Introduction to Microservices

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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 object-oriented 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.

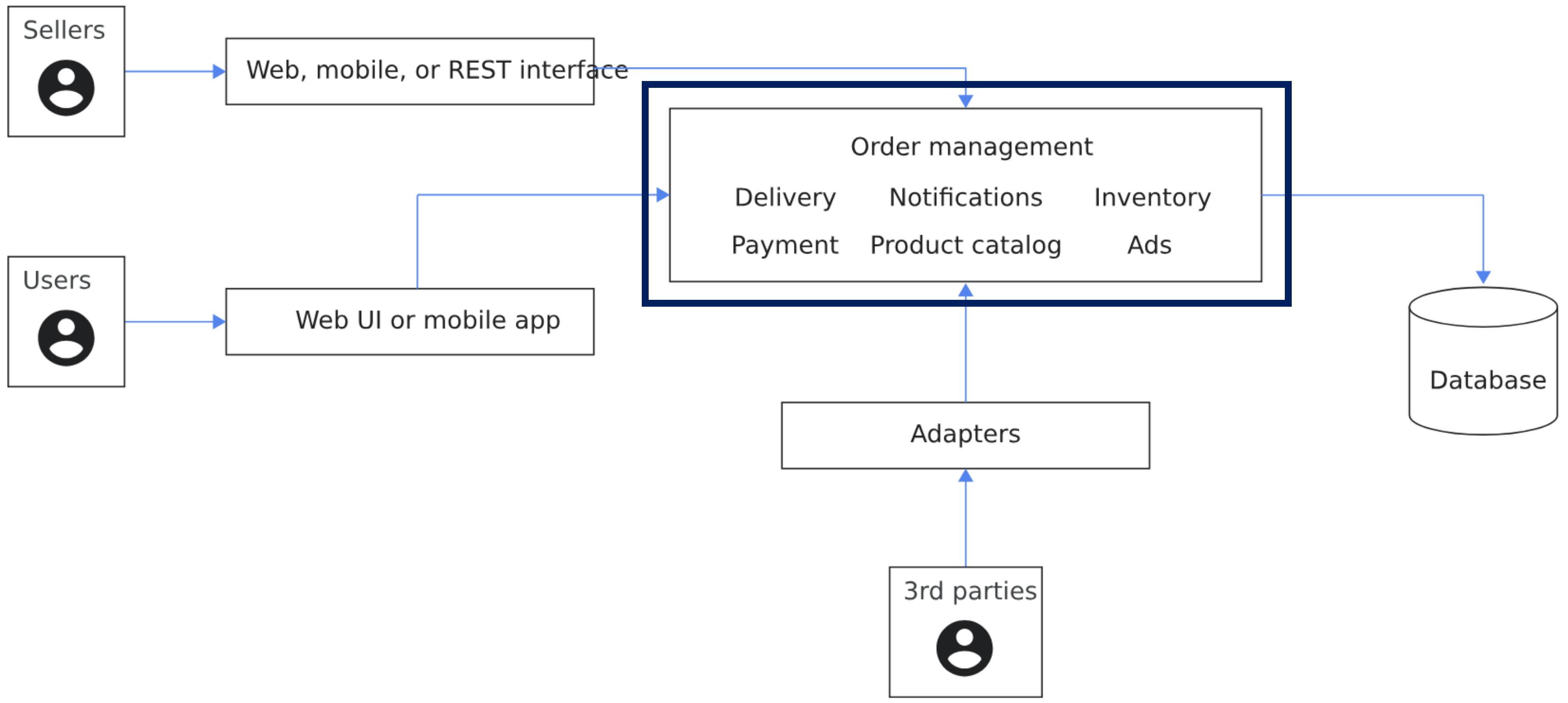


Diagram of a monolithic ecommerce application with several modules using a combination of programming language constructs. (https://cloud.google.com/architecture/microservices-architecture-introduction)

- **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.

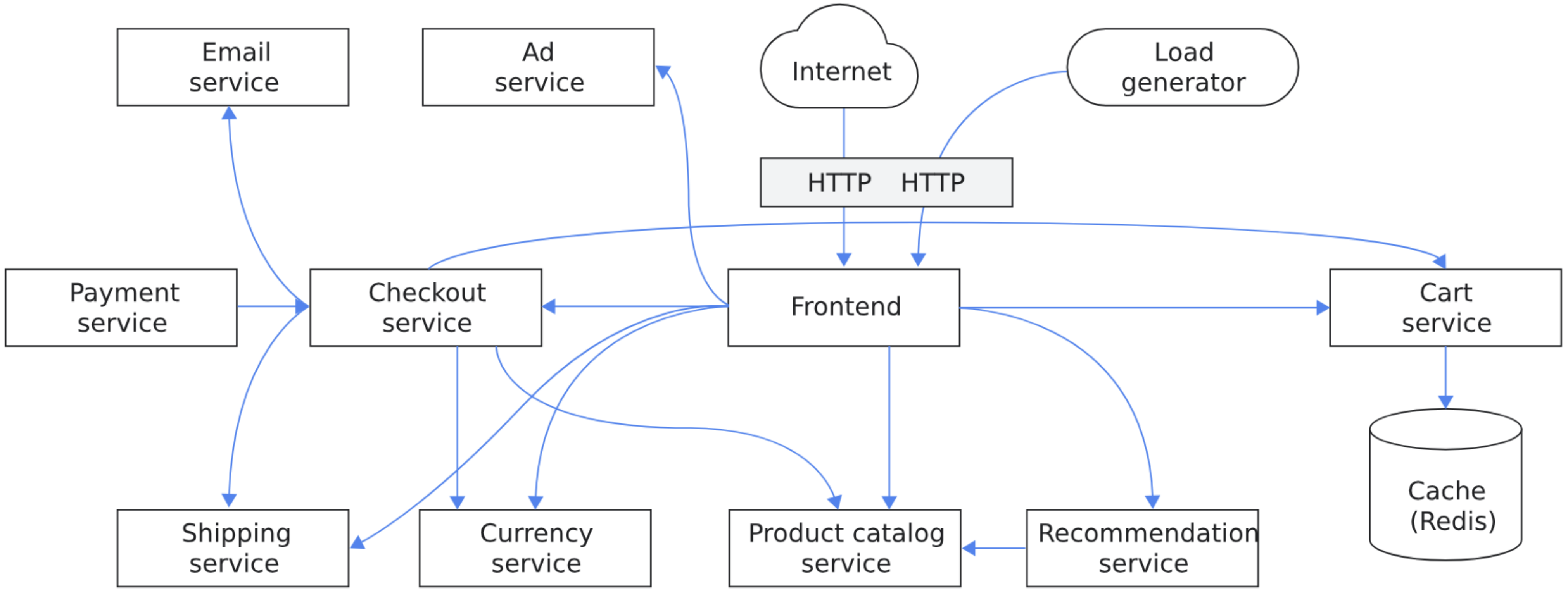
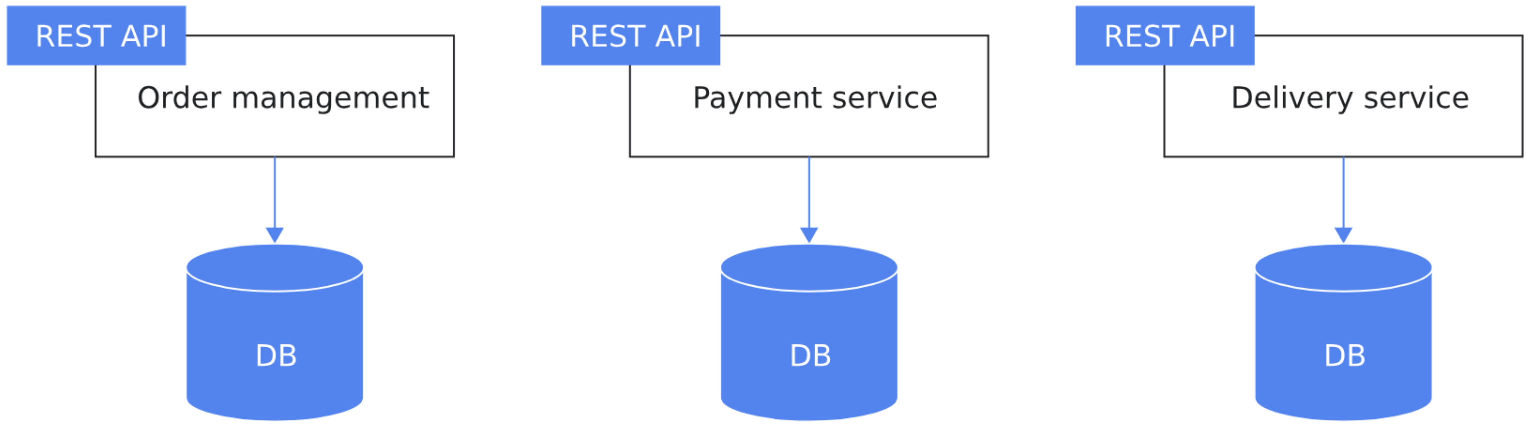


Diagram of an ecommerce application with functional areas implemented by microservices. (https://cloud.google.com/architecture/microservices-architecture-introduction)

- **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