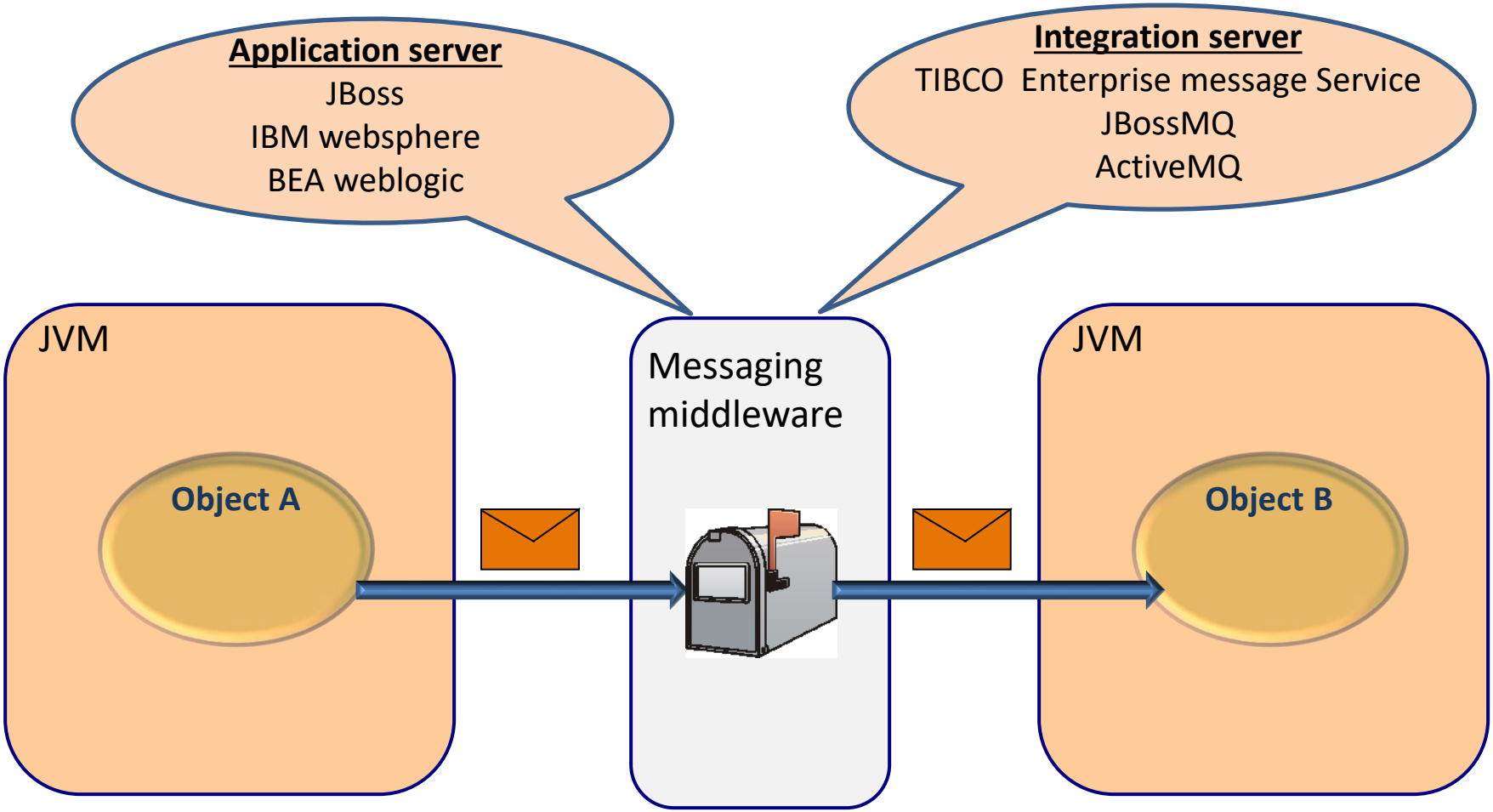
CS544

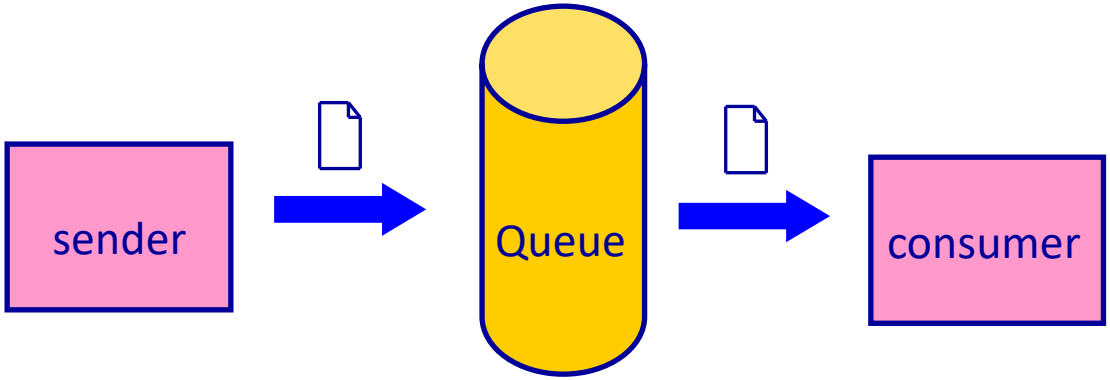
LESSON 11
MESSAGING

Java Message Service (JMS)



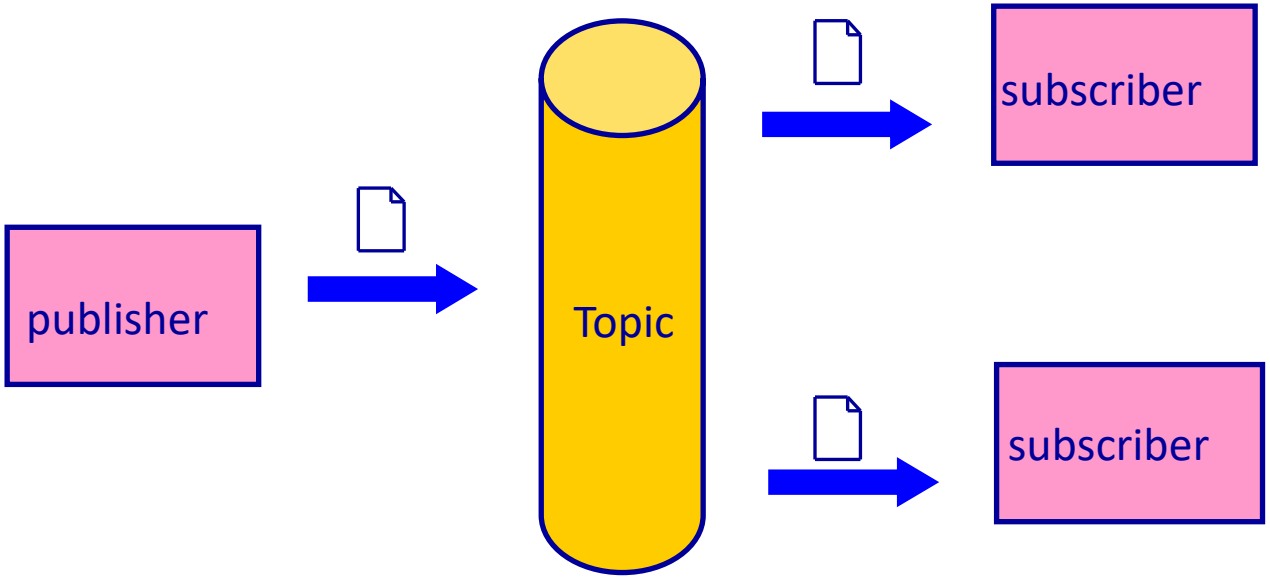
Point-To-Point (PTP)

- A dedicated consumer per Queue message



Publish-Subscribe (Pub-Sub)

- A message channel can have more than one '*consumer*'
  - Ideal for broadcasting



JMS sender

```
//Lookup a ConnectionFactory with JNDI
QueueConnectionFactory queueConnectionFactory = (QueueConnectionFactory)
jndiContext.lookup("MyJMS Connection Factory");
// Lookup a Destination with JNDI
Queue queue = (Queue) jndiContext.lookup("MyJMSQueue");
// Use the ConnectionFactory to create a Connection
QueueConnection queueConnection = queueConnectionFactory.createQueueConnection();
// Use the Connection to create a Session
QueueSession queueSession =
                queueConnection.createQueueSession(false,Session.AUTO_ACKNOWLEDGE);
// Use the Session to create a MessageProducer for this queue
QueueSender queueSender = queueSession.createSender(queue);
// Use the Session to create a Message
TextMessage message = queueSession.createTextMessage();
message.setText("Hello World");
// Use the MessageProducer to send the Message
queueSender.send(message);
```

JMS receiver

```
//Lookup a ConnectionFactory with JNDI
QueueConnectionFactory queueConnectionFactory = (QueueConnectionFactory)
jndiContext.lookup("MyJMS Connection Factory");
// Lookup a Destination with JNDI
Queue queue = (Queue) jndiContext.lookup("MyJMSQueue");
// Use the ConnectionFactory to create a Connection
QueueConnection queueConnection = queueConnectionFactory.createQueueConnection();
// Use the Connection to create a Session
QueueSession queueSession =
             queueConnection.createQueueSession(false,Session.AUTO_ACKNOWLEDGE);
// Use the Session to create a MessageReceiver for this queue
QueueReceiver queueReceiver = queueSession.createReceiver(queue);
//Start the connection such that messages get delivered
queueConnection.start();
//Receive the message
Message m = queueReceiver.receive(1);
TextMessage message = (TextMessage) m;
System.out.println("Receiving message: " +message.getText());
```

Spring ActiveMQ libraries

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-activemq</artifactId>
</dependency>
```

Spring JMS sender

```
@SpringBootApplication
@PropertySource(value = "classpath:application.properties")
@EnableJms
public class SpringJmsSenderApplication {

  public static void main(String[] args) {
    AnnotationConfigApplicationContext context = new
       AnnotationConfigApplicationContext(SpringJmsSenderApplication.class);
    JmsTemplate jmsTemplate = context.getBean(JmsTemplate.class);

    System.out.println("Sending a JMS message.");
    jmsTemplate.convertAndSend("testQueue", "Hello world!");
  }
}
```

Name of the queue

application.properties

```
spring.activemq.broker-url=tcp://localhost:61616
spring.activemq.user=admin
spring.activemq.password=admin
```

Spring JMS receiver

```java
@Component
public class MessageListener {

    @JmsListener(destination = "testQueue")
    public void receiveMessage(String msg) {
        System.out.println("Received :" + msg);
    }
}
```

Name of the queue

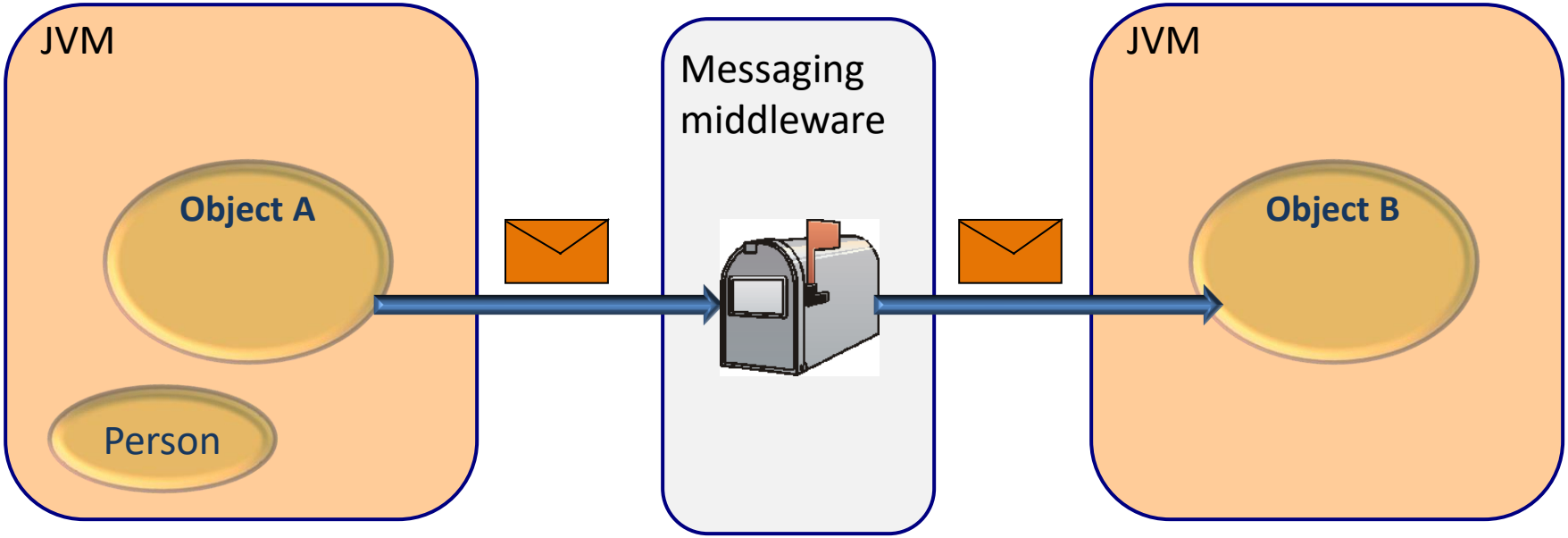
```java
@SpringBootApplication
@PropertySource(value = "classpath:application.properties")
@EnableJms
public class SpringJmsReceiverApplication {

  public static void main(String[] args) {
    AnnotationConfigApplicationContext context = new
        AnnotationConfigApplicationContext(SpringJmsReceiverApplication.class);

  }
}
```

application.properties

```
spring.activemq.broker-url=tcp://localhost:61616
spring.activemq.user=admin
spring.activemq.password=admin
```

Sending an object

```
public class Person {
  private String firstName;
  private String lastName;
  ...
}
```



Sending an object

```
@SpringBootApplication
@EnableJms
public class SpringJmsPersonSenderApplication implements CommandLineRunner {
  @Autowired
  JmsTemplate jmsTemplate;

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

  @Override
  public void run(String... args) throws Exception {
    Person person = new Person("Frank", "Brown");
    //convert person to JSON string
    ObjectMapper objectMapper = new ObjectMapper();
    String personAsString = objectMapper.writeValueAsString(person);

    System.out.println("Sending a JMS message:" + personAsString);
    jmsTemplate.convertAndSend("testQueue",personAsString);
  }

}
```

Convert object to JSON

Receiving an object

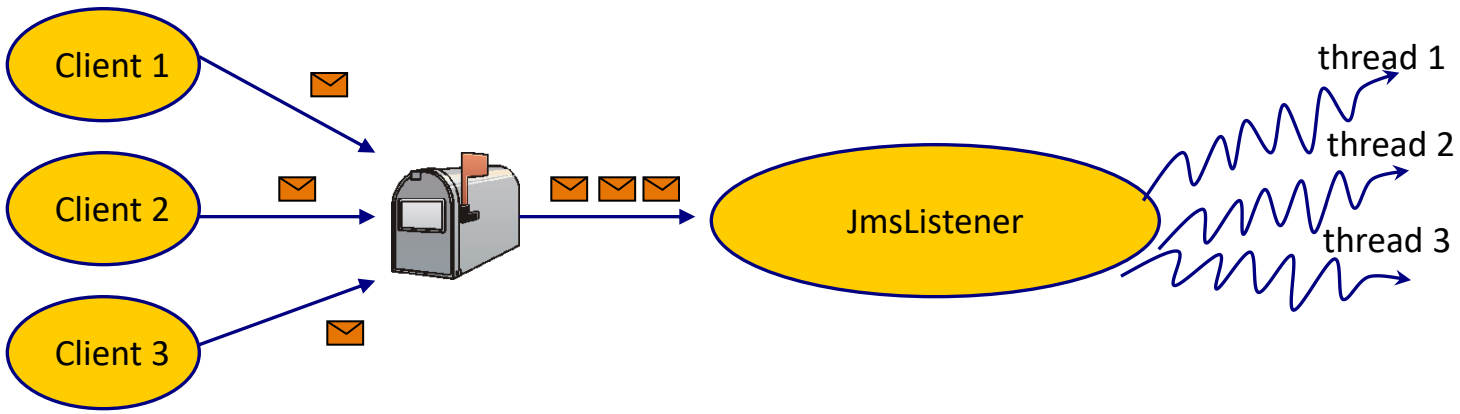
```
@SpringBootApplication
@EnableJms
public class SpringJmsReceiverApplication {
  public static void main(String[] args) {
    SpringApplication.run(SpringJmsReceiverApplication.class, args);
  }
}
```

```
@Component
public class PersonMessageListener {

  @JmsListener(destination = "testQueue")
  public void receiveMessage(final String personAsString) {
    ObjectMapper objectMapper = new ObjectMapper();
    try {
      Person person = objectMapper.readValue(personAsString, Person.class);
      System.out.println("JMS receiver received message:" + person.getFirstName()+" "+person.getLastName());

    } catch (IOException e) {
      System.out.println("JMS receiver: Cannot convert : " + personAsString+" to a Person object");
    }
  }
}
```

Convert JSON String to object

JMS and concurrency

- Every JmsListener method executes in its own thread



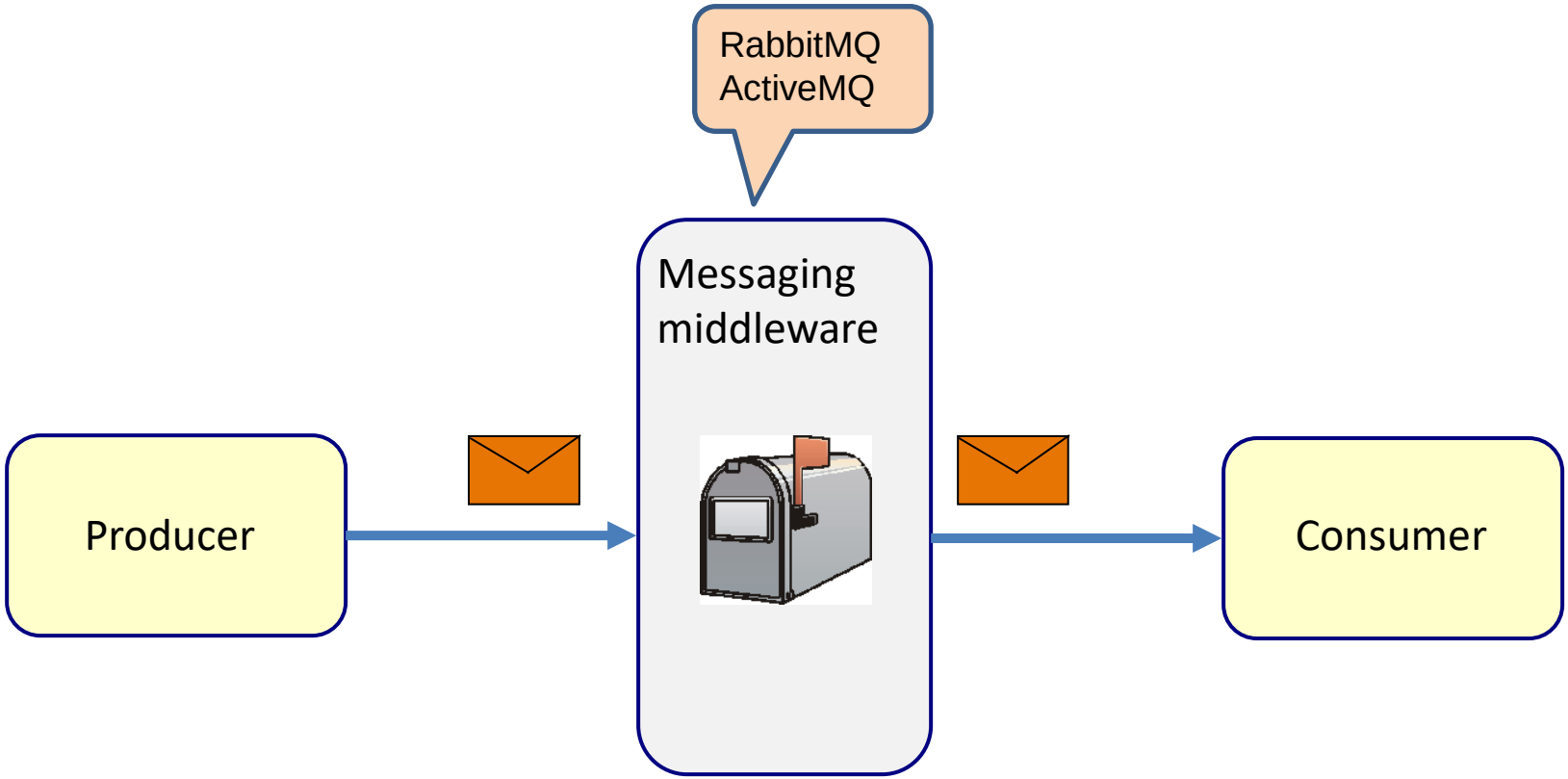
Main point

- Messaging gives loose coupling between the sender and the receiver.

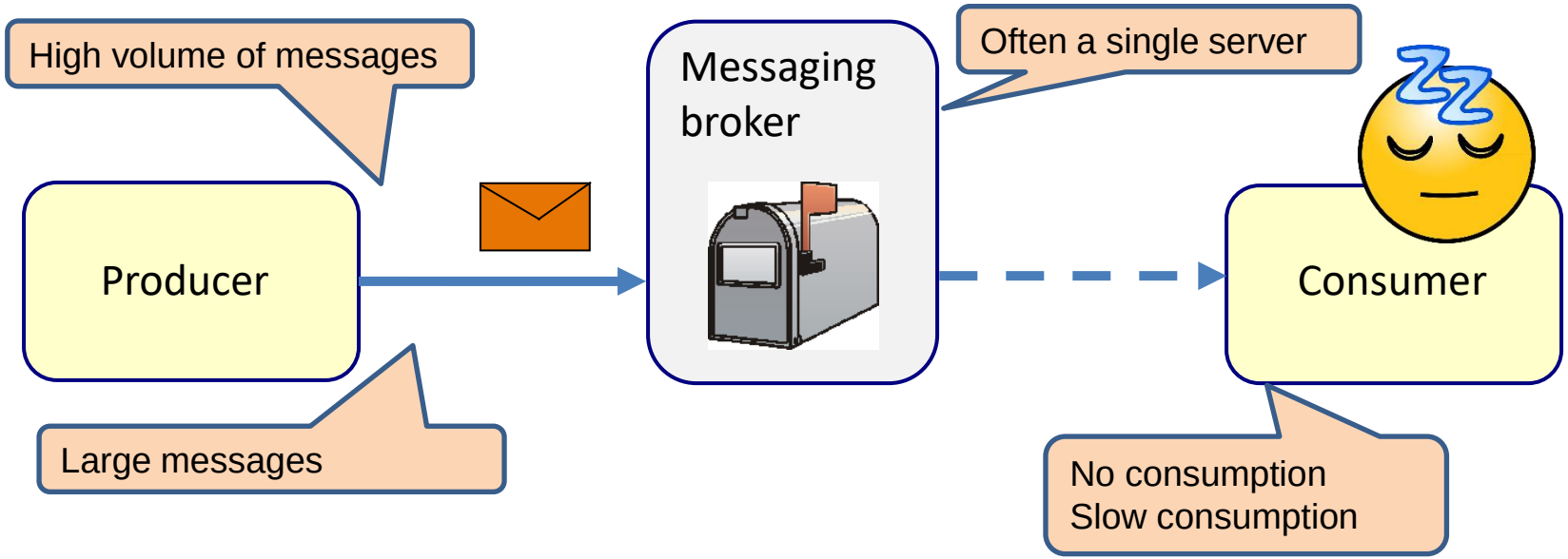
  Science of Consciousness: The whole relative creation is an expression of the same one unified field.

KAFKA

Traditional Messaging Systems

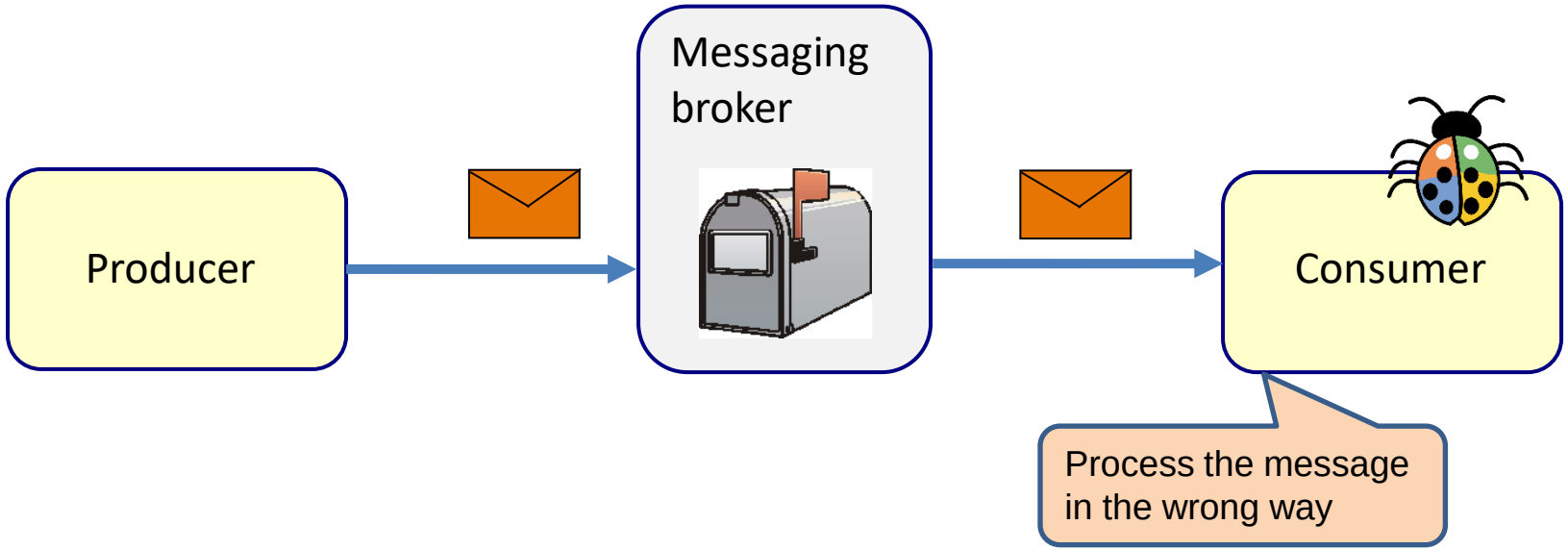


Problems with traditional messaging middleware



- If the consumer is temporally not available (or very slow) the message middleware has to store the messages
  - This restricts the volume of messages and the size of the messages
  - Eventually the message broker will fail

Problems with traditional messaging middleware



- If the consumer has a bug, and handles the messages incorrectly, then the messages are gone.
  - Not fault-tolerant

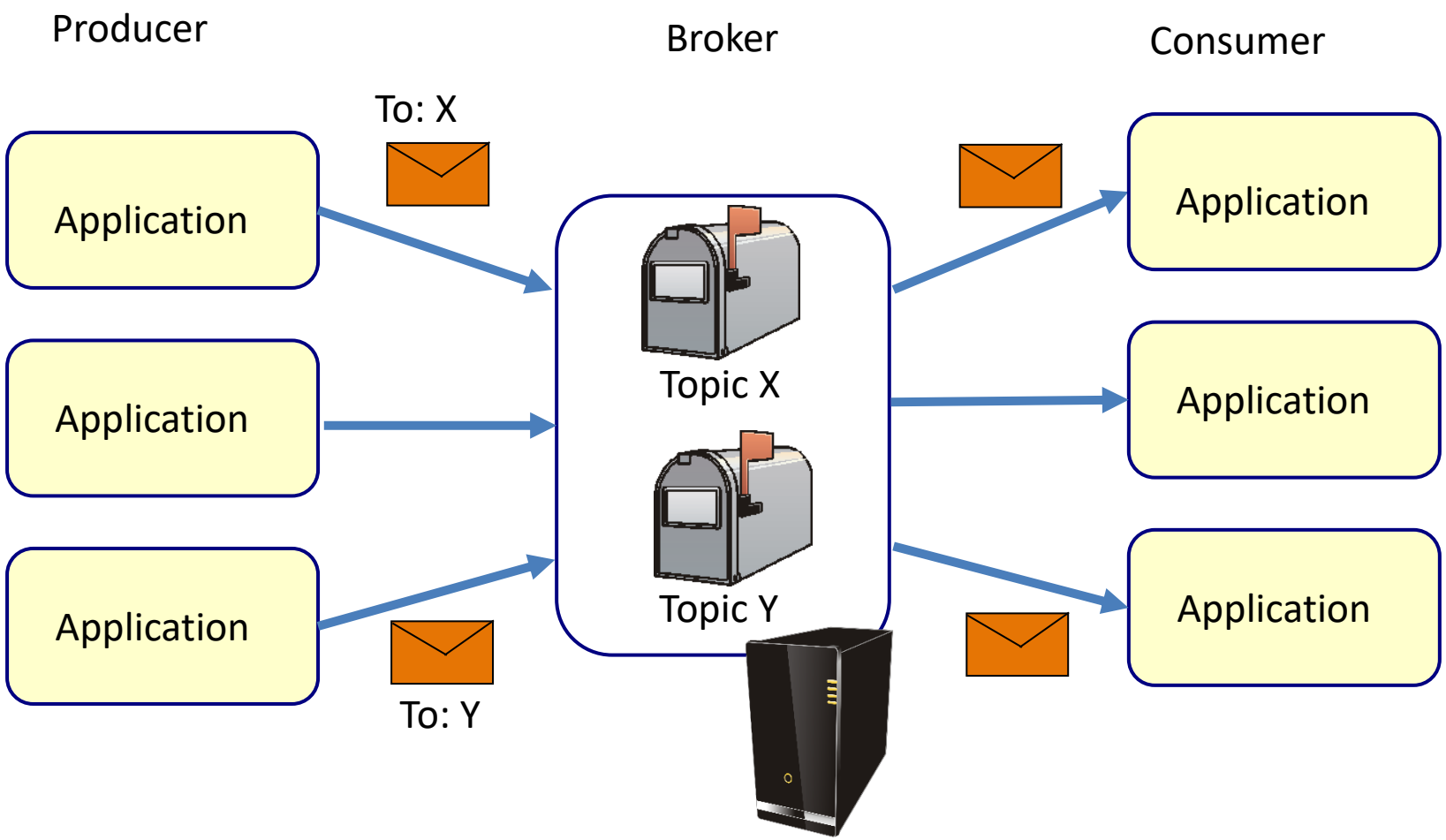
Apache Kafka

- Created by Linked In
- Characteristics
  - High throughput
  - Distributed
  - Unlimited scalable
  - Fault-tolerant
    - Reliable and durable
  - Loosely coupled Producers and Consumers
  - Flexible publish-subscribe semantics

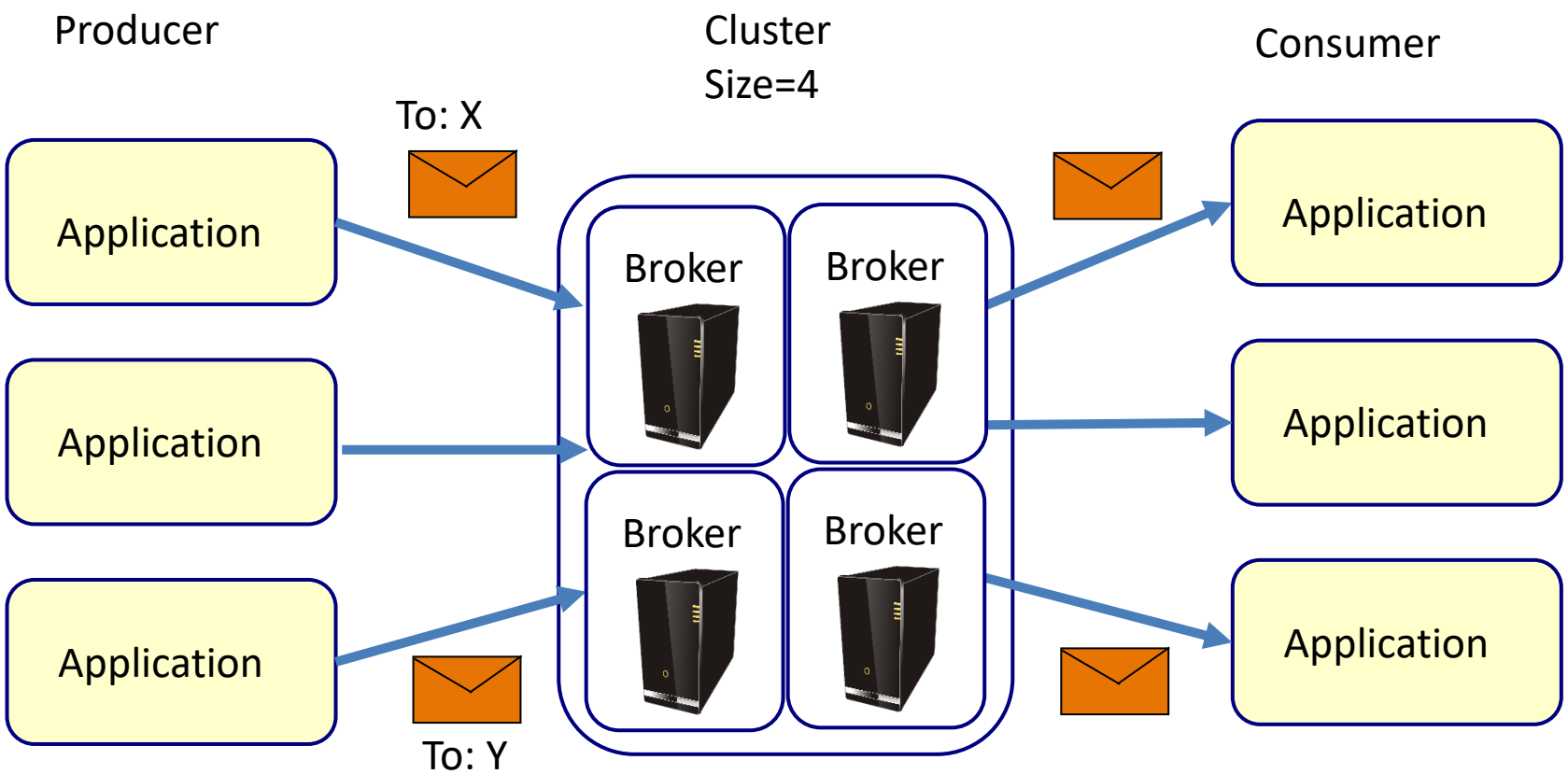
High Volume:
- Over 1.4 trillion messages per day
- 175 terabytes per day

High Velocity:
- Peak 13 million messages per second
- 2.75 gigabytes per second

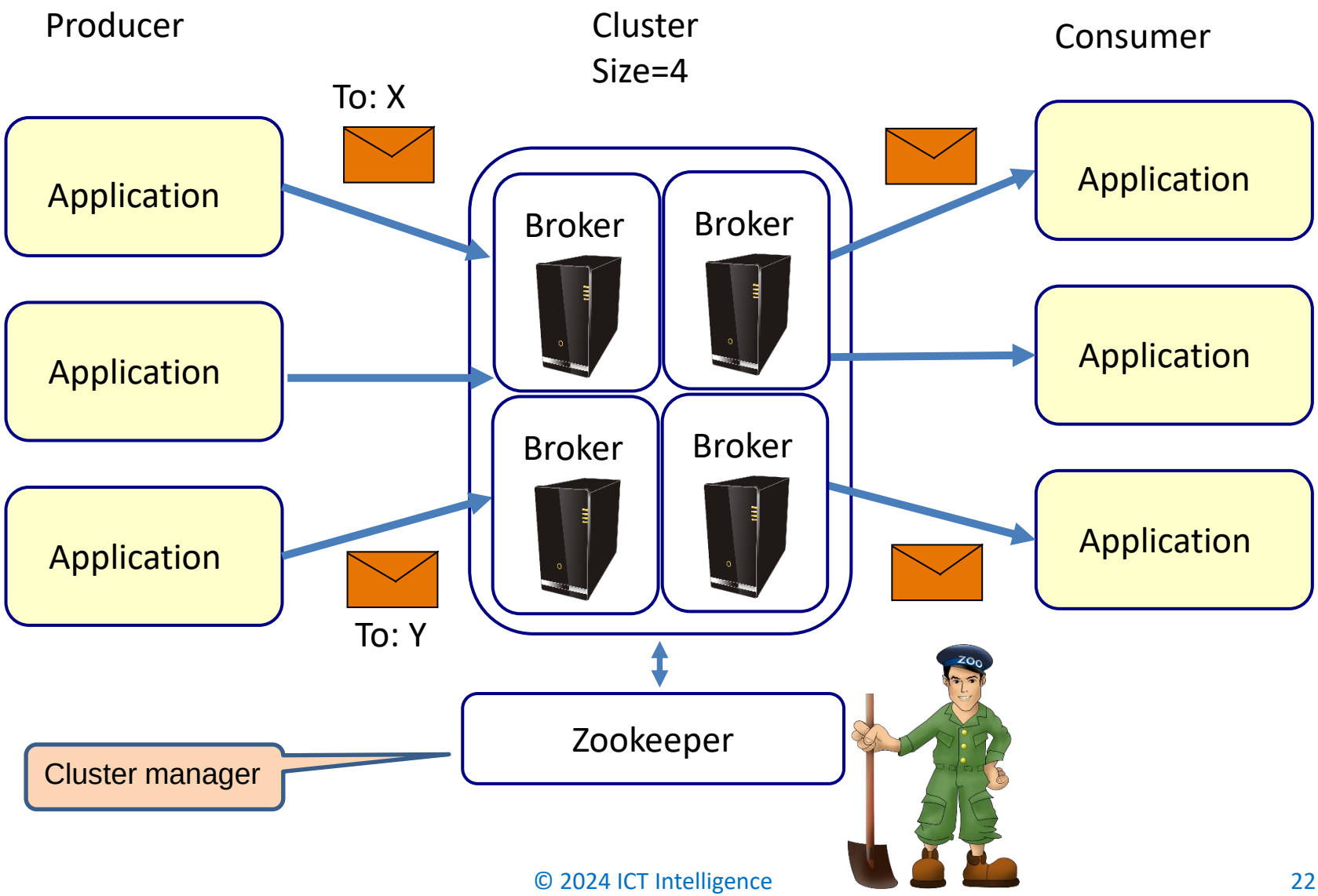
Kafka


Producer
Broker
Consumer
To: X
Application
Application
Application
To: Y
Topic X
Topic Y
Application
Application
Application

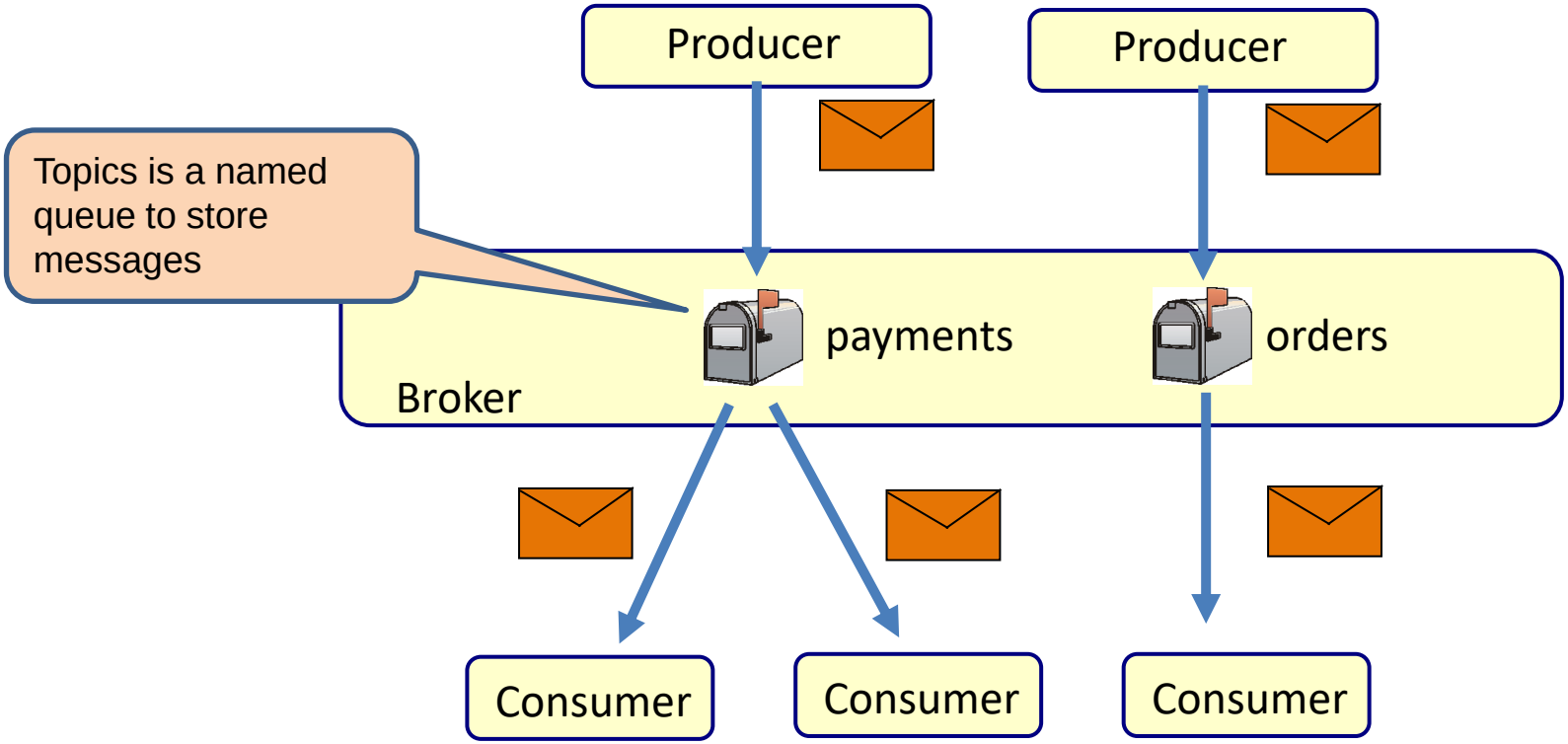
Cluster of Brokers



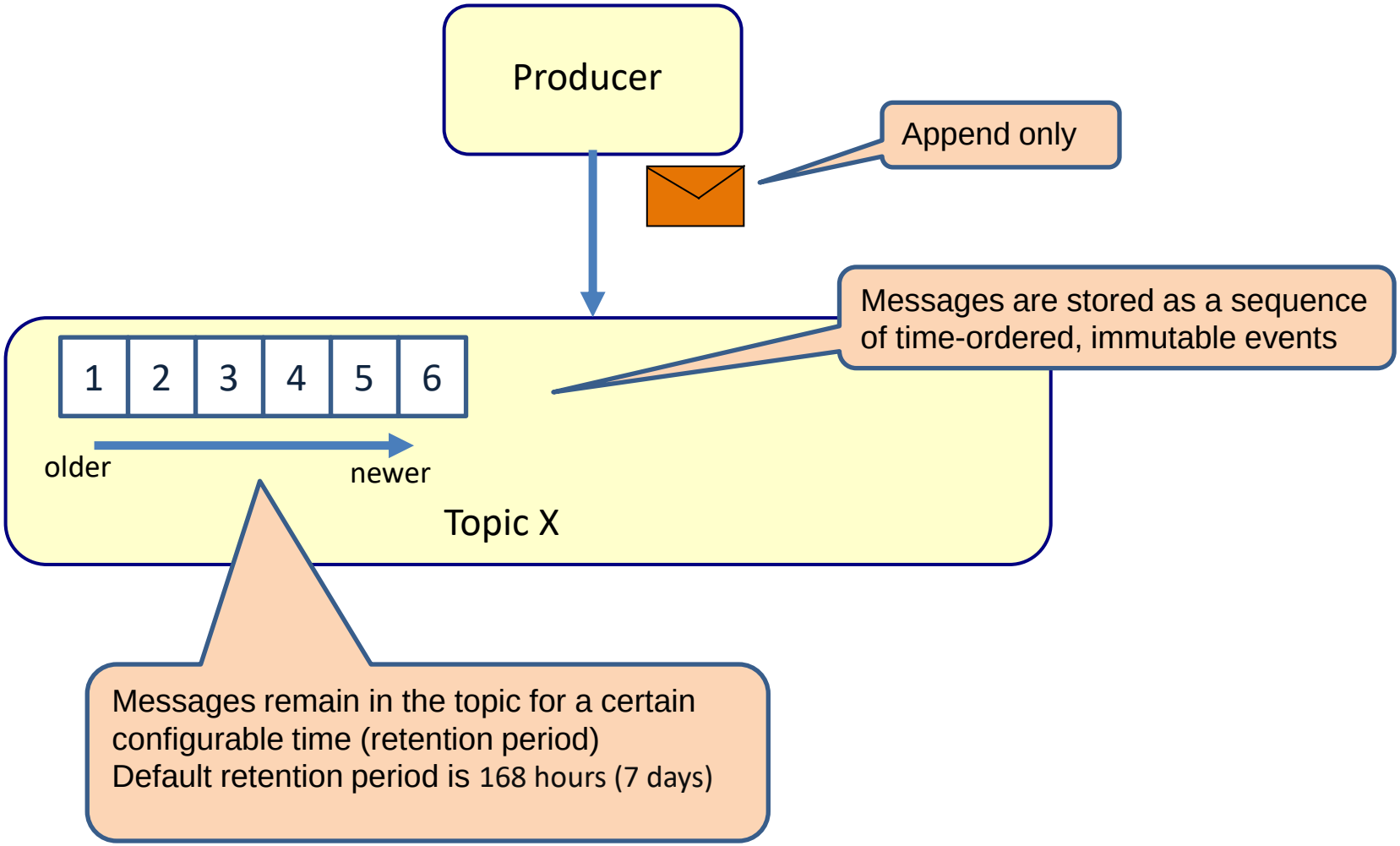
Apache Zookeeper



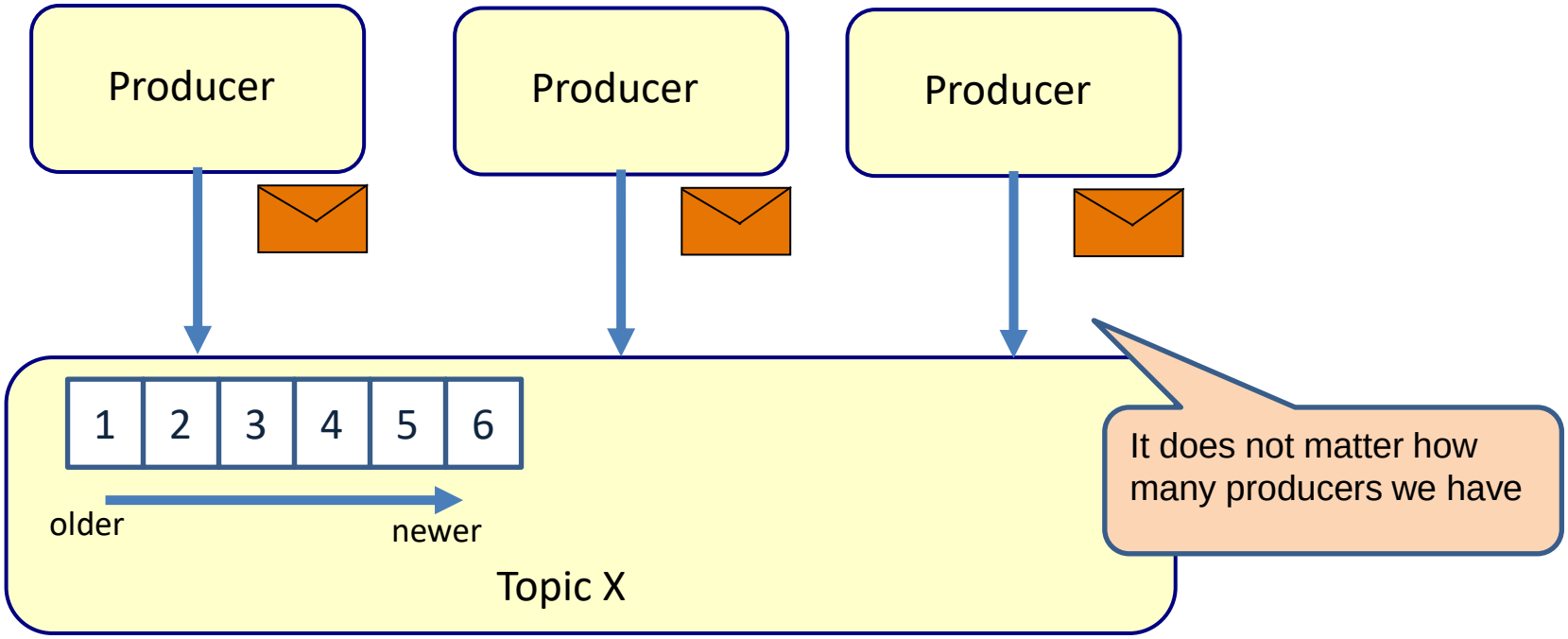
Topics


Producer
Producer
Topics is a named queue to store messages
payments
orders
Broker
Consumer
Consumer
Consumer

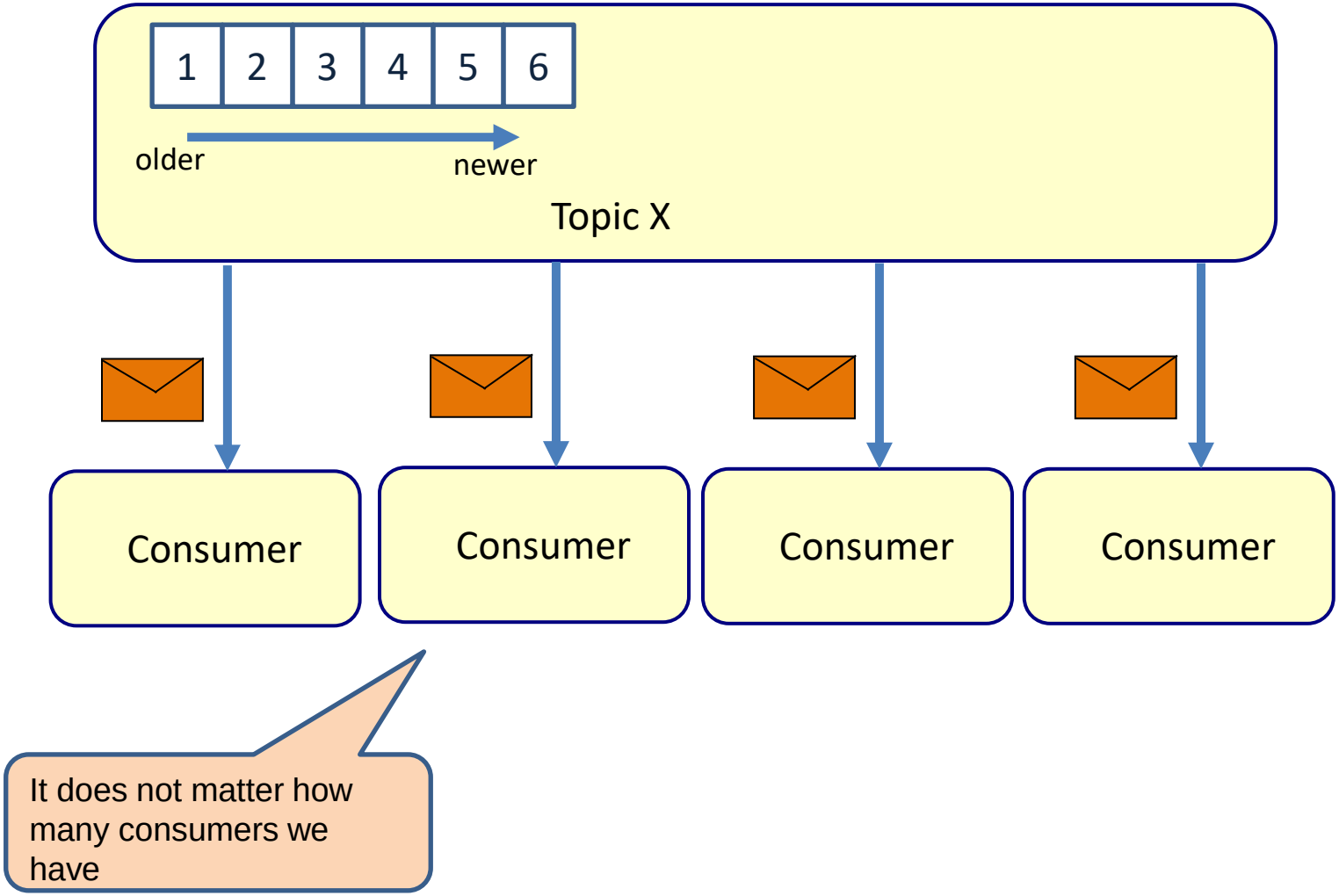
Event sourcing



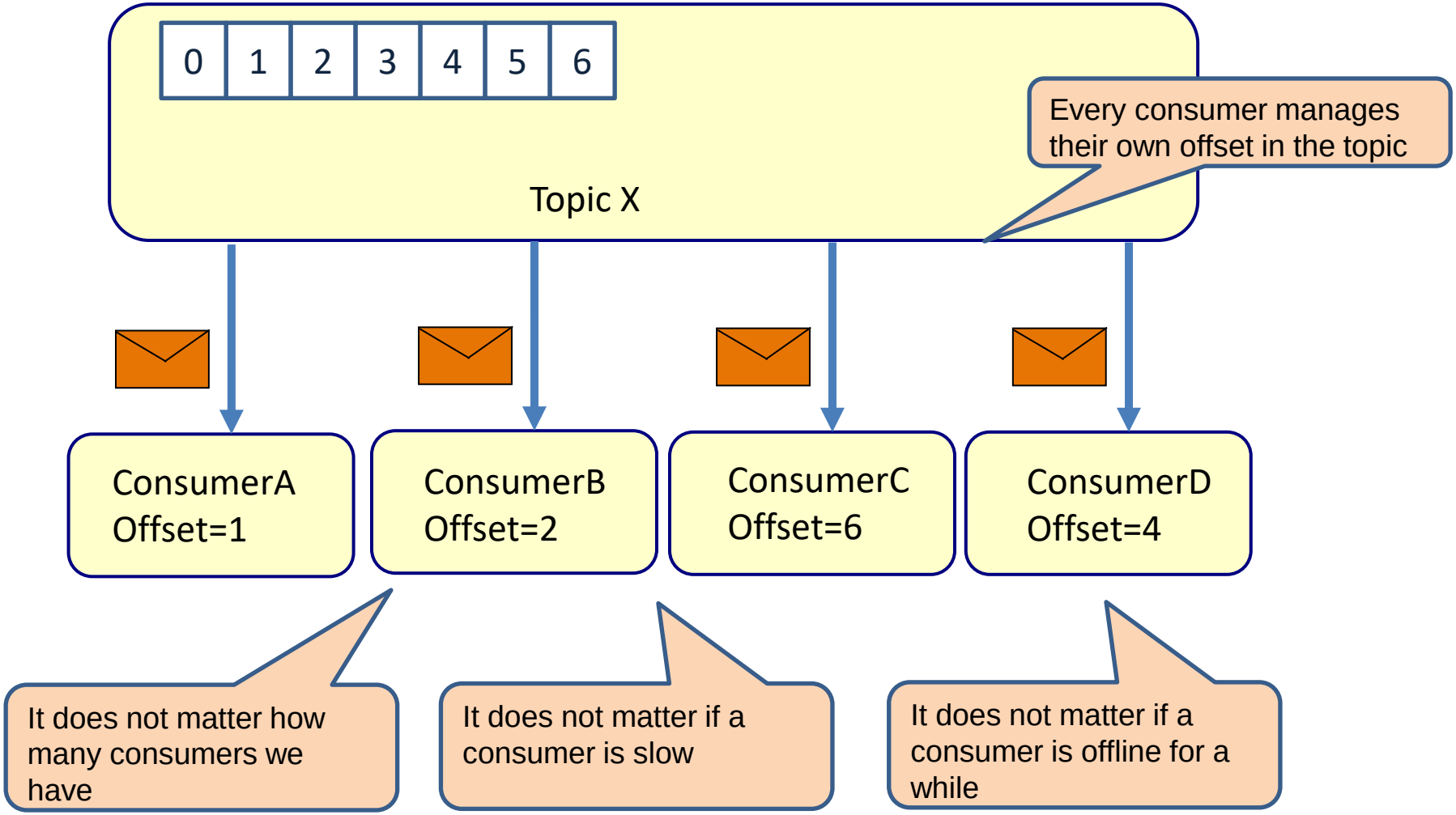
Why event sourcing?



Why event sourcing?

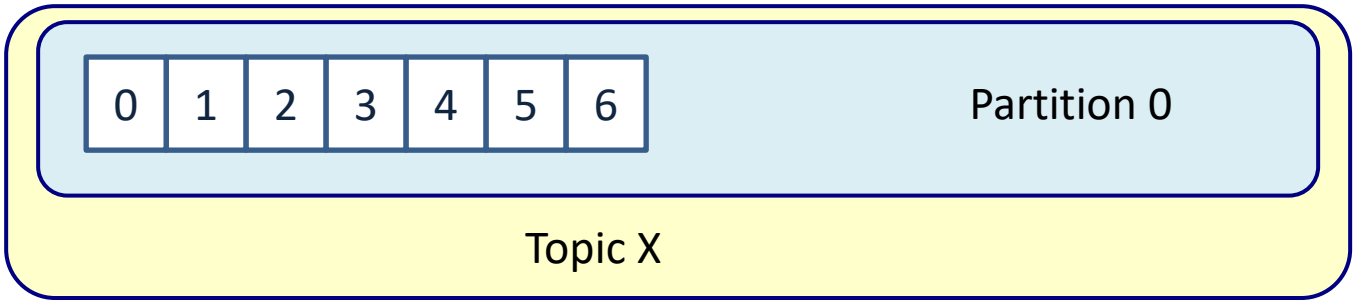


Offset

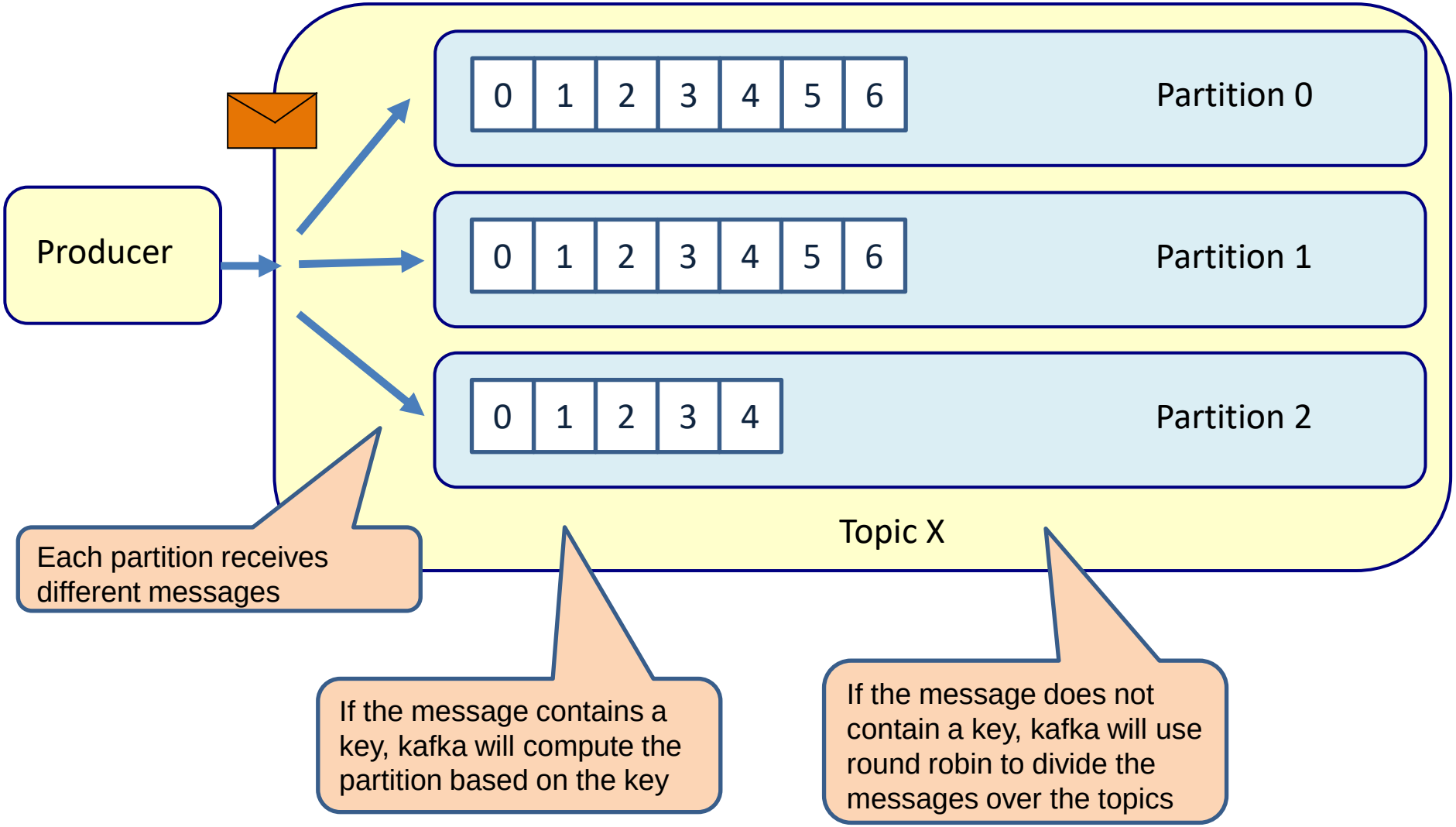


Partition

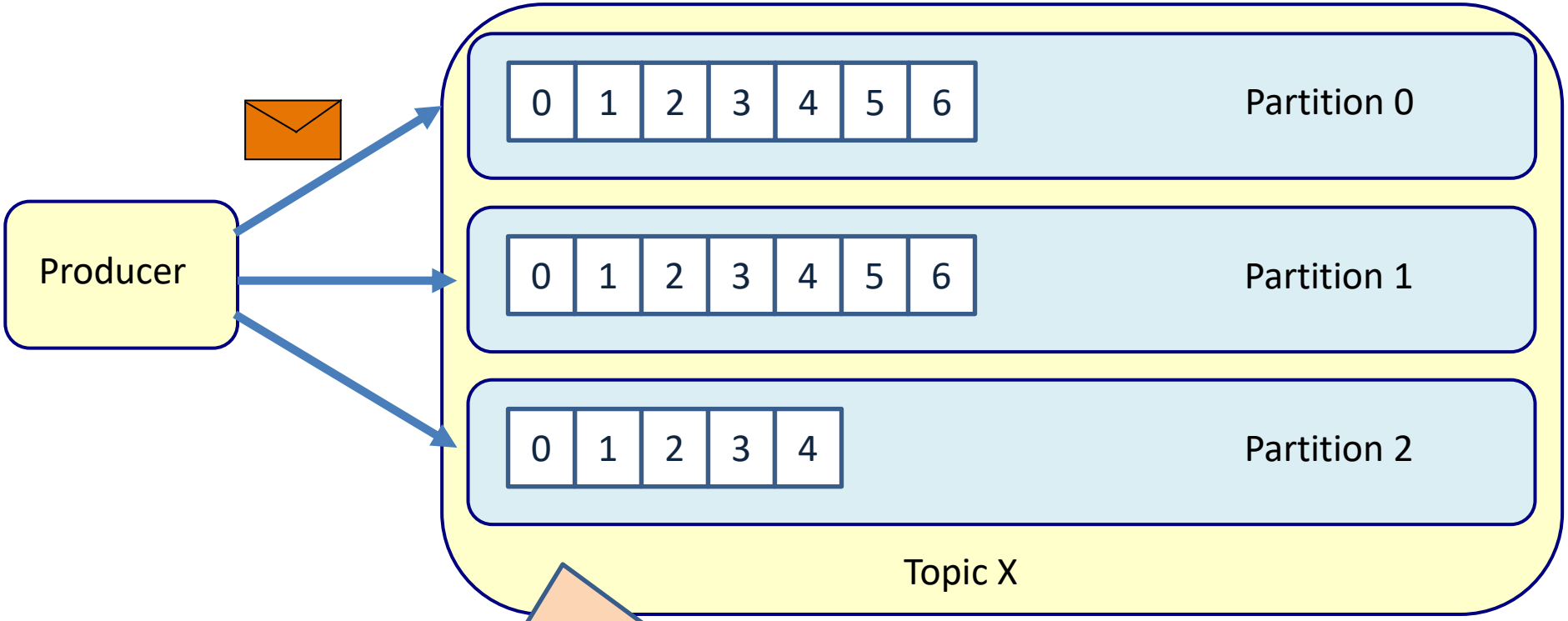
- Each topic has one or more partitions
  - This is configurable
- Each partition must fit on 1 broker



3 partitions



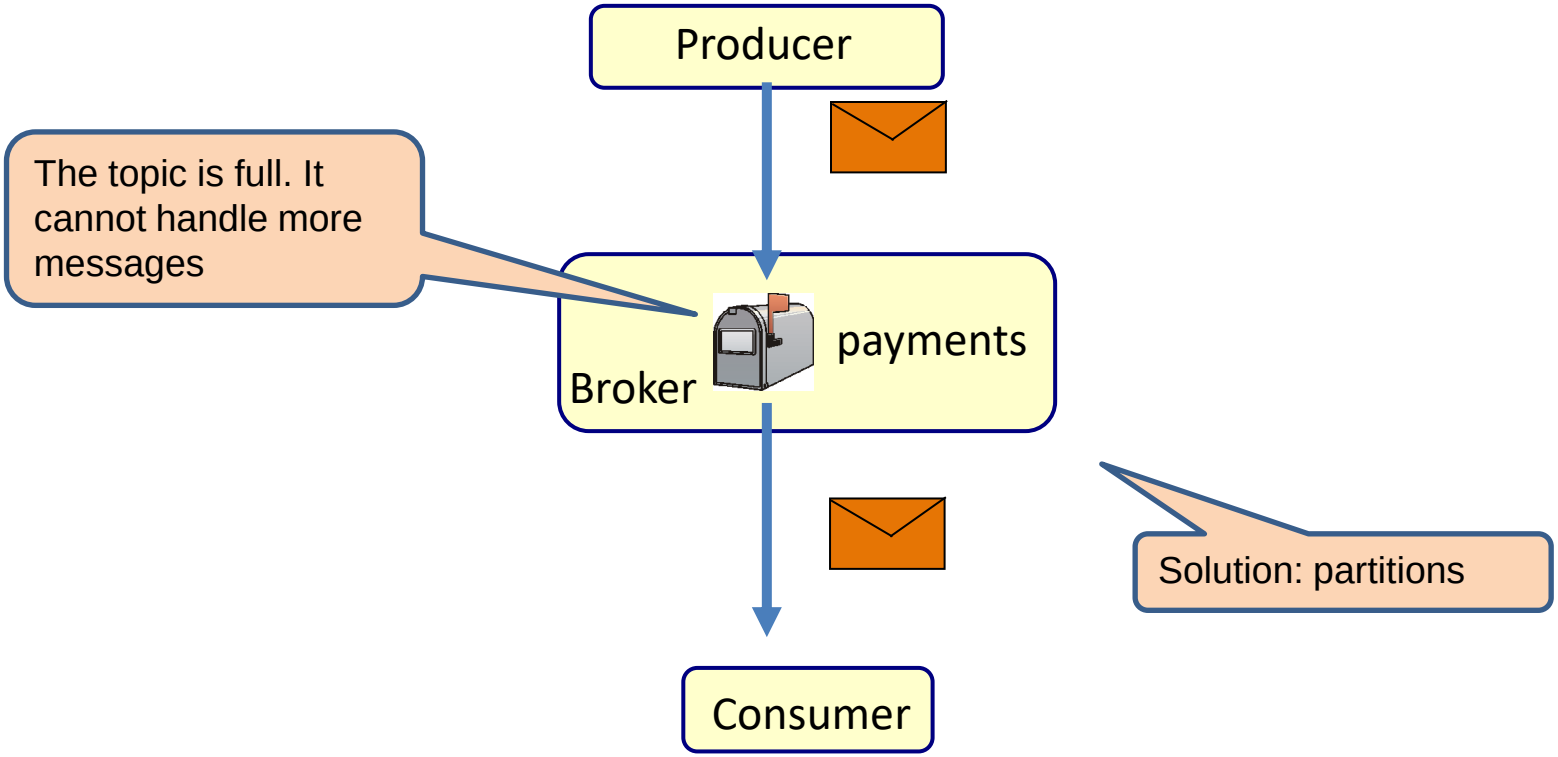
3 partitions



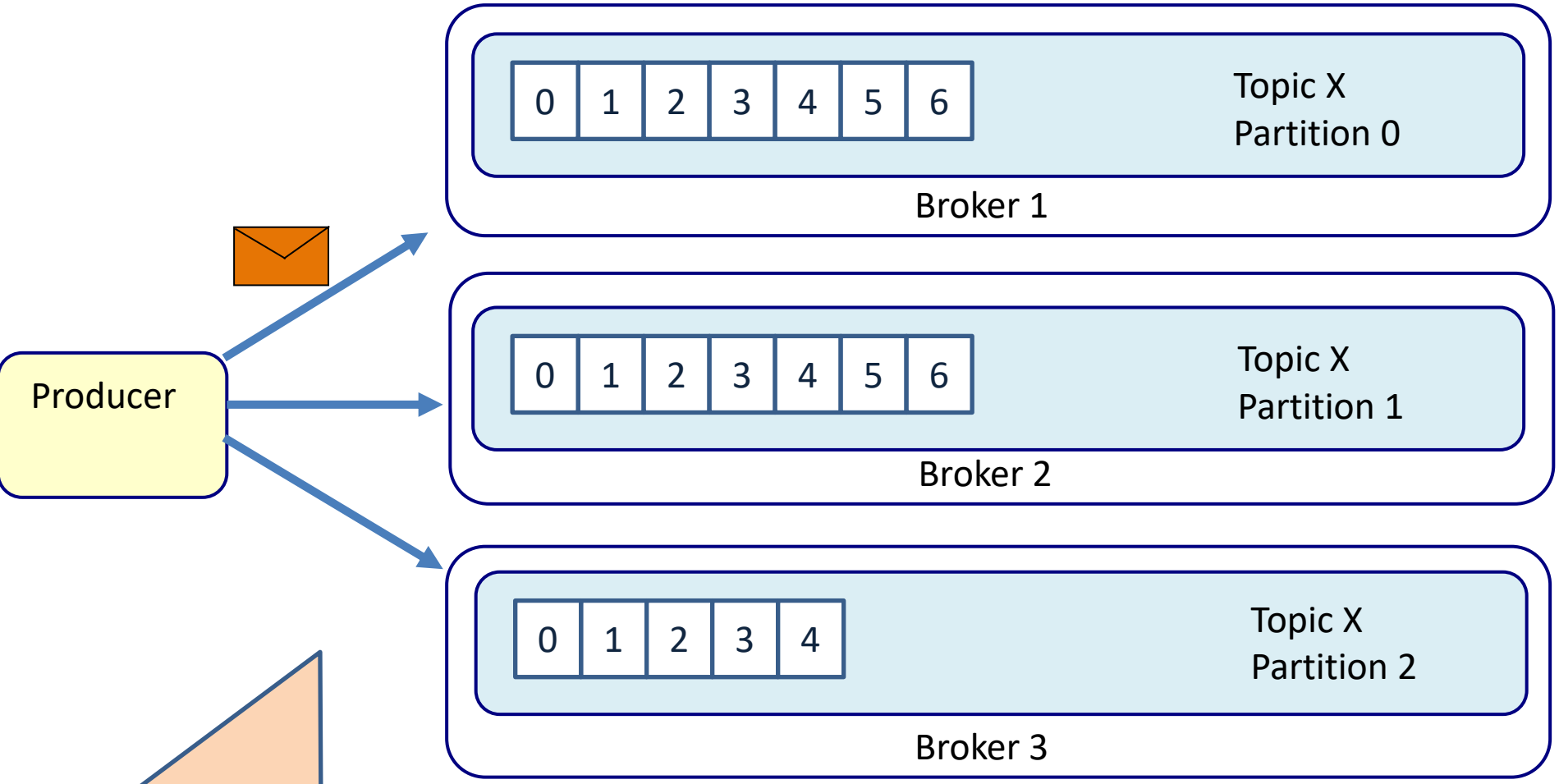
There is no message order between partitions
If this is important

- Use a single partition
- Let the consumer manage the order using a key

What if the topic gets too full?

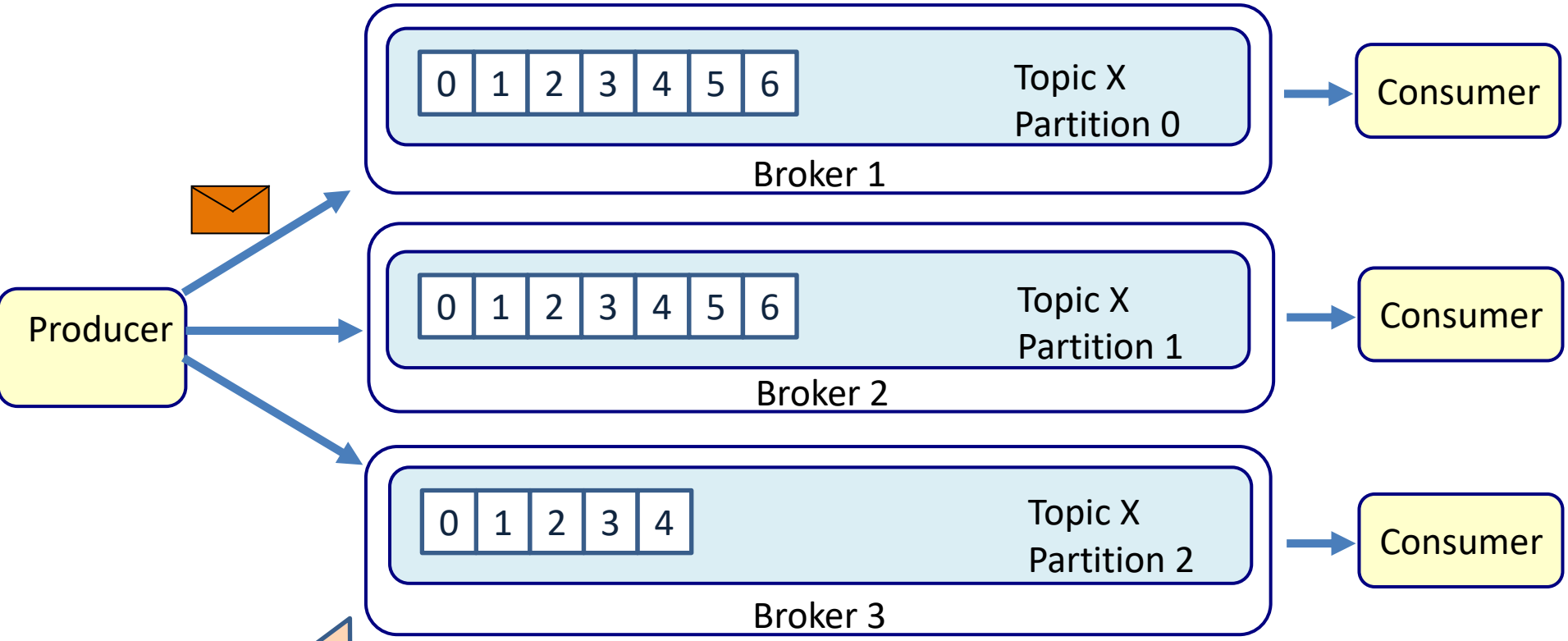


Scale out partitions



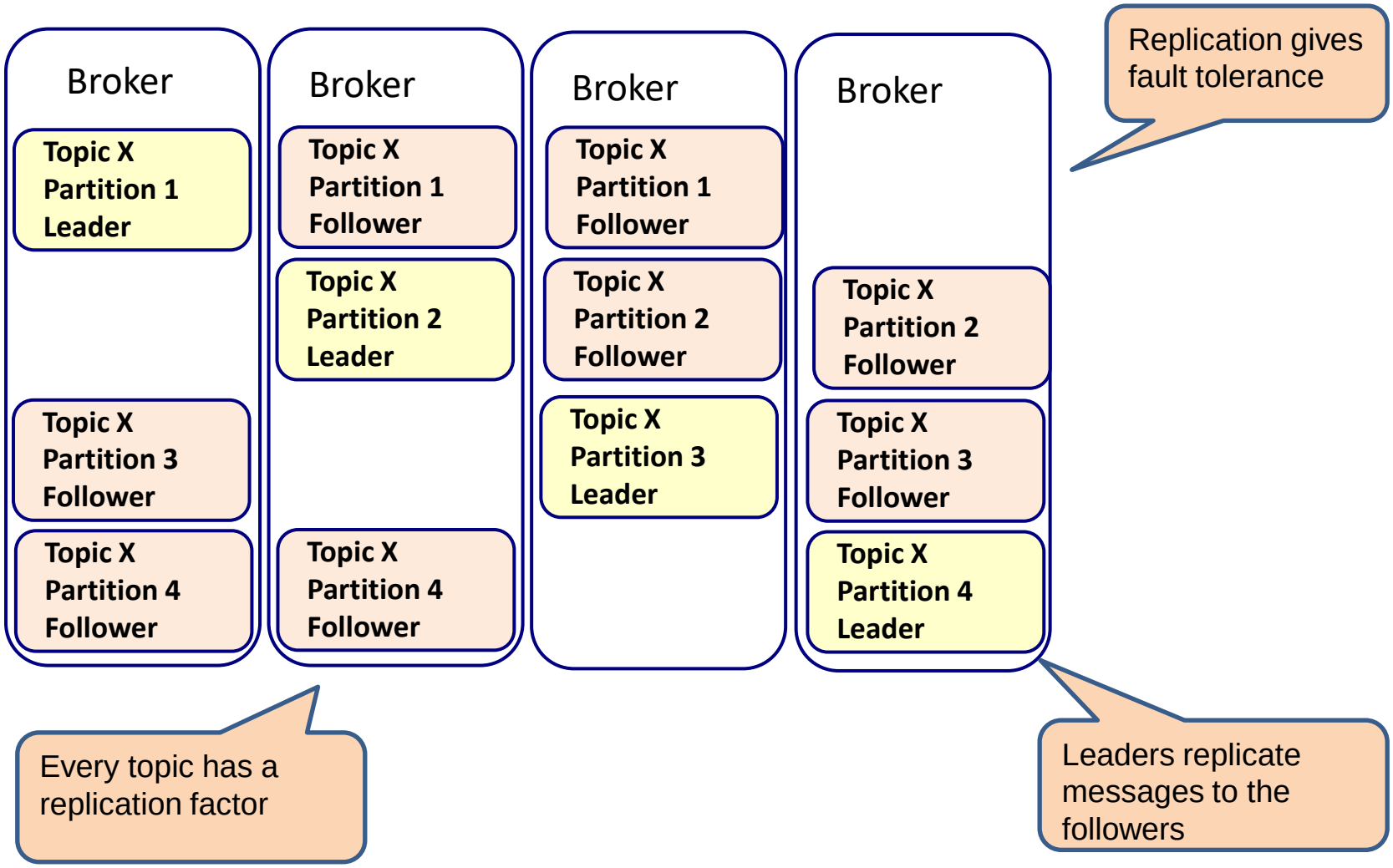
Increases
- Scalability (number of messages and their size)
- Higher levels of throughput (parallelism)

Scale out partitions



Increases
- Scalability (number of messages and their size)
- Higher levels of throughput (parallelism)

Replication

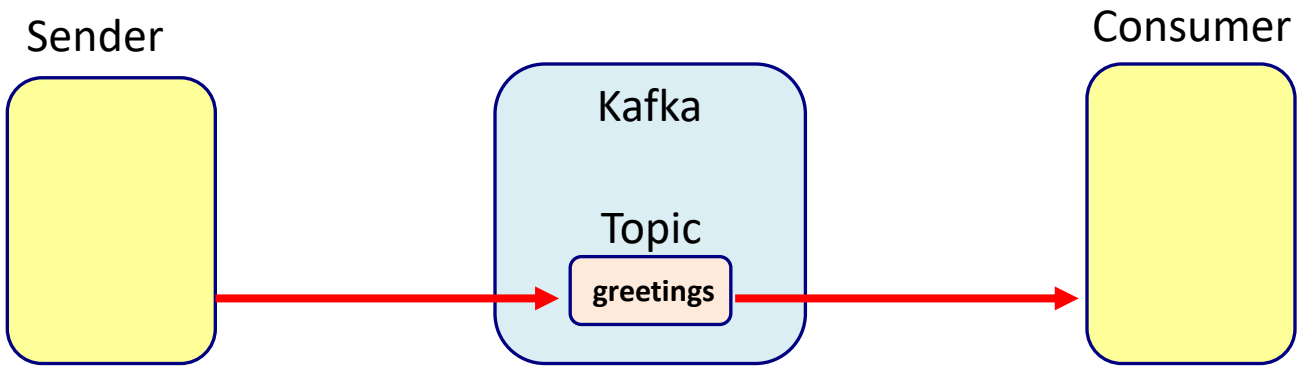


Creating a topic

```
~$ bin/kafka-topics.sh --create --topic my_topic \
> --zookeeper localhost:2181 \
> --partitions 3 \
> --replication-factor 3
```

SPRING BOOT AND KAFKA

Example



SenderApplication

```
@SpringBootApplication
@EnableKafka
public class SenderApplication implements CommandLineRunner {
   @Autowired
   Sender sender;

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

   @Override
   public void run(String... args) throws Exception {
      sender.send("topicA", "Hello World");
      System.out.println("Message has been sent");
   }
}
```

Sender

```
@Service
public class Sender {
   @Autowired
   private KafkaTemplate<String, String> kafkaTemplate;

   public void send(String topic, String message){
      kafkaTemplate.send(topic, message);
   }
}
```

application.properties

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id= gid
spring.kafka.consumer.auto-offset-reset= earliest
spring.kafka.consumer.key-deserializer= org.apache.kafka.common.serialization.StringDeserializer
spring.kafka.consumer.value-deserializer= org.springframework.kafka.support.serializer.JsonDeserializer
spring.kafka.producer.key-serializer= org.apache.kafka.common.serialization.StringSerializer
spring.kafka.producer.value-serializer= org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.consumer.properties.spring.json.trusted.packages=kafka


logging.level.root= ERROR
org.springframework= ERROR
```

ReceiverApplication

```
@SpringBootApplication
@EnableKafka
public class ReceiverApplication implements CommandLineRunner {


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

    @Override
    public void run(String... args) throws Exception {
        System.out.println("Receiver is running and waiting for messages");
    }
}
```

Receiver

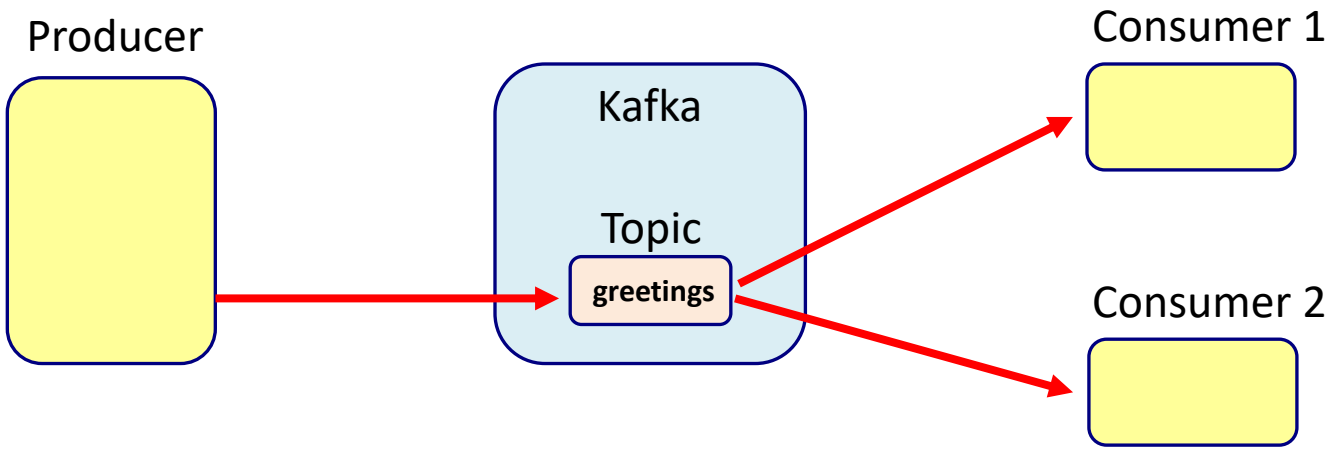
```
@Service
public class Receiver {

   @KafkaListener(topics = {"topicA"})
   public void receive(@Payload String message) {
      System.out.println("Receiver received message= "+ message);
   }
}
```

application.properties

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id= gid
spring.kafka.consumer.auto-offset-reset= earliest
spring.kafka.consumer.key-deserializer= org.apache.kafka.common.serialization.StringDeserializer
spring.kafka.consumer.value-deserializer= org.springframework.kafka.support.serializer.JsonDeserializer
spring.kafka.producer.key-serializer= org.apache.kafka.common.serialization.StringSerializer
spring.kafka.producer.value-serializer= org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.consumer.properties.spring.json.trusted.packages=kafka


logging.level.root= ERROR
org.springframework= ERROR
```

What if we have 2 consumers

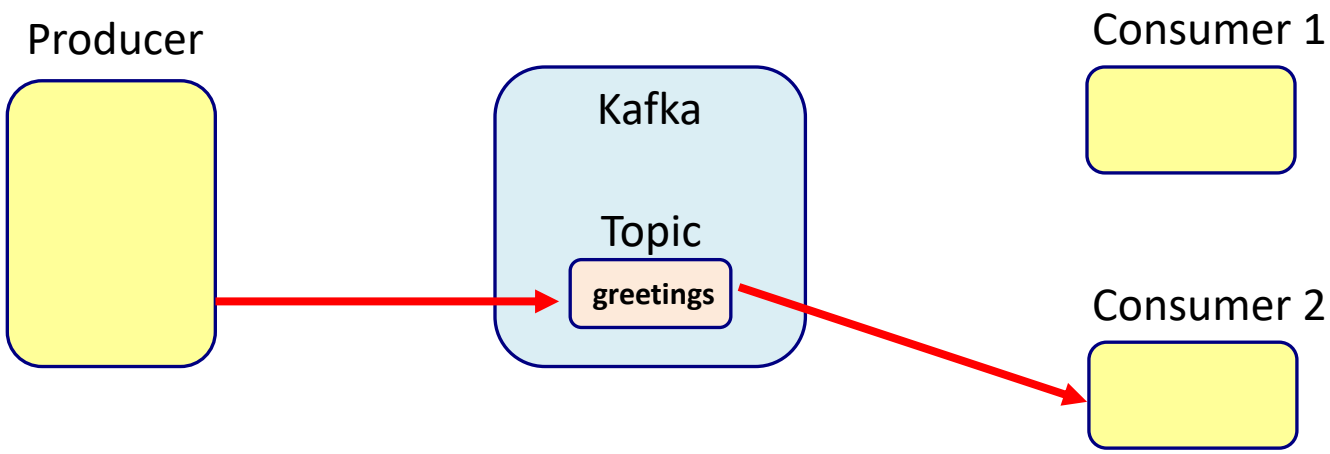
- The default behavior is pub/sub
  - Instead of point to point



- Both consumers receive the message

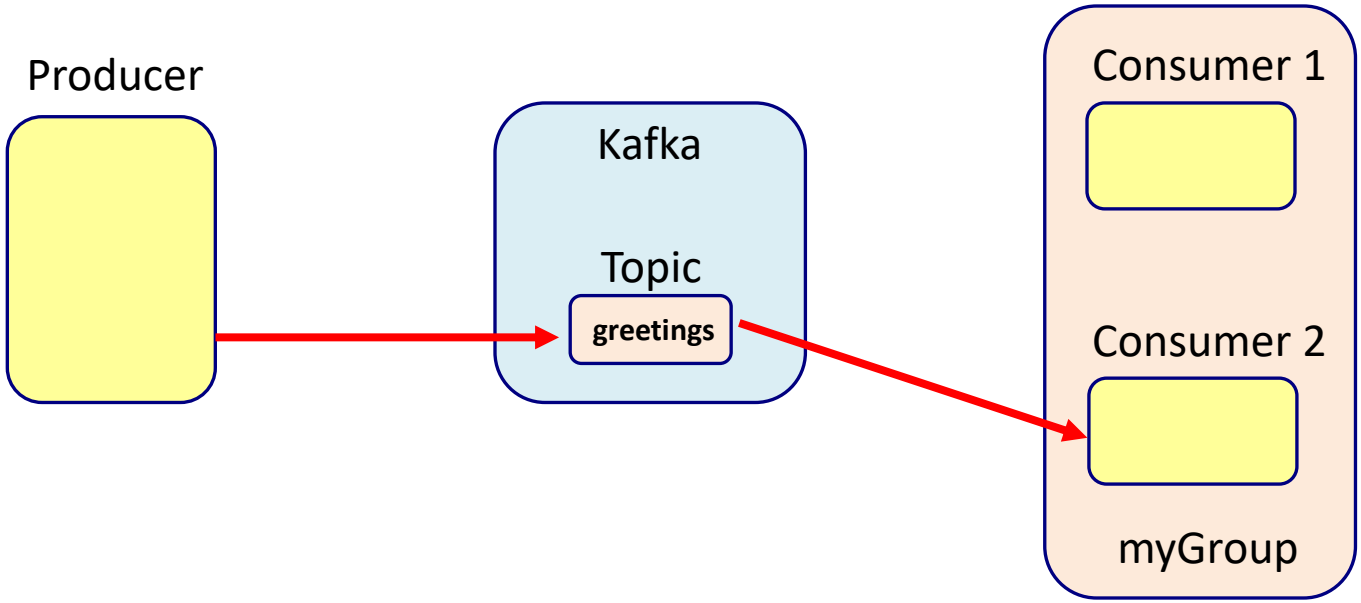
What if we want point to point

- Competing consumers



- Only one consumers receives the message

Consumer groups



application.properties

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id= gid
...
```

Give both consumers the same group-id

Send an object: Sender

```
@SpringBootApplication
@EnableKafka
public class OrderApplication implements CommandLineRunner {
   @Autowired
   Sender sender;

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

   @Override
   public void run(String... args) throws Exception {
      sender.send("ordertopic", new Order("A1276", LocalDate.now()+"", 1200.0));
      System.out.println("Order has been sent");
   }
}
```

```
public class Order {
   private String orderNumber;
   private String date;
   private double amount;
```

Sender

```
@Service
public class Sender {
   @Autowired
   private KafkaTemplate<String, Order> kafkaTemplate;

   public void send(String topic, Order order){
      kafkaTemplate.send(topic, order);
   }
}
```

application.properties

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id= gid
spring.kafka.consumer.auto-offset-reset= earliest
spring.kafka.consumer.key-deserializer= org.apache.kafka.common.serialization.StringDeserializer
spring.kafka.consumer.value-deserializer= org.springframework.kafka.support.serializer.JsonDeserializer
spring.kafka.producer.key-serializer= org.apache.kafka.common.serialization.StringSerializer
spring.kafka.producer.value-serializer= org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.consumer.properties.spring.json.trusted.packages=kafka


logging.level.root= ERROR
org.springframework= ERROR
```

Receiver Application

```
@SpringBootApplication
@EnableKafka
public class OrderApplication  {


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

}
```

```
public class Order {
   private String orderNumber;
   private String date;
   private double amount;
```

Receiver

```
@Service
public class Receiver {

   @KafkaListener(topics = {"ordertopic"})
   public void receive(@Payload Order order) {
      System.out.println("OrderReceiver 1 received order="+ order);
   }
}
```

application.properties

```
spring.kafka.bootstrap-servers=localhost:9092
spring.kafka.consumer.group-id= gid
spring.kafka.consumer.auto-offset-reset= earliest
spring.kafka.consumer.key-deserializer= org.apache.kafka.common.serialization.StringDeserializer
spring.kafka.consumer.value-deserializer= org.springframework.kafka.support.serializer.JsonDeserializer
spring.kafka.producer.key-serializer= org.apache.kafka.common.serialization.StringSerializer
spring.kafka.producer.value-serializer= org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.consumer.properties.spring.json.trusted.packages=kafka


logging.level.root= ERROR
org.springframework= ERROR
```

Main point

- Kafka is a distributed message broker that is fast, reliable and can handle large amounts of messages.

  Science of Consciousness: Pure consciousness is the field of all possibilities. At this level there are no limitations.