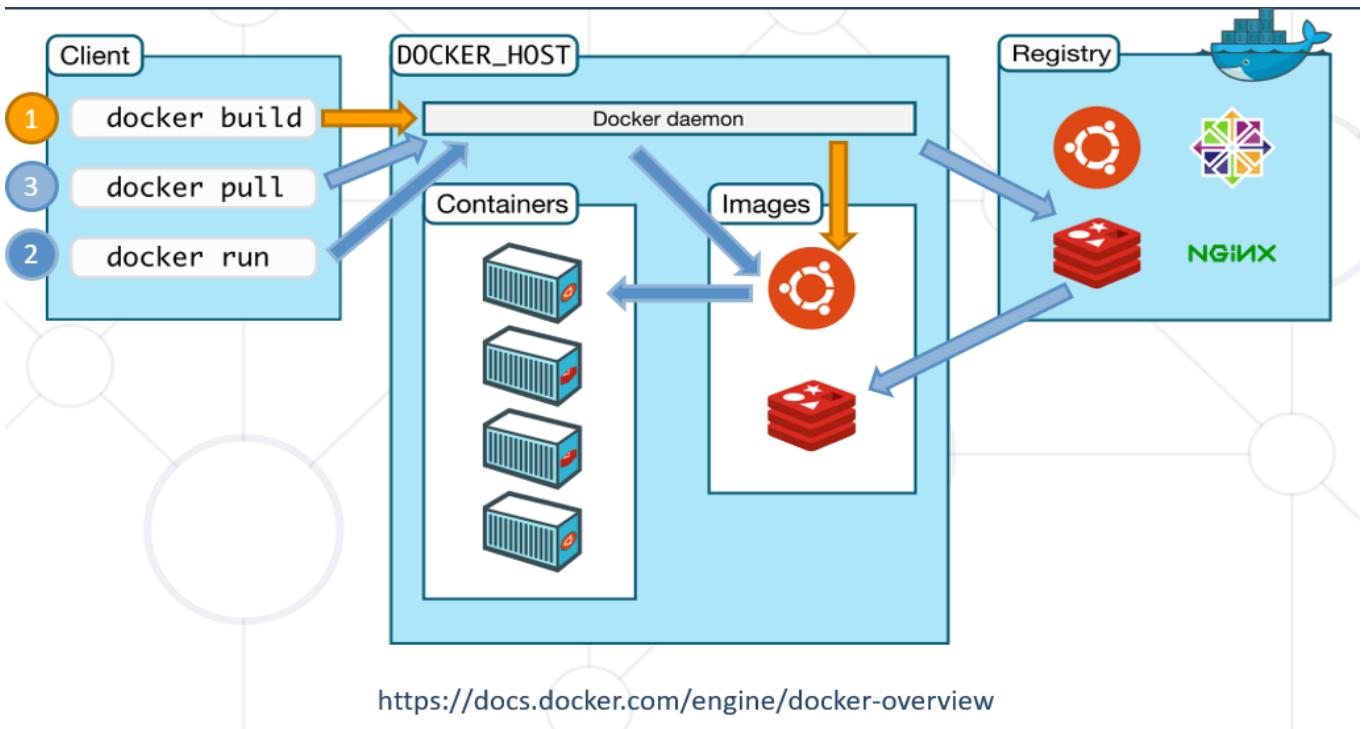
Workflow

docker build – създаване на docker image

docker pull – дърпане на image от регистри

docker run – стартирай ми контейнер

docker push – ако локално ние направим update и искали нашия image да го дистрибутираме към регистрирано.



<https://docs.docker.com/engine/docker-overview>

Client – Docker CLI (Docker Command Line Interface)

Docker host – това реално е Docker engine-а == Docker daemon

Не е задължително CLI и Docker host да са на една и съща машина. Но в прости думи – това е една и съща машина.

Docker платформата върви само на Линукс. С други думи на Windows и на MacOS пуска виртуална машина на Линукс, за да може да запали Докера.

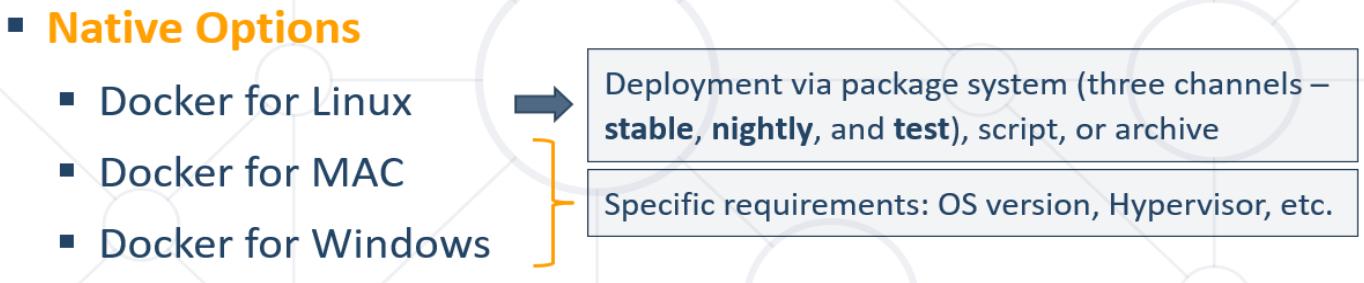
Registry – място където се споделят images – нещо като MVN repository

<https://hub.docker.com/>

2.3. Docker Installation

What We Need to Know?

- **Two Editions** (Community and Enterprise)
- **Native Options**
 - Docker for Linux – без Desktop 😊
 - Docker Desktop for MAC
 - Docker Desktop for Windows
- **Docker Toolbox** (deprecated) - All-in-one solution
 - For Mac and Windows



2.4. Working with Docker

Docker е оптимизиран откъм бързина, но не и откъм дисково пространство

Pull / Image Pull

- Purpose
 - Pull an image or a repository from a registry
- Old syntax

docker pull [OPTIONS] NAME[:TAG | @DIGEST]

- New syntax
- Example

docker image pull [OPTIONS] NAME[:TAG | @DIGEST]

- Example

docker image pull ubuntu:latest

Run / Container Run

- Purpose
 - Run a command in a new container
- Old syntax

docker run [OPTIONS] IMAGE [COMMAND] [ARG]

docker run -it ubuntu :latest // -it идва от interactive TTY – да имаме достъп отвън до контейнера отвътре
 docker run -it ubuntu :latest /bin/bash стартирай ми контейнера с имидж Ubuntu, и стартирай отвътре bash-a
 docker run -it nginx самият nginx може да пуска web приложение
 docker run -p 8080:80 nginx -p опция за forwarding of traffic (port forwarding)

Лявата страна на порта “8080:8080” е на нашата линукс сървърна машина, а дясната страна на порта е каквото е вътре в пуснатия един или няколко контейнера от image nginx.

docker run -d -p 8080:80 nginx -d опция за пускане на процеса в background/long run – като се изпълни процеса, то процеса остава и не се самоизчиства!

docker run -d -p 8081:80 nginx

docker ps						
CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES
2b171cfb6d1d	nginx	"/docker-entrypoint..."	17 seconds ago	Up 16 seconds	0.0.0.0:8081->80/tcp	heuristic_wozniak
44f014f68fe6	nginx	"/docker-entrypoint..."	About a minute ago	Up About a minute	80/tcp	heuristic_tharp
5bd2b56352b7	nginx	"/docker-entrypoint..."	3 minutes ago	Up 3 minutes	0.0.0.0:8080->80/tcp	hardcore_torvalds

- New syntax

docker container run [OPTIONS] IMAGE [COMMAND] [ARG]

- Example

```
docker container run -it ubuntu
```

Exec

Ако имаме няколко контейнера активни, то в нов терминал да си достъпим отвътре някой действащ контейнер примерно.

Runs a new command in a running container.

docker ps						
CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES
2b171cfb6d1d	nginx	"/docker-entrypoint..."	17 seconds ago	Up 16 seconds	0.0.0.0:8081->80/tcp	heuristic_wozniak
44f014f68fe6	nginx	"/docker-entrypoint..."	About a minute ago	Up About a minute	80/tcp	heuristic_tharp
5bd2b56352b7	nginx	"/docker-entrypoint..."	3 minutes ago	Up 3 minutes	0.0.0.0:8080->80/tcp	hardcore_torvalds

```
docker exec -it hardcore_torvalds bash
```

docker exec -it 5bd bash само с част от container id-то стават доста от докер командите

Kill

docker ps						
CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES
2b171cfb6d1d	nginx	"/docker-entrypoint..."	17 seconds ago	Up 16 seconds	0.0.0.0:8081->80/tcp	heuristic_wozniak
44f014f68fe6	nginx	"/docker-entrypoint..."	About a minute ago	Up About a minute	80/tcp	heuristic_tharp
5bd2b56352b7	nginx	"/docker-entrypoint..."	3 minutes ago	Up 3 minutes	0.0.0.0:8080->80/tcp	hardcore_torvalds

```
docker kill 5bd
```

само с част от container id-то стават доста от докер командите

Prune

Deletes both containers and images

```
docker system prune -a
```

```
> docker system prune -a
WARNING! This will remove:
- all stopped containers
- all networks not used by at least one container
- all images without at least one container associated to them
- all build cache
```

```
Are you sure you want to continue? [y/N] ■
```

Run container with a specific volume / Bind Mount

```
docker run -d -p 8080:80 -v /tmp/nginx:/user/share/nginx/html nginx
```

Рънни контейнер от nginx имидж, като копирай всичко от папка /tmp/nginx вътре в контейнера на път /user/share/nginx/html – като **-v** указва, че един вид това е volume. В случая този ред означава **Bind Mount** – директна връзка между външния свят и контейнра вътре, и е по-различно от volume. Volume заема произволно място на хост машината, докато в нашия случай ние сме си направили папка отвън, която да се копира вътре в контейнера.

Images / Image Ls

- Purpose

- List locally available images

- Old syntax

```
docker images [OPTIONS] [REPOSITORY[:TAG]]
```

- New syntax

`docker image ls [OPTIONS] [REPOSITORY[:TAG]]`

- Example

docker image ls fedora

Image inspect

```
docker image inspect my-java-app
```

```
1e/diff:/var/lib/docker/overlay2/c1c556891a4b387e3cd5b1eb1b3e72ddf9618d880159c0fdc3c20282263c
overlay2/352e44bf4faa4fa28471755c5a062584cd53900d5fa86b042522775bf450123e/diff:/var/lib/docker
5866cded237b6ca959a41fe5f4da006f497cccc18749b2fb3/diff:/var/lib/docker/overlay2/69e2716eaef228
ae0ff966c7a5409b3fe5631a1/diff:/var/lib/docker/overlay2/f2ff5ff0743396533cb831f5a2582a8e3810
a/diff",
        "MergedDir": "/var/lib/docker/overlay2/5h2pg3ob7dsgyvw3jew3woy8y/merged",
        "UpperDir": "/var/lib/docker/overlay2/5h2pg3ob7dsgyvw3jew3woy8y/diff",
        "WorkDir": "/var/lib/docker/overlay2/5h2pg3ob7dsgyvw3jew3woy8y/work"
    },
    "Name": "overlay2"
},
"RootFS": {
    "Type": "layers",
    "Layers": [
        "sha256:238e596eb101589755d14f2ad4a1979baa274147028bba76728b1b0a069c00e0",
        "sha256:351c9245173ad79b70abebe2c44a002e1966bf51ee0c592f1fc9e26a5eee8d37",
        "sha256:cc1604552e8286c86aad38dd0a81601bfbc836d49209b3eddf35457cf8b80f1",
        "sha256:c8741e780eeeefe4ba8ebbd08c35fdff7ecf28286408d236659928d3200703f13",
        "sha256:51694068bea664bd3ff337c8f147317fd4be41d39bf2b2b1ec58e37a0026c478",
        "sha256:3ee88a4da75a259f4df34bab26b62cae0db0fe01d60e1068a64b2a473a6ed48",
        "sha256:0c6ca47e35cfc6c1cd4705313cb1ae655c2d2c29d9a8df8abf1beaa2237275c7",
        "sha256:384dbe05c6ffd4f2b1f60d815d6ad423e60f456eba335a2e500174215e84454d",
        "sha256:db3e6ea1533dbe938ee30aae5448c4bca85b9c9ef177575018aaaf13911fc8",
        "sha256:7a3c52f719ba115637bf68a865f56c9a80fc88a135e2f921232fb12adb2d2483",
        "sha256:6c5a1b441c4b1ff401ff0af9b95ef6333db664f4fe3dc7fa51ee0b4f911859f7",
        "sha256:d3f9ca649fffb02f8bb3857f7212ff18f7a75467f9d41717fb249b9a26a07ca5"
    ],
    "Metadata": {
        "LastTagTime": "2024-02-08T12:00:44.233639383Z"
    }
}
```

```
        },
        "Architecture": "arm64",
        "Variant": "v8",
        "Os": "linux",
        "Size": 939514102,
        "VirtualSize": 939514102,
        "GraphDriver": {
            "Data": {
```

Ps / Container Ls

- Purpose
 - List containers
 - Old syntax

docker ps [OPTIONS]

- #### ■ New syntax

docker container ls [OPTIONS]

- Example

```
docker container ls -a -q
```

Rm / Container Rm

- Purpose
 - Remove one or more containers
- Old syntax

docker rm [OPTIONS] CONTAINER [CONTAINER]

- New syntax

docker container rm [OPTIONS] CONTAINER [CONTAINER]

- Example

docker container rm weezy_snake

Rmi / Image Rm

- Purpose
 - Remove one or more images
- Old syntax

docker rmi [OPTIONS] IMAGE [IMAGE]

- New syntax

docker image rm [OPTIONS] IMAGE [IMAGE]

- Example

docker image rm ubuntu fedora

Start / Container Start

- Purpose
 - Start one or more stopped containers
- Old syntax

docker start [OPTIONS] CONTAINER [CONTAINER]

- New syntax

docker container start [OPTIONS] CONTAINER [CONTAINER]

- Example

docker container start -a -i 0cbf27183

Restart / Container Restart

- Purpose
 - Restart a one or more containers
- Old syntax

docker restart [OPTIONS] CONTAINER [CONTAINER]

- New syntax

docker container restart [OPTIONS] CONTAINER [CONTAINER]

- Example

docker container restart 0cbf27183

Stop / Container Stop

- Purpose
 - Stop one or more running containers
- Old syntax

docker stop [OPTIONS] CONTAINER [CONTAINER]

- New syntax

docker container stop [OPTIONS] CONTAINER [CONTAINER]

- Example

docker container stop 0cbf27183

Unpause / Container Unpause

- Purpose
 - Unpause all processes within one or more containers
- Old syntax

docker unpause CONTAINER [CONTAINER]

- New syntax

docker container unpause CONTAINER [CONTAINER]

- Example

docker container unpause 0cbf27183

Attach / Container Attach

- Purpose
 - Attach to a running container
- Old syntax

docker attach [OPTIONS] CONTAINER

- New syntax

docker container attach [OPTIONS] CONTAINER

- Example

docker container attach 0cbf27183

docker -exec

Push / Image Push

- Purpose
 - Push an image or repository to a registry
- Old syntax

docker push [OPTIONS] NAME[:TAG]

- New syntax

docker image push [OPTIONS] NAME[:TAG]

- Example

```
docker image push repo-name/test:latest
```

Login to Docker registry

- Purpose
 - Log into a Docker registry
- Old syntax

```
docker login [OPTIONS] [SERVER]
```

- New syntax

```
docker login [OPTIONS] [SERVER]      като стария синтаксис
```

- Example

```
docker login
```

Logout from Docker registry

- Purpose
 - Log out from a Docker registry
- Old syntax

```
docker logout [SERVER]
```

- New syntax

```
docker logout [SERVER]      като стария синтаксис
```

- Example

```
docker logout
```

2.5. Image from DockerFile – изпичане на docker файл

General Structure (Dockerfile)

- Script, composed of commands and arguments
- Always begins with FROM instruction

```
# Set the base image
```

```
FROM nginx      Comment
```

```
# Set the maintainer
```

```
MAINTAINER John Smith      Command (Instruction)
```

```
# Copy files
```

```
COPY index.html /usr/share/nginx/html/
```

FROM

- Purpose
 - Defines the base image to use to start the build process
- Syntax

```
FROM <image>[:<tag>] [AS <name>]
```

- Example

```
# it is a good practice to state a version (tag)
```

```
FROM ubuntu:18.04
```

```
# for the latest version the tag could be skipped
```

```
FROM ubuntu
```

MAINTAINER

- Purpose

- Sets the author field of the image. It is deprecated

- Syntax

```
MAINTAINER <name>
```

- Example

```
# deprecated
```

```
MAINTAINER John Smith
```

```
# newer variant is this:
```

```
LABEL maintainer="John Smith"
```

RUN

- Purpose

- Used during build process to add software (forms another layer)

- Syntax

```
RUN <command>
```

- Example

```
# single command
```

```
RUN apt-get -y update
```

```
# more than one command
```

```
RUN apt-get -y update && apt-get -y upgrade
```

COPY

- Purpose

- Copy files between the host and the container

- Syntax

```
COPY [--chown=<user>:<group>] <src>... <dest>
```

- Example

```
# Copy single file
```

```
COPY readme.txt /root
```

```
# Copy multiple files
```

```
COPY *.html /var/www/html/my-web-app
```

ADD

- Purpose

- Copy files to the image

- Syntax

```
ADD [--chown=<user>:<group>] <src>... <dest>
```

- Example

Add single file from URL

```
ADD https://softuni.bg/favicon.ico /www/favicon.ico
```

Add tar file content

```
ADD web-app.tar /var/www/html/my-web-app
```

EXPOSE

- Purpose

- Informs Docker that the container listens on the specified ports

- Syntax

```
EXPOSE <port> [<port>/<protocol>...]
```

- Example

single port

```
EXPOSE 80
```

multiple ports

```
EXPOSE 80 8080
```

ENTRYPOINT

- Purpose

- Allows configuration of container that will run as an executable
- **Задължителната команда, която ще се изпълни в началото**

- Syntax

exec form, this is the preferred form

```
ENTRYPOINT ["executable", "param1", "param2"]
```

shell form

```
ENTRYPOINT command param1 param2
```

CMD

- Purpose

- Main purpose is to provide defaults for an executing container
- **Дефолтната команда, която ще се изпълни в началото**

- Syntax

exec form, this is the preferred form

```
CMD ["executable", "param1", "param2"]
```

as default parameters to ENTRYPOINT

```
CMD ["param1", "param2"]
```

shell form

```
CMD command param1 param2
```

CMD vs ENTRYPOINT

- Both define what **command** gets **executed** when **running** a container
 - Dockerfile should specify at **least one** of them
 - **ENTRYPOINT** should be defined when using the **container** as an **executable**
 - **CMD** should be used as a way of defining **default arguments** for an **ENTRYPOINT** command or for **executing an ad-hoc command** in a container
 - **CMD** will be overridden when **running** the container with **alternative arguments**
-
- Both have **exec** and shell **form**
 - When used **together always** use their **exec** form

Когато се използват заедно или поотделно:

CMD команда може да заема няколко аргумента

		ENTRYPOINT	
CMD	N/A	exec_entry p1_entry	[“exec_entry”, “p1_entry”]
	Error	/bin/sh -c exec_entry p1_entry	exec_entry p1_entry
	["exec_cmd", "p1_cmd"]	exec_cmd p1_cmd	exec_entry p1_entry exec_cmd p1_cmd
	["p1_cmd", "p2_cmd"]	p1_cmd p2_cmd	exec_entry p1_entry p1_cmd p2_cmd
	exec_cmd p1_cmd	/bin/sh -c exec_cmd p1_cmd	exec_entry p1_entry /bin/sh -c exec_cmd p1_cmd

Build / Image Build

- Purpose
 - Build an image from a Dockerfile
- Old syntax

docker build [OPTIONS] PATH | URL | -

- New syntax

docker image build [OPTIONS] PATH | URL | -

- Example - **-t** означава сложи му таг, а точката е текущата директория

docker image build -t new-image .

Ако създаваме локално docker image на M1, M2, M3 MacOS компютър (ARM или ARM64 процесорна архитектура), то би имало проблем този имидж като го качим в регистрирано и други потребители си го изтеглят и пуснат контейнер на обикновен Линукс. Затова ако сме на MacOS пускаме следната команда и тогава е доста голям шанса да работи: **docker build buildx --platform linux/amd64 my-java-app**.

Доста често в практиката тези docker images се билдват от Jenkins/GitHub actions агенти, и тъй като се билдват (чрез buildAaA.yml) на Линукс сървър, тогава го нямаме този проблем с ARM64! Т.е. преместваме създаването/изпичането на докер image в CI/CD pipeline-a.

Dockerfile example workflow

Example 1:

Dockerfile-build

```

# We start from openjdk17 base image to have JDK installed
FROM eclipse-temurin:17-jdk
WORKDIR /app

COPY build/libs/petclinic-0.0.1-SNAPSHOT.jar app.jar //копирай jar файла като
app.jar вътре в контейнера

CMD ["java", "-jar", "app.jar"] //Read & Write layer

```

In the terminal:

docker build -t my-java-app . -t означава сложи му таг, а точката е текущата директория

docker run -p -d 8080:8080 my-java-app

Example 2:

Dockerfile-build

```

# We start from openjdk17 base image to have JDK installed
FROM eclipse-temurin:17-jdk
WORKDIR /app //same as RUN mkdir app && cd app

//организираме layers по честота на промяна – т.е. src ще се променя често, тогава
измести копиранятията за gradle по-горе – това ще ги сложи в кеша за следващ image
build ще се изпълнява по-бързо
COPY gradlew . //копирай gradlew файла вътре в контейнера
COPY gradle gradle/ //копирай съдържанието на gradle папката вътре в контейнера
в директория gradle/
COPY build.gradle.kts .
COPY settings.gradle.kts .

COPY src src/ //копирай съдържанието на src папката вътре в контейнера в
директория src/
RUN ./gradlew bootJar

EXPOSE 8080

CMD sh -c 'java -jar build/libs/*.jar' //Read & Write layer

```

In the terminal:

docker build -t my-java-app . -t означава сложи му таг, а точката е текущата директория

След като image-а е изпечен/създаден, то може да пуснем container от него:

docker run -it my-java-app /bin/bash

Example 3 – with maven offline:

Dockerfile-build

```

# We start from openjdk17 base image to have JDK installed
FROM eclipse-temurin:17-jdk
WORKDIR /app //same as RUN mkdir app && cd app

COPY maven???*** .

# 3 layers runs

```

```

RUN apt update
RUN apt install java
RUN apt install python

# preferable to be only 1 layer instead of 3 layers!!!
RUN apt update && apt install java && apt install python

RUN mvn dependencies:go-offline

COPY src src/

RUN ./mvnw package

EXPOSE 8080

CMD sh -c 'java -jar build/libs/*.jar'

```

Example 4 – multistage

Заема по-малко място самият готов изпечен image

Dockerfile-multistage

```

# phase 1
FROM eclipse-temurin:17-jdk AS build
WORKDIR /app

COPY gradlew .
COPY gradle gradle/
COPY build.gradle.kts .
COPY settings.gradle.kts .

COPY src src/
RUN ./gradlew bootJar

# phase 2 - run the jar file
FROM eclipse-temurin:17-jre
WORKDIR /app

COPY --from=build /app/build/libs/*.jar app.jar

EXPOSE 8080
CMD sh -c 'java -jar app.jar'

```

Recommendations

- Don't create large images
- Don't use only the "latest" tag
- Don't run more than one process in a single container
- Don't rely on IP addresses
- Put information about the author

2.6. Demo summary + Gradle Wrapper and Gradle for Windows

Gradle

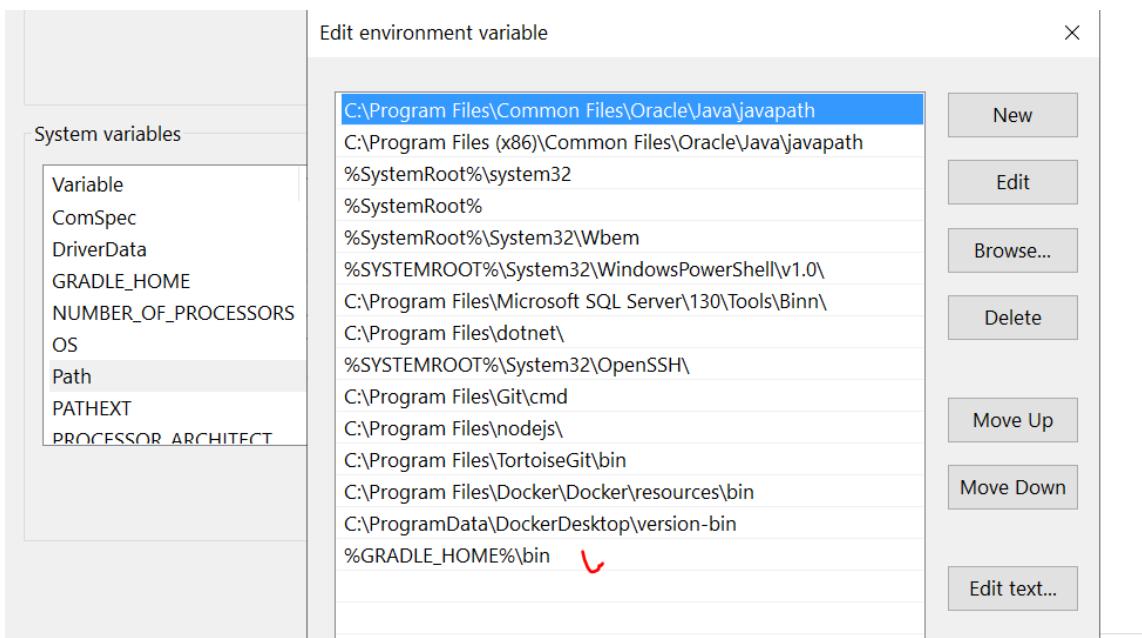
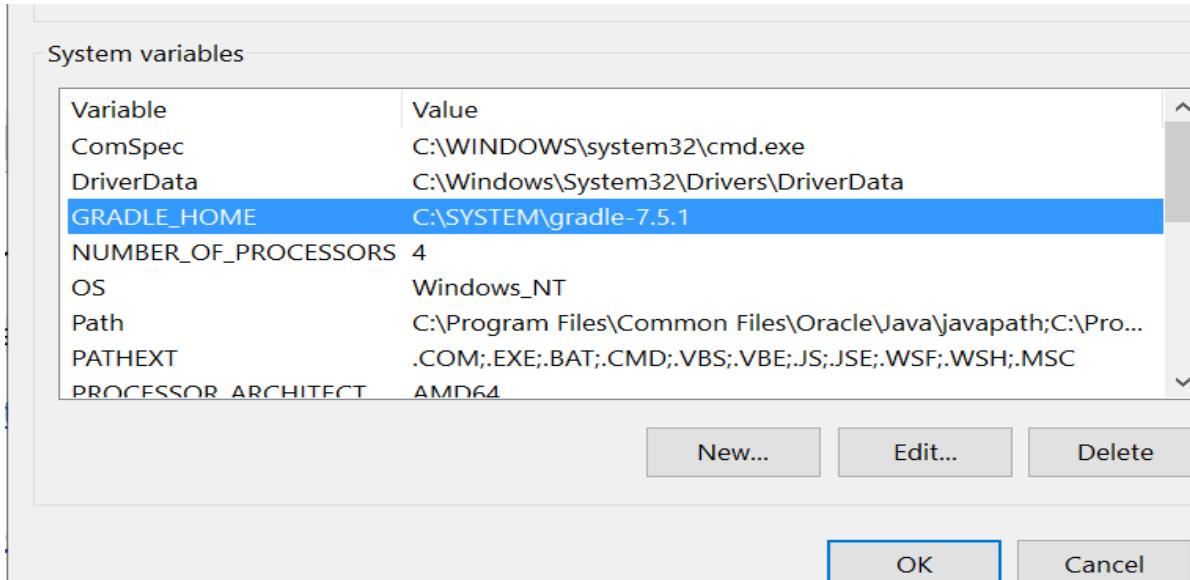
<https://tomgregory.com/what-is-the-gradle-wrapper-and-why-should-you-use-it/>

The Gradle wrapper is a script you add to your Gradle project and use to execute your build. The advantages are:

you don't need to have Gradle installed on your machine to build the project

the wrapper guarantees you'll be using the version of Gradle required by the project

you can easily update the project to a newer version of Gradle, and push those changes to version control so other team members use the newer version



```
gradle init
```

Running a build

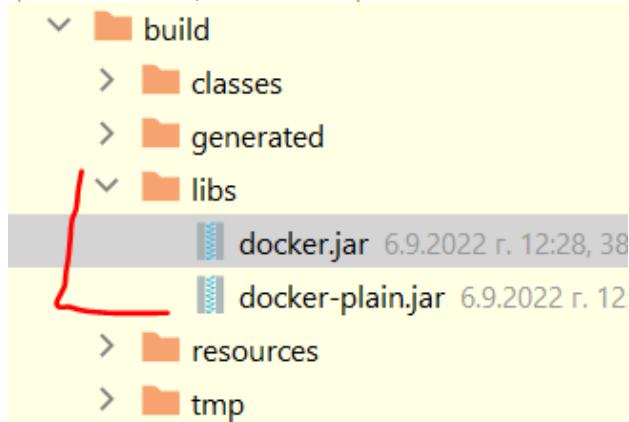
```
gradle build
```

```
gradle clean build
```

When you run the **build** command you'll see output like this.

This means that your application was assembled and any tests passed successfully. Gradle will have created a build directory if it didn't already exist, containing some useful outputs you should be aware of.

1. **the *classes* directory** contains compiled .class files, as a result of running the Java compiler against your application Java source files
2. **the *libs* directory** contains a generated jar file, an archive with all your compiled classes inside **ready to be executed or published** – ако махнем версията от build.gradle, то .jar файловете ще са с по-кратки имена.



- 3.
4. **the *reports* directory** contains an HTML report summarising your test results. If your build fails, then consult this report to see what went wrong.

You now know that running the Gradle build command is equivalent to running the build task, which you do in Windows with `gradlew build` and on Linux/Mac with `./gradlew build`. The *build* task depends on other tasks, and in some situations it may make sense to run a more specific task.

След което можем да го пуснем/run-нем този jar
`java -jar ./build/libs/docker.jar`

За да създадем .jar файл с Gradle, то тестовете трябва да минават

Maven

За да създадем .jar файл с Maven, то тестовете трябва да минават

Файлът /deployment/**Dockerfile**:



```
COPY build/libs/docker.jar app.jar
ENTRYPOINT ["java","-Djava.security.egd=file:/dev/.urandom -Xms256m -Xmx512m", "-jar","/app.jar"]
```

Ако използваме Maven, тези думички били различни
build/libs

От основната директория на проекта ни, под CMD на Windows пускаме следната команда

C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example>

docker build -t svilevvelikov/demo1:v1 -f deployment/Dockerfile .

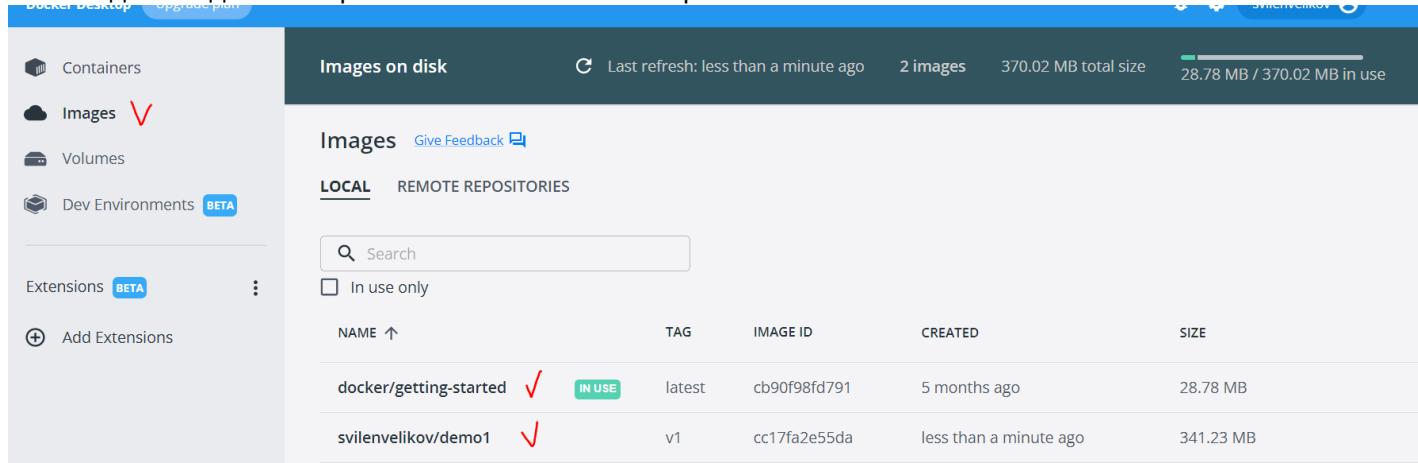
създай от .jar файла **image** с име demo1 версия 1 на user svilevvelikov и от текущата директория която е точка, изпълни Dockerfile.

docker images

в терминала показва всички имиджи качени на докер към момента

```
C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example>docker images
REPOSITORY          TAG      IMAGE ID      CREATED        SIZE
svilevvelikov/demo1    v1      cc17fa2e55da   5 minutes ago  341MB
docker/getting-started  latest   cb90f98fd791   4 months ago  28.8MB
```

Можем да ги видим и от приложението DockerDesktop



NAME	TAG	IMAGE ID	CREATED	SIZE
docker/getting-started	latest	cb90f98fd791	5 months ago	28.78 MB
svilevvelikov/demo1	v1	cc17fa2e55da	less than a minute ago	341.23 MB

I) Пускане на docker image-a

C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example>
docker run -p 8080:8080 svilevvelikov/demo1:v1

Когато image-a се run-не, то той става контейнер.

docker ps

покажи текущо активни контейнери

Качи image-a на облака docker repositories

docker push svilevvelikov/demo2:v2

останалите images са част от jdk и няма нужда да се пушват

```
PS C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example> docker push svilenvelikov/demo2:v2
The push refers to repository [docker.io/svilenvelikov/demo2]
4ced9a8f798d: Pushed
5a7e7a880634: Mounted from library/openjdk
3dccaa93bb0e: Mounted from library/openjdk
5c384ea5f752: Mounted from library/openjdk
293d5db30c9f: Mounted from library/openjdk
03127cdb479b: Mounted from library/openjdk
9c742cd6c7a5: Mounted from library/openjdk
v2: digest: sha256:3232e698c894f814aea10bb0e5ecbd61af3562e9b8bdea73dab5cb4d49acc547 size: 1794
```

Remove-ване на спрян контейнер

При опит да изтрием docker image:

Error response from daemon: conflict: unable to delete **5d4cf7396db** (must be forced) - image is being used by stopped container **d61b2cca0024**

```
PS C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example> docker rm
d61b2cca0024
```

Remove-ване на самия docker image

```
PS C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example> docker rmi
5d4cf7396db
```

Untagged: svilenvelikov/demo2:v2

Untagged: svilenvelikov/demo2@sha256:3232e698c894f814aea10bb0e5ecbd61af3562e9b8bdea73dab5cb4d49acc547

Deleted: sha256:5d4cf7396db1e26c28c46c664427ad0041b8afa23c23aeb5c8f4b28091e9ac6

Търси първо локално, след това търси от облака

Ако пуснем команда за рънване на изтрития локално image, то първо търси локално, след това търси на облака docker repositories

```
docker run -p 8080:8080 svilenvelikov/demo2:v2
```

```
PS C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example> docker run -p 8080:8080
svilenvelikov/demo2:v2
Unable to find image 'svilenvelikov/demo2:v2' locally
v2: Pulling from svilenvelikov/demo2
001c52e26ad5: Already exists
d9d4b9b6e964: Already exists
2068746827ec: Already exists
8510da692cda: Already exists
b6d84395b34d: Already exists
bf03fea6c3ad: Already exists
7ac2c538825b: Already exists
Digest: sha256:3232e698c894f814aea10bb0e5ecbd61af3562e9b8bdea73dab5cb4d49acc547
Status: Downloaded newer image for svilenvelikov/demo2:v2
```

II) Пускане на повече docker images - как 2 image-а си говорят когато са качени на Docker

PS C:\Temp projects\Spring Advanced\12 Containerization & Documentation\docker_example>

Docker Compose is a tool that was developed to help define and share multi-container applications. With Compose, we can create a YAML file to define the services and with a single command, can spin everything up or tear it all down.

`docker-compose -f ./local/local.yaml up`

`docker-compose -f ./local/local.yaml down`

Ако нямаме локално инсталиран MySQL например

The screenshot shows a file explorer interface with two main sections. The top section displays the contents of `local.yaml`, which defines two services: `db` and `docker-demo`. The `db` service uses the `arm64v8/mysql:oracle` image, maps port `3306:3306`, and runs a command to set character set and collation. The `docker-demo` service uses the `svilenvelikov/docker-demo:v3` image, maps port `8080:8080`, and sets environment variables for MySQL host, user, and password. The bottom section displays the contents of `application.yml`, which configures a Spring datasource to connect to the MySQL database using the `com.mysql.cj.jdbc.Driver` and the URL `jdbc:mysql://${MYSQL_HOST}:3306/demodocker?useSSL=false&createDatabaseIfNotExist=true&serverTimezone=UTC`.

```
version: '3.3'
services:
  db:
    image: arm64v8/mysql:oracle
    ports:
      - "3306:3306"
    command: ['--character-set-server=utf8mb4', '--collation-server=utf8mb4_bin', '--default-authentication-plugin=mysql_native_password']
    environment:
      - MYSQL_ALLOW_EMPTY_PASSWORD="yes"
      - MYSQL_DATABASE=intro
  docker-demo:
    image: svilenvelikov/docker-demo:v3
    ports:
      - "8080:8080" # web ui
    environment:
      - MYSQL_HOST=db
      - MYSQL_USER=root
      - MYSQL_PASSWORD=

```



```
application.yml
spring:
  datasource:
    driverClassName: com.mysql.cj.jdbc.Driver
    url:
      "jdbc:mysql://${MYSQL_HOST}:3306/demodocker?useSSL=false&createDatabaseIfNotExist=true&serverTimezone=UTC"
    username: "${MYSQL_USER:root}"
    password: "${MYSQL_PASSWORD:}"
```

III) Пускане на docker image с CMD опция

При стартиране на docker image-а да прави ping

При първата команда ping-ва от локалния сървър localhost/от локалния компютър.

При втората команда овъррайдваме CMD-то да бъде google.com и сега ping-ва от google.com

ENTRYPOINT не може да се override-не

```
FROM debian:wheezy
ENTRYPOINT ["/bin/ping"]
CMD ["localhost"]
}
$ docker run -it test
PING localhost (127.0.0.1): 48 data bytes

$ docker run -it test google.com
PING google.com (173.194.45.70): 48 data bytes
```

3. Kubernetes and orchestration