

# Microservices Architecture "The new normal"

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November 29, 2022

# Objectives

- ① Provide good Arabic content for the topic

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- ② Overview of Microservices
- ③ Move step forwards towards recent cloud tools
- ④ Leave your fear, and let's do it

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- Circuit Breaker Pattern
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- Monitoring

## 3 Microservices in Actions

- Project Structure
- Framework and Tools

# Definition

## Monolithic

A monolithic application is self-contained, and independent from other computing applications. The design philosophy is that the application is responsible not just for a particular task, but can perform every step needed to complete a particular function.

## Microservices

Microservices is a software development technique that arranges an application as a collection of loosely coupled services.

[https://en.wikipedia.org/wiki/Monolithic\\_application](https://en.wikipedia.org/wiki/Monolithic_application)

<https://en.wikipedia.org/wiki/Microservices>

# Why Microservices?

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# Microservices vs Monolithic

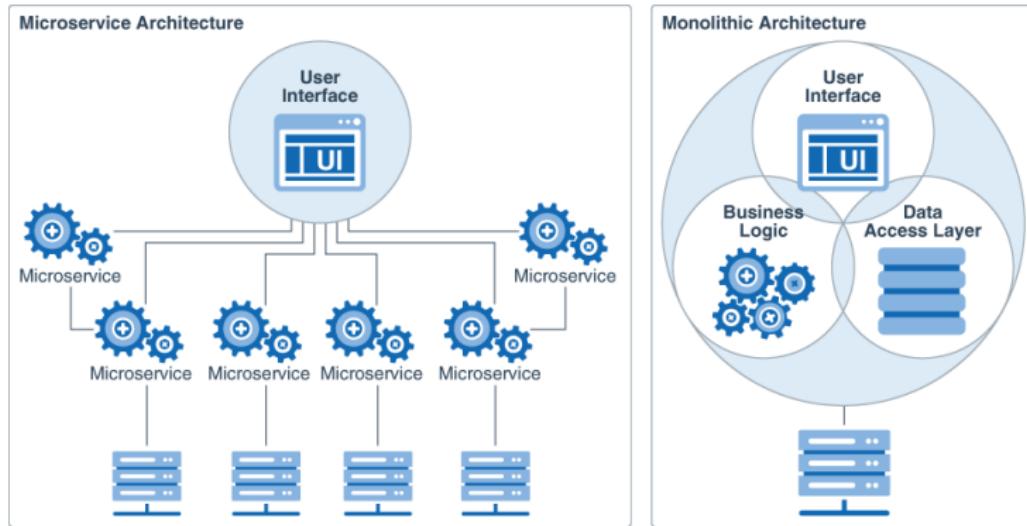


Figure: mivroservices vs monolithic

<https://docs.oracle.com/en/solutions/learn-architect-microservice/index.html>

# Closer Look

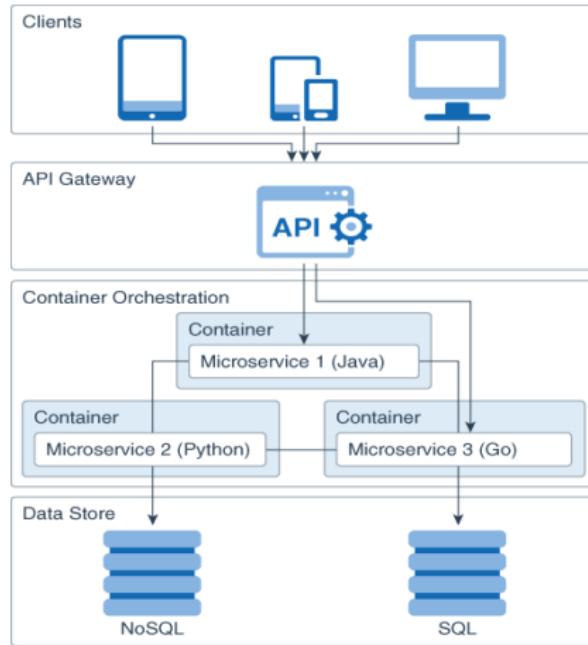


Figure: Microservices In Depth

# Microservices Architecture

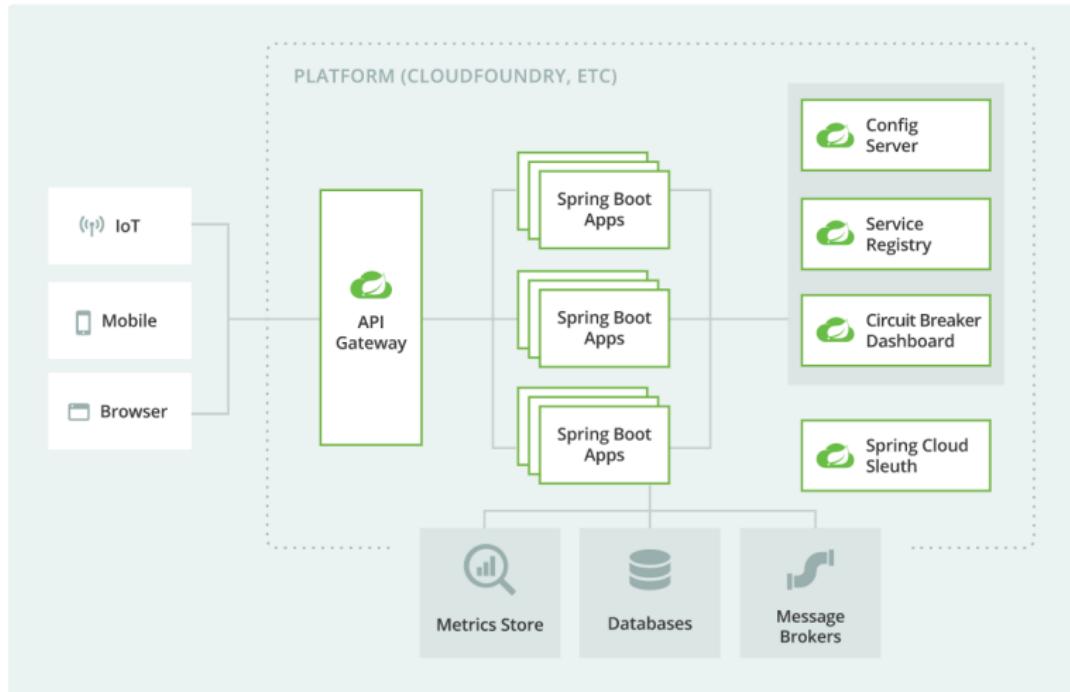


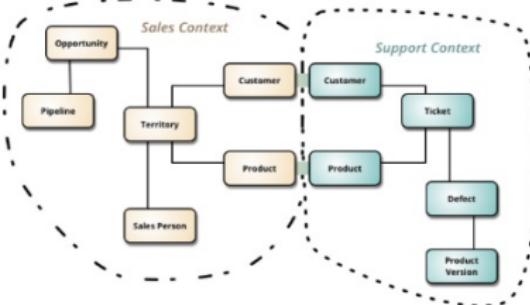
Figure: Microservices with Spring Cloud

# Microservice characteristics

## Single Responsibility

- Business Boundary
- Function Boundary

## Domain Driven Design (DDD)



<https://martinfowler.com/bliki/BoundedContext.html>

# Communication Design

## HTTP communication

Also known as **Synchronous communication**, the calls between services is a viable option for **service-to-service** via REST API.

## Message communication

Also known as **Asynchronous communication**, the services push messages to a message broker that other services subscribe to.

## Event-driven communication

Another type of **Asynchronous communication**, the services does not need to know the common message structure. Communication between services takes place via events that individual services produce.

# HTTP communication

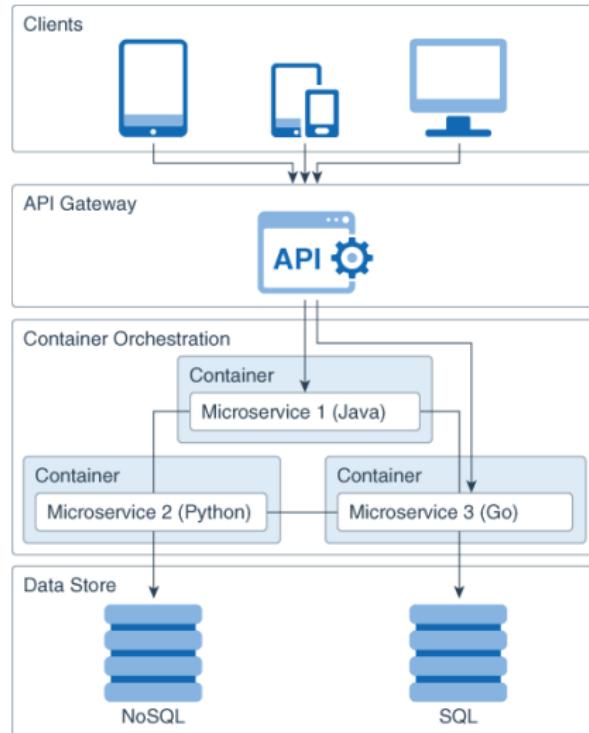


Figure: Synchronous calls

# Event-driven communication

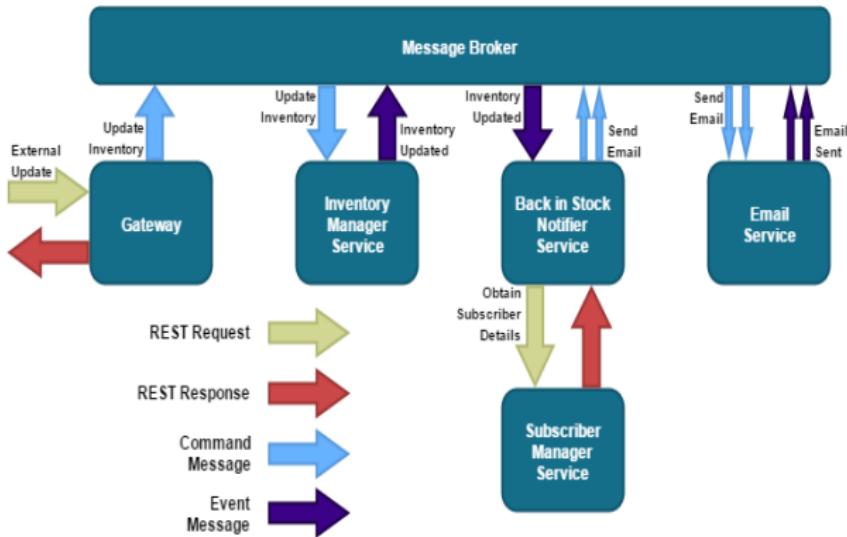


Figure: Asynchronous calls

<https://capgemini.github.io/architecture/is-rest-best-microservices>

# Why not SOAP?

It is possible to build a microservices-based architecture using SOAP which uses HTTP. But:

- it only uses POST messages to transfer data to a server.
- SOAP lacks concepts such as HATEOAS that enable relationships between microservices to be handled flexibly.
- The interfaces have to be completely defined by the server and known on the client.

Microservices; Flexible Software Architecture. "Eberhard Wolff"

# API Gateway

## API Gateway

API Gateway is a tool that makes it easy for developers to create(1), publish(2), maintain(3), monitor(4), and secure(5) APIs at any scale. APIs act as the "front door" for applications to access data, business logic, or functionality from your backend services.

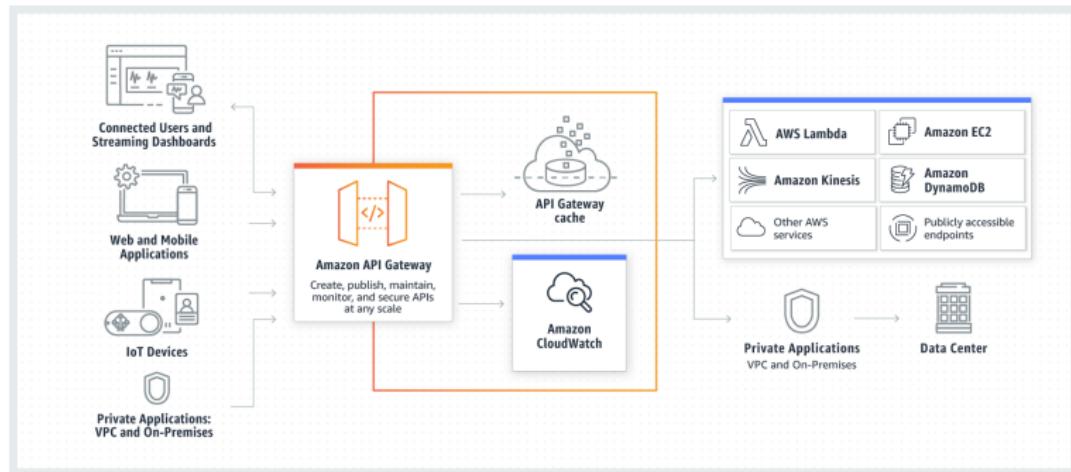


Figure: Amazon Gateway

# Orchestration and API Gateway cont...

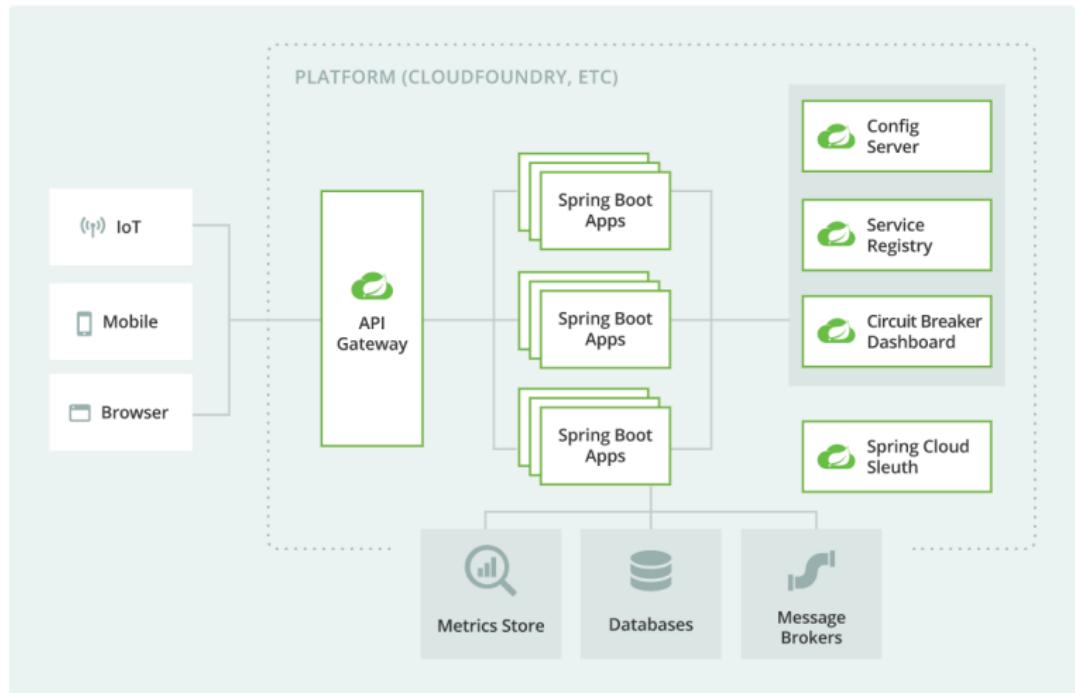


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# Available Market Options

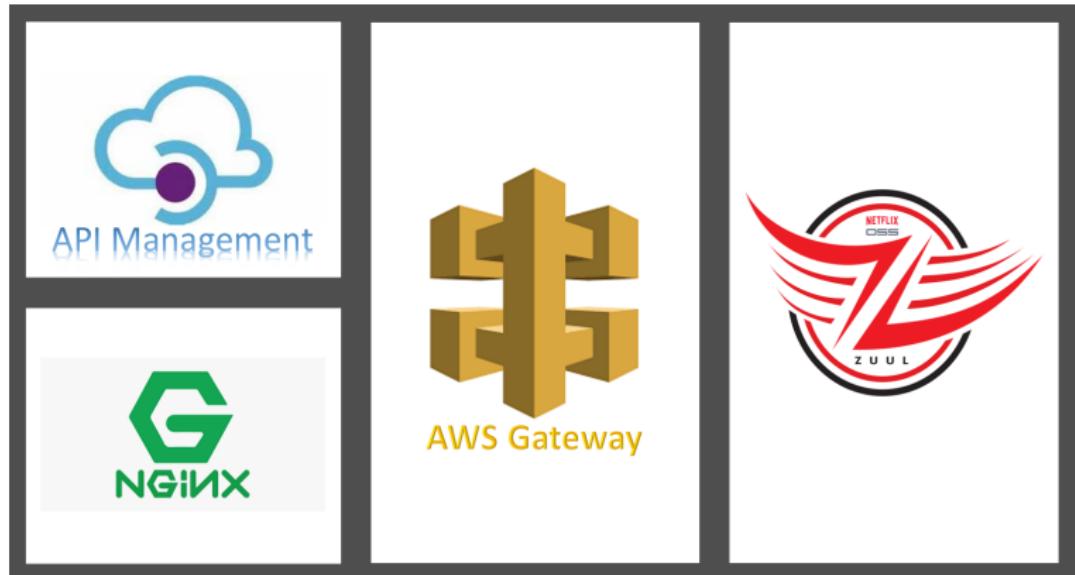


Figure: API Gateway Products

# Service Discovery

## Problem

In any distributed architecture, we need to find the physical address of where a machine is located.

## Solution

Using service discovery, a service can register itself when it is up and healthy. By using such technology you can achieve:

### ① Load balanced

- dynamically load balance requests across all service instances to ensure that the service invocations are spread across all the service instances managed by it.

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### ③ Fault-tolerant

- detect when a service instance isn't healthy and remove the instance from the list of available services.

# Service Discovery with Gateway

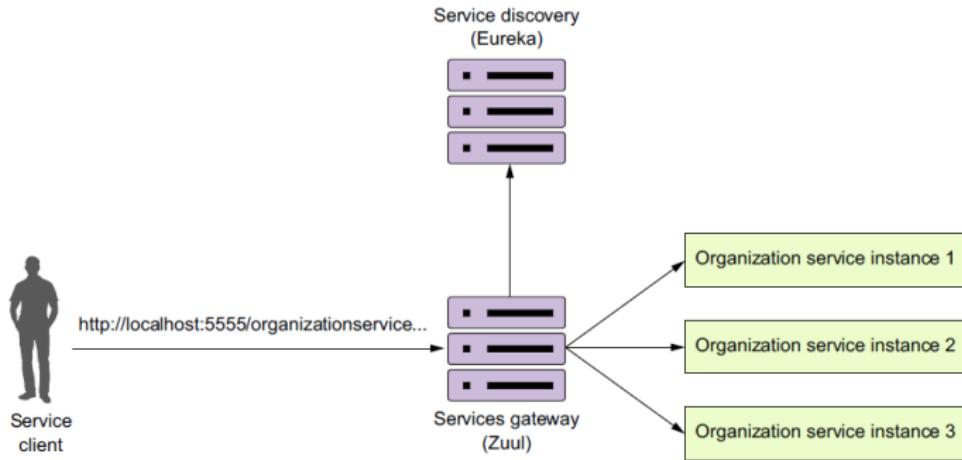


Figure: Service Registry and Gateway

# Available Market Options



SkyDNS

Figure: Service Registry Products

# The Twelve-Factor App

The Twelve-Factor App methodology is a methodology for building **software-as-a-service** applications

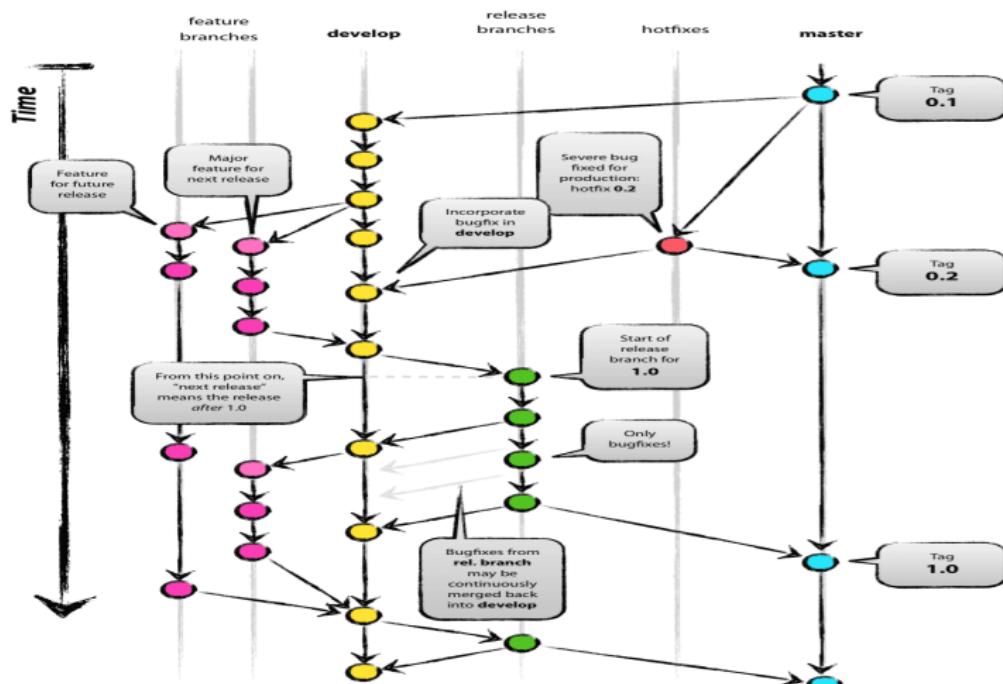
- ① Codebase
- ② Dependencies
- ③ Config
- ④ Backing services
- ⑤ Build, release, run
- ⑥ Processes
- ⑦ Port binding
- ⑧ Concurrency
- ⑨ Disposability
- ⑩ Dev/prod parity
- ⑪ Logs
- ⑫ Admin processes

<https://12factor.net>

# The Twelve-Factor App

## ① Codebase

- One codebase tracked in revision control, many deploys



# The Twelve-Factor App

## ② Dependencies

- Explicitly declare and isolate dependencies
- Consider the magic key **Portability**

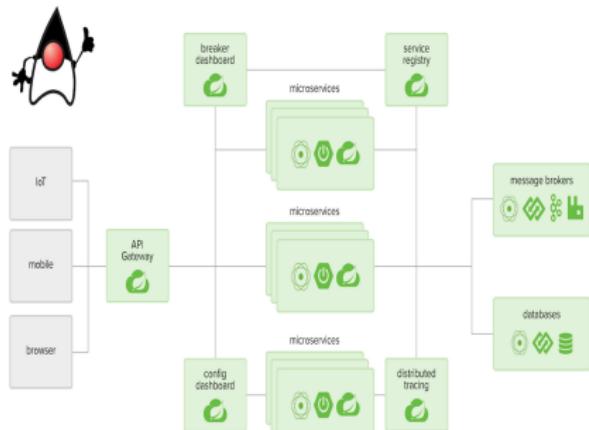


Diagram from <https://spring.io>

```
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-data-jpa</artifactId>
    </dependency>
    <dependency>
        <groupId>mysql</groupId>
        <artifactId>mysql-connector-java</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-tomcat</artifactId>
        <scope>compile</scope>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-actuator</artifactId>
        <version>2.3.0.RELEASE</version>
    </dependency>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-config</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-zipkin</artifactId>
    </dependency>
    <dependency>...
    </dependency>...
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```

*Never ever depend on operating system*

# The Twelve-Factor App

## ③ Configuration

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- 
- **Configuration in Legacy system is a challenge**
    - Unlike missing dependencies, System will not immediately crashed if configuration is missed
    - Give attention to URLs in legacy code

# Externalized and Dynamic Configurations

## Problem

Configurations will vary from environment to another, How to manage them?

## Solution

Centralize your configuration

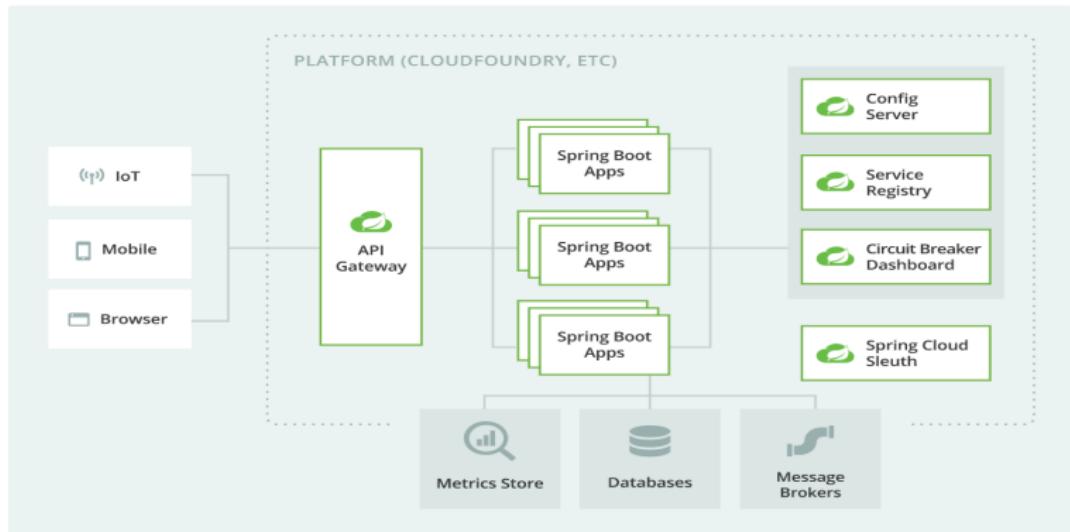


Figure: Microservices with Spring Cloud

# Available Market Options



Figure: Popular Config Stores

# Circuit Breaker Pattern

## Problem

- One of the big differences between in-memory calls and remote calls is that remote calls can fail, or hang without a response until some timeout limit is reached.

## Solution

### Fault Tolerance

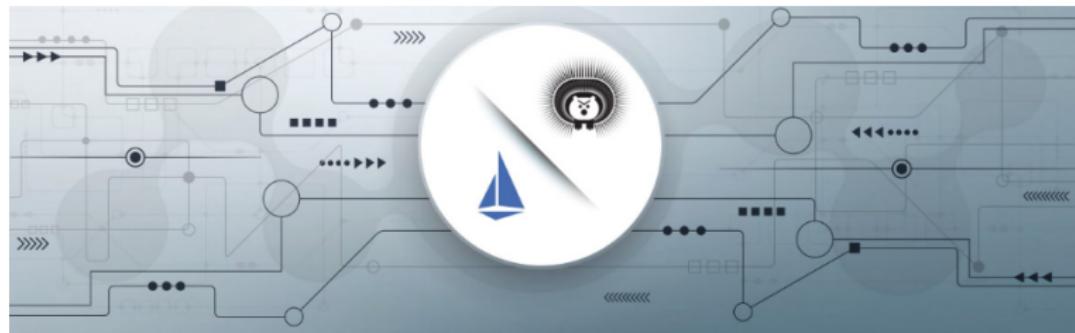


Figure: Circuit Breaker

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- One of the big differences between in-memory calls and remote calls is that remote calls can fail, or hang without a response until some timeout limit is reached.
- What's worse if you have many callers on a unresponsive supplier, then you can run out of critical resources leading to cascading failures across multiple systems.

## Solution

### Fault Tolerance

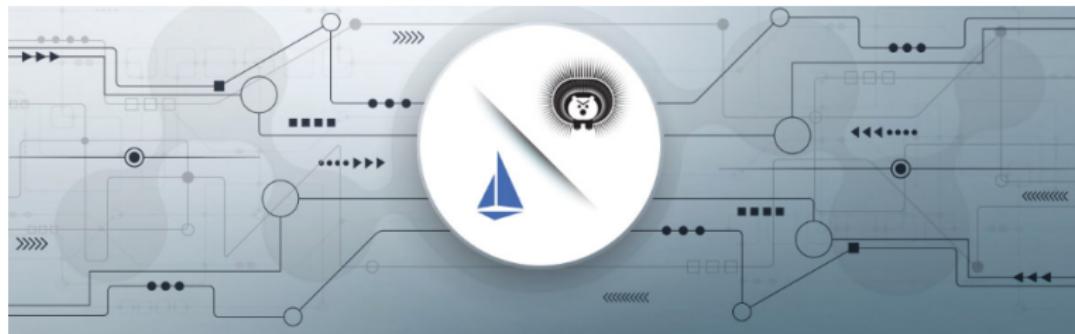


Figure: Circuit Breaker

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4     ...  
5 }  
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- This way you can switch between services smoothly on different environments via configurations provided by the environment.

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- ④ Feedback and Retrospective meetings after each sprint is very important

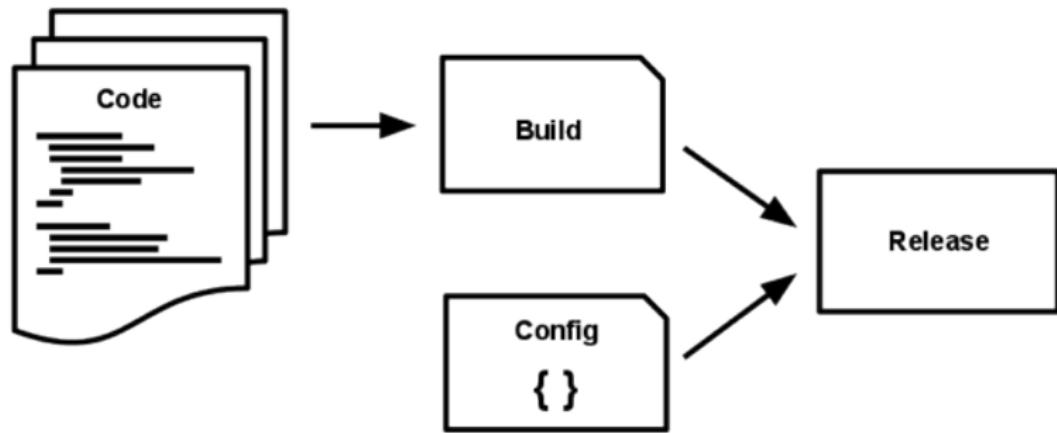


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## ⑤ Build, Release and Run (CI & CD)

Strictly separate build and run stages. In Microservices, this process is always related directly to development culture; How to be sure each time work will be delivered correctly?



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- **Don't Comment Out Failing Tests**
- **Don't push broken code.**

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### Continuous Integration Server

Automates the process of building, testing, reporting

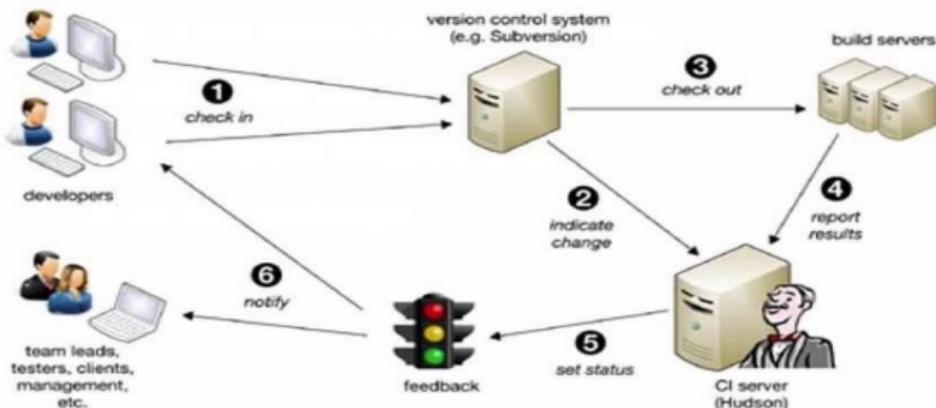


Image source: <http://www.methodsandtools.com/tools/tools.php?hudson>

Figure: CI Workflow

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- Using tagging, unique IDs and timestamp will be the only way to apply rollback if you want.

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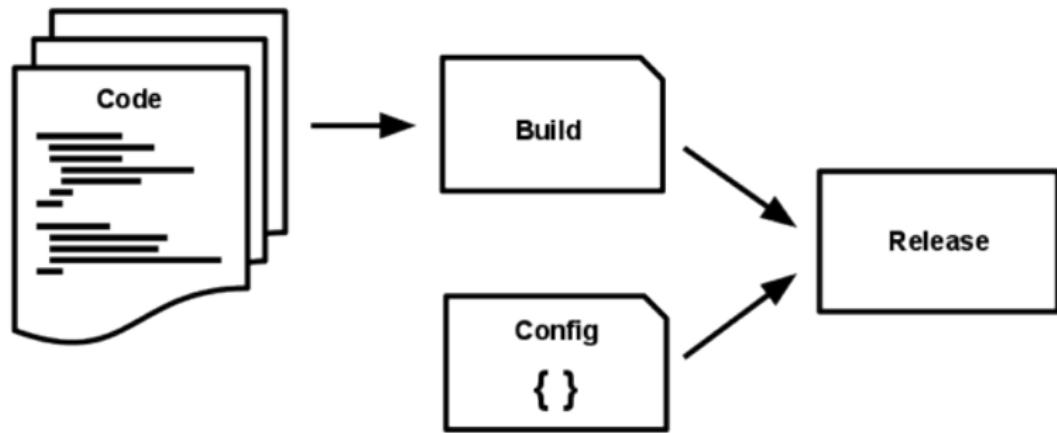
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- Builds are initiated by the app’s developers whenever new code is deployed. Runtime execution, by contrast, can happen automatically in cases such as a server reboot, or a crashed process being restarted by the process manager.
- the run stage should be kept to as few moving parts as possible, since problems that prevent an app from running can cause it to break in the middle of the night when no developers are on hand.

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Strictly separate build and run stages. In Microservices, this process is always related directly to development culture; How to be sure each time work will be delivered correctly?



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Execute the app as one or more **stateless** processes

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- For example, using filesystems and caching memory is a violation of twelve factor.
- Session state data is a good candidate for a datastore that offers time-expiration, such as Memcached or Redis.

# The Twelve-Factor App

## ⑥ Processes

Execute the app as one or more **stateless** processes

- Twelve-factor processes are stateless and share-nothing, and indeed Microservices are the same.
- Any data that needs to persist must be stored in a stateful backing service, typically a database.
- Asset packagers like *django-assetpackager* use the filesystem as a cache for compiled assets. This process of compiling should be done during the **build** stage.
- For example, using filesystems and caching memory is a violation of twelve factor.
- Session state data is a good candidate for a datastore that offers time-expiration, such as Memcached or Redis.
- It is important to know also that, Microservices must be totally stateless, and there is no way to keep state for backend services http requests.

# The Twelve-Factor App

## 7 Port Binding

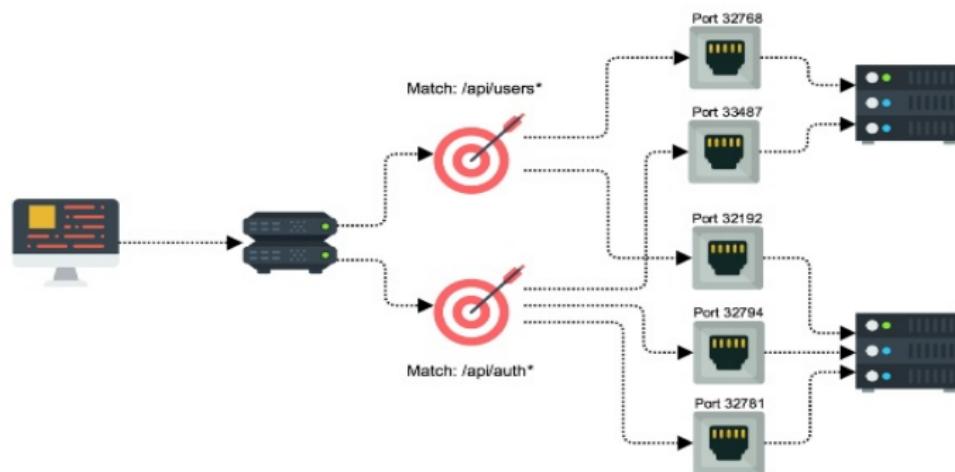
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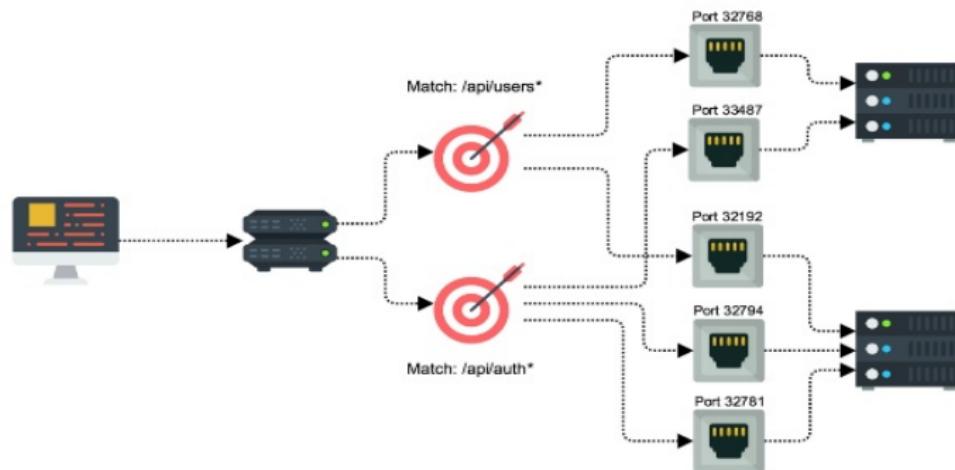


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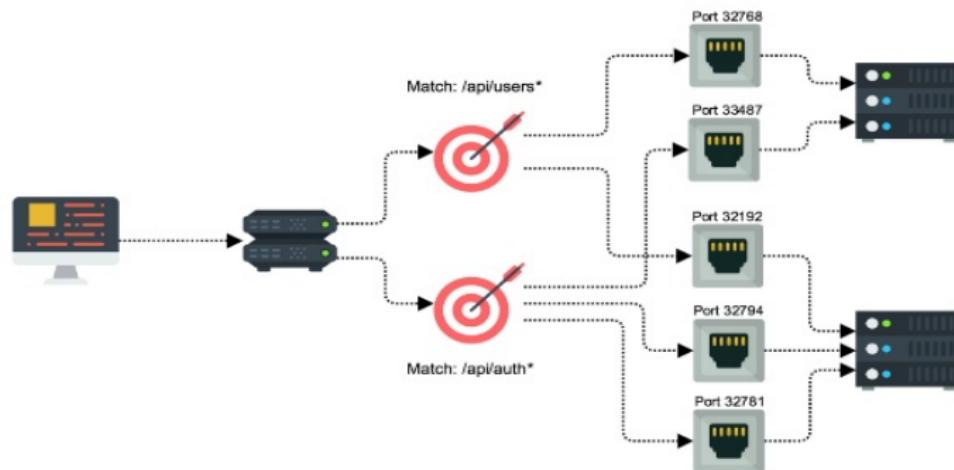


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- In a local development environment, you can visit a service URL like `http://localhost:5000/` to access the service exported by their app.
- In deployment, a routing layer handles routing requests from a public-facing hostname to the port-bound web processes.



# Data Sharing and Management

In old monolithic style, life was somewhat easy, but with microservices data management; you need to play harder.

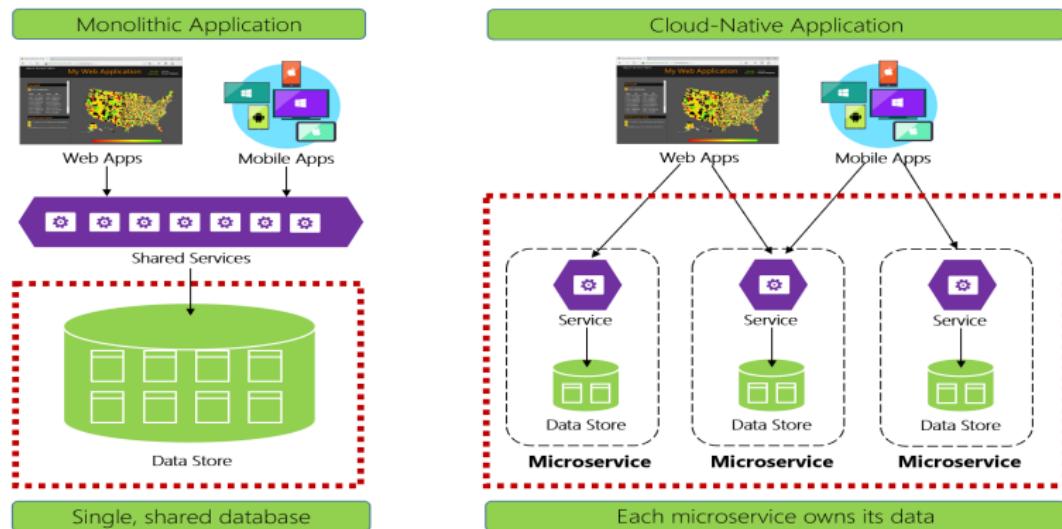


Figure: Distributed Data Architecture

# Data Sharing and Management

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A: It depends. However it is recommended to follow best practices.

The more simple and focused service you have, the easier management you get. A perfect way to do that, is applying DDD principles.

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While encapsulating data into separate microservices can increase agility, performance, and scalability, it also presents many challenges.

# Data Sharing and Management

## Cross-Service Queries

Usually you need to integrate to get\query data from other services

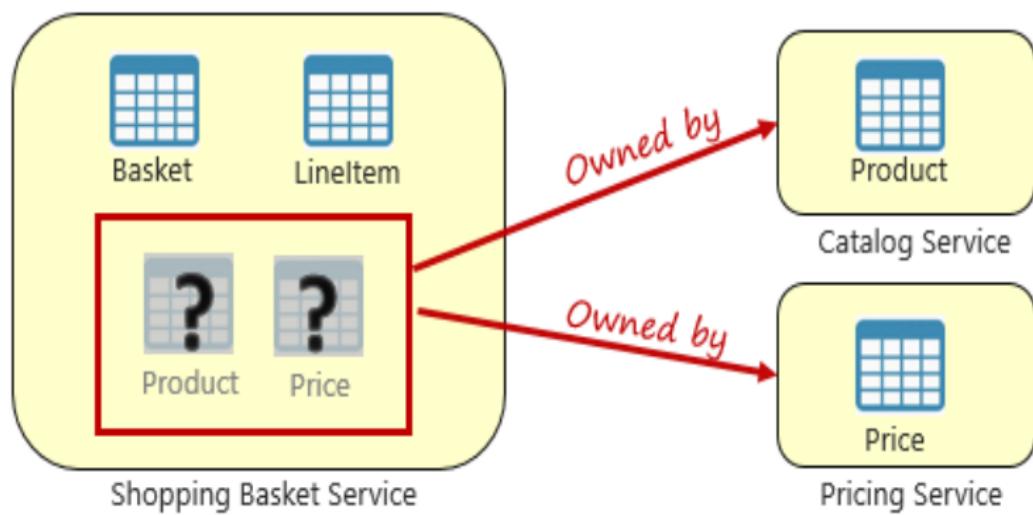


Figure: Querying across microservices

<https://docs.microsoft.com/en-us/dotnet/architecture/cloud-native/distributed-data>

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- If the data volume is huge, and is not changed quickly, good way to use is

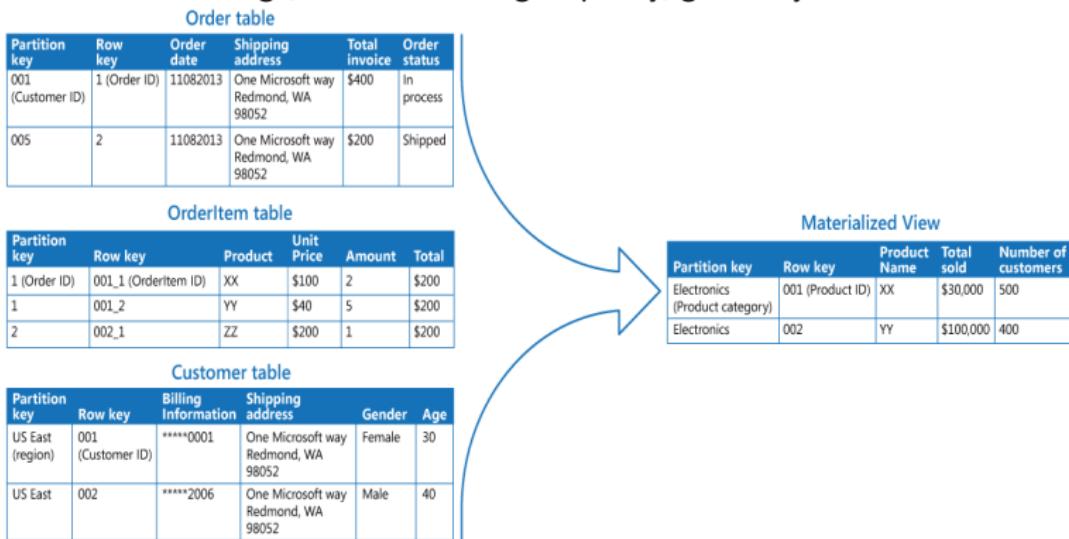


Figure: Materialized Views Pattern

# Data Sharing and Management

## Distributed Transactions

We move from a world of **immediate consistency** to that of **eventual consistency**. That is; in microservices. You can't depend on ACID transaction, but **BASE** which is acronym for **B**asic **A**vailability, **S**oft-state, and **E**ventual consistency

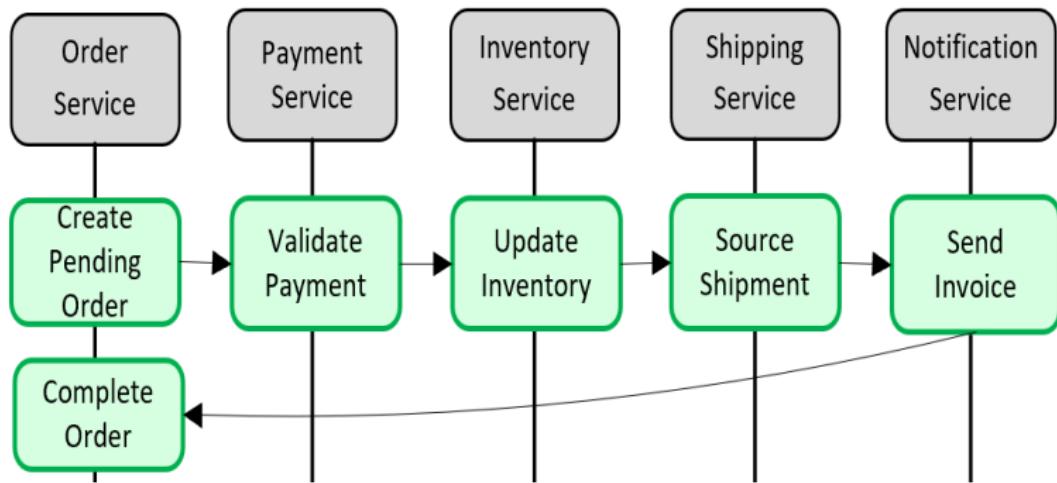


Figure: Transaction across microservices

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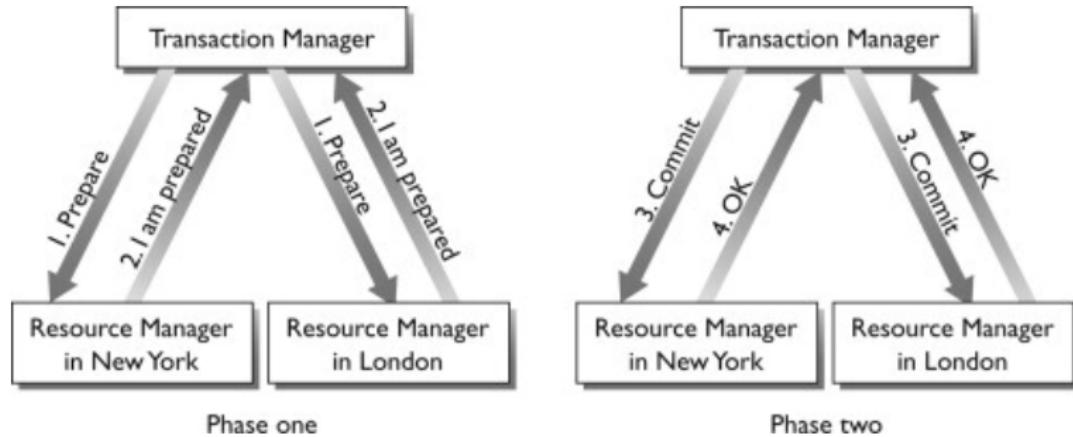


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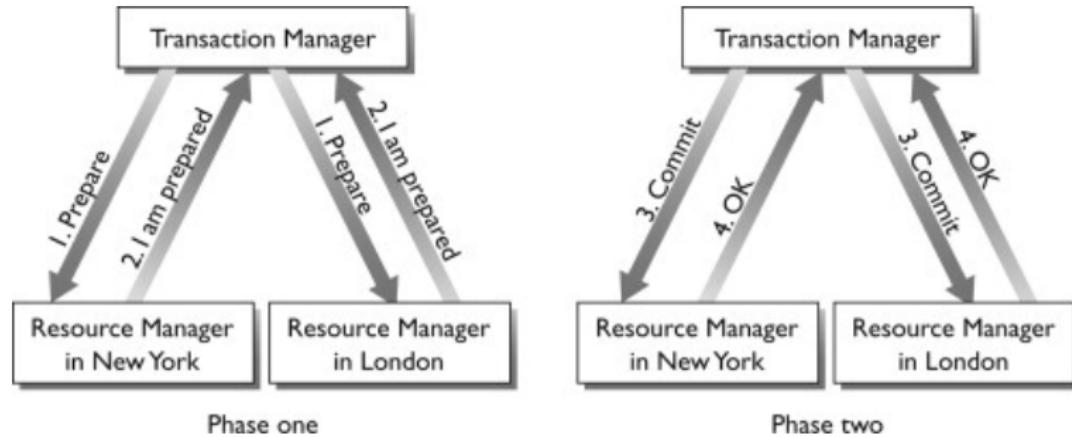


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- In real case, this is impractical, and will lead to locking and time consuming issue

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- The big father of this approach is **Saga pattern**

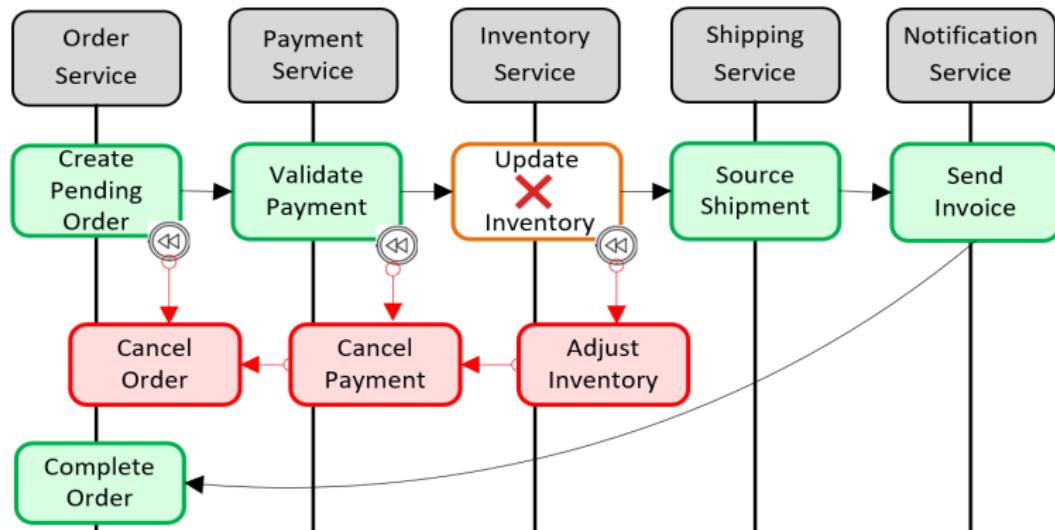


Figure: Rolling back a transaction

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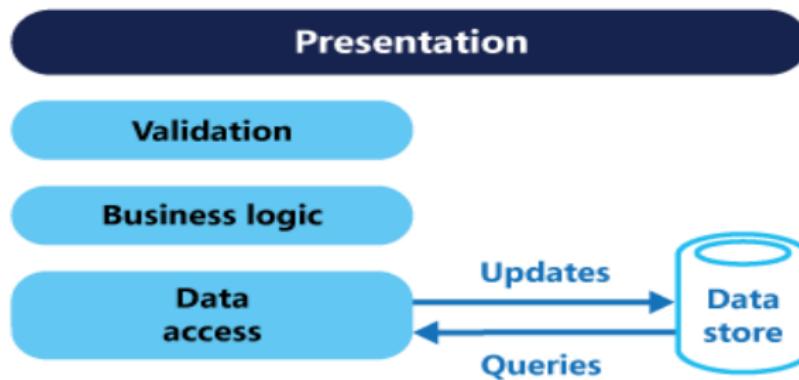


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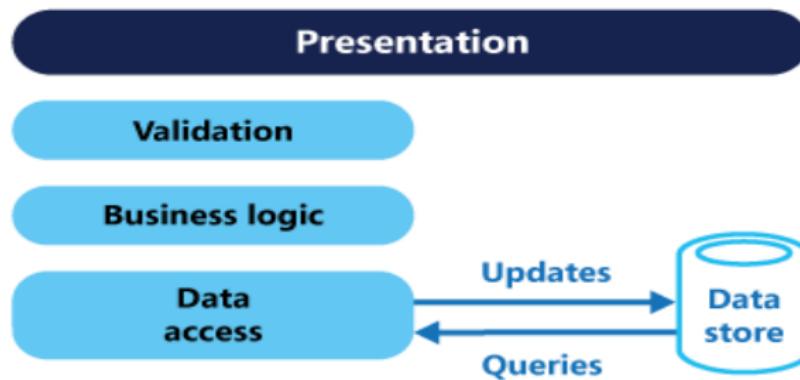


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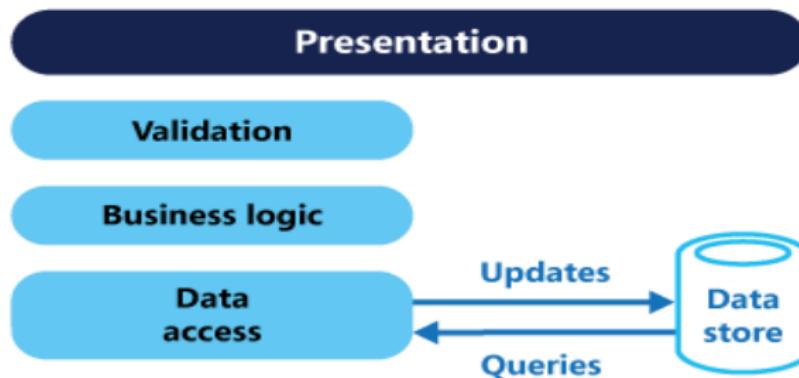


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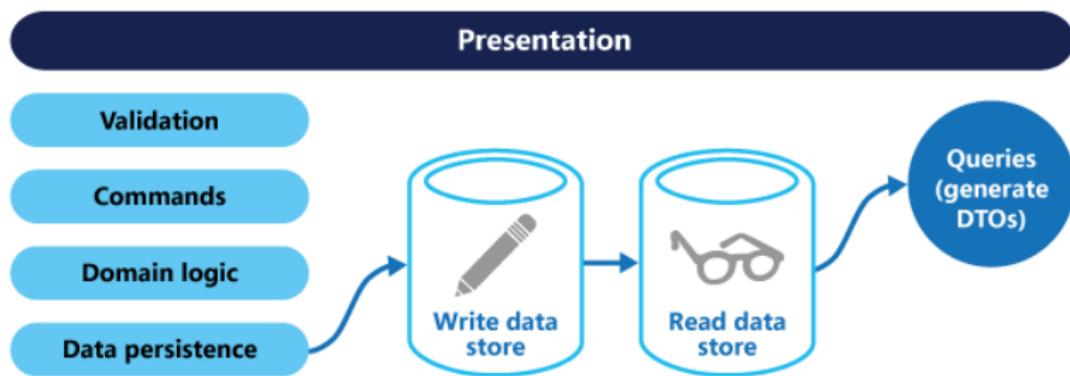


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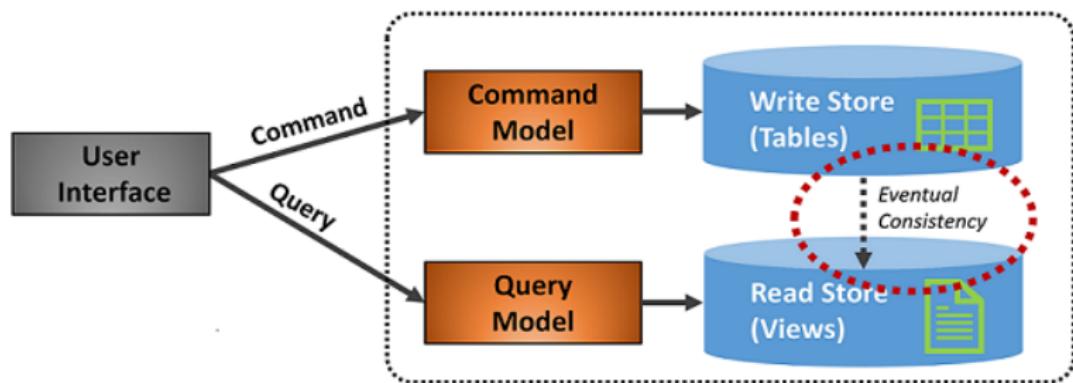


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- A good way to achieve this, is to use **Event Sourcing Pattern**

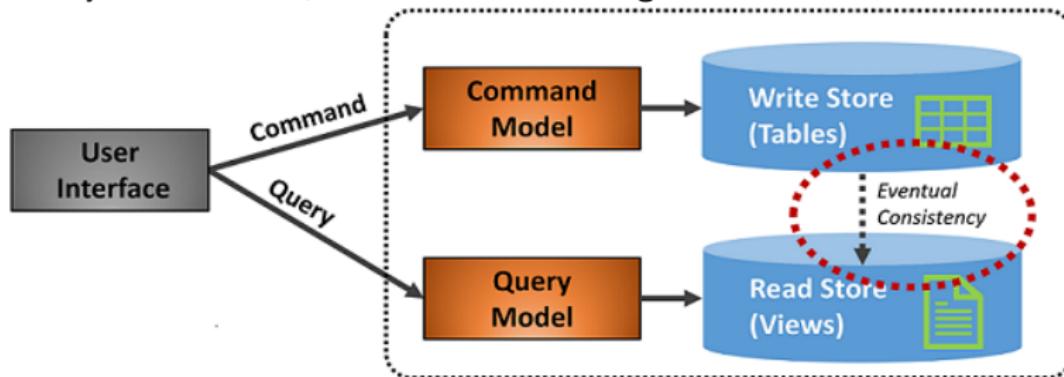


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- How did we get there? (*History is always matter*)
- An approach to handling operations on data that's driven by a sequence of events, each of which is recorded in an **append-only store**

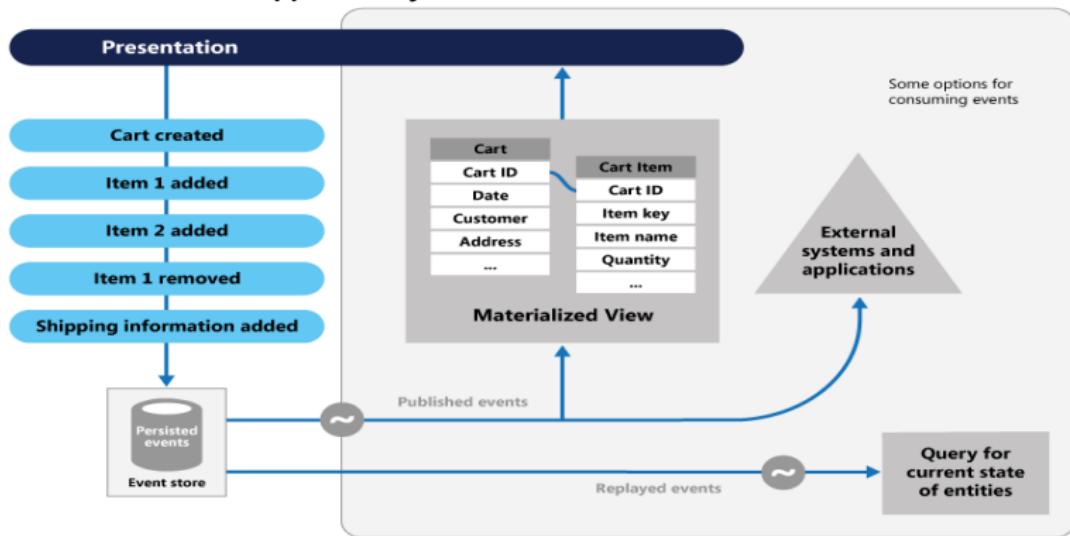


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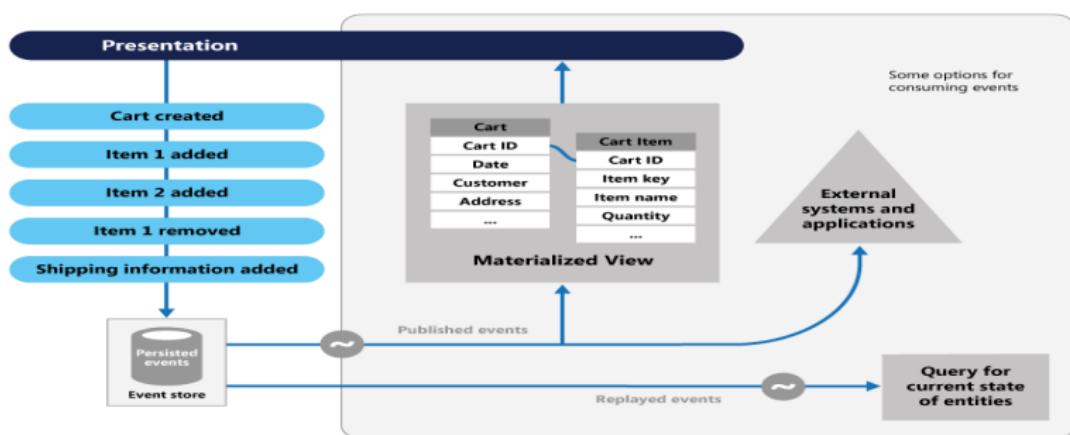


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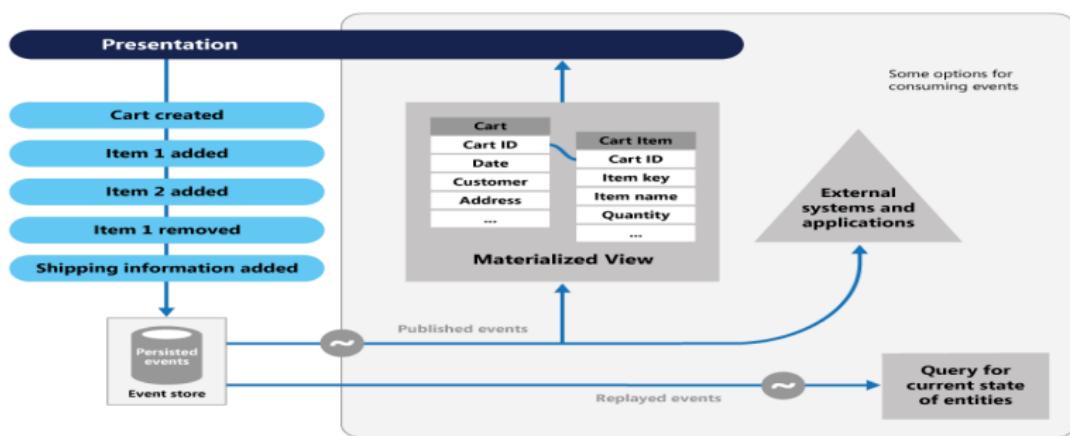


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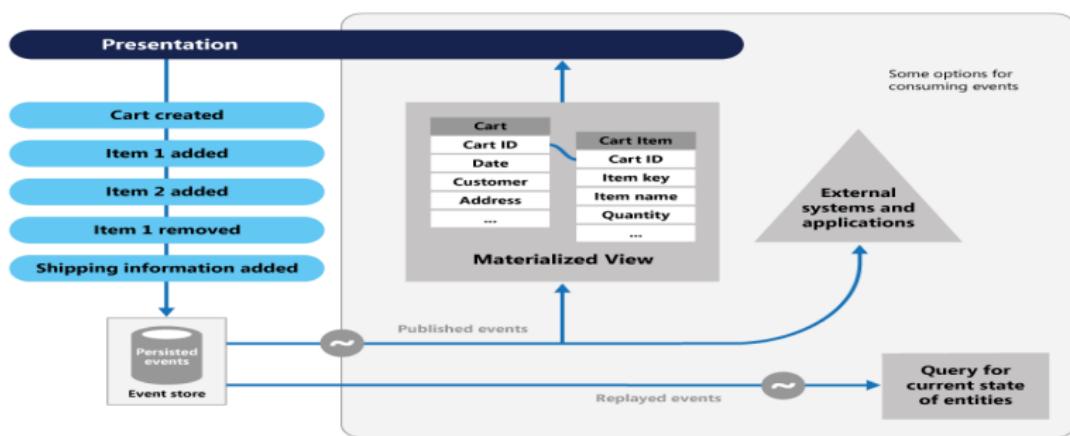


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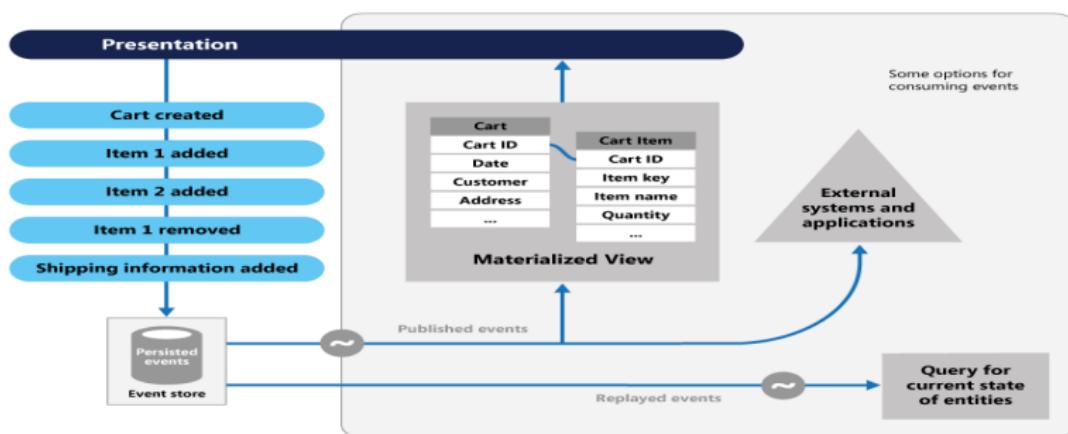


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- prevent concurrent updates from causing conflicts because it avoids the requirement to directly update objects in the data store

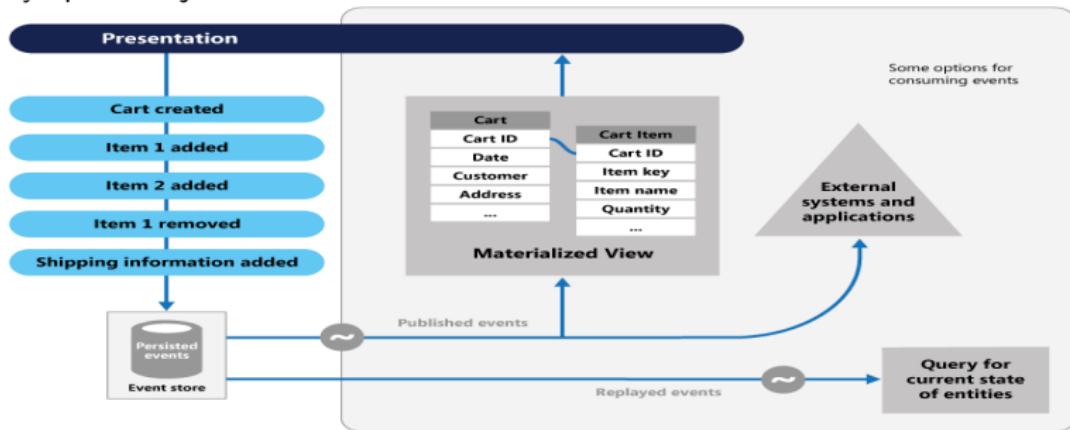


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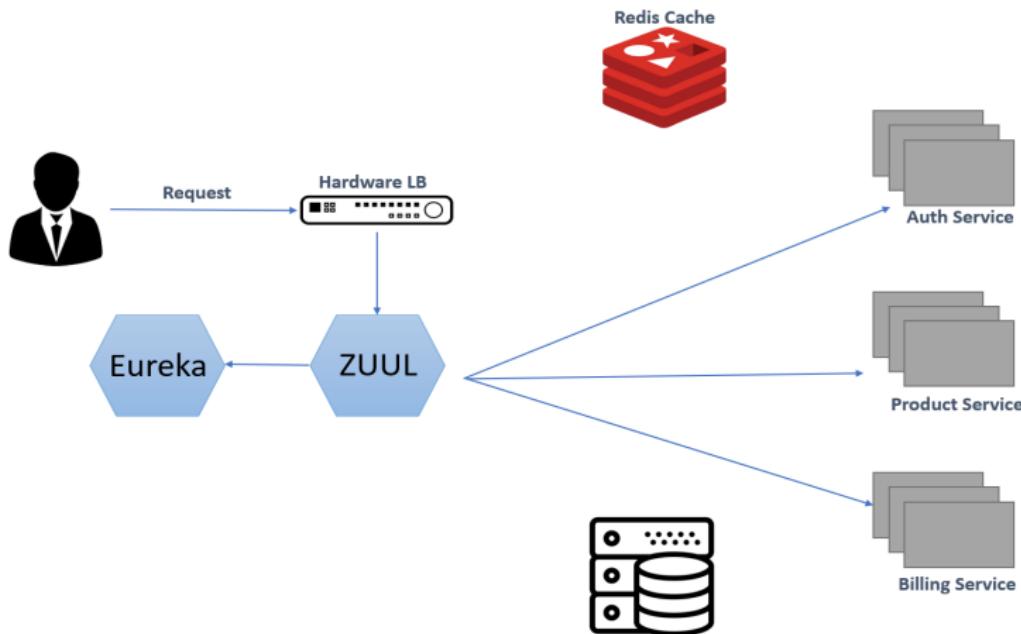


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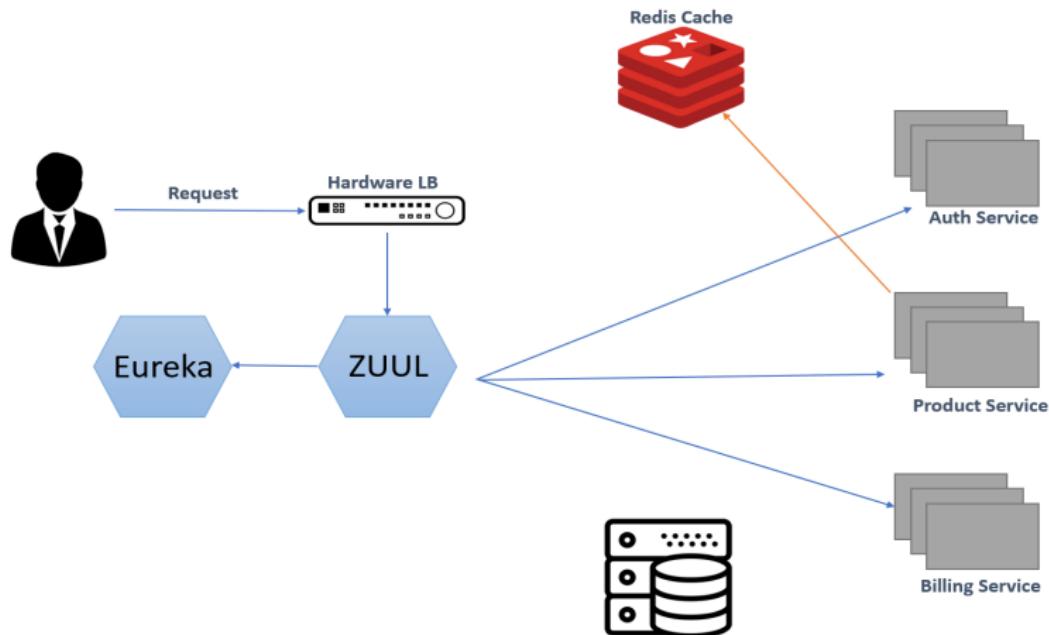


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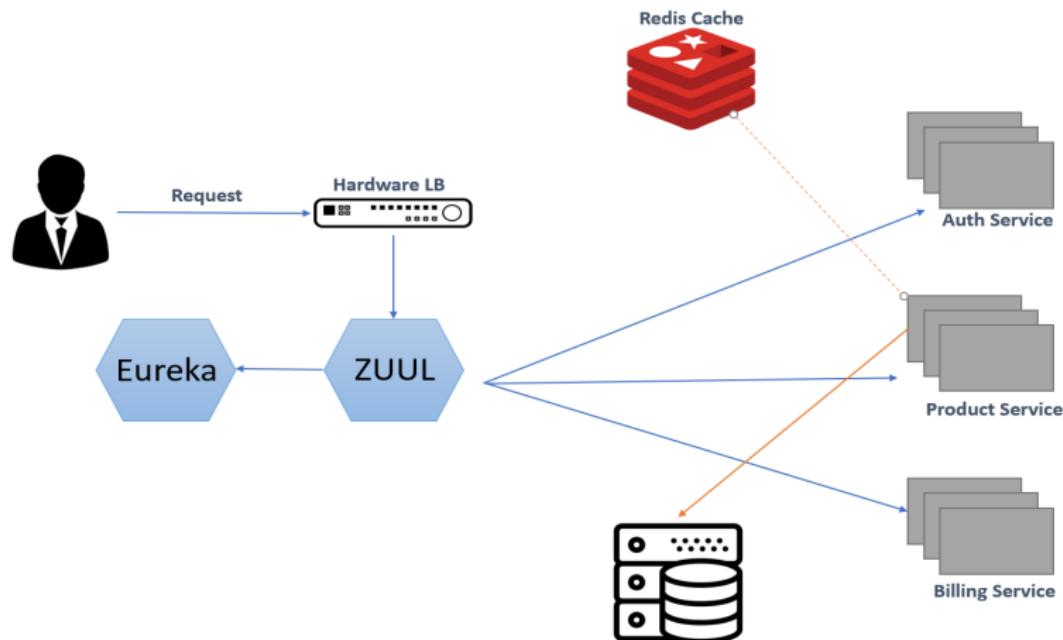


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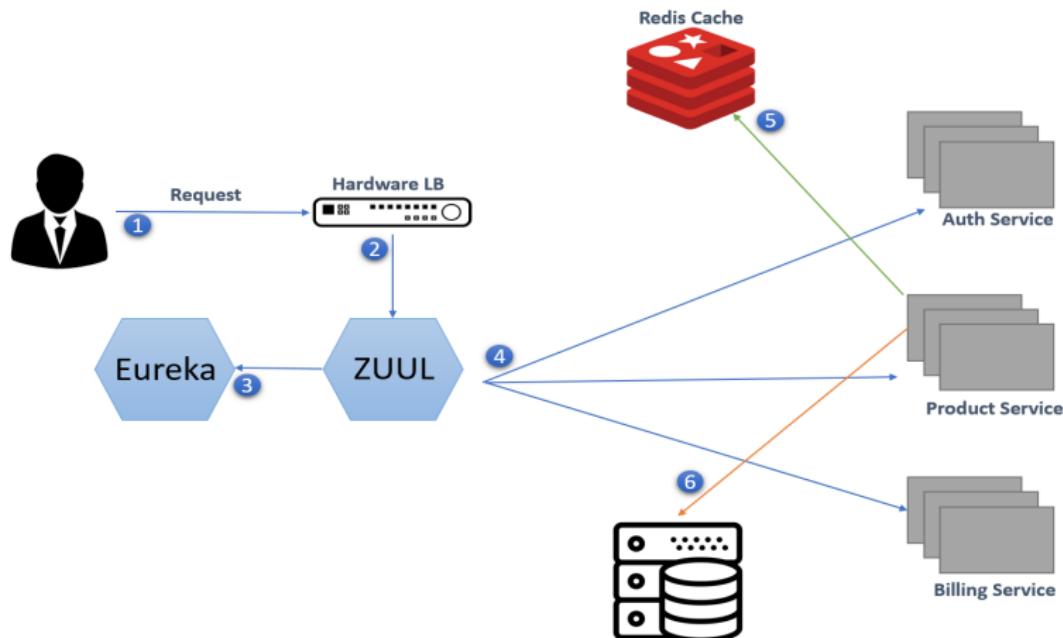


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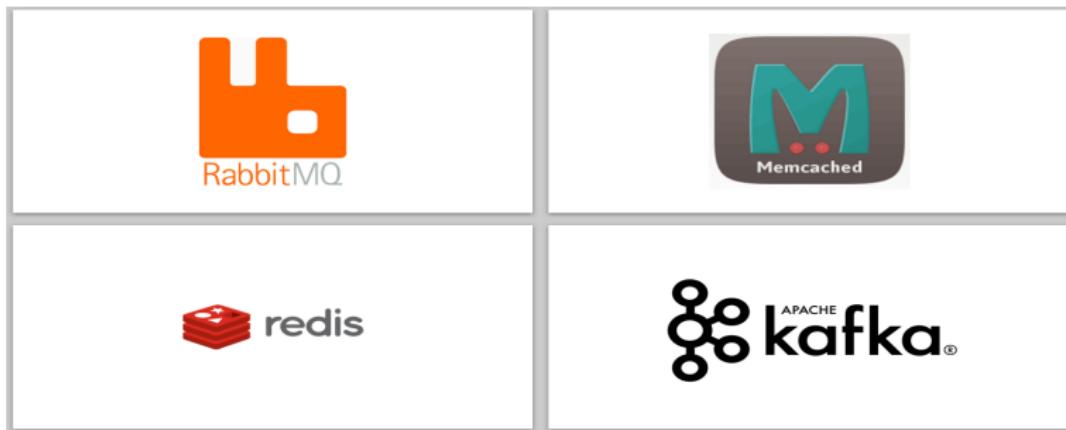


Figure: Shared DS Market Availability

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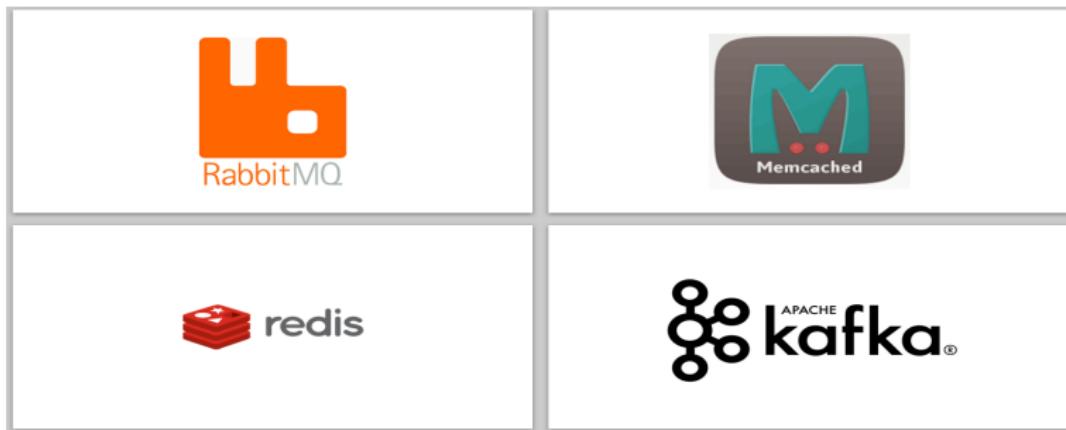


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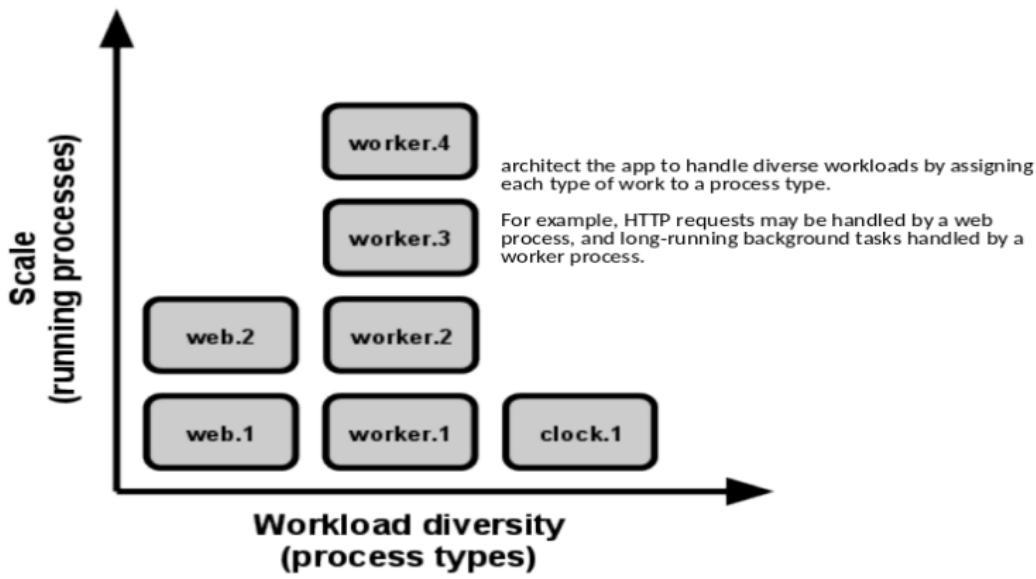
# The Twelve-Factor App

## ⑧ Concurrency

Build your app processes like unix process model based

```
1 $ wget http://memcached.googlecode.com/files/memcached-1.4.5.tar.gz  
2 $ make  
3 $ ./memcached -vv
```

- Download the application, Install and Start



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- You should give attention to what you are logging, that is you may need this data later, even on long term for analysis and reporting



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- You should give attention to what you are logging, that is you may need this data later, even on long term for analysis and reporting
- Today we have some good dedicated software which can aggregate files from different locations, like Logstash and Splunk



# The Twelve-Factor App

## 9 Logs

Logs are the app assets, and should be handled in a special way

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- Viewing the logs with reports also are different task with different good software like Kibana, Datadog, Fluentd, and others



# The Twelve-Factor App

## ⑩ Disposability

Maximize robustness with fast startup and **graceful** shutdown

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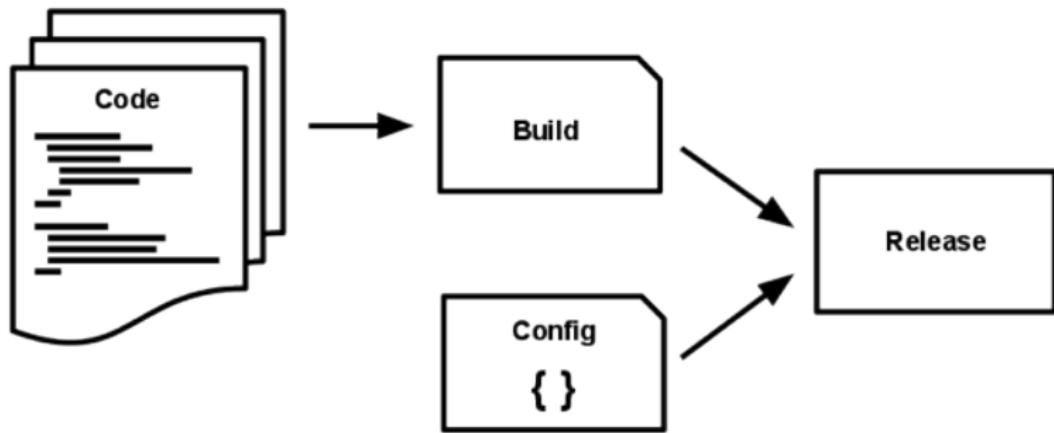
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- Processes should also be robust against sudden death, in the case of a failure in the underlying hardware. A recommended approach is use of a robust queueing backend, such as Beanstalkd, that returns jobs to the queue when clients disconnect or time out.

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## ⑪ Dev/prod parity

Keep development, staging, and production as similar as possible

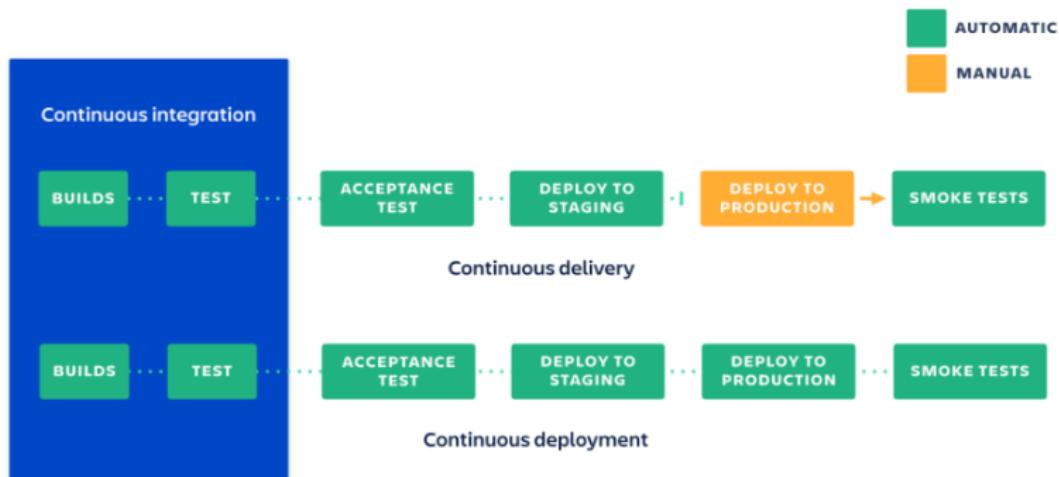


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- The twelve-factor app is designed for **continuous deployment**

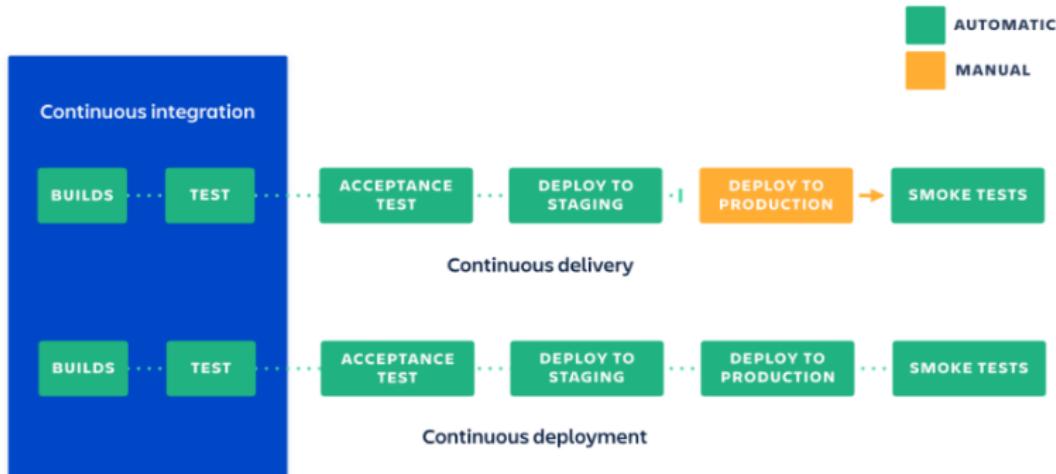


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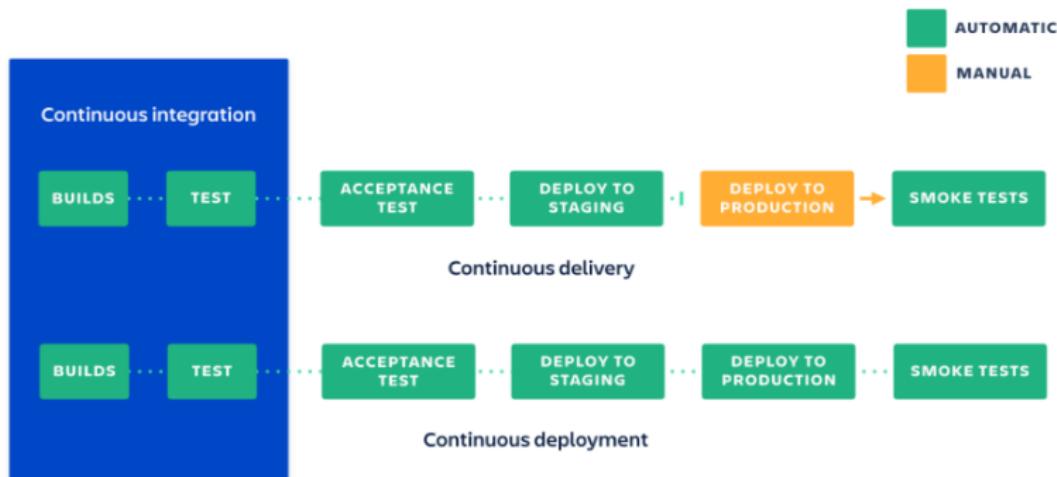


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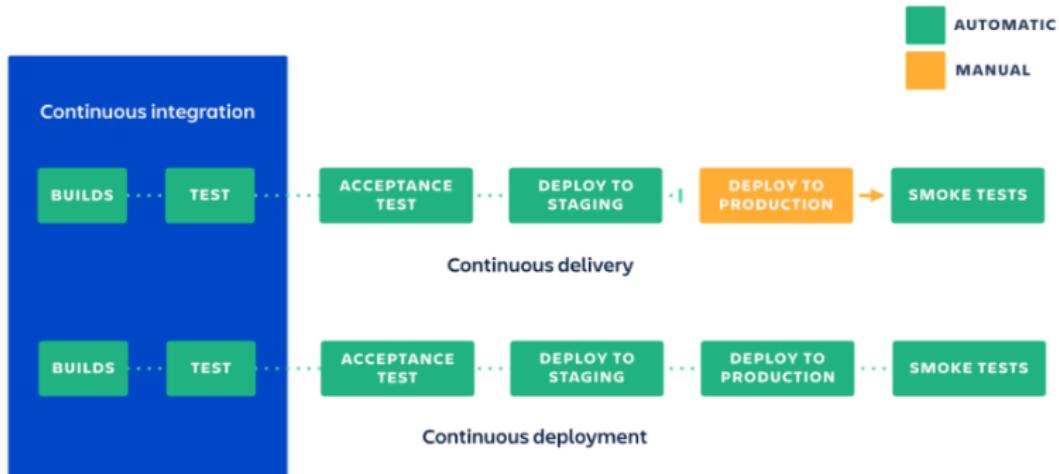


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- **The time gap:** A developer may work on code that takes days, weeks, or even months to go into production
- **The personnel gap:** Developers write code, ops engineers deploy it.
- **The tools gap:** Developers may be using a stack like Nginx, SQLite, and OS X, while the production deploy uses Apache, MySQL, and Linux.



# The Twelve-Factor App

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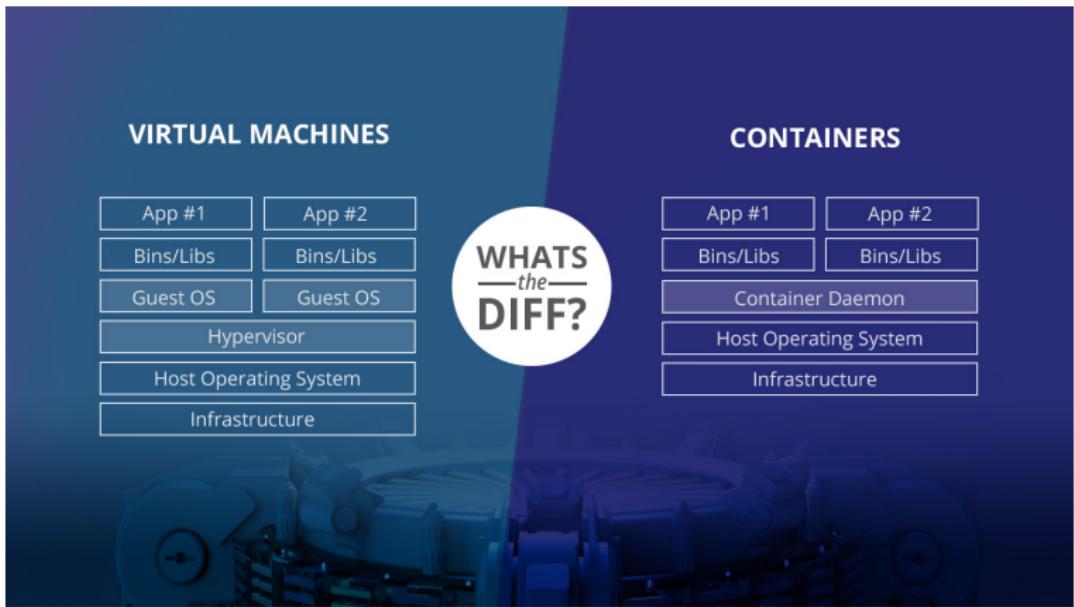
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- The twelve-factor app is designed for **continuous deployment** by keeping the gap between development and production small
- **Dockerization**



<https://www.backblaze.com/blog/vm-vs-containers>

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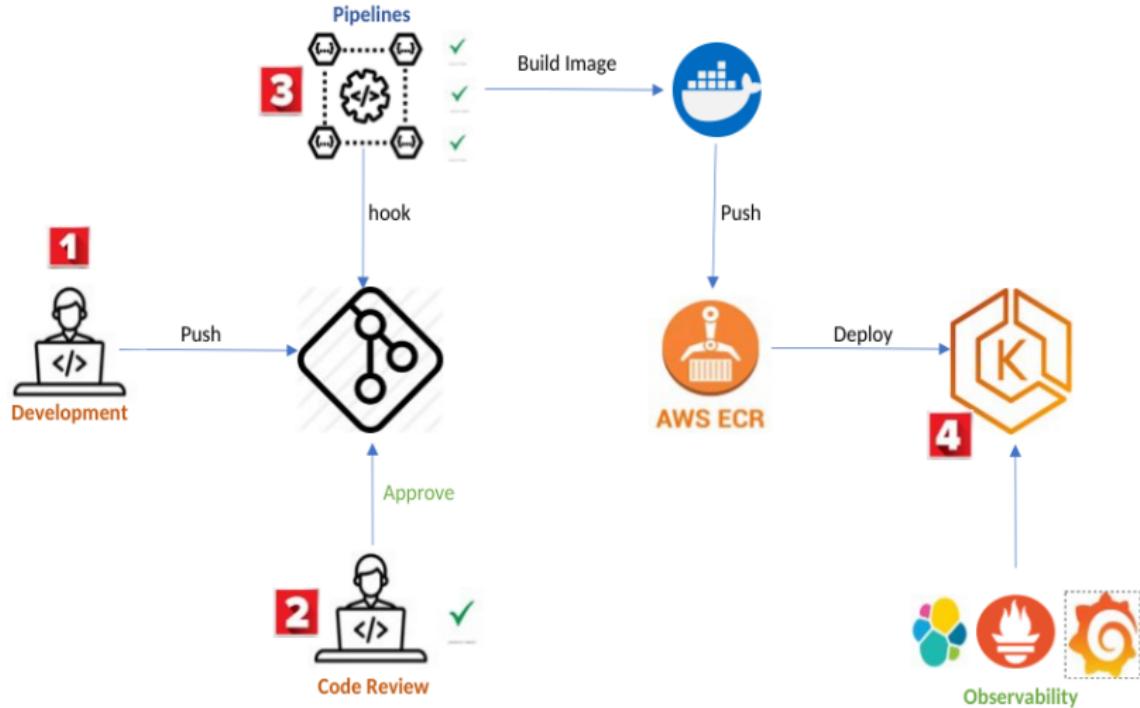
## Popular Orchestrators

- Docker Swarm
- Kubernetes
- AWS ECS
- Service Fabric
- Openshift



# Real Example

*Continuous Integration, and Deployment are your friends*



# Infrastructure as Code "IaC"

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- IaC should be always **Idempotent** this will enable Ops team to test their work on production-like environment before actual production
- Should I (SysAdmin/Operator) learn programming to apply IaC?

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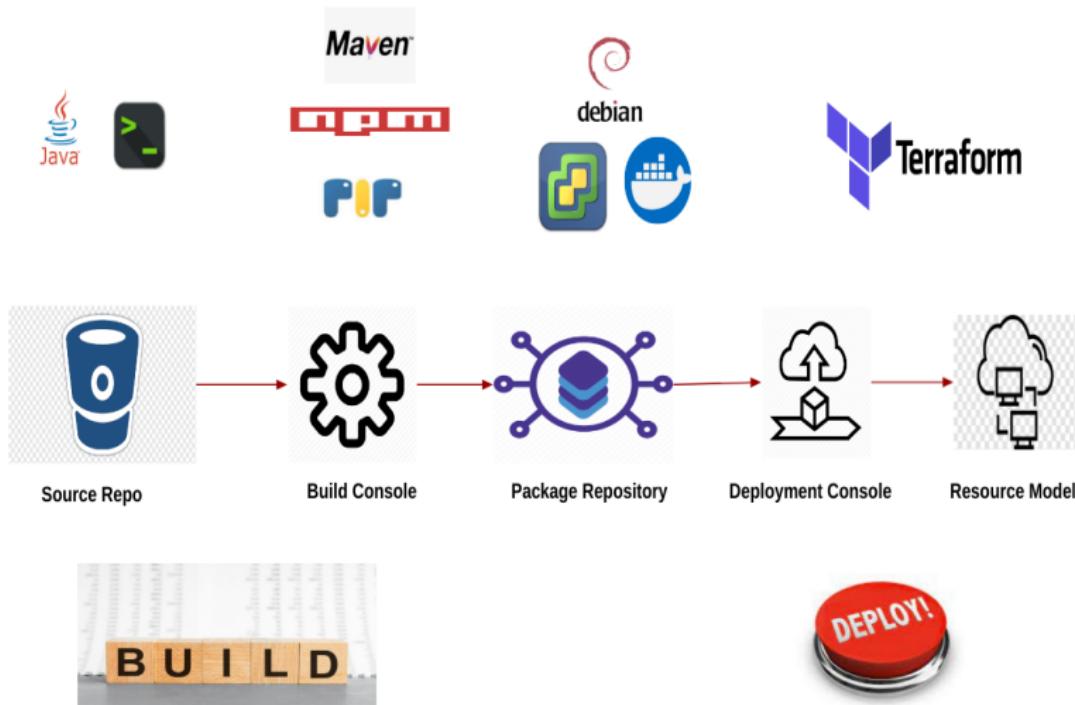
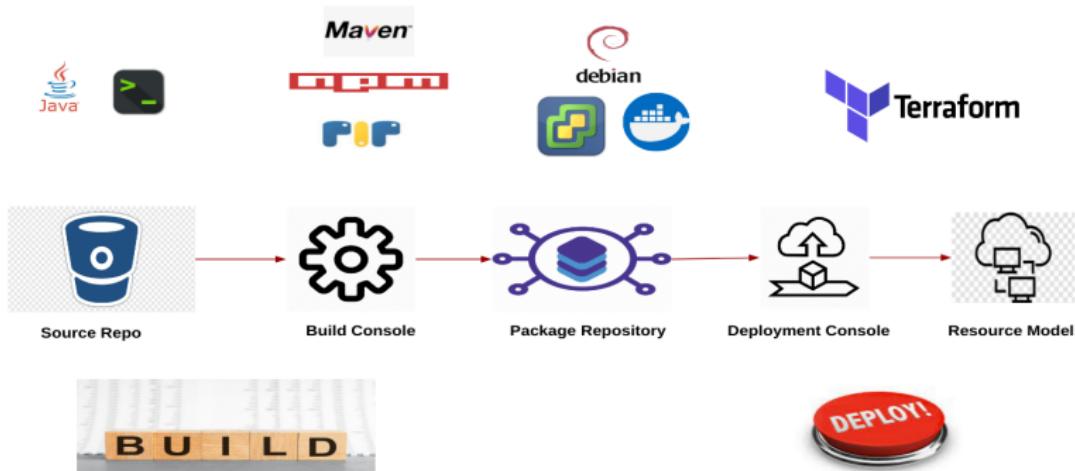


Figure: Service Delivery Platform

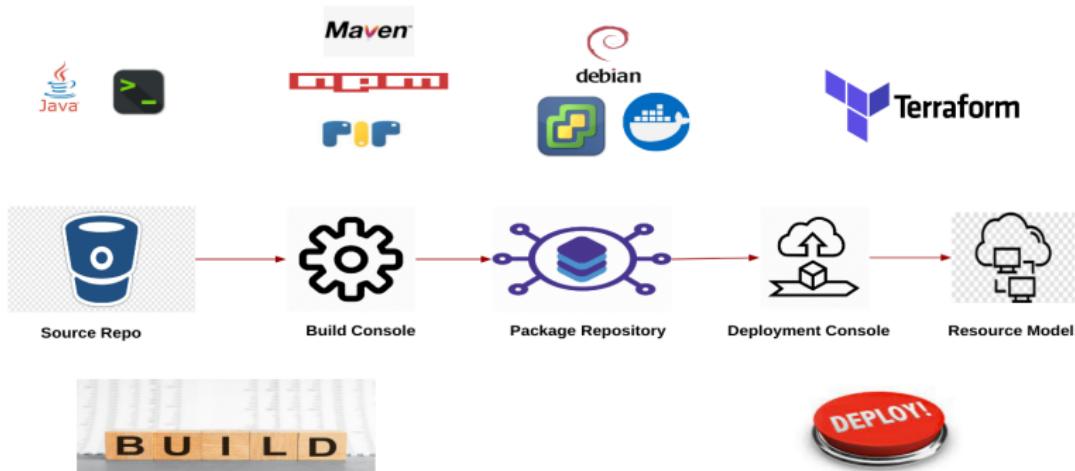
# Infrastructure as Code "IaC"

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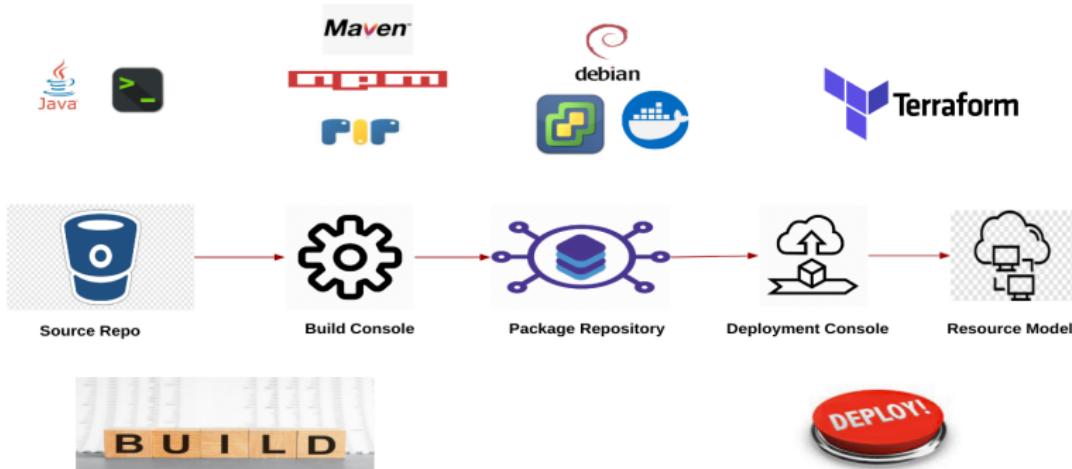
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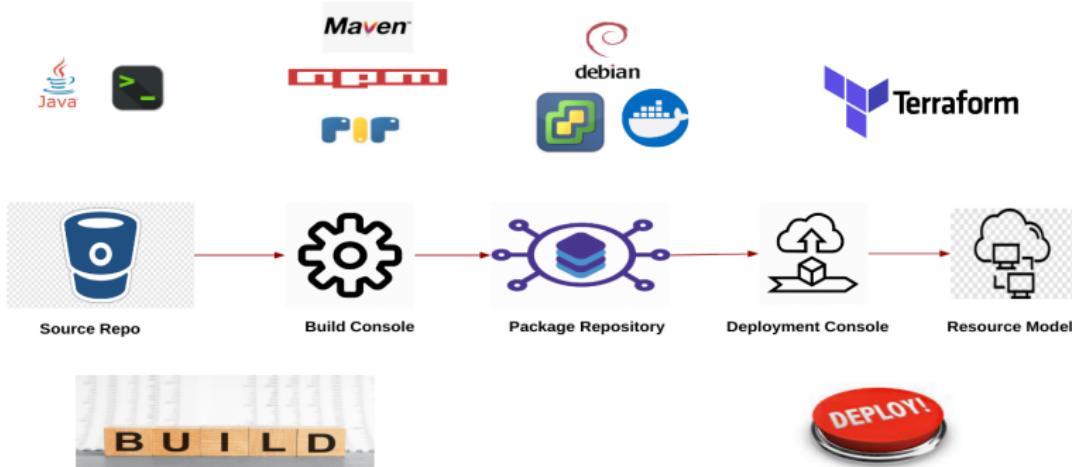
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  - ChefSpec Test Simulator and Coverage
  - ServerSpec and TestInfra for Integration testing



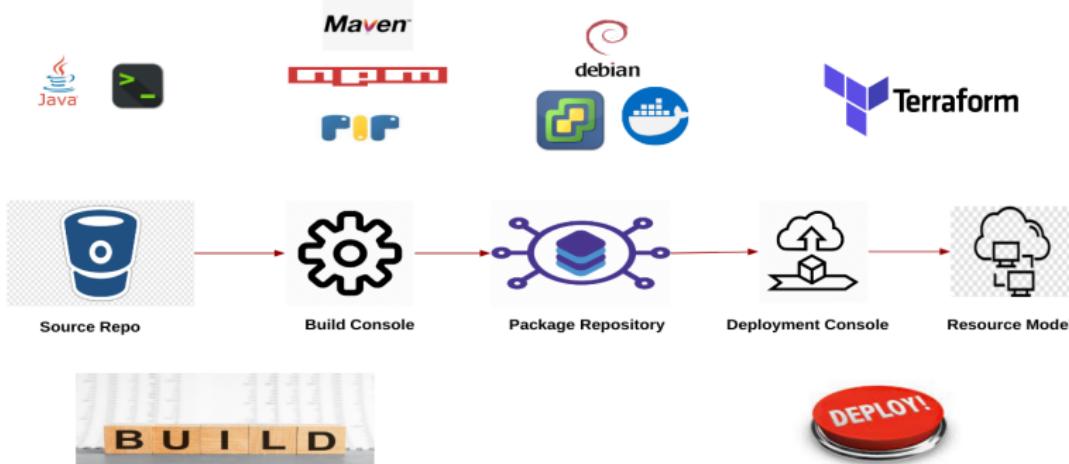
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- There will be always kind of tension between Dev team and Ops team; especially if Ops team is applying SRE principles



# Communication Design

## HTTP communication

Also known as **Synchronous communication**, the calls between services is a viable option for **service-to-service** via REST API.

## Message communication

Also known as **Asynchronous communication**, the services push messages to a message broker that other services subscribe to.

## Event-driven communication

Another type of **Asynchronous communication**, the services does not need to know the common message structure. Communication between services takes place via events that individual services produce.

# Communication Design

## Online purchase example

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- Save it

```
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2     saveOrder(order);  
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6         auditOrderDetails(order);  
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8 }  
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10 charge(Order order) {  
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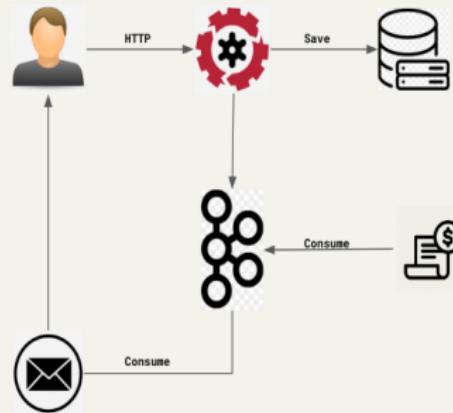
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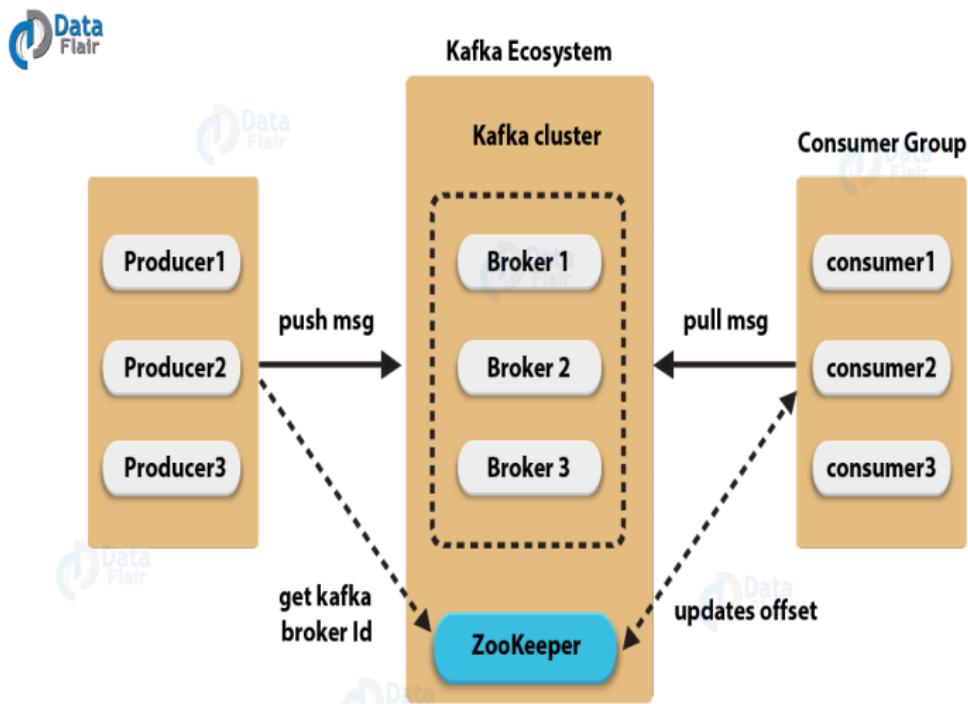
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# Communication Design

## Online purchase example [Kafka-Architecture]



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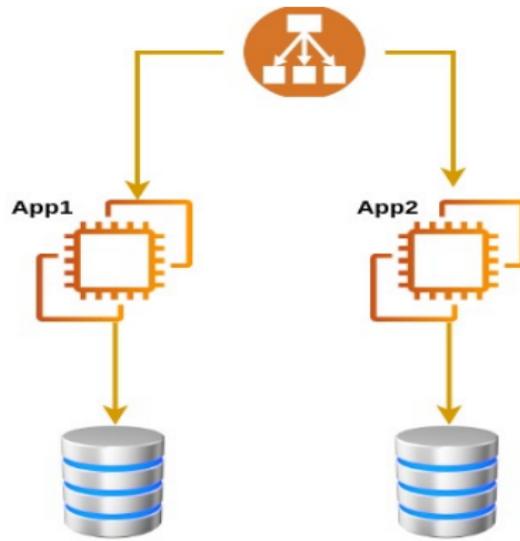
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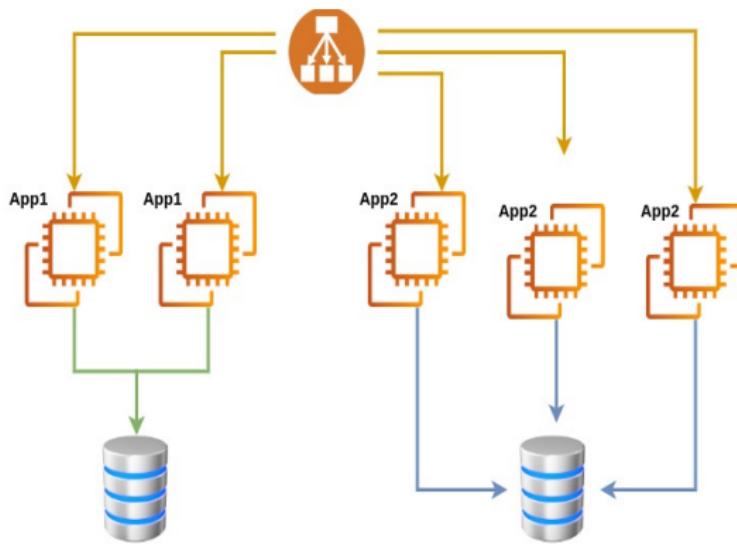
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- SLA is 99.99%

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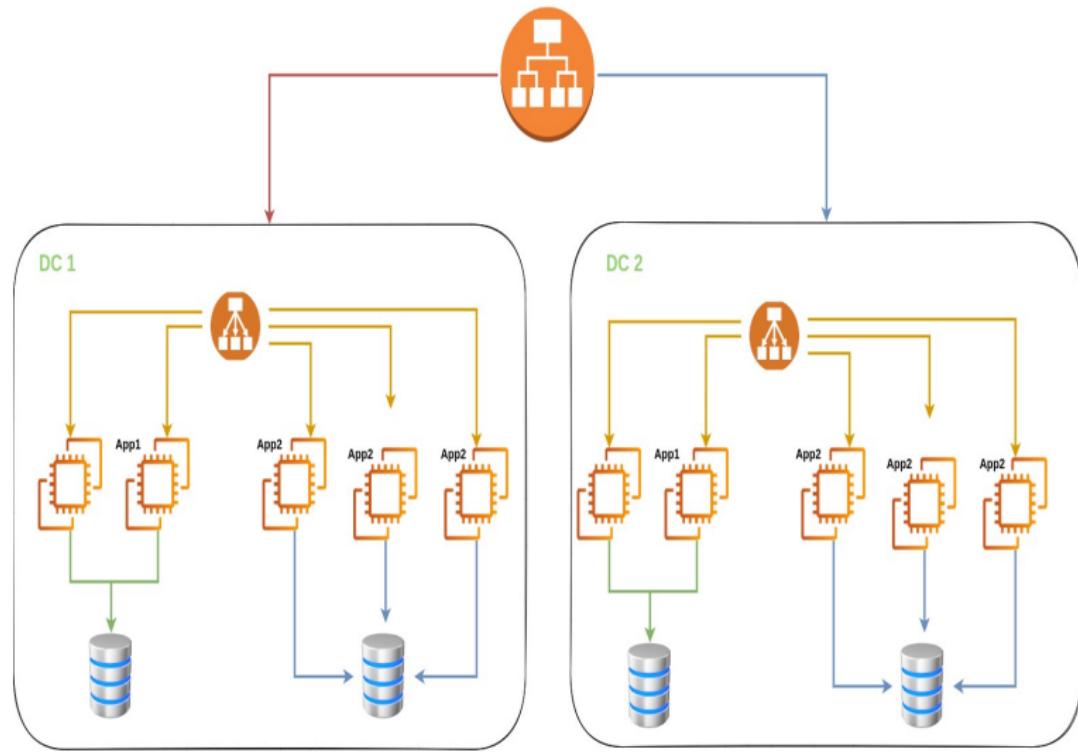
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## Horizontal Scaling



# Scalability and High Availability

## Fault Tolerant



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# Thanks for Watching