

Microservices Architecture "The new normal"

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Objectives

- ① Provide good Arabic content for the topic

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- ② Overview of Microservices

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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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- 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/Microservices>

Why Microservices?

① Unit design

- The application consists of loosely coupled services.
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- Each microservice can be scaled independently of the other services.

Microservices vs Monolithic

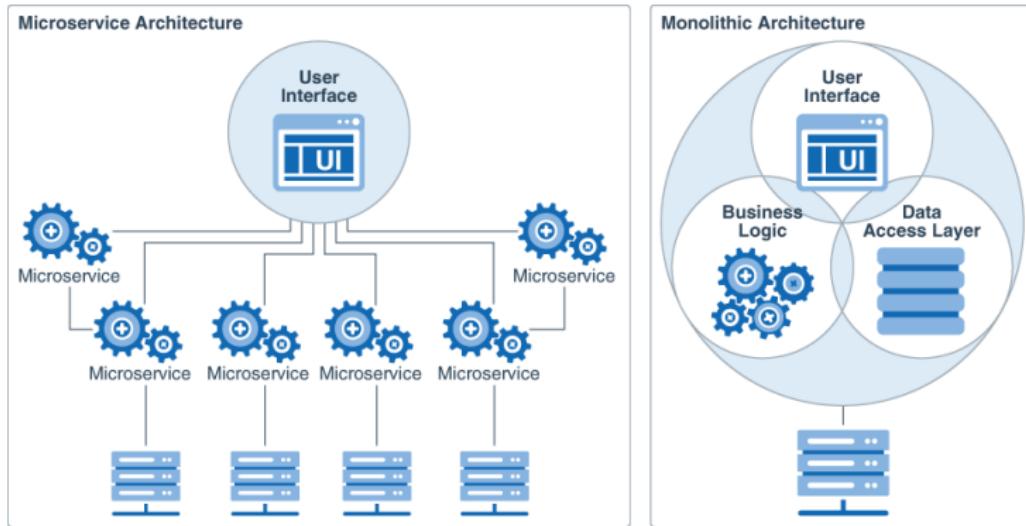


Figure: mivroservices vs monolithic

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

Closer Look

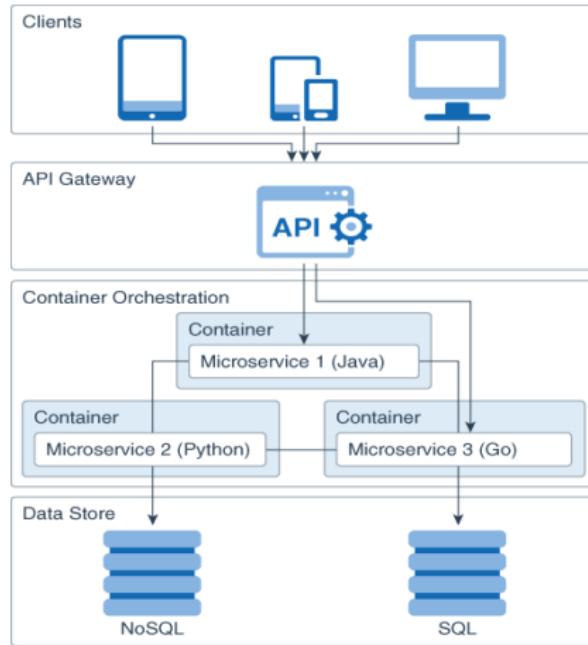


Figure: Microservices In Depth

Microservices Architecture

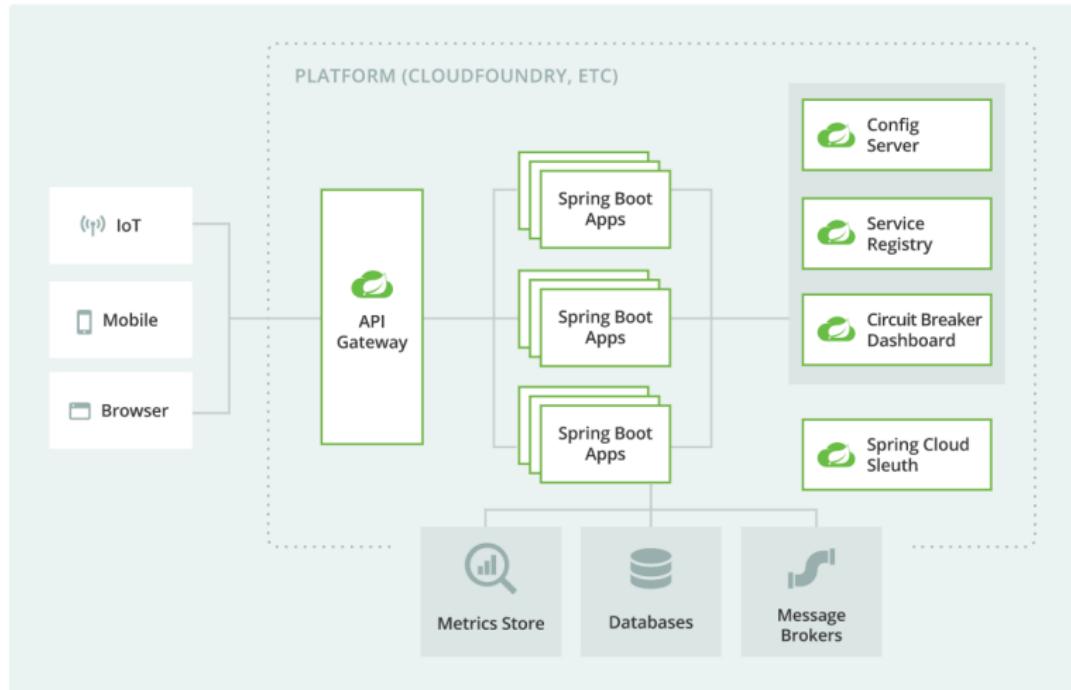


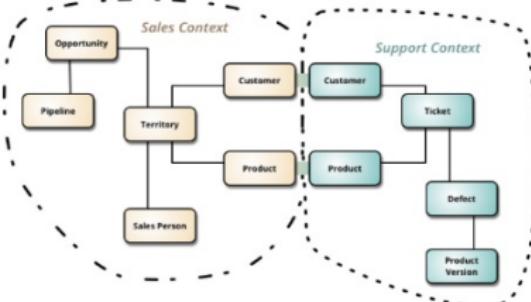
Figure: Microservices with Spring Cloud

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

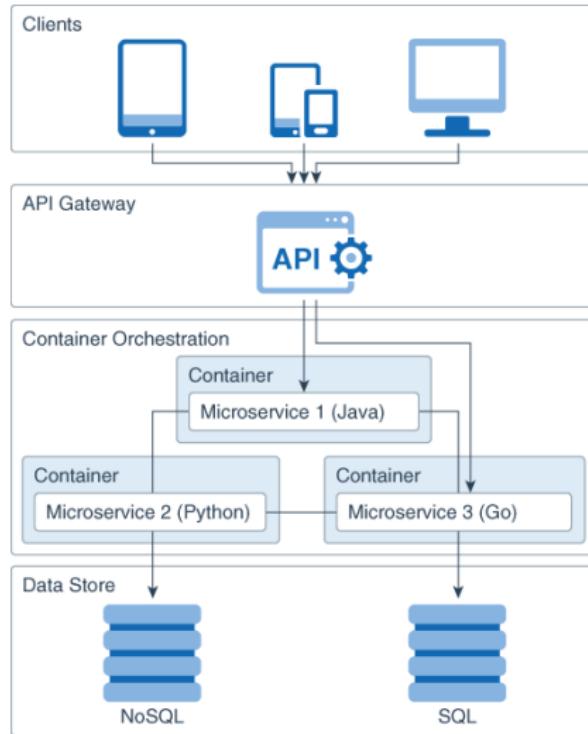


Figure: Synchronous calls

Event-driven communication

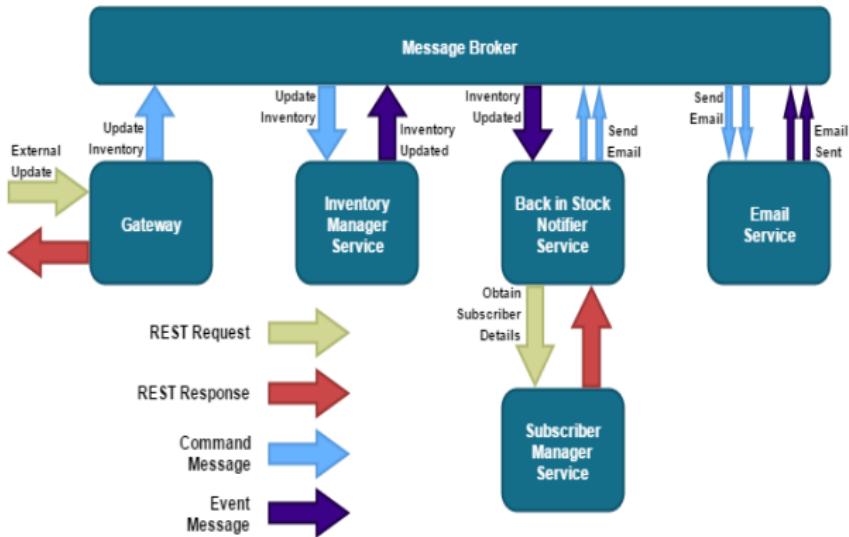


Figure: Asynchronous calls

<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...

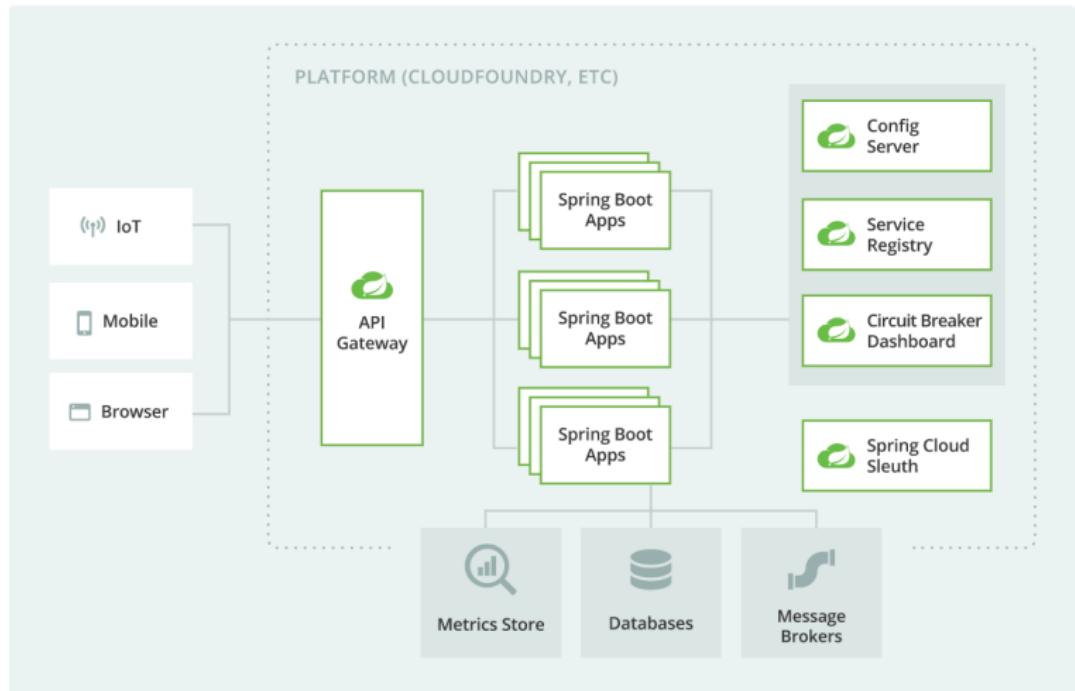


Figure: Microservices with Spring Cloud

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

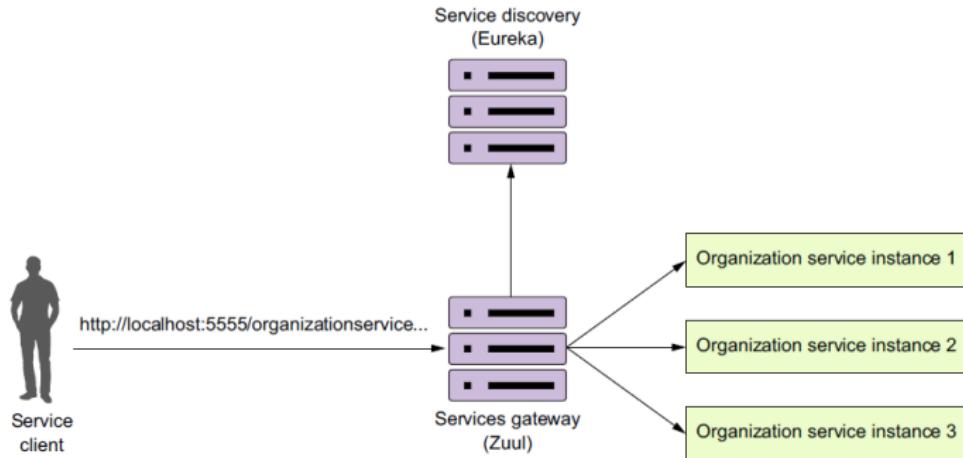
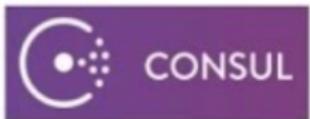


Figure: Service Registry and Gateway

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

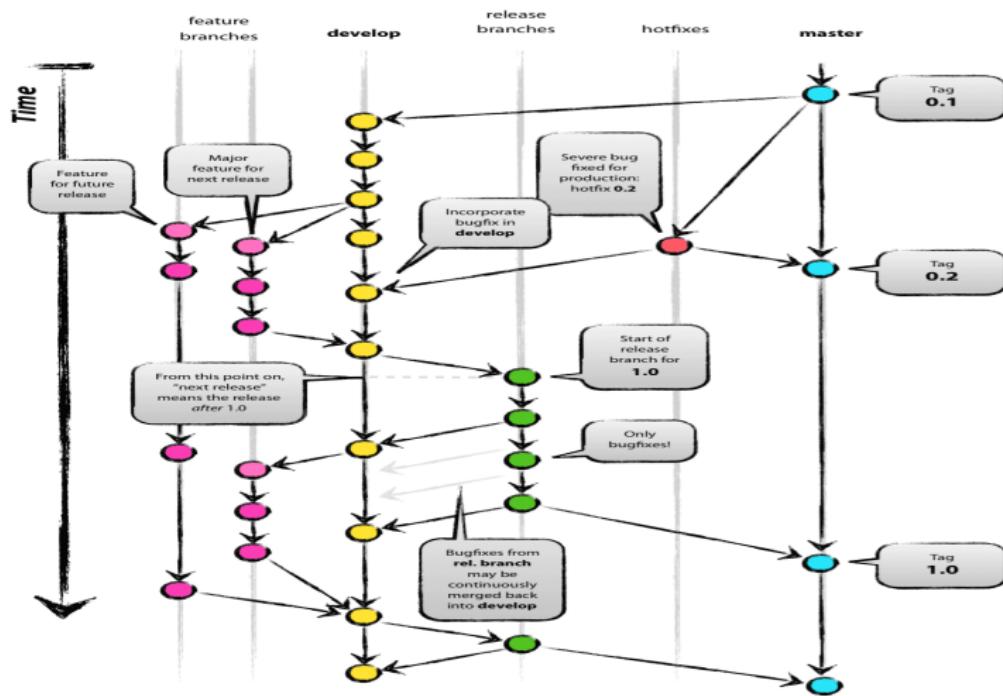
- ① Codebase
- ② Dependencies
- ③ Config
- ④ Backing services
- ⑤ Build, release, run
- ⑥ Processes
- ⑦ Port binding
- ⑧ Concurrency
- ⑨ Disposability
- ⑩ Dev/prod parity
- ⑪ Logs
- ⑫ Admin processes

<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**

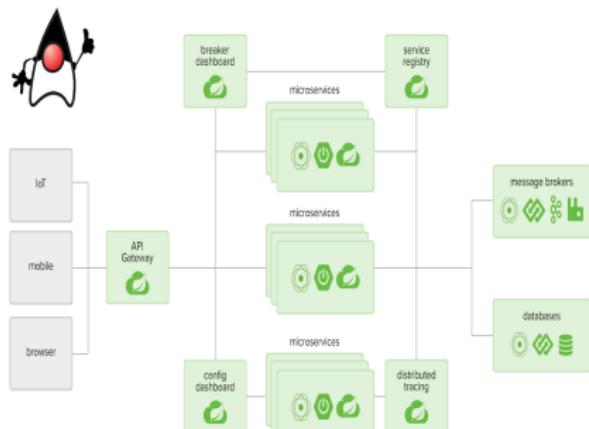


Diagram from <https://spring.io>

```
<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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</dependencies>
```

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

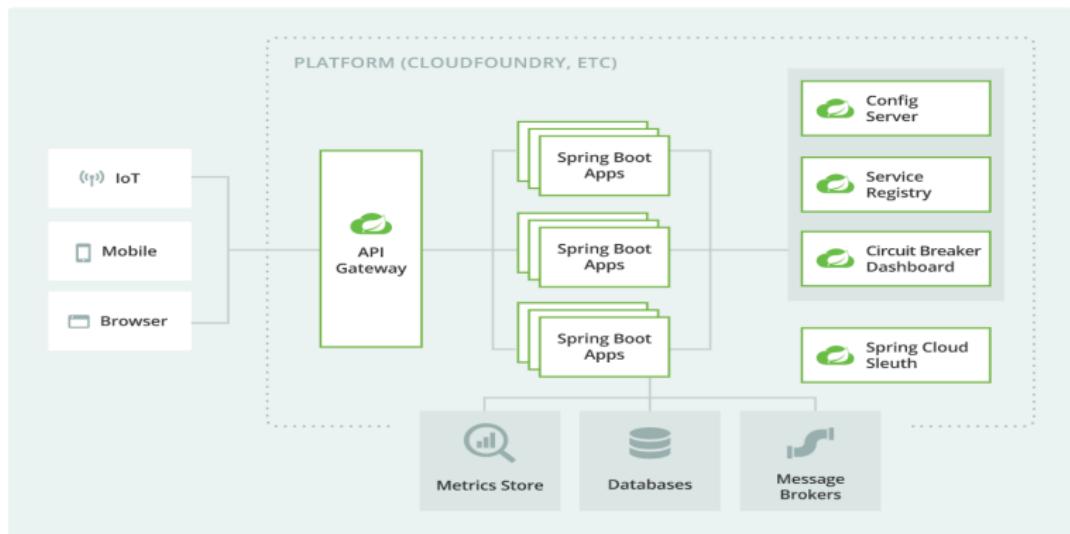


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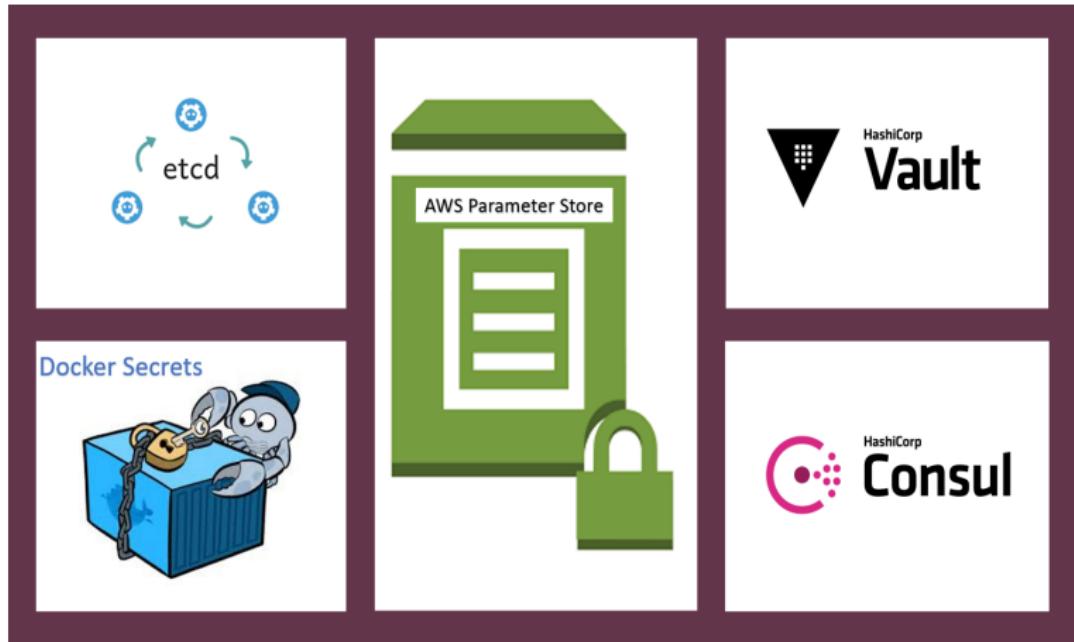


Figure: Popular Config Stores

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

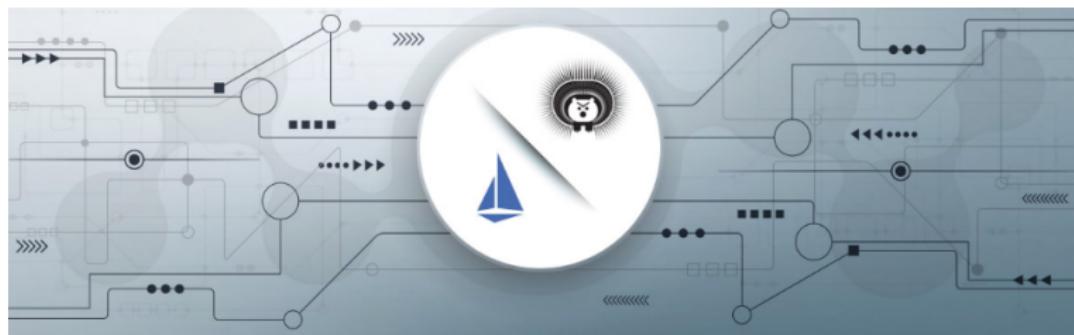


Figure: Circuit Breaker

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.
- 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

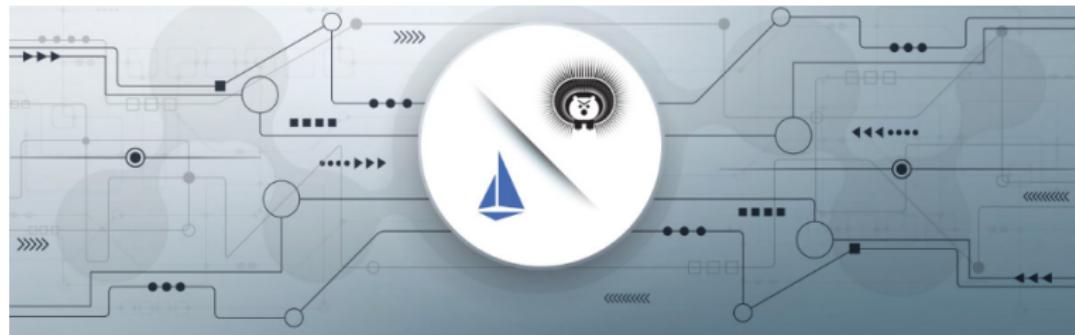


Figure: Circuit Breaker

The Twelve-Factor App

④ Backing Service

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- Examples include data stores, queueing, and caching systems

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- A good way for this is as mentioned in config talk.

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1 public void useHardCodedResources( long userId ) {  
2     final String URL = "https://10.20.30.90/api/user/";  
3     User user = restTemplate.getObject( URL + userId , User.class );  
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

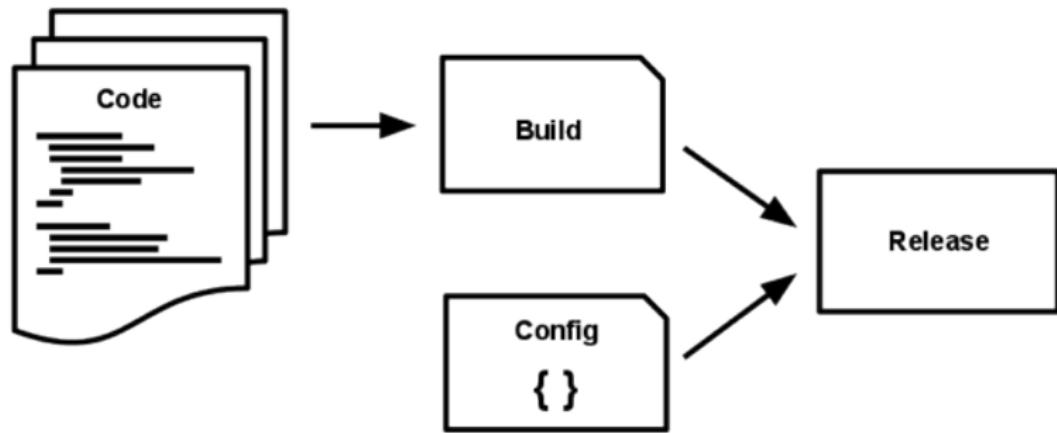


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The Twelve-Factor App

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?



The Twelve-Factor App

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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

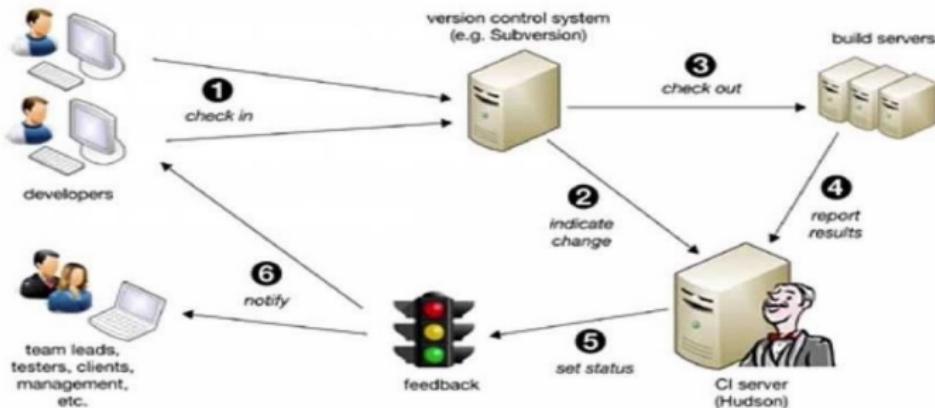


Image source: <http://www.methodsandtools.com/tools/tools.php?hudson>

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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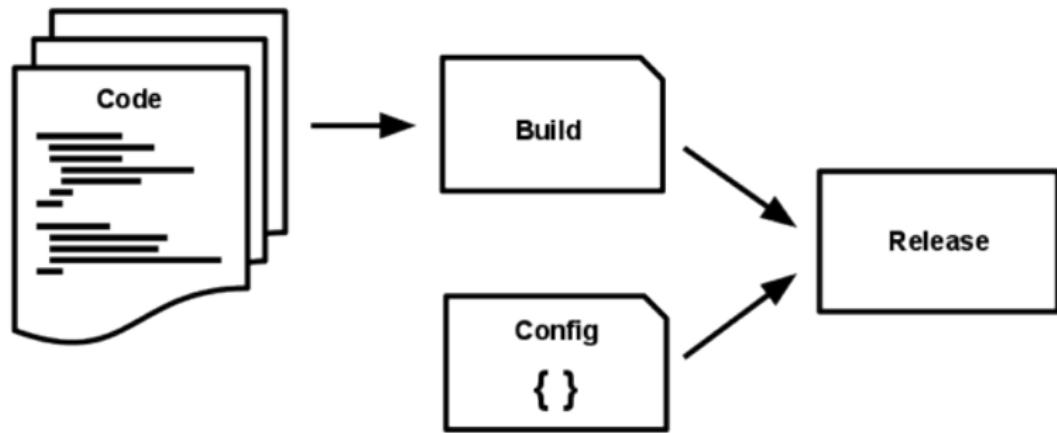
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- Builds are initiated by the app’s developers whenever new code is deployed. Runtime execution, by contrast, can happen automatically in cases such as a server reboot, or a crashed process being restarted by the process manager.
- the run stage should 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.

The Twelve-Factor App

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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?



The Twelve-Factor App

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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.
- 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

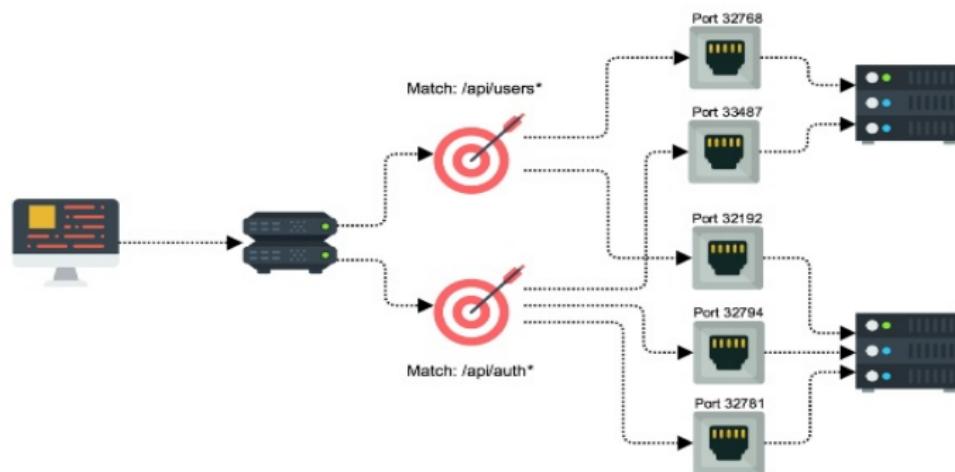
Export services via port binding

The Twelve-Factor App

7 Port Binding

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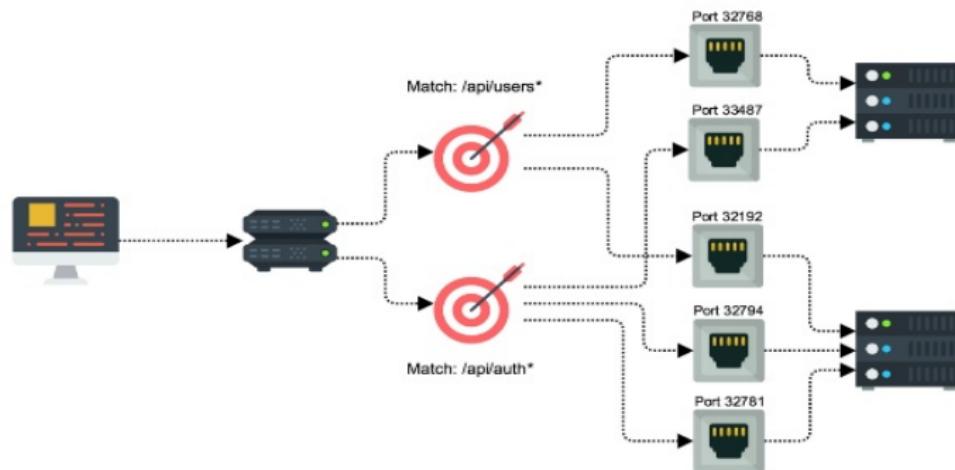


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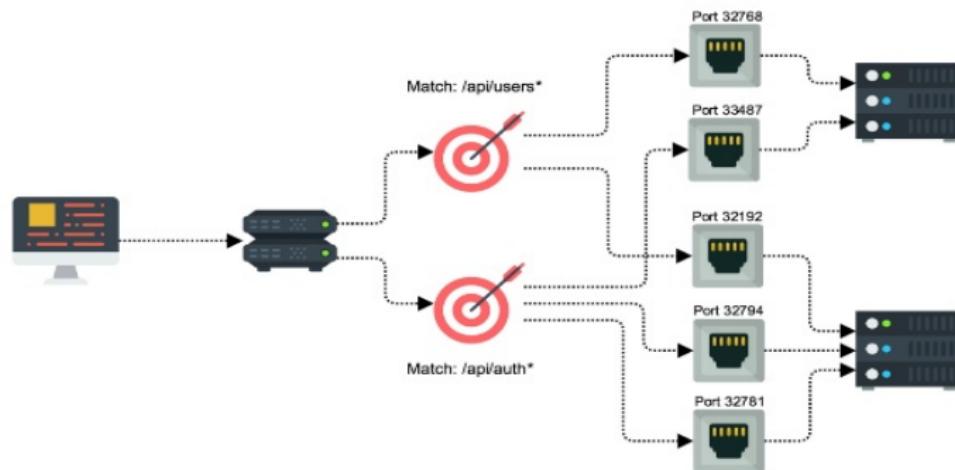


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- In a local development environment, you can visit a service URL like `http://localhost:5000/` to access the service exported by their app.
- In deployment, a routing layer handles routing requests from a public-facing hostname to the port-bound web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



Data Sharing and Management

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

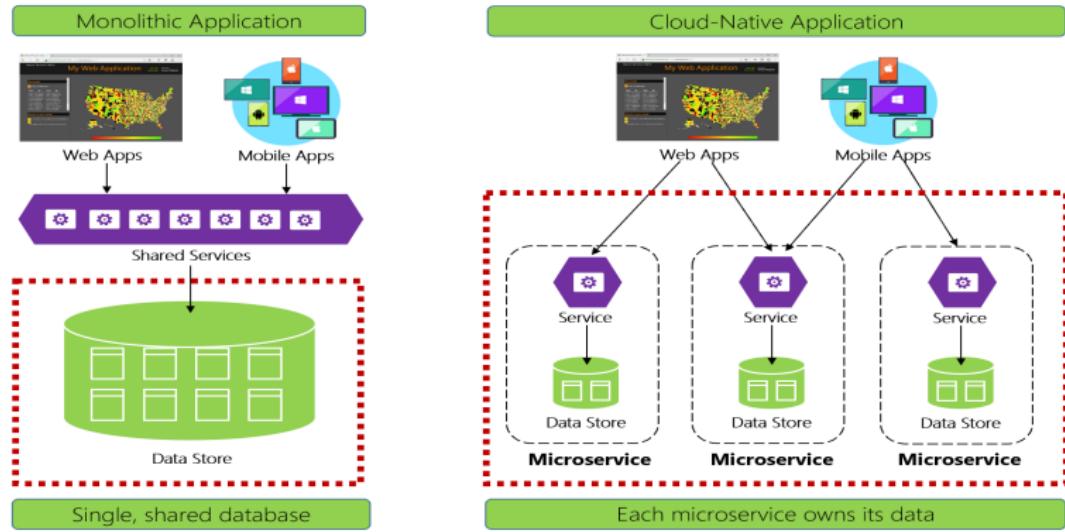


Figure: Distributed Data Architecture

Data Sharing and Management

Why database per service?

- Domain data is encapsulated within the service

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Which way is better?

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

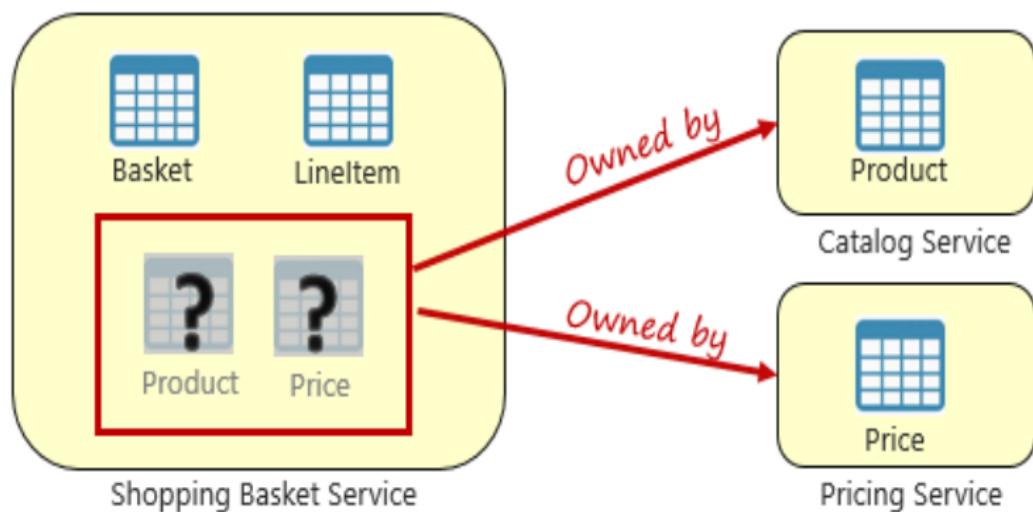


Figure: Querying across microservices

<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

Order table

Partition key	Row key	Order date	Shipping address	Total invoice	Order status
001 (Customer ID)	1 (Order ID)	11082013	One Microsoft way Redmond, WA 98052	\$400	In process
005	2	11082013	One Microsoft way Redmond, WA 98052	\$200	Shipped

OrderItem table

Partition key	Row key	Product	Unit Price	Amount	Total
1 (Order ID)	001_1 (Orderitem ID)	XX	\$100	2	\$200
1	001_2	YY	\$40	5	\$200
2	002_1	ZZ	\$200	1	\$200

Customer table

Partition key	Row key	Billing Information	Shipping address	Gender	Age
US East (region)	001 (Customer ID)	*****0001	One Microsoft way Redmond, WA 98052	Female	30
US East	002	*****2006	One Microsoft way Redmond, WA 98052	Male	40

Materialized View

Partition key	Row key	Product Name	Total sold	Number of customers
Electronics (Product category)	001 (Product ID)	XX	\$30,000	500
Electronics	002	YY	\$100,000	400

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

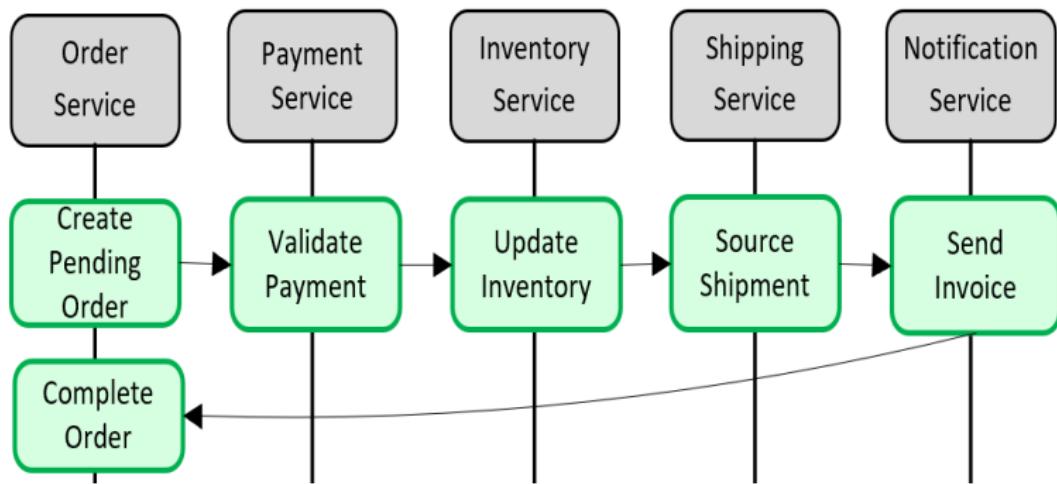


Figure: Transaction across microservices

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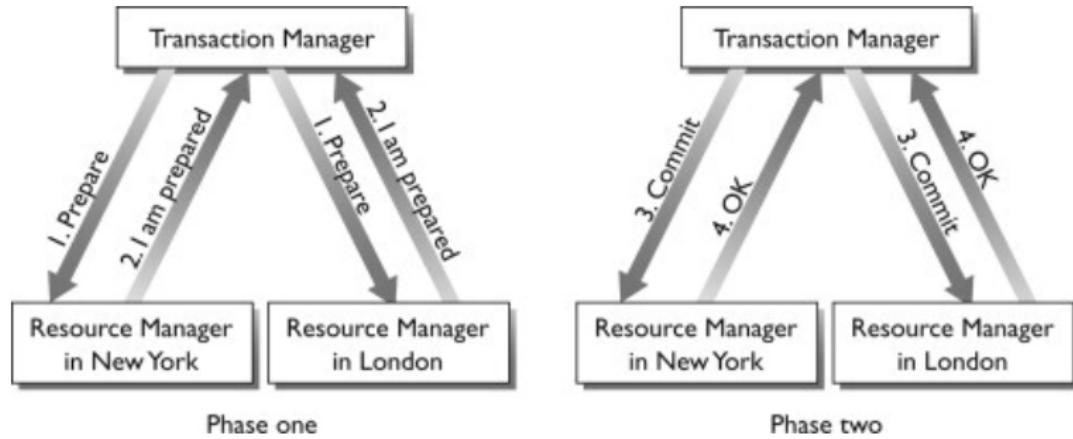


Figure: Two-phase Commit pattern

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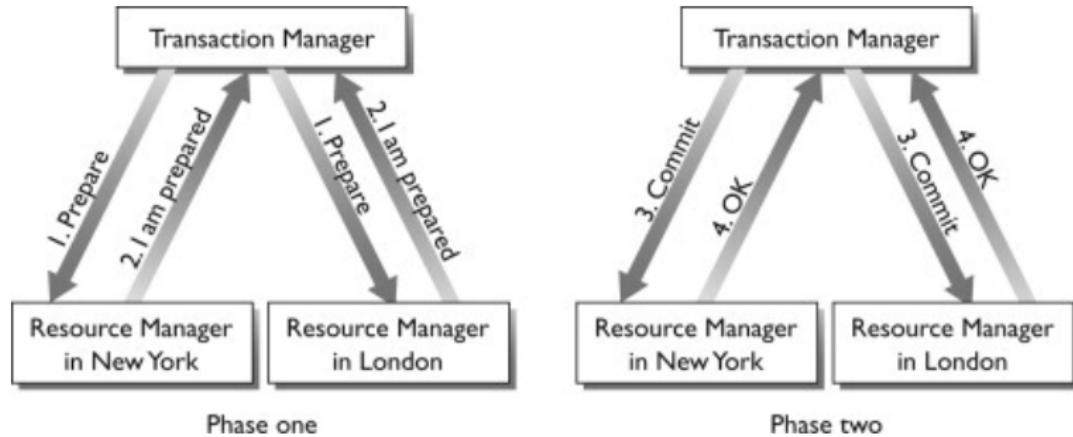


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- In real case, this is impractical, and will lead to locking and time consuming issue

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

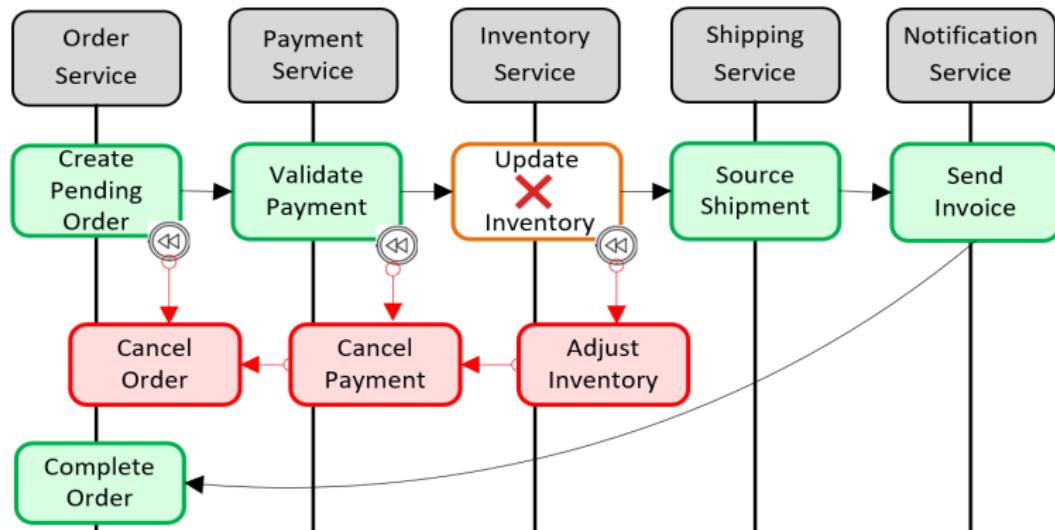


Figure: Rolling back a transaction

Data Sharing and Management

Command and Query Responsibility Segregation (**CQRS**)

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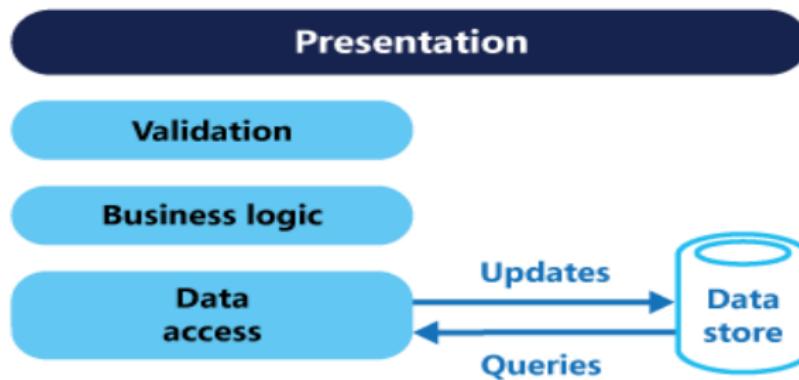


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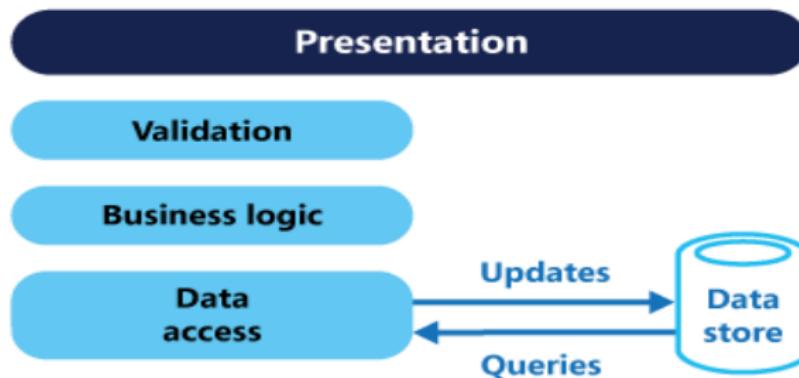


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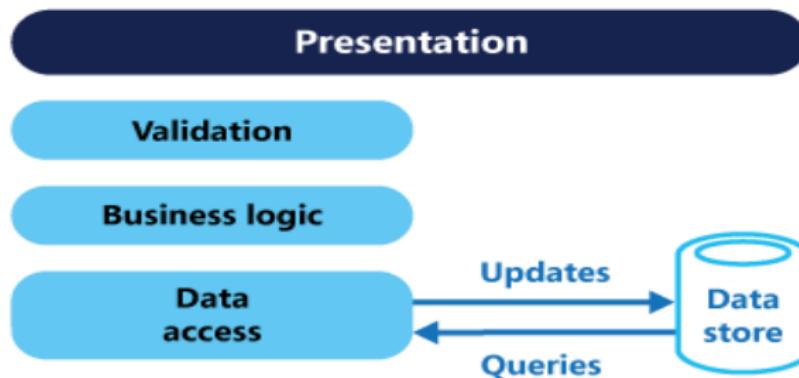


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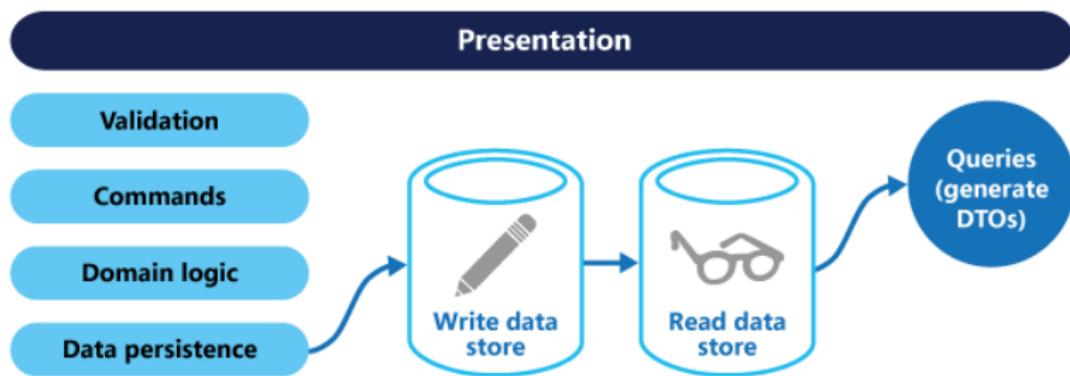


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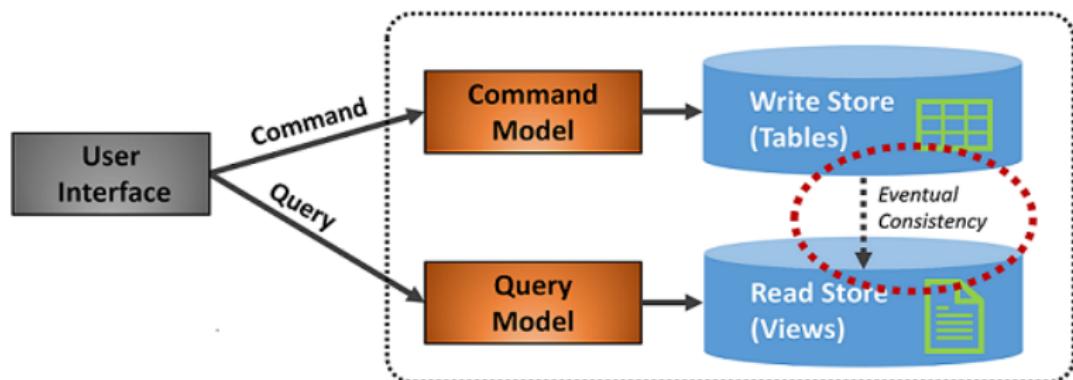


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- A good way to achieve this, is to use **Event Sourcing Pattern**

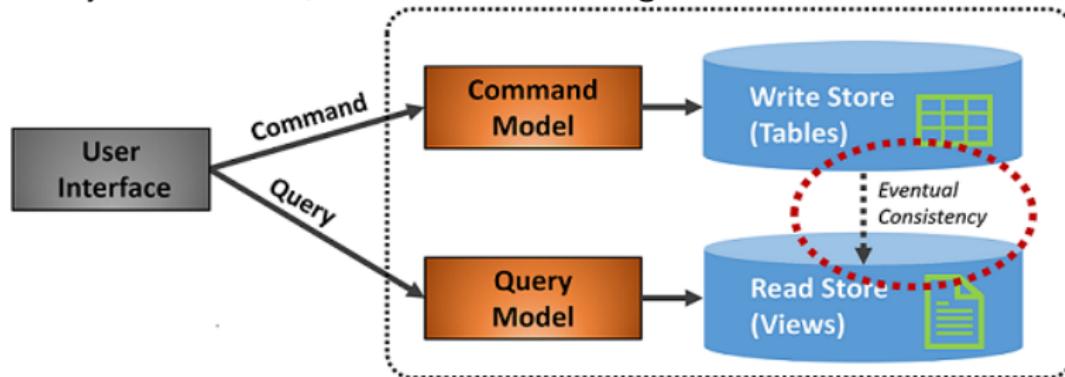


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- How did we get there? (*History is always matter*)
- An approach to handling operations on data that's driven by a sequence of events, each of which is recorded in an **append-only store**

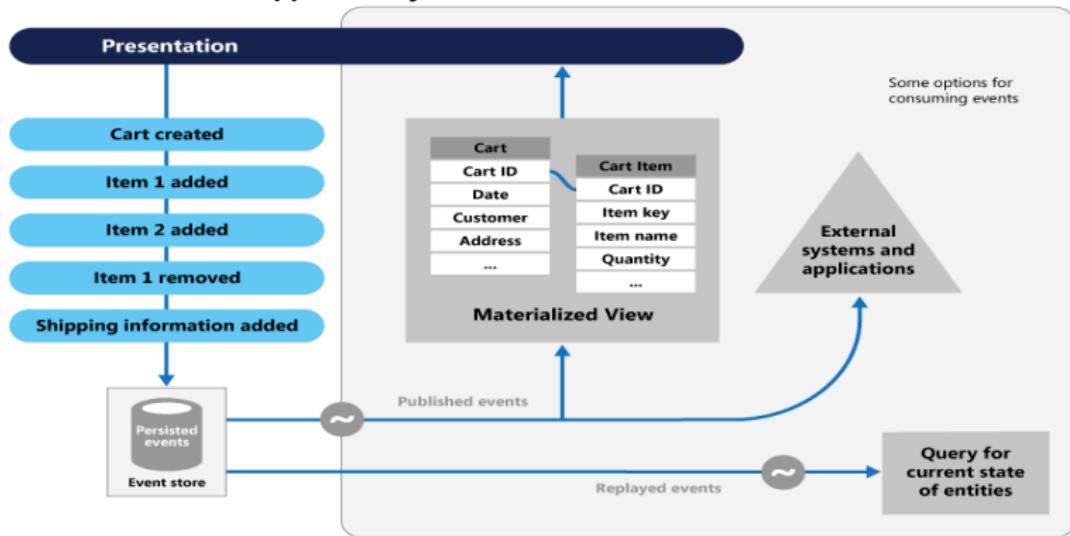


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Data Sharing and Management

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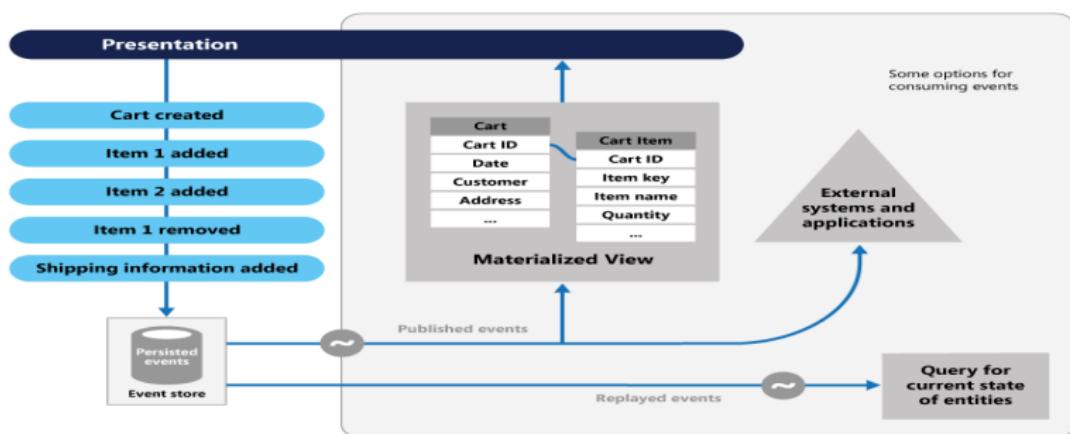


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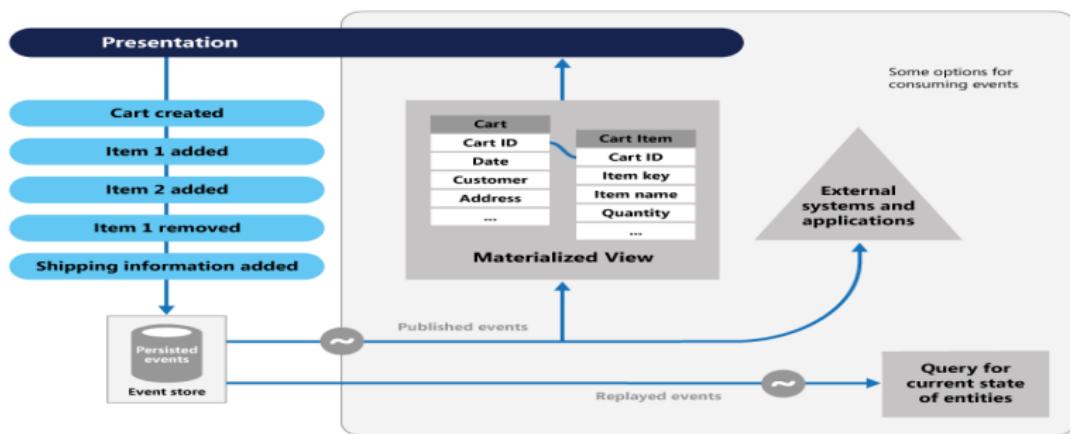


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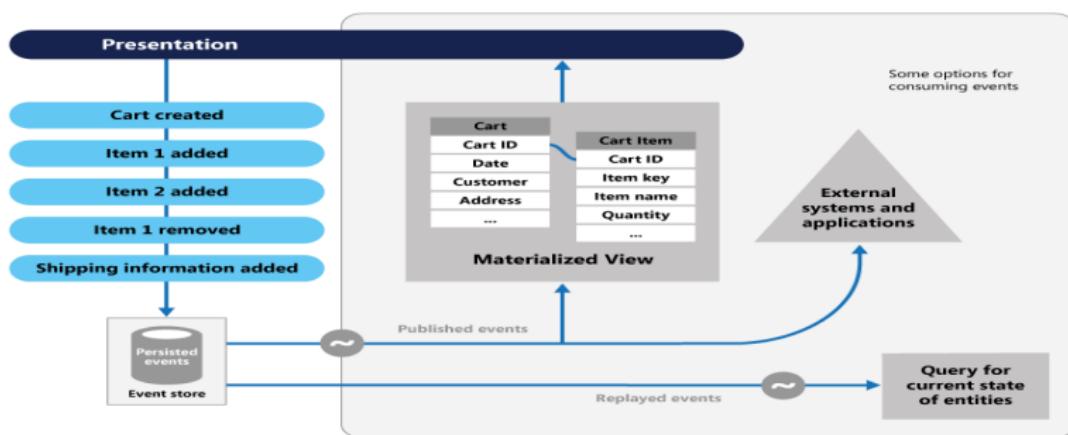


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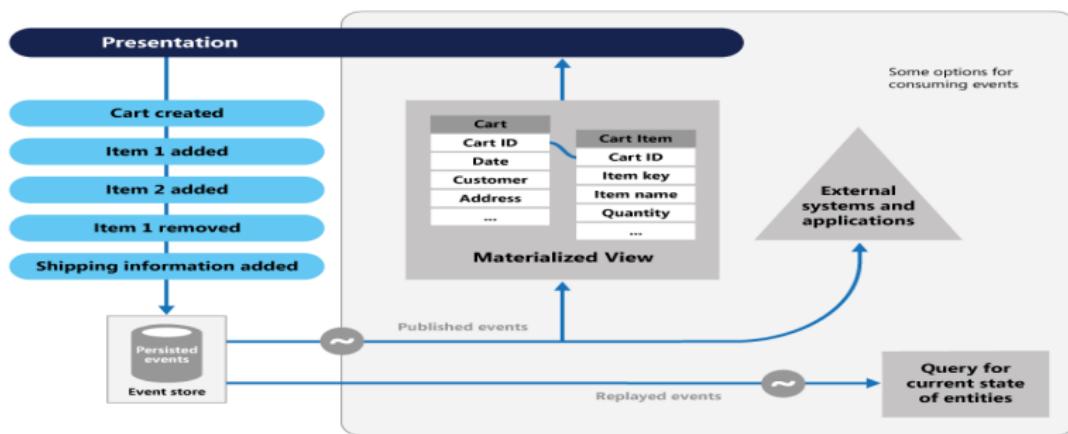


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- prevent concurrent updates from causing conflicts because it avoids the requirement to directly update objects in the data store

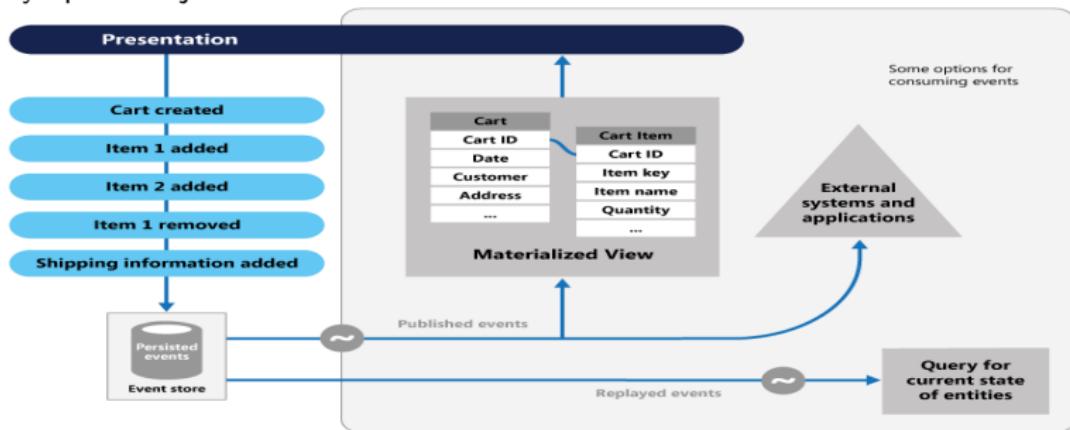


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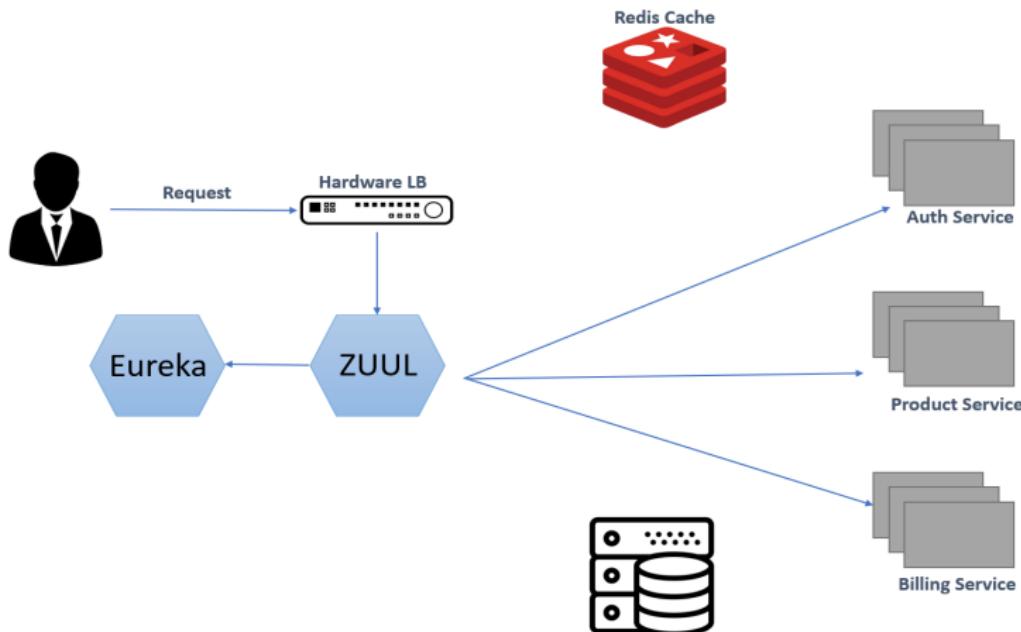


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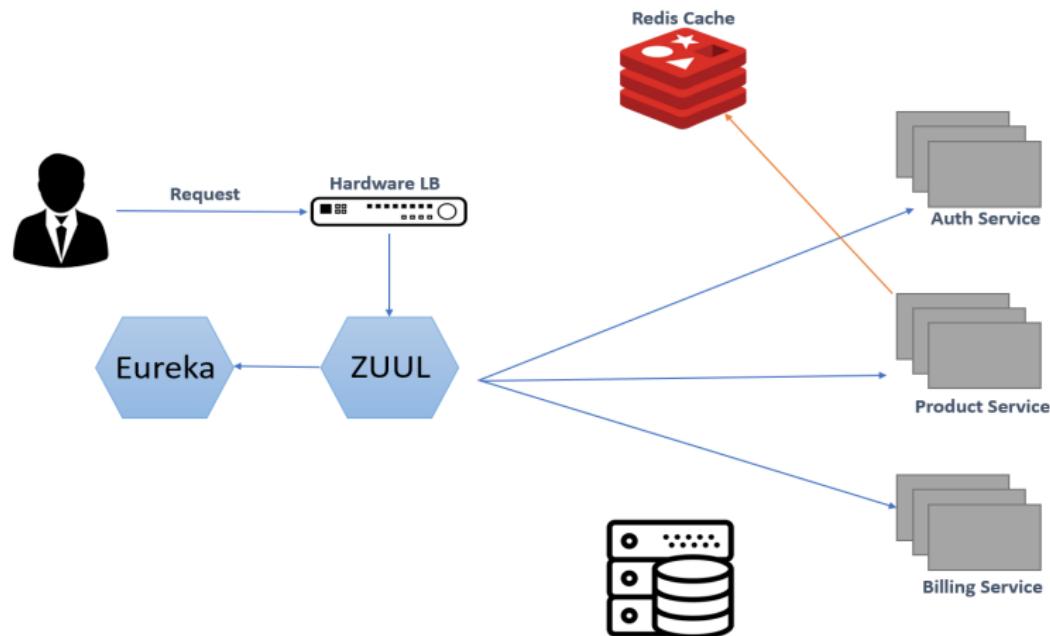


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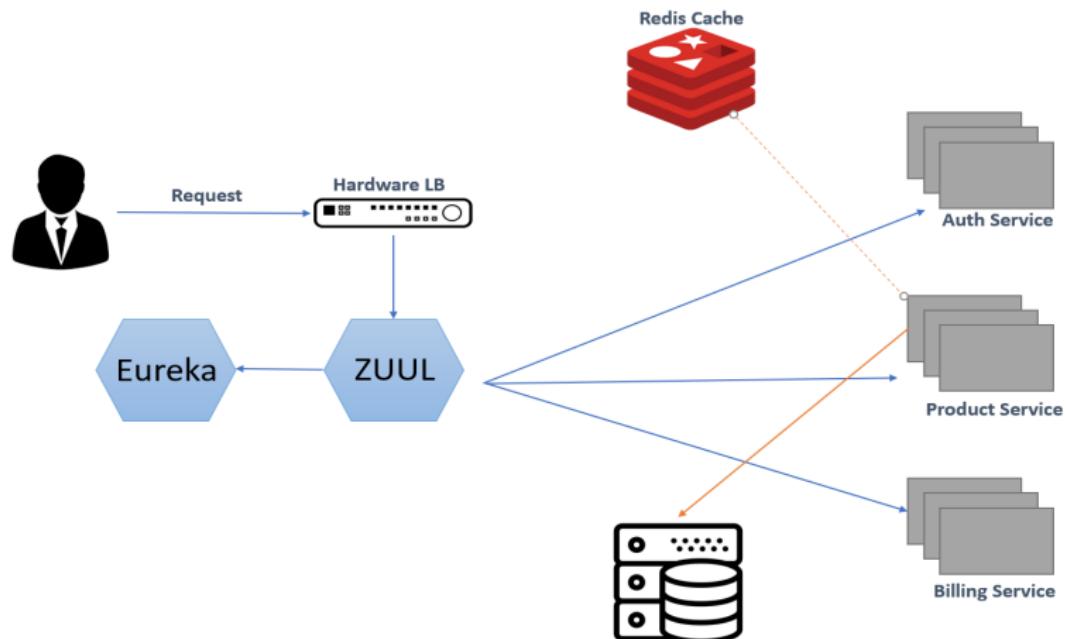


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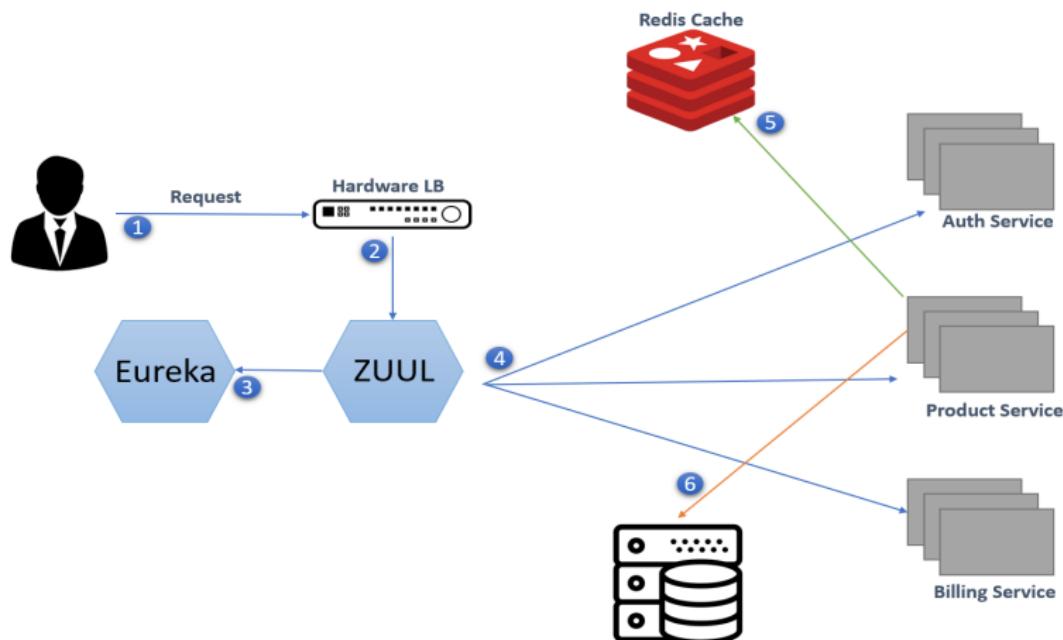


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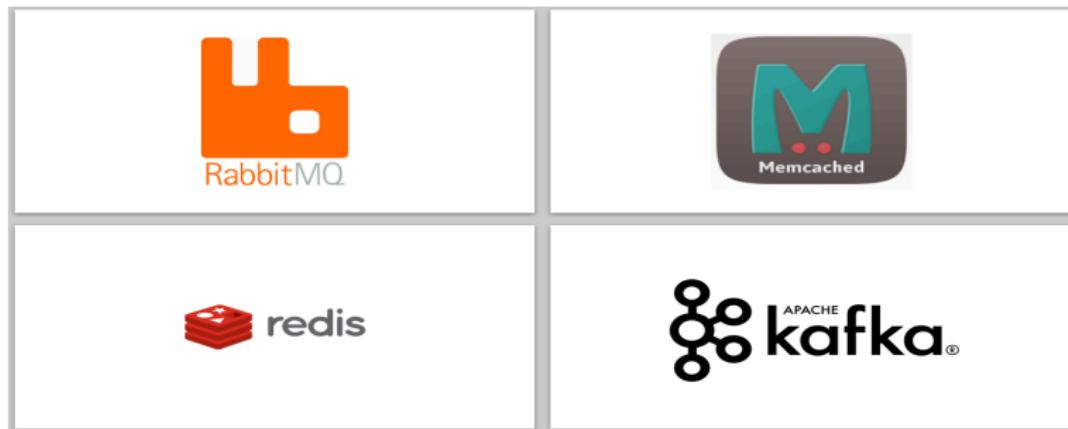


Figure: Shared DS Market Availability

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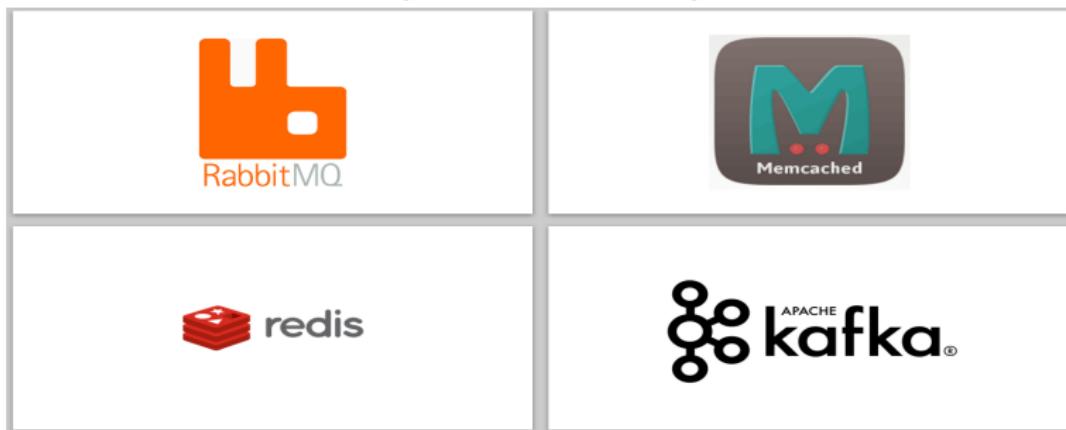


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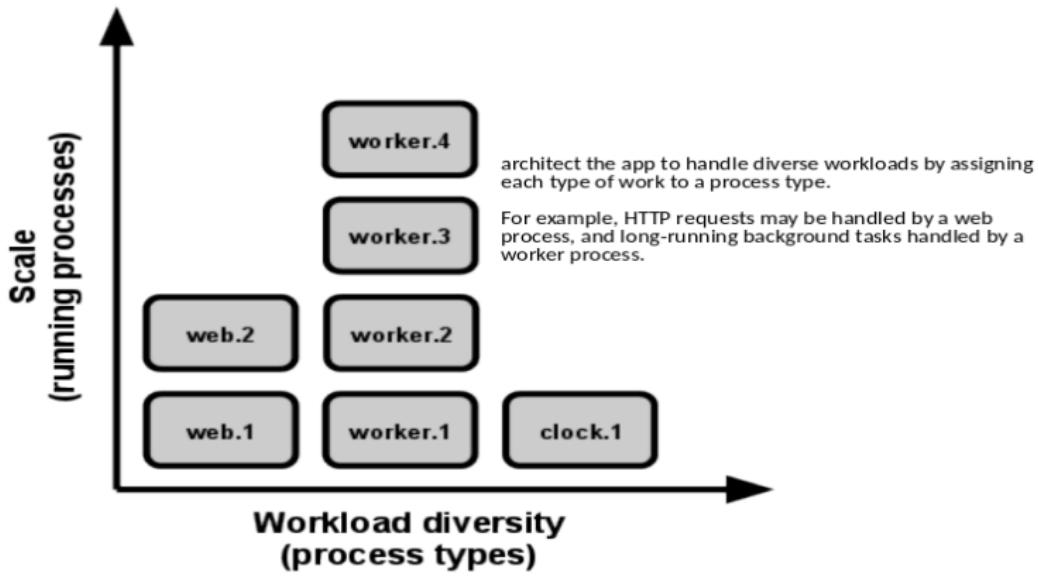
The Twelve-Factor App

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



The Twelve-Factor App

⑨ Logs

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The Twelve-Factor App

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- Today we have some good dedicated software which can aggregate files from different locations, like Logstash and Splunk



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- Logs are streams, and it is not the app job how to save them?
- A dedicated process should do this, and app work is output logs only
- 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
- 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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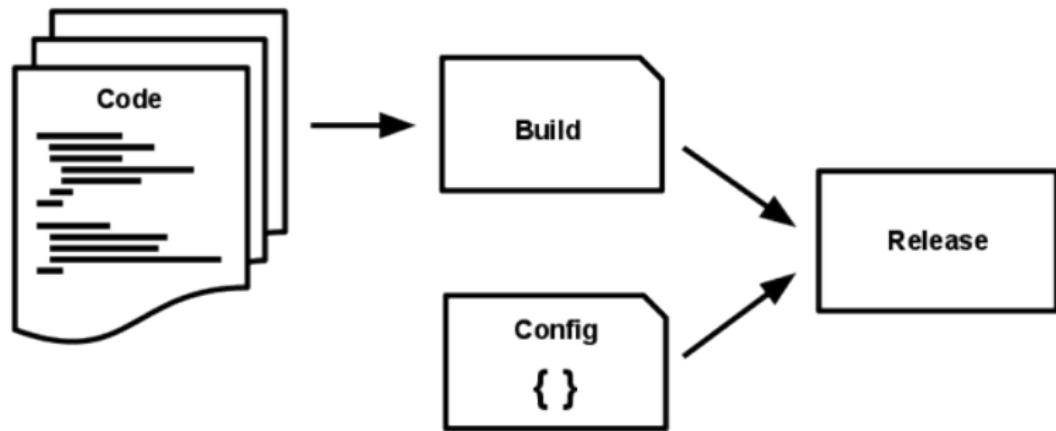
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- Processes should also be robust against sudden death, in the case of a failure in the underlying hardware. A recommended approach is use of a robust queueing backend, such as Beanstalkd, that returns jobs to the queue when clients disconnect or time out.

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⑪ Dev/prod parity

Keep development, staging, and production as similar as possible

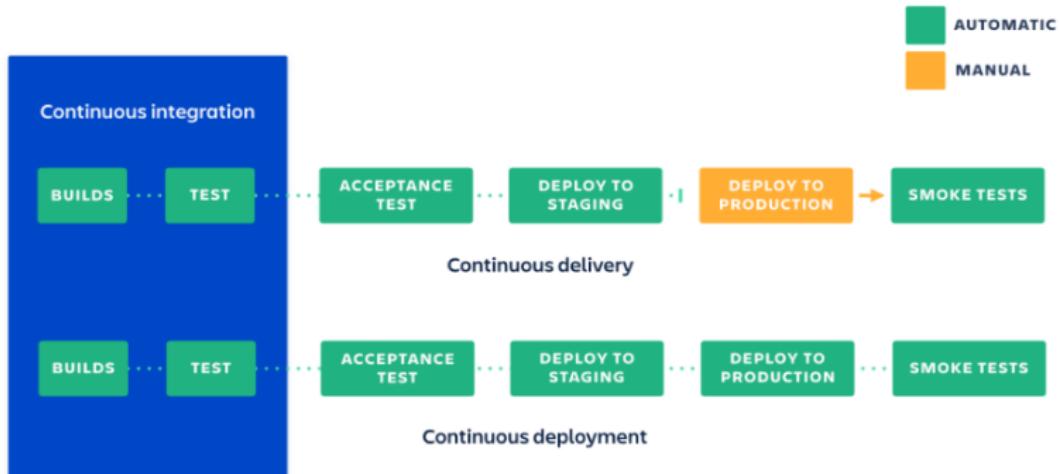


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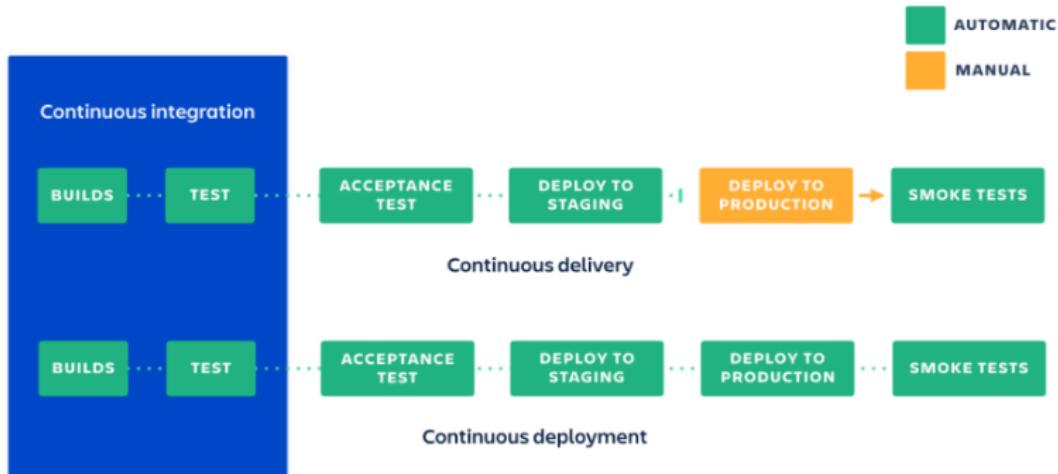


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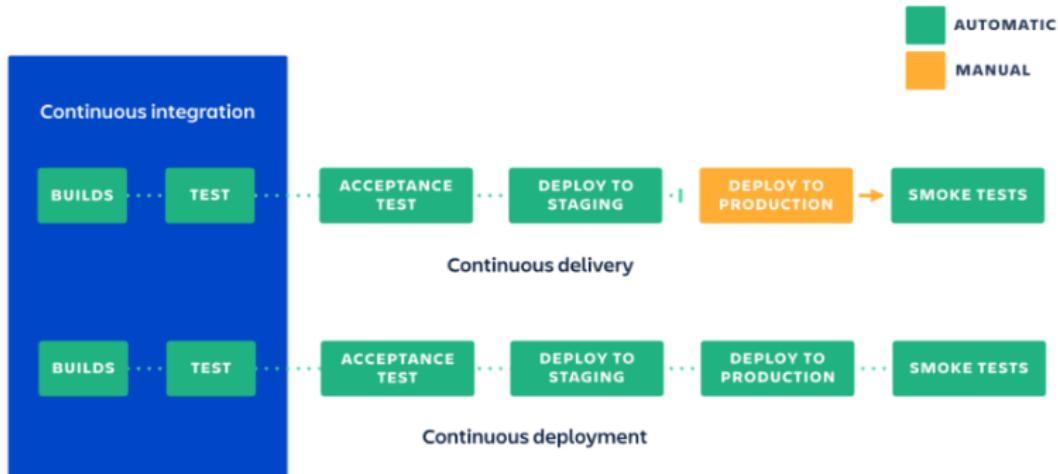


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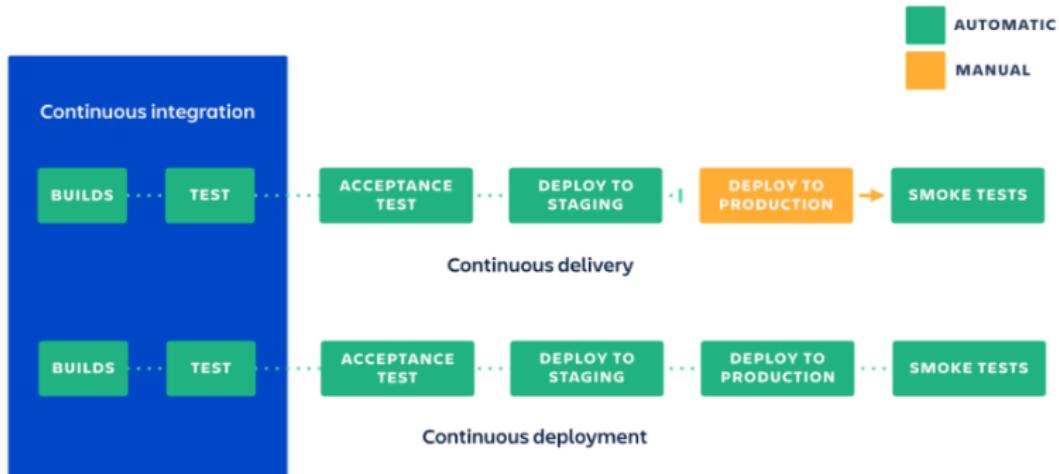


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- **The personnel gap:** Developers write code, ops engineers deploy it.
- **The tools gap:** Developers may be using a stack like Nginx, SQLite, and OS X, while the production deploy uses Apache, MySQL, and Linux.



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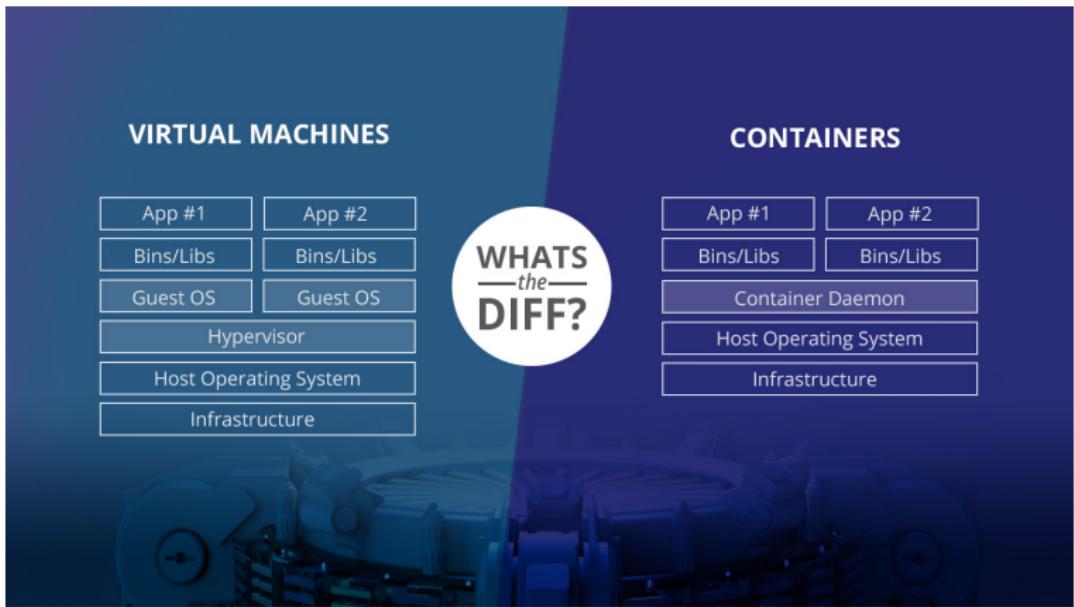
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- **Dockerization**



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

Service Orchestrators

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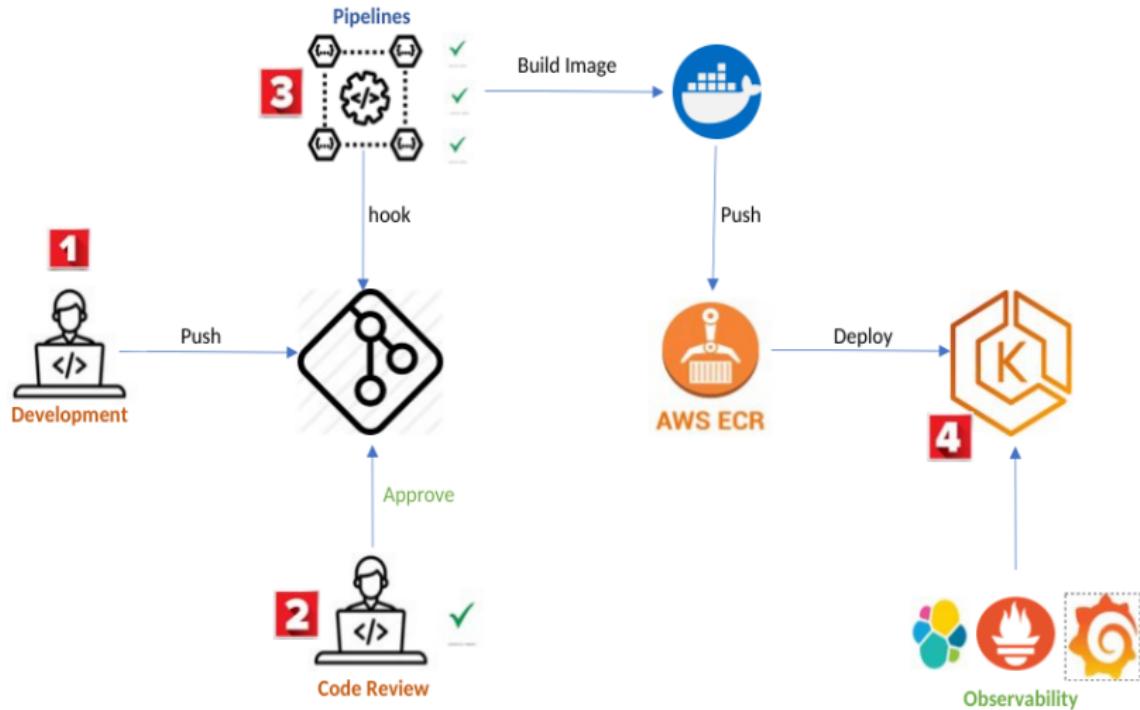
Popular Orchestrators

- 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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- Should I (SysAdmin/Operator) learn programming to apply IaC?

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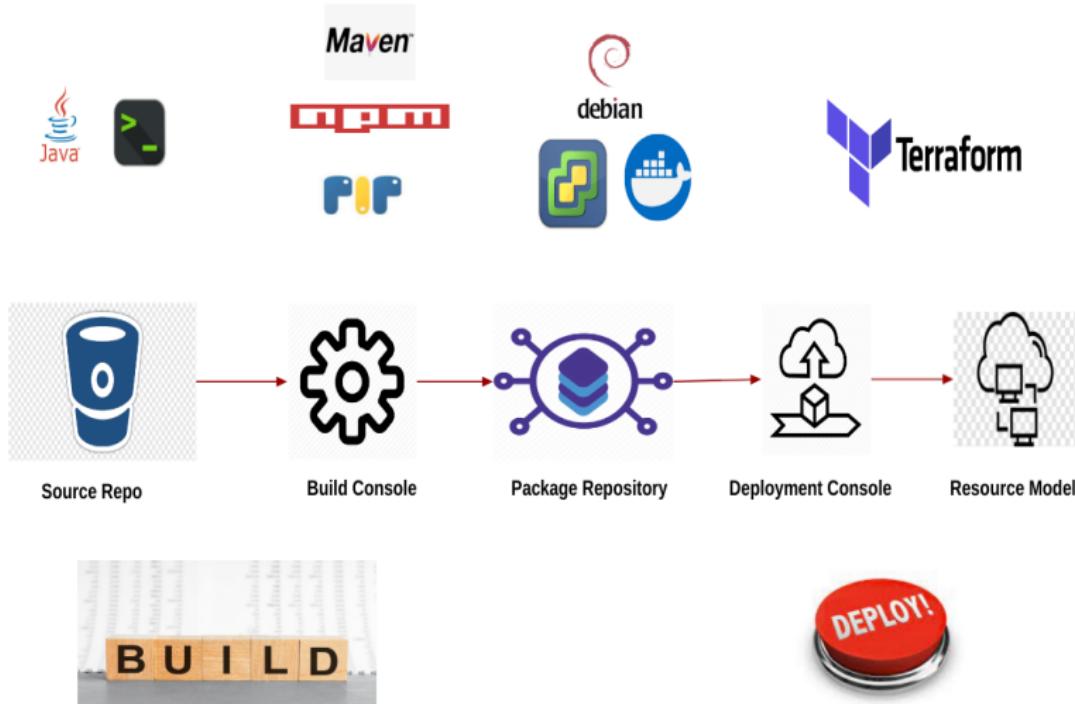
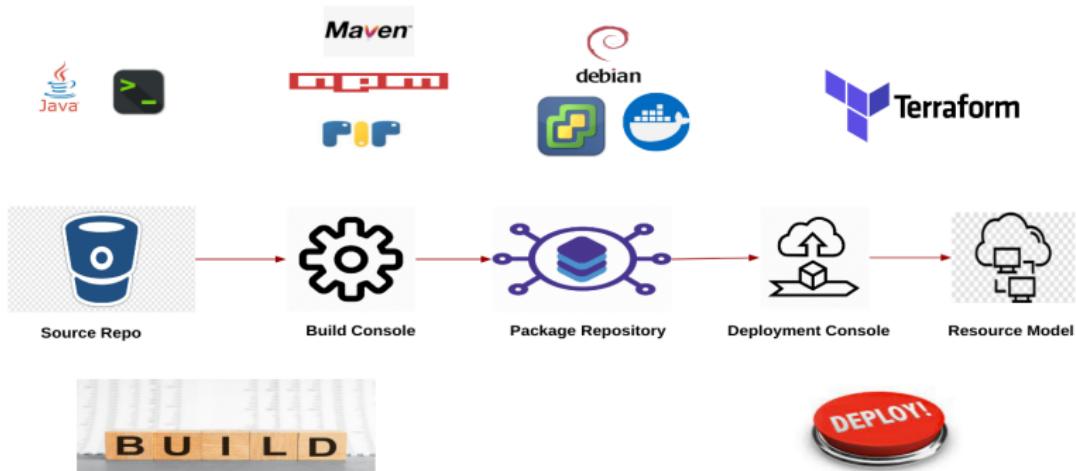


Figure: Service Delivery Platform

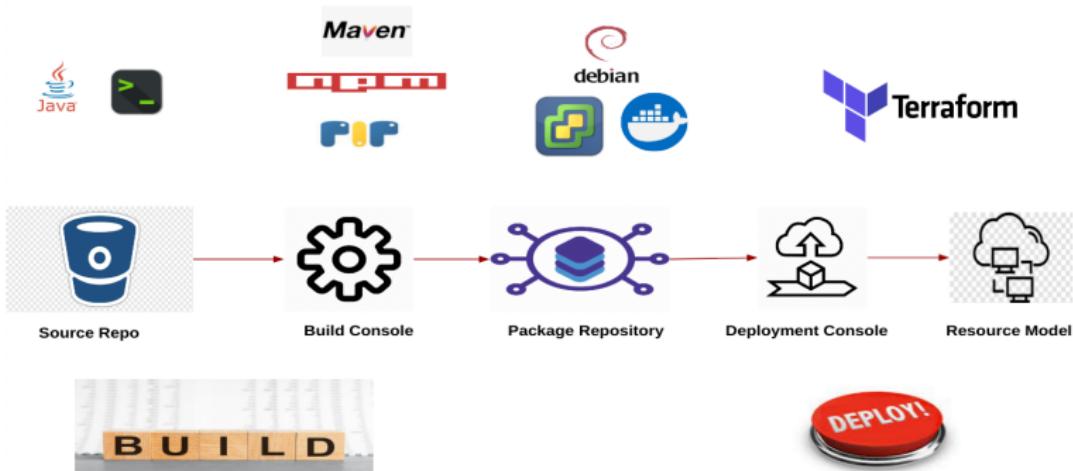
Infrastructure as Code "IaC"

- But how to ensure quality of code?



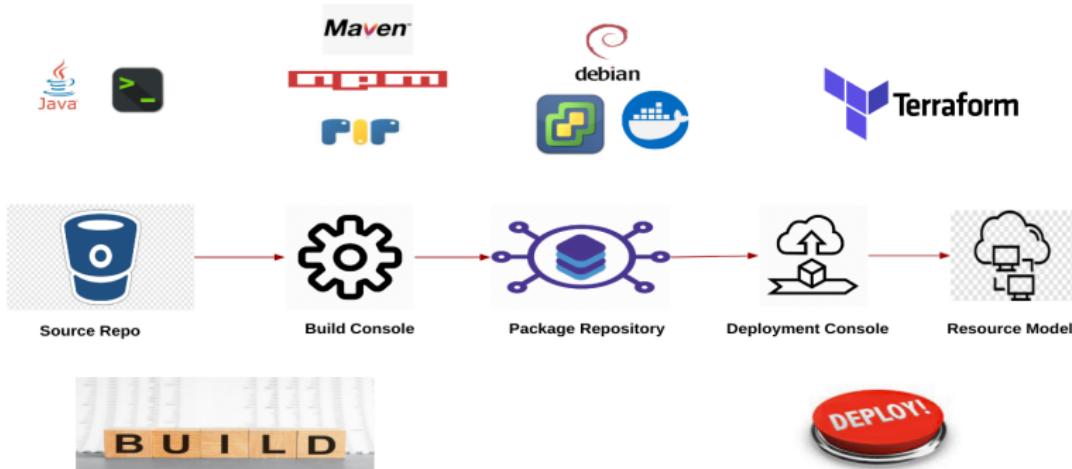
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- Answer: Testing



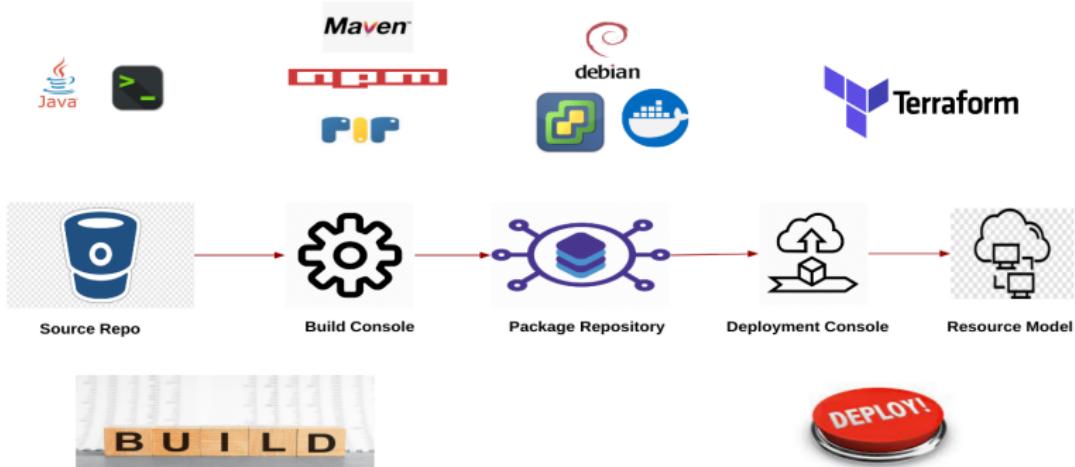
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 - Rubocop Formatter and Foodcritic Linter
 - ChefSpec Test Simulator and Coverage
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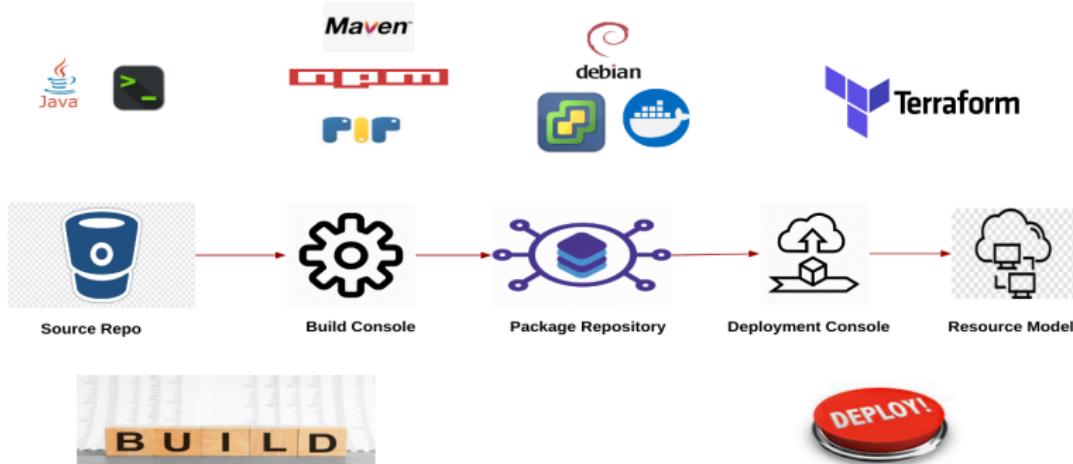
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- There will be always kind of tension between Dev team and Ops team; especially if Ops team is applying SRE principles



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

Communication Design

Online purchase example

- Save it

```
1 submitOrder(Ordeer order) {  
2     saveOrder(order);  
3     if (checkDuplicates(order)) {  
4         charge(order);  
5         sendEmail(order);  
6         auditOrderDetails(order);  
7     }  
8 }  
9  
10 charge(Order order) {  
11     // call Charging service  
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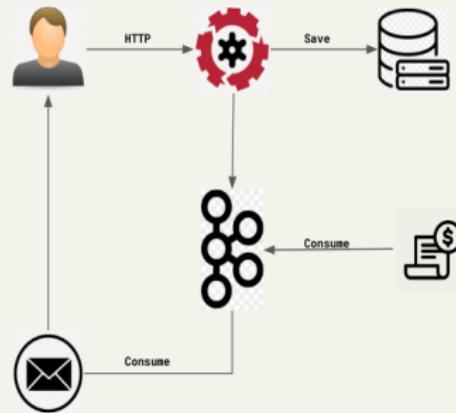
- Time Consuming
- Resource Consuming
- Not scalable

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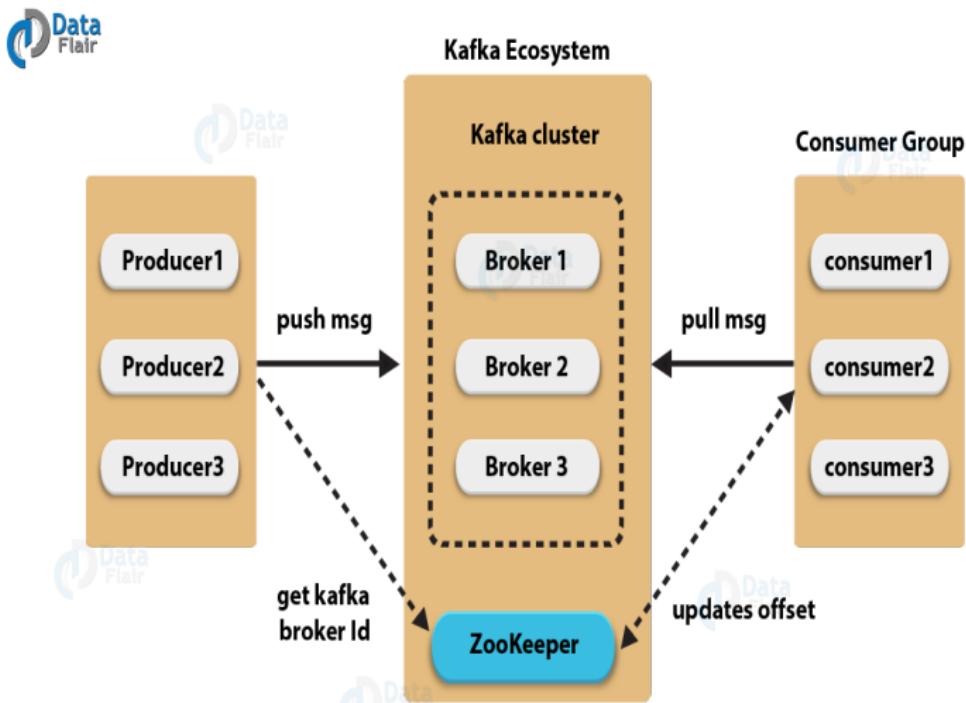
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Communication Design

Online purchase example [Kafka-Architecture]



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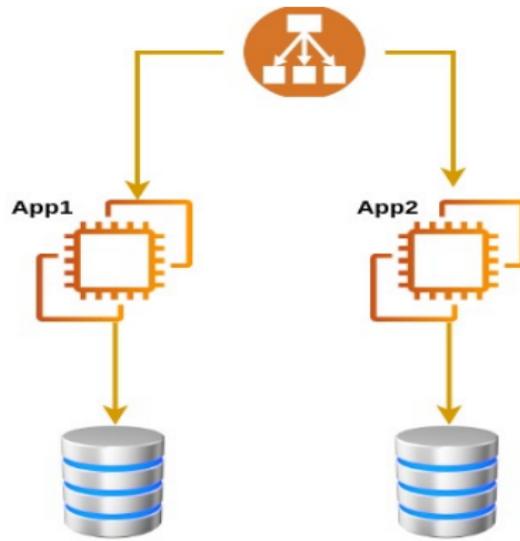
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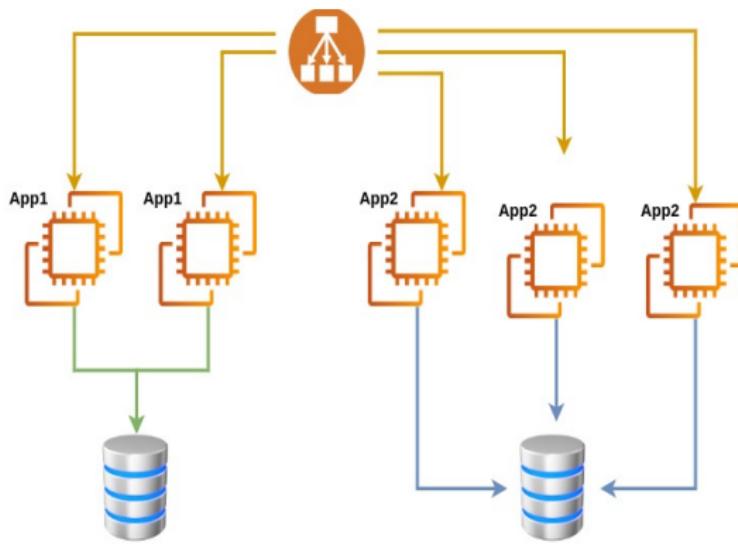
- The availability percentage of your service within period of time
- SLA is 99.99%

Scalability and High Availability



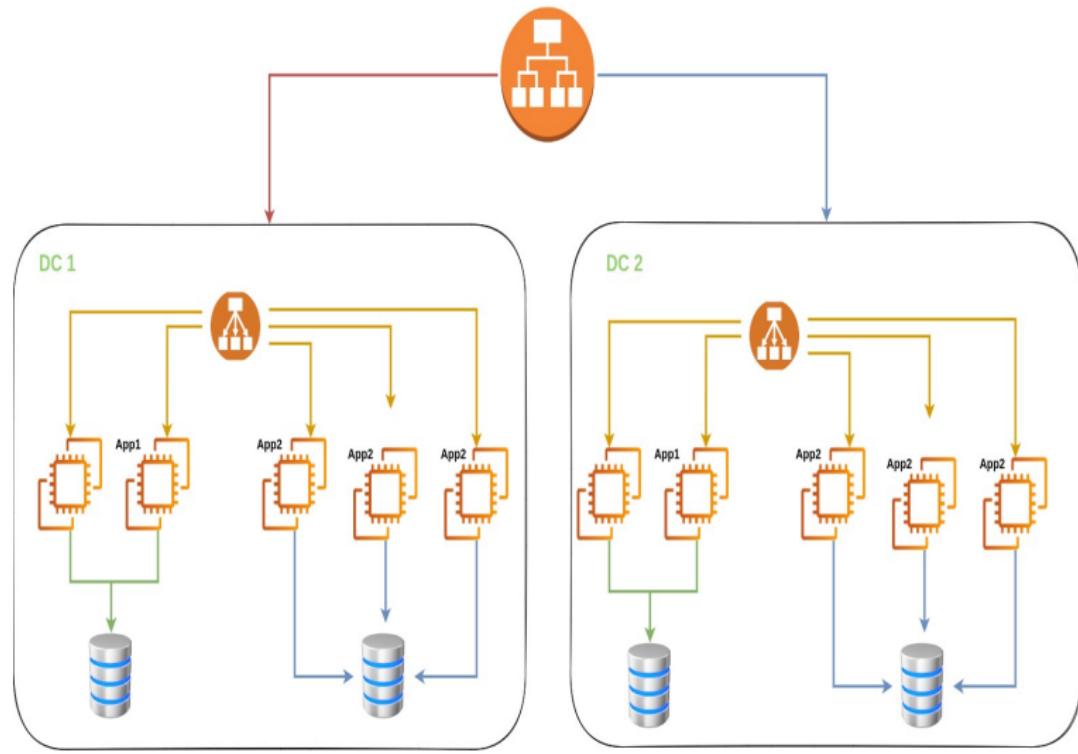
Scalability and High Availability

Horizontal Scaling



Scalability and High Availability

Fault Tolerant



Monitoring

One of the most hassle part in Microservices is **tracing**! What, How and Why this error occurred?

- Logging
- Tracing
 - Request may span multiple microservices, you should have some tracker over this.
 - Trace ID is a good way to do that
- Monitor matrices

Common Issues

One of the most hassle part in Microservices is **tracing!** What, How and Why this error occurred?

- No common knowledge

Service A sends to Service B, but response from Service B never reach back; *solution for such case can be Retry*

- Service is not available at current moment!

Solution for such case can be Queue system

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Thanks for Watching