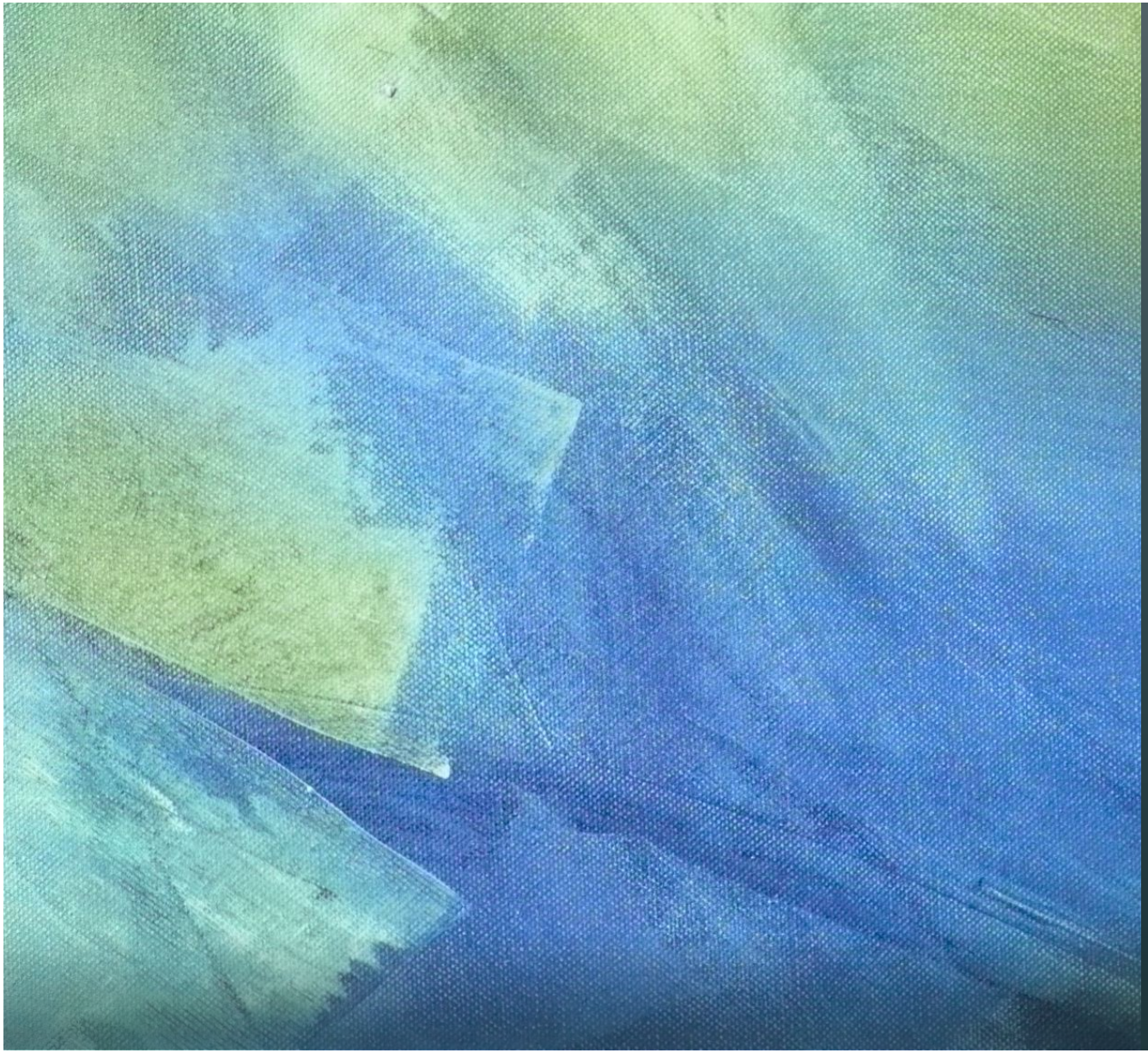


Introduction to Microservice Architecture

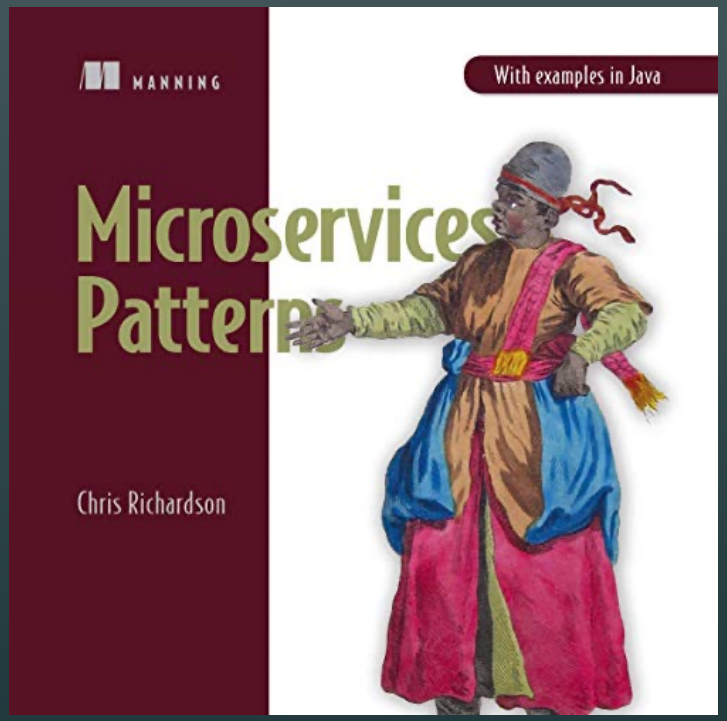
Wiwat Vatanawood

Duangdao Wichadakul

Nuengwong Tuaycharoen

Pittipol Kantavat

References



- Book
  - Chris Richardson, Microservices Patterns: With examples in Java, Manning, 2019
- Website
  - https://microservices.io/

The Chapter covers

- The symptoms of monolithic hell and how to escape it by adopting the microservice architecture
- The essential characteristics of the microservice architecture and its benefits and drawbacks
- How microservices enable the DevOps style of development of large, complex applications
- The microservice architecture pattern language and why you should use it

Agenda

- **A brief refresher on software architecture**
- From monolith to microservices
- Microservices != silver bullet
- Applying the microservice pattern language

What is software architecture?

"The software architecture of a computing system is the set of structures needed to reason about the system, which comprise software elements, relations among them, and properties of both."

Documenting Software Architectures, Bass et. al.

What is software architecture?

Architecture is multi-dimensional

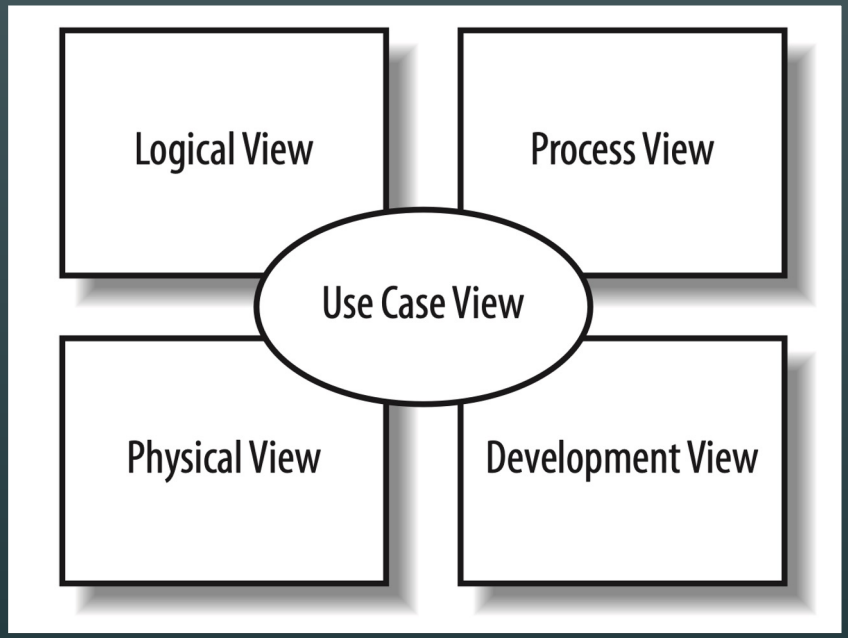
e.g. Structural, electrical, plumbing, mechanical

⇒

Described by multiple views

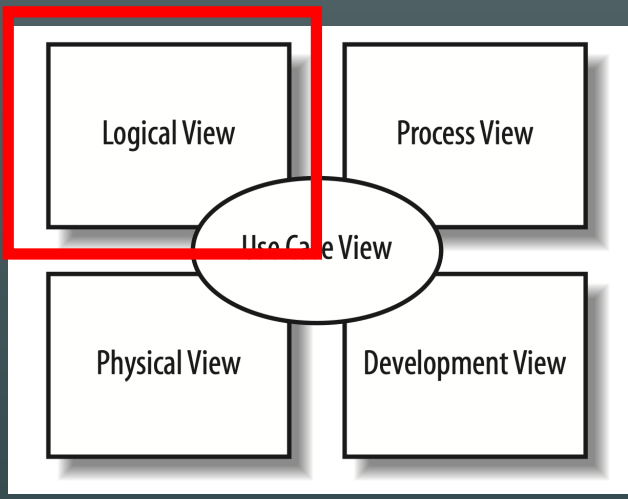
View = (elements, relations, properties)

Philippe Kruchten's 4+1 view model

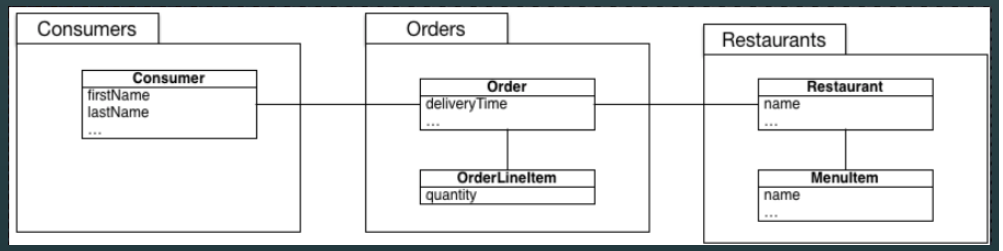


- Philippe Kruchten (born 1952) is a Canadian software engineer, and Professor of Software Engineering at University of British Columbia in Vancouver, Canada.

Logical view

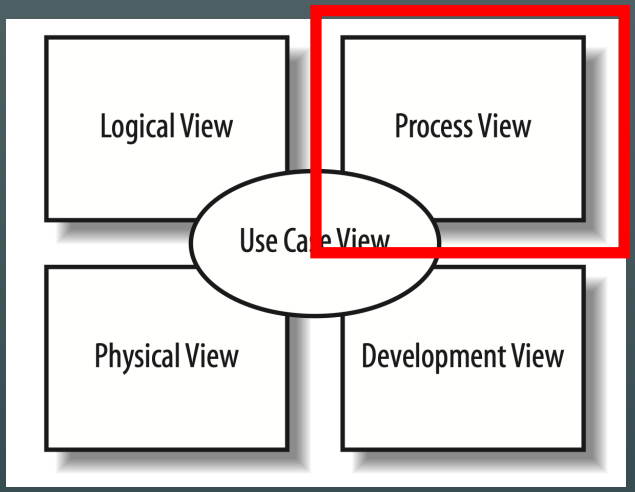


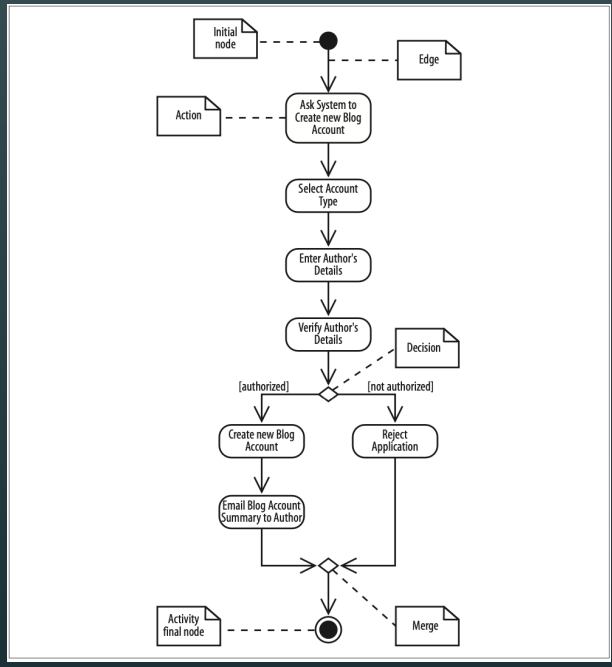
- Describes the abstract descriptions of a system's parts.
- Used to model what a system is made up of and how the parts interact with each other.
- The types of UML diagrams that typically make up this view include class, object, package, state machine, and interaction diagrams.



Process view

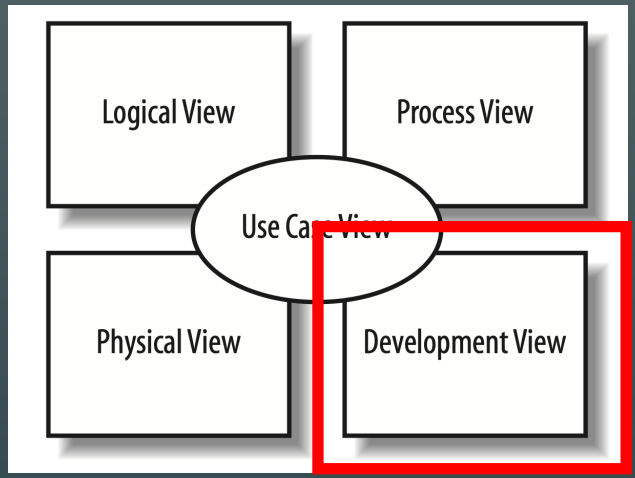
- Describes the processes within your system.
- It is particularly helpful when visualizing what must happen within your system.
- This view typically contains activity diagrams.

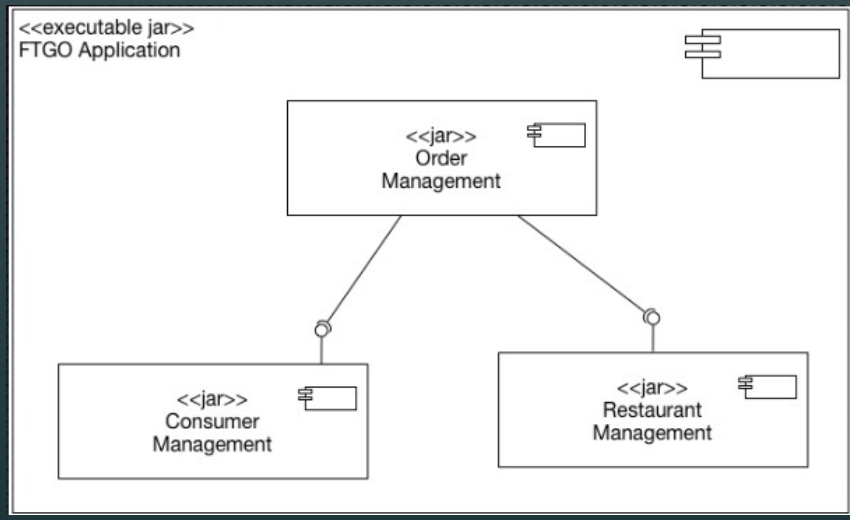




Development view (Implementation view)

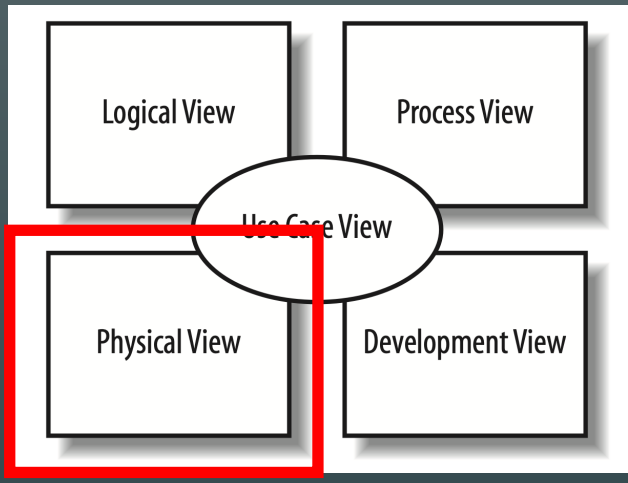
- Describes how your system's parts are organized into modules and components.
- It is very useful to manage layers within your system's architecture.
- This view typically contains package and component diagrams.

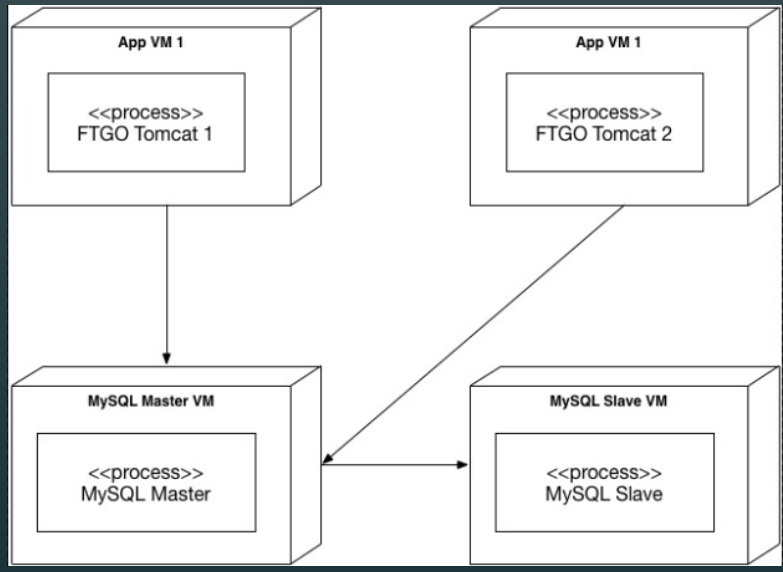




Physical view (Deployment view)

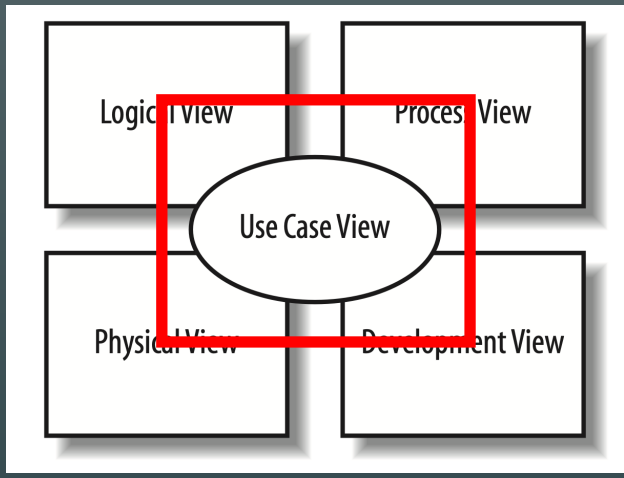
- Describes how the system's design, as described in the three previous views, is then brought to life as a set of real-world entities.
- The diagrams in this view show how the abstract parts map into the final deployed system.
- This view typically contains deployment diagrams.

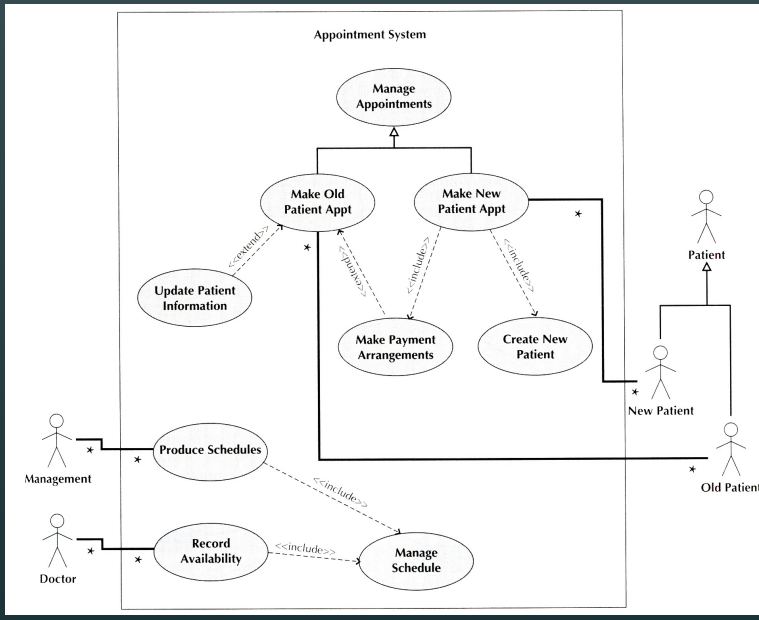




Use case view

- Describes the functionality of the system being modeled from the perspective of the outside world.
- This view is needed to describe what the system is supposed to do.
- All of the other views rely on the use case view to guide them—that's why the model is called 4+1.
- This view typically contains use case diagrams, descriptions, and overview diagrams.





Why architecture matters?

- Enables an application to satisfy the second category of requirements: its quality-of-service requirements
- Non-functional requirements
- Also known as quality attributes and are the so-called –ilities

- Maintainability
- Testability
- Deployability
- Evolvability
- Scalability
- Security
- Reliability
- …

Development velocity

https://en.wikipedia.org/wiki/Non-functional_requirement

Businesses must innovate faster

$\Rightarrow$

Build better software faster

- **Reducing** lead time
- **Increasing** deployment frequency

Modern software development: moving fast and not breaking things!

2017 State of DevOps Report | presented by Puppet + DORA

Table 2: 2017 IT performance by cluster

Survey questions	High IT performers	Medium IT performers	Low IT performers
Deployment frequency *For the primary application or service you work on, how often does your organization deploy code?*	46x On demand (multiple deploys per day)	Between once per week and once per month	Between once per week and once per month*
Lead time for changes *For the primary application or service you work on, what is your lead time for changes (i.e., how long does it take to go from code commit to code successfully running in production)?*	440x Less than one hour Netflix: 16 minutes	Between one week and one month	Between one week and one month*
Mean time to recover (MTTR) *For the primary application or service you work on, how long does it generally take to restore service when a service incident occurs (e.g., unplanned outage, service impairment)?*	24x Less than one hour	Less than one day	Between one day and one week
Change failure rate *For the primary application or service you work on, what percentage of changes results either in degraded service or subsequently requires remediation (e.g., leads to service impairment, service outage, requires a hotfix, rollback, fix forward, patch)?*	5x lower 0-15% Amazon: ~0.001%	0-15%	31-45%

Modern software development

Process:
DevOps/Continuous delivery/deployment

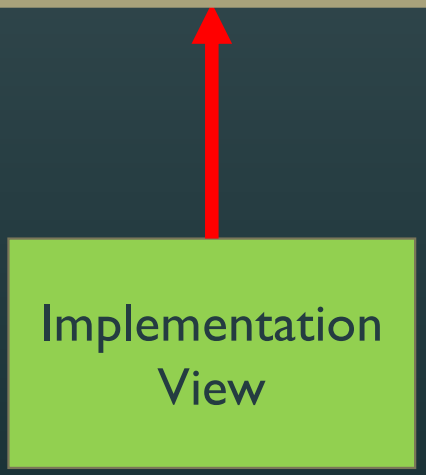
Organization:
Small, autonomous teams

Architecture:
??

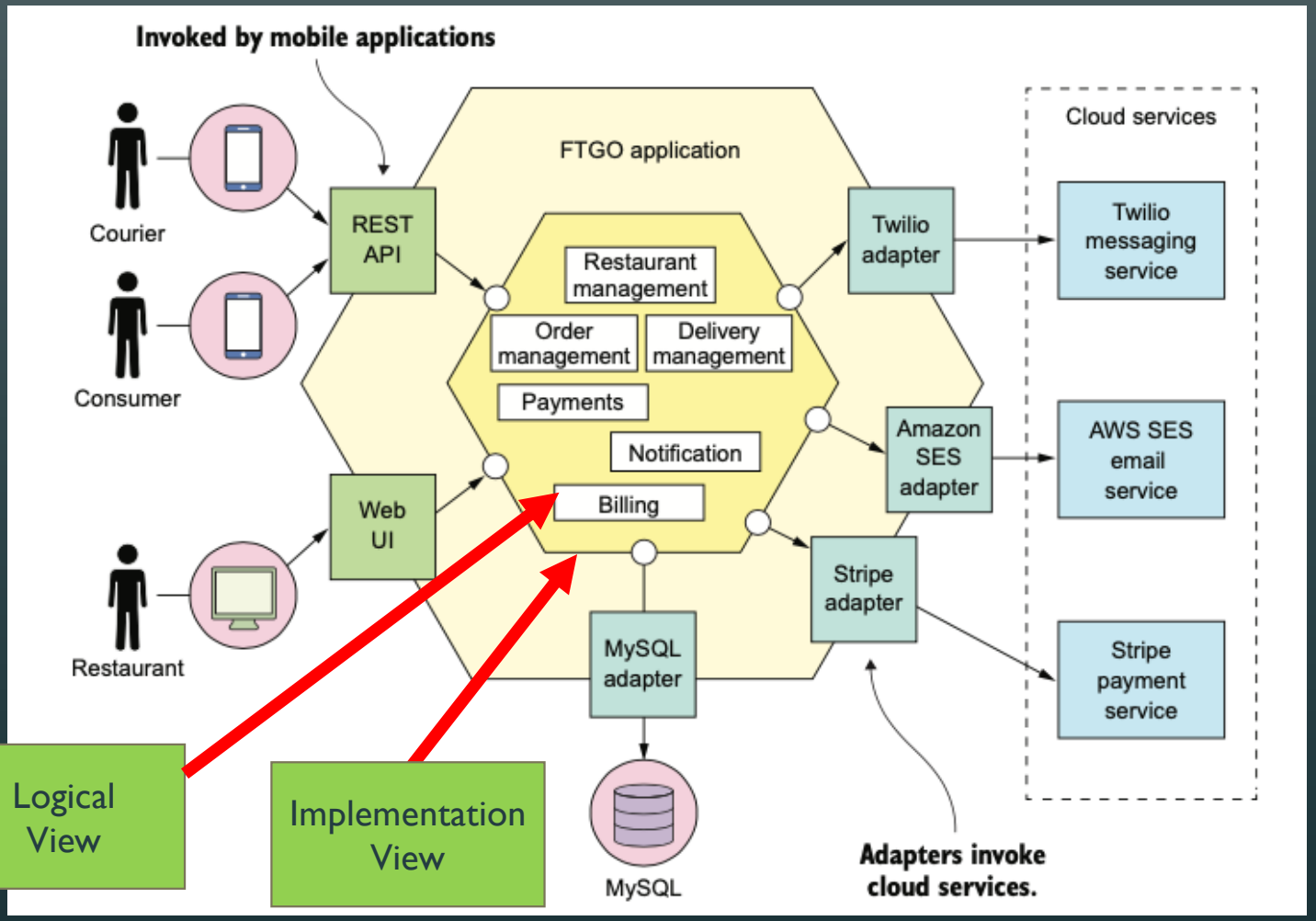
Agenda

- A brief refresher on software architecture
- **From monolith to microservices**
- Microservices != silver bullet
- Applying the microservice pattern language

The monolithic architecture is an **architectural style** that structures the **application** as a **single executable component**



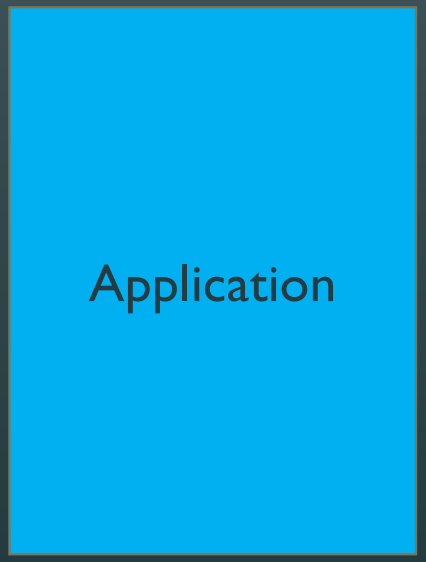
Traditional: Monolithic architecture



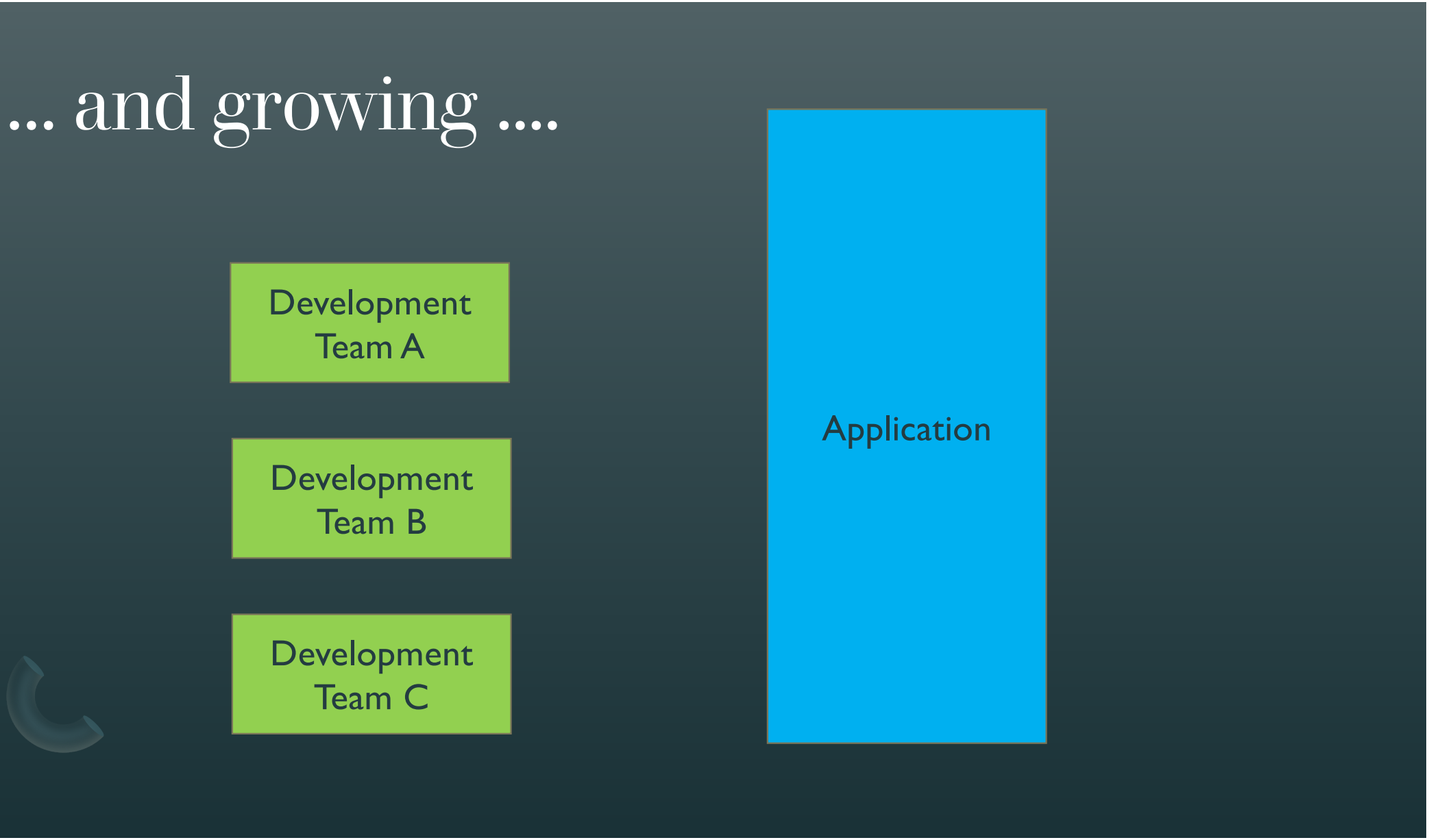
-ilities of small monoliths

- Maintainability
- Testability
- Deployability
- …

But successful applications keep growing ....



... and growing ....


Development Team A
Development Team B
Development Team C
Application

Eventually:

agile development
and deployment
becomes
impossible

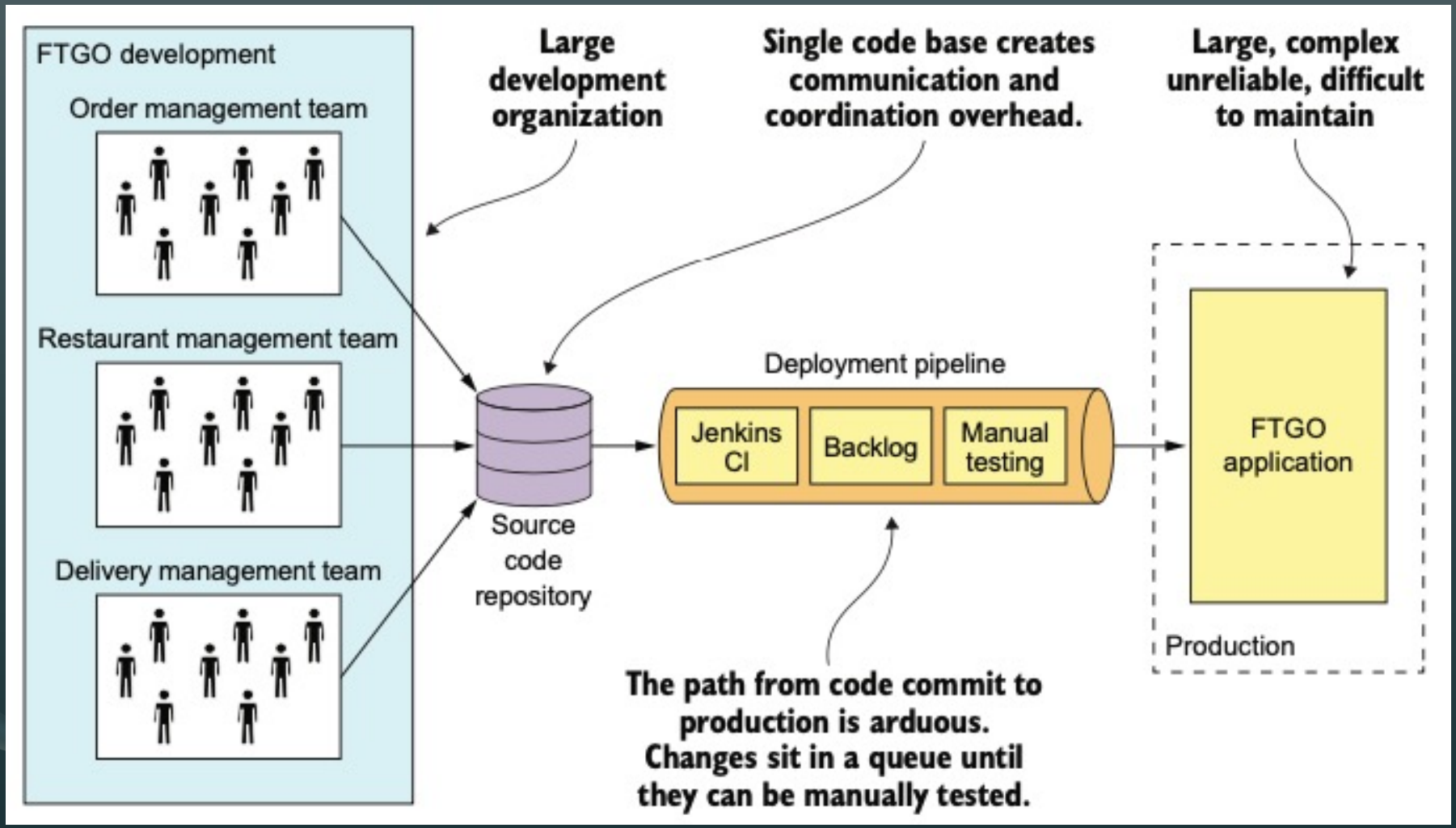
=

monolithic hell

-ilities of large monoliths

- Maintainability
- Testability
- Deployability
- …

The slow march toword monolithic hell



Living in monolithic hell (1)

- Complexity intimidates developers
  - Fixing bugs and correctly implementing new features become difficult and time consuming
  - Deadline are missed
- Development is slow
  - The large application overload and slow down developer's IDE
  - The application takes a long time to start up

Living in monolithic hell (2)

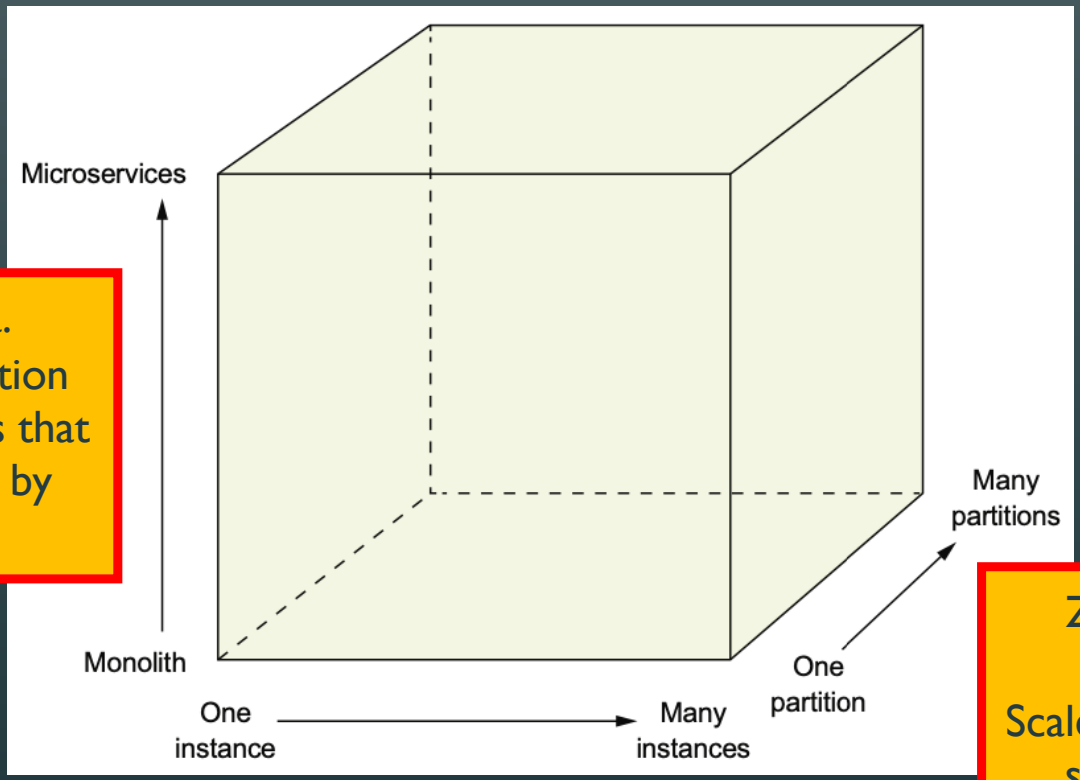
- Path from commit to deployment is long and arduous
  - The build is frequently in an unreleasable state
  - Painful merges
- Scaling is difficult
  - Data consume a lot of memory
  - CPU is intensively used

Living in monolithic hell (3)

- Delivering a reliable monolith is challenging
  - There are frequent production outages
  - Due to lack of testability
- Locked into increasing obsolete technology stack
  - Difficult to adopt new frameworks and languages
  - Difficult to upgrade version for each components

The microservice architecture is an **architectural style** that **structures** an application as a **set of loosely coupled, services** organized around **business capabilities**

Scale cube and microservices

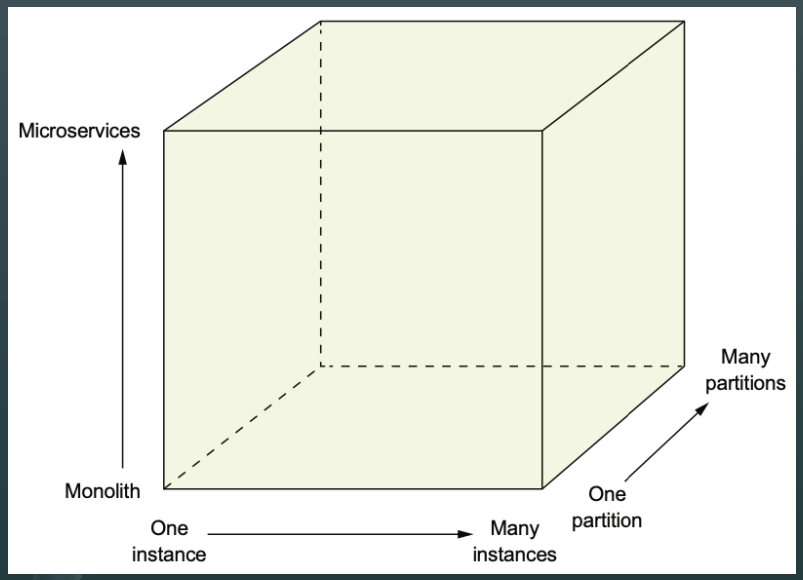


Y-axis scaling, a.k.a. functional decomposition
Scale by splitting things that are different, such as by function.

Z-axis scaling, a.k.a. data partitioning
Scale by splitting similar things, such as by customer ID.

X-axis scaling,
a.k.a. horizontal duplication
Scale by cloning.

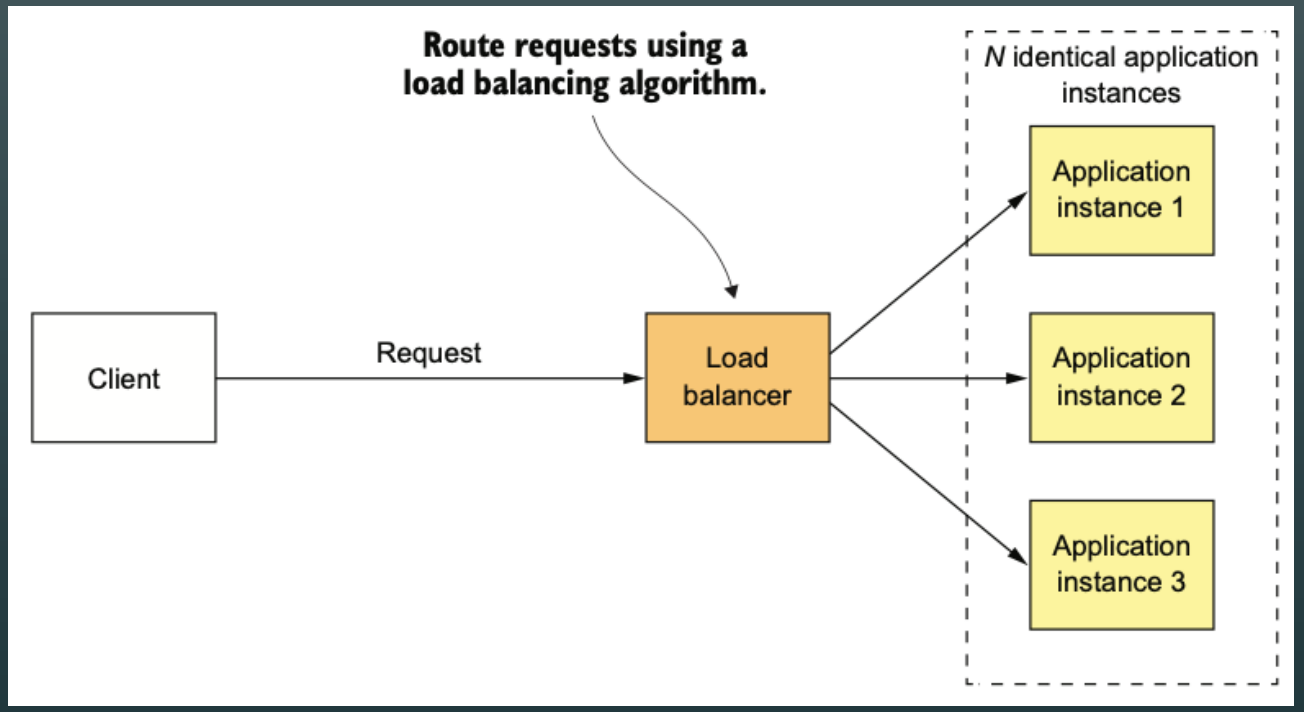
X-axis :- scaling load balances requests across multiple instances (1)



X-axis scaling,
a.k.a. horizontal duplication
Scale by cloning.

- X-axis scaling is a common way to scale a monolithic application
- Running multiple instances of the application behind a load balancer
- The load balancer distributes requests among the N identical instances of the application

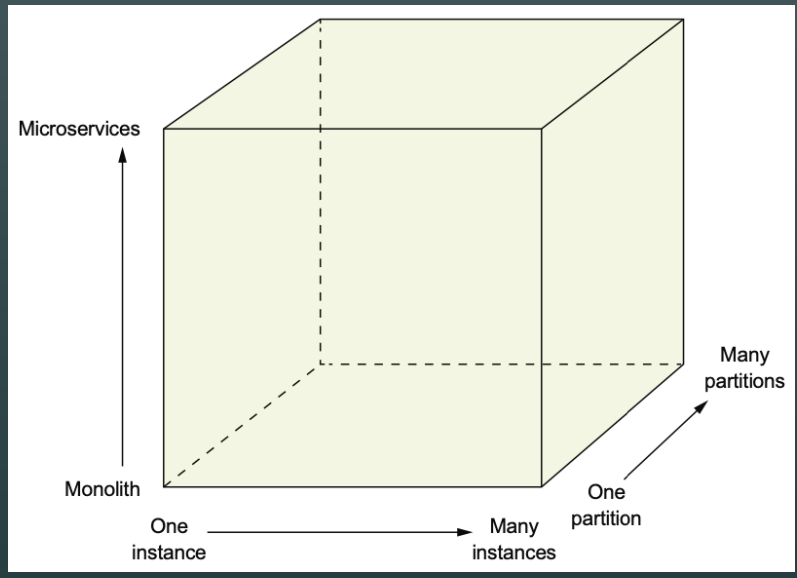
X-axis :- scaling load balances requests across multiple instances (2)



- X-axis is great way of improving the capacity and availability of an application.

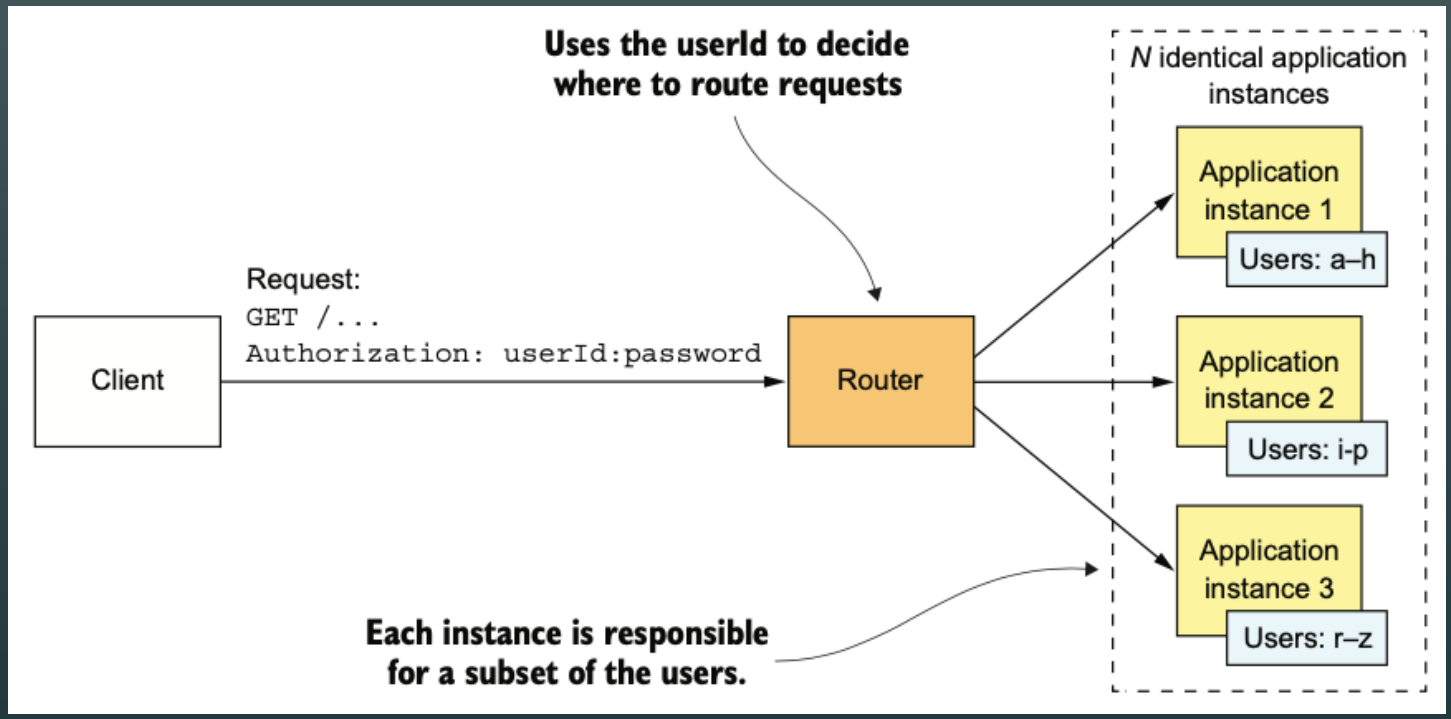
Z-axis :- scaling routes requests based on an attribute of the request (1)

- Also runs multiple instances of the monolith application
- But each instance is responsible for only a subset of the data
- The router in front of the instances uses a request attribute to route it to the appropriate instance
- for example, route requests using *userId*.



Z-axis scaling, a.k.a. data partitioning
Scale by splitting similar things, such as by customer ID.

Z-axis :- scaling routes requests based on an attribute of the request (2)

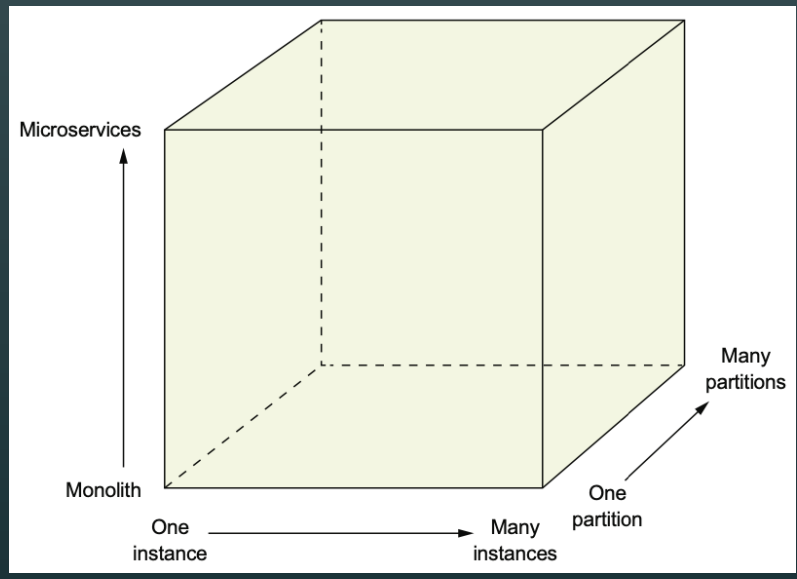


- Z-axis scaling is a great way to scale an application to handle increasing transaction and data volumes.

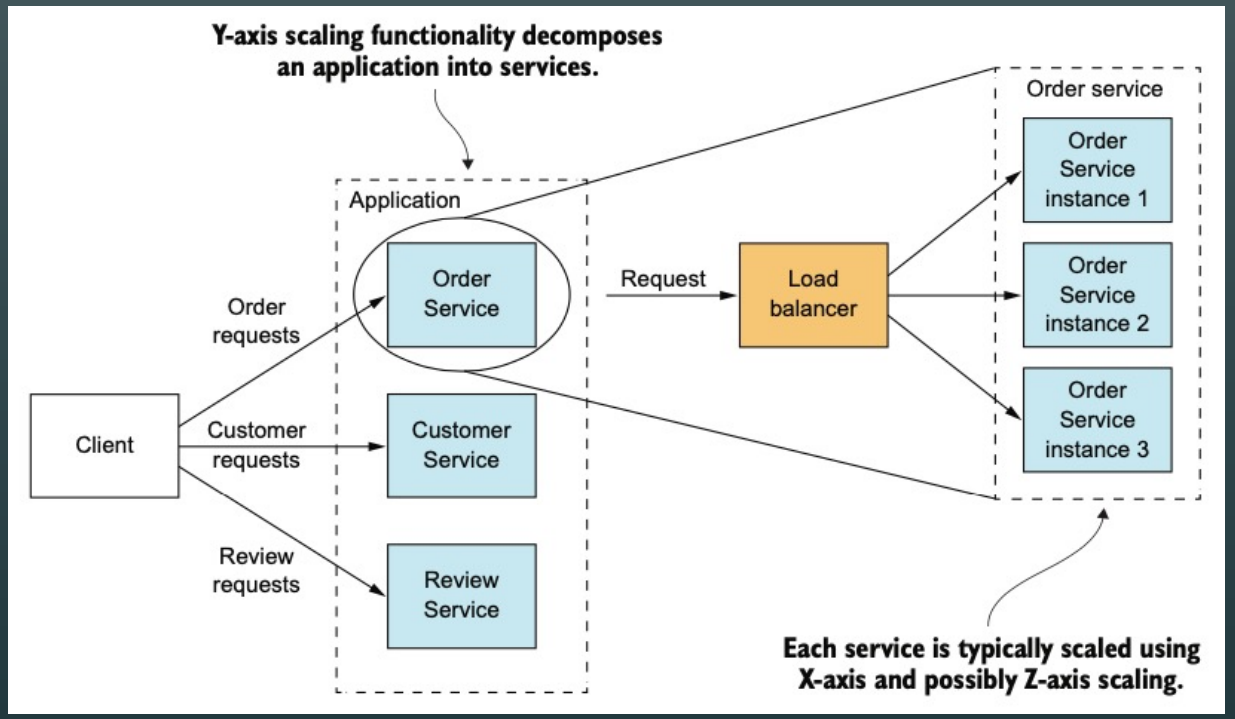
Y-axis :- scaling functionally decomposes an application into services (1)

- Y-axis scaling, or functional decomposition, solves the problem of increasing development and application complexity.
- Splitting a monolithic application into a set of services
  - for examples, order management, customer management, and so on

Y-axis scaling, a.k.a. functional decomposition Scale by splitting things that are different, such as by function.

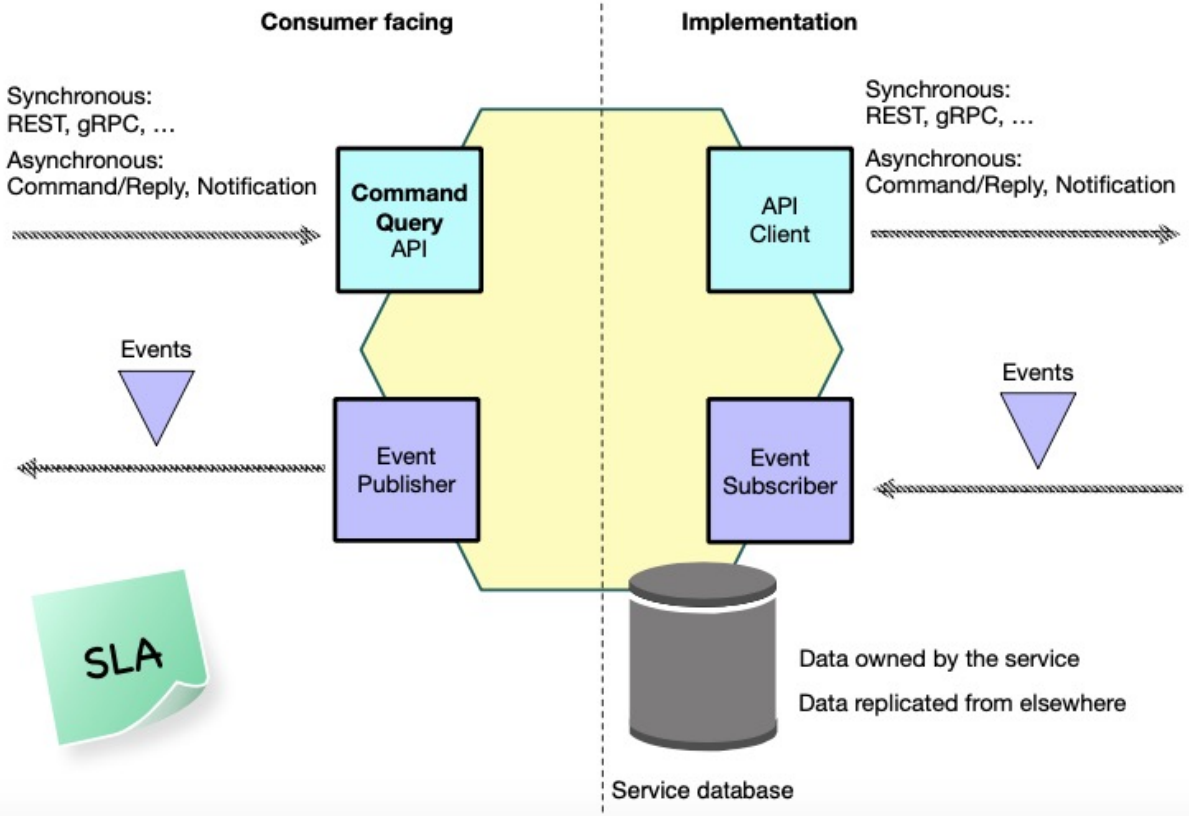


Y-axis :- scaling functionally decomposes an application into services (2)

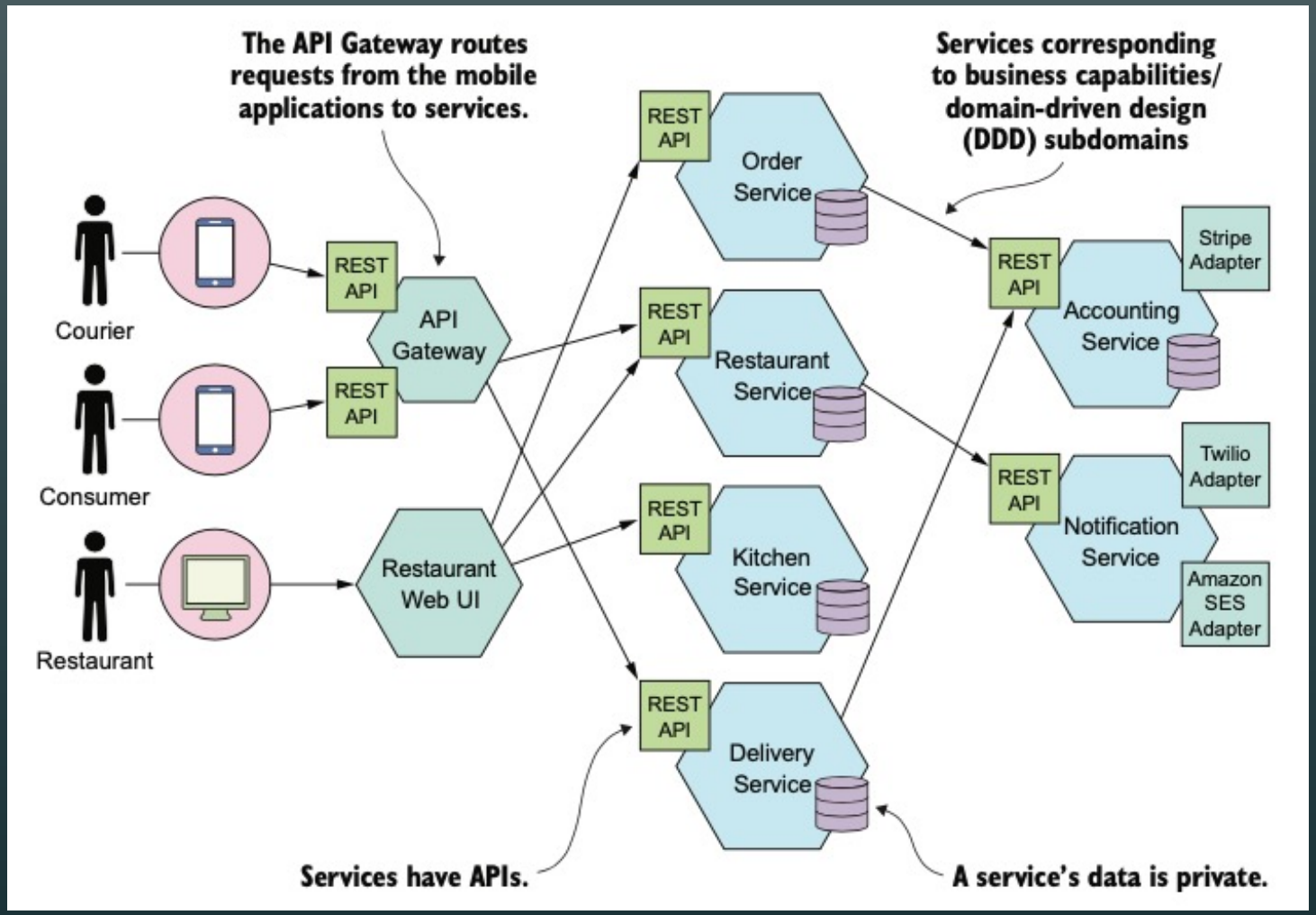


- A service can be scaled using X-axis scaling and, possibly, Z-axis scaling.

Service = independently deployable component



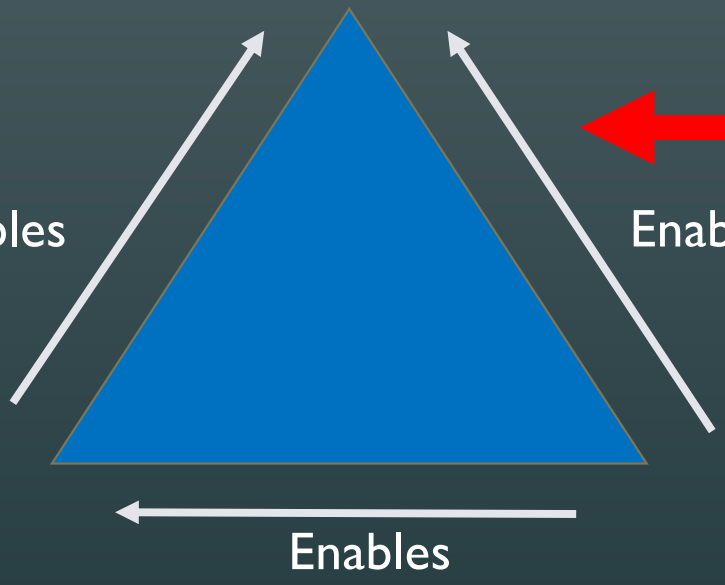
Solution: microservice architecture



-ilities of microservice architecture

- Maintainability
- Testability
- Deployability
- …

Process:
DevOps/Continuous delivery/deployment



Services improve testability and deployability

Organization:
Small, autonomous teams

Architecture:
Microservice architecture

Teams own services

Microservices ⇒

Evolve the technology stack

- Pick a new technology when
  - Writing a new service
  - Make major changes to an existing service
- Let you experiment and fail safely

Agenda

- A brief refresher on software architecture
- From monolith to microservices
- **Microservices != silver bullet**
- Applying the microservice pattern language

No silver bullet

No Silver Bullet
—Essence and Accident in Software Engineering

Frederick P. Brooks, Jr.
University of North Carolina at Chapel Hill

There is no single development, in either technology or management technique, which by itself promises even one order-of-magnitude improvement within a decade in productivity, in reliability, in simplicity.

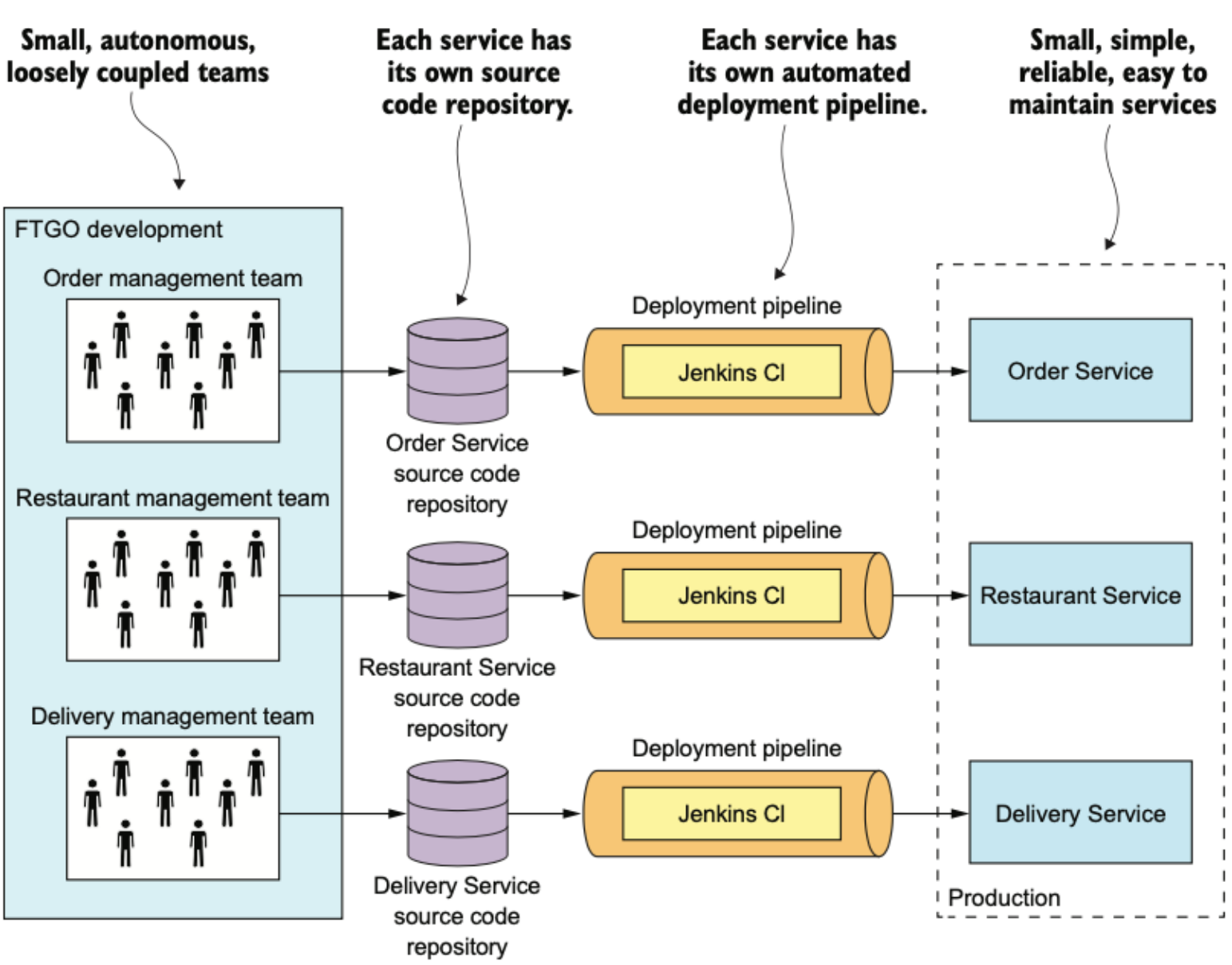
https://en.wikipedia.org/wiki/Fred_Brooks

Benefits of the microservice architecture (1)

- It enables the continuous delivery and deployment of large, complex applications
  - continuous delivery/deployment is part of DevOps
    (a set of practices for the rapid, frequent, and reliable delivery of software)
  - 3 ways that the microservice architecture enables CD
    - It has the testability required by continuous delivery/deployment
    - It has the deployability required by continuous delivery/deployment
    - It enables development teams to be autonomous and loosely coupled

Benefits of the microservice architecture (2)

- Services are small and easily maintained
  - The code is easier for a developer to understand
  - The small code base doesn't slow down the IDE, making developers more productive
  - Each service typically starts a lot faster than a large monolith does


Small, autonomous, loosely coupled teams
Each service has its own source code repository.
Each service has its own automated deployment pipeline.
Small, simple, reliable, easy to maintain services
FTGO development
Order management team
Restaurant management team
Delivery management team
Order Service source code repository
Restaurant Service source code repository
Delivery Service source code repository
Deployment pipeline
Jenkins CI
Deployment pipeline
Jenkins CI
Deployment pipeline
Jenkins CI
Order Service
Restaurant Service
Delivery Service
Production

Benefits of the microservice architecture (3)

- Services are independently deployable
  - Each service in a microservice architecture can be scaled independently
  - CPU-intensive vs. memory-intensive no need to be deployed together
- It enables teams to be autonomous
- It has better fault isolation
- It allows easy experimenting and adoption of new technologies

Drawback of the microservice architecture (1)

- Finding the right set of services is challenging
  - If you decompose a system incorrectly, you'll build a distributed monolith
  - It has the drawbacks of both the monolithic and the microservice architecture.

Drawback of the microservice architecture (2)

- Distributed systems are complex
  - Makes development, testing, and deployment difficult
  - Requires the use of unfamiliar techniques
    - Must use *sagas* to maintain data consistency across services
    - Must implement queries using either API composition or CQRS views

Drawback of the microservice architecture (3)

- Deploying features that span multiple services requires careful coordination
  - Need to create a rollout plan that orders service deployments based on the dependencies between services

Drawback of the microservice architecture (4)

- Deciding when to adopt the microservice architecture is difficult
  - A startup should begin with a monolithic application
  - When the problem is how to handle complexity
    → It makes sense to decompose the application into microservices

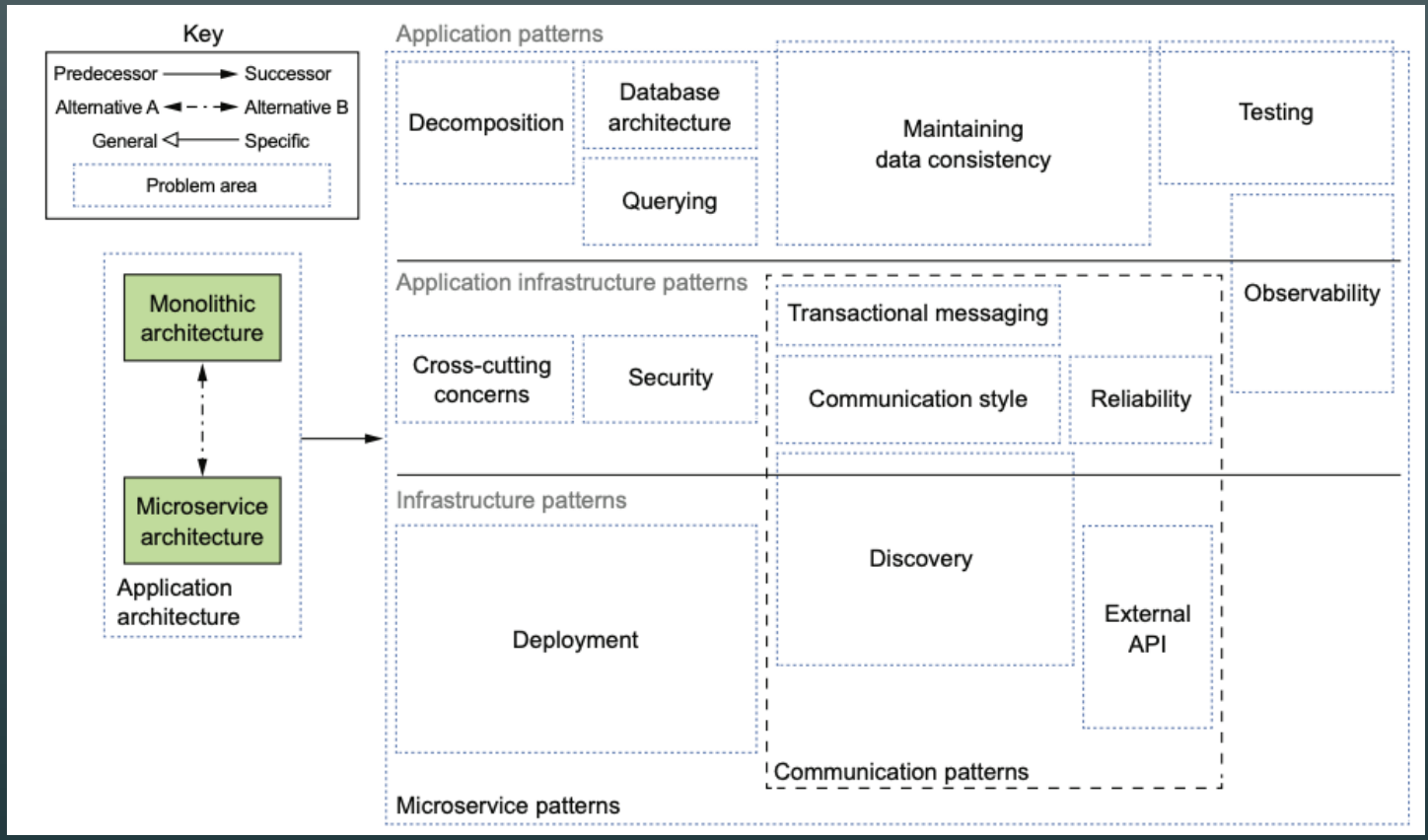
Agenda

- A brief refresher on software architecture
- From monolith to microservices
- Microservices != silver bullet
- **Applying the microservice pattern language**

Patterns and Pattern Language

- A pattern is a reusable solution to a problem that occurs in a particular context.
- The pattern language guides you when developing an architecture.
- What architectural decisions you must make for each decision:
  - Available options
  - Trade-offs of each option

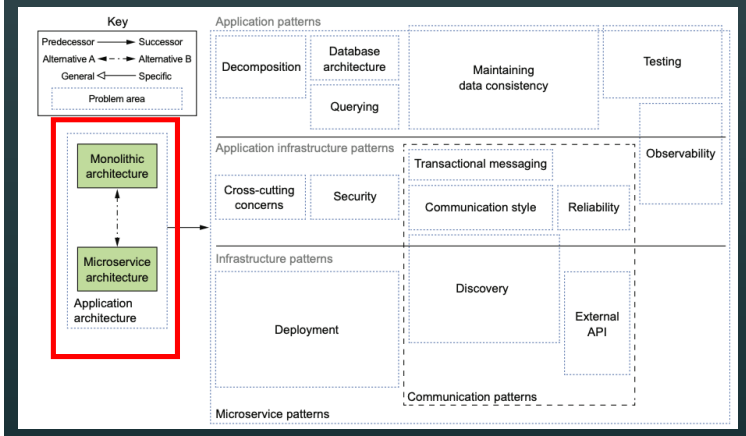
A high-level view of the Microservice architecture pattern language

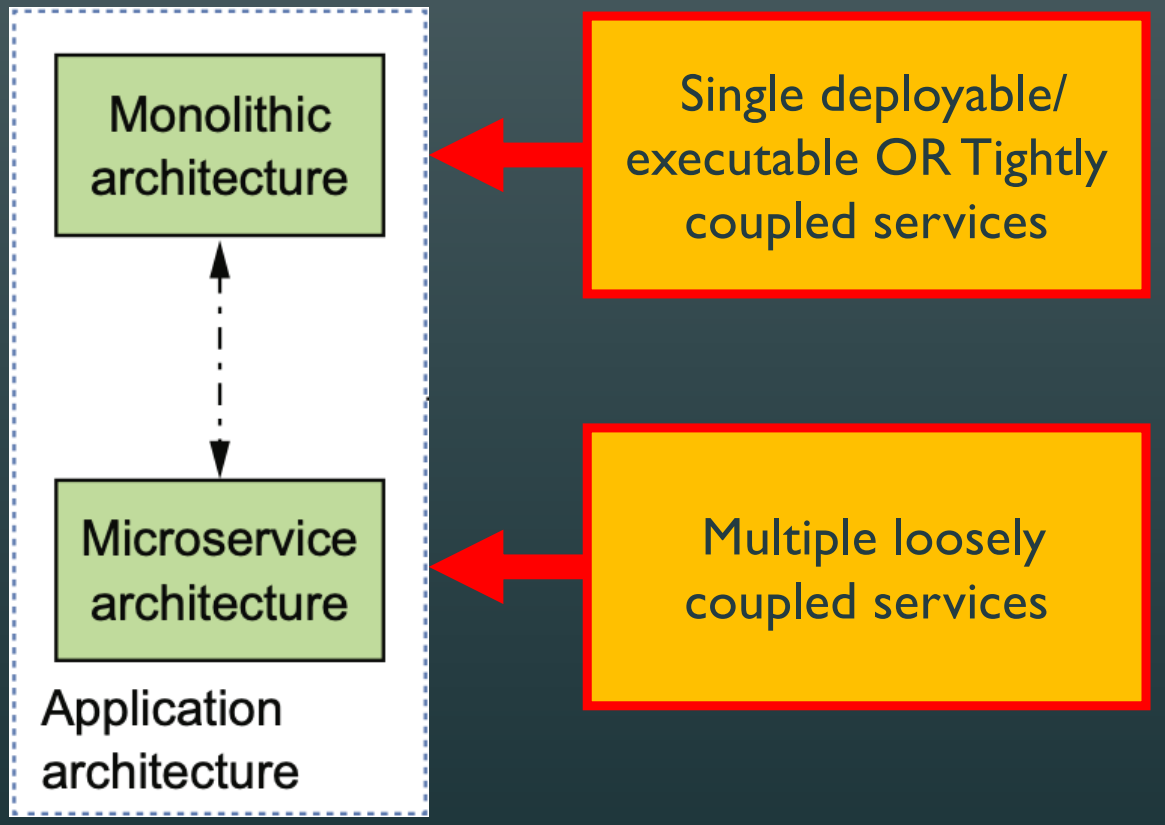


Application patterns —These solve problems faced by developers.
Application infrastructure —These are for infrastructure issues that also impact development.
Infrastructure patterns —These solve problems that are mostly infrastructure issues outside of development.

Issue: What's the deployment architecture?

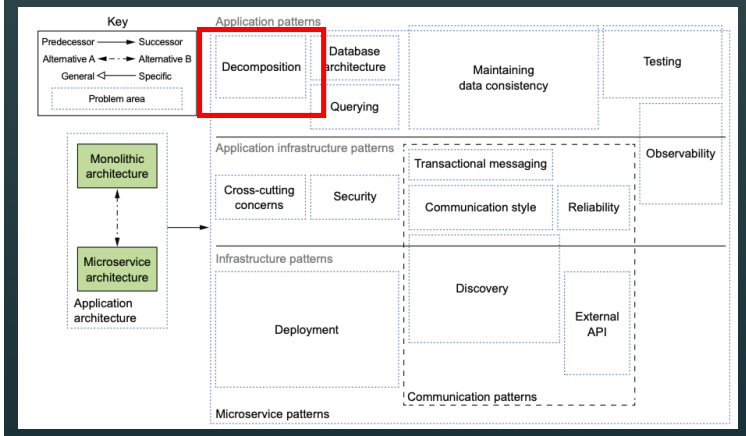
- Force :-
  - Maintainability
  - Testability
  - Deployability

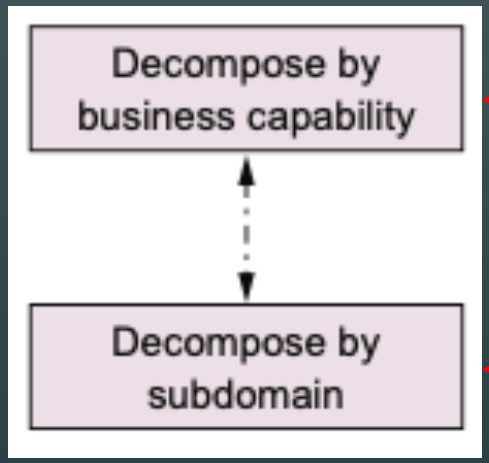




Issue: How to decompose an application into services?

- Force :-
  - Stability
  - Cohesive
  - Loosely couples
  - Not too large

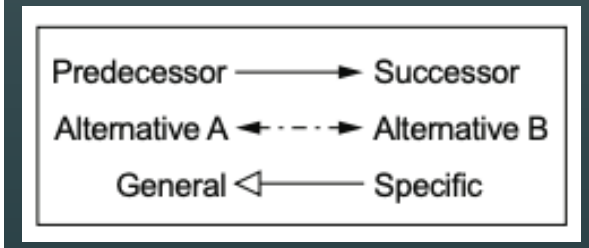


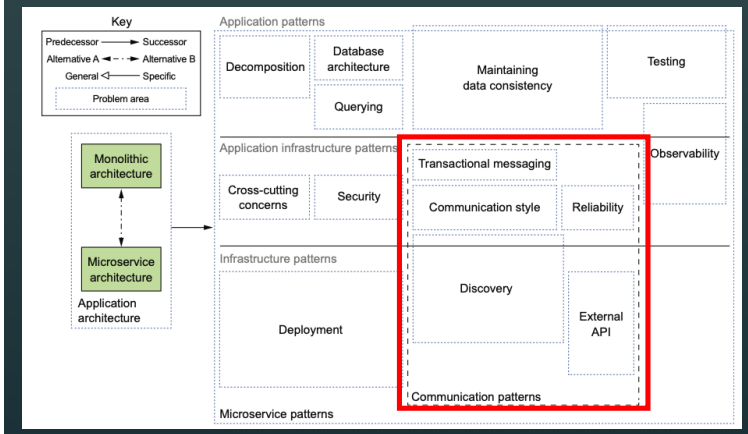


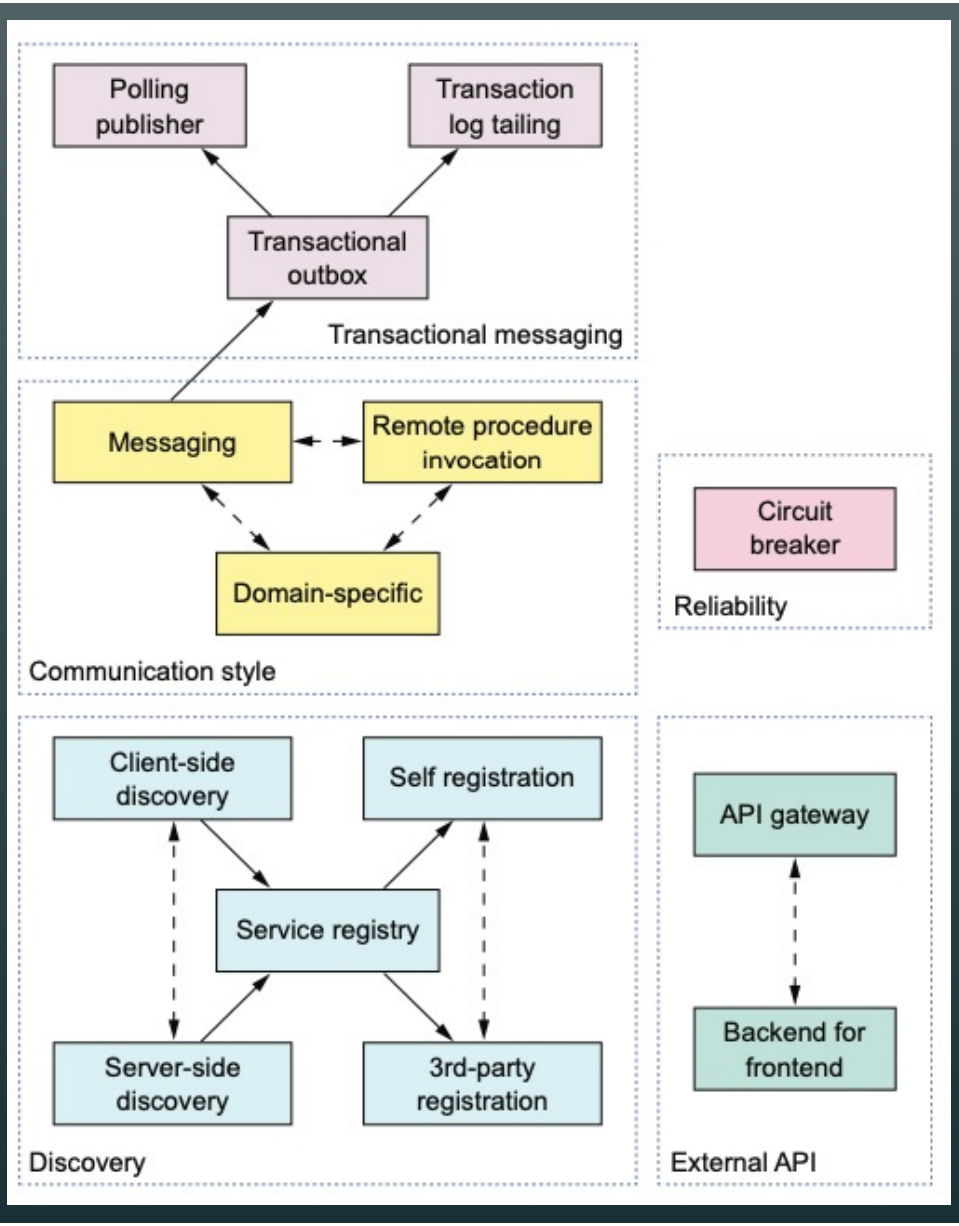
Organize around business capabilities

Organize around DDD subdomains

The five groups of communication patterns

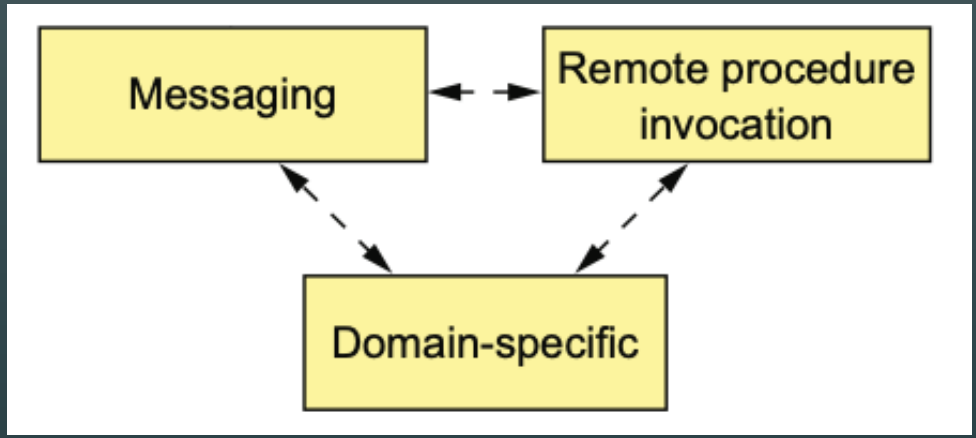


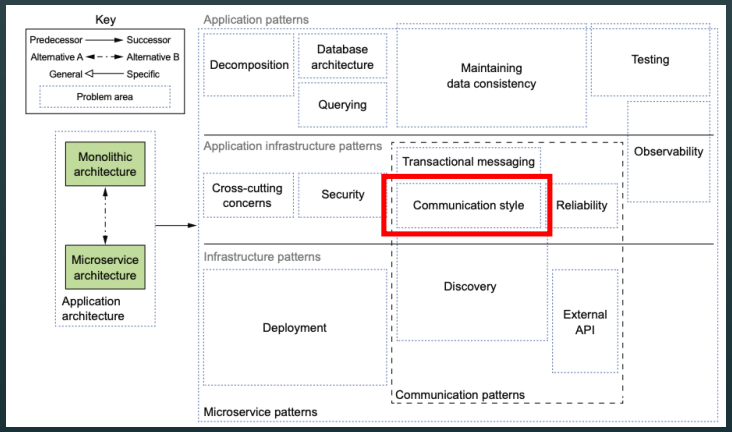


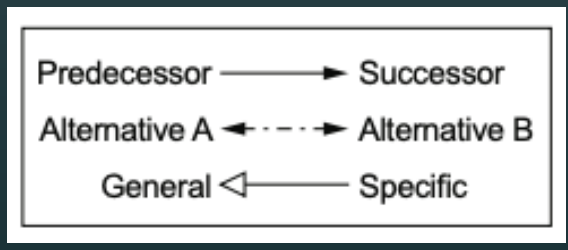


Issue: How do services communicate?

- Force :-
  - Services must communicate
  - Usually processes on different machines

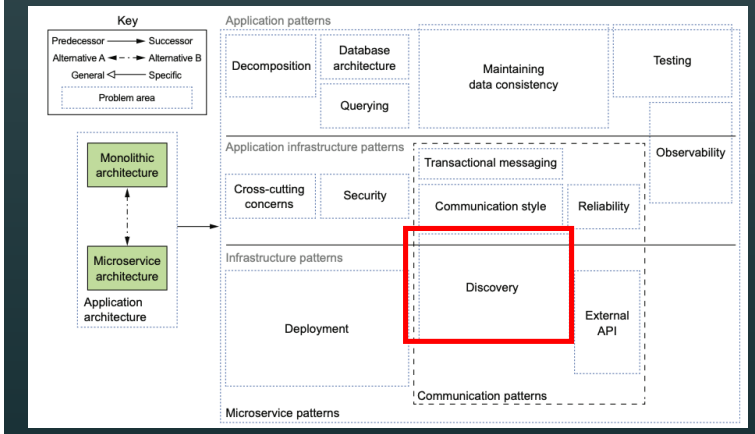


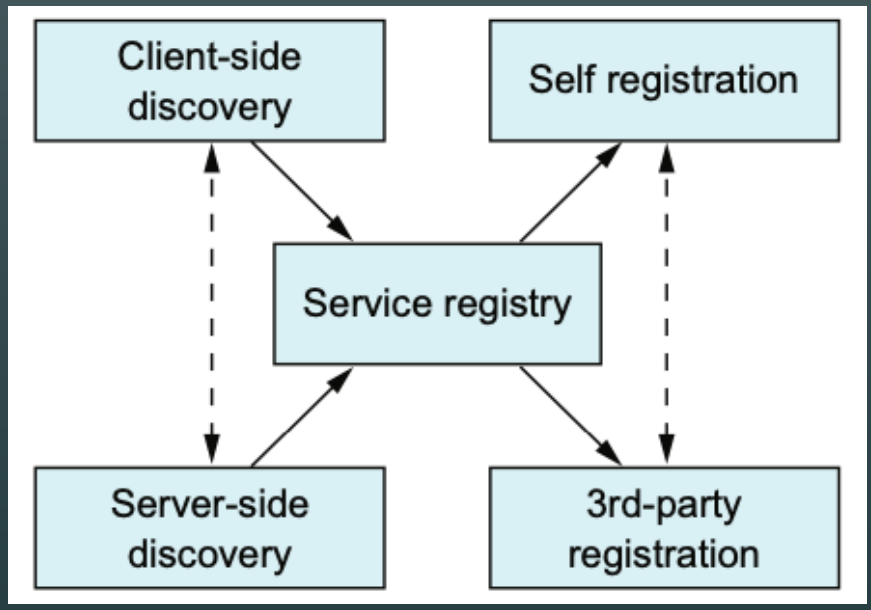


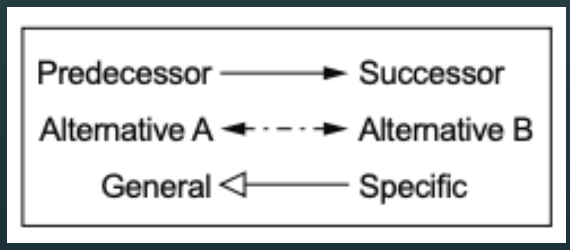


Issue: How to discover a service instance's network location?

- Force :-
  - Client needs IP address of service instance
  - Dynamic IP addresses
  - Dynamically provisioned instances

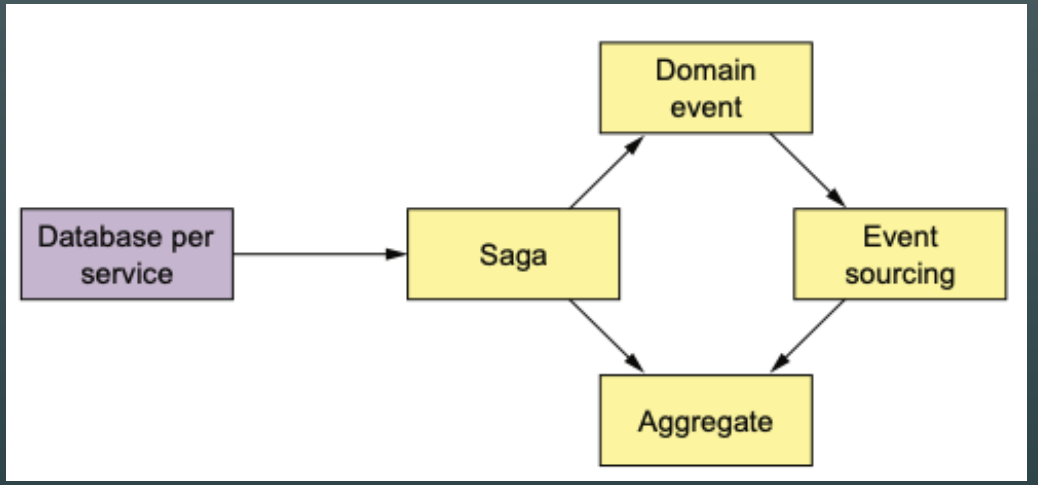


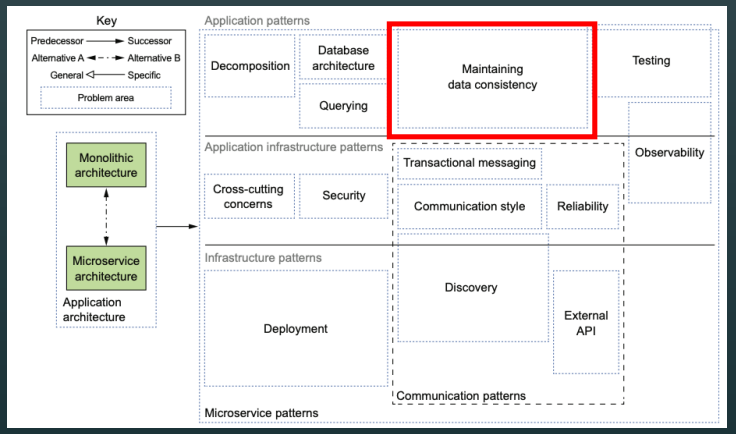




Issue: how to maintain data consistency?

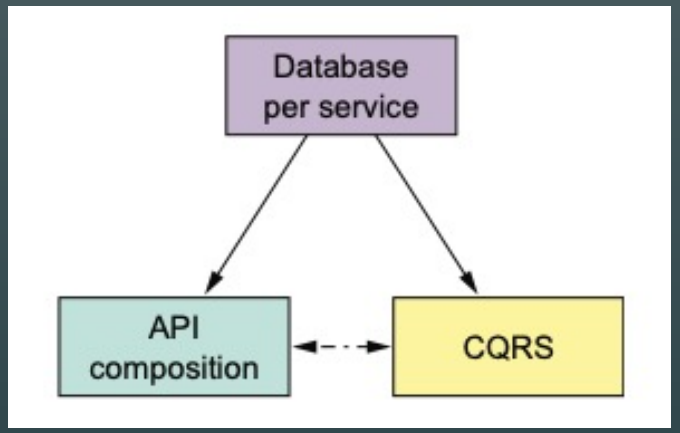
- Context :-
  - Each service has its own database
  - Data is private to a service
- Forces :-
  - Transactional data consistency must be maintained across multiple services
  - 2PC (two-phase commit) is not an option

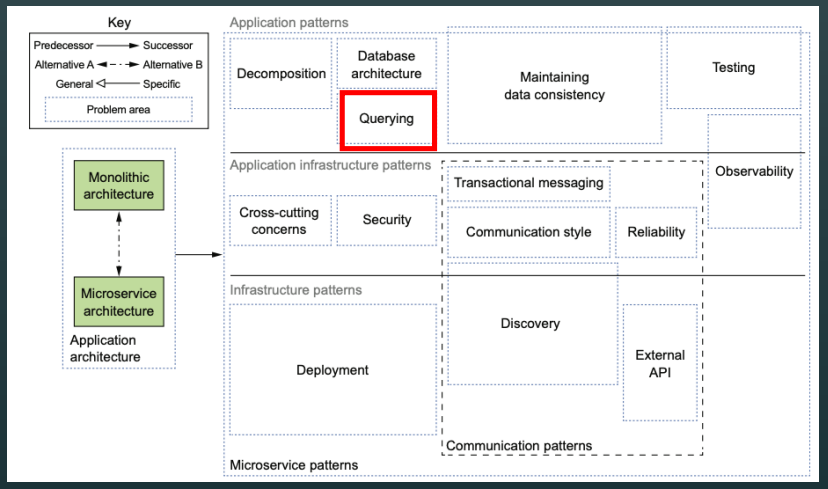




Issue: How to perform queries?

- Context :-
  - Each service has its own database
- Force :-
  - Queries must join data from multiple services
  - Data is private to a service

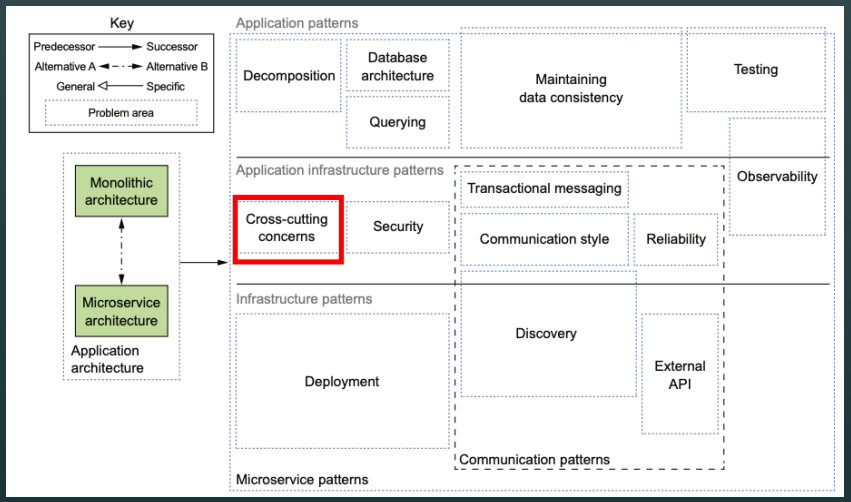




Issue: How to handle cross cutting concerns?

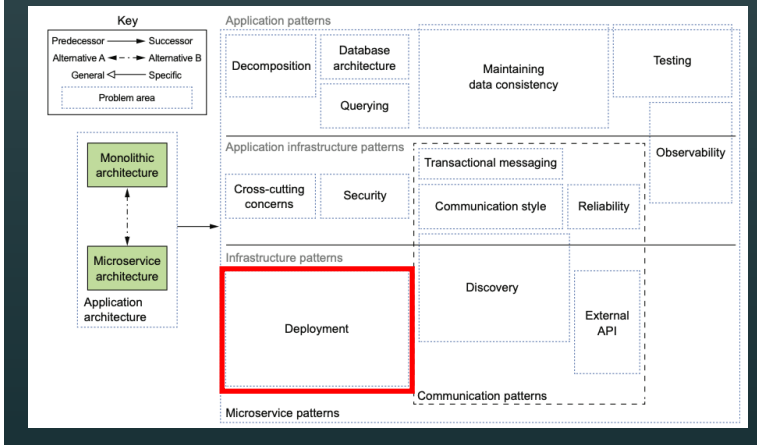
- Force :-
  - Every service must implement logging; externalize configuration; health check endpoint; metrics; ...

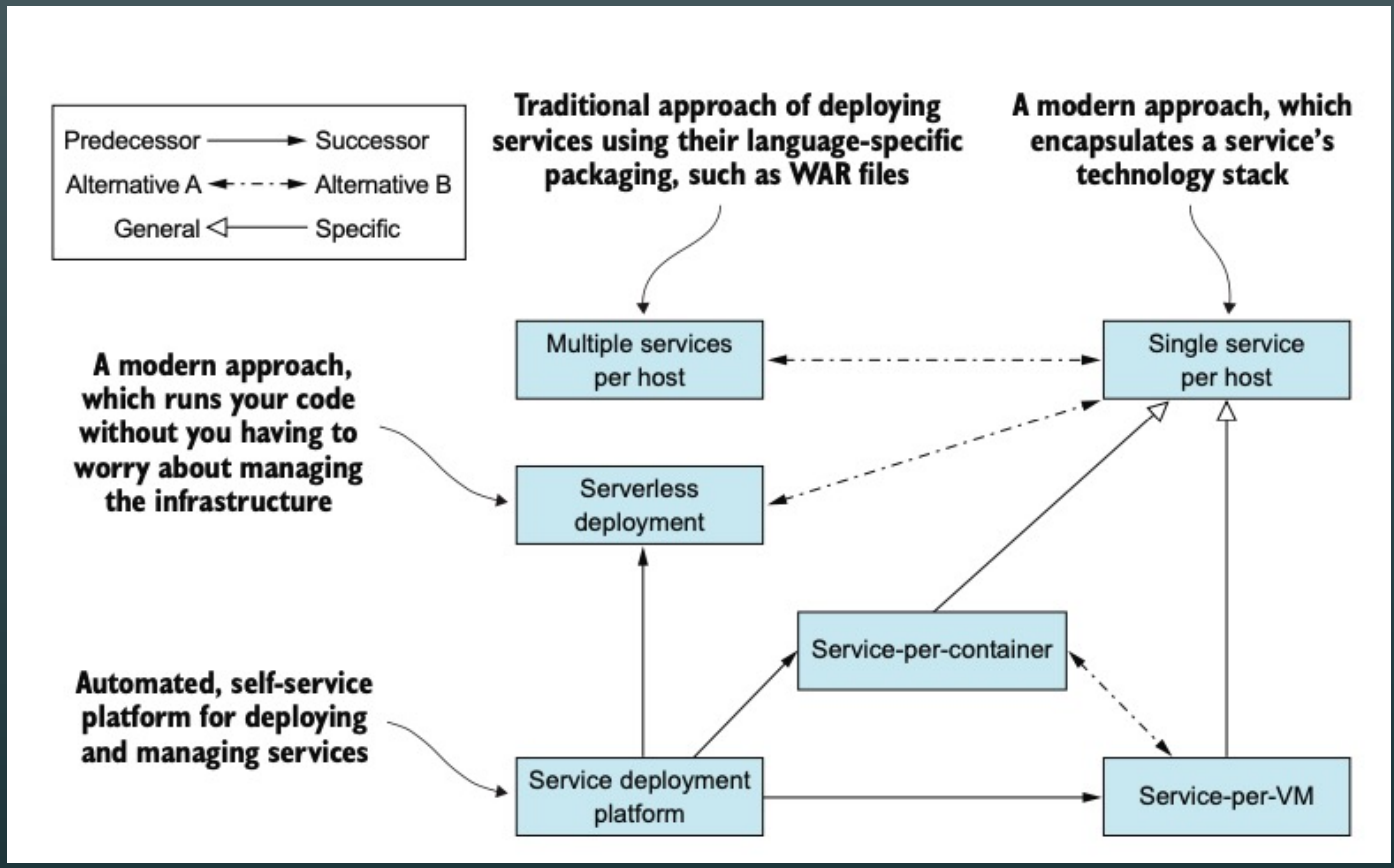
Microservice Chassis



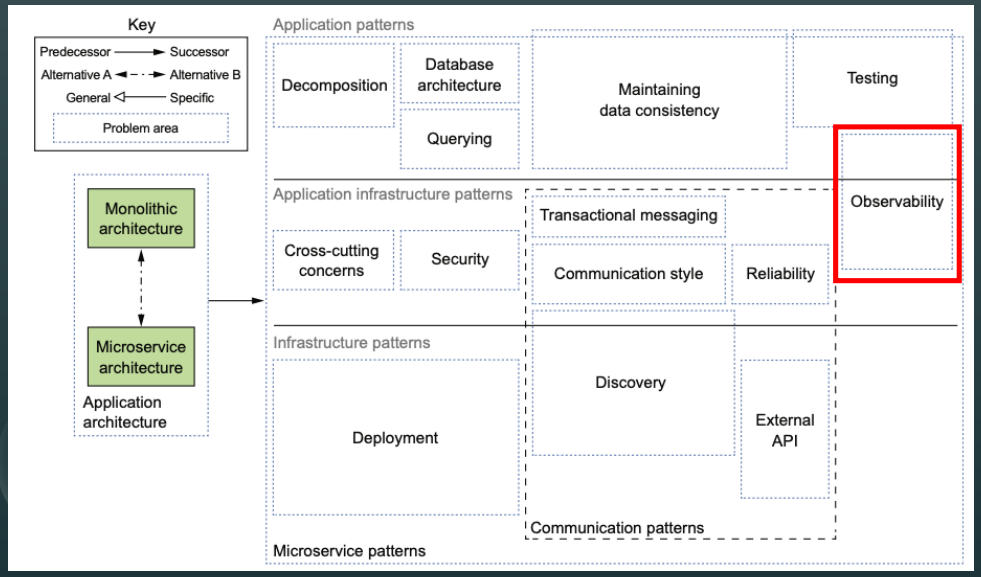
Issue: How to deploy an application's services?

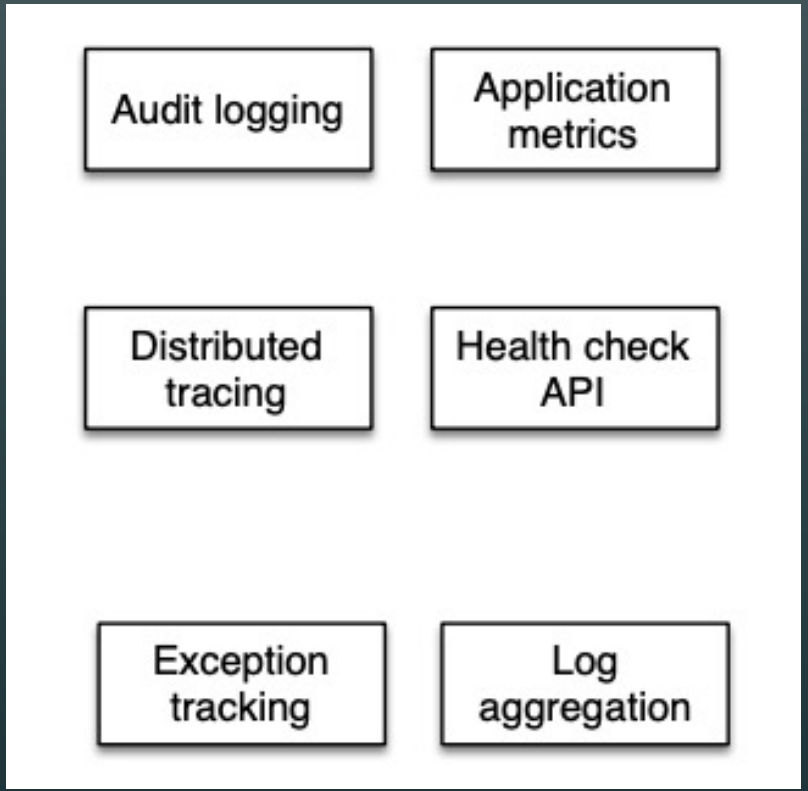
- Force :-
  - Multiple languages
  - Isolated
  - Constrained
  - Monitor-able
  - Reliable
  - Efficient





Issue: how to monitor the behavior of your application?





Summary

- The goal of architecture is to satisfy non-functional requirements
- For continuous delivery/deployment use the appropriate architectural style
  - Small applications ⇒ Monolithic architecture
  - Complex applications ⇒ Microservice architecture
- Use the pattern language to guide your decision making