

Introduction to Microservices

Ravindu Nirmal Fernando SLIIT | March 2025

Foundations of Modern Software Architecture: Paving the Way for Microservices

- Influential Concepts and Technologies
 - **Domain-Driven Design:** Emphasizing the importance of reflecting real-world complexities in our code for better system modeling.
 - **Continuous Delivery:** Revolutionizing software deployment, making every code check-in a potential release candidate.
 - Web Communication Advancements: Enhancing how machines interact, leading to more efficient and robust systems.
- Architectural Shifts
 - From Layered to Hexagonal: Moving away from traditional layered architectures to avoid hidden complexities in business logic.
 - **Embracing Virtualization:** Utilizing on-demand provisioning and resizing of resources for greater flexibility with cloud computing.
- Organizational Practices
 - **Small Autonomous Teams:** Inspired by tech giants like Amazon and Google, promoting ownership and lifecycle management of services.
 - Learning from Netflix: Building resilient, scalable systems that can withstand and adapt to change.

Microservices: A Natural Progression

- Emergence from Real-World Use: Microservices weren't pre-planned but evolved as a response to practical needs in software development.
- Responding to Change: Offering the agility and flexibility to adapt to new technologies and market demands.

Monolithic Applications

Basic Structure

- Single-Tiered Structure: Built as a single, unified unit.
- Combined Modules: Functional modules like UI, server logic, and database interactions are combined.

Design and Construction

- Modular Architecture: Follows a modular structure within a single unit, aligning with objectoriented principles.
- Programming Constructs: Defined using language-specific constructs (e.g., Java packages).
- Build Artifacts: Built as a single artifact, such as a Java JAR file.

Characteristics

- Inter-module Dependencies: Modules are tightly coupled and interdependent.
- Unified Deployment: Deployed as a single entity.

Scalability

 Scalability Approach: Scaling involves replicating the entire application, not individual components.

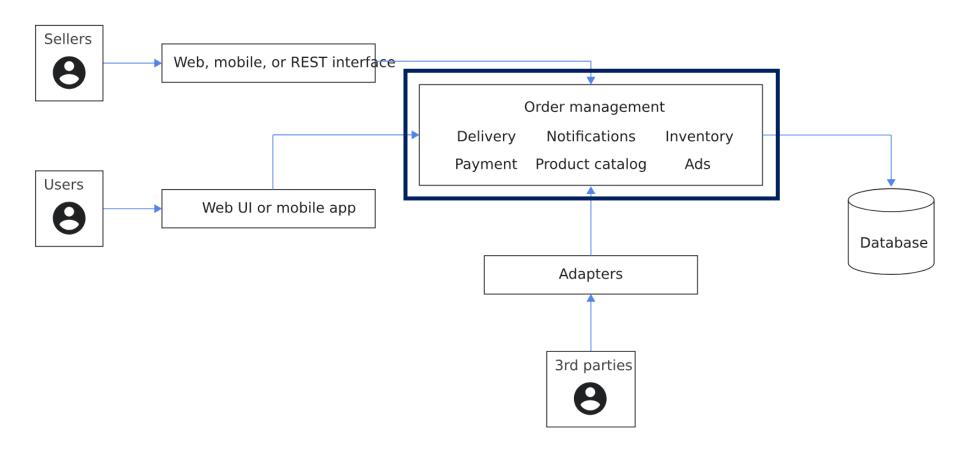


Diagram of a monolithic ecommerce application with several modules using a combination of programming language constructs. (https://cloud.google.com/architecture/microservices-architecture-introduction)

Benefits of Monolithic Architecture

- Simplified Testing: Tools like Selenium enable end-to-end testing of the entire application.
- Ease of Deployment: Deployment involves simply copying the packaged application to a server.
- **Resource Sharing**: All modules share memory, space, and resources, streamlining cross-cutting concerns like logging, caching, and security.
- Intra-Process Communication: Direct module-to-module calls can offer performance advantages over network-dependent microservices.

Challenges of Monolithic Architecture

- **Scalability Issues**: Difficulty in scaling when different modules have conflicting resource requirements.
- Complexity in Maintenance and Updates: As the application grows, implementing changes becomes more complicated due to tightly coupled modules.
- **CI/CD Complications**: Continuous integration and deployment become challenging as any update requires redeploying the entire application.
- Vulnerability to System Failures: A bug in any module, like a memory leak, can crash the entire system.
- **Technological Rigidity**: Adopting new frameworks or languages is costly and time-consuming, as it often requires rewriting the entire application.

Understanding Microservices

Core Characteristics

- **Small and Focused**: Aimed at doing one thing well, avoiding sprawling codebases.
- Cohesion and Single Responsibility: Adhering to the principle of grouping related code and separating unrelated functionalities.

Size and Scope

- No Fixed Size: Size varies based on language expressiveness and domain complexity.
- **Team Alignment**: Ideally sized to be managed by a small team.
- Balance in Size: Smaller services maximize benefits but increase complexity.

Autonomy

- **Independent Entities**: Deployed separately, can be different technologies, possibly as isolated services on a PAAS or as individual operating system processes.
- **Network Communication**: Services communicate via network calls, ensuring separation and reducing tight coupling.

Deployment and Change Management

- **Independent Deployment**: Services can be deployed independently without impacting others.
- **API-Centric Interaction**: Services expose APIs for interaction, emphasizing decoupled, technology-agnostic interfaces.

Decoupling

- **Key to Microservices**: Essential for maintaining independence and achieving the benefits of microservices architecture.
- Change and Deployment: Ability to change and deploy a service independently is crucial.

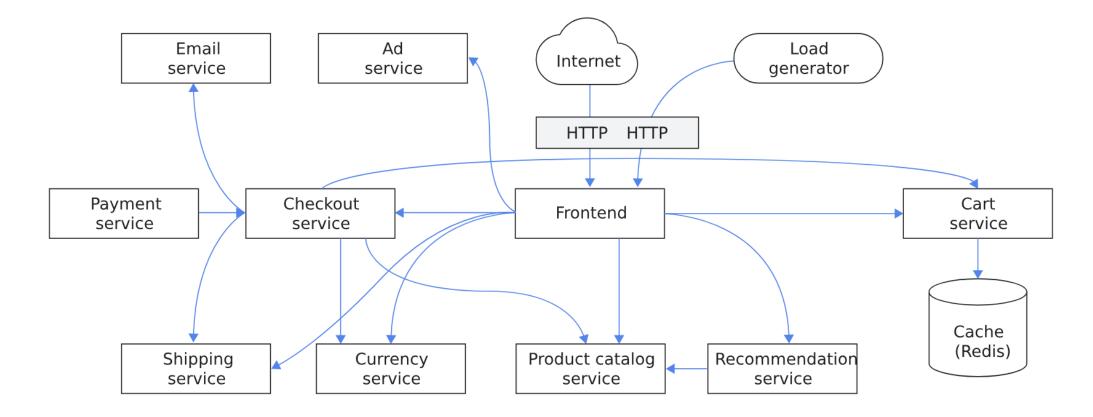
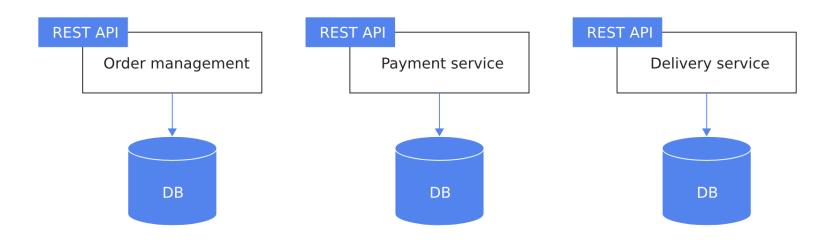


Diagram of an ecommerce application with functional areas implemented by microservices. (https://cloud.google.com/architecture/microservices-architecture-introduction)

Database Relationship

- Service-Specific Databases: Each microservice has its own database tailored to its requirements.
- Loose Coupling: This approach ensures loose coupling by routing data requests through service APIs instead of a shared database.
- Independent Data Management: Each service manages its data independently, enhancing autonomy and reducing interdependencies.



Benefits of Microservices Architecture

Aspect	Benefit Details
Enhanced Development and Maintenance	 Breaks application into smaller, manageable chunks. Clear boundaries with defined APIs. Quicker development, easier understanding and maintenance.
Team Autonomy and Efficiency	 Independent development of services by teams. Full lifecycle ownership of services. Flexibility to use different programming languages (Polyglot Development).
Improved Scalability and Market Responsiveness	 Independent scaling based on service needs. Hardware optimization for resource requirements. Faster product delivery and improved time to market.

Challenges of Microservices Architecture

Challenge Category	Challenge Details
Complexity in Distributed Systems	 Necessity of choosing and implementing inter-service communication mechanisms. Managing partial failures and service unavailability.
Transaction Management Across Services	 Handling atomic operations across multiple microservices (Distributed Transactions). Maintaining data consistency during failures (Consistency Issues).
Testing and Deployment Complexities	 Requirement for comprehensive testing across multiple services. Complexities in managing multiple service deployments and service discovery.
Operational Overhead	 Increased need for monitoring and alerting across more services. Higher risk of failure due to more points of service-to-service communication. Challenges in productionizing and maintaining robust operations infrastructure.
Performance and Suitability Considerations	 Potential latency issues due to network calls between services. Not suitable for all types of applications, especially those requiring real-time data processing. Importance of clear communication and service boundary planning.

Migrating from Monolithic to Microservices: Key Considerations

Consideration Category	Details
Assessing the Need for Migration	 Evaluate if microservices align with business goals and pain points. Consider simpler alternatives like autoscaling or enhanced testing.
Starting the Migration Process	 Begin with extracting and deploying one service independently. Adopt an iterative approach, learning and adapting with each service migration.
Strategic Implementation	 Recognize varying approaches to microservice size and quantity among teams. Emphasize continuous learning and strategy refinement.
Future Learning and Strategies	 Explore strategies for detailed refactoring from monolithic to microservices. Plan for ongoing education and adaptation of methods.

References

- https://cloud.google.com/architecture/microservices-architecture-introduction
- Building Microservices, Sam Newman