# Microservices Architecture

Facilitated by Kent State University

Duration:

* 10 Hours
* Synchronous Virtual

Instructor:

* Maha Ali Allouzi, PhD,
* Associate Professor
* Department of Computer Science

# Pre-work: Please complete prior to attending this course

* Docker Desktop (Windows/macOS) or Docker Engine (Linux): https://www.docker.com/products/docker-desktop
* Git: <https://git-scm.com>
* Python 3.8+ installed and added to PATH (required for running sample microservices)
* Visual Studio Code (recommended) with Docker and GitLens extensions
* Postman or Insomnia (optional, for API testing)
* GitHub account (to clone the repository)

# Course Objectives

* Explain the fundamentals of Microservices architecture, including its advantages over monolithic systems and key architectural patterns like event-driven and request-driven designs.
* Analyze and decompose a monolithic application into microservices using concepts such as bounded contexts, domain-driven design (DDD), and the Strangler Pattern.
* Design and implement microservices with independent databases, services, and APIs, ensuring proper encapsulation and autonomy.
* Build and run containerized microservices using Docker, including writing Dockerfiles and using docker-compose to manage multi-service systems.
* Apply principles of API management including service discovery, API gateways, and micro-frontends for large-scale applications.
* Implement event-driven microservices using message brokers like RabbitMQ or Kafka, and understand delivery semantics (at-most-once, at-least-once, exactly-once).
* Demonstrate microservices testing techniques, such as unit testing, contract testing, and integration testing using tools like Pact or Spring Cloud Contract.
* Deploy and observe microservices in a containerized environment, using Kubernetes (Minikube or Docker Compose), Prometheus for metrics, and Jaeger/OpenTelemetry for tracing.
* Evaluate the resilience, scalability, and maintainability of microservice-based systems, and identify best practices for production-readiness.

**Lecture 1: Microservices Fundamentals & Migration**

**1.1 Introduction to Microservices and Event-Driven Architecture**

* Concepts of Microservices
* Event-Driven vs Request-Driven Architectures

**1.2 Microservices Architecture: Benefits and Challenges**

* Scalability, Resilience, Independent Deployment
* Common pitfalls and complexity

**1.3 Microservices Boundaries and Core Principles**

* Bounded Contexts and Domain-Driven Design (DDD)
* Coupling, Cohesion, Autonomy

**1.4 Decomposition of Monoliths**

* How to identify boundaries and extract services
* Use of Strangler Pattern and other migration techniques

**1.5 Migration to Microservices: Steps, Tips, and Patterns**

* Incremental migration
* Database decomposition
* Infrastructure readiness

**Hands-on Lab:**

* Analyze a sample monolith and design a decomposition strategy
* Dockerize two services from a broken-down monolith

**Assessment:**

* **Quiz 1**: Migration & architecture challenges

**Lecture 2: Principles, APIs, and Event-Driven Design**

**2.1 Databases in Microservices Architecture**

* Database per service
* Managing consistency and data duplication

**2.2 The DRY Principle and Shared Libraries**

* Avoiding tight coupling through shared logic
* Proper use of libraries

**2.3 Micro-frontends and API Management**

* Frontend composition for large-scale teams
* API Gateway and Service Discovery

**2.4 Introduction to Event-Driven Architecture**

* Pub/Sub and Event Stream concepts
* Loose coupling via events

**2.5 Message Broker Technologies and Semantics**

* Kafka, RabbitMQ
* At-most-once, at-least-once, exactly-once delivery

**2.6 Event-Driven Microservices Design Patterns**

* Saga Pattern
* Command Query Responsibility Segregation (CQRS)
* Event Sourcing

**Hands-on Lab:**

* Set up API Gateway (e.g., Kong/NGINX)
* Implement a simple producer-consumer using RabbitMQ or Kafka

**Assessment:**

* **Quiz 2**: DRY, APIs, Message Brokers

**Lecture 3: Testing, Observability, and Deployment**

**3.2 Testing Microservices**

* Testing pyramid
* Contract testing (Pact, Spring Cloud Contract)
* Staging & Production validation

**3.3 Observability in Microservices**

* Logging (Python example)
* Metrics (Prometheus)
* Tracing (Jaeger, OpenTelemetry)

**3.4 Deployment Strategies**

* Cloud VMs vs Dedicated Hosts vs Serverless
* Containers and orchestration

**3.5 Kubernetes for Microservices**

* Deploying services to Kubernetes
* ConfigMaps, Secrets, Services, and Ingress

**Hands-on Lab:**

* Deploy a simple event-driven microservice on Minikube or Docker Compose
* Add logging and metrics instrumentation

**Assessment:**

* **Quiz 3**: testing, observability, deployment

**Course Schedule:**

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| --- | --- | --- |
| Time | Duration | Topic |
| 8:30 – 8:50 AM | 20 min | 1.1 Introduction to Microservices and Event-Driven Architecture |
| 8:50 – 9:10 AM | 20 min | 1.2 Microservices Architecture: Benefits and Challenges |
| 9:10 – 9:30 AM | 20 min | 1.3 Microservices Boundaries and Core Principles |
| 9:30 – 9:50 AM | 20 min | 1.4 Decomposition of Monoliths |
| 9:50 – 10:10 AM | 20 min | 1.5 Migration to Microservices: Steps, Tips, and Patterns |
| 10:10 – 10:20 AM | 10 min | Short Break |
| 10:20 – 11:20 AM | 60 min | Hands-on Lab: Decomposition strategy + Dockerizing services |
| 11:20 – 11:50 AM | 30 min | Assessment: Quiz 1 + discussion |
| 11:50 – 12:00 PM | 10 min | Wrap-up and Q&A |
| Time | Duration | Topic |
| 8:30 – 8:45 AM | 15 min | 2.1 Databases in Microservices Architecture |
| 8:45 – 9:00 AM | 15 min | 2.2 The DRY Principle and Shared Libraries |
| 9:00 – 9:20 AM | 20 min | 2.3 Micro-frontends and API Management |
| 9:20 – 9:40 AM | 20 min | 2.4 Introduction to Event-Driven Architecture |
| 9:40 – 10:00 AM | 20 min | 2.5 Message Broker Technologies and Semantics |
| 10:00 – 10:20 AM | 20 min | 2.6 Event-Driven Microservices Design Patterns |
| 10:20 – 10:30 AM | 10 min | Short Break |
| 10:30 – 11:20 AM | 50 min | Hands-on Lab: API Gateway setup + RabbitMQ/Kafka |
| 11:20 – 11:50 AM | 30 min | Assessment: Quizzes 2, 3, and 4 |
| 11:50 – 12:00 PM | 10 min | Wrap-up and Q&A |
| Time | Duration | Topic |
| 8:30 – 8:50 AM | 20 min | 3.2 Testing Microservices |
| 8:50 – 9:10 AM | 20 min | 3.3 Observability in Microservices |
| 9:10 – 9:30 AM | 20 min | 3.4 Deployment Strategies |
| 9:30 – 9:50 AM | 20 min | 3.5 Kubernetes for Microservices |
| 9:50 – 10:00 AM | 10 min | Short Break |
| 10:00 – 11:00 AM | 60 min | Hands-on Lab: Deploy to Logging + Metrics |
| 11:00 – 11:30 AM | 30 min | Assessment: Quizzes 5 & 6 |
| 11:30 – 12:00 PM | 30 min | Wrap-up, feedback, and open discussion |

**References**

1. Newman, Sam. Building Microservices: Designing Fine-Grained Systems. O’Reilly Media, 2015. ISBN: 9781491950357.
2. Chandramouli, Ramaswamy. Security Strategies for Microservices-Based Application Systems. NIST Special Publication 800-204A, National Institute of Standards and Technology, U.S. Department of Commerce, October 2019. <https://doi.org/10.6028/NIST.SP.800-204A>
3. **F5, Inc.** (2015). Introduction to Microservices. Retrieved from <https://www.f5.com/company/blog/nginx/introduction-to-microservices>

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