

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

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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

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⑤ Scalability

- Each microservice can be scaled independently of the other services.

Microservices vs Monolithic

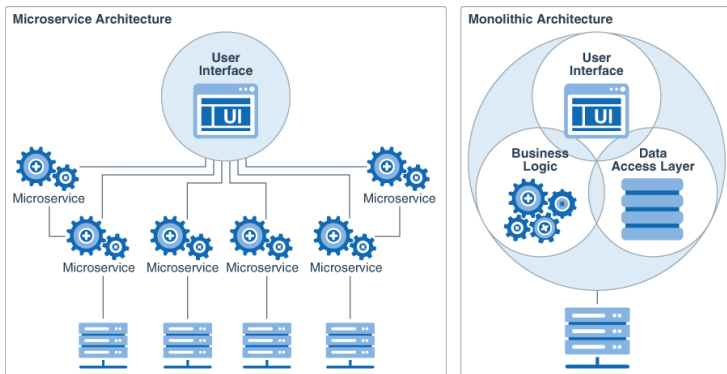


Figure: microservices vs monolithic

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

Closer Look

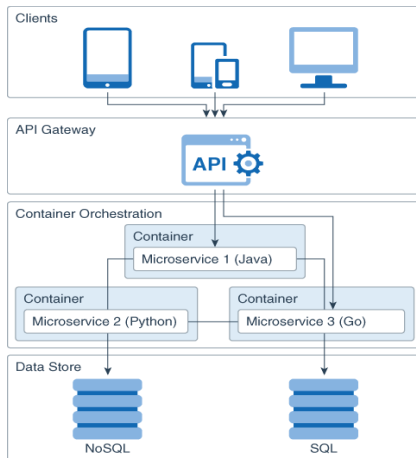


Figure: Microservices In Depth

Microservices Architecture

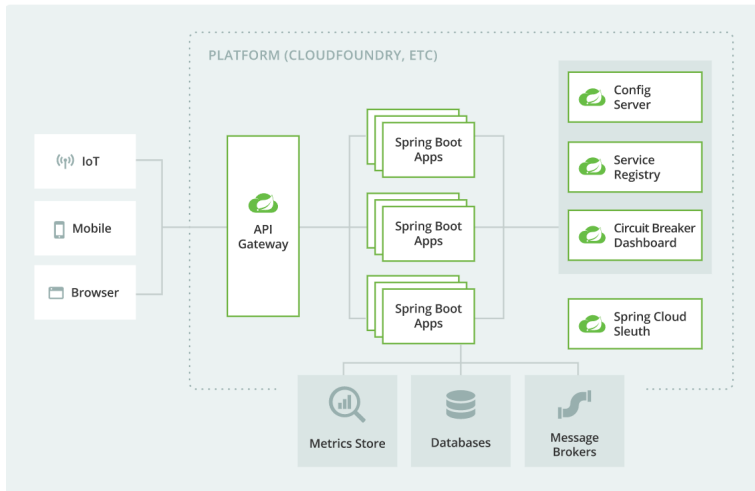
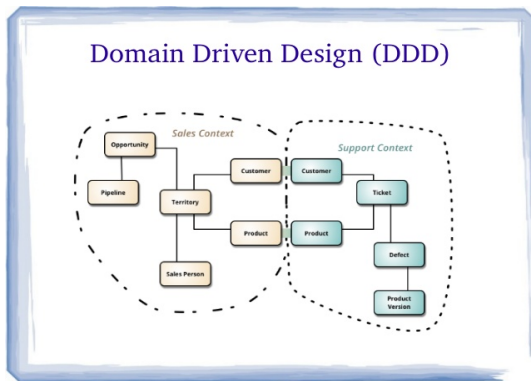


Figure: Microservices with Spring Cloud

Microservice characteristics

Single Responsibility

- Business Boundary
- Function Boundary



<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.

<https://blog.logrocket.com/methods-for-microservice-communication>

HTTP communication

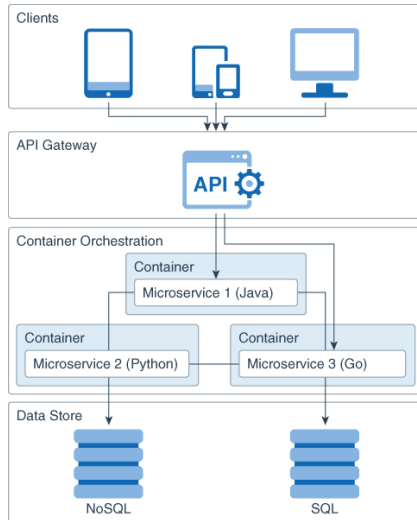


Figure: Synchronous calls

Event-driven communication

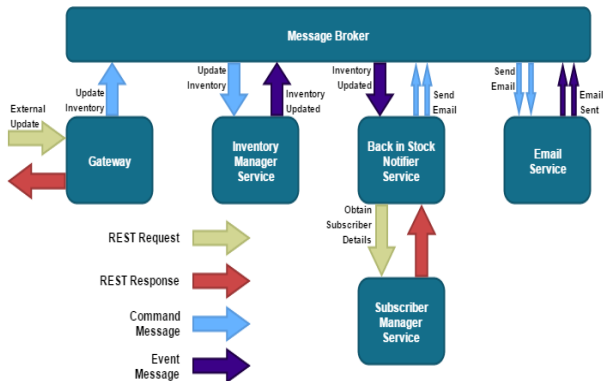


Figure: Asynchronous calls

<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.

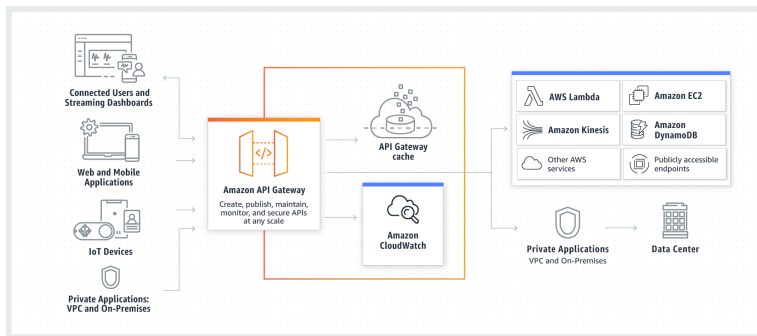


Figure: Amazon Gateway

Orchestration and API Gateway cont...

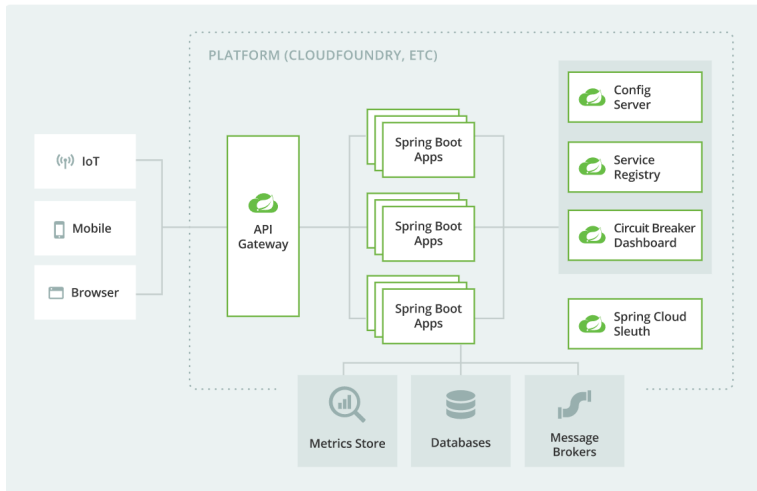


Figure: Microservices with Spring Cloud

Available Market Options



Figure: API Gateway Products

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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- ② Resilient
 - client should “cache” service information locally. Local caching allows for gradual degradation of the service discovery feature so that if service discovery service does become unavailable, applications can still function and locate the services based on the information maintained in its local cache.

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 - client should “cache” service information locally. Local caching allows for gradual degradation of the service discovery feature so that if service discovery service does become unavailable, applications can still function and locate the services based on the information maintained in its local cache.
- ❸ Fault-tolerant
 - detect when a service instance isn't healthy and remove the instance from the list of available services.

Service Discovery with Gateway

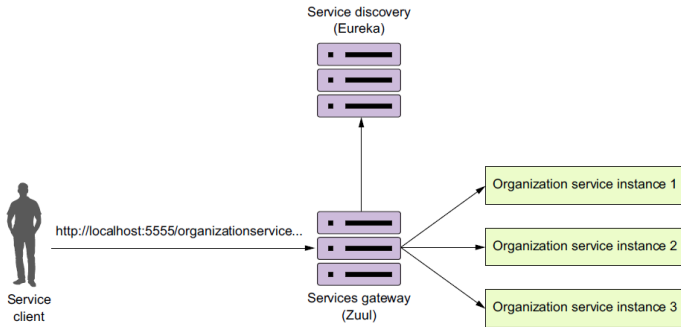


Figure: Service Registry and Gateway

Available Market Options



Figure: Service Registry Products

The Twelve-Factor App

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

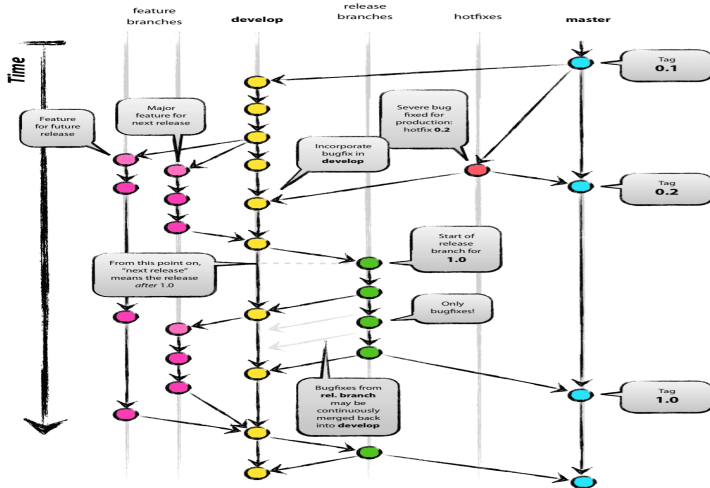
- 1 Codebase
- 2 Dependencies
- 3 Config
- 4 Backing services
- 5 Build, release, run
- 6 Processes
- 7 Port binding
- 8 Concurrency
- 9 Disposability
- 10 Dev/prod parity
- 11 Logs
- 12 Admin processes

<https://12factor.net>

The Twelve-Factor App

1 Codebase

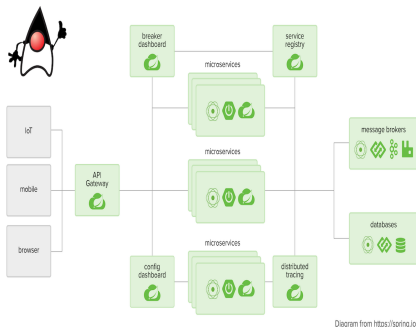
- One codebase tracked in revision control, many deploys



The Twelve-Factor App

2 Dependencies

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



```
<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>
<dependency>...</dependency>
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```

Never ever depend on operating system

The Twelve-Factor App

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- **Credentials are not configuration, but secrets**
 - Never ever store credentials in code
 - Don't save credentials in PLAINTEXT with config, but hashed
- **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

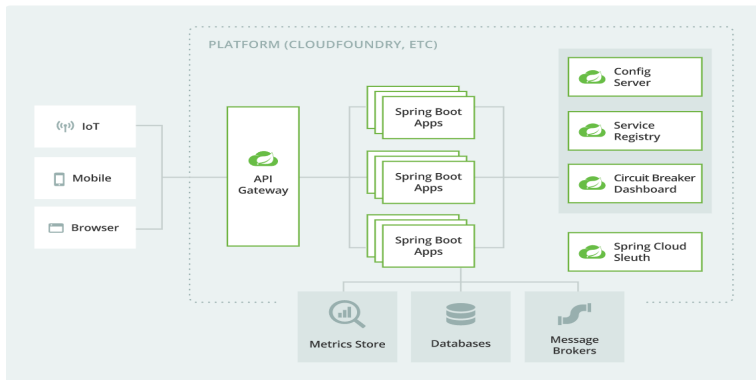


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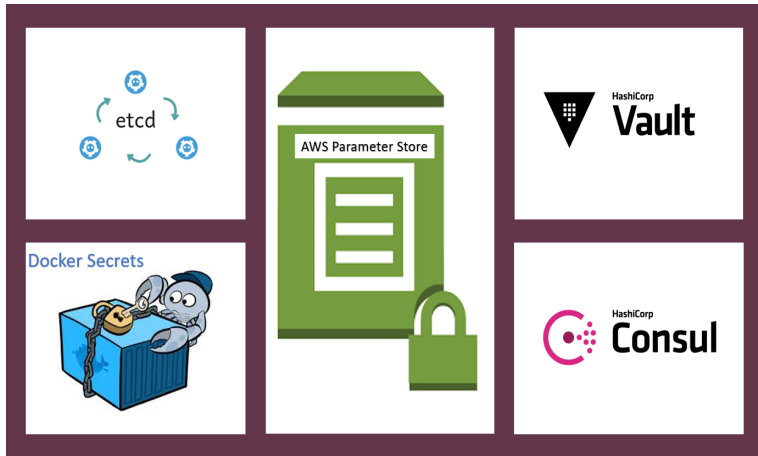


Figure: Popular Config Stores

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

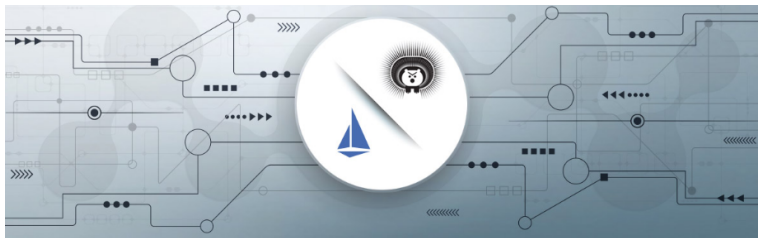


Figure: Circuit Breaker

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 an unresponsive supplier, then you can run out of critical resources leading to cascading failures across multiple systems.

Solution

Fault Tolerance

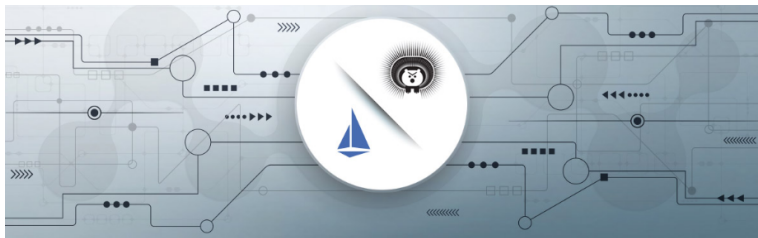


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- A good way for this is as mentioned in config talk.

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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 }  
6  
7 public void useAttachedResources(String resourceConfig, long userId) {  
8     User user = restTemplate.getObject(resourceConfig + userId, User.class);  
9     ...  
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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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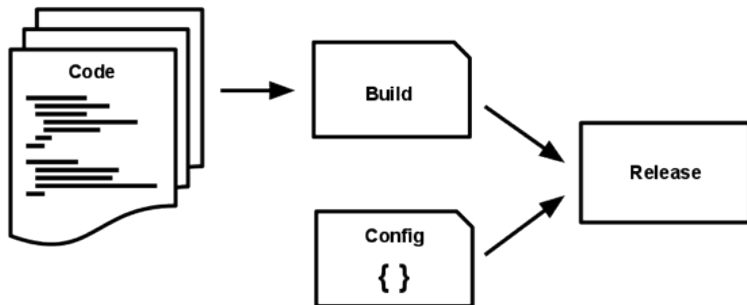


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The Twelve-Factor App

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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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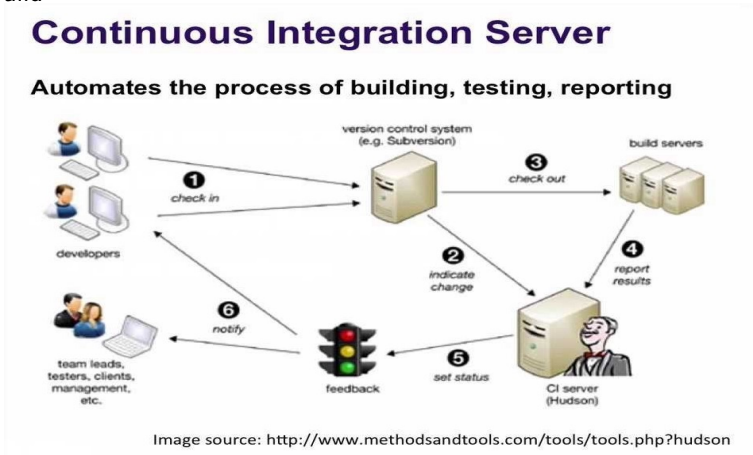


Figure: CI Workflow

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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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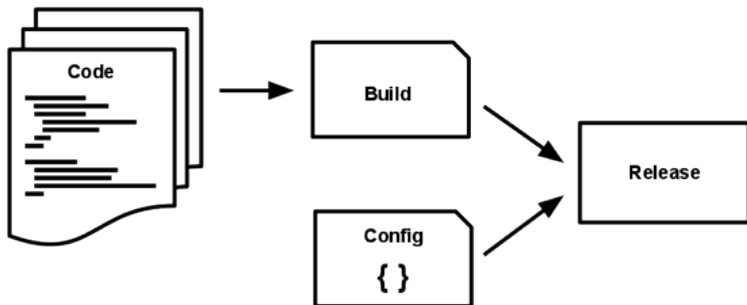
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- the run stage should be kept to as few moving parts as possible, since problems that prevent an app from running can cause it to break in the middle of the night when no developers are on hand.

The Twelve-Factor App

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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.

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7 Port Binding

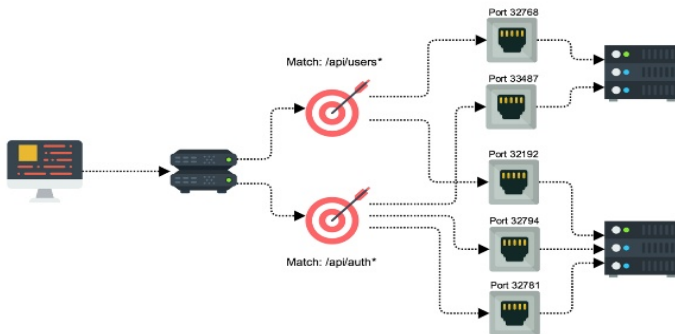
Export services via port binding

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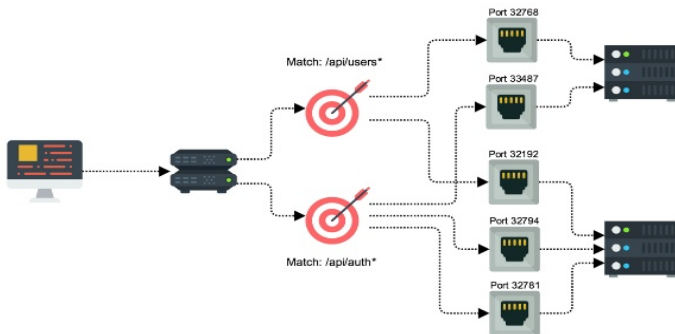


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Export services via port binding

- The Microservice is self-contained and does not rely on injection of a webserver to create a web-facing service.
- In a local development environment, you can visit a service URL like `http://localhost:5000/` to access the service exported by their app.

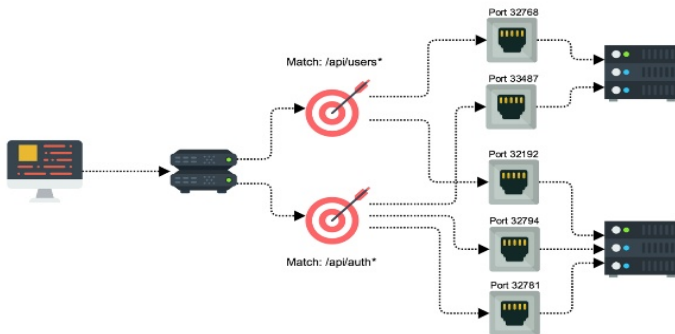


The Twelve-Factor App

7 Port Binding

Export services via port binding

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Data Sharing and Management

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

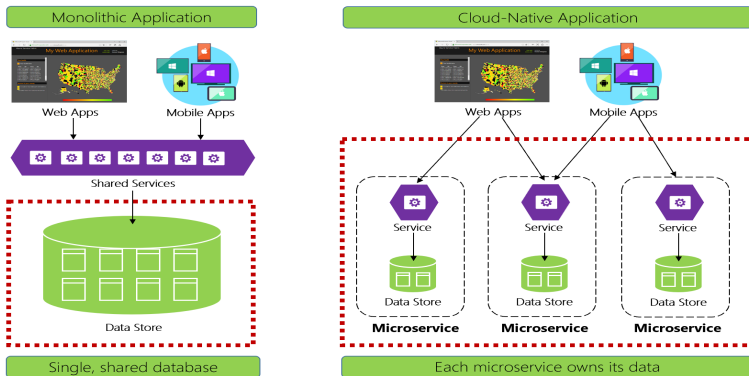


Figure: Distributed Data Architecture

Data Sharing and Management

Why database per 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

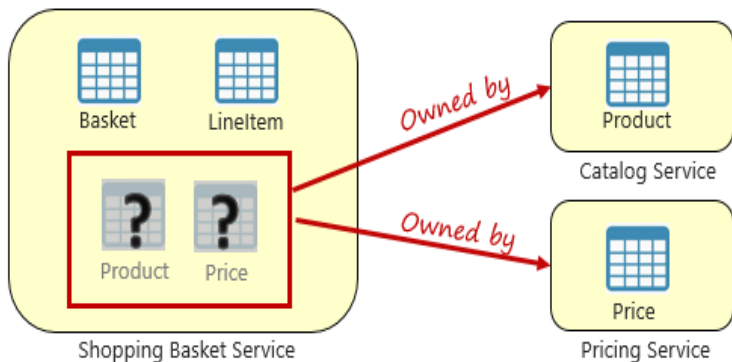


Figure: Querying across microservices

<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

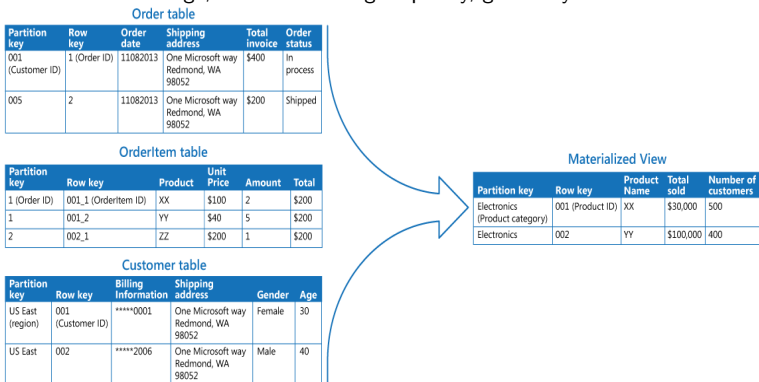


Figure: Materialized Views Pattern

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

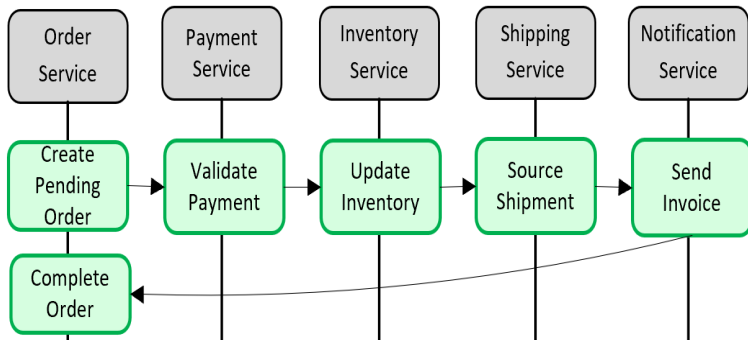


Figure: Transaction across microservices

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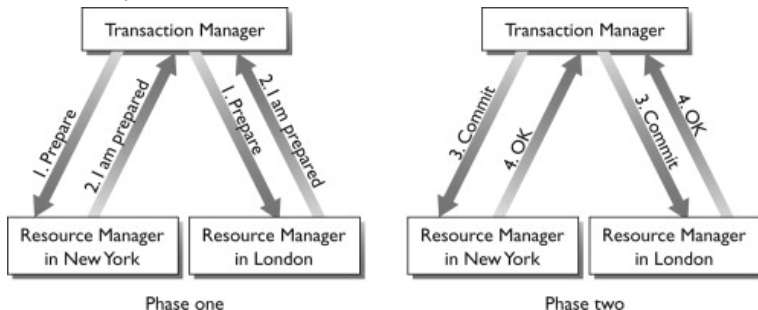


Figure: Two-phase Commit pattern

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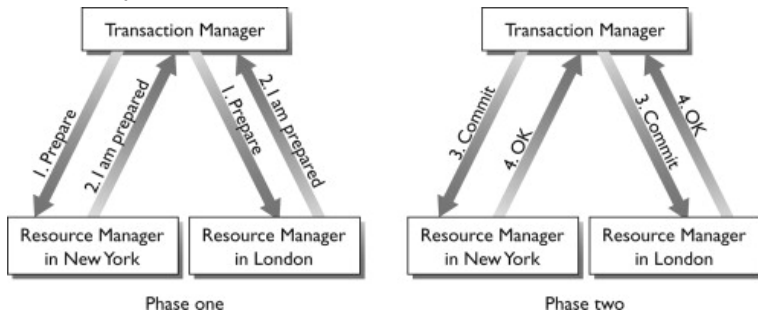


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- In real case, this is impractical, and will lead to locking and time consuming issue

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

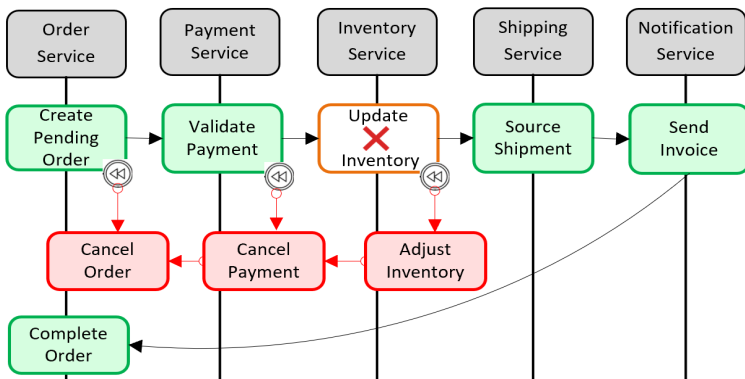


Figure: Rolling back a transaction

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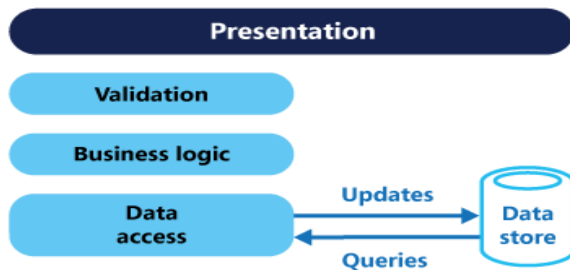


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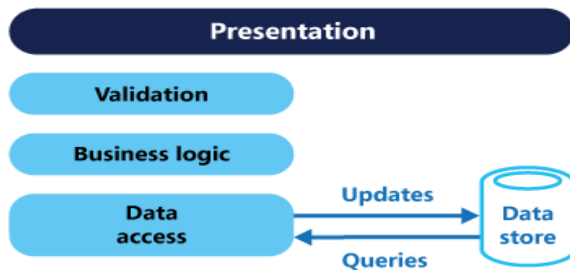


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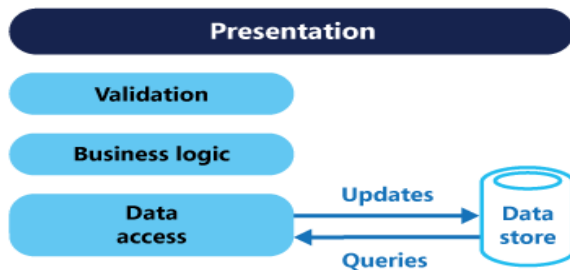


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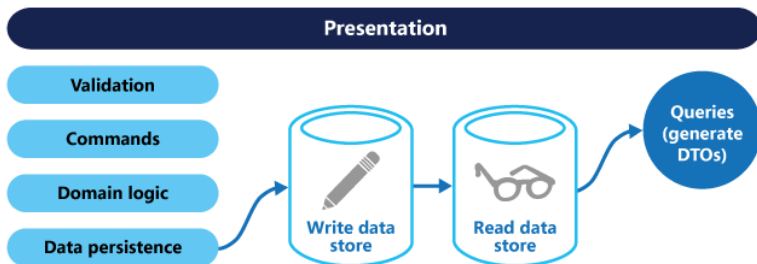


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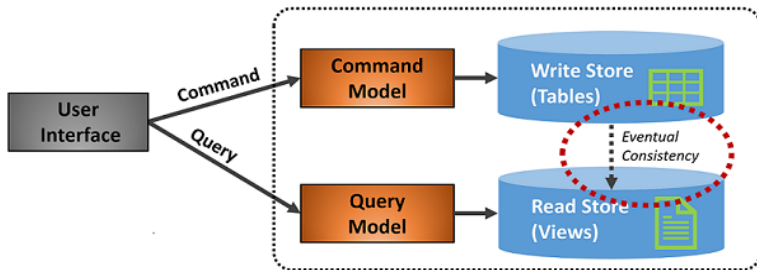


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- A good way to achieve this, is to use **Event Sourcing Pattern**

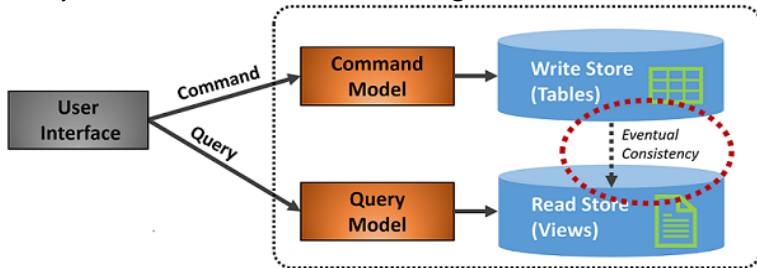


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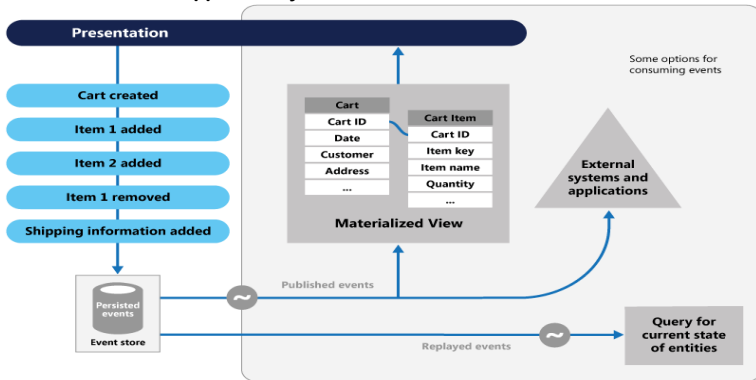


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Data Sharing and Management

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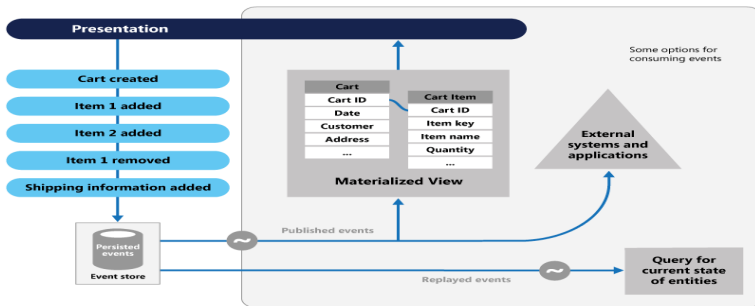


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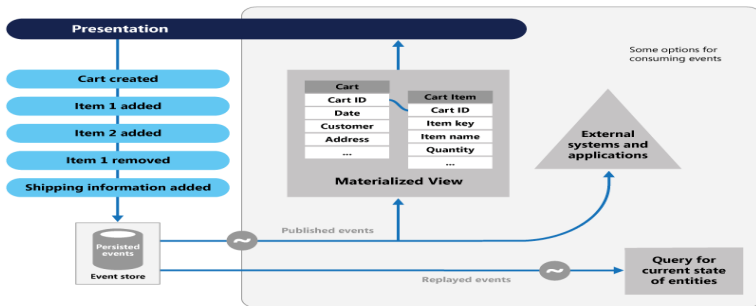


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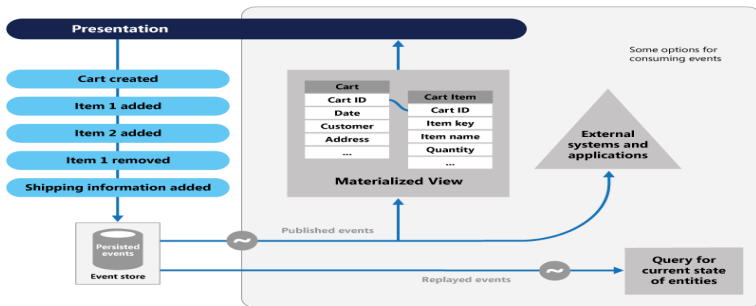


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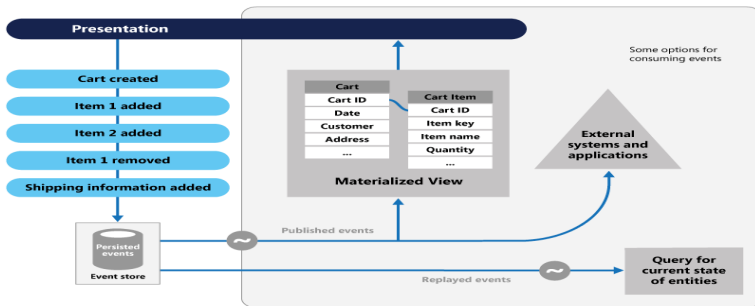


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- prevent concurrent updates from causing conflicts because it avoids the requirement to directly update objects in the data store

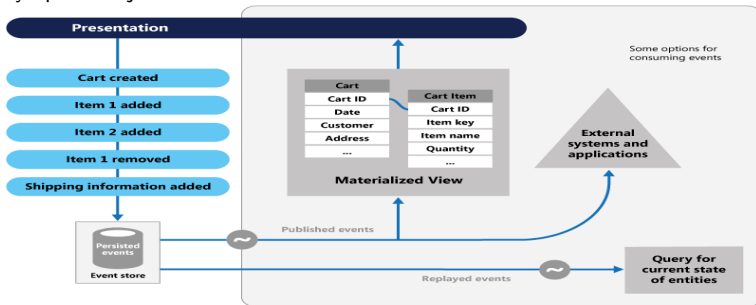


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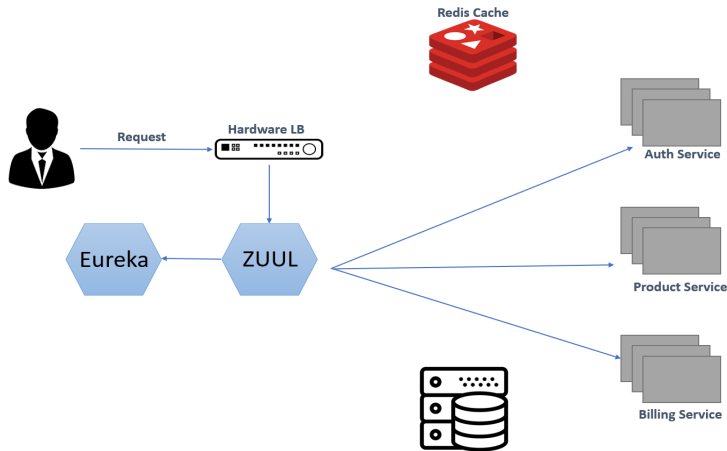


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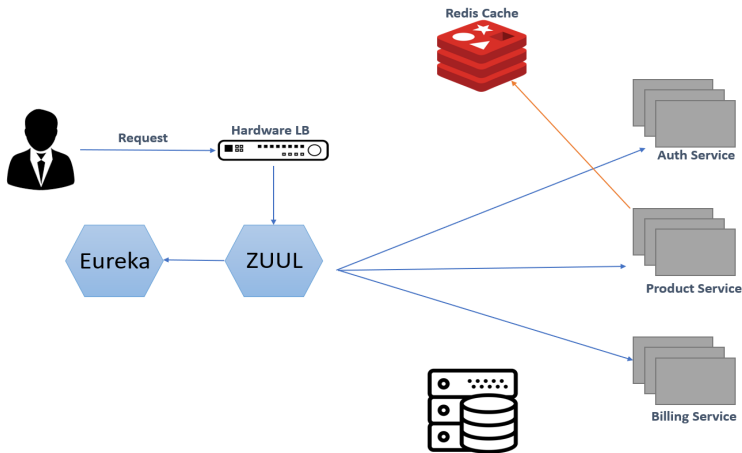


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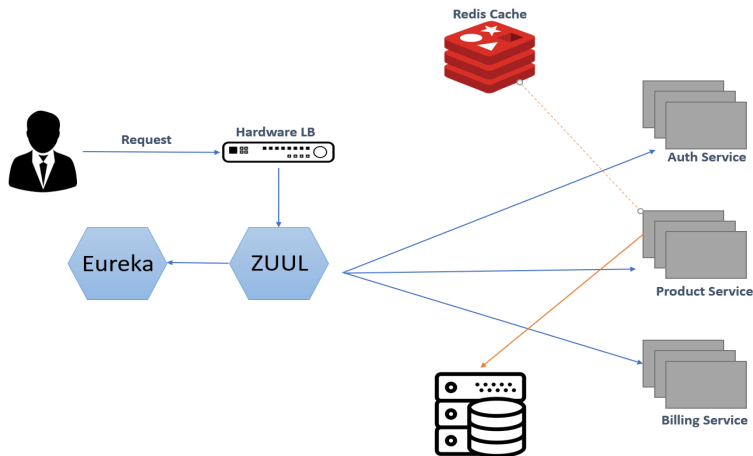


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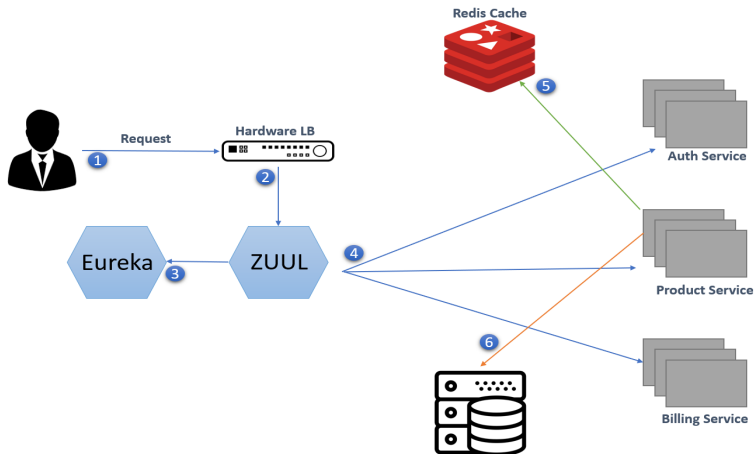


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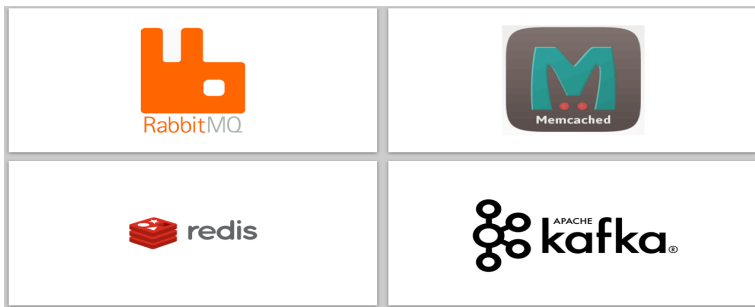


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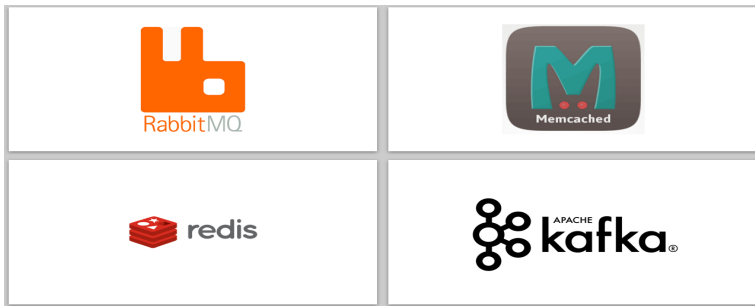


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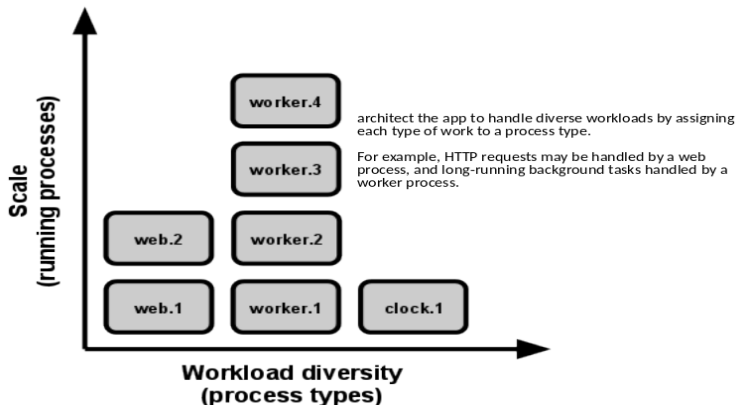
The Twelve-Factor App

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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9 Logs

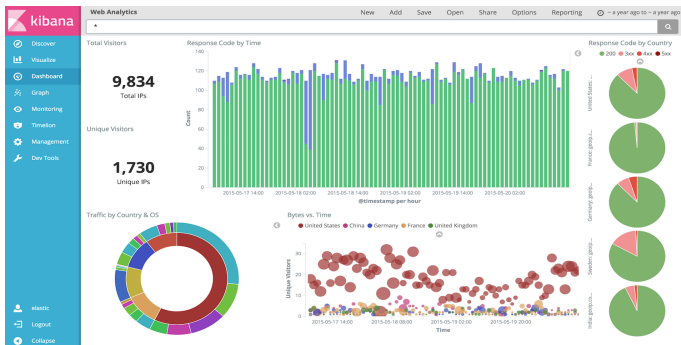
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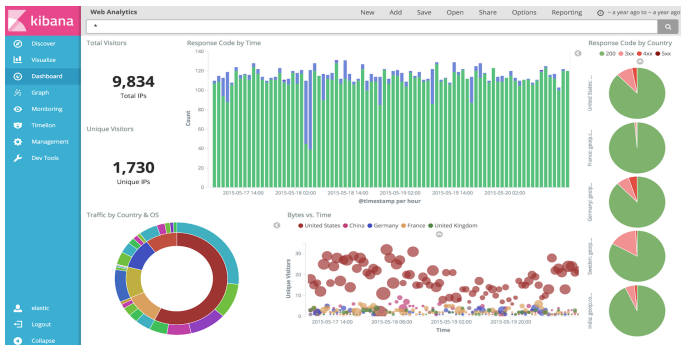


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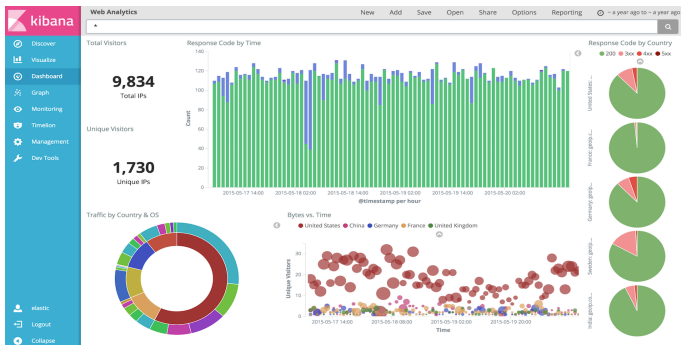
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- Viewing the logs with reports also are different task with different good software like Kibana, Datadog, Fluentd, and others



The Twelve-Factor App

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The Twelve-Factor App

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

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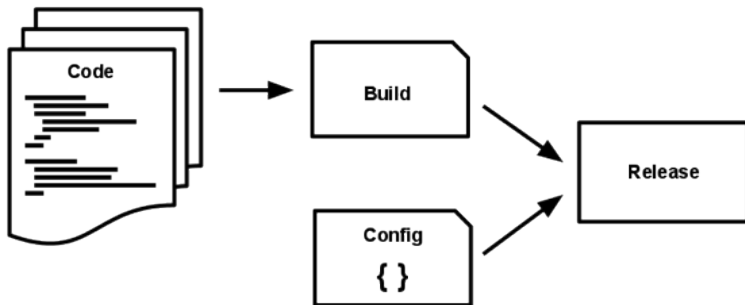
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- Processes should also be robust against sudden death, in the case of a failure in the underlying hardware. A recommended approach is use of a robust queueing backend, such as Beanstalkd, that returns jobs to the queue when clients disconnect or time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

The Twelve-Factor App

11 Dev/prod parity

Keep development, staging, and production as similar as possible

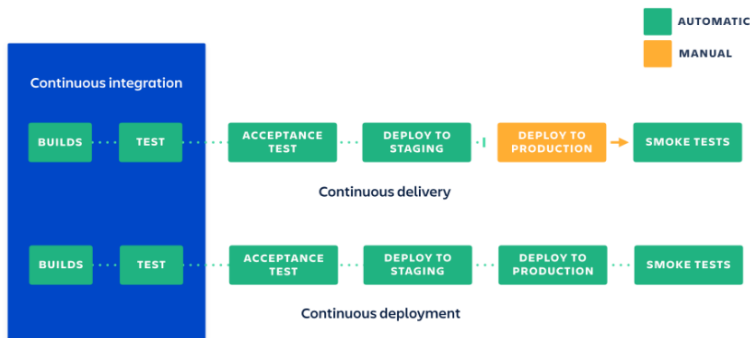


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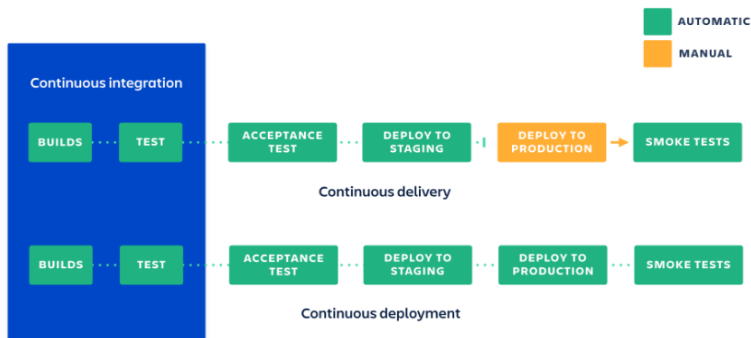


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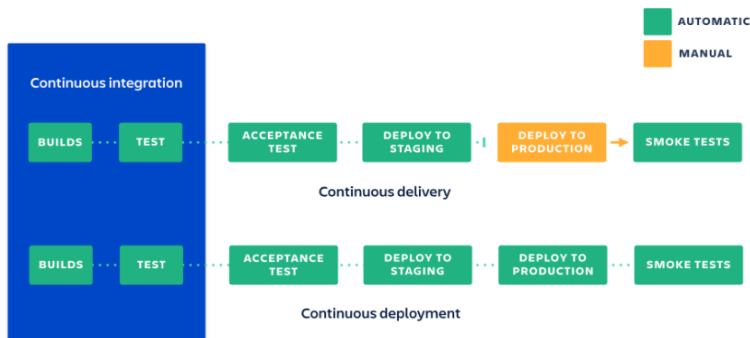


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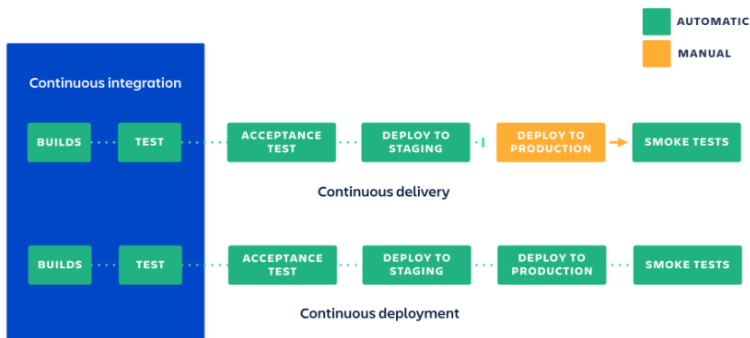


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- **The tools gap:** Developers may be using a stack like Nginx, SQLite, and OS X, while the production deploy uses Apache, MySQL, and Linux.



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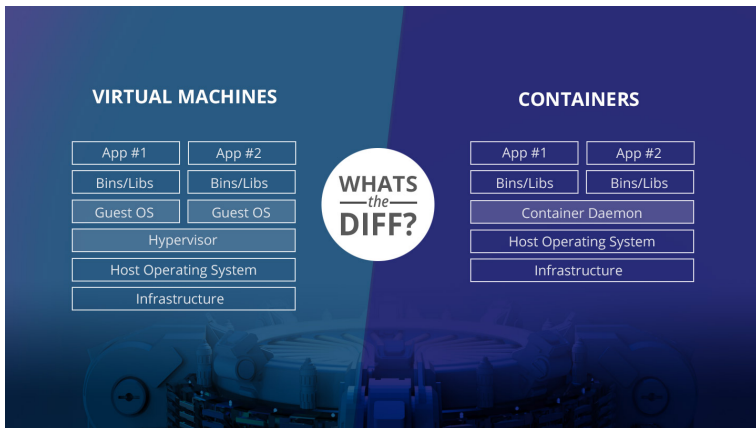
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- **Dockerization**



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

Service Orchestrators

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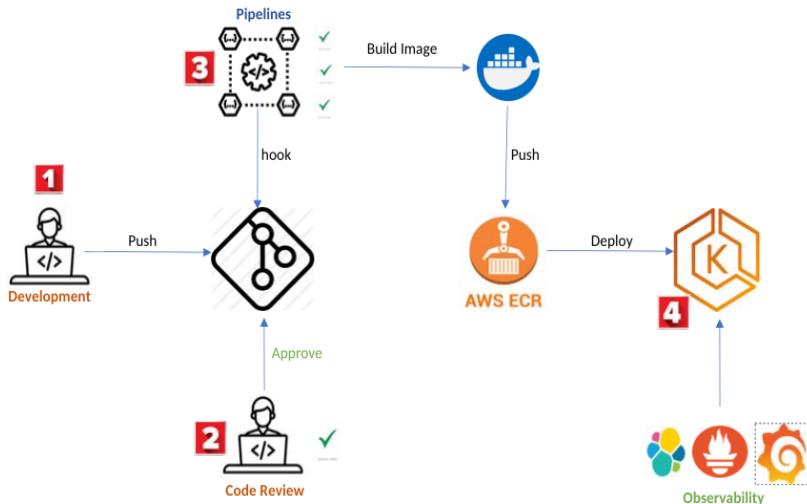
Popular Orchestrators

- 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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- The reason is Operator/SysAdmin usually uses **Imperative** way on building his job
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- It is better to use **Declarative** way on building such pipelines

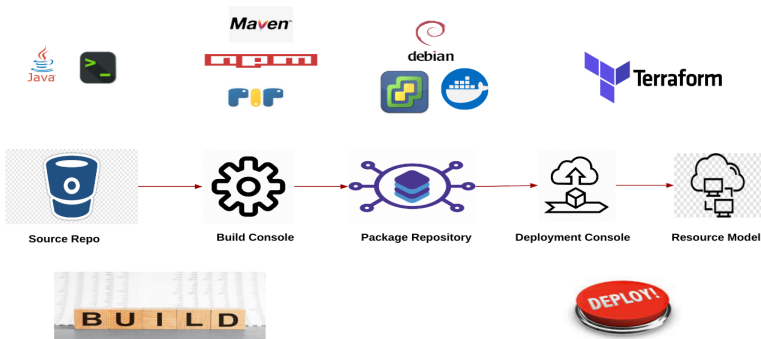
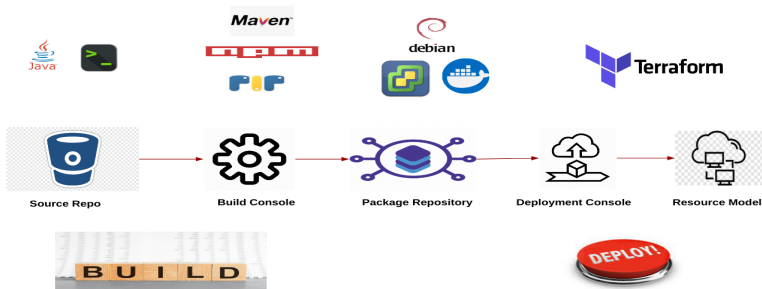


Figure: Service Delivery Platform

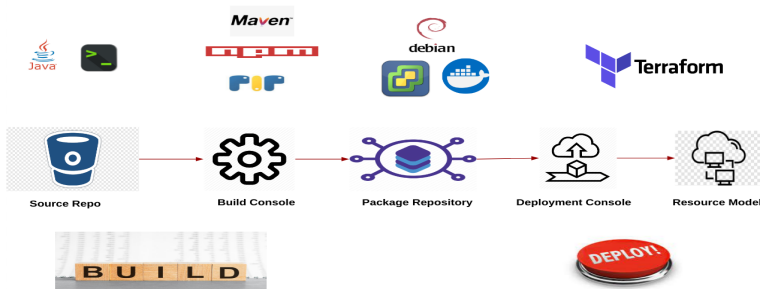
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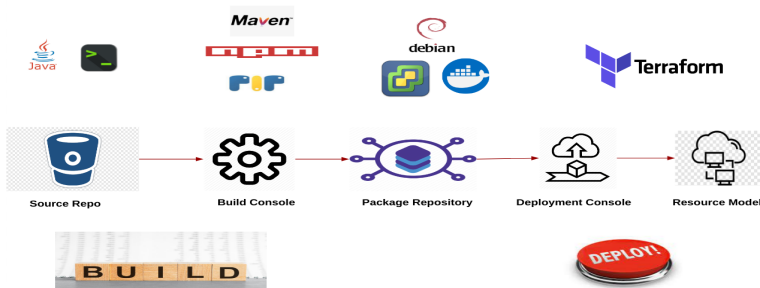
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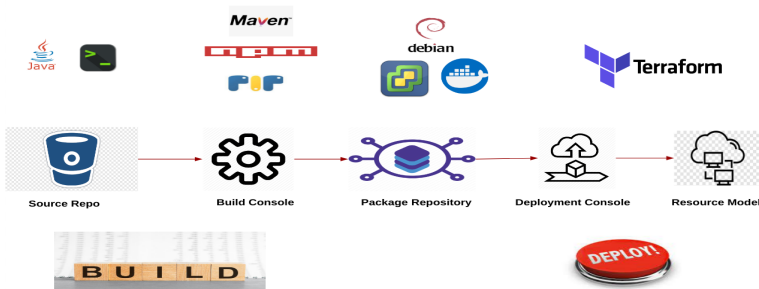
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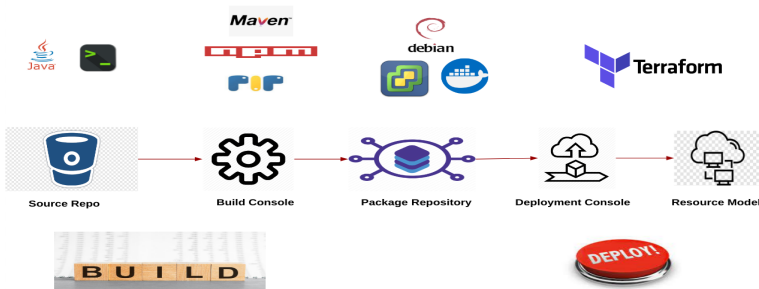
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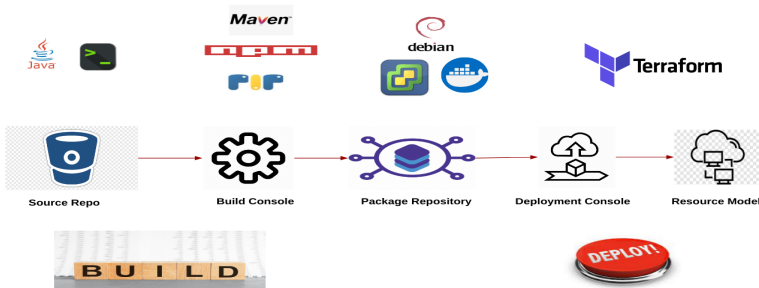
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- There will be always kind of tension between Dev team and Ops team; especially if Ops team is applying SRE principles



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