

Instituto Superior Técnico / Universidade de Lisboa
Integração Empresarial / Enterprise Integration
MAP45_1 – 2025 – duration: 45 minutes. This MAP contains 4 pages.

Part I. Multiple choice. Fill the following table with only one option that corresponds to the **most** correct response.

Response Question 1 (0,75v)	Response Question 2 (0,75v)	Response Question 3 (0,75v)	Response Question 4 (0,75v)	Response Question 5 (0,75v)	Response Question 6 (0,75v)	Response Question 7 (0,75v)	Response Question 8 (0,75v)	Response Question 9 (0,75v)	Response Question 10 (0,75v)
A	B	B	D	D	B	D	C	A	B

Question 1. Integration using data-oriented integration and Message Oriented Middleware have one common feature:

- a) Remote processing, involving consumer decoding
- b) The same performance
- c) Strongly coupled between producer and consumer
- d) High development effort always involved

Question 2. Regarding Quarkus framework:

- a) The reactor pattern allows the association of I/O events with Worker Threads
- b) The reactor pattern invokes the event handlers when the expected event is received
- c) The proactor pattern is a synchronous version of the reactor pattern
- d) The proactor pattern allows the association of I/O events with Worker Threads

Question 3. An application built with a microservices framework shall:

- a) Communicate with other microservices and thus allowing a time coupled pattern of communication
- b) Communicate with other microservices and thus allowing a time decoupled pattern of communication
- c) Communicate with other microservices using shared databases
- d) Use a programming model of using service synchronous invocation

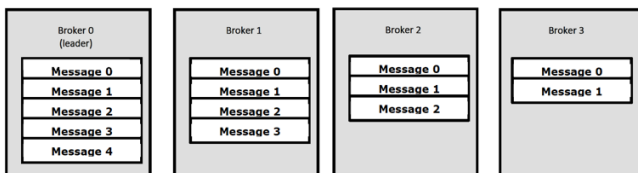
Question 4. The main characteristics of an asynchronous message system, implemented as a cluster, is:

- a) Both the client and the servers must be running simultaneously
- b) The interaction requires a callback
- c) The integration tolerates cluster crash failures
- d) The system tolerates consumer failures but not cluster failures

Question 5. Regarding the context of a microservice framework, which sentence is false?

- a) Microservices are based on the principle that they can be choreographed by a controller service
- b) Microservices supports the implementation related to a business entity
- c) An application based on microservices defines a choreography using its interface
- d) Microservices are highly dependent on an Enterprise Service Bus

Question 6. Consider that a KAFKA cluster is configured to be all in-sync replicas (ISR) mode. A topic has one partition replicated on 4 brokers, accordingly to the figure:



- a) Message 3 can be read by a consumer as it is replicated in 50% of the brokers
- b) Message 0 can be consumed as it is stored in all brokers
- c) Message 2 can be read by a consumer even not replicated in all brokers
- d) For improving load distribution, a consumer can read from Broker 1

Question 7. Which component of a Kafka architecture implements the concepts of: Fire-and-forget, Synchronous messages or asynchronous messages:

- a) In-sync replica
- b) Consumer Group
- c) Consumer
- d) Producer

Question 8. The Kafka policy to distribute messages by partition is the following:

- a) Partition Number = hash(key) / #Partitions(broker)
- b) Partition Number = hash(key) % #Partitions(broker)
- c) Partition Number = hash(key) % #Partitions(topic)
- d) Partition Number = hash(key) % #Brokers(topic)

Question 9. The terraform state sharing allows the provisioning of an environment where:

- a) The posterior resources depend on the formers
- b) The formers resources depend on the posterior
- c) The state is *a priori* known, i.e., before execution
- d) The state is known only in the end of all execution

Question 10. What is the result obtained with the following command when executed against a Kafka cluster?

```
/usr/local/kafka/bin/kafka-topics.sh --describe --bootstrap-server ec2-54-221-164-123.compute-1.amazonaws.com:9092,ec2-54-91-42-183.compute-1.amazonaws.com:9092,ec2-3-90-109-20.compute-1.amazonaws.com:9092,ec2-18-212-94-70.compute-1.amazonaws.com:9092 --topic PURCHASE
```

- a) describing how a topic has been created in terms of events
- b) describing the current state of a topic in terms of its partitions
- c) describing how a topic has been created in terms of partitions
- d) describing the current state of a topic in terms of its events

Part II. Explain the concepts. Use the designated space to formulate your concise answer.

Question 11. (2v) Explain what is the purpose of the mechanism of Kafka partition and how should the partitions be defined? Justify, in detail, your answer.

Topics are broken down into partitions where each partition is a single log, with the purpose of distributing the storage and computation of a topic that cannot be divided.

There is no limitation of creating partitions by each broker. Partitions should be defined accordingly with the definition of available filesystem distribution, the available cpus and network restrictions.

Question 12. (2v) Is it possible to delete or update a message contained in a Kafka Commit log? Why or why not?

No, it's not possible. Why? a commit log is designed to provide a durable record of all transactions so that they can be replayed to consistently build the state of a system.

Question 13. (2v) What is the mechanism of Quarkus Non-blocking database with pipelining, and explain in detail how does it work?

It's a mechanism that enables the shared connection for a database, requiring a for compatible database for that purpose. The following figure explain the components required on I/O thread. In the opposite of blocking, or non-blocking, database, the worker thread and I/O thread are released to further processing until the database finishes the computation and then call-back the I/O thread for end of computation on the Quarkus side.

Question 14. (2v) What is the Kafka Consumer group rebalancing mechanism, and in which conditions should it be executed? Explain in detail.

Consumers work as part of a consumer group, which is one or more consumers that work together to consume a topic. The group ensures that each partition is only consumed by one member. Additionally, if a single consumer fails, the remaining members of the group will reassign the partitions being consumed to take over for the missing member: Rebalance -> when it is required to execute.

Part III. Develop a solution.

Question 15. (1,5v) Considering the following terraform file, how do you specify a policy to define a range of inbound ports from 9090 to 9099, to be reached by any other machine in the outside network into this new EC2 instance?

```
terraform {
  required_version = ">= 1.0.0, < 2.0.0"
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 4.0"
    }
  }
}

provider "aws" {
  region = "us-east-1"
}

resource "aws_instance" "exampleDeployQuarkus" {
  ami                = "ami-0e7290665643979b5"
  instance_type      = "c6g.medium"
  vpc_security_group_ids = [aws_security_group.instance.id]
  key_name            = "vockey"
  user_data           = "${file("quarkus.sh")}"
  user_data_replace_on_change = true
  tags = {
    Name = "terraform-deploy-QuarkusProject-loyaltycard"
  }
}

resource "aws_security_group" "instance" {
  name = var.security_group_name
  egress {
    from_port = 0
    to_port   = 0
    protocol  = "-1"
    cidr_blocks = ["0.0.0.0/0"]
    ipv6_cidr_blocks = [ ":::/0"]
  }
}

variable "security_group_name" {
  description = "The name of the security group"
  type        = string
  default     = "terraform-Quarkus-instance13"
}
```

```
Define the following inside resource "aws_security_group" "instance" {
  ingress {
    from_port = 9095
    to_port   = 9095
    protocol  = "-1"
    cidr_blocks = ["0.0.0.0/0"]
    ipv6_cidr_blocks = [ ":::/0"]
  }
}
```

Question 16. (3v) Consider the following process model description that the **PharmacyComp** company follows when a client submits a drug prescription:

The process starts when a technician receives a new prescription.

The process interest involves three participants: Technician, Pharmacist and Pharmacy System.

First, the technician enters the prescription details. Afterwards, the pharmacy system performs a drug utilization review. If an alarm is triggered, then the Pharmacist Perform a Thorough check. Otherwise, the pharmacy system checks the insurance coverage (3rd party company) to verify credit.

If drugs are covered by insurance, then the technician collect the drugs from shelves and the Pharmacist check its quality.

If drugs quality is OK the technician collects the payment and the process ends.

Otherwise, technician repeats the drugs collection from shelves and the Pharmacist check its quality again.

From the textual description above, what are the microservices that you need to create to support this process model? (IMPORTANT – remember the definition of microservice)

At least the following microservices – aligned with the business entities presented in the textual description:

Technician - CRUD

Pharmacist - CRUD

Client - CRUD

Order – CRUD – relates the client with drug

Drug - CRUD

Insurance – CRUD – relates with client

Payment – CRUD - relates with order