Cloud Computing with Micro Services Architecture

WhoAmI.json

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"professor": {

"name": "Dr. Kamlendu Pandey",

"city": "Surat, India",

"bio": "Java Enthusiast, The witness
Consciousness",
"work": {
"company": "VNSGU ",
"role": "Professor, Coordinator"
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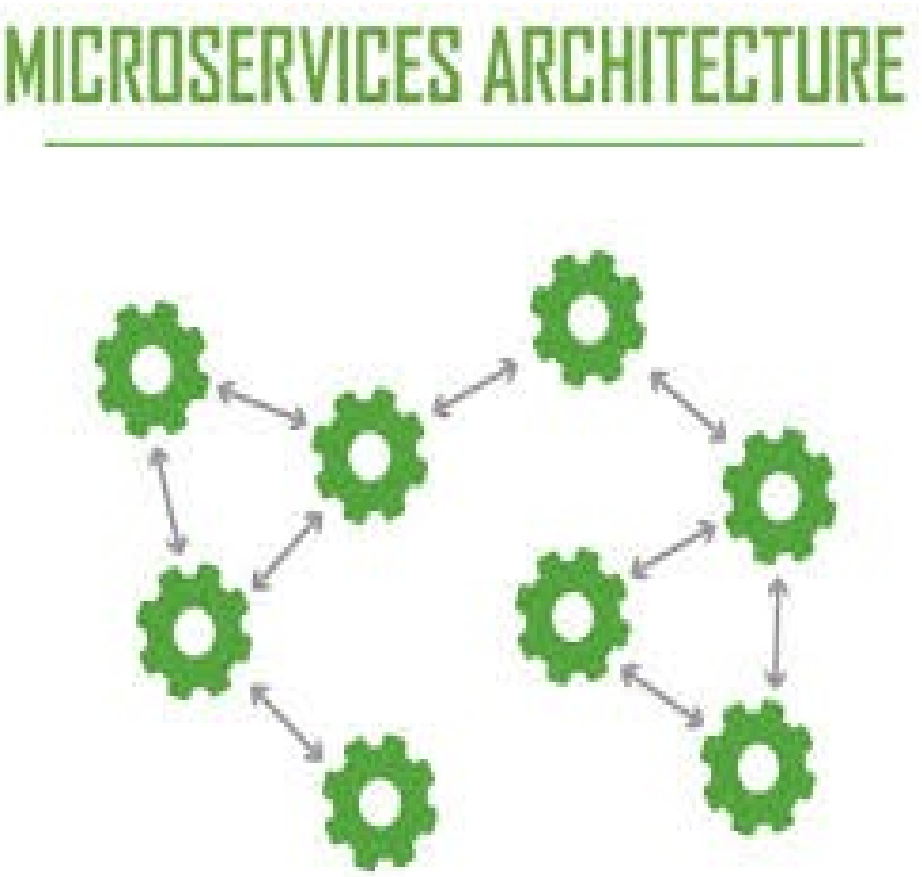

What is a Software Architecture

Software architecture refers to the fundamental structures or methodology of a software system and the discipline of creating such structures and systems. Each structure comprises software elements, relations among them, and properties of both elements and relations.

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Types of Software Architectures

- Old Monolithic (COBOL, FoxPro)
- Blackboard (AI Problems)
- Client-Server (Data and Web Apps, Visual Basic)
- Compnent Based (Over the shelf-COM, Beans etc)
- Distributed (EJBs, DCOM, CORBA)
- Model-View-Control
- Layered- CS (Enterprise Java)
- Service Oriented (SOA)
- REST (http Methods based Web Services)
- Micro Services (Microprofile, Springboot)

What is a Software Design Pattern

A software design pattern is a general, reusable solution to a commonly occurring problem within a given context in software design. It is not a finished design that can be transformed directly into source or machine code

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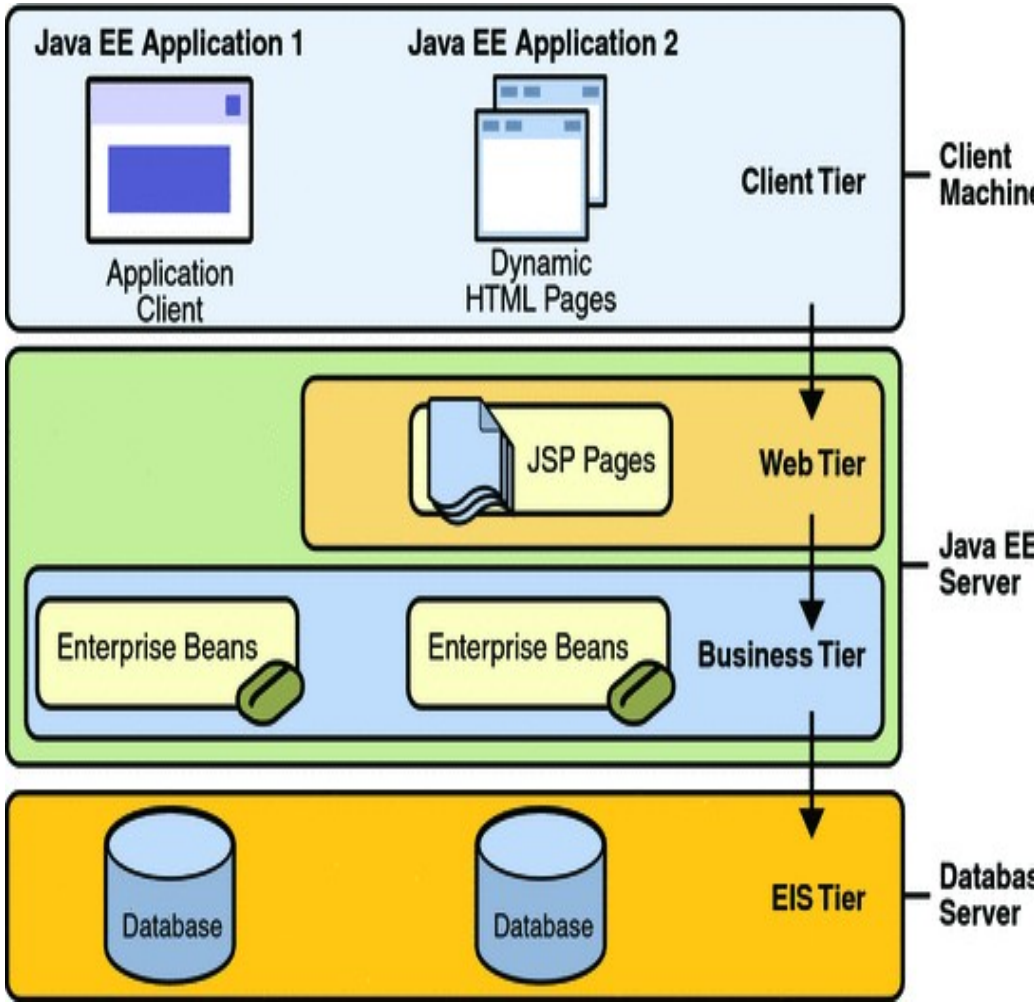
What We have been doing till now?

We have been developing developing applications using

- Java EE Layered Architecture
- Distributed Components
- Messaging Infrastucture
- SOAP and REST communication Pattern
- A UI/UX using JSF/JSP
- MVC Design Pattern
- Central Security Control and Propagation
- JNDI
- Application Servers
- CDI



So What is wrong in this ?

Well Nothing wrong as such, but it may not meet the current expecations and demands of performance industry and its users. The reasons are

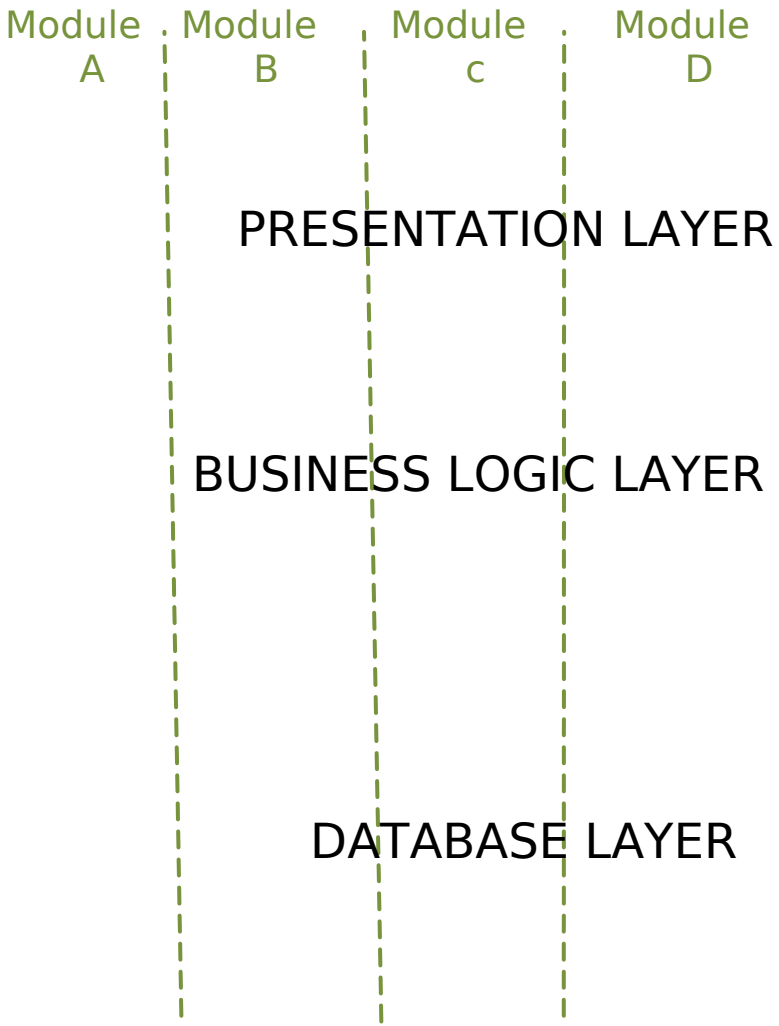
- All the software layers like BL, UI and Data Layer are packed into one Enterprise Application (jar, war, ear)
-
- The Entire Application is deployed on a production server.
- As requirement grows the application changes and it is undeployed and deployed many times. (Interruption to services)

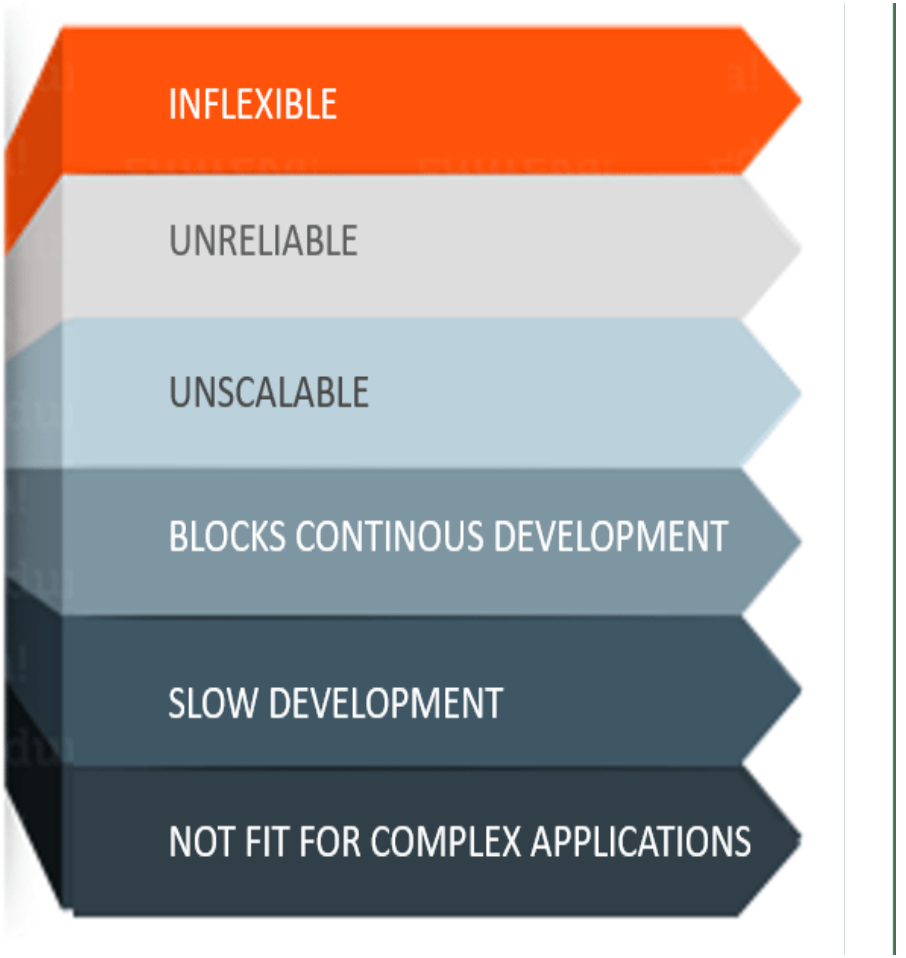
- The old team may leave and new team joins. Looses track of logic and thought process

- When Load increases scaling becomes a dificult issue

- Dissatisfied customers and painstaking development

They are still Monoliths





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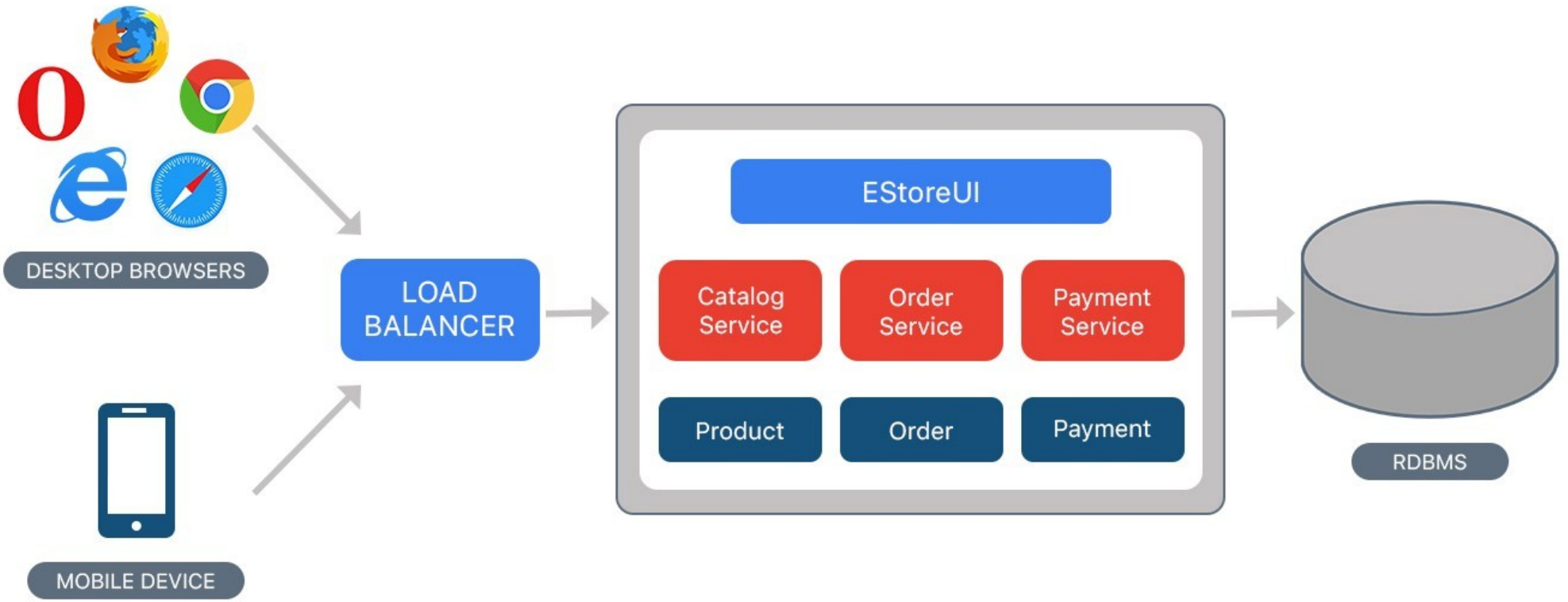
And This is how they work



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Limitations of Monolithic Applications

- A simple elegant monolith will grow into a uncontrollable beast as LOC grows exponentially with more client stories
- Over the time impossible to understand by single developer
- Sheer size slows down development and increases startup time on server. This is a problem when application server is frequently restarted
- Continuos development and delivery is a unthinkable in complex monolith
- Difficult to scale as different modules have different memory requirement (A cpu intensive image processing and an inline db require different vms on amazon)
- Reliability is big issue as a small bug may effect whole project and instances
- Difficult to adopt new smart incoming frameworks. It becomes white elephant over the time

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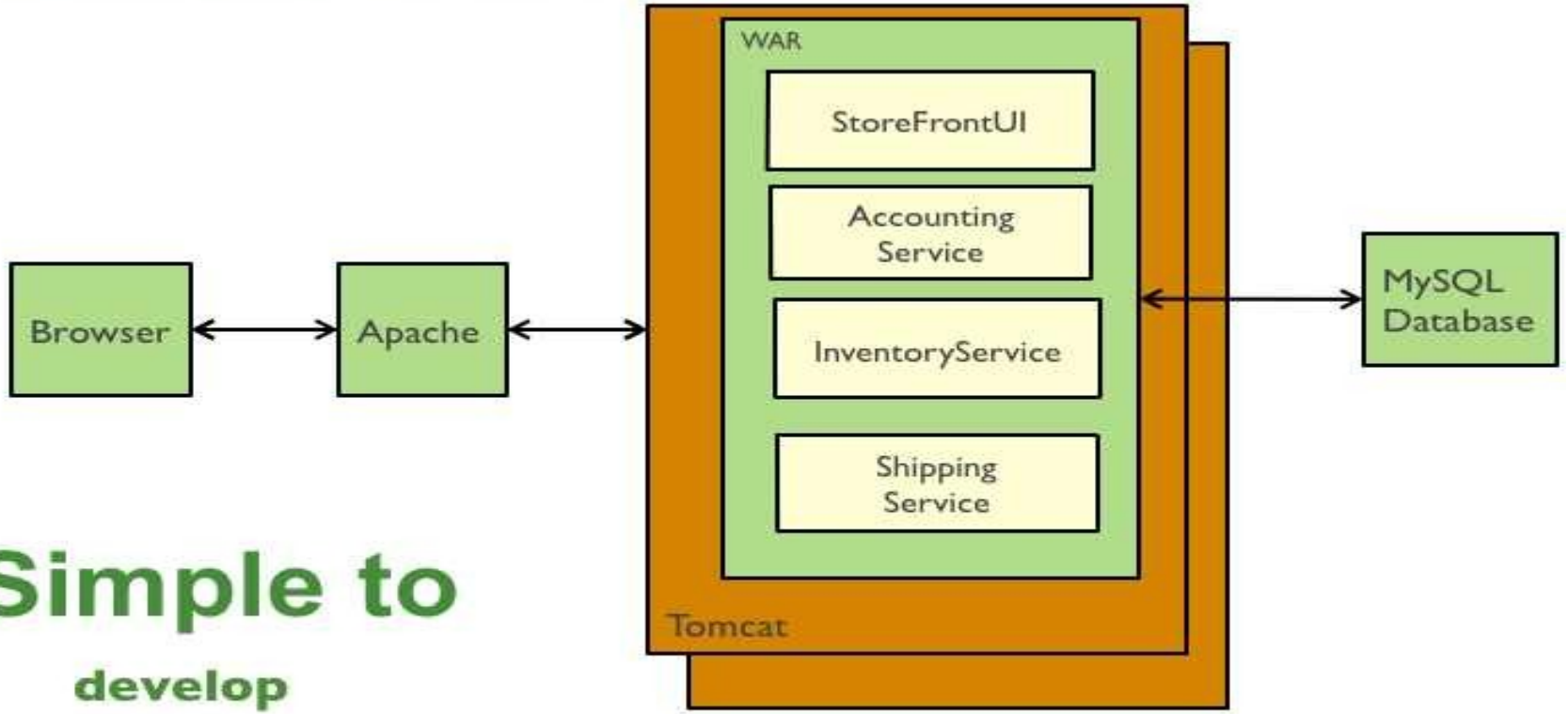
An Example

Traditional web application architecture



Simple to

develop
test
deploy
scale

When the time goes by. The Problems which appear

- Overloaded IDE
- Overloaded web container
- Continuous deployment is difficult
- Scaling the application can be difficult
- Obstacle to scaling development
- Requires a long-term commitment to a technology stack

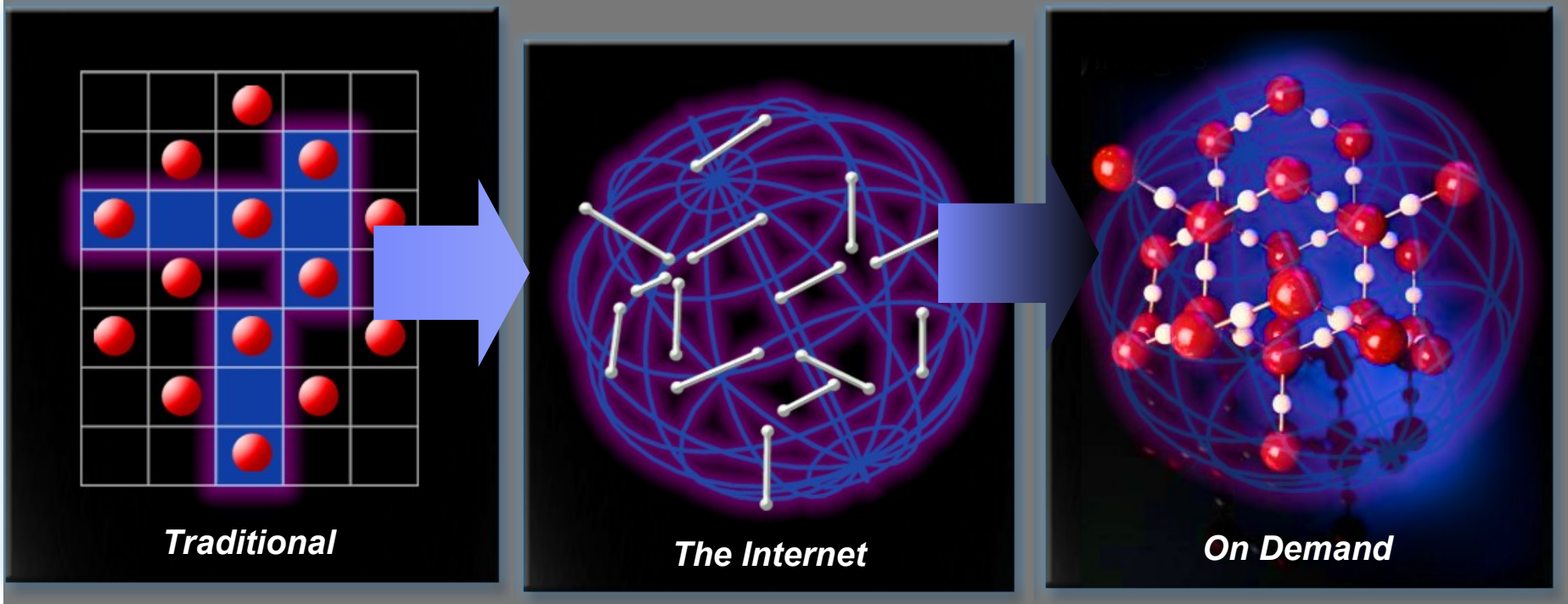
So, What is the solution ?

We shall look for the solutions which can overcome the existing issues of monolith and allows

- Smart Decomposition of Application Domain
- Small elegant independent services capable of being deployed and scaled independently
- Support of Continuous Integration and Delivery
- Supports Services Discovery
- Support orchestration and choreography
- Support API gateways

The Solution 1 : Service Oriented Architecture

The information technology industry



Structured
Calculations
Data Processing
Transactions

Open Standards
Connectivity
Flexibility
Simplicity
Scalability

Rich, Modular Components
Composition/Orchestration
Dynamic Applications
Flexible Business Solutions

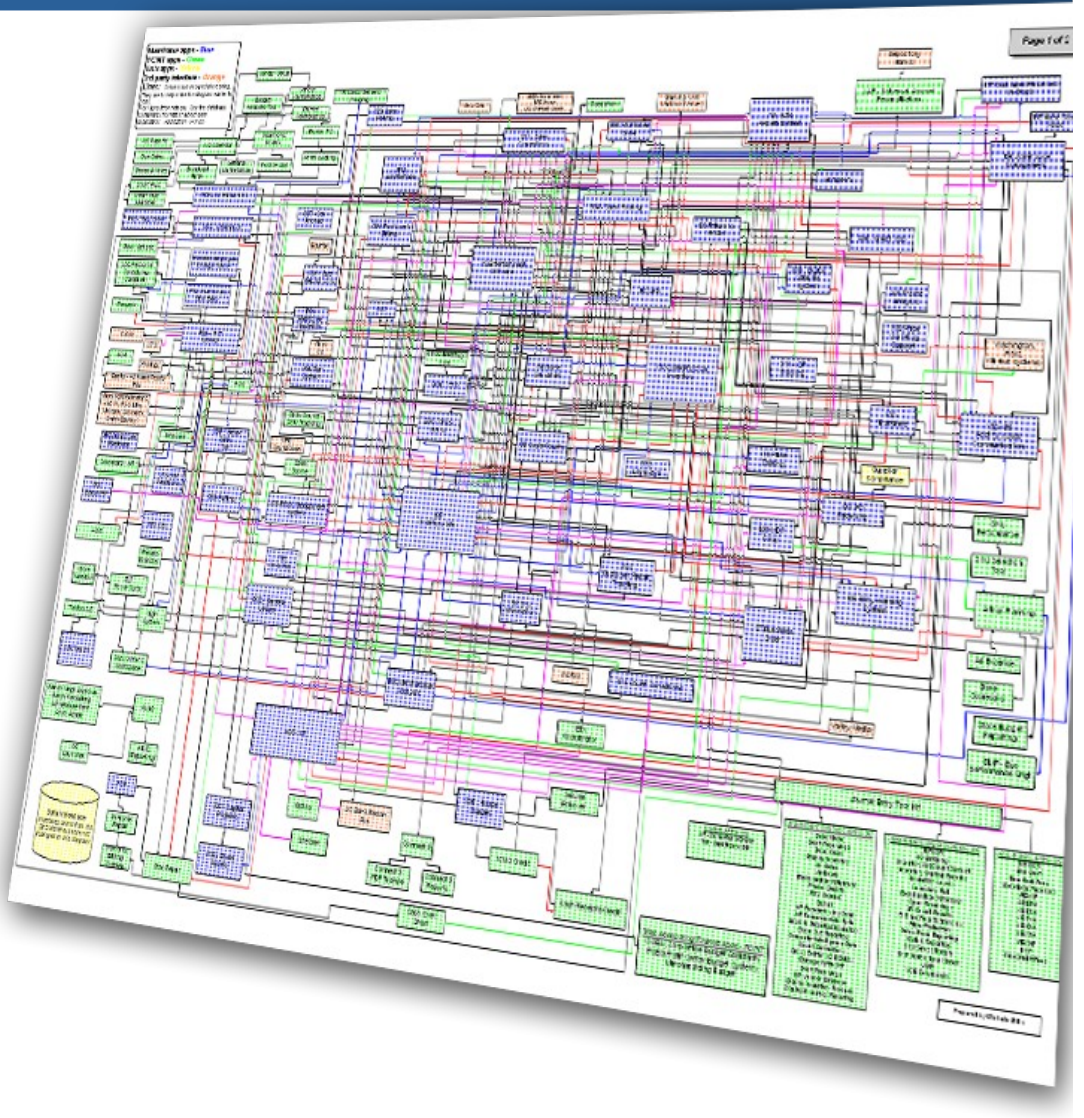
Moving to a new state…

On Demand Business

*An enterprise whose **business processes — integrated end-to-end** across the company and with key partners, suppliers and customers — can **respond with flexibility and speed** to any customer demand, market opportunity or external threat.*

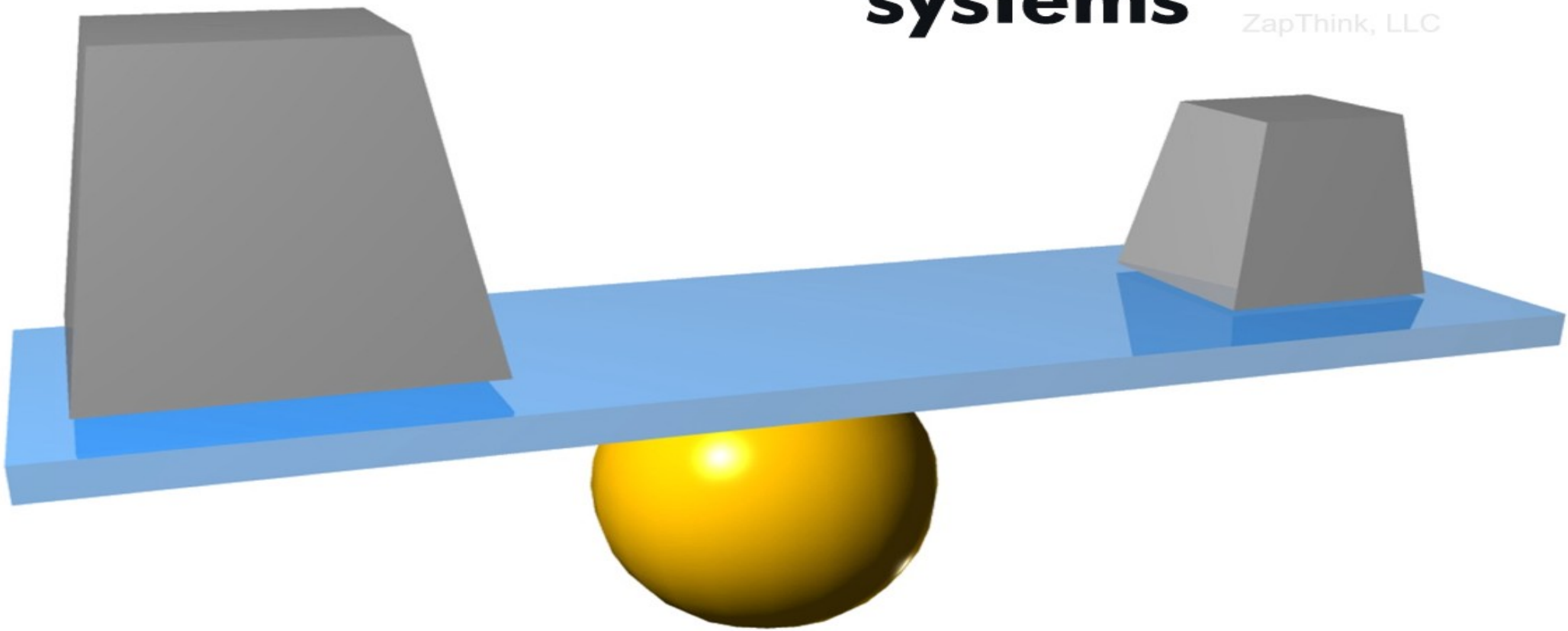
What are the barriers to business flexibility and reuse?

- Lack of business process standards
- Architectural policy limited
- Point application buys to support redundant LOB needs
- Infrastructure built with no roadmap



The Cost of Business Integration …

70% of IT development budgets are spent on integrating different systems

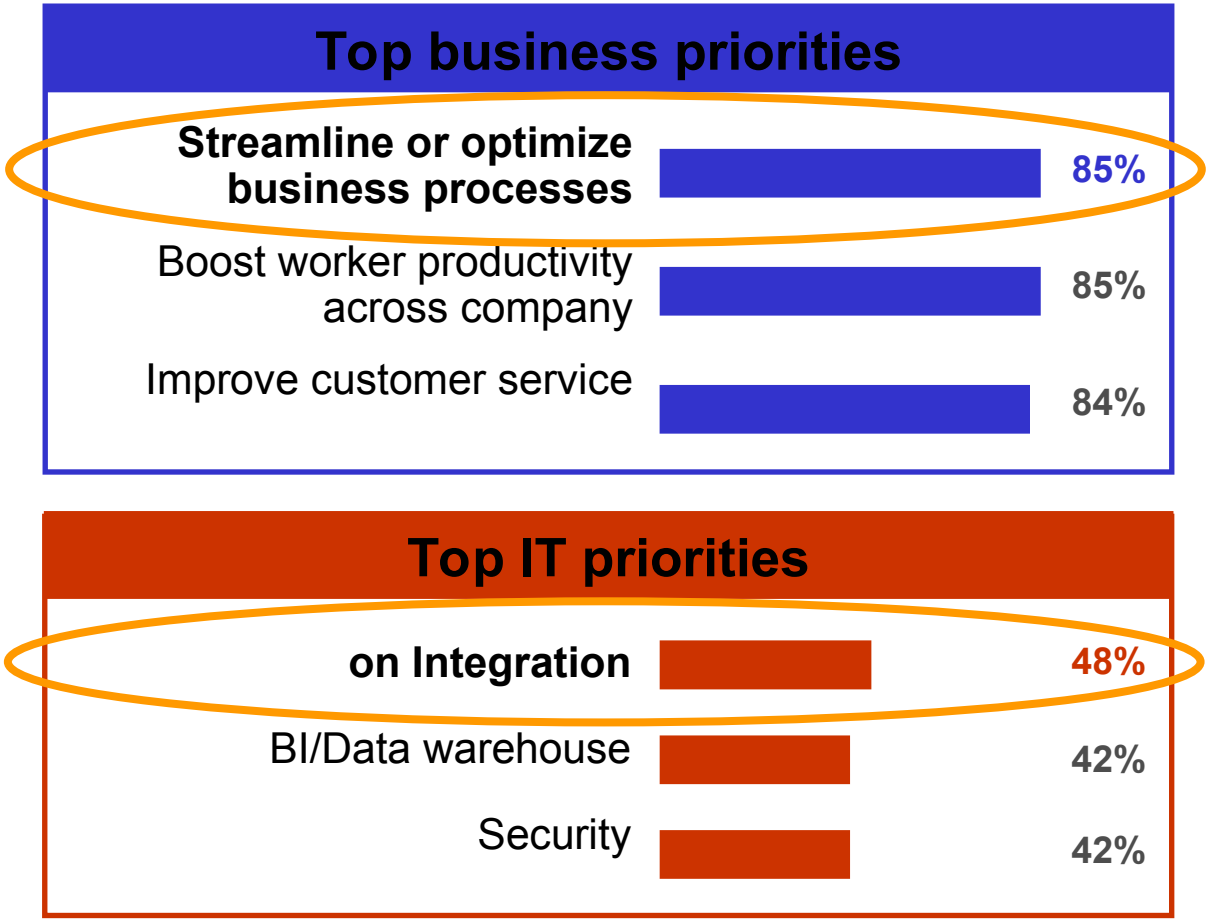


Changing Market Conditions Drive On Demand Business Needs: Addressing Top Business and IT Priorities

"More than 80% of CEOs see unpredictable market forces as the key inhibitor to growth."

Source: IBM's Global CEO Survey, February 2004

- Economic volatility and globalization
- Increasing consolidation across industries
- Increasing regulations and industry standards
- Technical realities



Sources: *Outlook 2004: Priorities 1Q InformationWeek* Research, January 2004; Merrill Lynch CIO Survey Results, September 2004

The Challenge: Business and IT Alignment

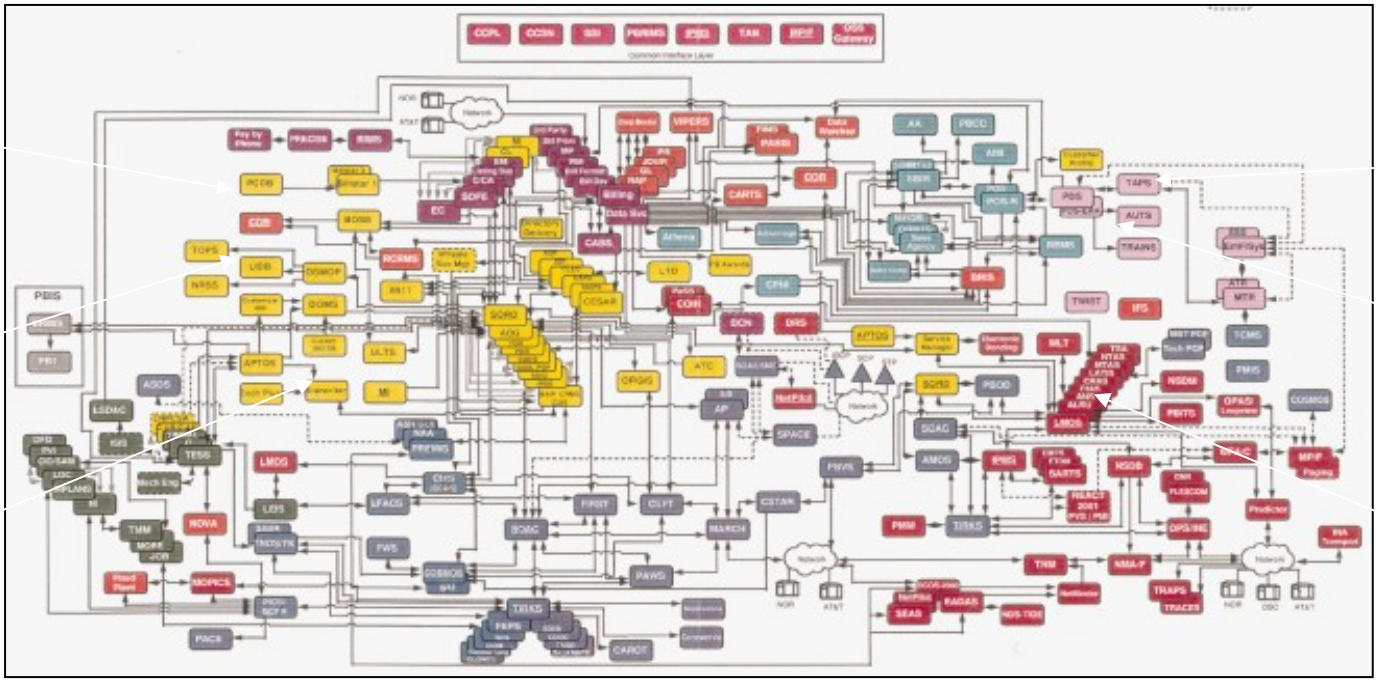
Business Pressures:

- Launch new and innovative products
- Shorter change cycles
- Customized products for niche markets

Partner

Customers

Channels



Employees

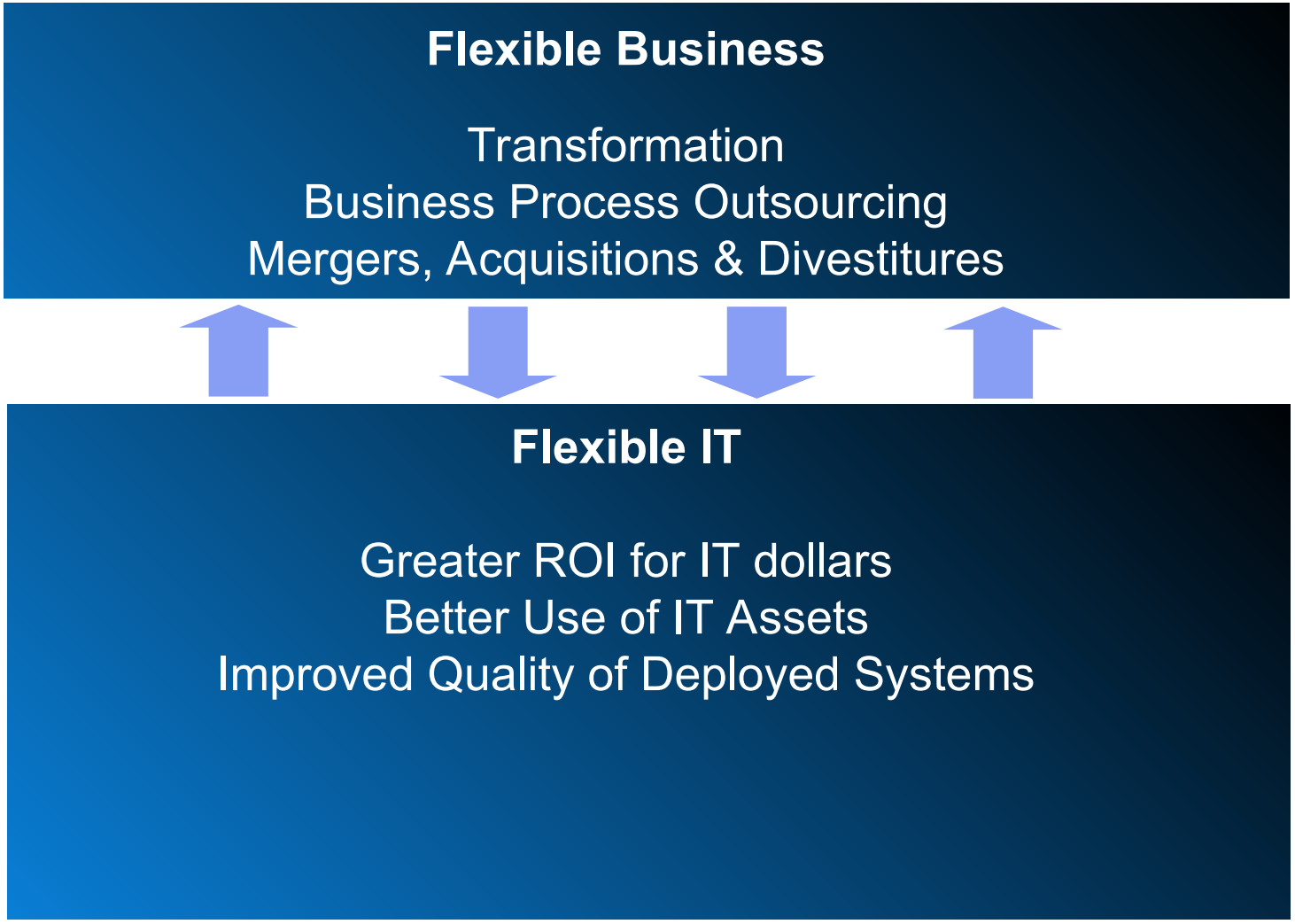
Suppliers

3rd Party Providers

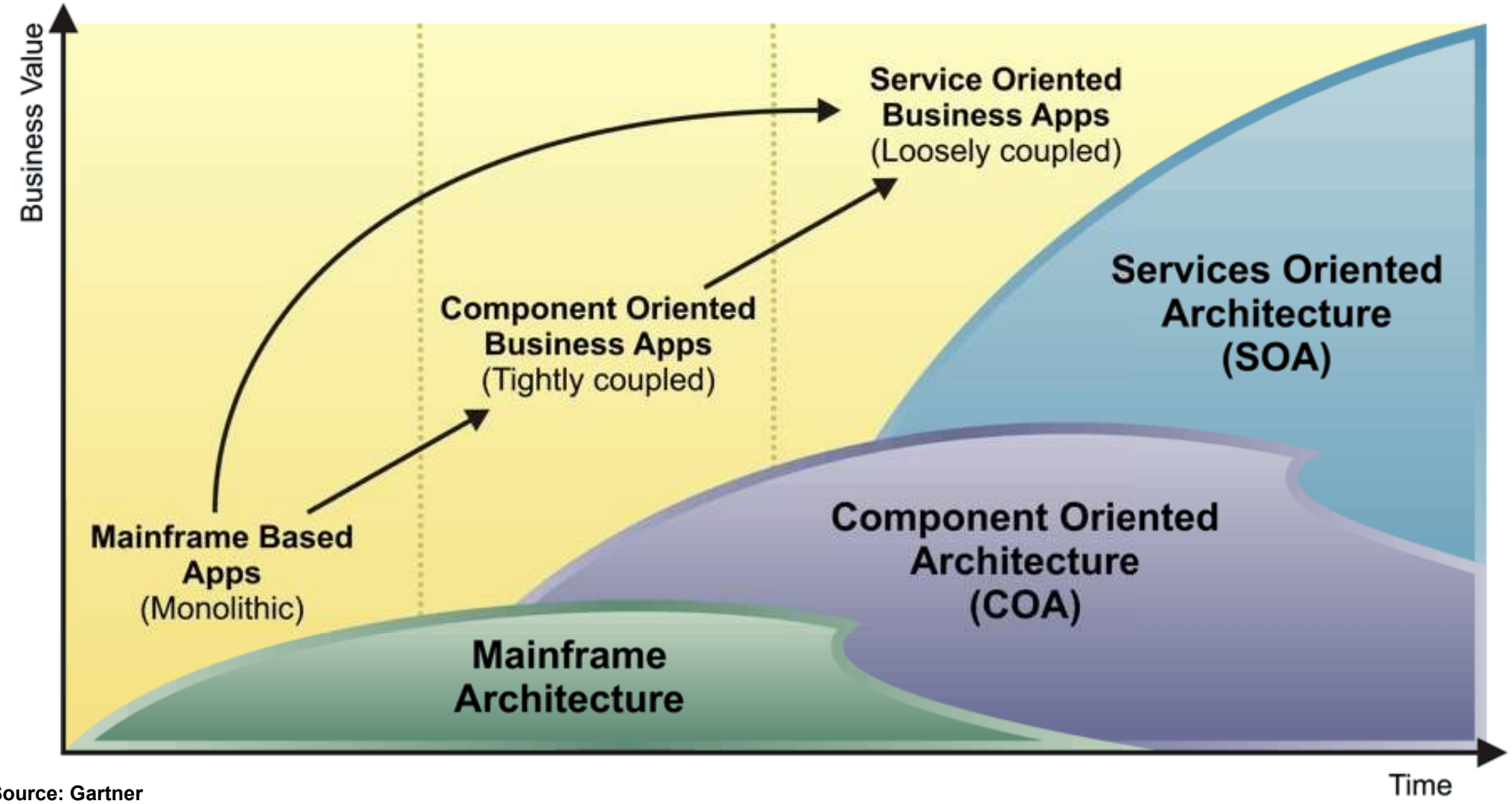
IT Constraints:

- Complex processes and systems
- Complex applications and interfaces
- IT budget priorities on maintenance, not new investments

Whatever you want are key drivers for SOA



SOA Represents the Next Evolutionary Step to Improve Business Agility and Flexibility



Source: Gartner

What is SOA?

… a service?

A **repeatable business task** – e.g., check customer credit; open new account

… service orientation?

A way to integrate your **business as linked services** with their unique outcomes

… service oriented architecture (SOA)?

An IT **architectural style** that supports service orientation

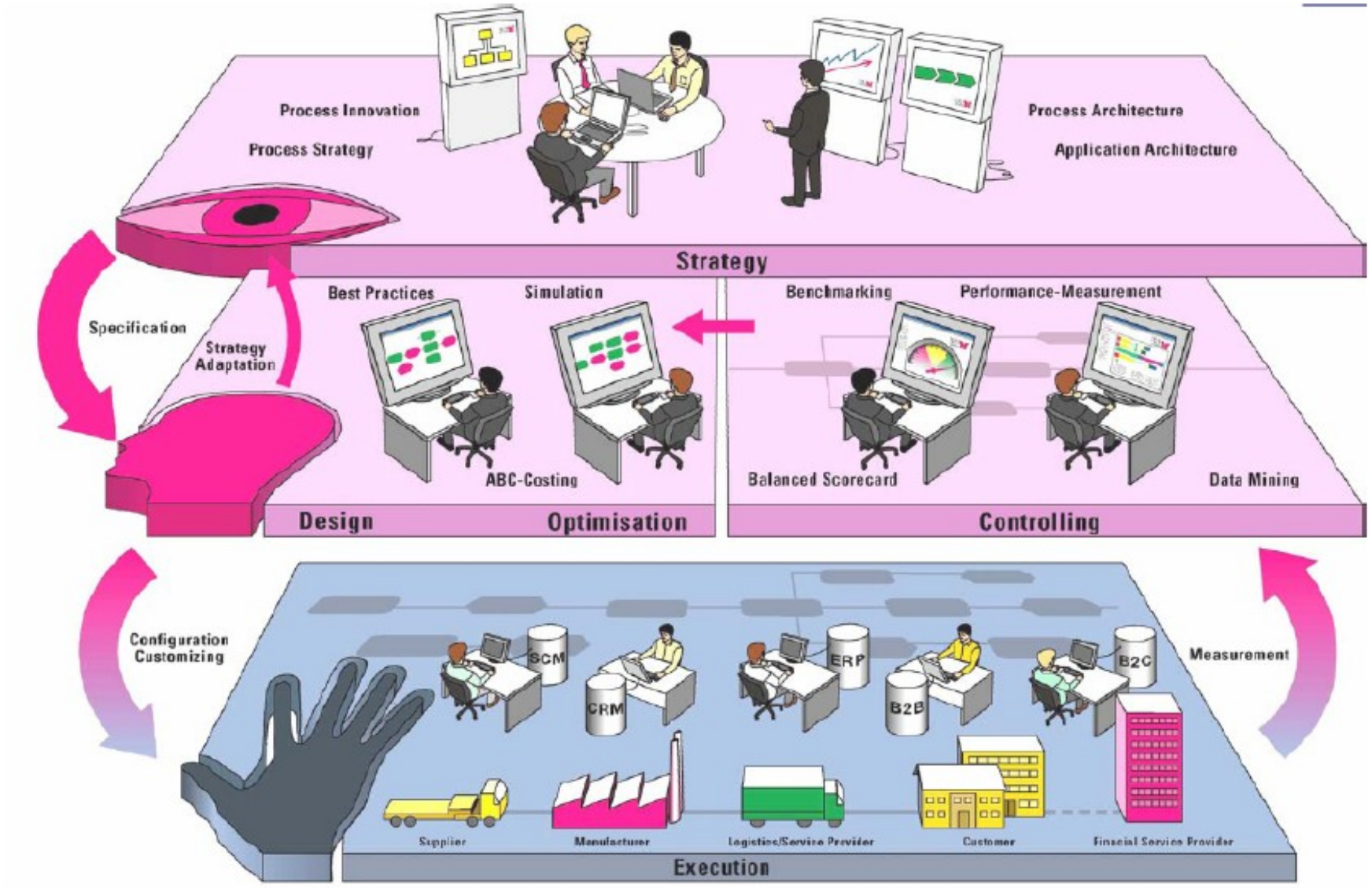
… a composite application?

A set of **related & integrated** services that support a business process built with SOA

Key terms for SOA

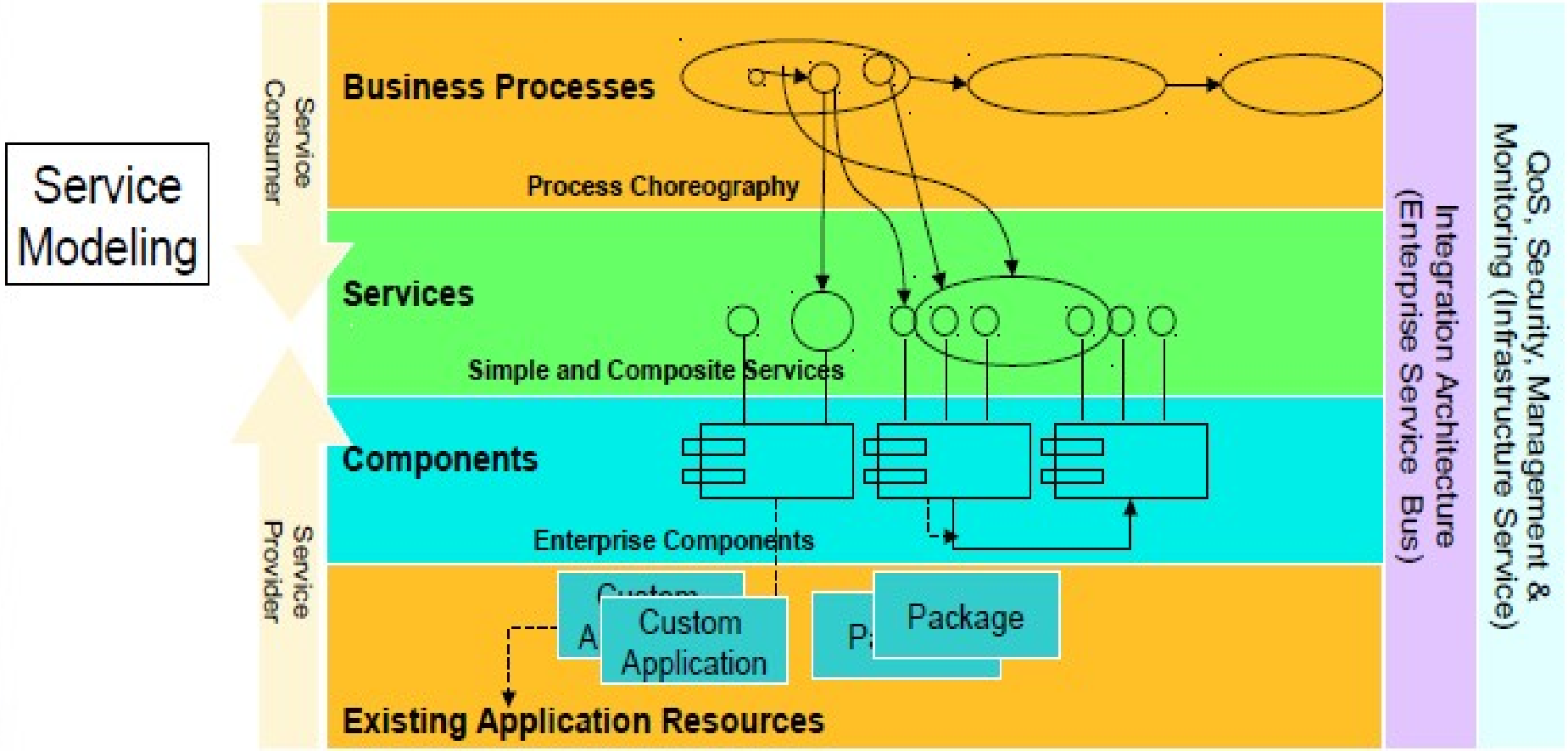
- **A *service* is representative of a repeatable business task. Services are used to encapsulate the functional units of an application by providing an interface that is well defined and implementation independent. Services can be invoked (consumed) by other services or client applications.**
- ***Service orientation* defines a method of integrating business applications and processes as linked services. we’re talking about a thought process and a business philosophy not about technology.**

How Business Works?



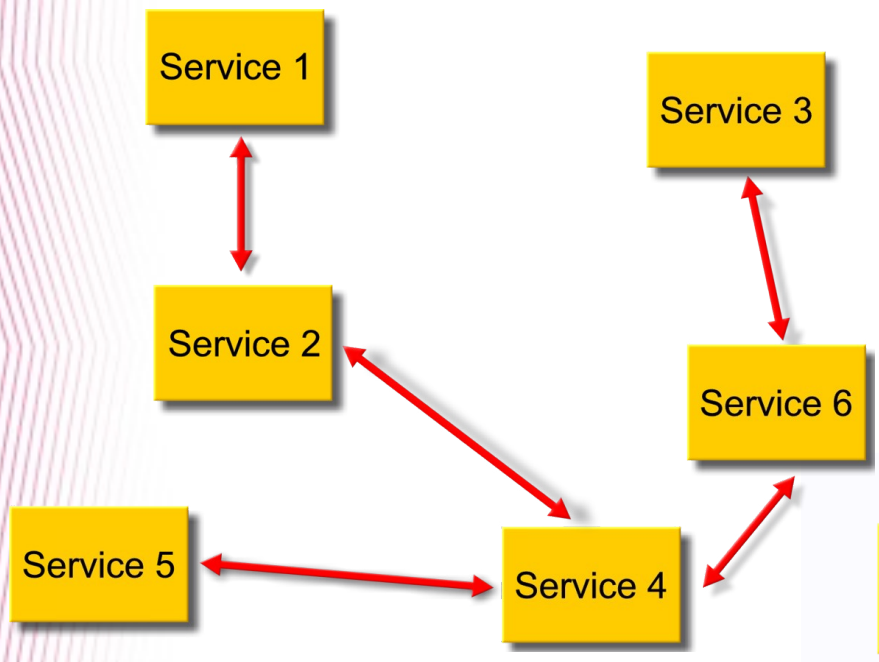
Service-Oriented Solutions – Architecture View

An SOA is composed of multiple layers.
At the heart of the SOA are Services, Components that realize services and Service Flows.



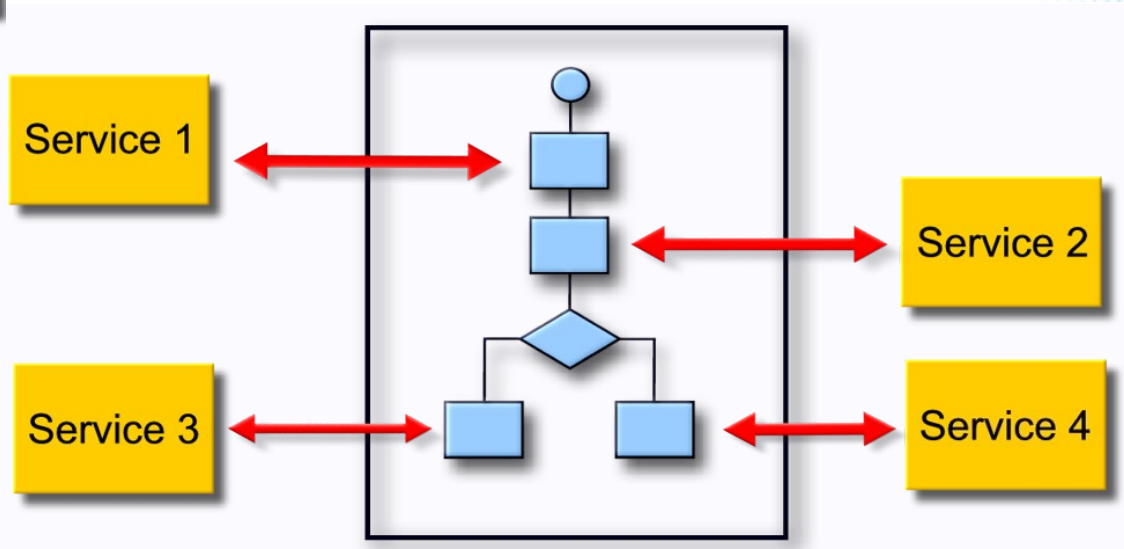
The Choreography Challenge with Composite Application…

◄ From



To ►

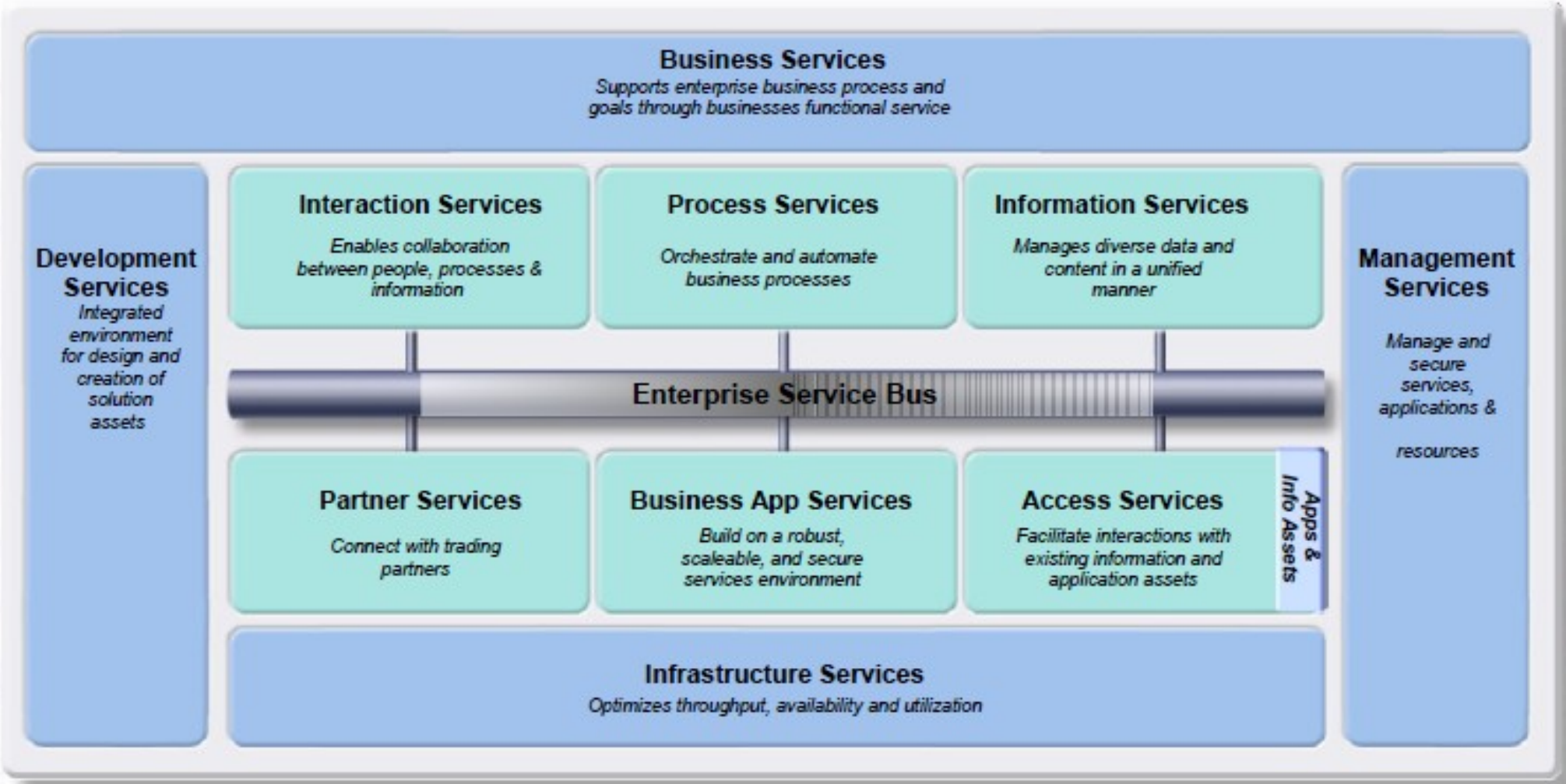
Composite Application representing a business process



Key Feature - Enterprise Service Bus

Defining the capabilities for your SOA environment

SOA Reference Architecture



Key Features of Enterprise Service Bus

- Messaging from one service to other
-Routing
-Centralised Security
-Profiling
-Metering
-MessageTransformation on Fly
-Protocol Independency

View performance and modify dashboards in real time

- Scorecard view implemented through Key Performance Indicators
- Track and modify business process flows
  - Eliminate redundancies or inefficiencies
  - Identify bottlenecks – balance workloads
  - Reduce latencies
- View information the way you want to see it
  - Management dashboards and reporting capabilities,
  - trending information
  - Tools to customize or define new dashboards
- Monitor different perspectives of business process metrics
  - Cost, time, resources

SOA Benefits

- **Saves money, time, and people**
- **Eliminates frustrations with IT**
- **Justifies IT investments**
- **Provides business executives with a clear understanding of what IT does and its value**
- **Eliminates IT's 6-6 answer (that is, the project will take 6 months and cost 6 figures)**
- **Provides a business and competitive differentiator**

When a change in business process no longer requires a change to application programming logic, you have a successful SOA; your company has attained competitive business agility.

When SOA is beneficial?

An SOA could be the difference between the success and failure of the next:

- **Department, intra-company, or inter-company merger**
- **Acquisition**
- **Divestiture**
- **Product or service rollout**
- **Business partner, customer, or supplier addition**
- **Geographical expansion**
- **Competitive onslaught**

When not to implement SOA?

- **When you have a homogeneous IT environment**
- **When true real-time performance (nanoseconds response times) is absolutely critical**
- **When flexibility is not needed**
- **When tight coupling is needed**
- **If the organization isn’t ready for it**

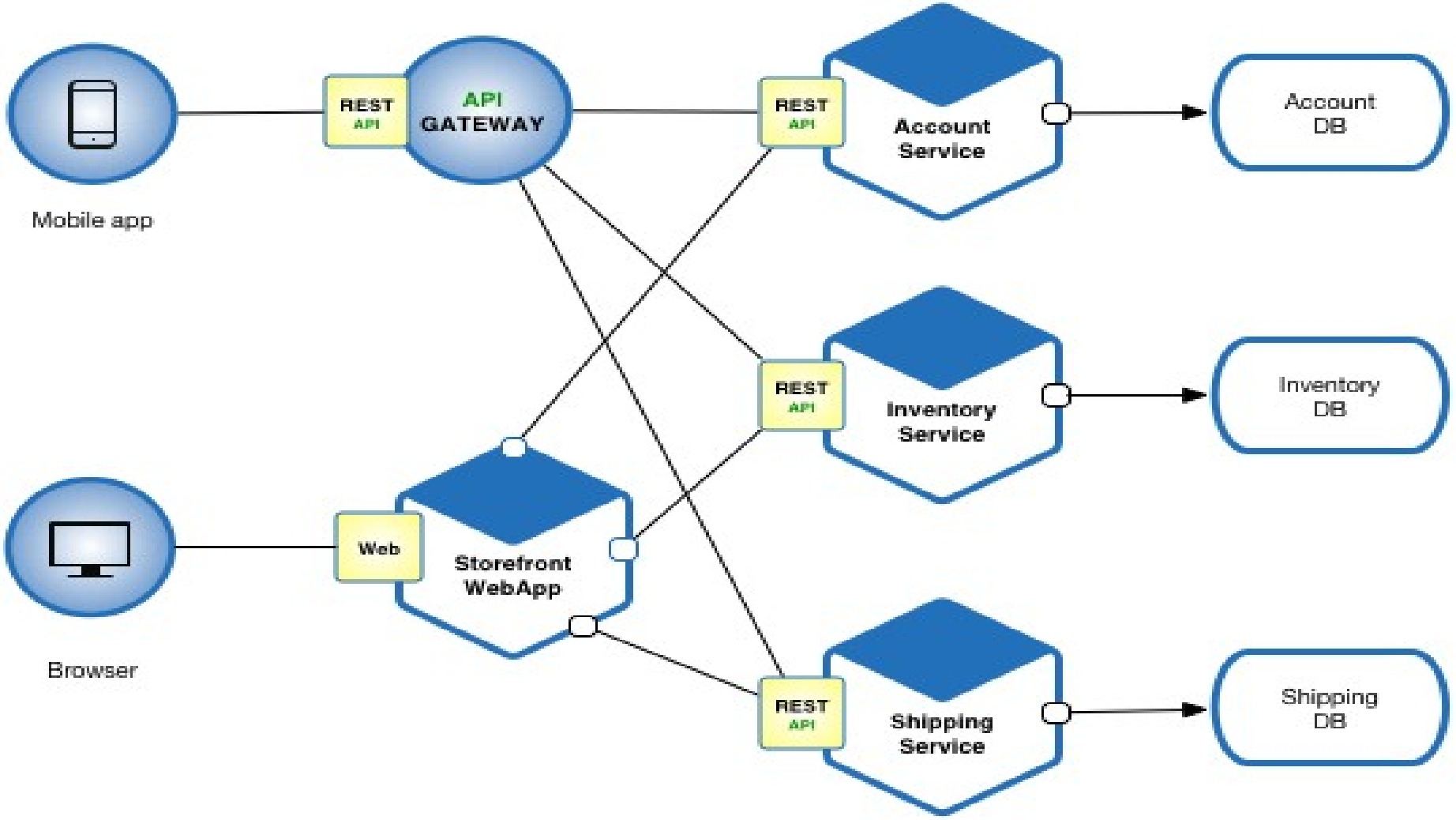
Pitfalls of SOA

- **Highly Proprietery (Oracle, IBM) . Less stable open source products**
- **Relying on JAX-WS and XML standards which is obsolete now a days**
- **Provision of Enterprise Service Bus made it higly bulky and centralised**
- **Could not convince the community about its utility**
- **Scaling was a major issue**

What we need now is

- There is a team of developers working on the application
- New team members must quickly become productive
- The application must be easy to understand and modify
- You want to practice continuous deployment of the application
- You must run multiple instances of the application on multiple machines in order to satisfy scalability and availability requirements
- You want to take advantage of emerging technologies (frameworks, programming languages, etc)

Solution 2- Micro Services Architecture



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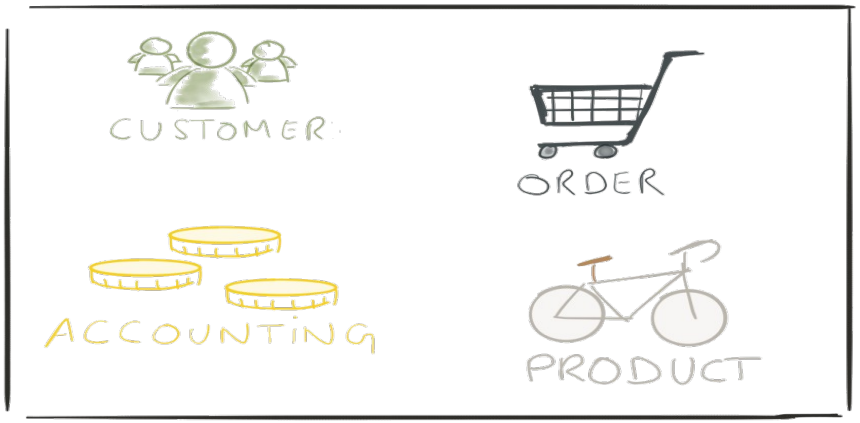
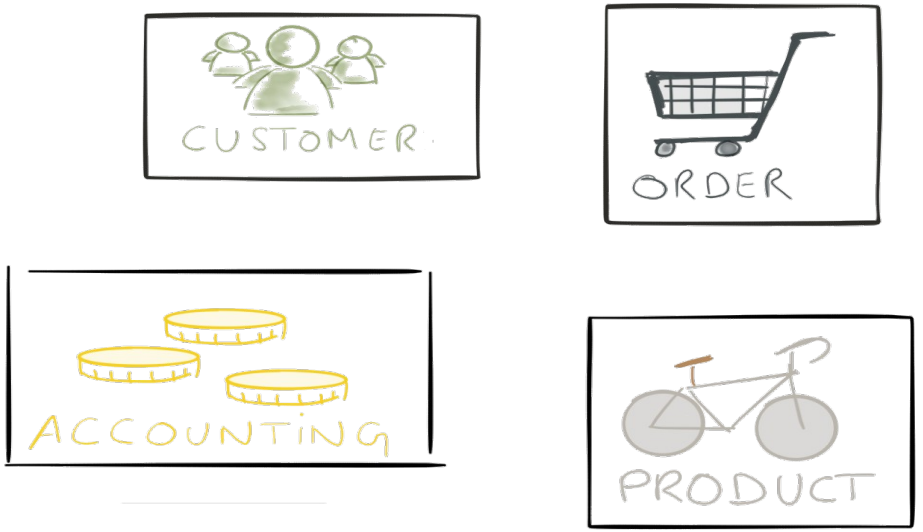


One Server
(Container)

monolith



Multiple Container
Instances

microservices

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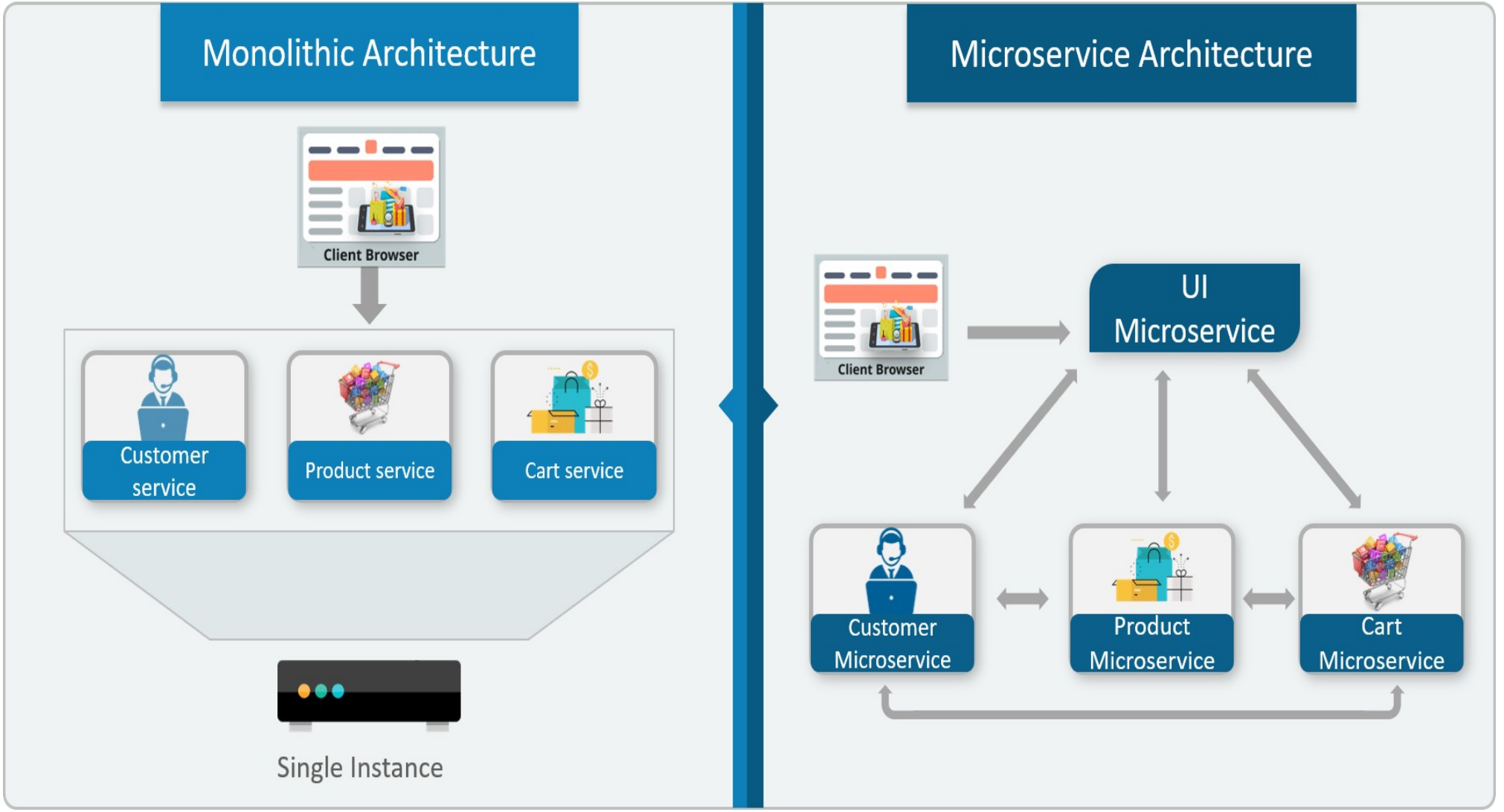
A Monolith Dicomposed into Microservices



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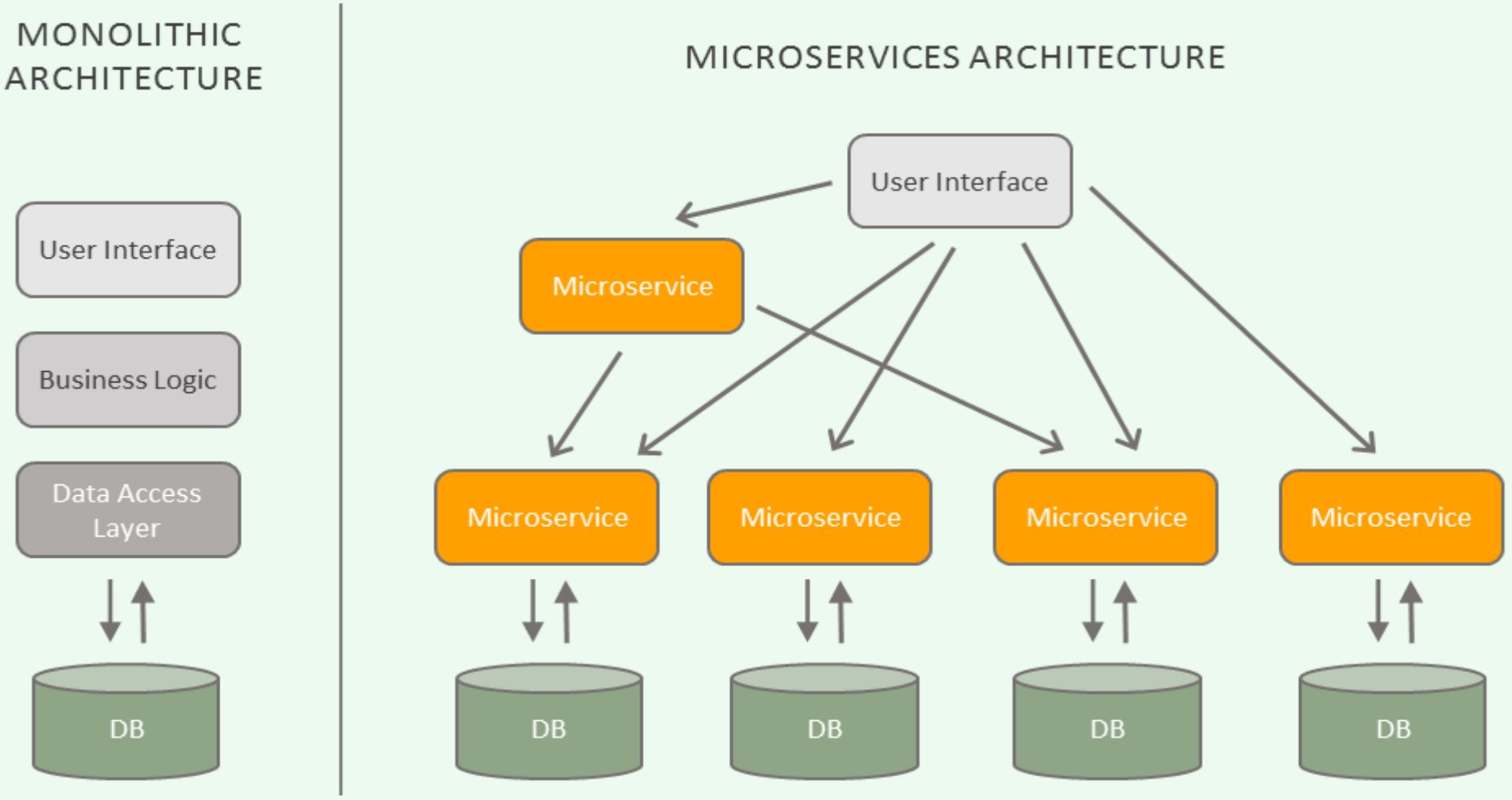
This architecture called - Micro Services Architecture



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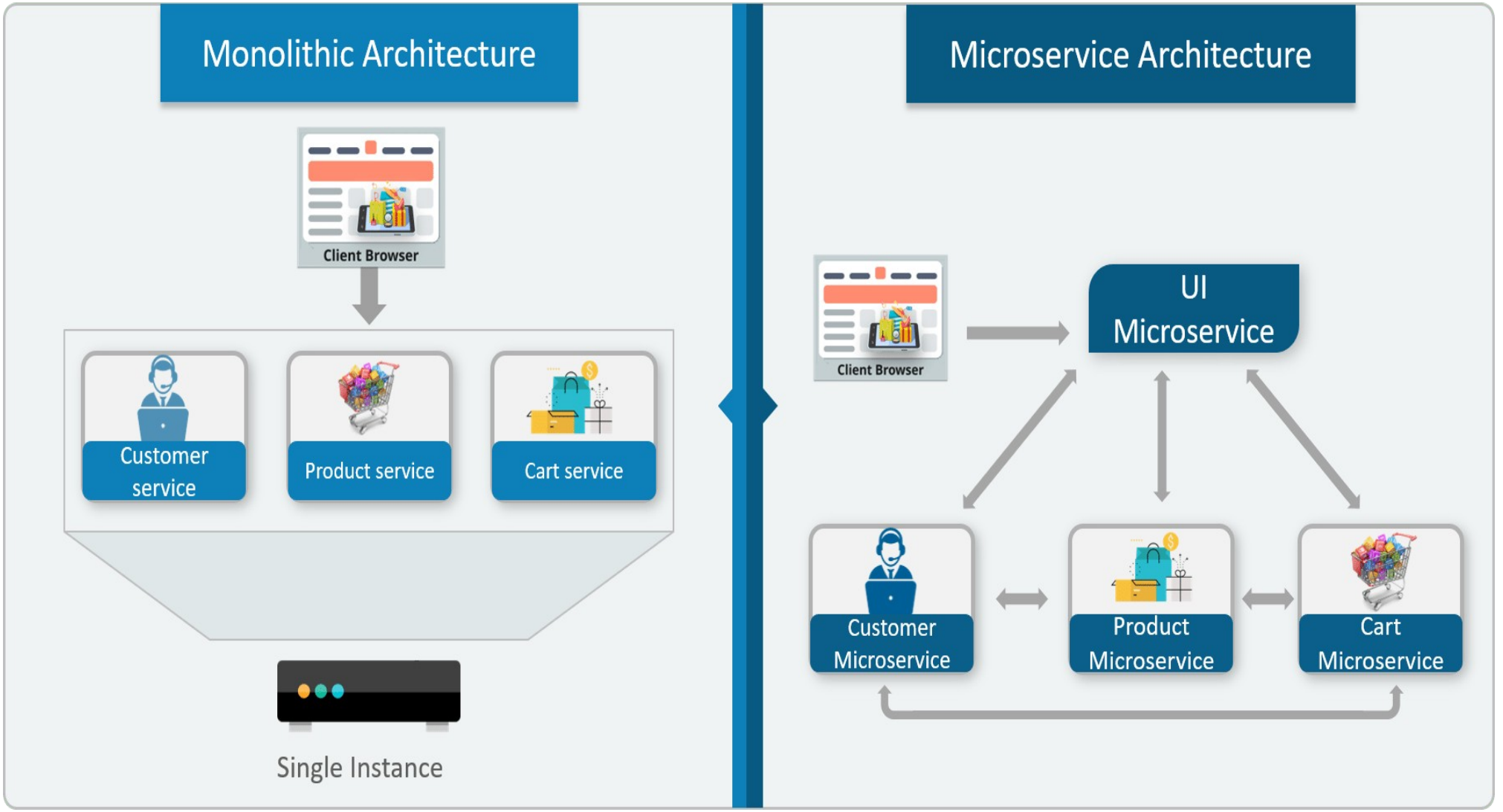

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MICRO SERVICES APPLICATION DEVELOPMENT ARCHITECTURE

Some Development platforms like Java or .NET are providing a complete architecture to develop microservice based applications

Java Provides us with 2 strong platforms

1. 

2. Java Spring Boot

We Realize microservices in Java by JAVA MICROPROFILE ARCHITECTURE

Eclipse java Microprofile has following features

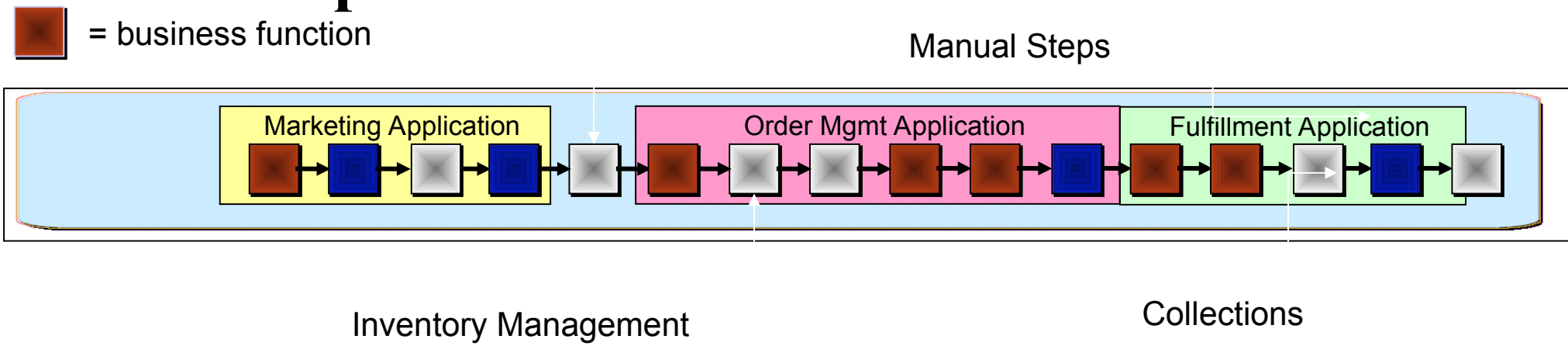
- JAX-RS - REST
- CDI
- JSON-P Json
- Common Annotations
- Config
-
- Metrics
- Health Check
- Fault Tolerance
- JWT Authentication
- OpenTracing
- OpenAPI
-
- Rest Client

The Expectations are :

- Enables the continuous delivery and deployment of large, complex applications.
- Improved maintainability
- Better testability - services are smaller and faster to test
- Better deployability - services can be deployed independently
- Easier for a developer to understand
- The IDE is faster making developers more productive
- The application starts faster, which makes developers more productive, and speeds up deployments
- Improved fault isolation.
- Eleminates any long-term commitment to a technology stack

Traditional Business Process

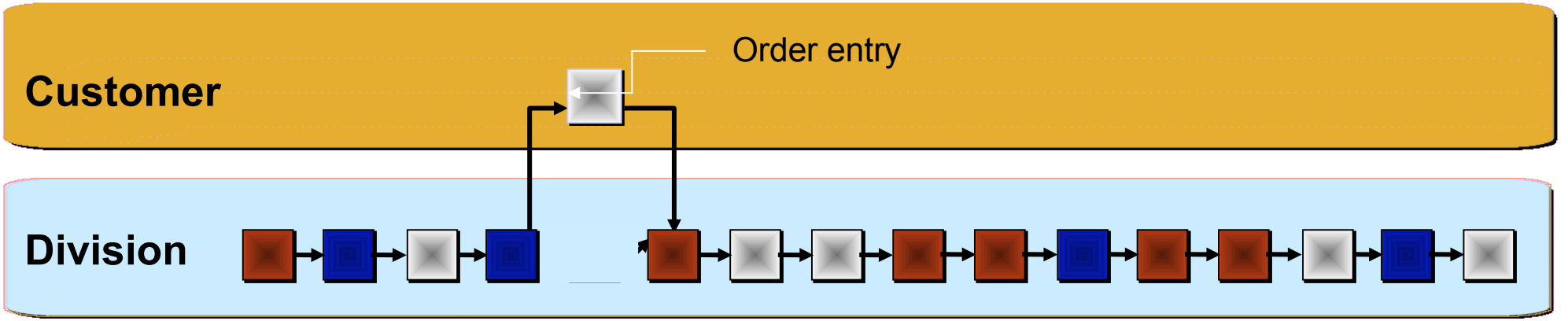
Example: Order to Cash Process



- Business process is embedded in three separate applications
- Changes to the process are difficult to implement
- New processes which are designed this way require long development cycles
- Business functions are tightly coupled within applications
- Process cannot be easily measured and managed

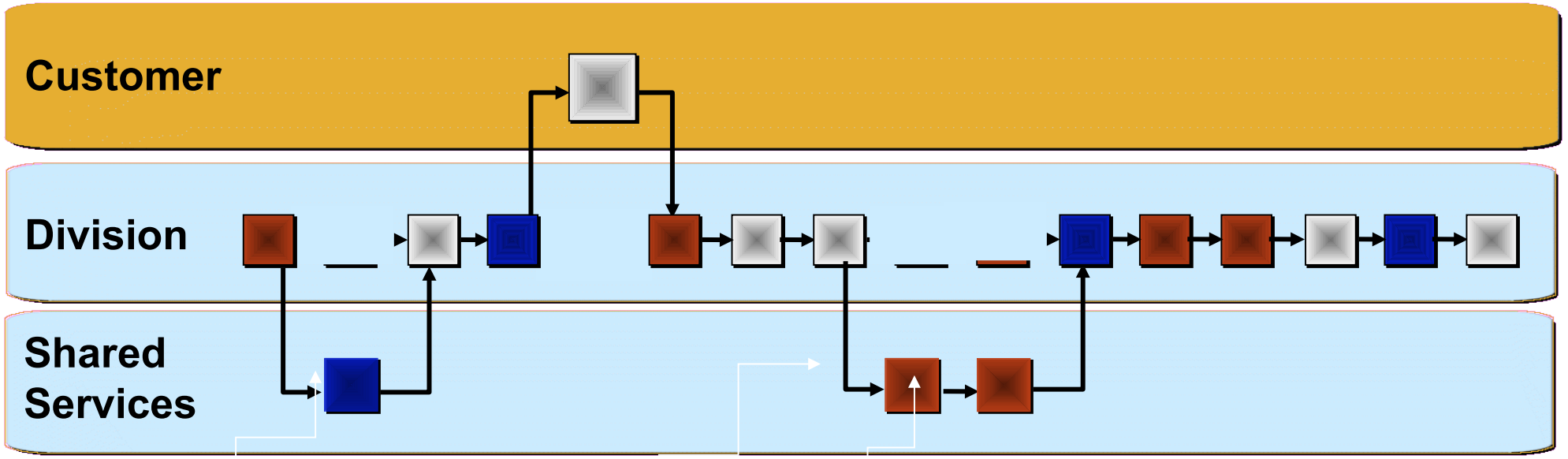
Result: Business cannot respond quickly to demand

On Demand Flexibility: Customer Self Service



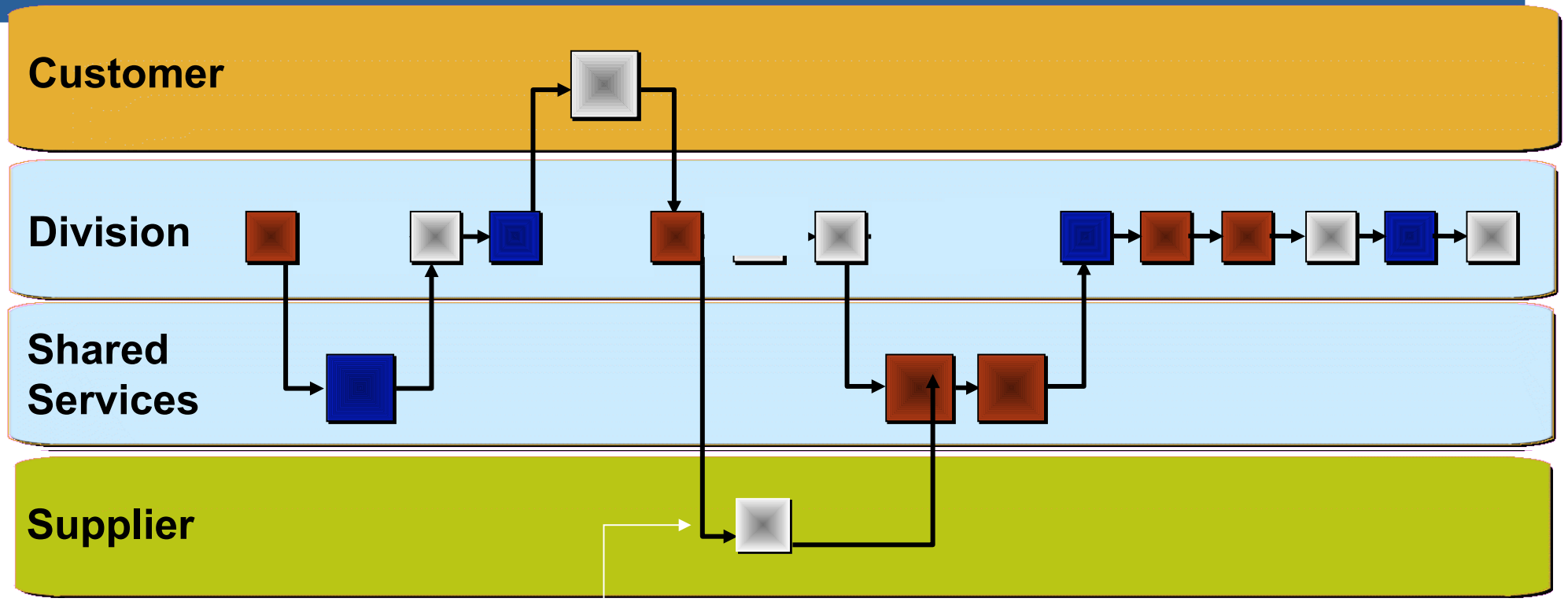
- Customers now order online using a web browser and the Internet
- Business partners can order using a web service call from their own process
- Customers are better served

On Demand Flexibility: Shared Services



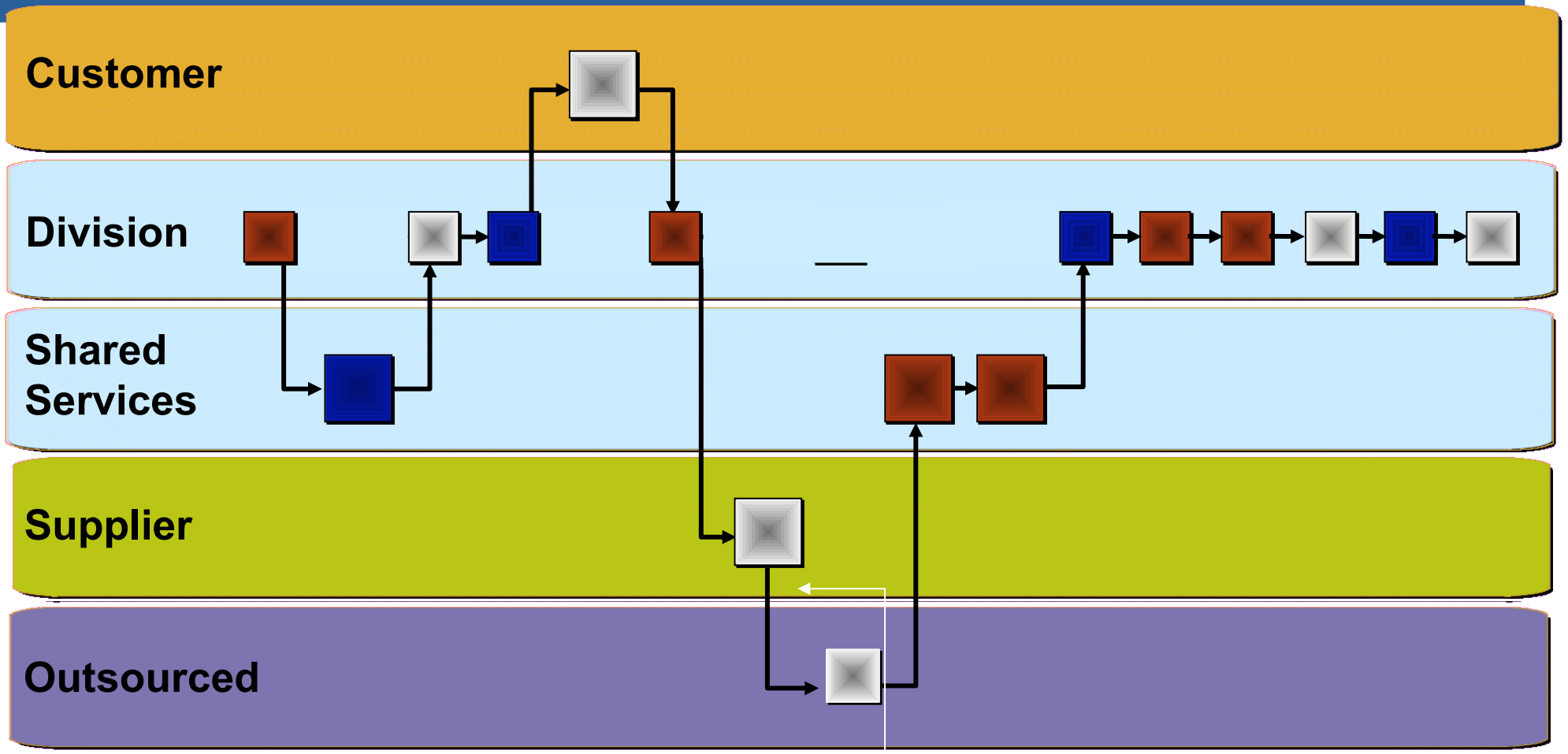
- Common business functions are shared across the enterprise
- Marketing, Billing, and Receivables are handled uniformly
- Enterprise can scale across divisions and lower costs

On Demand Flexibility: Vendor Managed Inventory



- Minimize or eliminate inventory management function
- Costs are reduced because less inventory is needed
- Inventory servicing is better because of supplier integration with the process

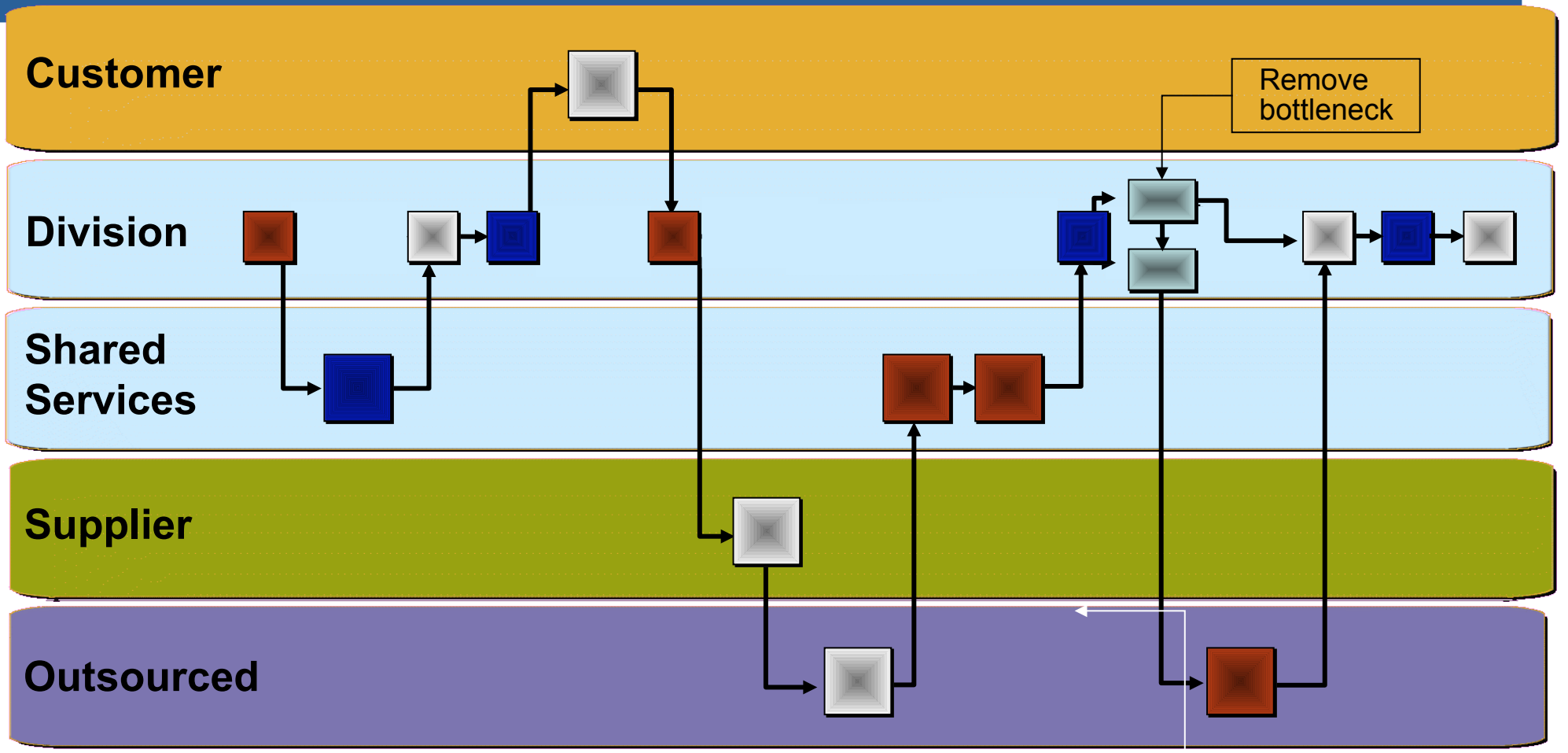
On Demand Flexibility: Outsource



Shipping

- Shipping is not a core competency
- Shipping companies (e.g. FedEx, DHL, UPS) have more capabilities
- Reduce shipping infrastructure and overhead costs

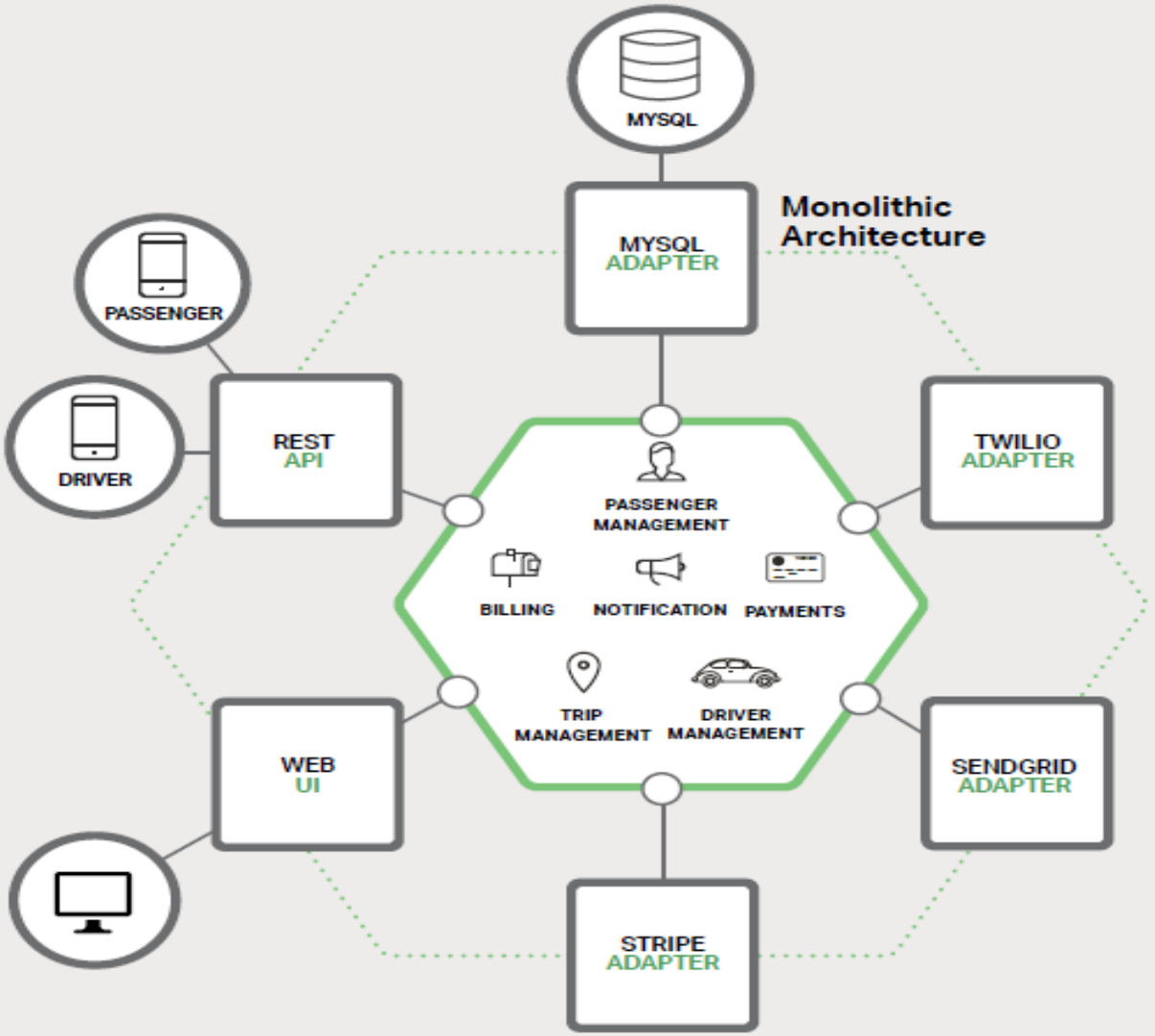
On Demand Flexibility: Improve the Process



- Identify and remove bottlenecks in the process
- Customize the business rules and policies to better serve customers
- A more efficient business process costs less

Alternative flow path

Another Example – A Monolith Cab App



An Enterprise Application of a Cab based Appplication like that of Uber/OLA

A modular application deployed as Monolith as

1. Written in a single language.

2. deployed on one kind of server

3. depending on adapters fro outside world.

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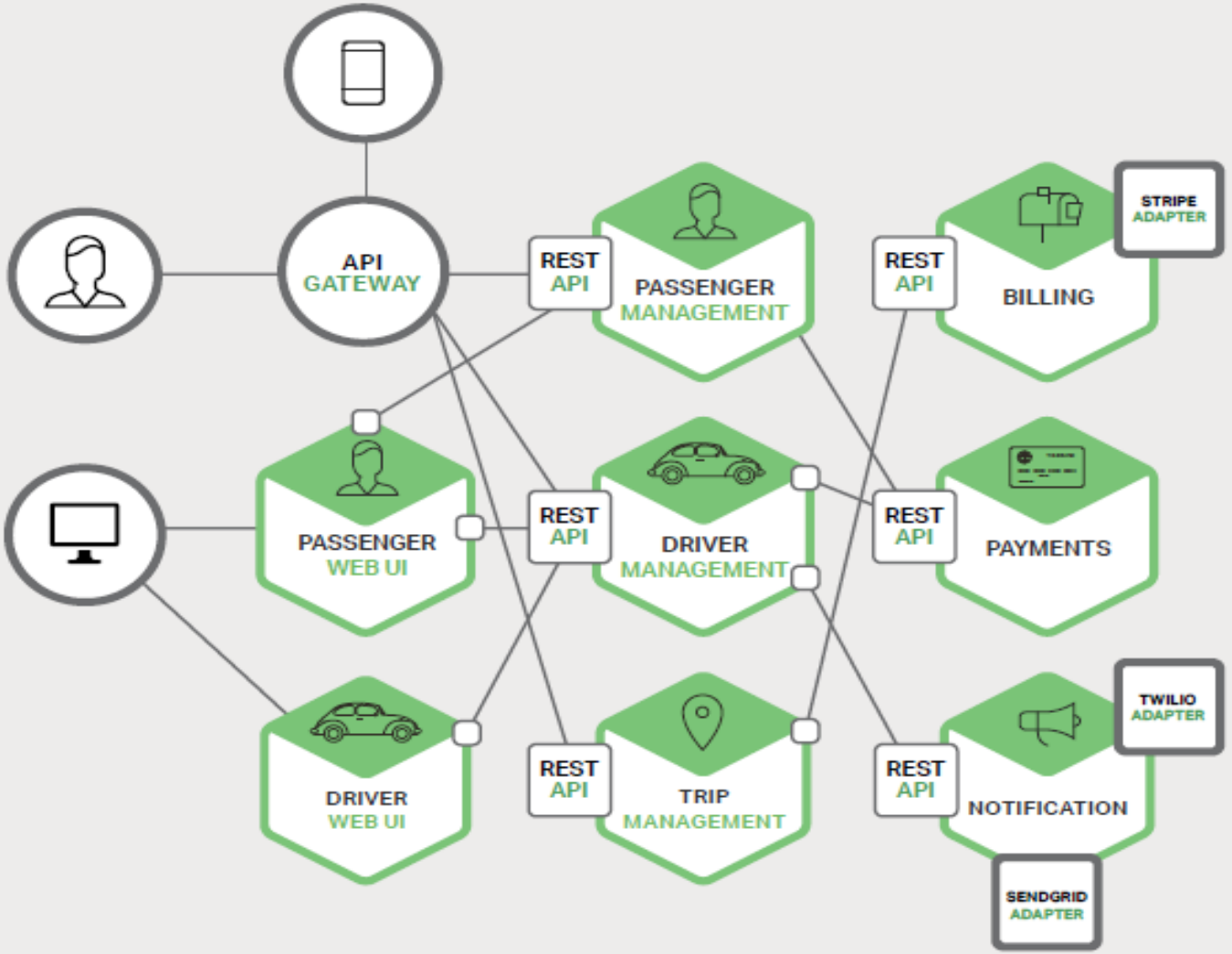
Monolith Cab App Decomposed into MSA



The monolith broken into a Micro Services Architecture **as**

1. Every module is independent and runnining int its own container

2. The services communicate through Rest API calls

3. Loose coupled applications

4. Independent of client interface

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How to achieve this : The Steps

1. Decomposition of Monolith into Microservices
2. Database per Service
3. Transaction Management Strategy
4. Deployment Patterns
5. Discovery Access Restrictions with API- Gateways
6. Observation and Monitoring

Decomposition with Domain Driven Design

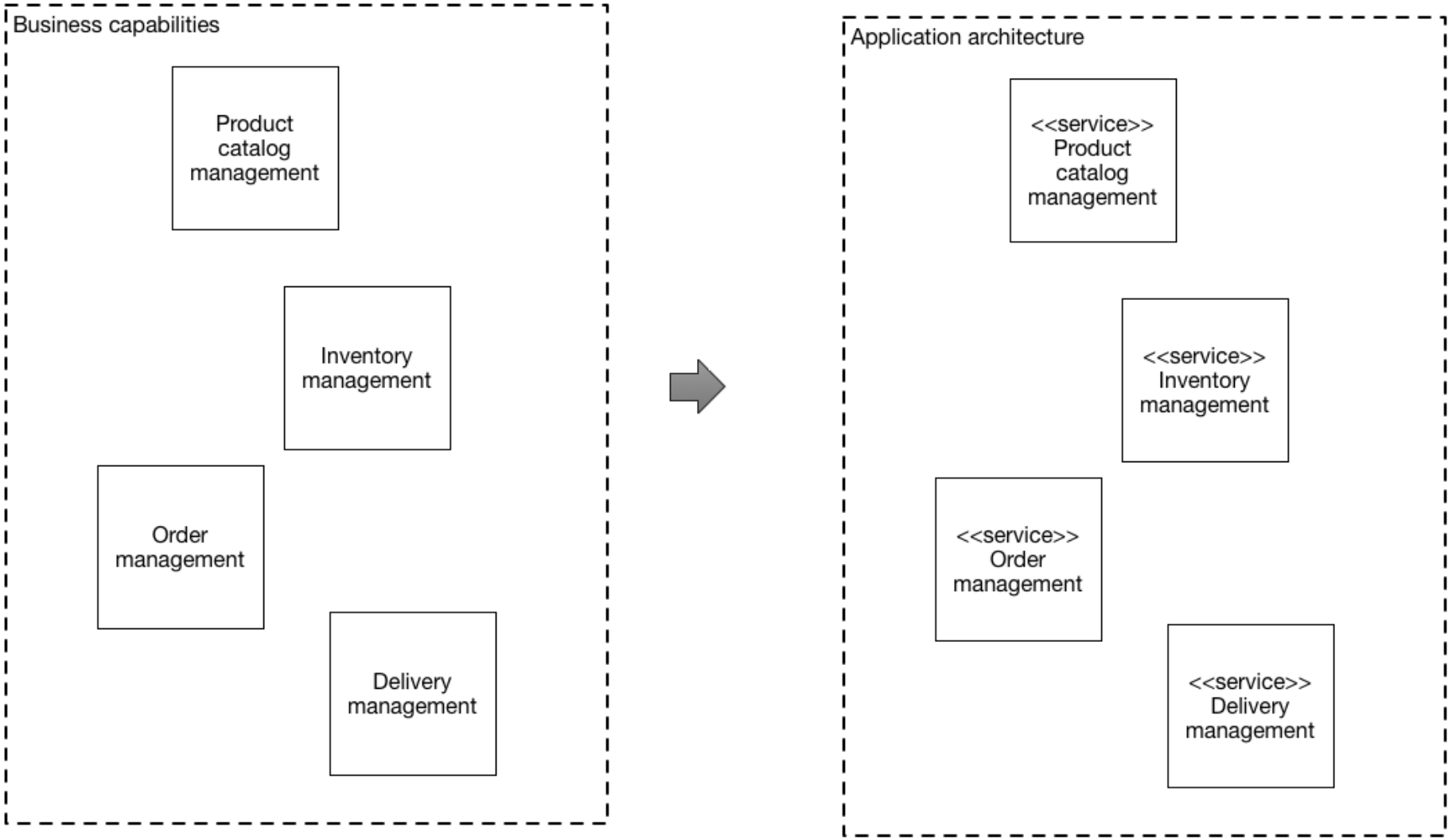
The steps to decompose a monolith

1. Decomposition by Business Capability

2. Decomposition by Sub-Domains

3. Service Per Team

Decomposition by Business Capability



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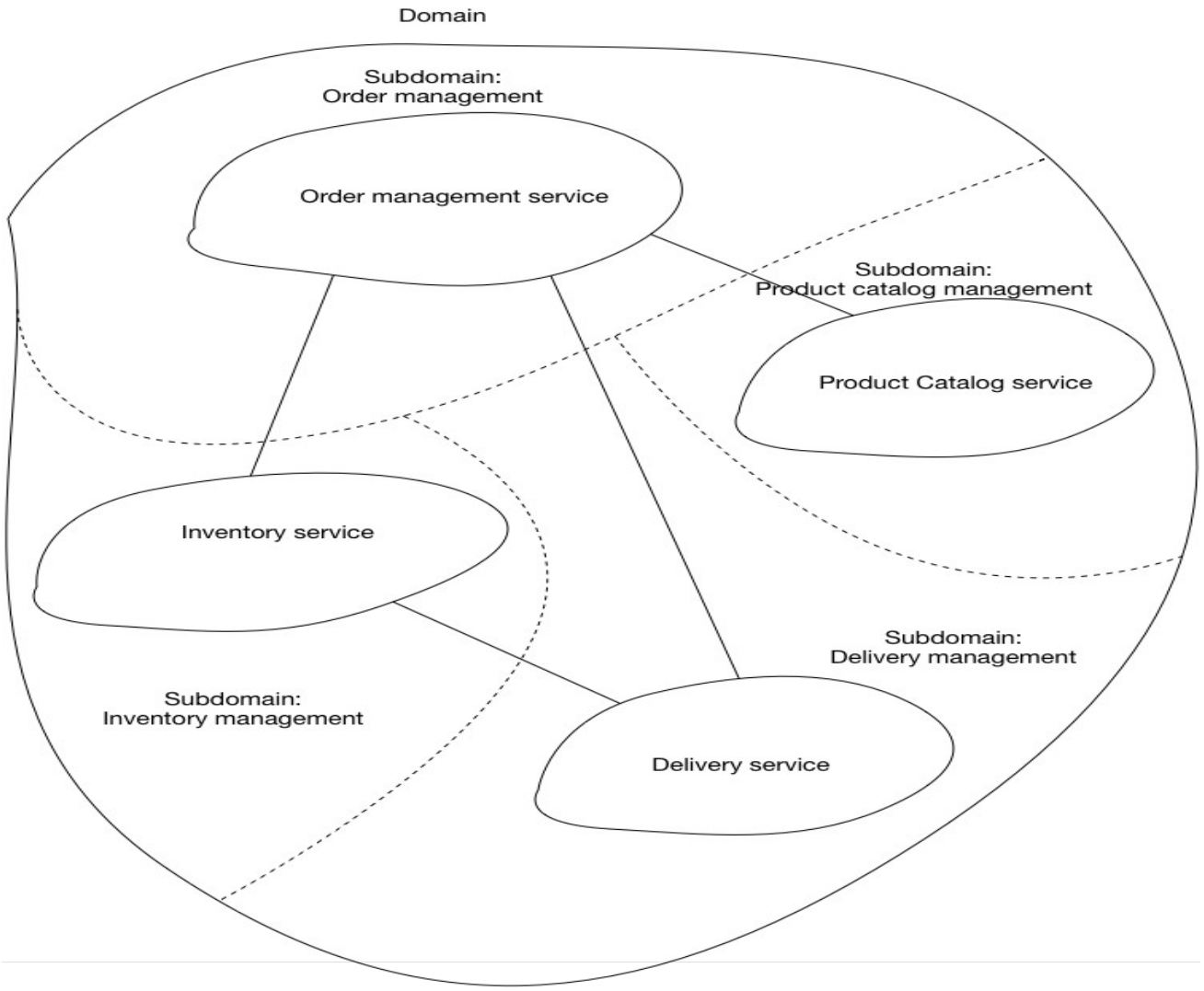
Decomposition by Sub domain



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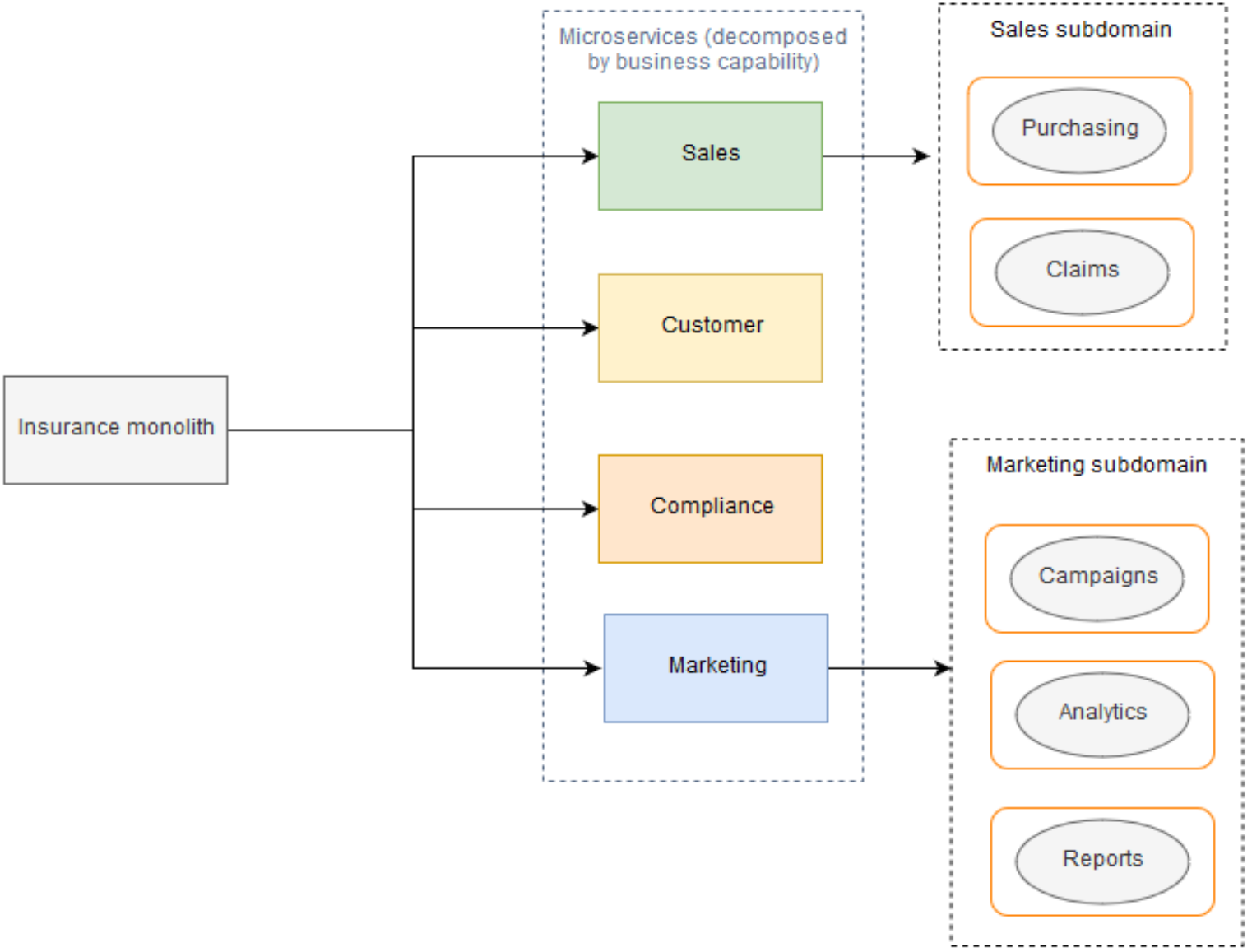
Decomposition by Sub domain



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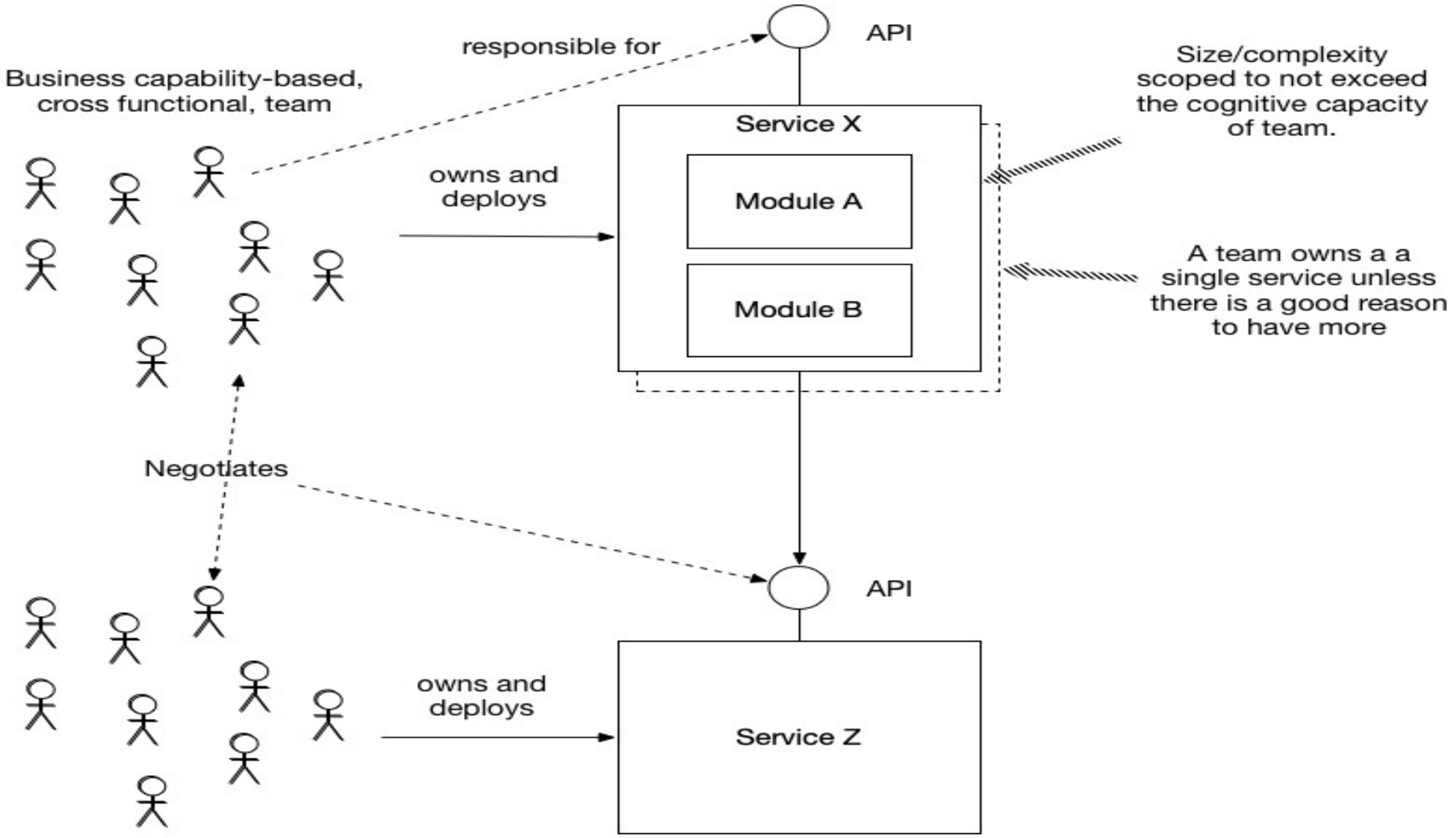
Decomposition by Service Per Teams



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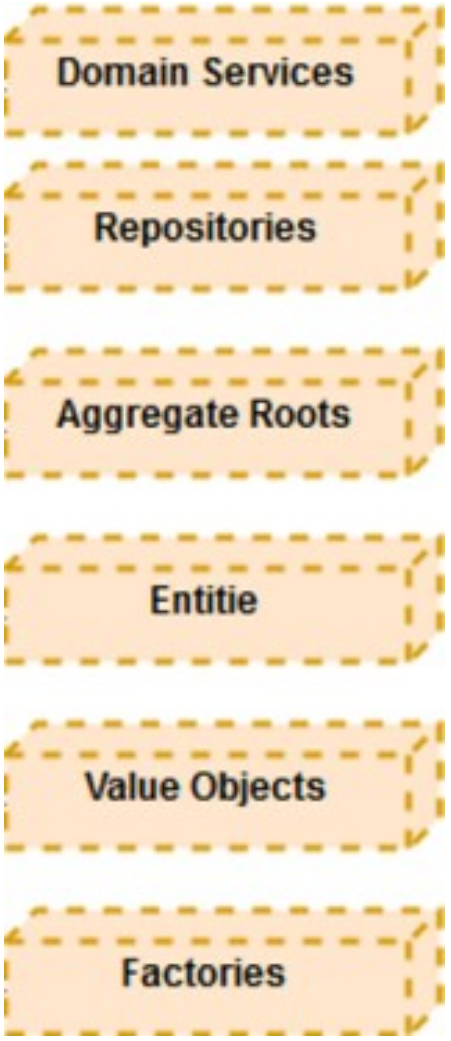
Domain Driven Design for Monolith to MicroServices

The Domain Driven Design involves following terms

1. Domain
2. Subdomains
3. Domain Model
4. Defined Bounded Contexts (Domain Model + DB Schema + UI + Web Services (API))
5. Ubiquitous Language
6. Context Map
7. entity, value object, aggregate, services, factory, and repository are the building blocks also known as the tactical approach to Domain-Driven Design toward its full realization:

Domain Driven Design

Building blocks of Domain Driven Design



Transforming Domain Driven Design to Micro Services Architecture

1)Define a set of bounded contexts for a microservices application

1)Then we looked more closely at one of these bounded contexts, the Change management bounded context, and identified a set of entities, aggregates, and domain services for that bounded context

1) by doing so we can define an architecture that structures the application as a set of loosely coupled, collaborating services. Each service implements a set of narrowly, related functions

1)For example, an application might consist of services such as the order management service, the customer management service, etc.

Microservice, a component in this architecture:

1)Each is a miniature application

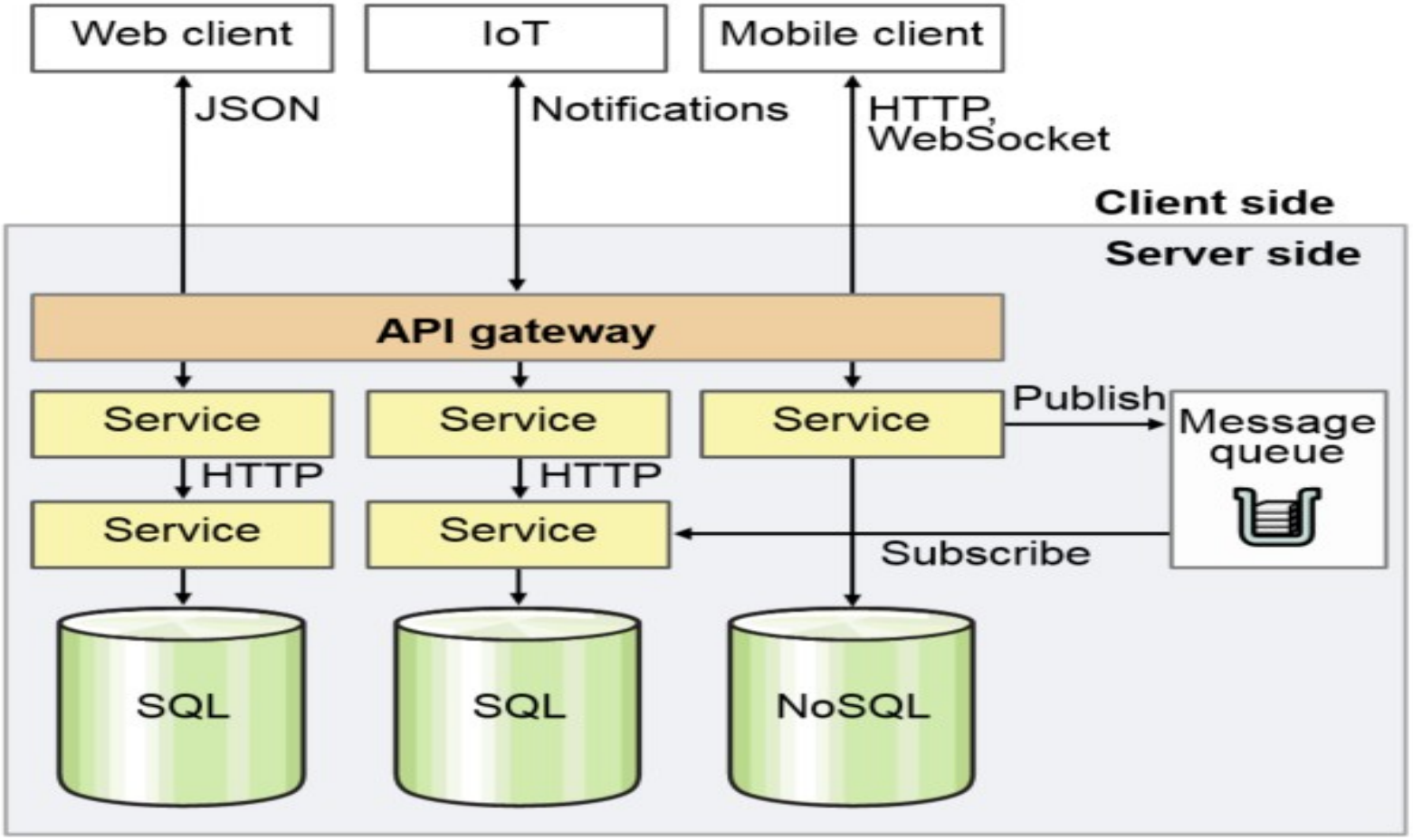
1)Each is focused on one task, a business capability (The Single Responsibility principle: Each microservice implements only one business responsibility from the bounded domain context. From a software point of view, the system needs to be decomposed into multiple components where each component becomes a microservice. Microservices have to be lightweight, in order to facilitate smaller memory footprints and faster startup times.)

1)Each can be deployed and updated independently

1)They are loosely coupled

1)Each has a well-defined interface: REST APIs

Microservice Architecture:



Microservice Architecture: Benefits

1)Microservices architecture is a very promising way of designing and building highly scalable applications in an agile way. The services themselves are straightforward, focusing on doing only one thing well, so they’re easier to test and ensure higher quality.

1)Each service can be built with the best-suited technologies and tools, allowing polyglot persistence and such. You don’t have to be stuck with a new choice of technology for the rest of the project.

1)Multiple developers and teams can deliver independently under this architecture. This is great for continuous delivery, allowing frequent releases while keeping the rest of the system stable.

Microservice Architecture: Benefits

4) In case a service goes down, it will only affect the parts that directly depend on it (if there are such parts). The other parts will continue to function well.

5) Externalized configuration: This externalizes the configurations in the config server so that it can be maintained in a hierarchical structure, per environment.

6) Consistent: Services should be written in a consistent style, as per the coding standards and naming convention guidelines...

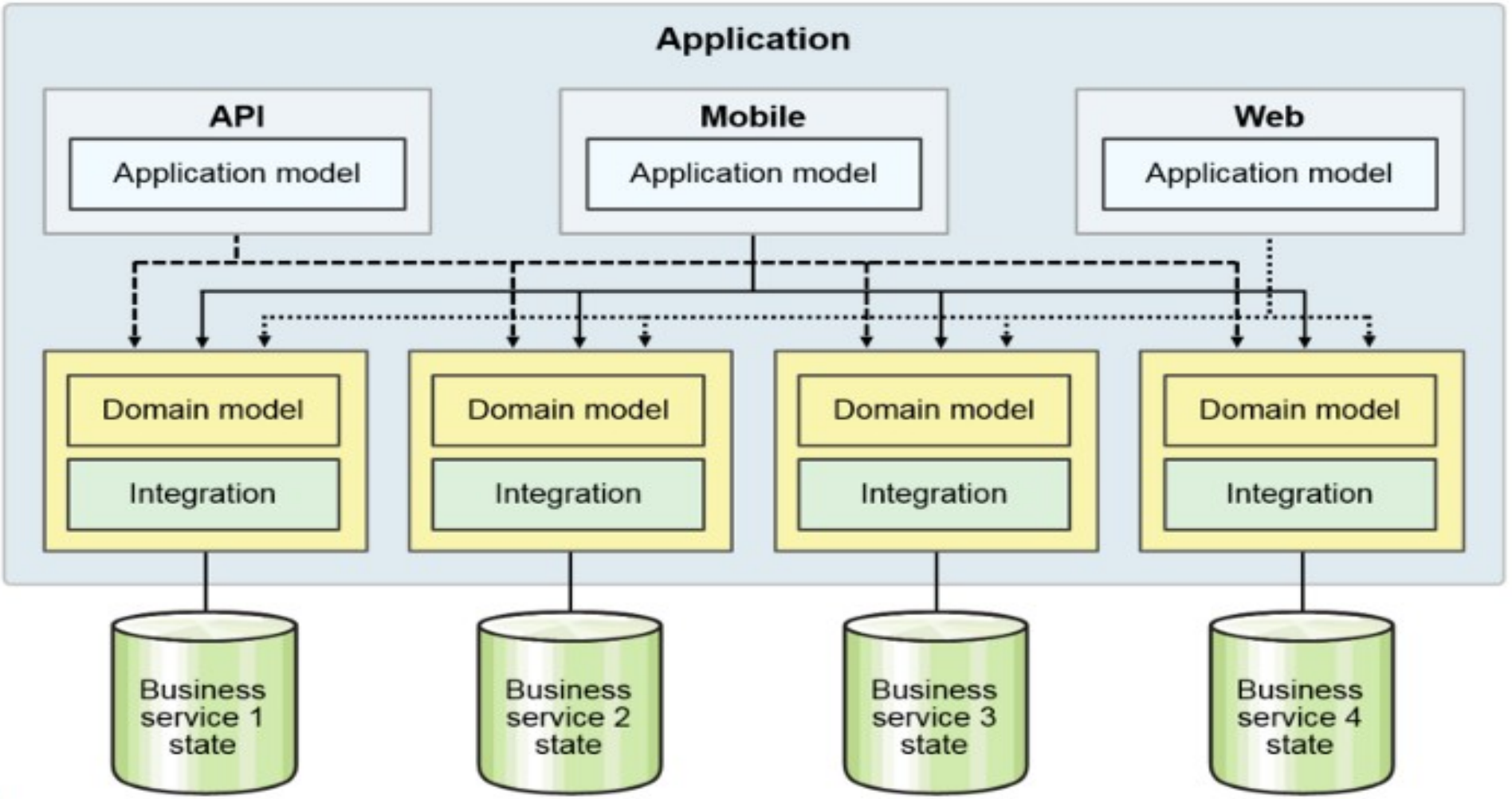
Microservice Architecture: Benefits

7) Resilient: Services should handle exceptions arising from technical reasons (connectivity and runtime), and business reasons (invalid inputs) and not crash. Patterns, such as circuit breakers and bulk headers, help isolate and contain failures.

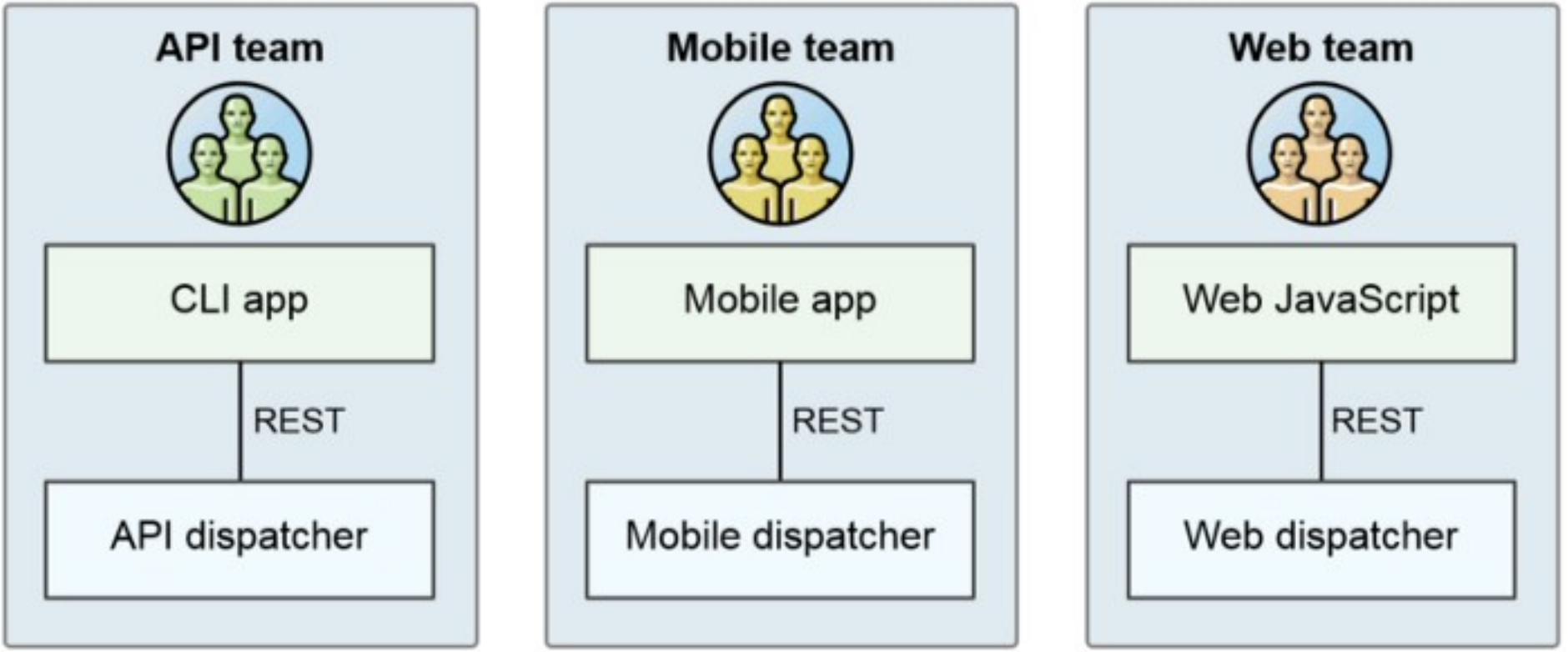
8) Good citizens: Microservices should report their usagestatistics, the number of times they are accessed, their average response time, and so on through the JMX API or the HTTP API.

9)Versioned: Microservices may need to support multiple versions for different clients until all clients migrate to higher versions. There should be a clear version strategy in terms of supporting new features and bug fixing…

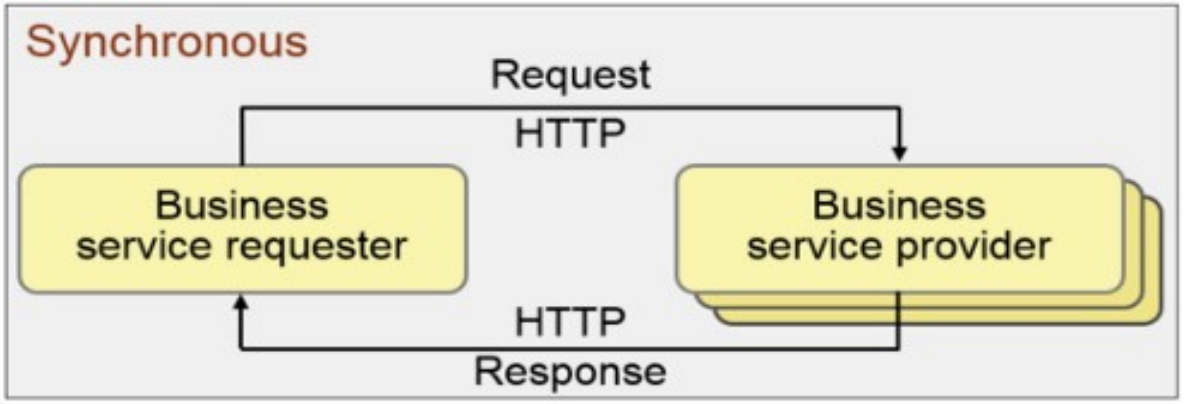
Microservice Architecture: Layers

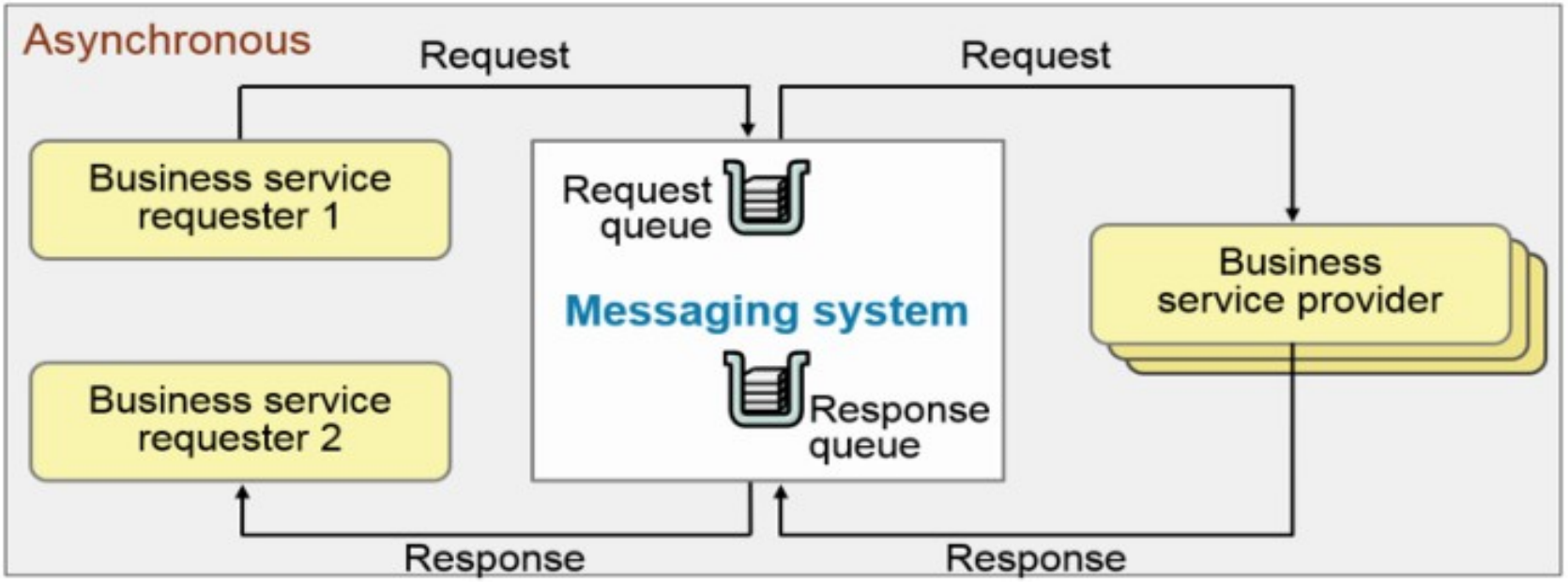


Microservice Architecture: Dispatchers and Client

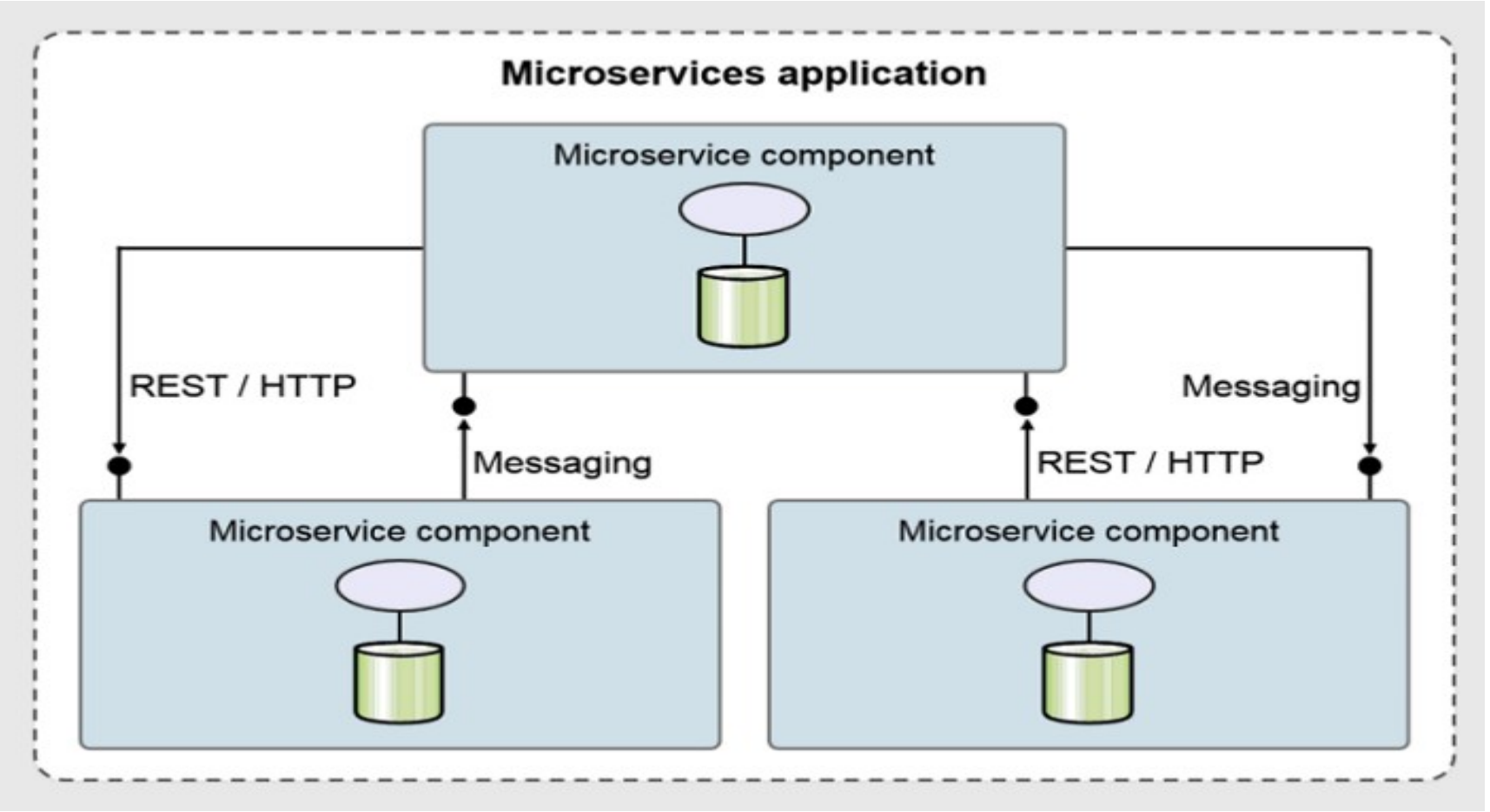


Microservice Architecture: Inter communication





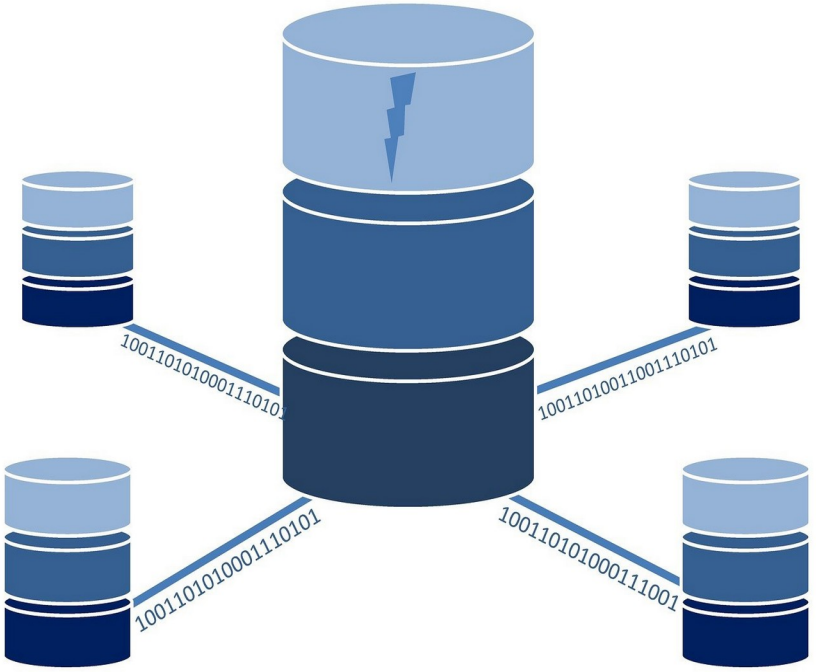
Microservice Architecture: Hybrid Inter communication

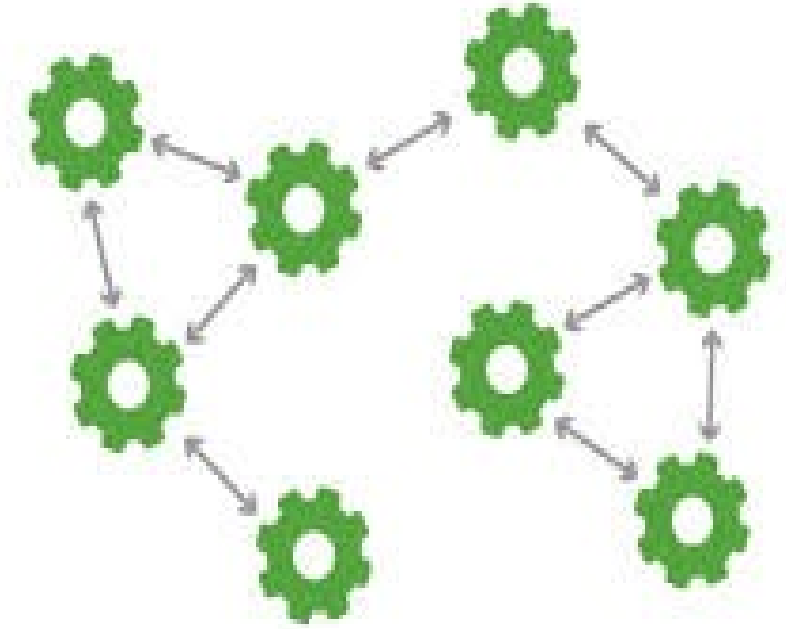


Decomposition Outcomes

- The architecture must be stable
- Services must be cohesive. A service should implement a small set of strongly related functions.
- Services must conform to the Common Closure Principle - things that change together should be packaged together - to ensure that each change affect only one service
- Services must be loosely coupled - each service as an API that encapsulates its implementation. The implementation can be changed without affecting clients
- A service should be testable
- Each service be small enough to be developed by a “two pizza” team, i.e. a team of 6-10 people
- Each team that owns one or more services must be autonomous. A team must be able to develop and deploy their services with minimal collaboration with other teams.

MicroServices
Handling Database Complexities





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MicroServices Essentials - Handling Database Complexities

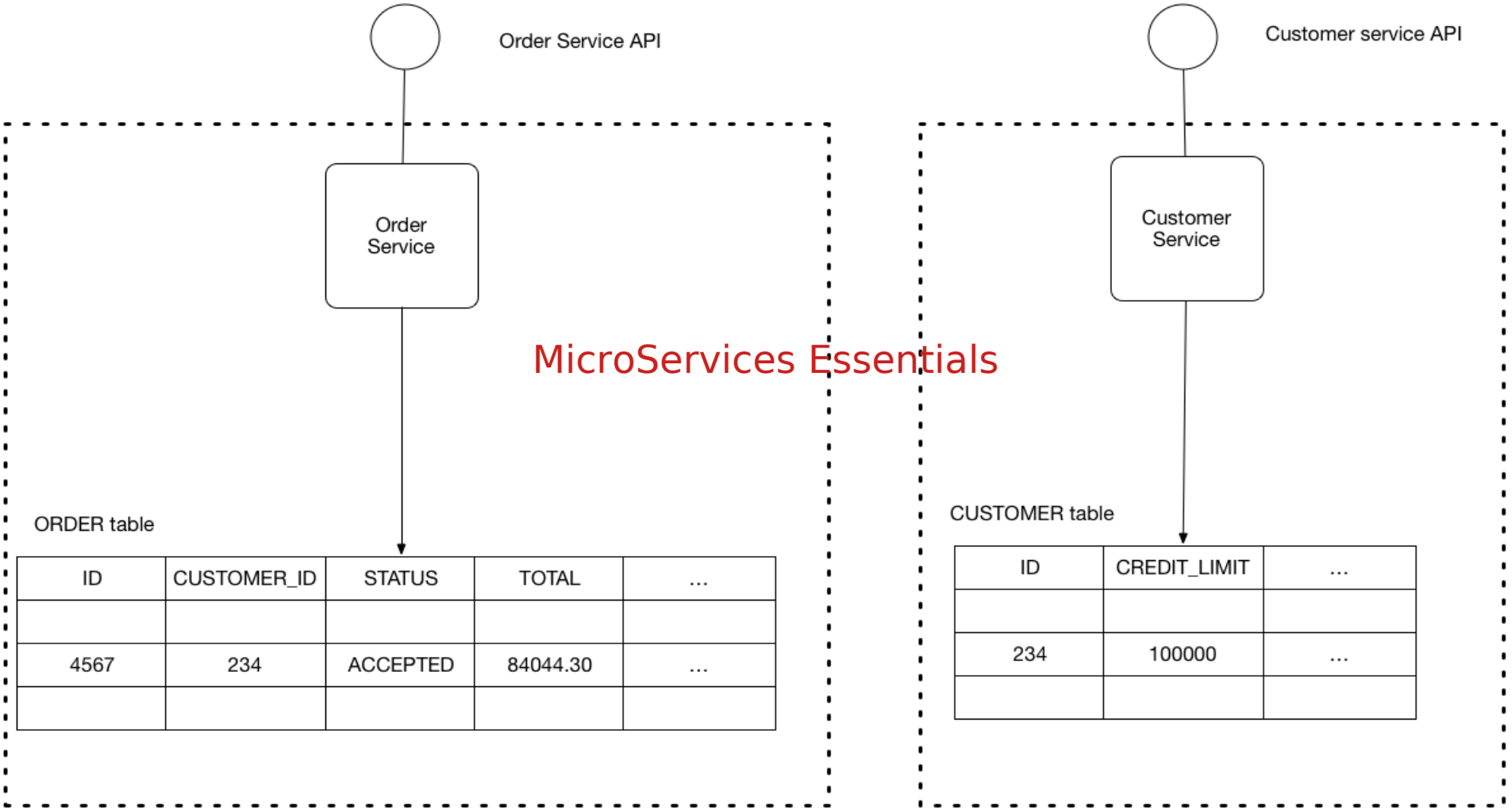
- The service's database is effectively part of the implementation of that service. It cannot be accessed directly by other services. If you are using a relational database then the options are:

- Private-tables-per-service – each service owns a set of tables that must only be accessed by that service

- Schema-per-service – each service has a database schema that's private to that service

- Database-server-per-service – each service has it's own database server.

MicroServices Essentials
Database per Service



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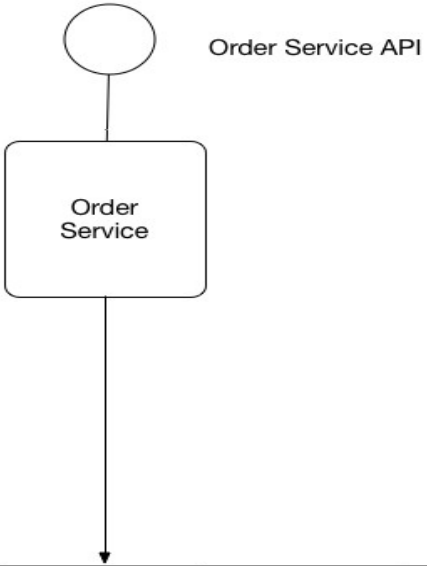
MicroServices Essentials
Shared Database

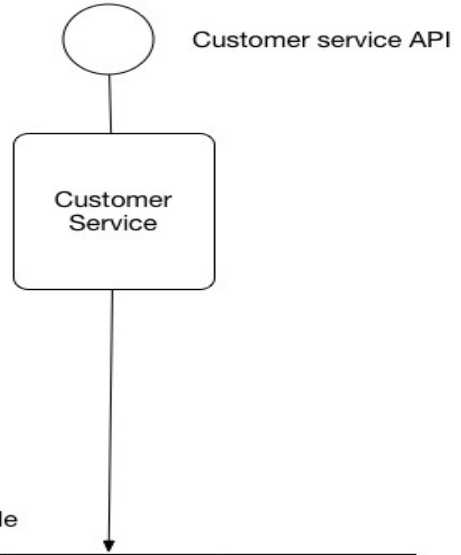
The reason for going for shared database for multiple services

- Some transaction spawn over many services
- Some operations require data from multiple services
- Database replication is required



ORDER table

ID	CUSTOMER_ID	STATUS	TOTAL	...
4567	234	ACCEPTED	84044.30	...



CUSTOMER table

ID	CREDIT_LIMIT	...
234	100000	...

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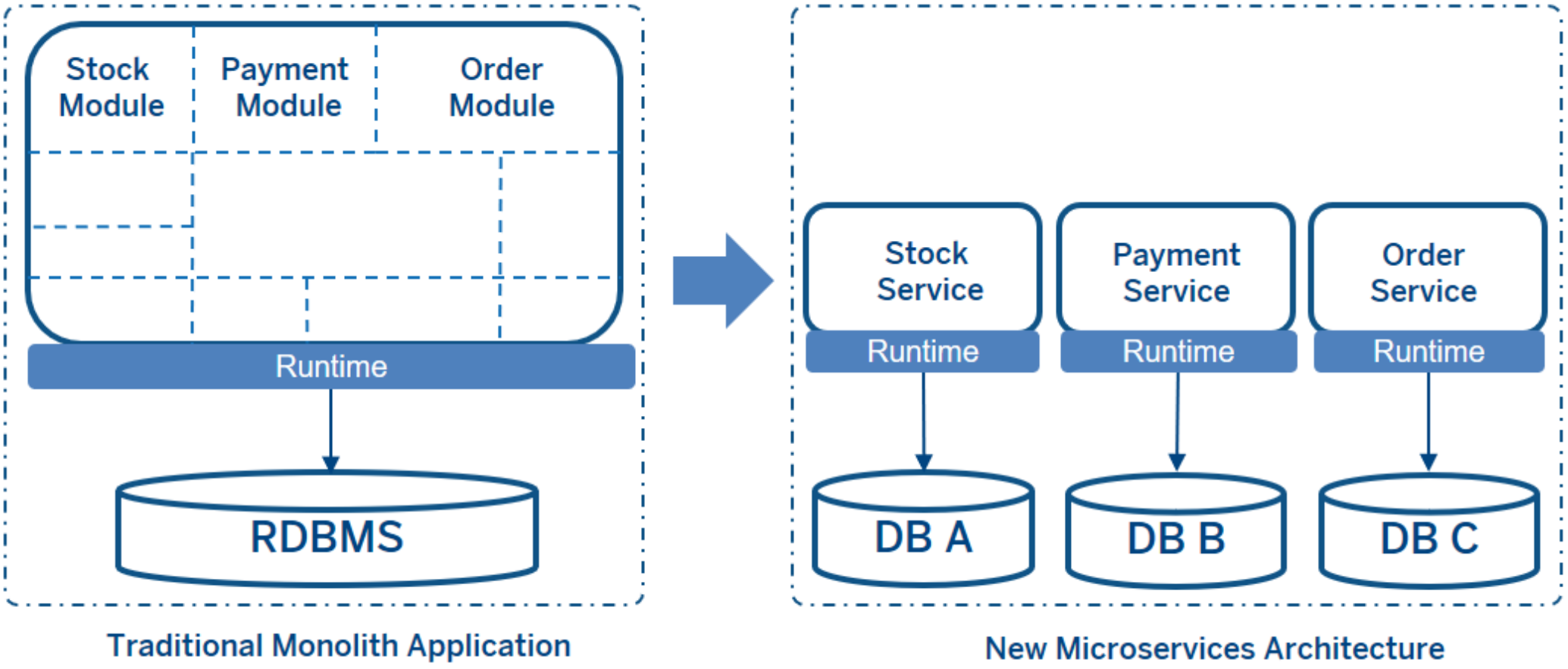
MicroServices Essentials

Shared Database in Monolith and Microservices



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MicroServices Essentials
Shared Database in Monolith and Microservices

The Problem: Data Consistency in Distributed Systems

For monolith applications, a shared relational database handles and guarantee data consistency by ACID transactions. The acronym ACID means:

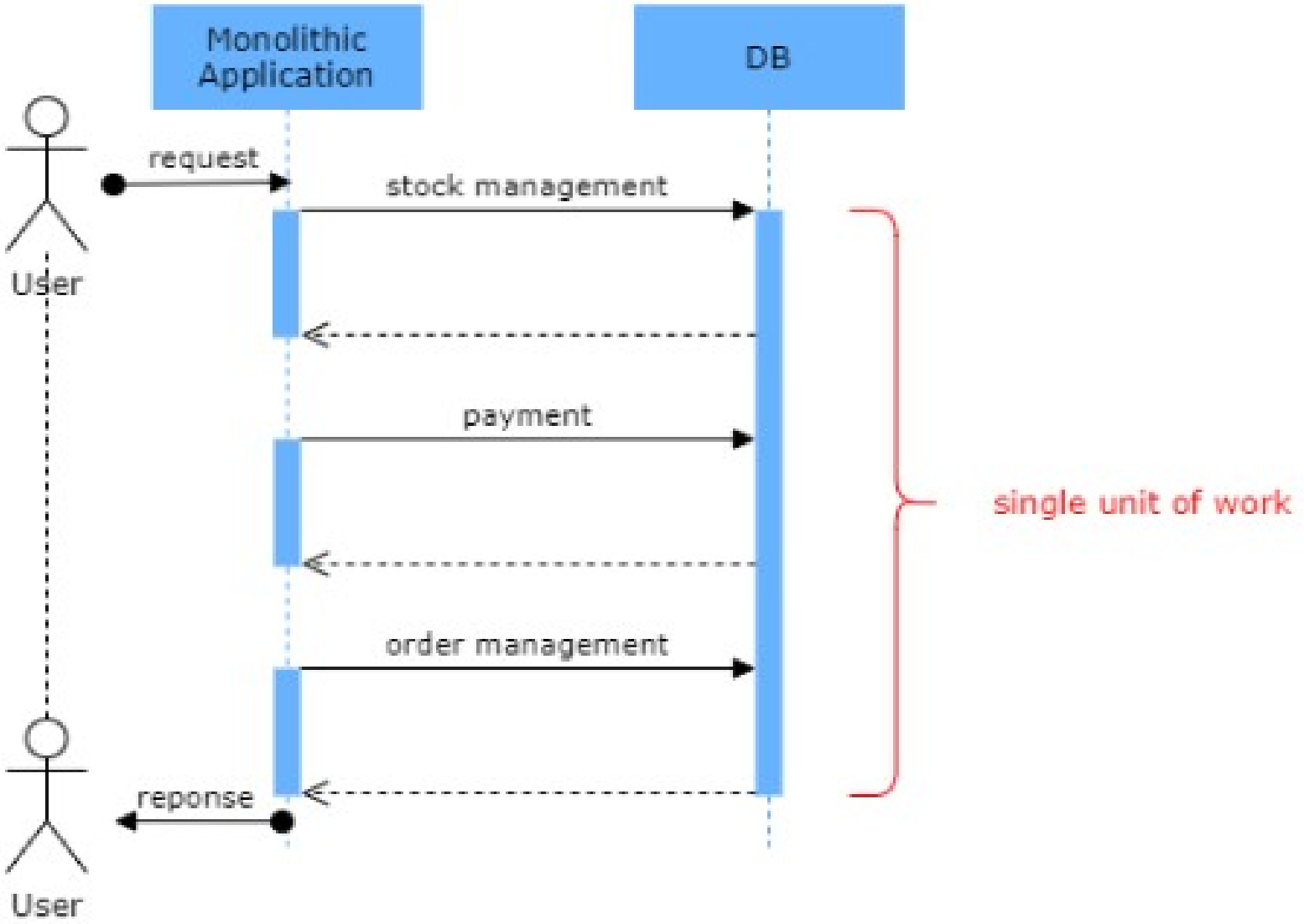
Atomicity: all the steps of a transaction is succeeded or failed together, no partial state, all or nothing.

Consistency: all data in the database is consistent at the end of transaction.

Isolation: only one transaction can touch the data in the same time, other transactions wait until completion of the working transaction.

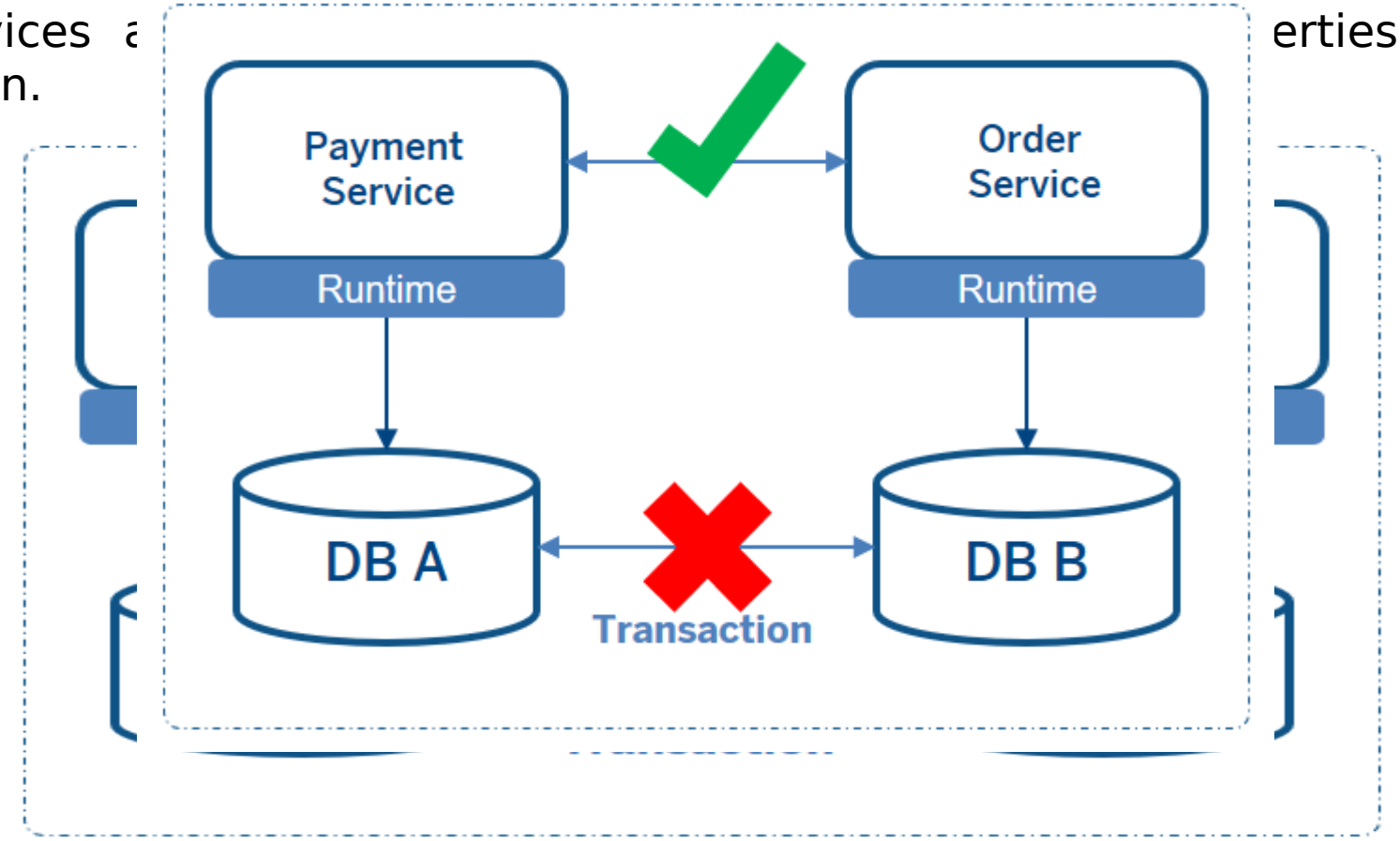
Durability: data is persisted in the database at the end of the transaction.

MicroServices Essentials
Shared Database in Monolith and Microservices



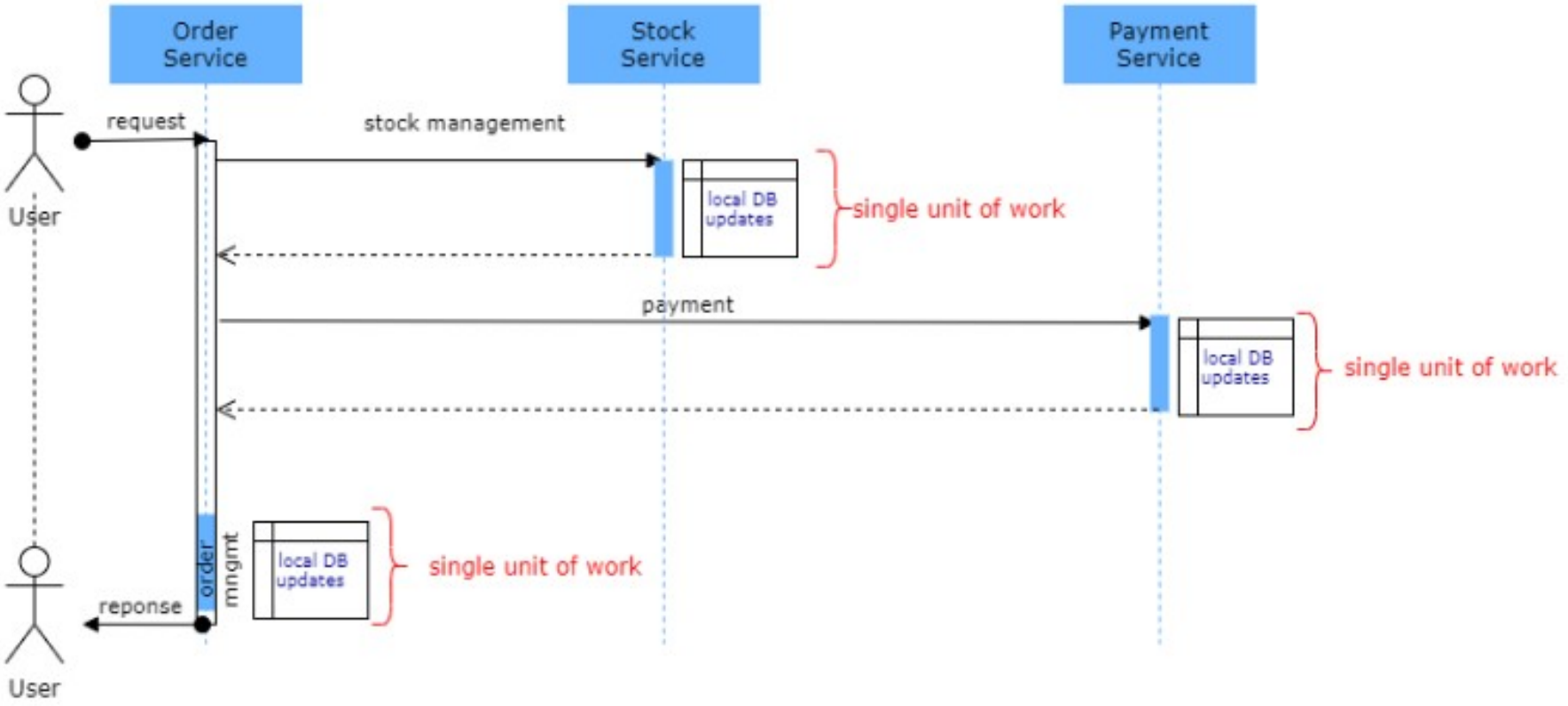
MicroServices Essentials
Shared Database in Monolith and Microservices

But in a microservices architecture, each microservice has its own data store which has different technologies. So, there is no central database, no single unit of work. Business logic is spanned to the multiple local transactions. This means that you can't use single transaction unit of work among databases in a microservices a erties in your application.



MicroServices Essentials
Shared Database in Monolith and Microservices

Transactional Issue in Micro Services as every service has separate databases



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Possible Solutions

First of all, there is no single solution which works well for each case. Different solutions can be applied depending on the use-case.

There are two main approaches to solve the problem:

- Distributed transactions
- Eventual consistency

Distributed Transaction in Microservices

Distributed Transactions

In a distributed transaction, transactions are executed on two or more resources (e.g. databases, message queues). Data integrity is guaranteed across multiple databases by distributed transaction manager or coordinator.

A distributed transaction is a very complex process since multiple resources are involved in the process.
Two-phase commit(2PC) is a blocking protocol used to guarantee that all the transactions are succeeded or failed together in a distributed transaction.

The XA standard is a specification for the 2PC distributed transactions. JTA includes standard API for XA. JTA-compliant application servers support XA out-of-the-box. But all the resources have to be deployed to a single JTA platform to run 2PC. For a microservice architecture, it is not suitable.

MicroServices Essentials
Distributed Transaction in Microservices

Benefits of Distributed Transactions

- Strong data consistency
- Support ACID features

Drawbacks of Distributed Transactions

- Very complex process to maintain
- High latency & low throughput since it is a blocking process (not suitable for high load scenarios)
- Possible deadlocks between transactions
- Transaction coordinator is a single point of failure

Eventual Consistency in Microservices

Eventual Consistency

Eventual consistency is a model used in distributed systems to achieve high availability. In an eventual consistent system, inconsistencies are allowed for a short time until solving the problem of distributed data.

This model doesn’t apply to distributed ACID transactions across microservices. Eventual consistency uses the BASE database model.

The acronym **BASE** means;

Basically Available: ensures availability of data by replicating it across the nodes of the database cluster

Soft-state: due to lock of the strong consistency data may change over the time. Consistency responsibility is delegated to the developers.

Eventual consistency: immediate consistency may not possible with BASE but consistency will be provided eventually (in a short time).

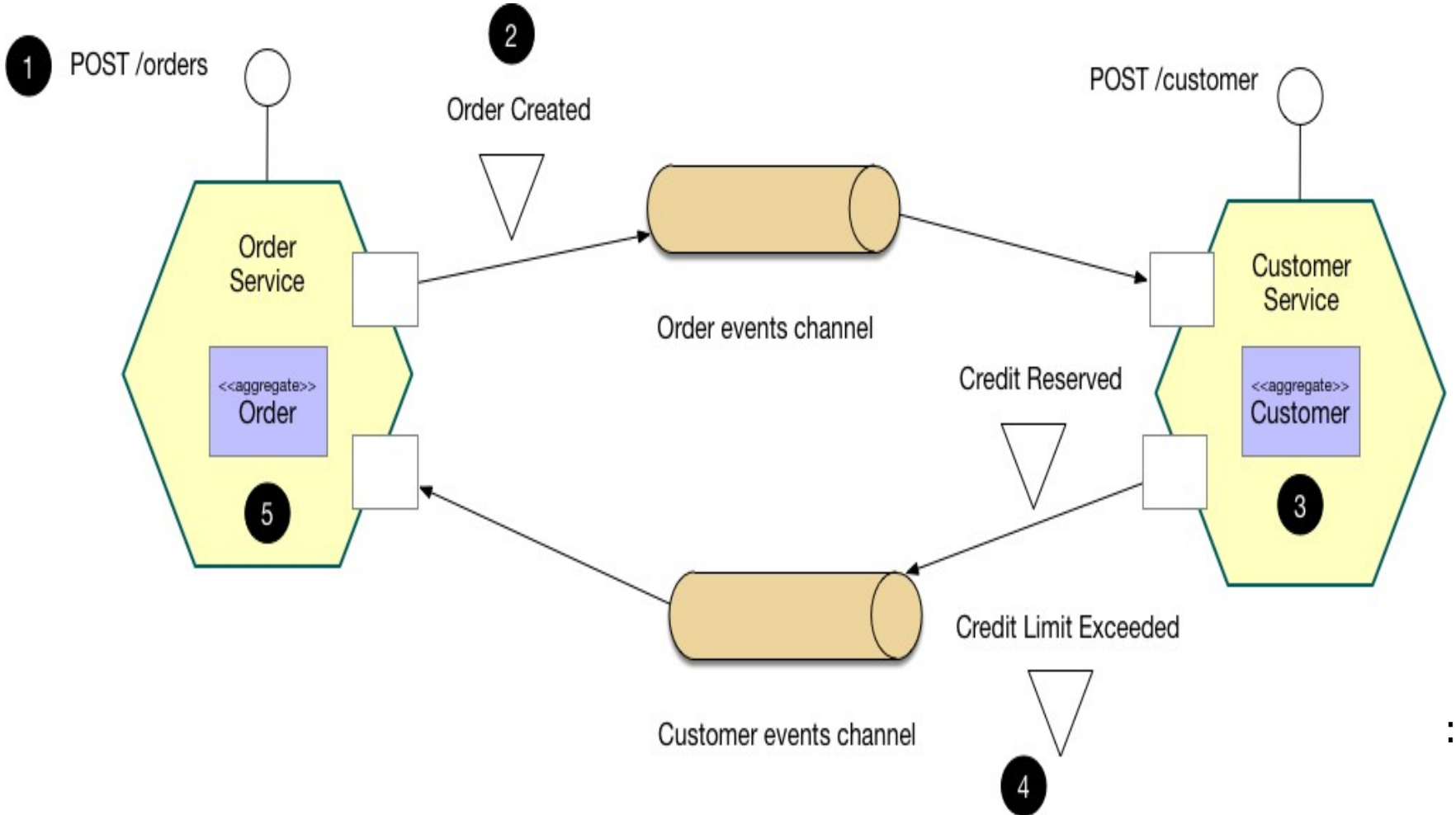
MicroServices Essentials
SAGA and Microservices

SAGA is a common pattern that operates the eventual consistency model.
The Saga pattern is an asynchronous model, based on a series of services. In a Saga pattern, the distributed transaction is performed by asynchronous local transactions on all related microservices. Each services updates their own data in a local transaction. Saga manages the execution of the sequence of services.
Two most common implementations of Saga transactions are:

1. Choreography Based SAGA
2. Orchestration Based SAGA

MicroServices Essentials
Using SAGA – Choreography Based

A saga is a sequence of local transactions where each transaction updates data within a single service. The first transaction is initiated by an external request corresponding to the system operation, and then each subsequent step is triggered by the completion of the previous one



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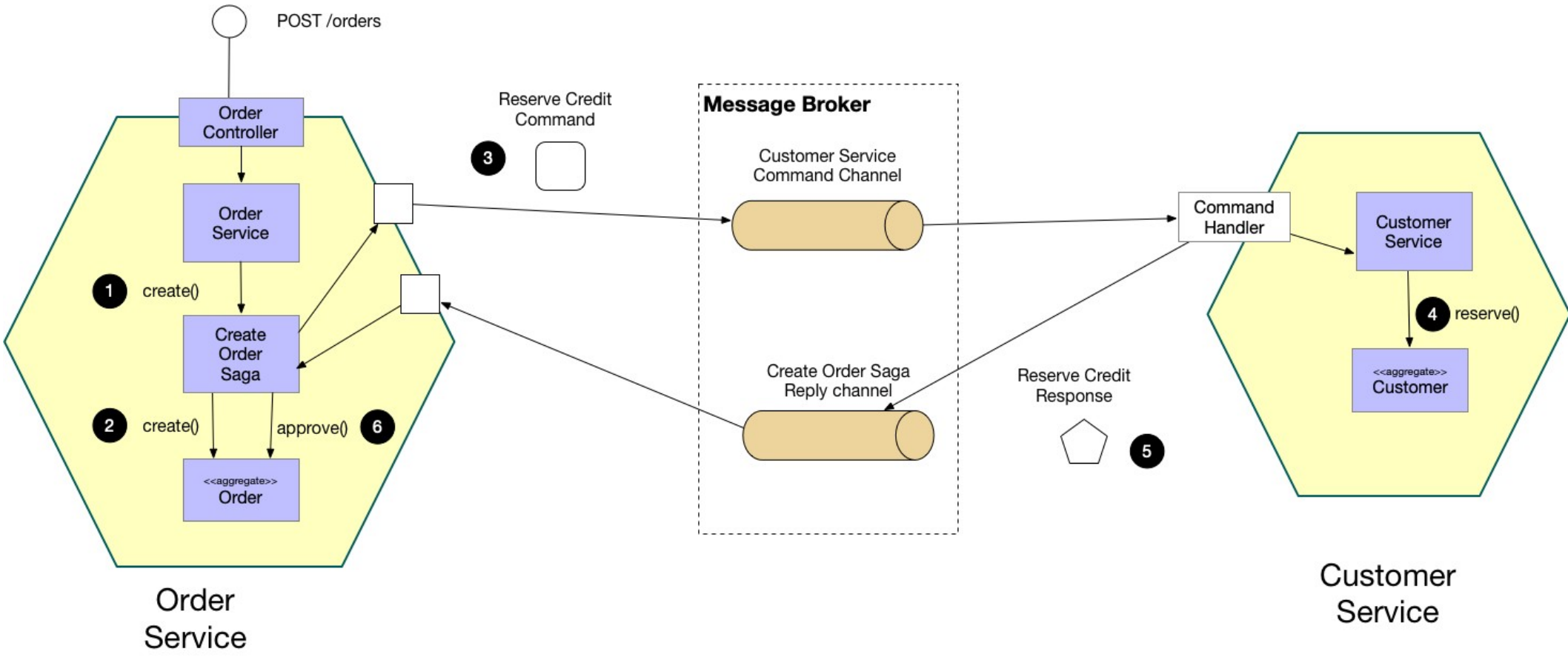
MicroServices Essentials
Using SAGA – Orchestration Based



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MicroServices Essentials
SAGA and Microservices

Benefits of SAGA

- Perform non-blocking operations running on local atomic transactions
- Offer no deadlocks between transactions
- Offer no single point of failure

Drawbacks of SAGA

- Eventual data consistency does not have read isolation, needs extra effort (e.g. the user could see the operation being completed, but in a few second, it is cancelled due to a compensation transaction.)
- Difficult to debug, when participant service count is increased
- Increased development cost (actual service developments plus compensations service developments are required)
- Design is complex

MicroServices Essentials

Command Query Responsibility Segregation (CQRS) – Query from Multiple Services

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MicroServices Essentials

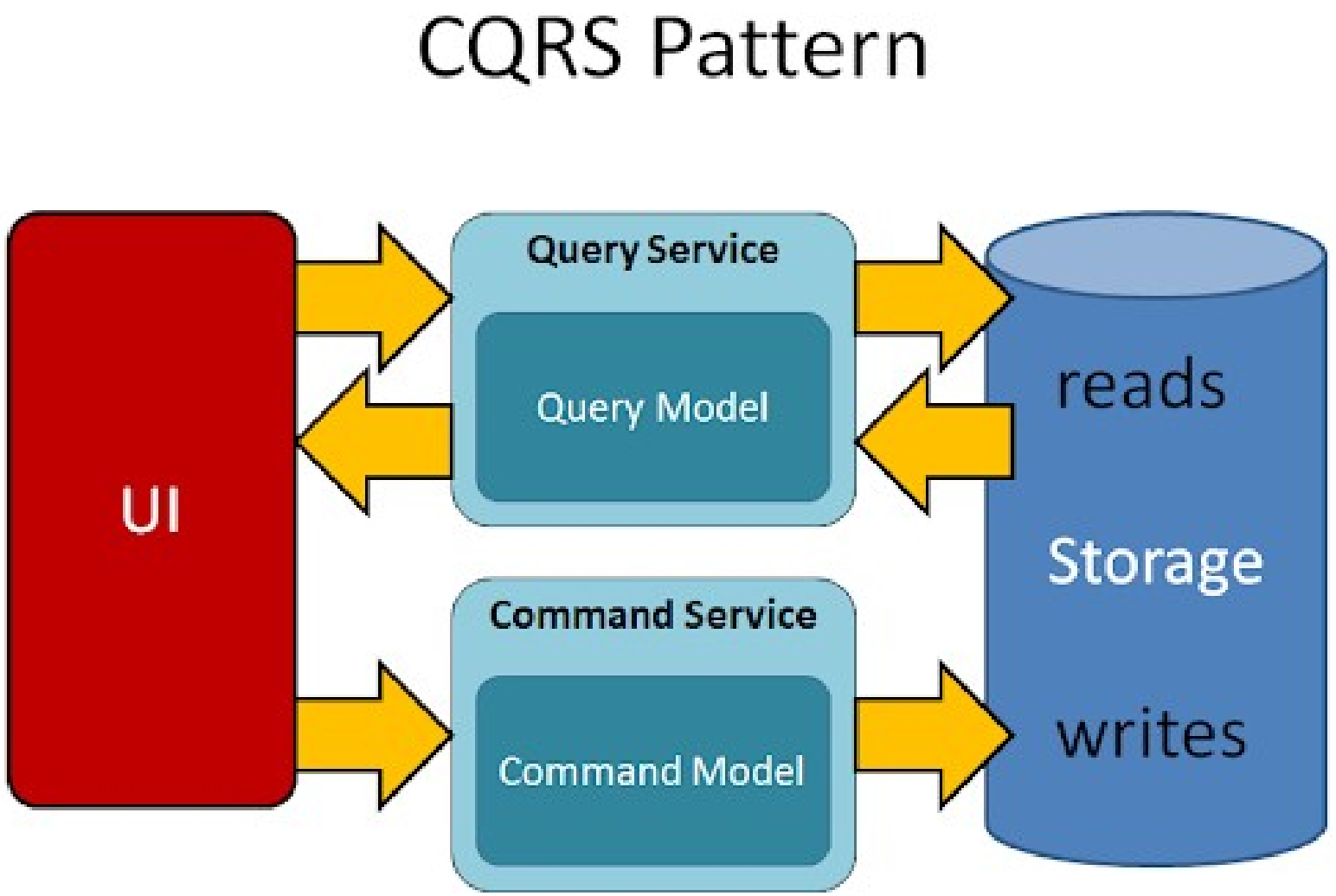
Command Query Responsibility Segregation (CQRS) – Query from Multiple Services

The Command and Query Responsibility Segregation (CQRS) pattern propose separating the write data model from the read data model.

This separation of responsibilities would provide the flexibility to decide whether the read and write services should coexist in the same data store or be managed in completely different databases.

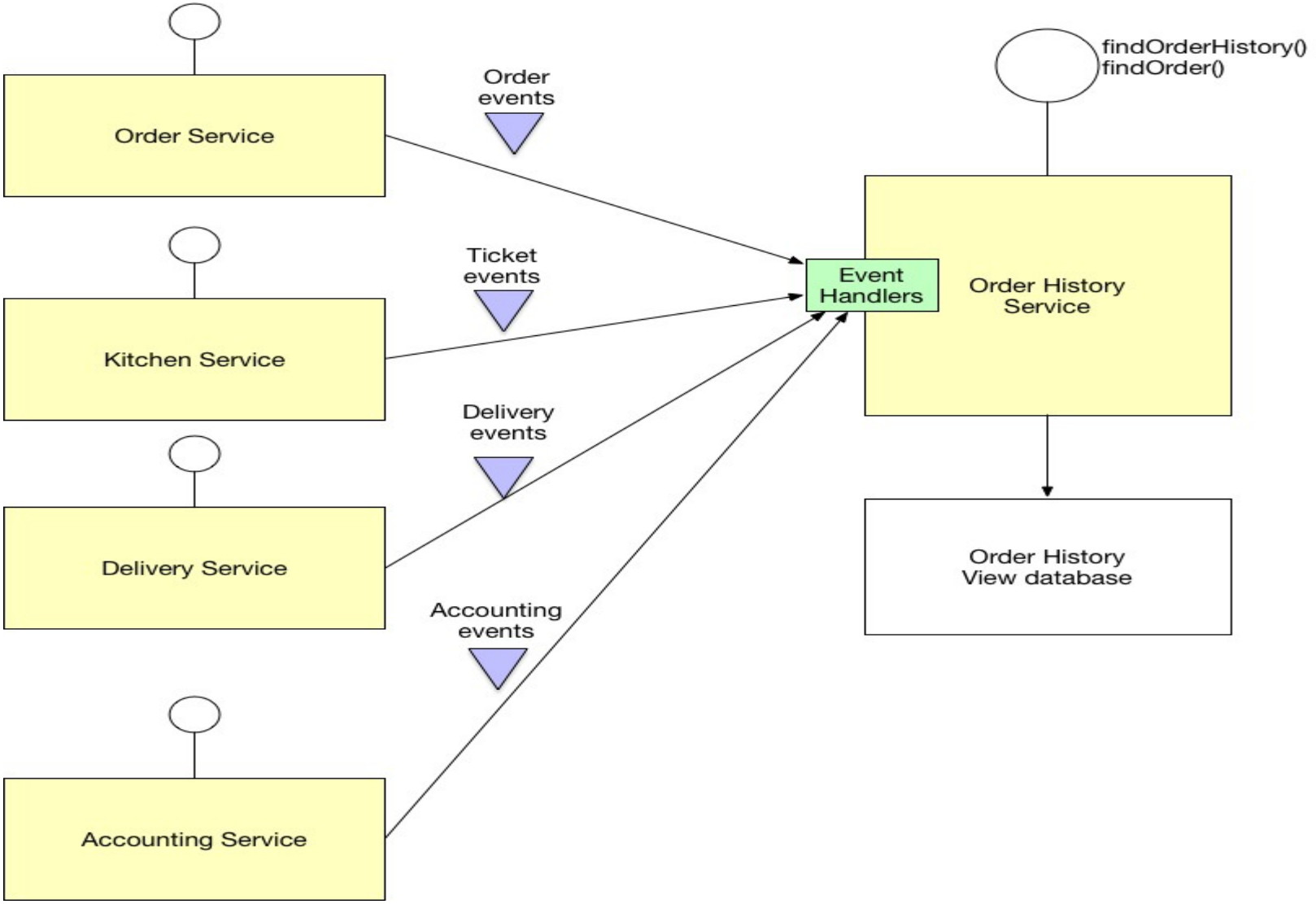
MicroServices Essentials

Command Query Responsibility Segregation (CQRS) – Query from Multiple Services



MicroServices Essentials

Command Query Responsibility Segregation (CQRS) – Query from Multiple Services



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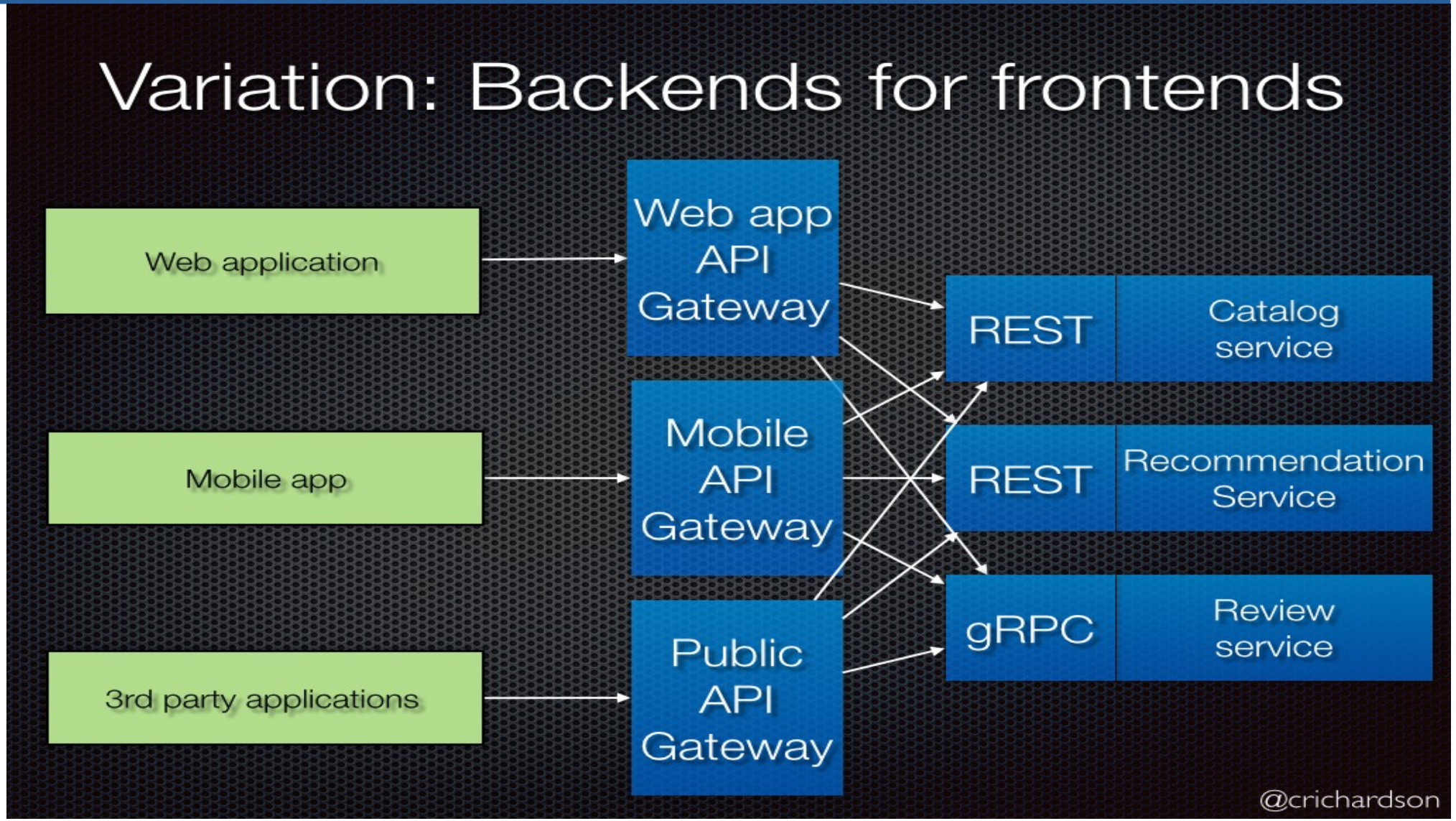
Command Query Responsibility Segregation (CQRS) – Benefits

- **Advantages**
- **Facilitates distributing development workload**
- **Easier maintenance**
- **Optimized database design**
- **Easier scalability**
- **Enhanced security**
- **Disadvantages**
- **Added complexity**
- **Eventual consistency**

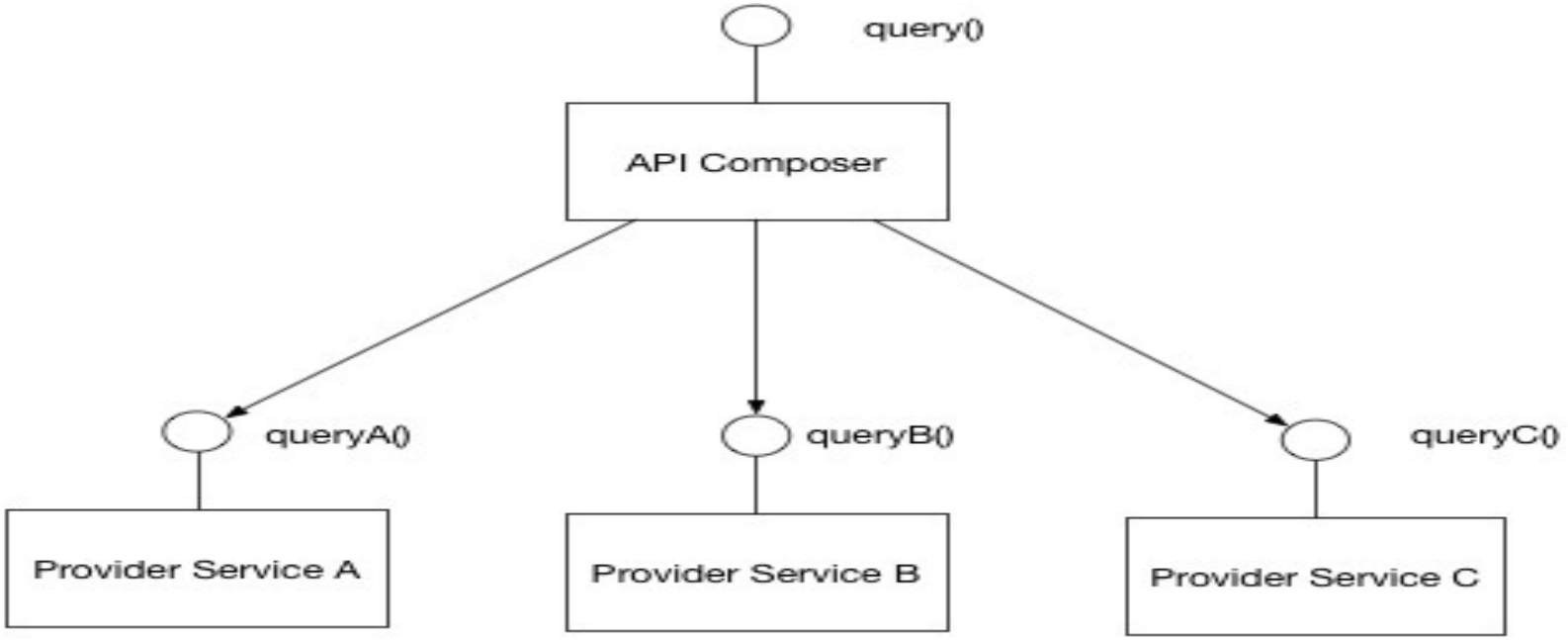
MicroServices Essentials

Accessing Services using API Gateway



MicroServices Essentials
API Composition

Implement a query by defining an API Composer, which invoking the services that own the data and performs an in-memory join of the results.



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Accessing Services using API Gateway

Using an API gateway has the following benefits:

- Insulates the clients from how the application is partitioned into microservices
- Insulates the clients from the problem of determining the locations of service instances
- Provides the optimal API for each client
- Reduces the number of requests/roundtrips. For example, the API gateway enables clients to retrieve data from multiple services with a single round-trip. Fewer requests also means less overhead and improves the user experience. An API gateway is essential for mobile applications.
- Simplifies the client by moving logic for calling multiple services from the client to API gateway
- Translates from a “standard” public web-friendly API protocol to whatever protocols are used internally

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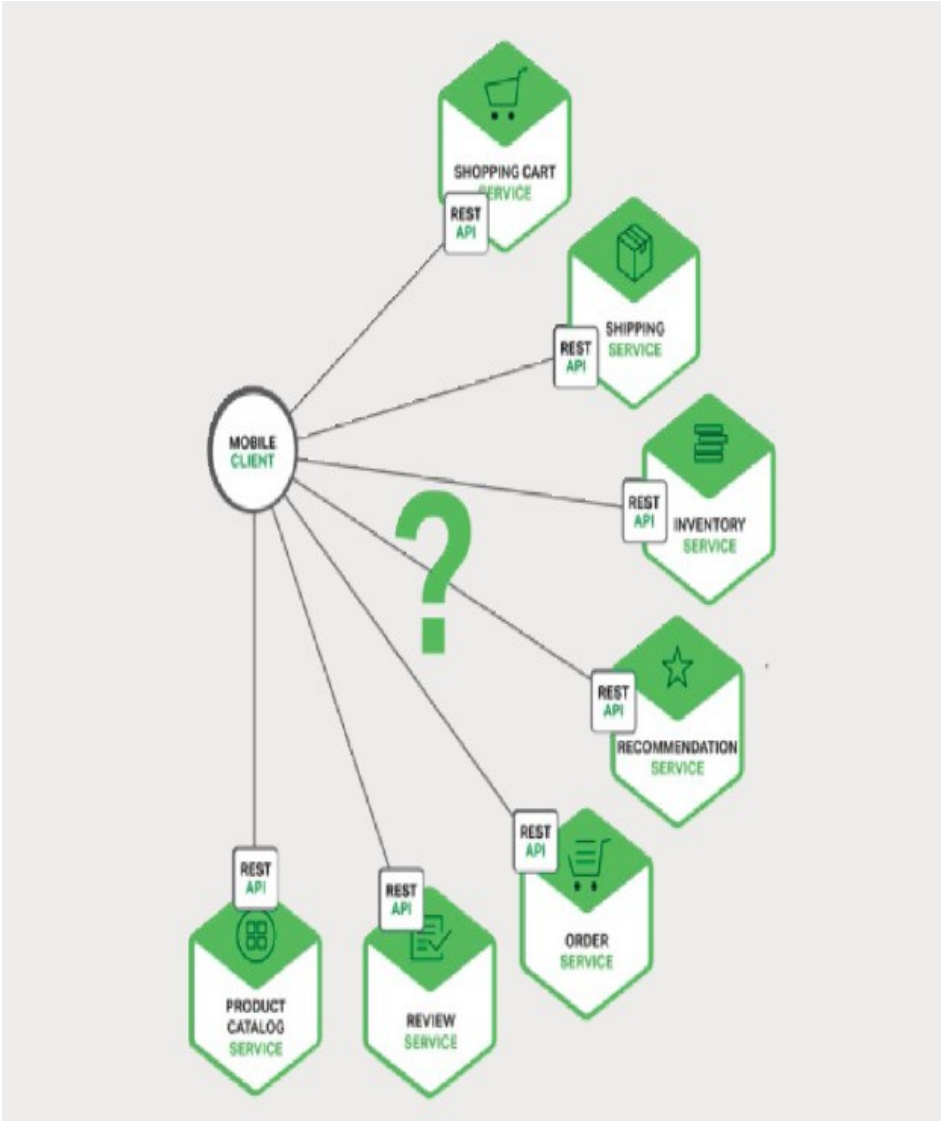
- Problems without API Gateways



In a conventional micro service based application, The client page has responsibility of calling each service and render all the results on page. The services may be 10, 100 or may be thousand :

The challenges are

1) The services may change their position dynamically as per thedecision of orchestrator or load balancers.

2) The URL of all the services must be on hand. For a few it can be maintained but when services are large in number it becomes difficult.

3) The diverse range of protocols and their configuration may require change in code of rendring

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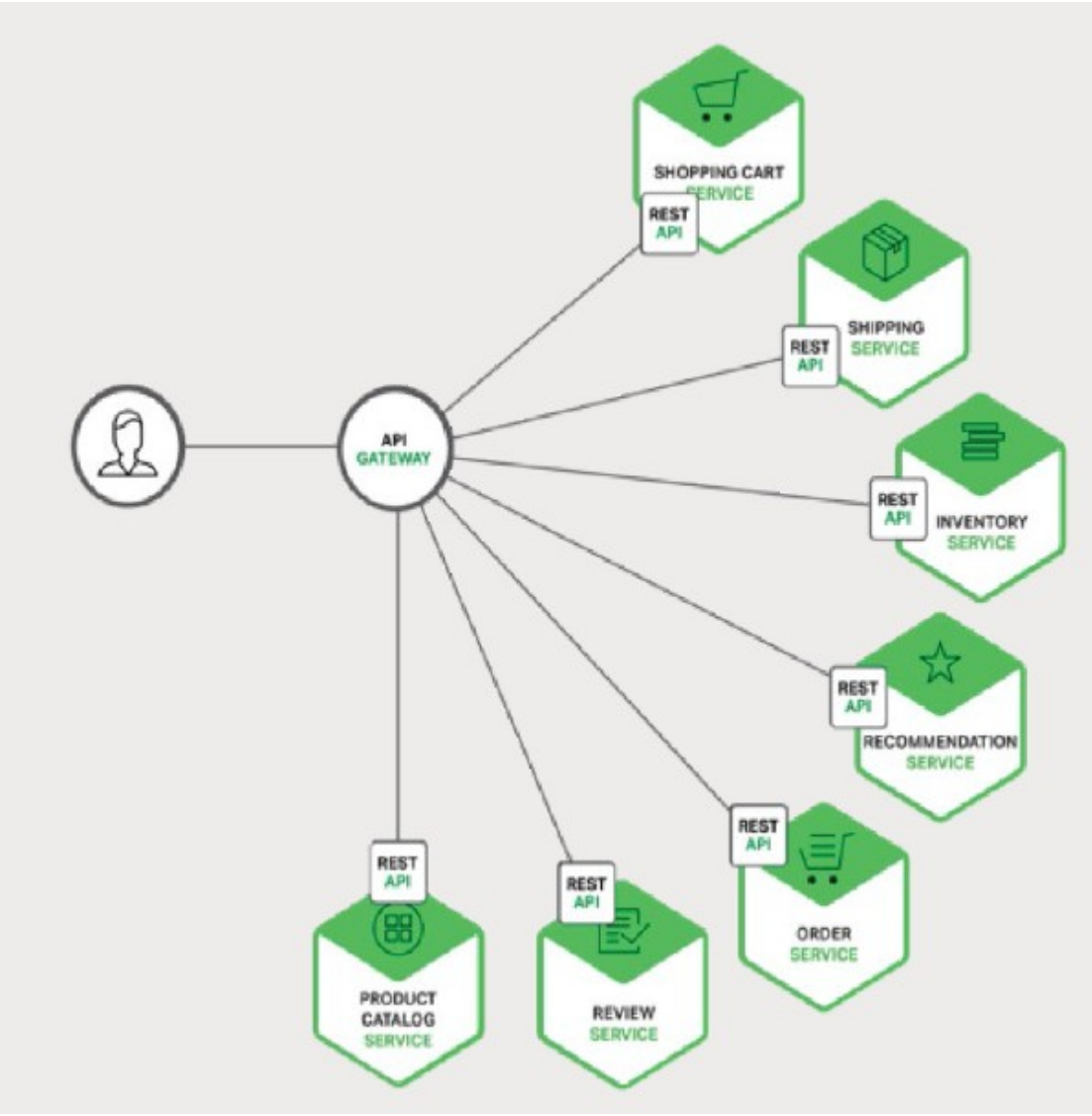
- With API Gateways



An API gateway is responsible for

- **Request routing**
- **Composition**
- **Protocol translation**

The client does not have to remember al the service location nor it has to cal them individually. On single URL to AP server will do everything on behalf o client.

API gateway is an independent server meant for proxying and reverse proxying the client-server request on micro service based applications. The API Gateway will often handle a request by invoking multiple microservices and aggregating the results. It can translate between web protocols such as HTTP and WebSocket and web-unfriendly protocols that are used internally.

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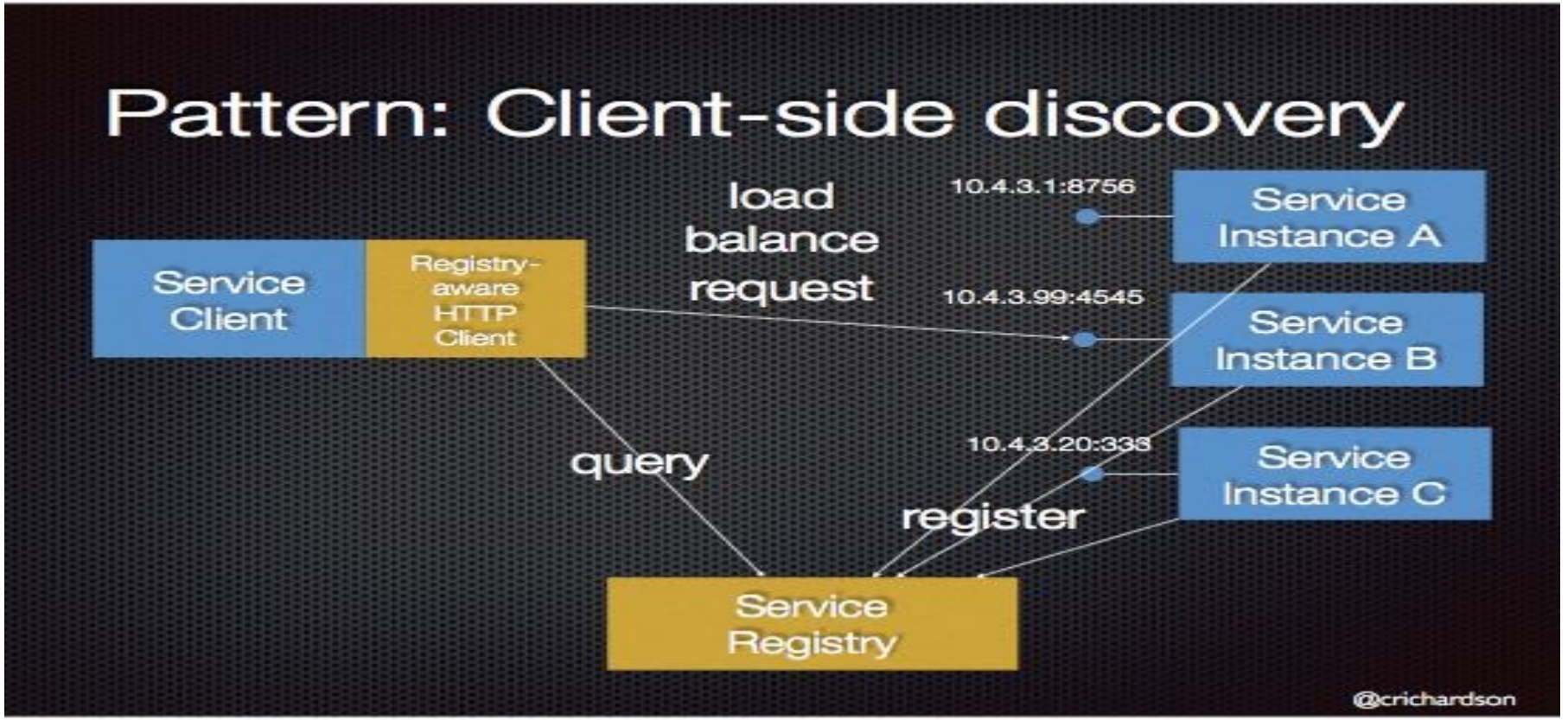
Other Aspects of API Gateways : Service Discovery

Services typically need to call one another. A modern microservice-based application typically runs in a virtualized or containerized environments where the number of instances of a service and their locations changes dynamically.



Modularity (TEAM)

A product not a project

UI - team

SERVER - team

Dba - team

monolith

UI

dba

SERVER

UI

dba

SERVER

UI

dba

SERVER

microservices

MICRO SERVICES APPLICATION DEVELOPMENT ARCHITECTURE

Some Development platforms like Java or .NET are providing a complete architecture to develop microservice based applications

Java Provides us with 2 strong platforms

1. 

2. Java Spring Boot

JAVA MICROPROFILE ARCHITECTURE

- JAX-RS - REST
- CDI
- JSON-P Json
- Common Annotations
- Config
-
- Metrics
- Health Check
- Fault Tolerance
- JWT Authentication
- OpenTracing
- OpenAPI
-
- Rest Client

MICRO SERVICES TOOL CHAIN FOR DEVELOPMENT

PLAN

CODE

Code Management

Code Configuration Management

ANSIBLE

Code Integration

Code Testing

Code Packaging

MICRO SERVICES TOOL CHAIN

DEPLOYMENT

CONTAINARIZATION

ORCHESTRATION AND LOAD BALANCING

ACCESS CONTROL or API GATWAYS

INGRESS

MONITORING

A SCENARIO OF MICRO SERVICES – Developer Prospective

1. **The developers write the code in favourite IDE And Eclipse Micro profile**

2. **The developers chooses the lightest possible server in this cas – Payara Micro Edition / TomEE And Eclipse Micro profile**

3. **The developers Build and Test the project using Maven /Ant**

4. **The developers create the image and deploy the project on Docker Container with network and volume settings ocker Hub. Push the Images to Docker Hub**

5. **The developers Puts the images from Docker Hub to Kubernetes Pods and Services for orchestration and load balancing**

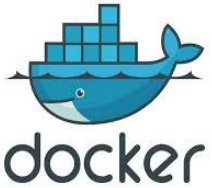
5. **The developers give access to the outside client using a API gateway**

A SCENARIO OF MICRO SERVICES – Client Perspective

1. The Client connects to the IP of API gateway specifying the service

2. The API gateway Calls the K8 cluster and services
K8 responsible for load balancing and persistence

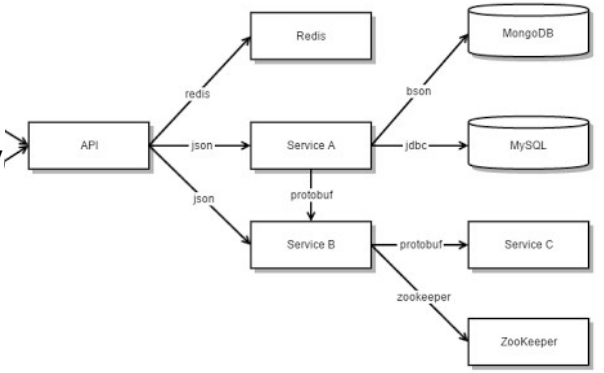
3. The pods invoke the containers



4. The container calls the service end point

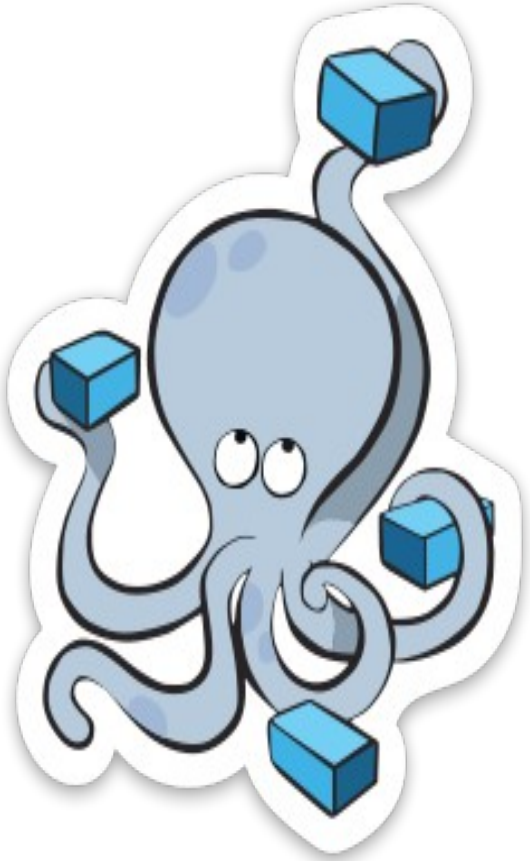
JAX-RS

5. Service May call other services internally or database to giv output



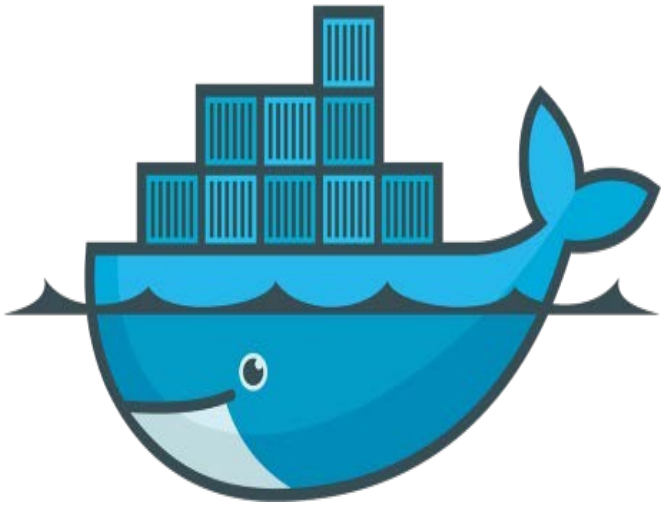
6. Finally Client gets the response

Introduction to Docker



docker

What Is Docker?



- Lightweight, open, secure platform
  Simplify building, shipping, running apps

- Runs natively on Linux or Windows Server
- Runs on Windows or Mac Development machines (with a virtual machine)
- Relies on "images" and "containers"

Some Docker vocabulary

Docker Image

The basis of a Docker container. Represents a full application

Docker Container

The standard unit in which the application service resides and executes

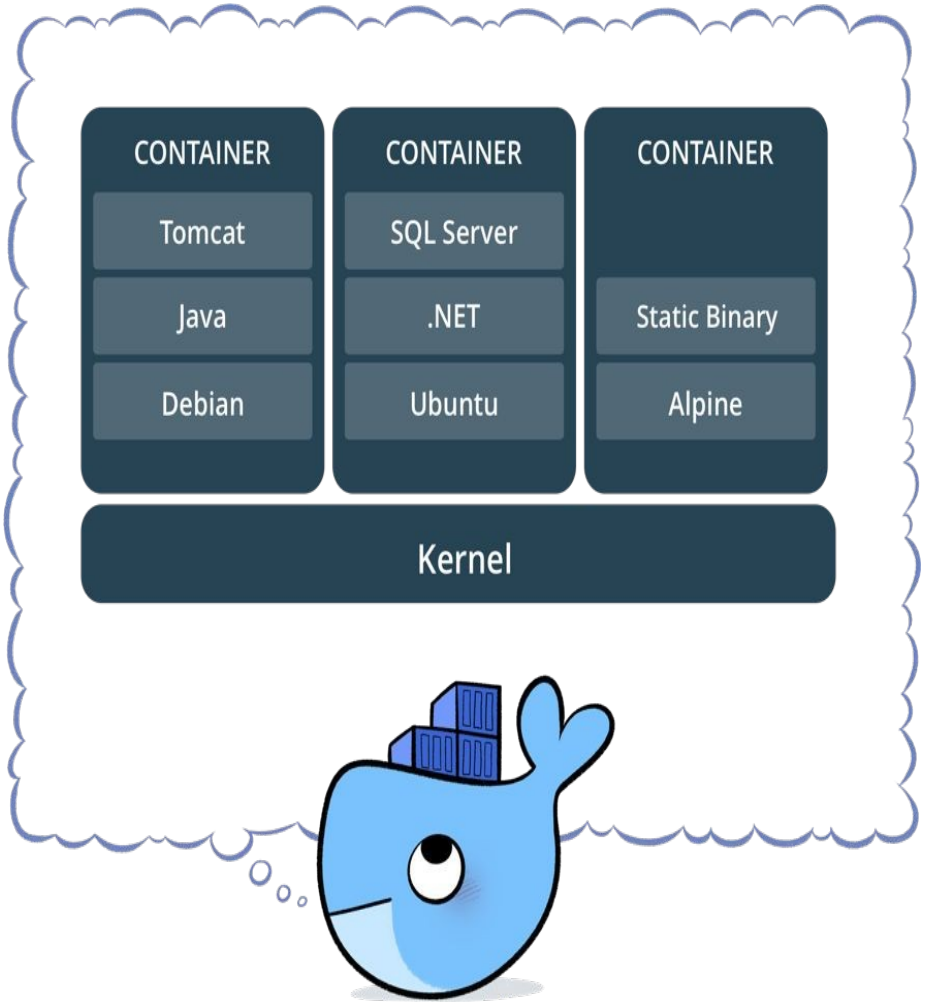
Docker Engine

Creates, ships and runs Docker containers deployable on a physical or virtual, host locally, in a datacenter or cloud service provider

Registry Service (Docker Hub(Public) or Docker Trusted Registry(Private))

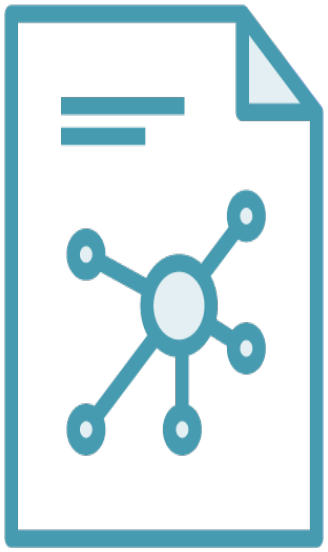
Cloud or server based storage and distribution service for your images

What is a container?



- Standardized packaging for software and dependencies
- Isolate apps from each other
- Share the same OS kernel
- Works for all major Linux distributions
- Containers native to Windows Server 2016

The Role of Images and Containers



Docker Image

Example: Ubuntu with Node.js and Application Code

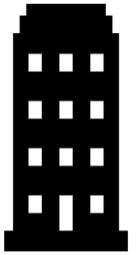
Docker Container

Created by using an image. Runs your application.

Docker containers are NOT VMs

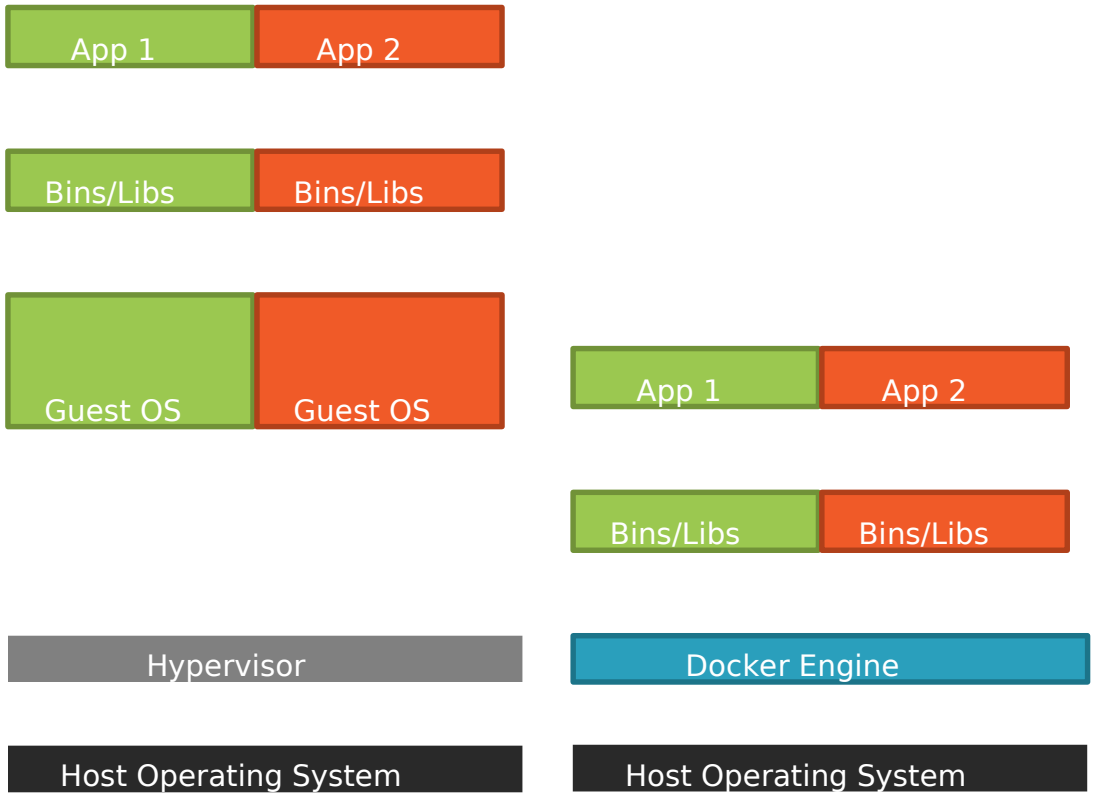
- Easy connection to make
- Fundamentally different architectures
- Fundamentally different benefits

Maquina Virtual



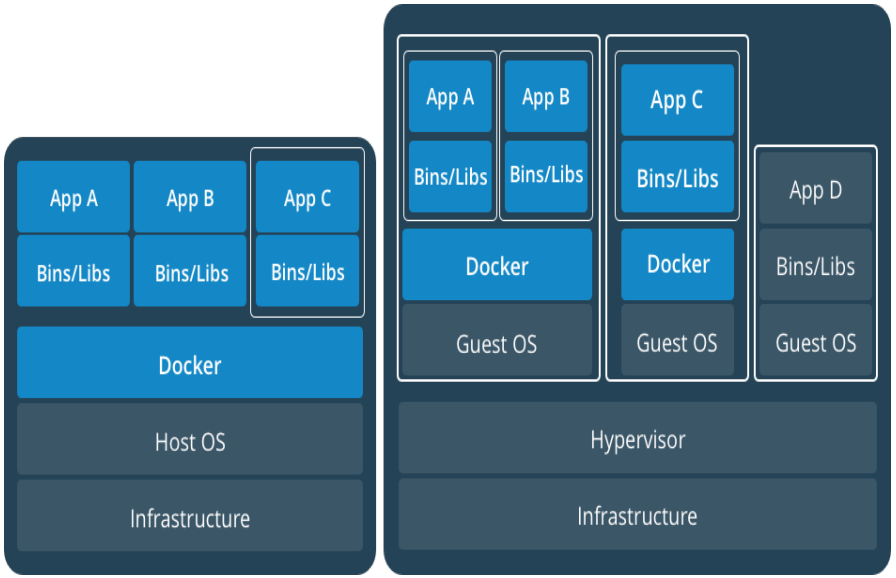
Contenedores

Docker Containers Versus Virtual Machines



Virtual Machines

Docker Containers



docker

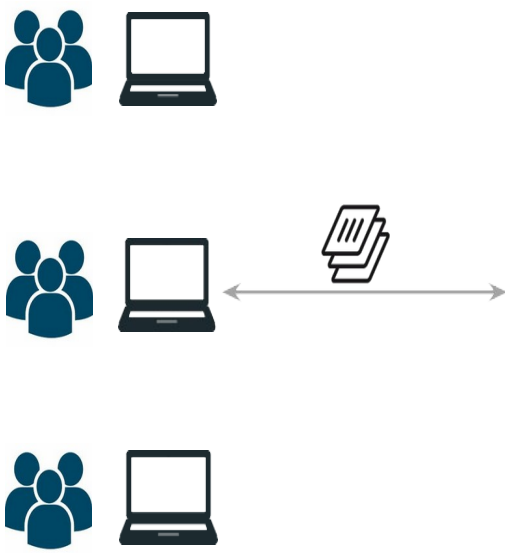
Using Docker: Build, Ship, Run Workflow

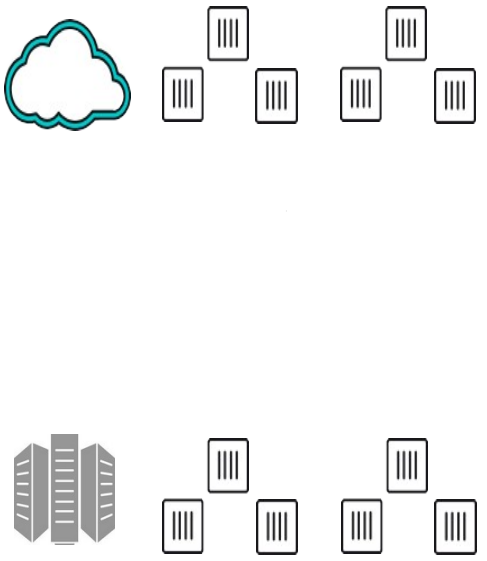
Developers | **IT Operations**

BUILD
Development Environments

SHIP
Create & Store Images

RUN
Deploy, Manage, Scale





docker

Basic Docker Commands

```
$ docker image pull node:latest

$ docker image ls
$ docker container run –d –p 5000:5000 –-name node node:latest

$ docker container ps

$ docker container stop node(or <container id>)

$ docker container rm node (or <container id>)

$ docker image rmi (or <image id>)

$ docker build –t node:2.0 .

$ docker image push node:2.0

$ docker --help
```

Dockerfile – Linux Example

Dockerfile

```
# Create image based on the official Node 6 image from dockerhub
FROM node:latest

# Create a directory where our app will be placed
RUN mkdir -p /usr/src/app

# Change directory so that our commands run inside this new directory
WORKDIR /usr/src/app

# Copy dependency definitions
COPY package.json /usr/src/app

# Install dependecies
RUN npm install

# Get all the code needed to run the app
COPY . /usr/src/app

# Expose the port the app runs in
EXPOSE 4200

# Serve the app
CMD ["npm", "start"]
```

- Instructions on how to build a Docker image
- Looks very similar to “native” commands
- Important to optimize your Dockerfile

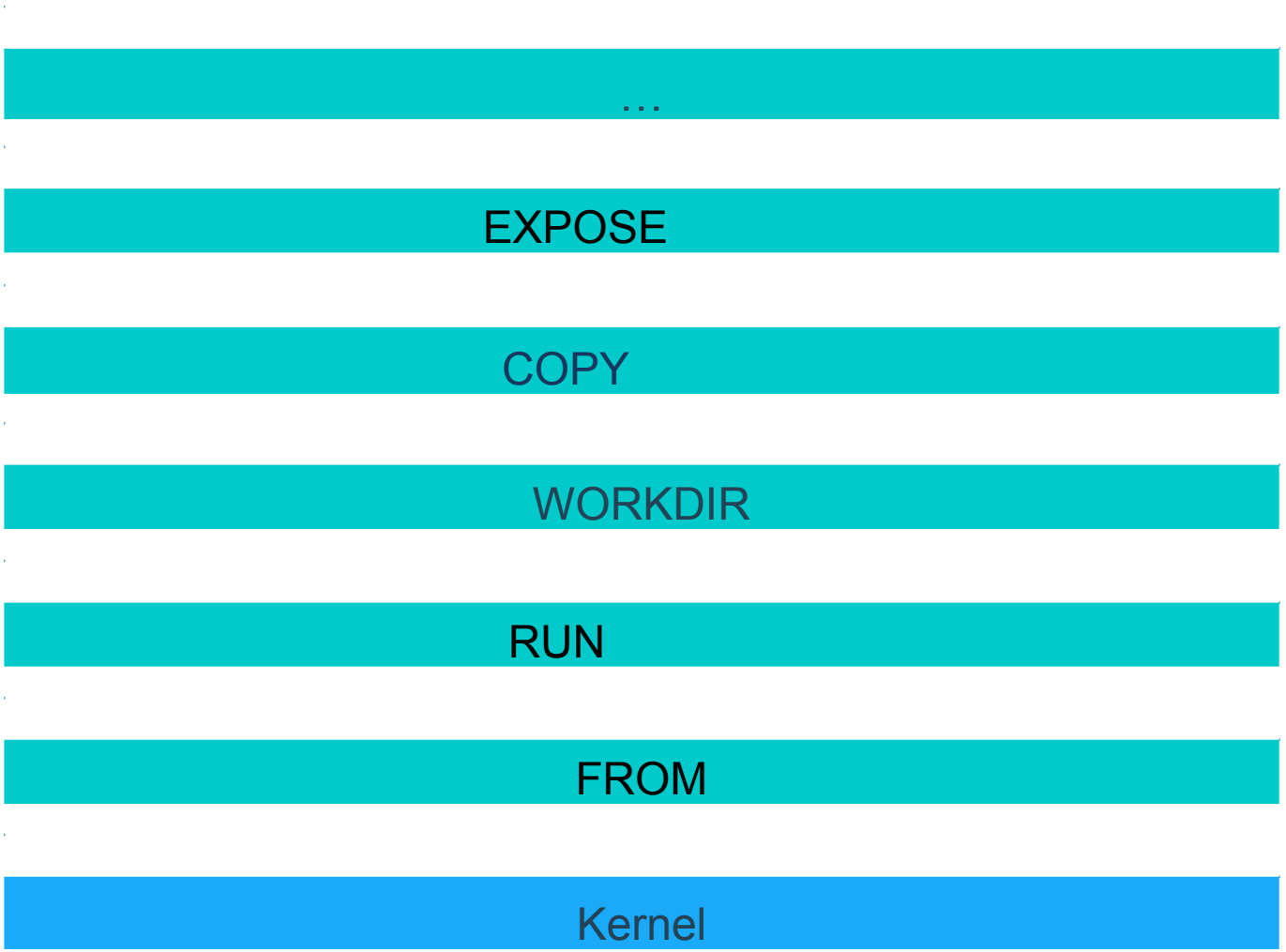
Section 2:
Anatomy of a Docker Container Docker Volume
Volume Use Cases

Let’s Go Back to Our Dockerfile

Dockerfile

```
# Create image based on the official Node 6 image from dockerhub
FROM node:latest

# Create a directory where our app will be placed
RUN mkdir -p /usr/src/app

# Change directory so that our commands run inside this new directory
WORKDIR /usr/src/app

# Copy dependency definitions
COPY package.json /usr/src/app

# Install dependecies
RUN npm install

# Get all the code needed to run the app
COPY . /usr/src/app

# Expose the port the app runs in
EXPOSE 4200

# Serve the app
CMD ["npm", "start"]
```

Each Dockerfile Command Creates a Layer



Docker Image Pull: Pulls Layers

```
Alexander@DESKTOP-90ATKET MINGW64 ~/Docker/Demo
$ docker pull nginx:latest
latest: Pulling from library/nginx
bc95e04b23c0: Pull complete
f3186e650f4e: Pull complete
9ac7d6621708: Pull complete
Digest: sha256:b81f317384d7388708a498555c28a7cce778a8f291d90021208b3eba3fe74887
Status: Downloaded newer image for nginx:latest
```

Docker Volumes

- Volumes mount a directory on the host into the container at a specific location

- Can be used to share (and persist) data between containers
  - Directory persists after the container is deleted
    - Unless you explicitly delete it

- Can be created in a Dockerfile or via CLI

Why Use Volumes

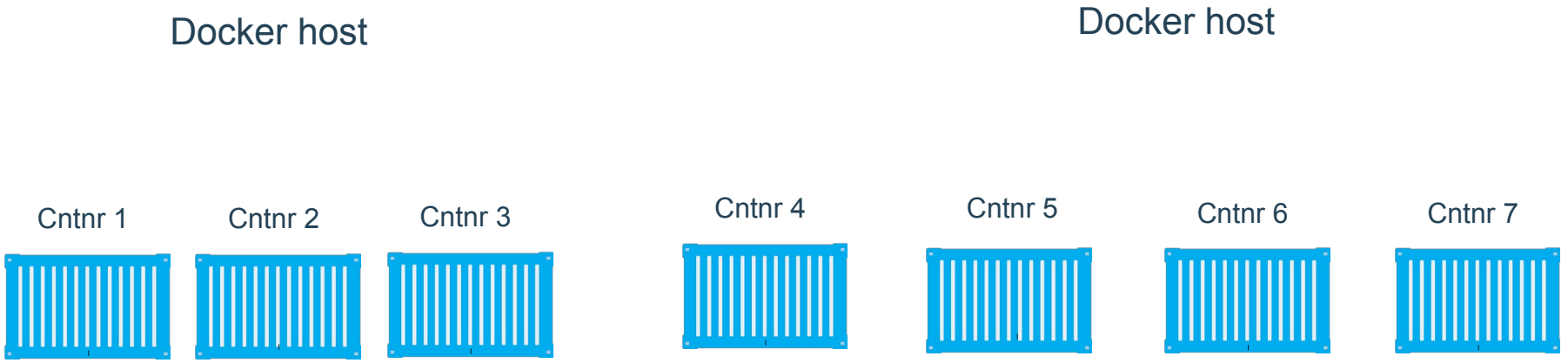
- Mount local source code into a running container

```
docker container run -v $(pwd):/usr/src/app/  myapp
```

- Improve performance
  - As directory structures get complicated traversing the tree can slow system performance
- Data persistence

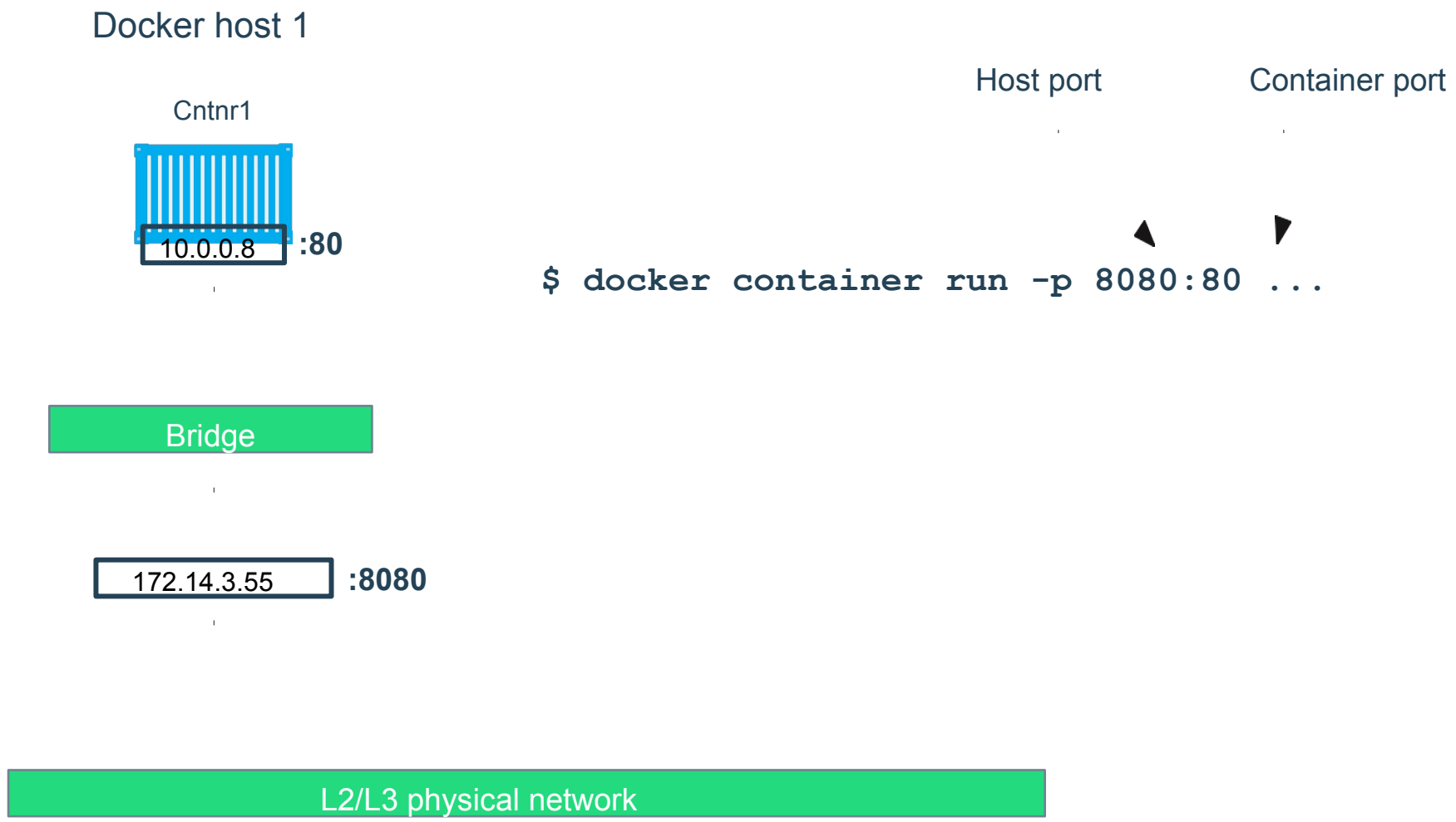
Section 3: Networking

What is Docker Bridge Networking




```
docker network create -d bridge --name bridgenet1
```

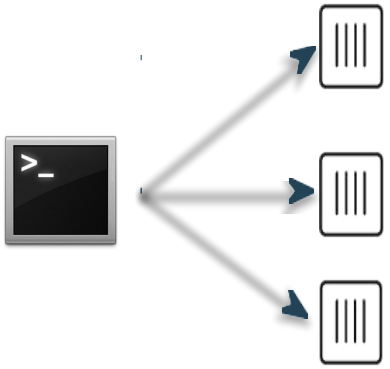
Docker Bridge Networking and Port Mapping



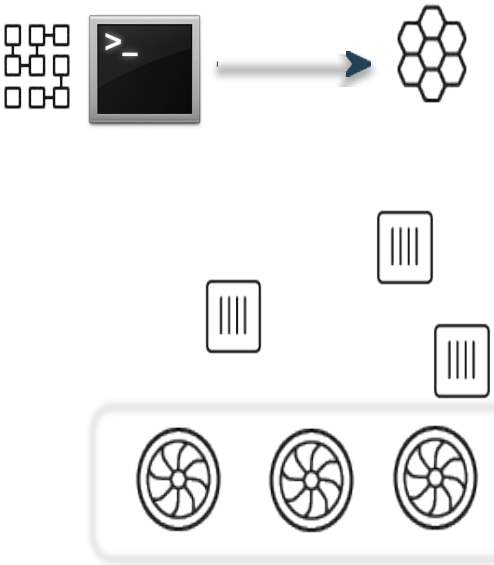
Section 4: Docker Compose

Docker Compose: Multi Container Applications

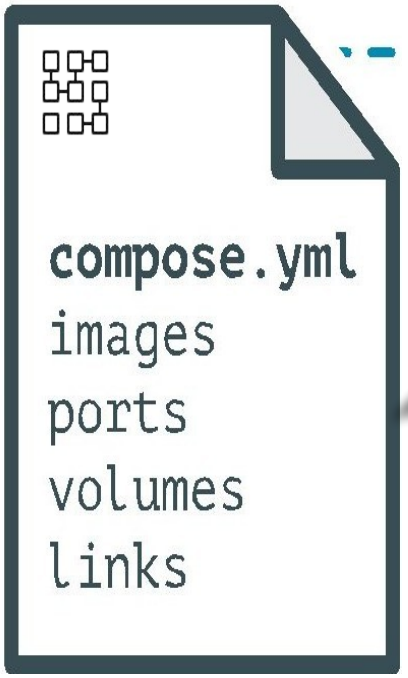
- Build and run one container at a time
- Manually connect containers together
- Must be careful with dependencies and start up order



- Define multi container app in compose.yml file
- Single command to deploy entire app
- Handles container dependencies
- Works with Docker Swarm, Networking, Volumes, Universal Control Plane



Docker Compose: Multi Container Applications




```
version: '2' # specify docker-compose version

# Define the services/containers to be run
services:
angular: # name of the first service
build: client # specify the directory of the Dockerfile
ports:
- "4200:4200" # specify port forewarding

express: #name of the second service
build: api # specify the directory of the Dockerfile
ports:
- "3977:3977" #specify ports forewarding

database: # name of the third service
image: mongo # specify image to build container from
ports:
- "27017:27017" # specify port forewarding
```

docker

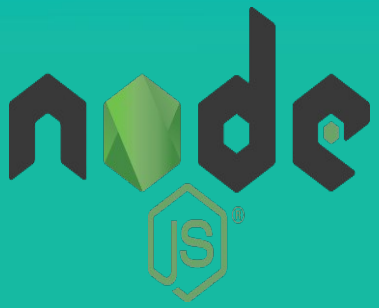
Docker Compose: Scale Container Applications

docker

Demo

Angular

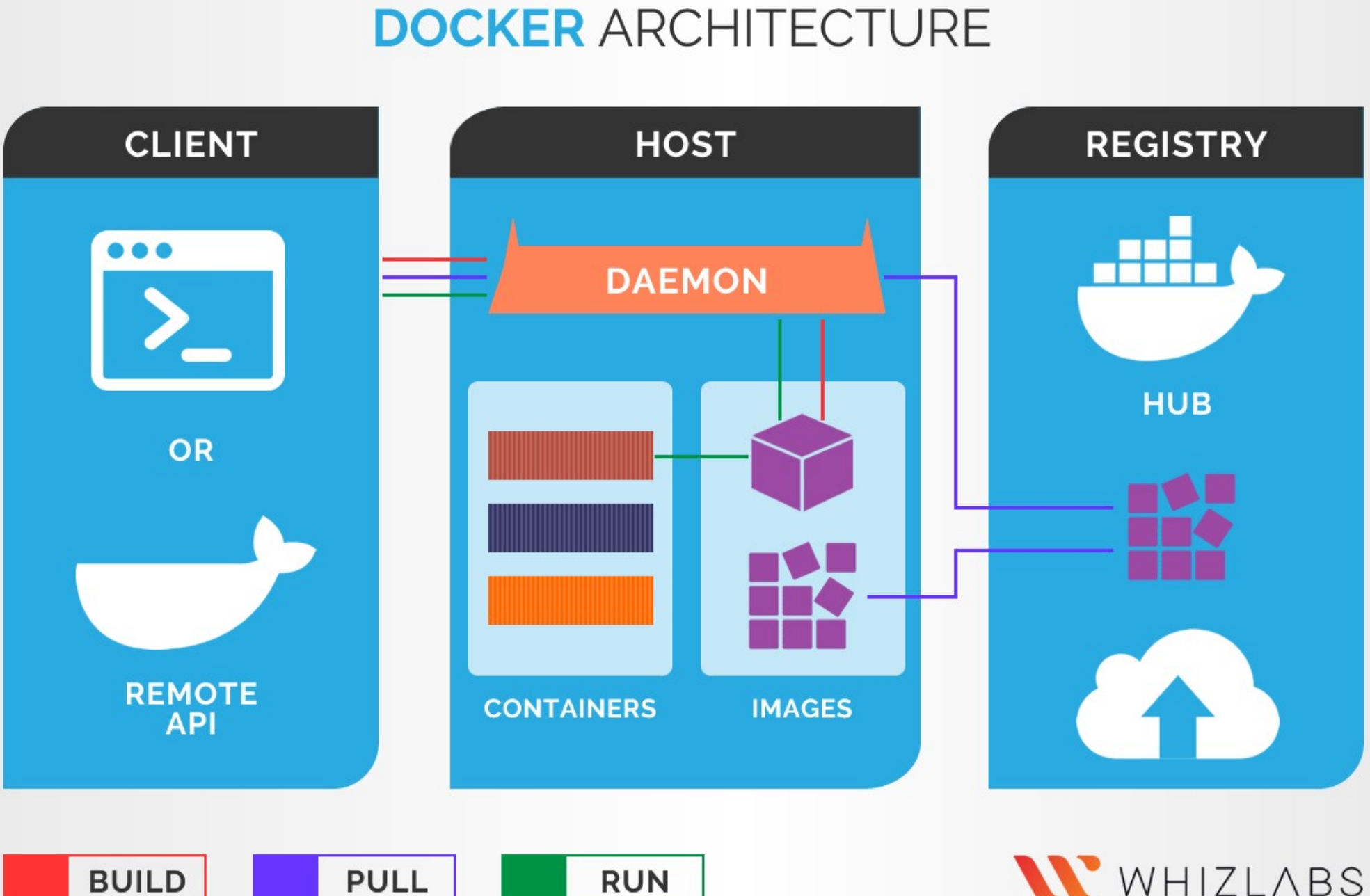
Node.js/Express



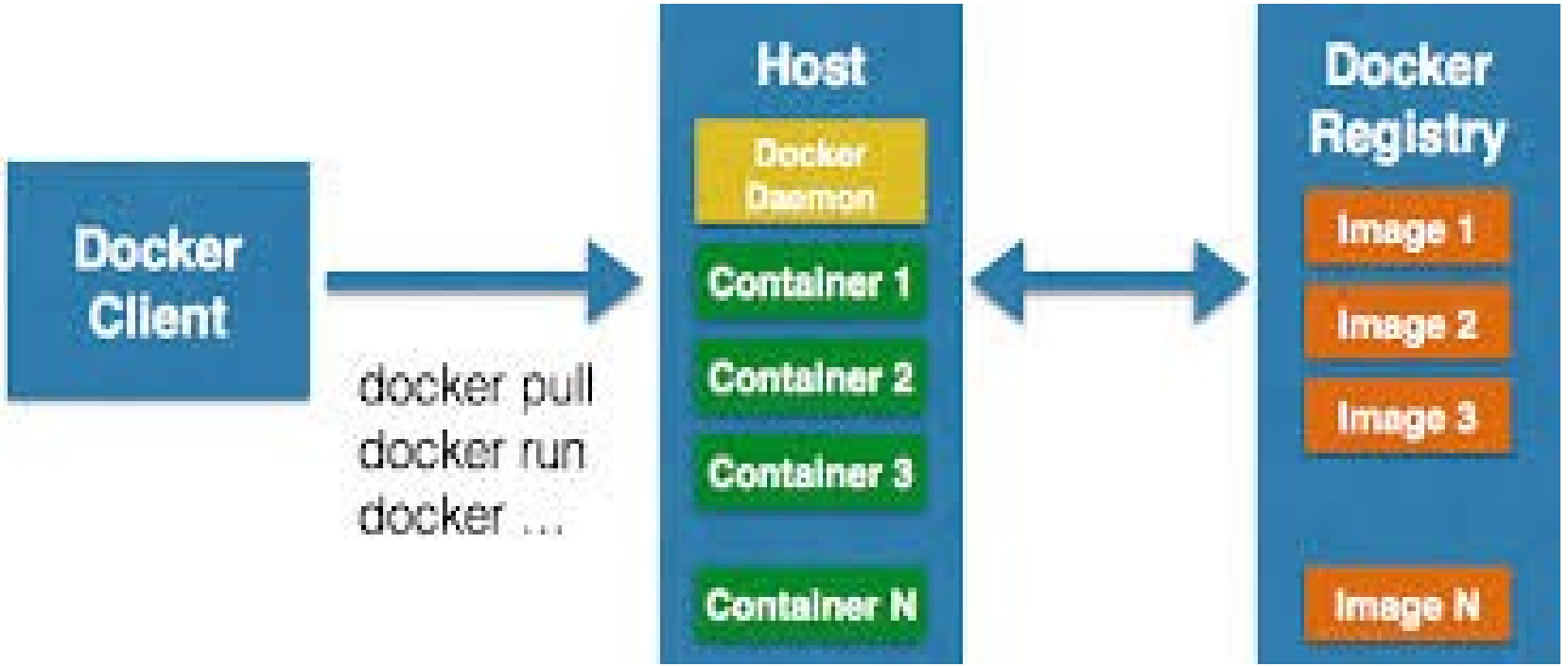
Mongo DB

docker

Docker Architecture



Docker Execution



Steps of Using Docker

Installing Docker

$ apt-get install docker-ce

2. **Registing on dockerhub (www.dockerhub,com)**

3. Pull Image from docker hub

$ docker pull <image_name>:tagname
eg docker pull mysql/mysql-server:latest

Steps of Using Docker

4. **create your own image with the help of existing image on docker hub**

File Name : Dockerfile

```
FROM payara/micro  ## image from docker hub

COPY ExampleProject1.war $DEPLOY_DIR
```

-- Navigate to the folder where Dockerfile is lying

```
$ docker build -t mywebapp:1.0 .
```

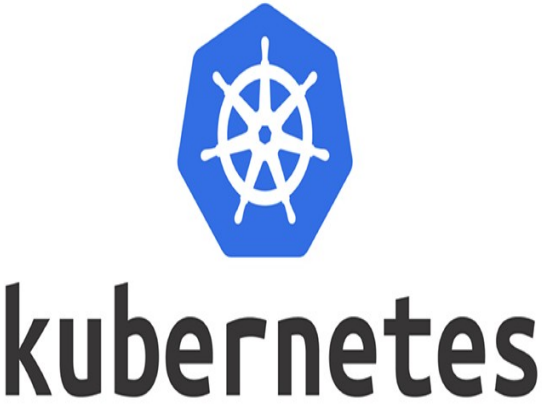
5. **Now Run the image as container**

```
$ docker run –name=web -p 9070:8080 mywebapp:1.0
```

6. **Open the browser and use** url http://localhost:9070/MyWebApp/

Advance users can use docker-compose to run multiple images in one command

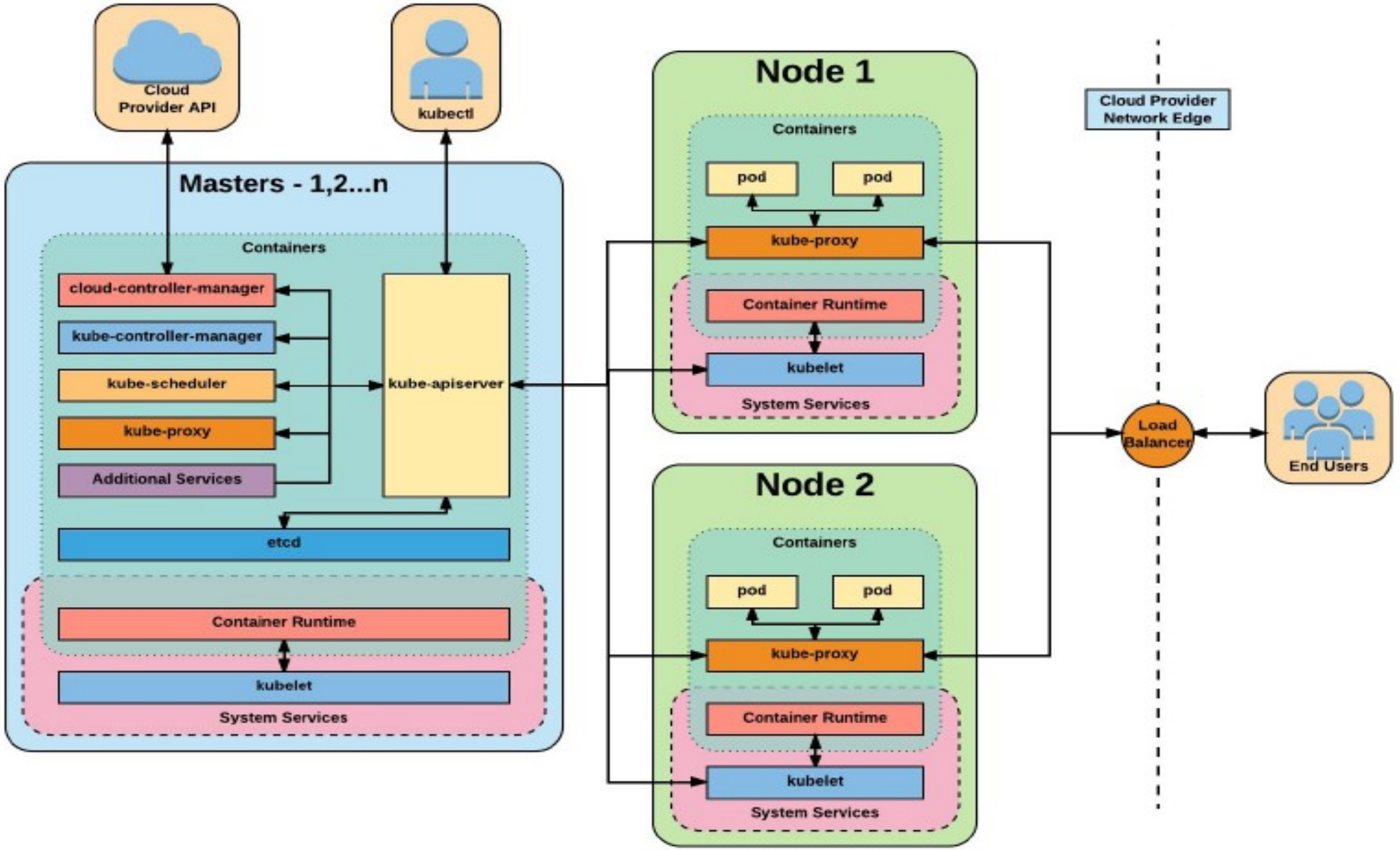
KUBERNETES – THE MASTER ORCHESTRATOR



KUBERNETES – THE MASTER ORCHESTRATOR

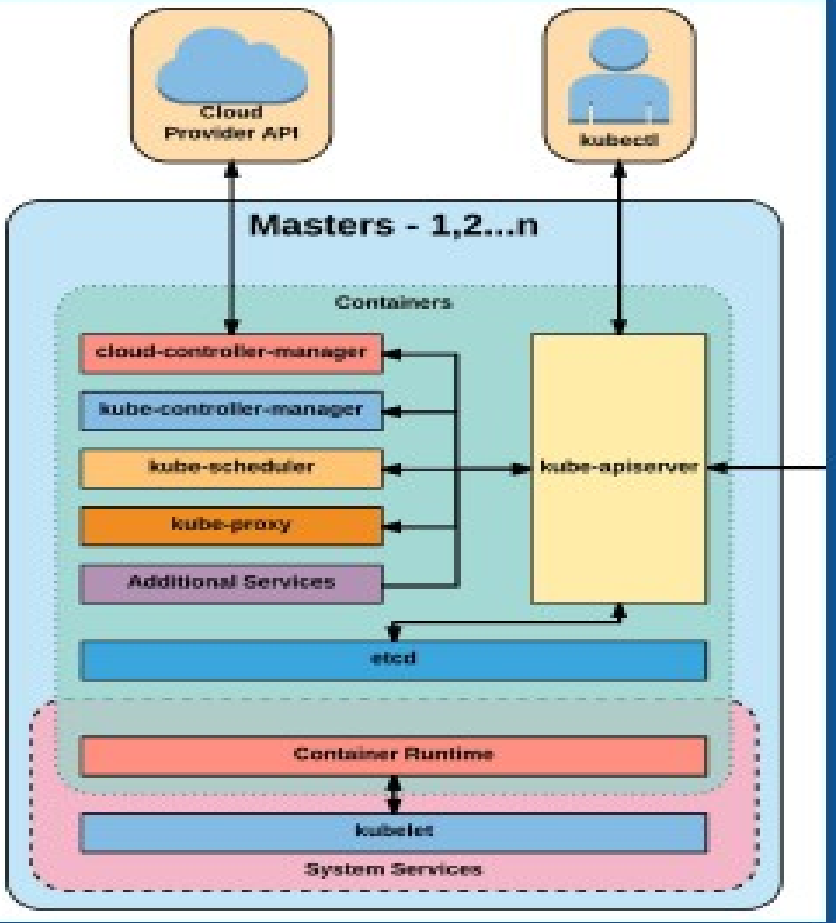
Kubernetes is a portable, extensible, open-source platform for managing containerized workloads and services, that facilitates both declarative configuration and automation. It has a large, rapidly growing ecosystem. Kubernetes services, support, and tools are widely available.

KUBERNETES – ARCHITECTURE



KUBERNETES – ARCHITECTURE

Master Components



- Kube-apiserver
- Etcd
- Kube-controller-manager
- Cloud-controller-manager
- Kube-scheduler

KUBERNETES – ARCHITECTURE

kube-apiserver

The apiserver provides a forward facing REST interface into the kubernetes control plane and datastore. All clients, including nodes, users and other applications interact with kubernetes **strictly** through the API Server.

It is the true core of Kubernetes acting as the gatekeeper to the cluster by handling authentication and authorization, request validation, mutation, and admission control in addition to being the front-end to the backing datastore.

etcd

Etcd acts as the cluster datastore; providing a strong, consistent and highly available key-value store used for persisting cluster state.

KUBERNETES – ARCHITECTURE

kube-controller-manager

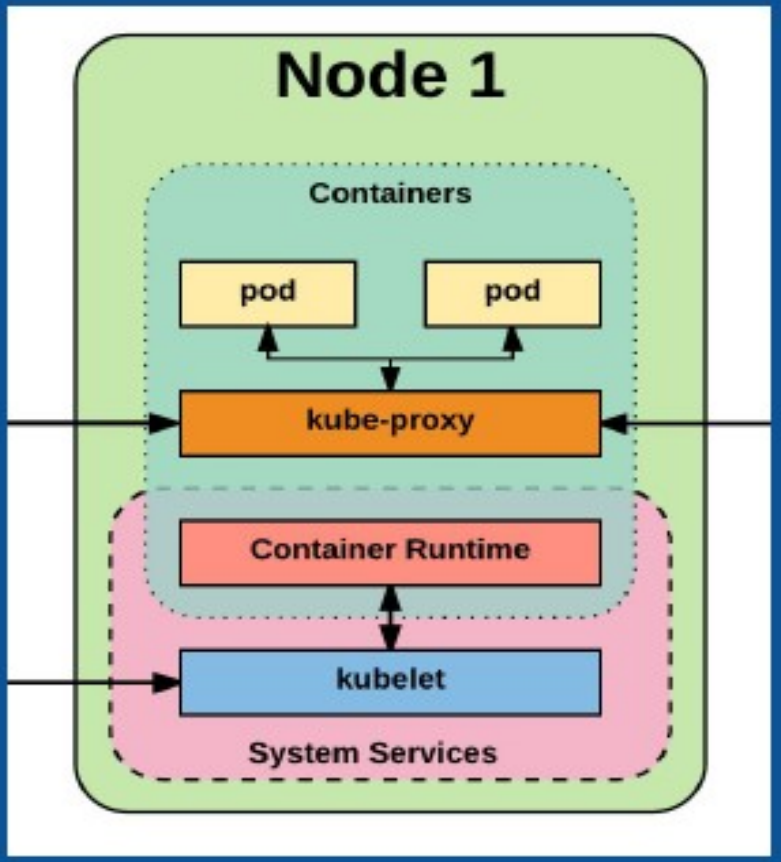
The controller-manager is the primary daemon that manages all core component control loops. It monitors the cluster state via the apiserver and steers the cluster towards the desired state.

kube-scheduler

Kube-scheduler is a verbose policy-rich engine that evaluates workload requirements and attempts to place it on a matching resource. These requirements can include such things as general hardware reqs, affinity, anti-affinity, and other custom resource requirements.

KUBERNETES – ARCHITECTURE

Node Components



- Kubelet
- Kube-proxy
- Container runtime engine

KUBERNETES – ARCHITECTURE

kubelet

Acts as the node agent responsible for managing pod lifecycle on its host. Kubelet understands YAML container manifests that it can read from several sources:

- File path
- HTTP Endpoint
- Etcd watch acting on any changes
- HTTP Server mode accepting container manifests over a simple API.

kube-proxy

Manages the network rules on each node and performs connection forwarding or load balancing for Kubernetes cluster services.

Available Proxy Modes:

- Userspace
- iptables

KUBERNETES – ARCHITECTURE

Container Runtime

With respect to Kubernetes, A container runtime is a CRI (Container Runtime Interface) compatible application that executes and manages containers.

- Containerd (docker)
- Cri-o
- Rkt
- Kata (formerly clear and hyper)
- Virtlet (VM CRI compatible runtime)

Containers in a pod exist within the same network namespace and share an IP; allowing for intrapod communication over *localhost*.

Pods are given a cluster unique IP for the duration of its lifecycle, but the pods themselves are fundamentally ephemeral.

Services are given a persistent cluster unique IP that spans the Pods lifecycle.

External Connectivity is generally handed by an integrated cloud provider or other external entity (load balancer)

KUBERNETES – ARCHITECTURE

Kubernetes Concepts - Core

Cluster - A collection of hosts that aggregate their available resources including cpu, ram, disk, and their devices into a usable pool.

Master - The master(s) represent a collection of components that make up the control plane of Kubernetes. These components are responsible for all cluster decisions including both scheduling and responding to cluster events.

Node - A single host, physical or virtual capable of running pods. A node is managed by the master(s), and at a minimum runs both kubelet and kube-proxy to be considered part of the cluster.

Namespace - A logical cluster or environment. Primary method of dividing a cluster or scoping access.

KUBERNETES – ARCHITECTURE

Concepts - Core (cont.)

Label - Key-value pairs that are used to **identify**, describe and group together related sets of objects. Labels have a strict syntax and available character set. *

Annotation - Key-value pairs that contain **non-identifying** information or metadata. Annotations do not have the the syntax limitations as labels and can contain structured or unstructured data.

Selector - Selectors use labels to filter or select objects. Both equality-based (=, ==, !=) or simple key-value matching selectors are supported.

KUBERNETES – ARCHITECTURE

```yaml
apiVersion: apps/v1beta2
kind: Deployment
metadata:
  name: nginx
  annotations:
    description: "nginx frontend"
  labels:
    app: nginx
    tier: frontend
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
      tier: frontend
  template:
    metadata:
      labels:
        app: nginx
        tier: frontend
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
```

Labels, and Annotations, and Selectors

Labels:
app: nginx
tier: frontned

Annotations
description: “nginx frontend”

Selector:
app: nginx
tier: frontend

KUBERNETES – ARCHITECTURE

```yaml
apiVersion: apps/v1beta2
kind: Deployment
metadata:
  name: nginx
  annotations:
    description: "nginx frontend"
  labels:
    app: nginx
    tier: frontend
spec:
  replicas: 3
  selector:
    matchExpressions:
      - {key: app, operator: In, values: [nginx]}
      - {key: tier, operator: In, values: [frontend]}
  template:
    metadata:
      labels:
        app: nginx
        tier: frontend
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
```

Set-based selectors

Valid Operators:

- In
- NotIn
- Exists
- DoesNotExist

Supported Objects with set-based selectors:

- Job
- Deployment
- ReplicaSet
- DaemonSet
- PersistentVolumeClaims

KUBERNETES – ARCHITECTURE

Concepts - Workloads

Pod - A pod is the smallest unit of work or management resource within Kubernetes. It is comprised of one or more containers that share their storage, network, and context (namespace, cgroups etc).

ReplicationController - Method of managing pod replicas and their lifecycle. Their scheduling, scaling, and deletion.

ReplicaSet - Next Generation ReplicationController. Supports set-based selectors.

Deployment - A declarative method of managing stateless Pods and ReplicaSets. Provides rollback functionality in addition to more granular update control mechanisms.

KUBERNETES – ARCHITECTURE

```yaml
apiVersion: apps/v1beta2
kind: Deployment
metadata:
  name: nginx
  annotations:
    description: "nginx frontend"
  labels:
    app: nginx
    tier: frontend
spec:
  replicas: 3
  mindReadySeconds: 10
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 5
      maxUnavailable: 2
  selector:
    matchLabels:
      app: nginx
      tier: frontend
  template:
    metadata:
      labels:
        app: nginx
        tier: frontend
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
```

Deployment

Contains configuration of how updates or 'deployments' should be managed in addition to the pod template used to generate the ReplicaSet.

ReplicaSet

Generated ReplicaSet from Deployment spec.

```yaml
apiVersion: apps/v1beta2
kind: ReplicaSet
metadata:
  name: nginx
  annotations:
    description: "nginx frontend"
  labels:
    app: nginx
    tier: frontend
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
      tier: frontend
  template:
    metadata:
      labels:
        app: nginx
        tier: frontend
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
```

KUBERNETES – ARCHITECTURE

Service

- Acts as the unified method of accessing replicated pods.
- Four major Service Types:
  - CluterIP - Exposes service on a strictly cluster-internal IP (default)
  - NodePort - Service is exposed on each node's IP on a statically defined port.
  - LoadBalancer - Works in combination with a cloud provider to expose a service outside the cluster on a static external IP.
  - ExternalName - used to references endpoints **OUTSIDE** the cluster by providing a static internally referenced DNS name.

```yaml
kind: Service
apiVersion: v1
metadata:
  name: nginx
spec:
  type: ClusterIP
  selector:
    app: nginx
  ports:
  - protocol: TCP
    port: 80
    targetPort: 80
```

KUBERNETES – ARCHITECTURE

Ingress Controller

- Deployed as a pod to one or more hosts
- Ingress controllers are an external controller with multiple options.
  - Nginx
  - HAproxy
  - Contour
  - Traefik
- Specific features and controller specific configuration is passed through annotations.

```yaml
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  annotations:
    kubernetes.io/ingress.class: "nginx"
  name: nginx-ingress
spec:
  rules:
  - host: foo.bar.com
    http:
      paths:
      - path: /nginx
        backend:
          service: nginx
          servicePort: 80
```

KUBERNETES – ARCHITECTURE

Concepts - Storage

Volume - Storage that is **tied to the Pod Lifecycle**, consumable by one or more containers within the pod.

PersistentVolume - A PersistentVolume (PV) represents a storage resource. PVs are commonly linked to a backing storage resource, NFS, GCEPersistentDisk, RBD etc. and are provisioned ahead of time. Their lifecycle is handled independently from a pod.

PersistentVolumeClaim - A PersistentVolumeClaim (PVC) is a request for storage that satisfies a set of requirements instead of mapping to a storage resource directly. Commonly used with dynamically provisioned storage.

StorageClass - Storage classes are an abstraction on top of an external storage resource. These will include a provisioner, provisioner configuration parameters as well as a PV reclaimPolicy.

KUBERNETES – ARCHITECTURE

Persistent Volumes

```yaml
apiVersion: v1
  kind: PersistentVolume
  metadata:
    name: pv-nfs
  spec:
    capacity:
      storage: 500Gi
    volumeMode: Filesystem
    accessModes:
      - ReadWriteMany
    persistentVolumeReclaimPolicy: Recycle
    storageClassName: slow
    mountOptions:
      - hard
      - nfsvers=4.1
    nfs:
      path: /data
      server: 10.255.100.10
```

- PVs are a cluster-wide resource
- Not directly consumable by a Pod
- PV Parameters:
  - Capacity
  - accessModes
    - ReadOnlyMany (ROX)
    - ReadWriteOnce (RWO)
    - ReadWriteMany (RWX)
  - persistentVolumeReclaimPolicy
    - Retain
    - Recycle
    - Delete
  - StorageClass

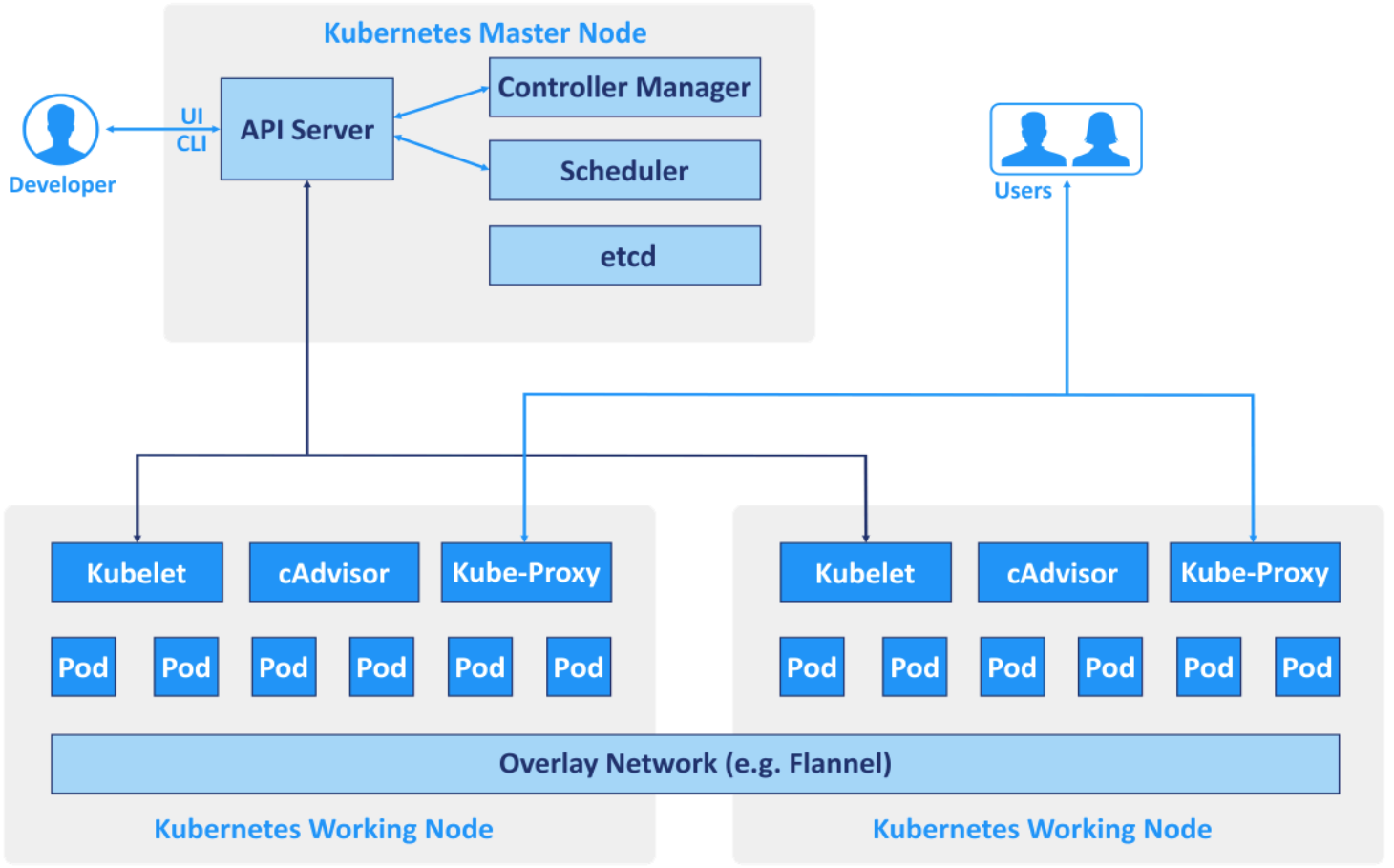
KUBERNETES – ARCHITECTURE

Persistent Volume Claims

```
apiVersion: v1
  kind: PersistentVolumeClaim
  metadata:
    name: my-nfs-pvc
  spec:
    accessModes:
    - ReadWriteMany
    resources:
      requests:
        storage: 50Gi
    storageClass: slow
```

- PVCs are scoped to namespaces
- Supports accessModes like PVs
- Uses resource request model similar to Pods
- Claims will consume storage from matching PVs or StorageClasses based on *storageClass* and selectors.

Working of Kubernetes



Pod : Container manager ,
etcd : Persistent Storage
minikube : Managed Kubernetes

Kube-Proxy : Service Connector
ambassador : API gateway
Ingress : Load Balancer

Steps of Using Kubernetes

1. **Install minikube – a single cluster kubernetes engine (see on line)**

2. Install kubectl

3. **Using kubectl we can issue commands to minikube**

Pods : They contain container instances (one or more replicas)

Services : The are front end connecting to respective pods

-- We write a yaml file for services, pods, networks and storages
4. command to create service and pods

$ kubectl apply -f stockmanager-service.yaml

5. viewing services and pods
$ kubectl get svc and kubectl get pods

6. execute the service

$ minikube service service_name

Putting MSA on Amazon Web Services Cloud

22:12:43

Putting MSA on Amazon Web Services Cloud

We are using following services of AWS for MSA

1. AWS Educate / Private Account

2. AWS client for command line tasks

3. IAM for creating users, groups and roles

4. Elastic Compute 2 (EC2) for machine instance

5. Elastic Container Service (ECS) for docker image repository

5.Elastic IP

6. Docker, Minikube and Kubernetes instance on EC2 instance

7. API Gateway – Ingress Controller

22:12:43

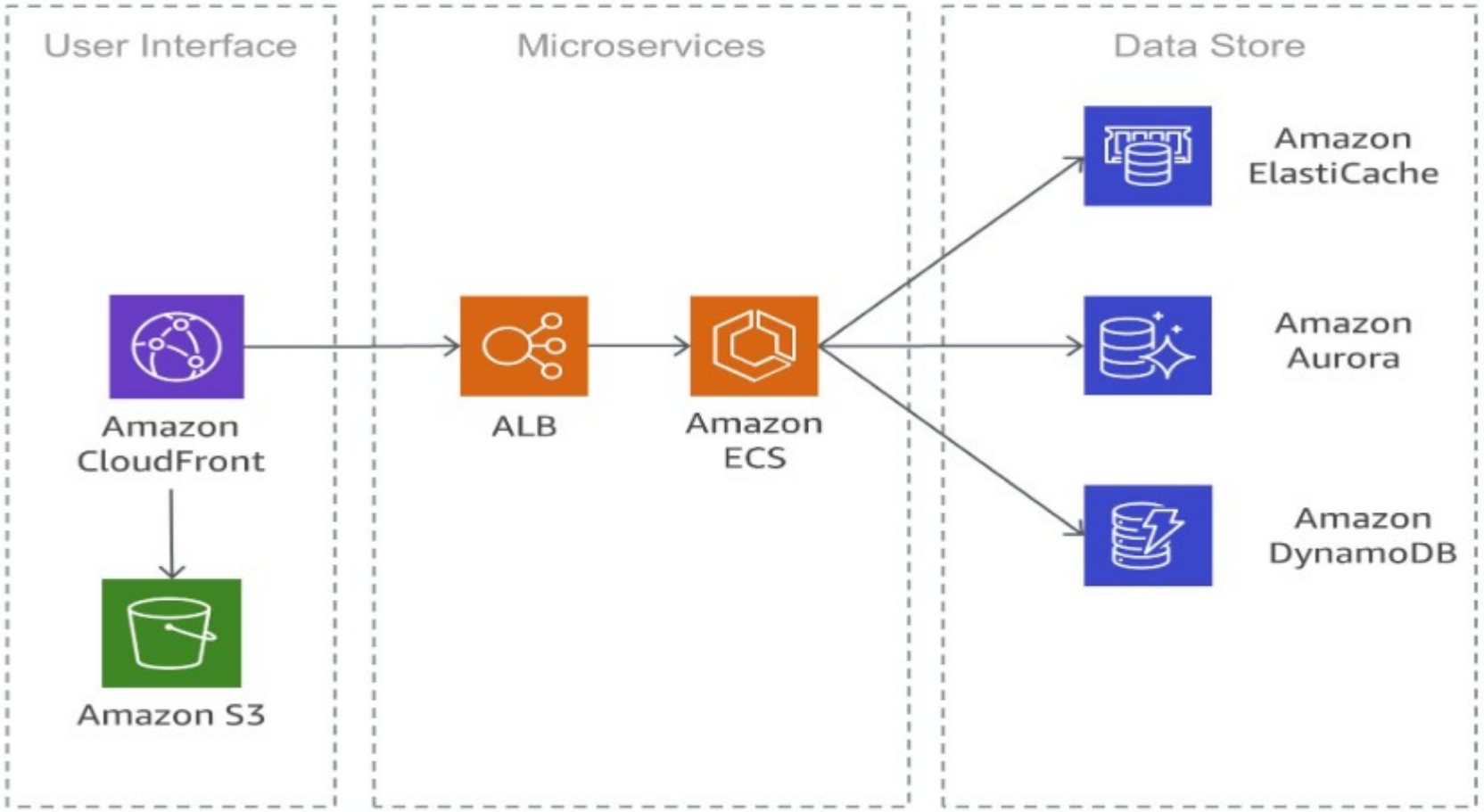
Service Observability

- Log aggregation
- Application metrics
- Audit logging
- Distributed tracing
- Exception tracking
- Health check API
- Log deployments and changes

Deployments - Types

- Multiple service instances per host
- Service instance per host
- Service instance per VM
- Service instance per Container (Docker based)
- Serverless deployment (AWS, Azure, EKS, Google Cloud)
- Service deployment platform (Kubernetes, Swarm)

Amazon Cloud and Micro Services



MICRO SERVICES SOFTWARE ENGINEERING MODEL

EVERY STAGE HAS ITS OWN TOOL
– ALL THE TOOLS TOGATHER FORM A TOOL CHAIN

Micro Services Transactions with Eventual Consistency

MicroServices Essentials - Database per Service

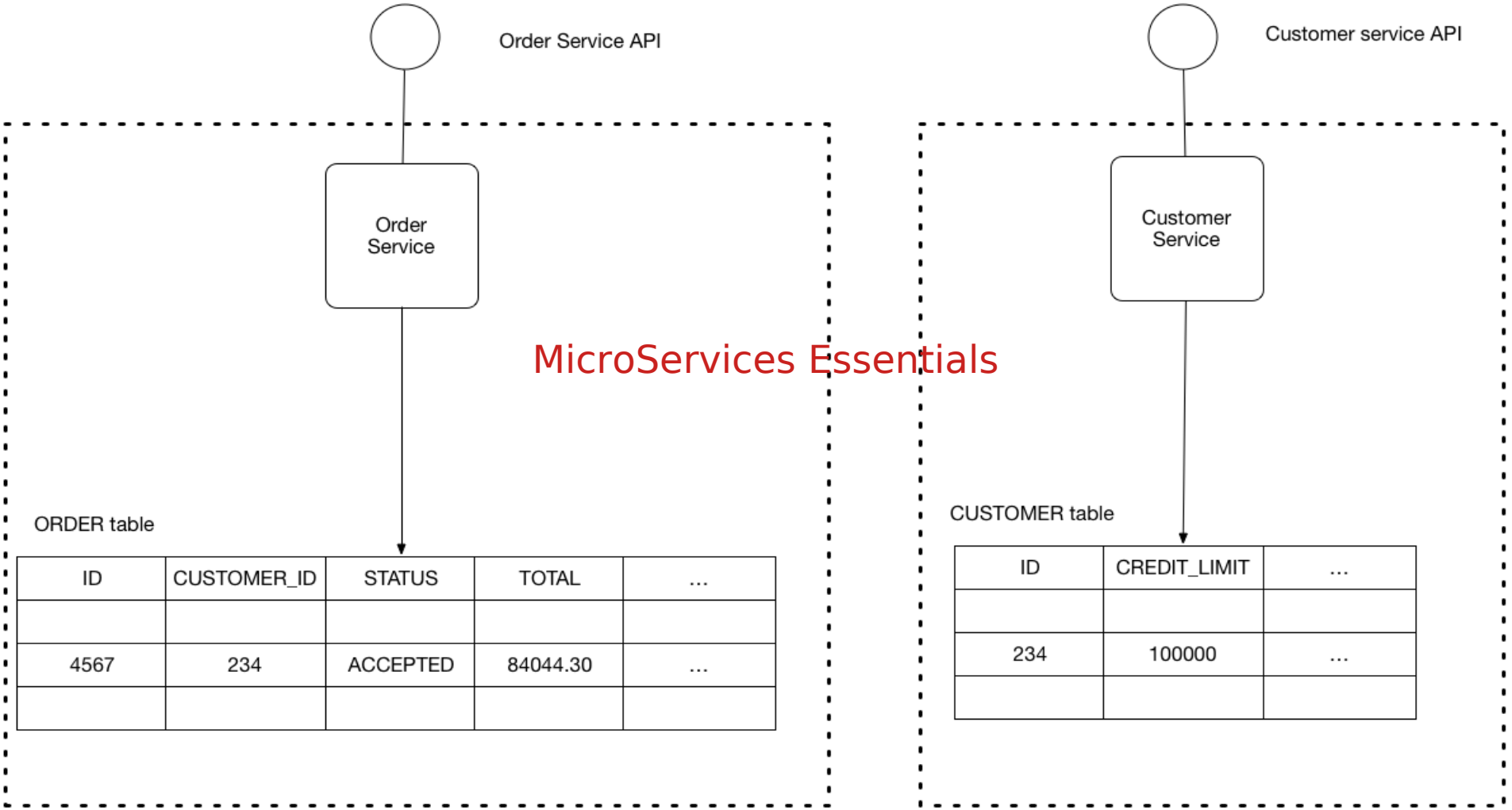
- The service's database is effectively part of the implementation of that service. It cannot be accessed directly by other services. If you are using a relational database then the options are:

- Private-tables-per-service – each service owns a set of tables that must only be accessed by that service

- Schema-per-service – each service has a database schema that's private to that service

- Database-server-per-service – each service has it's own database server.

MicroServices Essentials
Database per Service



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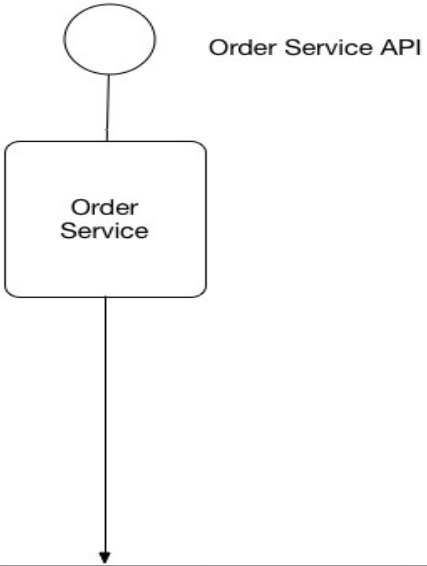
MicroServices Essentials
Shared Database

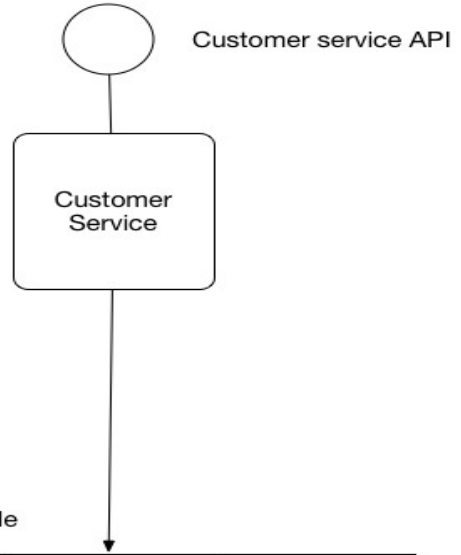
The reason for going for shared database for multiple services

- Some transaction spawn over many services
- Some operations require data from multiple services
- Database replication is required



ORDER table

ID	CUSTOMER_ID	STATUS	TOTAL	...
4567	234	ACCEPTED	84044.30	...



CUSTOMER table

ID	CREDIT_LIMIT	...
234	100000	...

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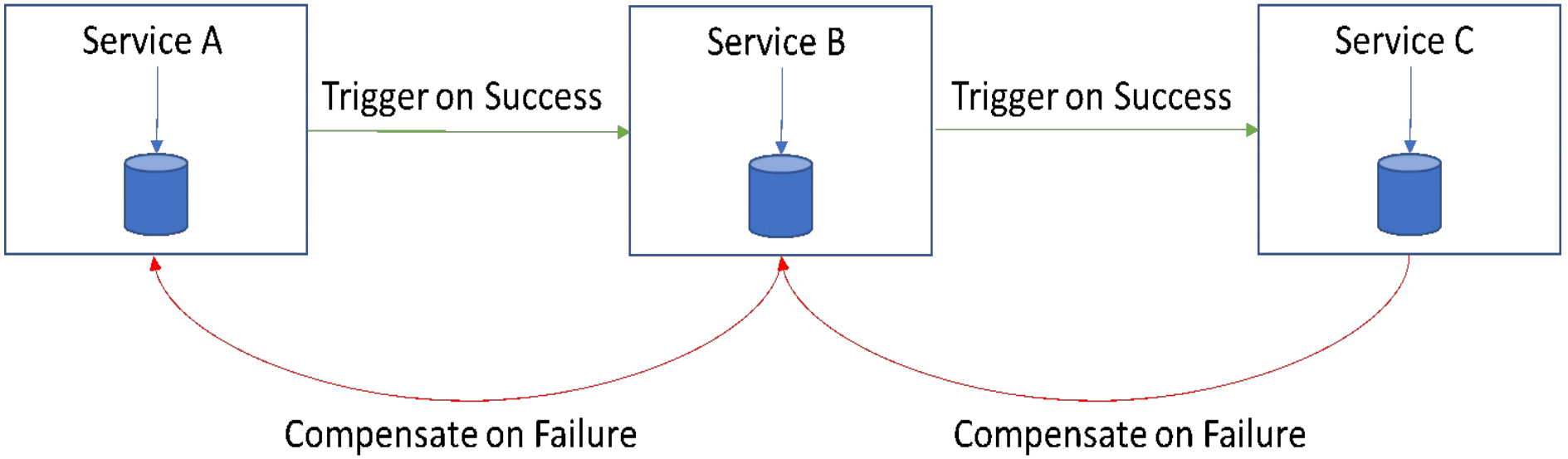
Data Transactions : Eventual Consistency

WITH SAGA PATTERN

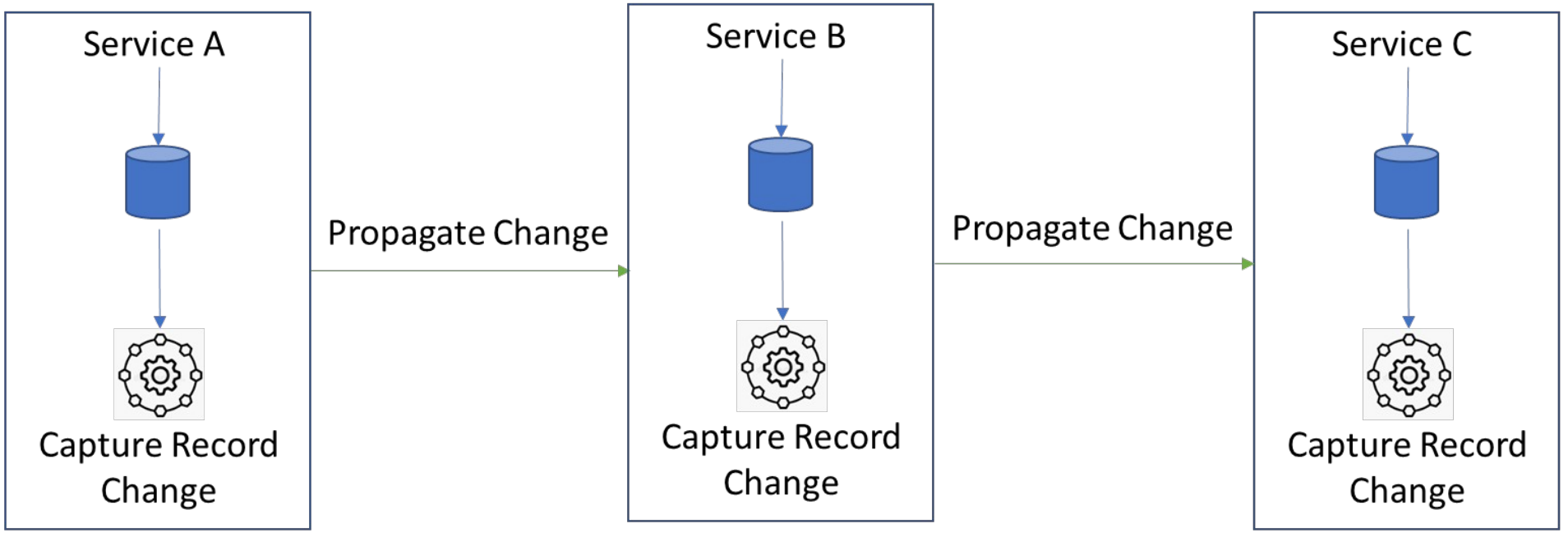


Data Transactions : Eventual Consistency

Transactions that span multiple services are viewed as a **SAGA**/chain of simple atomic local transactions at each service level. Thus, a service completes and commits its transaction, notifies the next service in the chain with an event/message to trigger the next local transaction and so on and so forth. If one transaction in this chain fails, owing to any particular reason, it basically triggers an undo operation coming backward in the chain. It is thus imperative to address pattern failures while designing the architecture

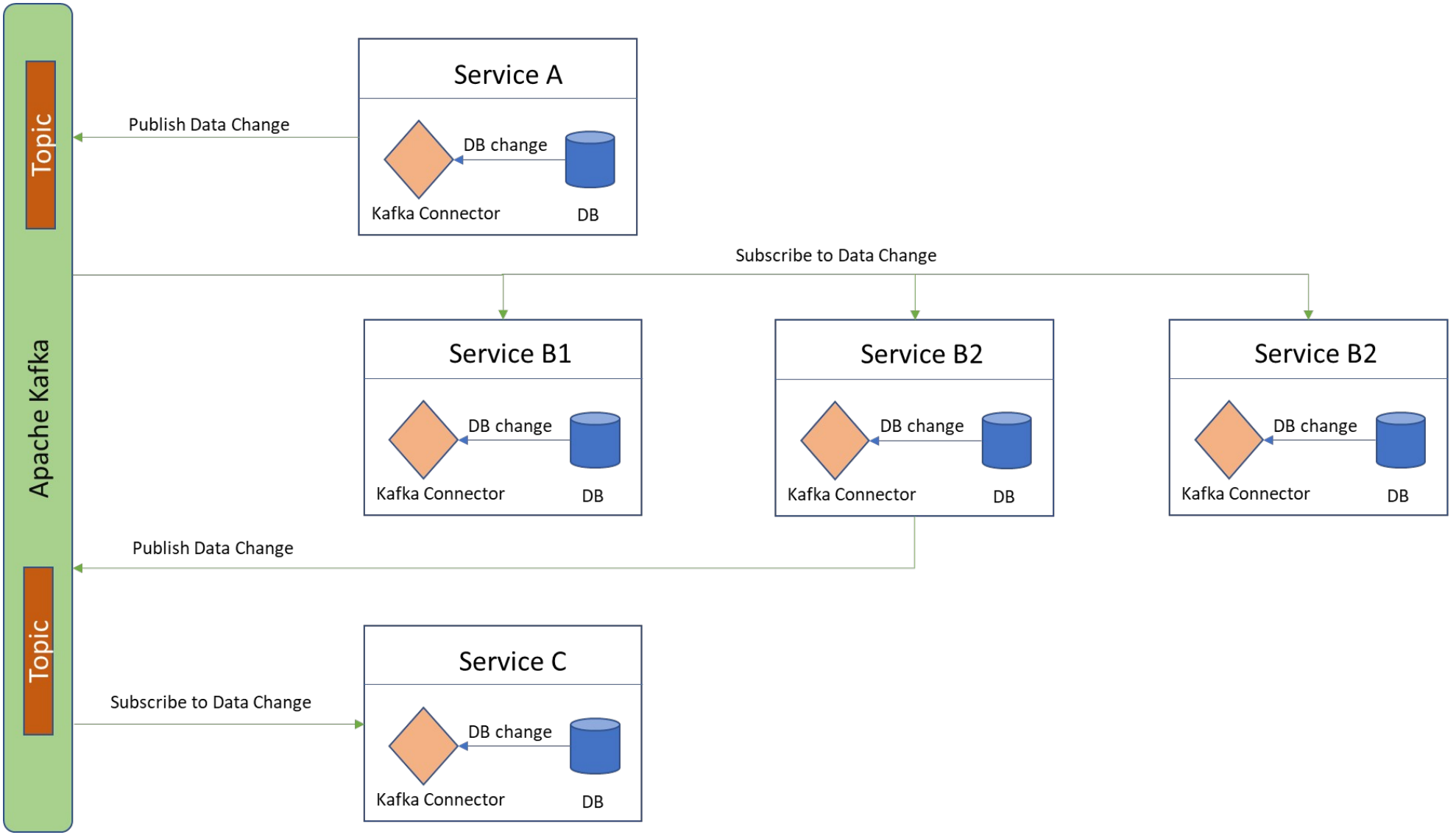
Data Transactions : Eventual Consistency

WITH TRANSACTION LOGS



Data Transactions : Eventual Consistency

WITH MESSAGE QUEUES



Data Transactions :
Eventual Consistency : BASE vs ACID

For Micro Services

BASE is an acronym for Basically Available, Soft state and Eventual Consistency

For Conventional

ACID is an acronym for Atomicity, Consistent, Isolated and Durable

Apache Kafka – from Apache

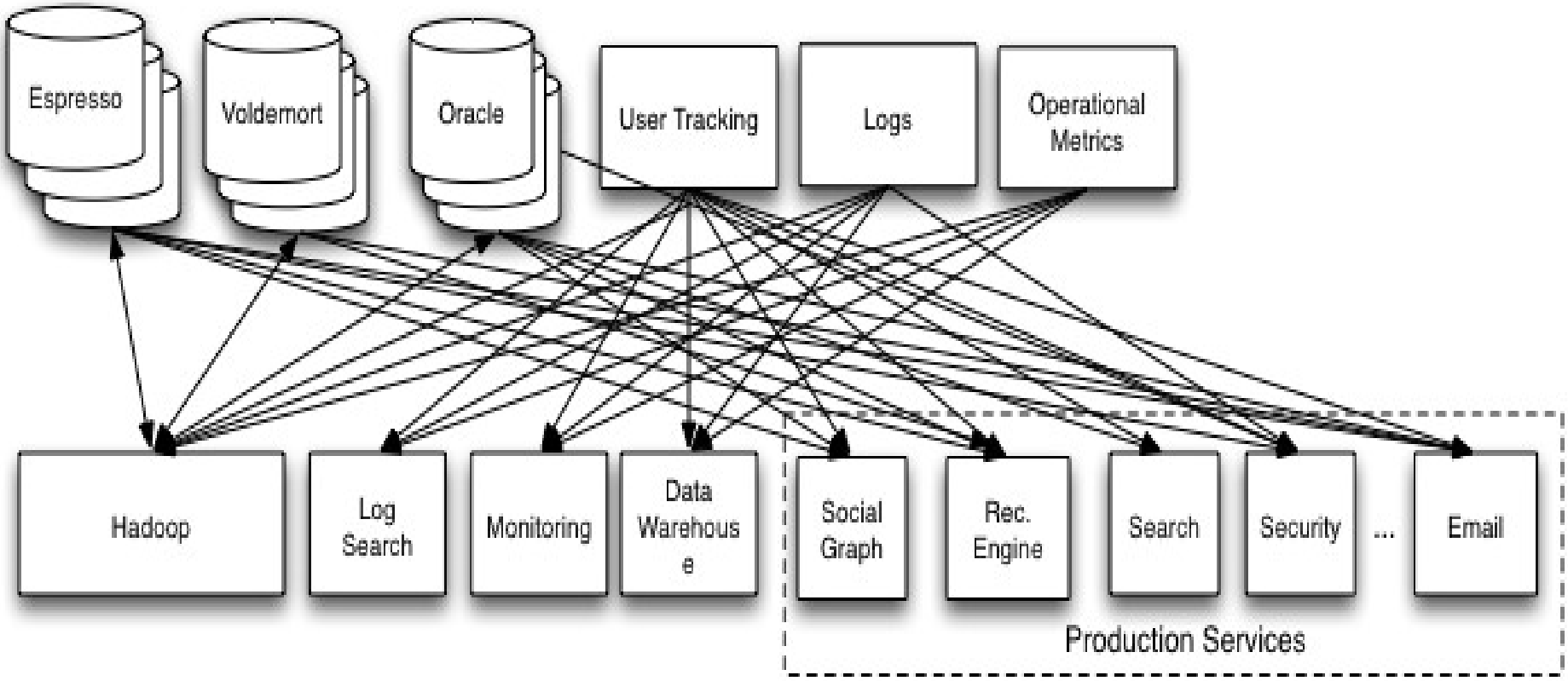
- Apache Kafka is a distributed publish-subscribe messaging system. It is designed to support the following
  - Persistent messaging that provide constant time performance even with many TB of stored messages.
  - High-throughput: even with very modest hardware Kafka can support hundreds of thousands of messages per second
  - .
  - Explicit support for partitioning messages over Kafka servers and distributing consumption over a cluster of consumer
  - machines while maintaining per-partition ordering semantics.
  - Support for parallel data load into Hadoop.

Background

- LinkedIn product donated to Apache
- Most core developers are from LinkedIn
- Pretty good pickup outside of LinkedIn: Netflix , Air BnB & Urban Airship for example
- Fun fact: no logo yet

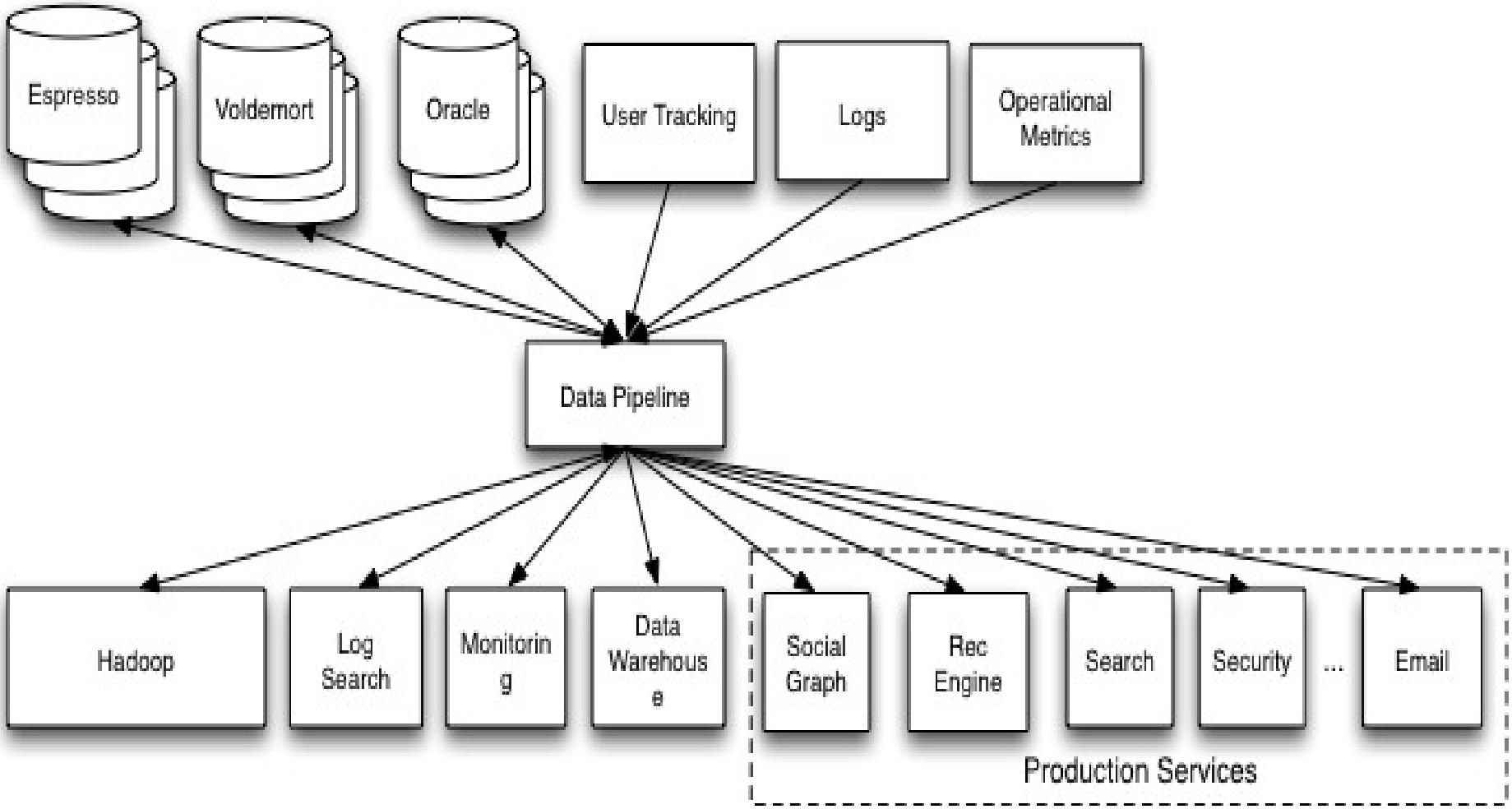
Data Integration

Point to Point integration (thanks to LinkedIn for slide)



(Thanks to http://linkstate.wordpress.com/2011/04/19/recabling-project/)

What we'd really like (thanks to LinkedIn for slide)



Looks Familiar: JMS to the rescue!

Okay: Data warehouse to the rescue!

Okay: CICS to the rescue!

Kafka changes the paradigm

Kafka doesn’t keep track of who consumed which message

Consumption Management

- Kafka leaves management of what was consumed up to the business logic
- Each message has a unique identifier (within the topic and partition)
- Consumers can ask for message by identifier, even if they are days old
- Identifiers are sequential within a topic and partition.

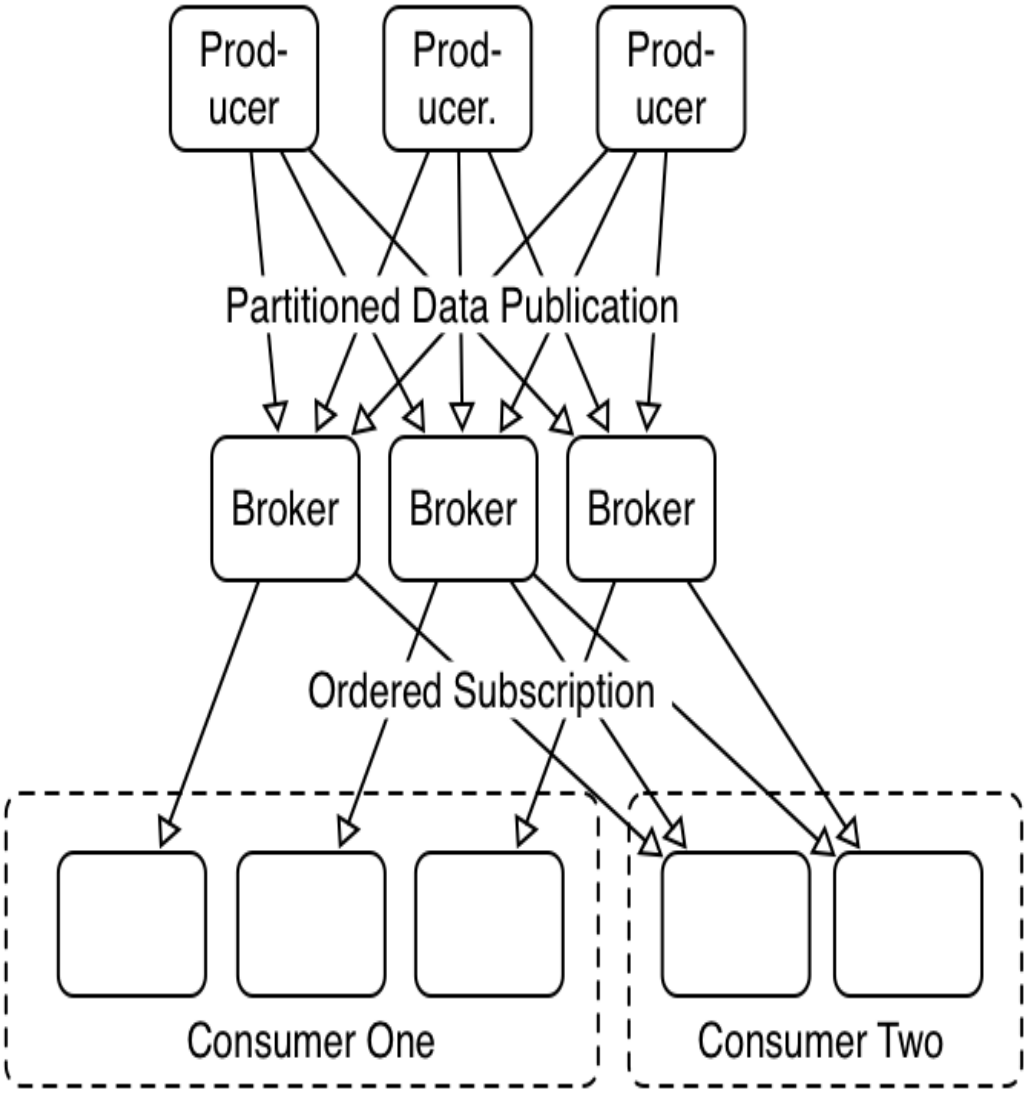
Why is Kafka Interesting?

Horizontally scalable messaging system

Terminology

- Topics are the main grouping mechanism for messages
- Brokers store the messages, take care of redundancy issues
- Producers write messages to a broker for a specific topic
- Consumers read from Brokers for a specific topic
- Topics can be further segmented by partitions
- Consumers can read a specific partition from a Topic

Architecture (thanks to LinkedIn for slide)



Producers

- Pretty Basic API
- Partitioning is a little odd, requires Producers to know about partition scheme
- Producers DO NOT know about consumers

Consumers: Consumer Groups

- Easiest to get started with
- Kafka makes sure only one thread in the group sees a message for a topic (or a message within a Partition)
- Uses Zookeeper to keep track of what messages were consumed in which topic/partitions
- No ‘once and only once’ delivery semantics here
- Rebalance may mean a message gets replayed

Consumers: Simple Consumer

- Consumer subscribes to a specific topic and partition
- Consumer has to keep track of what message offset was last consumed
- A lot more error handling required if Brokers have issues
- But a lot more control over which messages are read. Does allow for ‘exactly once’ messaging

Consumer Model Design

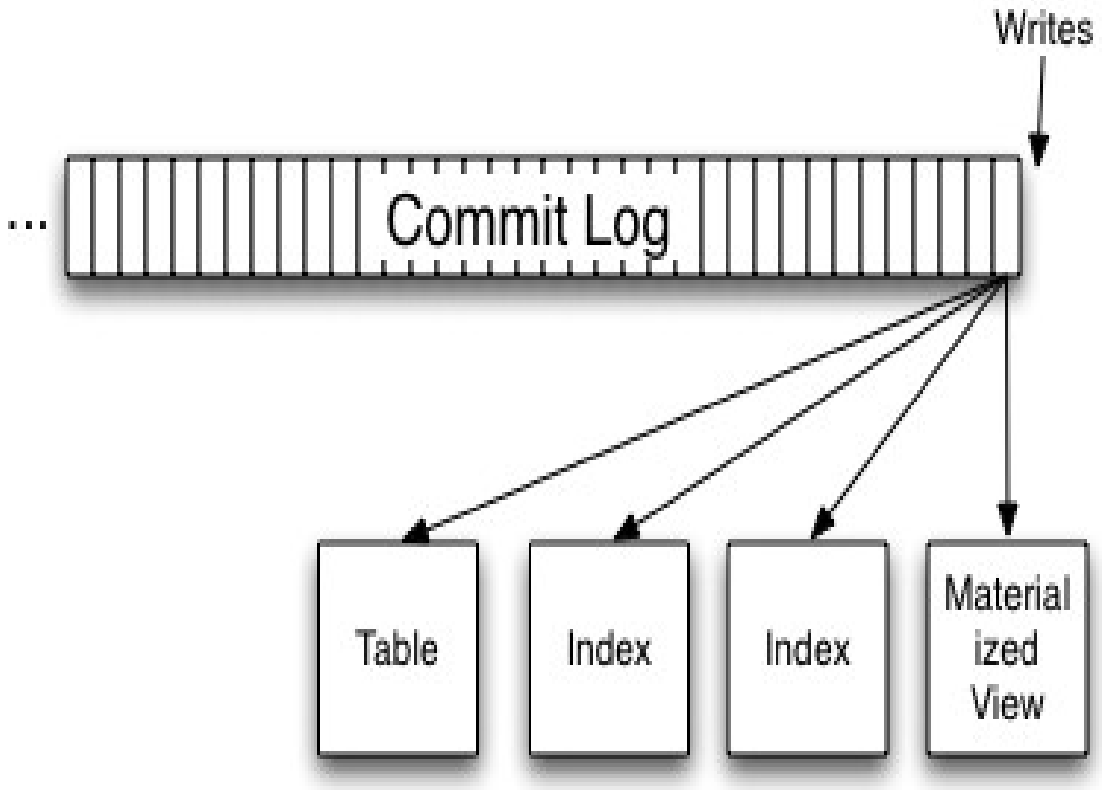
- Partition design impacts overall throughput
  - Producers know partitioning class
  - Producers write to single Broker ‘leader’ for a partition
- Offsets as only transaction identifier complicates consumer
  - ‘throw more hardware’ at the backlog is complicated
  - Consumer Groups == 1 thread per partition
    - If expensive operations can’t throw more threads at it
- Not a lot of ‘real world’ examples on balancing # of topics vs. # of partitions

Why is Kafka Interesting?

Memory Mapped Files

Kernel-space processing

What is a commit log? (thanks to LinkedIn for slide)



Brokers

- Lightweight, very fast message storing
- Writes messages to disk using kernel space NOT JVM
- Uses OS Pagecache
- Data is stored in flat files on disk, directory per topic and partition
- Handles the replication

Brokers continued

- Very low memory utilization – almost nothing is held in memory
- (Remember, Broker doesn’t keep track of who has consumed a message)
- Handle TTL operations on data
- Drop a **file** when the data is too old

Why is Kafka Interesting?

Stuff just works

Producers and Consumers are about business logic

Consumer Use Case: batch loading

- Consumers don’t have to be online all the time
- Wake up every hour, ask Kafka for events since last request
- Load into a database, push to external systems etc.
- Load into Hadoop (Stream if using MapR)

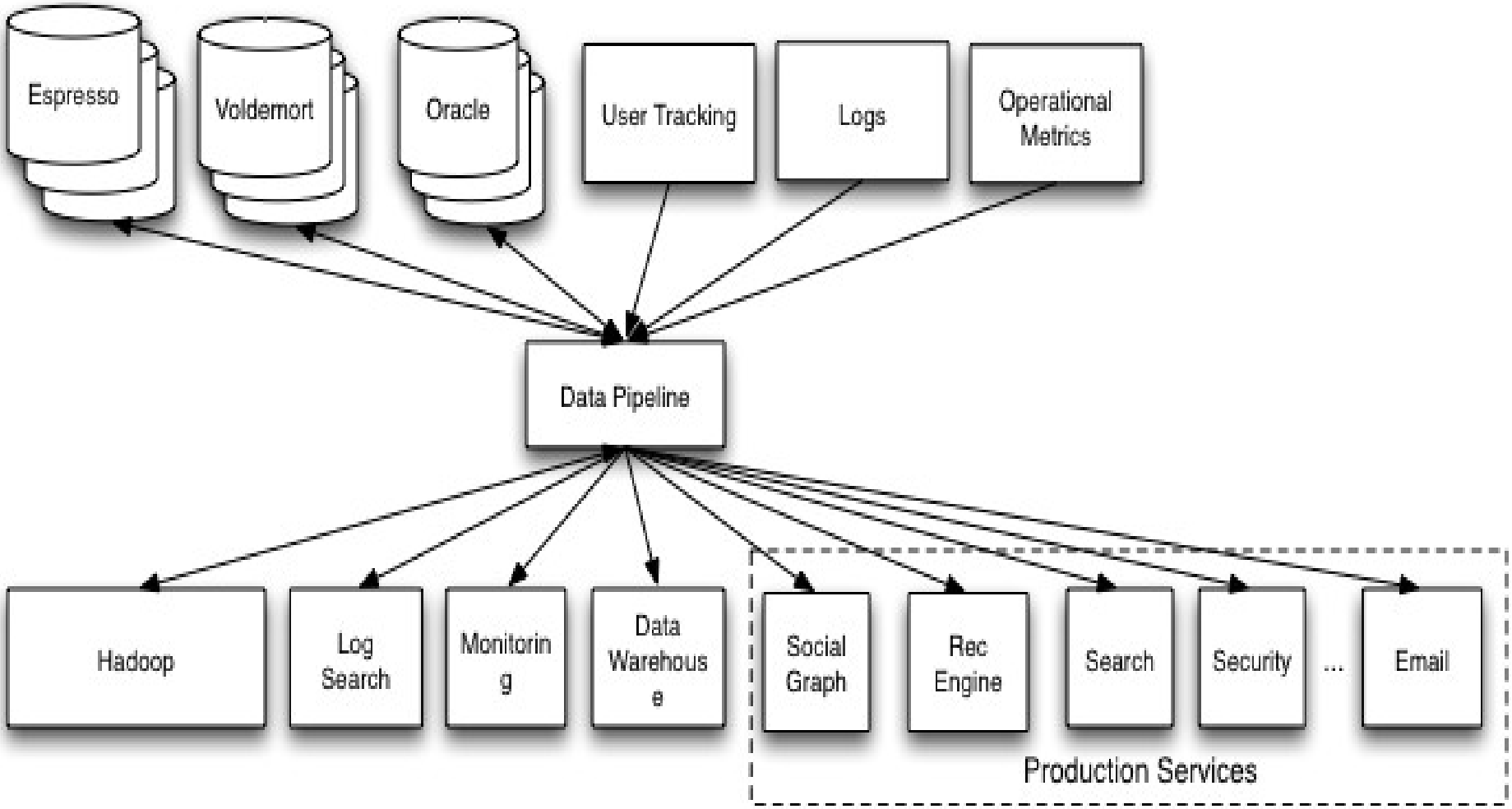
Adding Producers

- Define Topics and # of partitions via Kafka tools
- (possibly tell Kafka to balance leaders across machines)
- Start producing

Adding Consumers

- Using Kafka adding consumers doesn’t impact producers
- Minor impact on Brokers (just keeping track of connections)

Finally Apache Kafka Works Everywhere and is best suited for PubSub Applications and Event Outsourcing



Micro Service Observability

22:12:43

Service Observability

- Fault Tolerance
- Health check
- Log aggregation
- Application metrics
- Audit logging
- Distributed tracing
- Log deployments and changes

Service Observability – Fault Tolerance

Annotations for Fault Tolerance

RETRY

@Retry // Retry indicates that this should trigger retry the method call several times in case the remote server call results in an exception

//@Retry(maxDuration = 5000, maxRetries = 3, delay = 500, jitter = 200)

@Fallback(fallbackMethod = "getCachedAuthor") // Fallback indicates that we should fall back to the local cache if the method fails even after several retries the circuit is open

@Timeout(value = 4, unit = ChronoUnit.SECONDS)

Service Observability – Fault Tolerance

Add a Circuit Breaker around a method invocation to fail fast

@CircuitBreaker // CircuiBreaker wraps the call in a circuit breaker which opens after several failures and closes again after some time

Once an external system you call is down or returning 503 as it is currently unavailable to process further requests, you might not want to access it for a given timeframe again. This might help the other system to recover and your methods can fail fast as you already know the expected response from requests in the past. For this scenario, the Circuit Breaker pattern comes into place.

The **Circuit Breaker** offers a way to fail fast by directly failing the method execution to prevent further overloading of the target system and indefinite wait or timeouts. With MicroProfile Fault Tolerance we have an annotation to achieve this with ease:

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Service Observability – Fault Tolerance

States of circuit breaker

There are three different states a Circuit Breaker can have:

- closed,
- Opened,
- half-open.

In the closed state, the operation is executed as expected. If a failure occurs while e.g. calling an external service, the Circuit Breaker records such an event. If a particular threshold of failures is met, it will switch to the open state.

Once the Circuit Breaker enters the open state, further calls will fail immediately. After a given delay the circuit enters the half-open state.

Within the **half-open** state, trial executions will happen. Once such a trial execution fails, the circuit transitions to the open state again. When a predefined number of these trial executions succeed, the circuit enters the original closed state.

Service Observability – Fault Tolerance

This annotation also allows defining the exception types to skip and to fail on:

```
@CircuitBreaker(successThreshold = 10, requestVolumeThreshold =
5, delay = 500,
    skipOn = {NumberFormatException.class},
    failOn = {RuntimeException.class})

@CircuitBreaker(successThreshold = 10, requestVolumeThreshold =
5, delay = 500,
    skipOn = {NumberFormatException.class},
    failOn = {RuntimeException.class})
```

Service Observability – Fault Tolerance

Let’s have a look at the following example:

```
@CircuitBreaker(successThreshold = 10, requestVolumeThreshold =
5, failureRatio = 0.5, delay = 500)
@Fallback(fallbackMethod = "getFallbackData")
public String getRandomData() {
    if (ThreadLocalRandom.current().nextLong(1000) < 300) {
        return "random duke";
    } else {
        throw new RuntimeException("Random data not available");
    }
}
```

In the example above I define a Circuit Breaker which enters the open state once 50% (failureRatio=0.5) of five consecutive executions (requestVolumeThreshold=5) fail. After a delay of 500 milliseconds in the open state, the circuit transitions to half-open. Once ten trial executions (successThreshold=10) in the half-open state succeed, the circuit will be back in the closed state.

Service Observability – Asynchronous Execution

Execute a method asynchronously with MicroProfile Fault Tolerance

Some use cases of your system might not require synchronous and in-order execution of different tasks. For instance, you can fetch data for a customer (purchased orders, contact information, invoices) from different services in parallel. The MicroProfile Fault Tolerance specification offers a convenient way for achieving such asynchronous method executions: @Asynchronous:

```
@Asynchronous
public Future<String> getConcurrentServiceData(String name) {
    System.out.println(name + " is accessing the concurrent service");
    return CompletableFuture.completedFuture("concurrent duke");
}
```

Service Observability – Bulk Heads

Apply Bulkheads to limit the number of concurrent calls

The Bulkhead pattern is a way of isolating failures in your system while the rest can still function. It’s named after the sectioned parts (bulkheads) of a ship. If one bulkhead of a ship is damaged and filled with water, the other bulkheads aren’t affected, which prevents the ship from sinking.

Imagine a scenario where all your threads are occupied for a request to a (slow-responding) external system and your application can’t process other tasks. To prevent such a scenario, we can apply the @Bulkhead annotation and limit concurrent calls:

Service Observability – Bulk Heads

```
@Bulkhead(5)
@Asynchronous
public Future<String> getConcurrentServiceData(String name)
throws InterruptedException {
    Thread.sleep(1000);
    System.out.println(name + " is accessing the concurrent service");
    return CompletableFuture.completedFuture("concurrent duke");
}
```

In this example, only five concurrent calls can enter this method and further have to wait. If this annotation is used together with @Asynchronous, as in the example above, it means thread isolation. In addition and only for asynchronous methods we can specify the length of the waiting queue with the attribute waitingTaksQueue. For non-async methods, the specification defines to utilize semaphores for isolation.

Service Observability – Bulk Heads

Confiurability of fault Tolerance – write in config file

The pattern for external configuration is the following:
<classname>/<methodname>/<annotation>/<parameter>:

de.rieckpil.blog.RandomDataProvider/accessFlakyService/Retry/
maxRetries=10
de.rieckpil.blog.RandomDataProvider/accessFlakyService/Retry/
delay=300

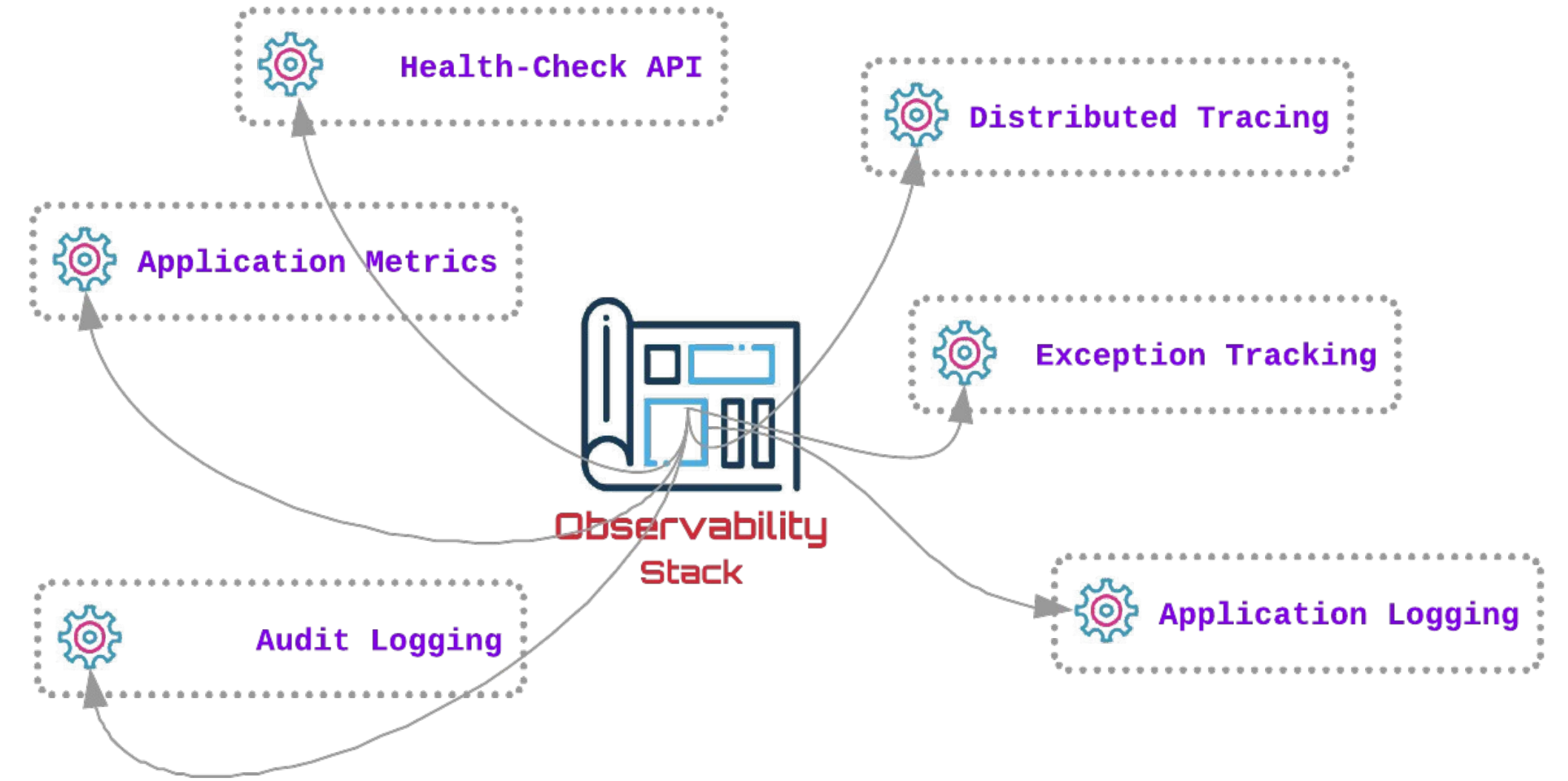
Service Observability – Health Check

Health Check

```
// You need to write this class every project
@Health
@ApplicationScoped
public class HealthCheckService implements HealthCheck {
    @Override
    public HealthCheckResponse call() {
        return HealthCheckResponse.named("health")
                                .up()
                                .withData("Author", "Kamlendu Pandey")
                                .withData("Website", "https://localhost")
                                .build();
    }
}
```

http://localhost:8080/health will give you the status of deployed services on payara

Service Observability – Observability Stack



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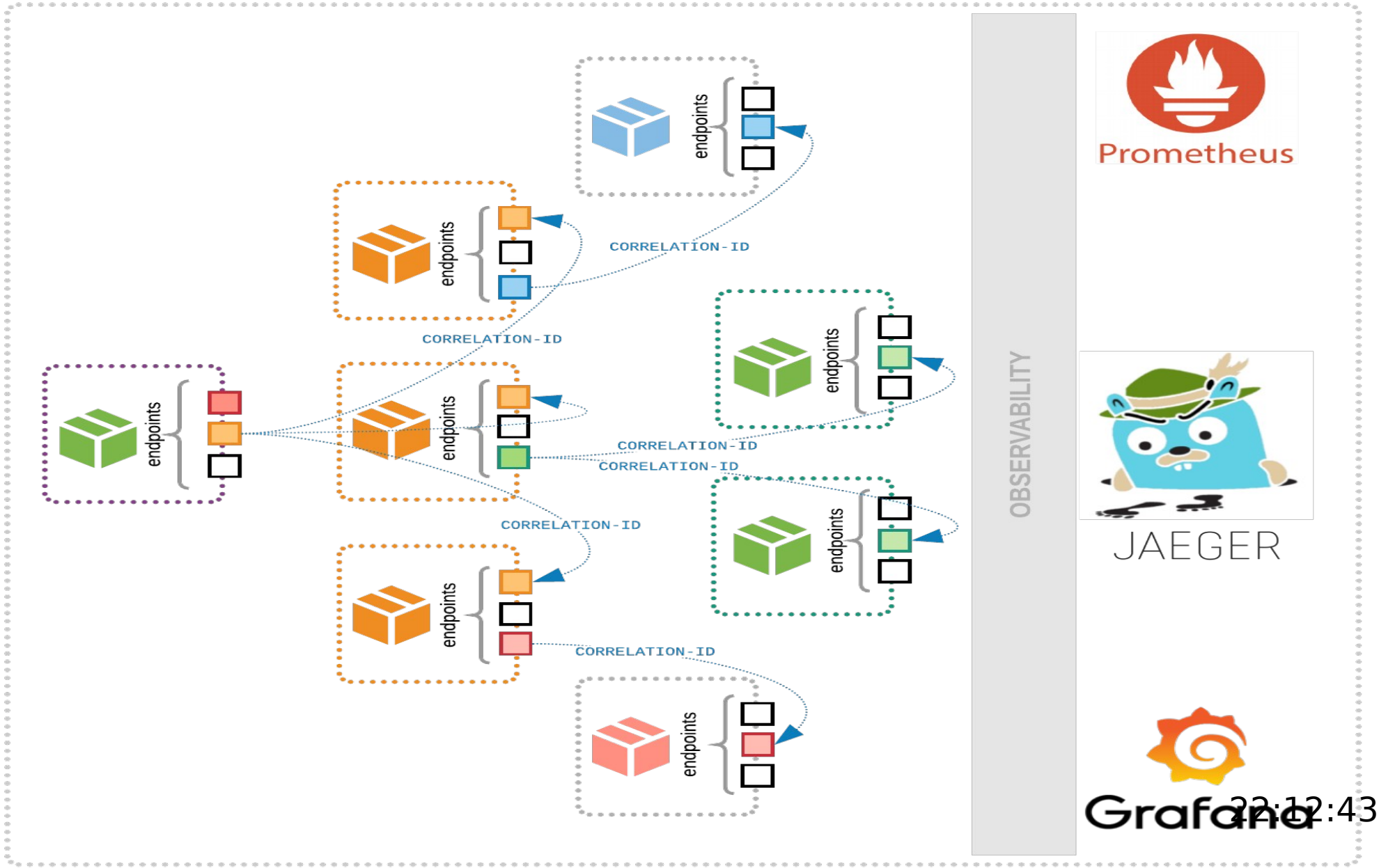
Service Observability – Observability Tools



Service Observability – Tool Chain Prometheus

OBSERVABILITY

JAEGER

Prometheus is an open-source tool for instrumenting and monitoring metrics. It works in a pull-based manner, makes HTTP requests to your metric endpoint with the pre-determined time intervals(default 10seconds), and store these metrics in its own time-series database. Prometheus also provides a GUI to make queries over these metrics with its own query language PromQL. It provides basic graphics to visualize metrics. Prometheus also has an alert plugin to produce alerts according to metrics values.

Service Observability – Tool Chain - Jagger

OBSERVABILITY

High Scalability – Jaeger backend is designed to have no single points of failure and to scale with the business needs.

Native support for OpenTracing – Jaeger backend, Web UI, and instrumentation libraries have been designed from the ground up to support the OpenTracing standard.

Storage Backend – Jaeger supports two popular open-source NoSQL databases as trace storage backends: Cassandra 3.4+ and Elasticsearch 5.x/6.x.

Modern UI – Jaeger Web UI is implemented in Javascript using popular open-source frameworks like React.

Cloud-Native Deployment – Jaeger backend is distributed as a collection of Docker images. Deployment to Kubernetes clusters is assisted by

Service Observability – Tool Chain - Grafana

OBSERVABILITY

JAEGER

Grafana Grafana is an open-source metric analytics and visualization suite. It is most commonly used for visualizing time series data for infrastructure and application analytics but many use it in other domains including industrial sensors, home automation, weather, and process control.

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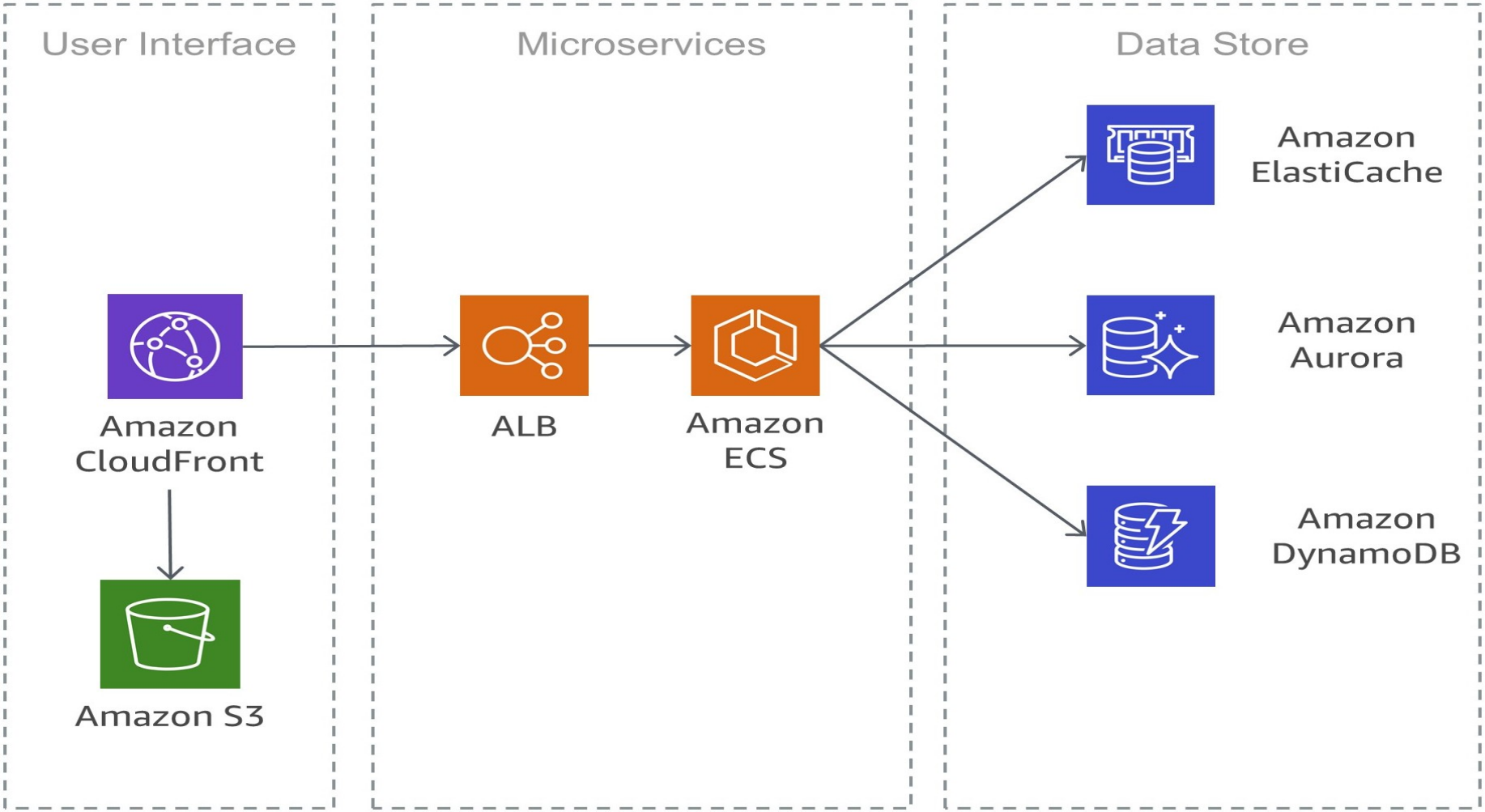
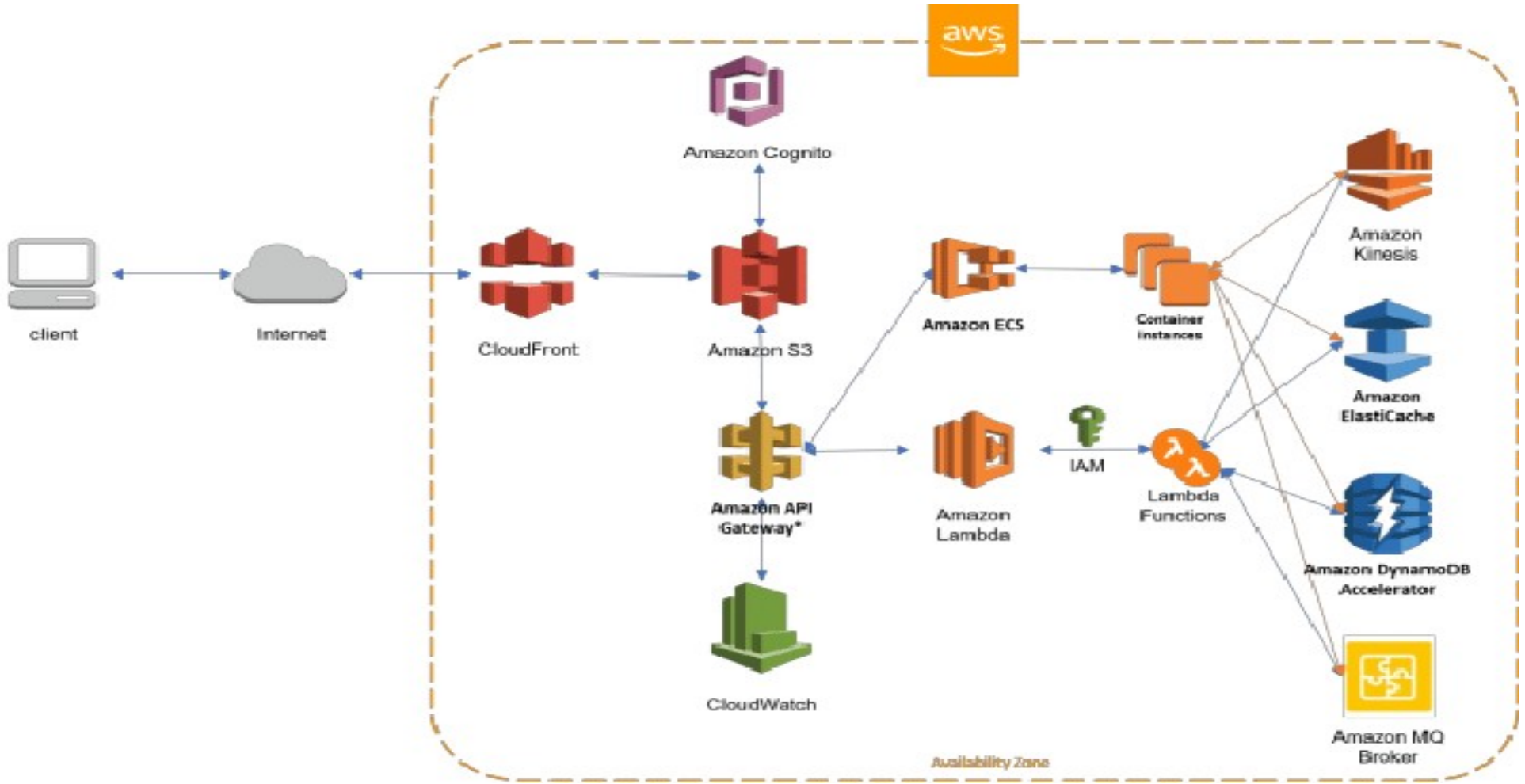
Amazon Cloud and Micro Services



Amazon Cloud and Micro Services (More Specefic)



Cloud Front : Cloud Access ,
Amazon ECS : containers
Amazon EKS : Managed Kubernetes

Amazon S3 : Data Storage
IAM : Authentication/Authorization
ALB : Load Balancer


code
plan
build
Dev
release
Ops
deploy
operate
test
monitor

THANKS !