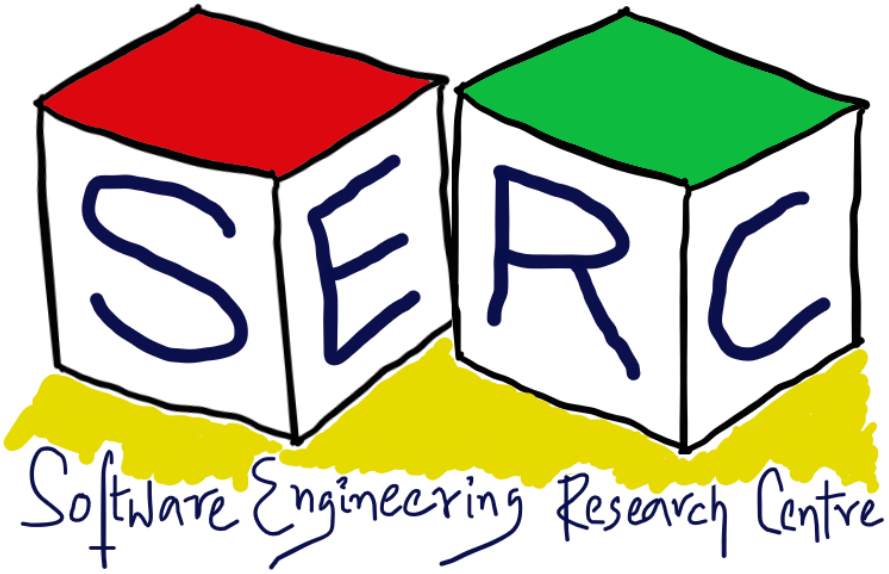
Architectural Styles & Patterns

CS6.401 Software Engineering



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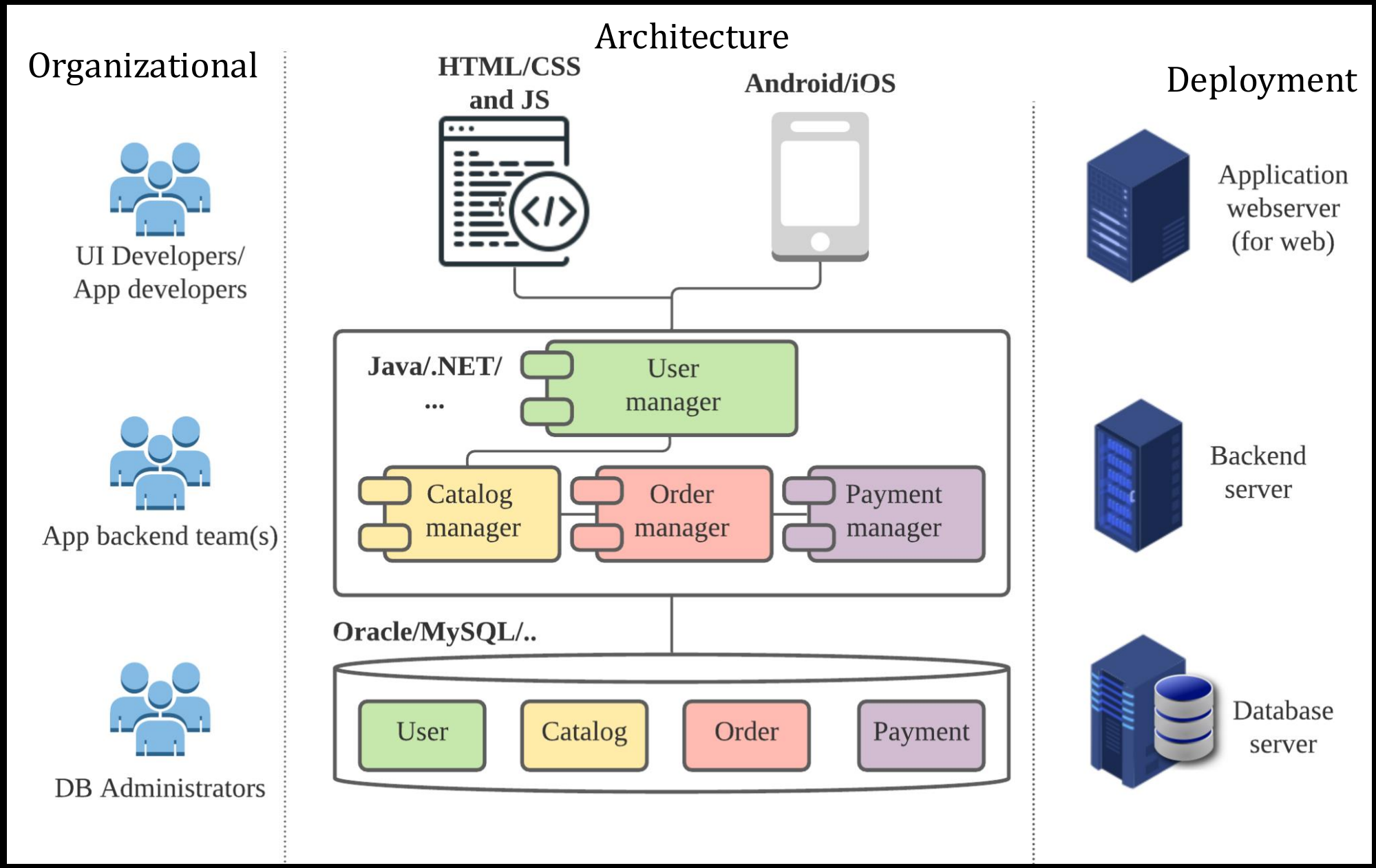
Acknowledgements

The materials used in this presentation have been gathered/adapted/generate from various sources as well as based on my own experiences and knowledge -- Karthik Vaidhyanathan

Sources:

1. Software Architecture in Practice, Len Bass, 2nd, 3rd edition
2. Various sources from the web that has been duly credited in the respective slide

Monolithic Approach to E-commerce



Microservices!

Domain Driven Design

Large-Scale Systems

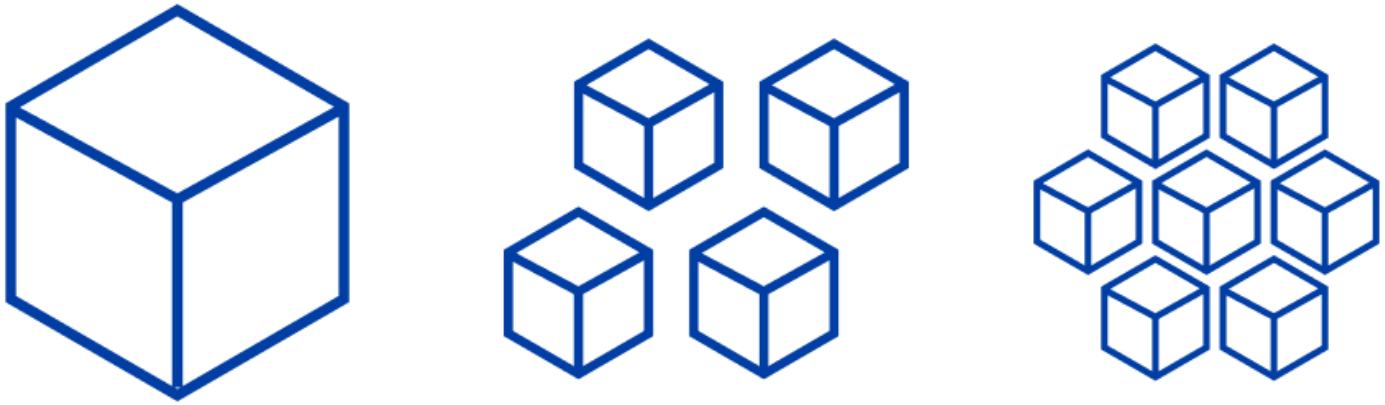
Continuous Delivery

Infrastructure Automation

Small Autonomous Teams

Microservices

Moving Towards Microservices



MONOLITHIC
Single unit

SOA
Coarse-grained

MICROSERVICES
Fine-grained

1990 2000 2010

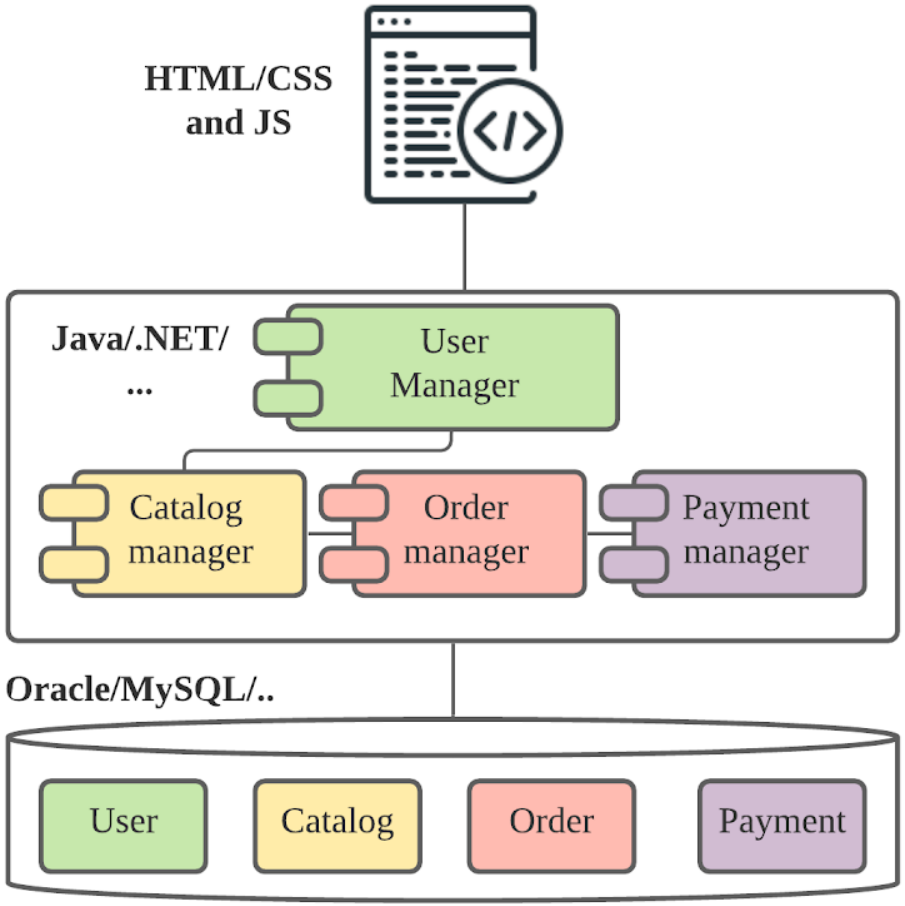
Microservices: What does it Mean?

"Small autonomous services that work together" -- Sam Newman

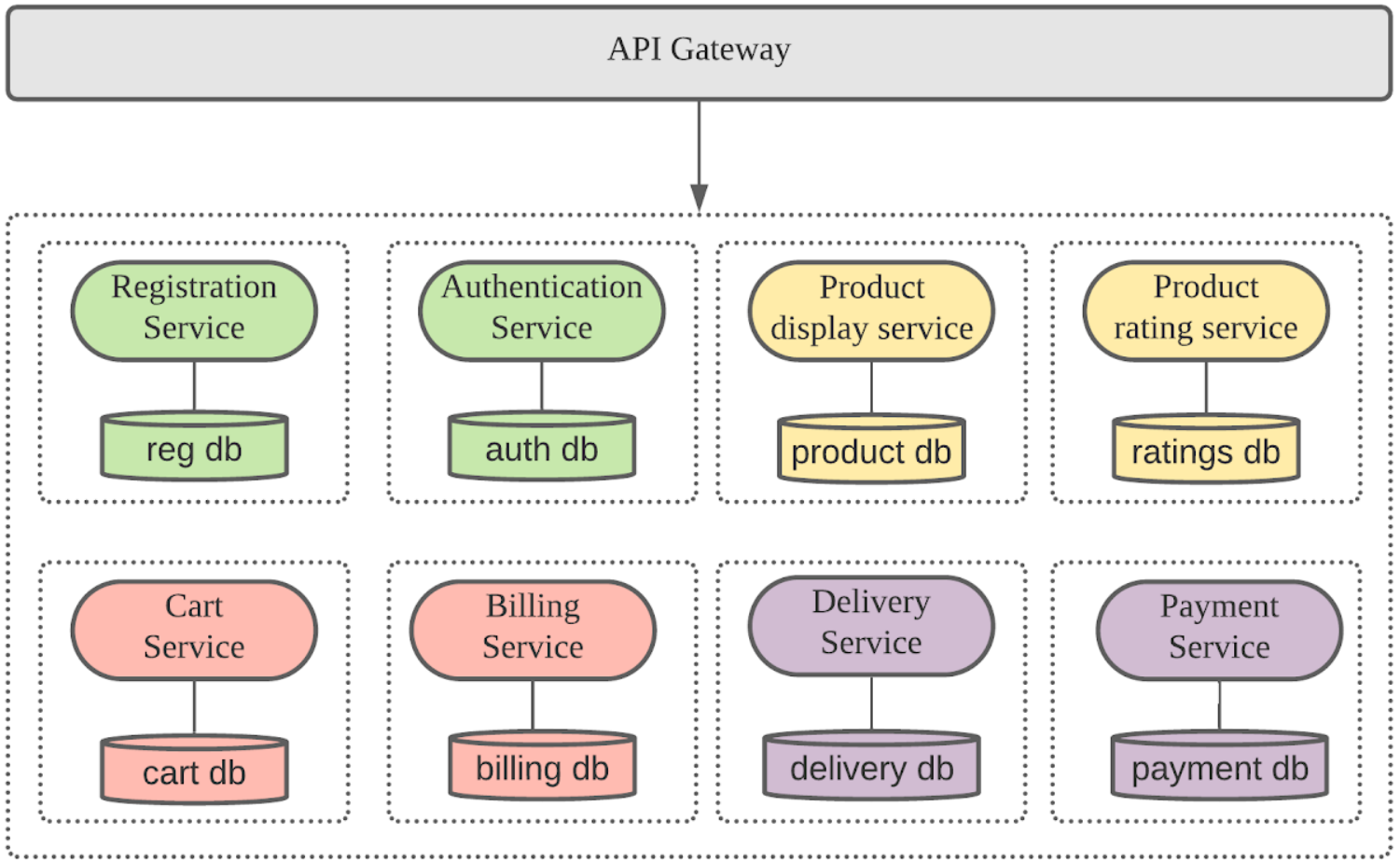
"It is an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms, often an HTTP resource API" -- Martin Fowler

Microservices: What does it Mean?

Monolithic Version



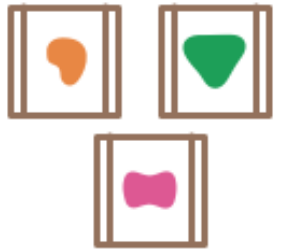
Microservices Version



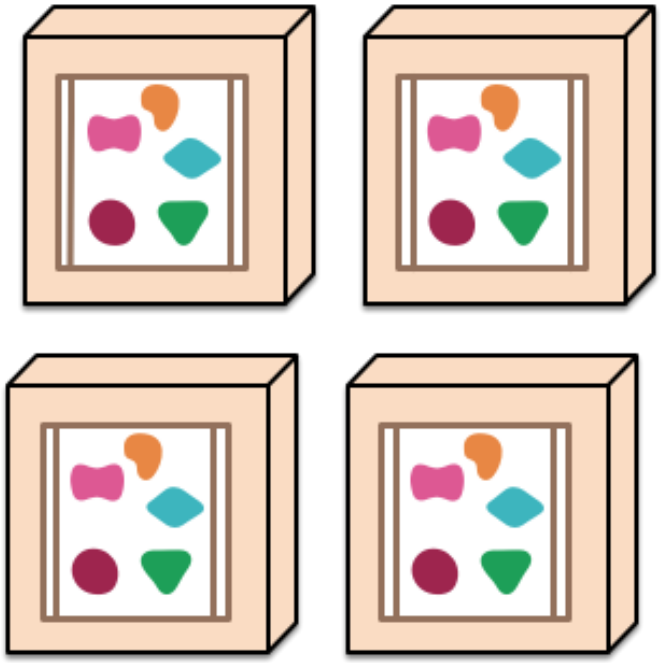
Microservices: What does it Mean?

A monolithic application puts all its functionality into a single process...

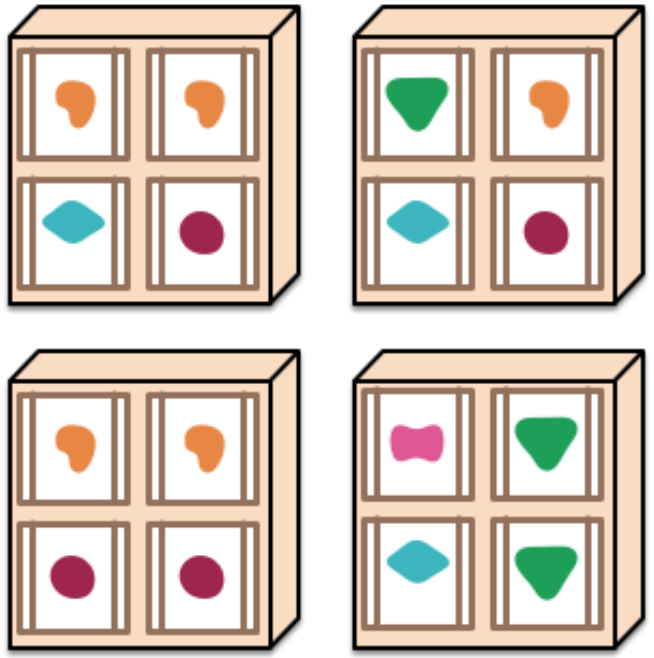
A microservices architecture puts each element of functionality into a separate service...



... and scales by replicating the monolith on multiple servers

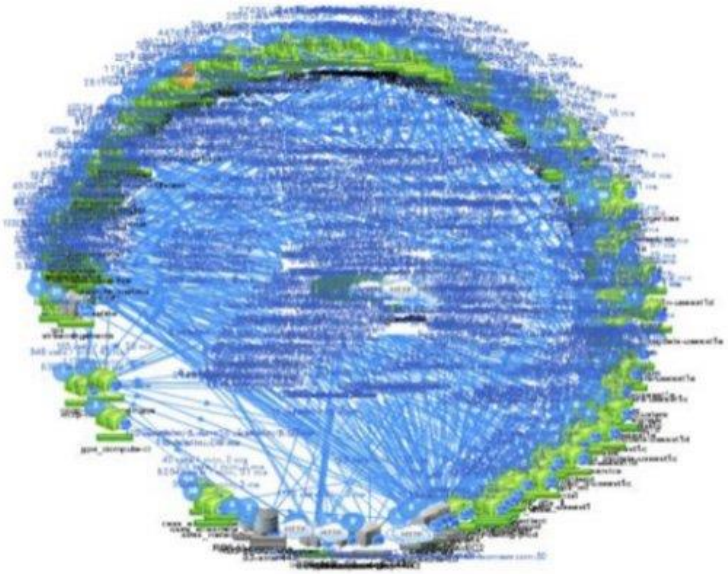


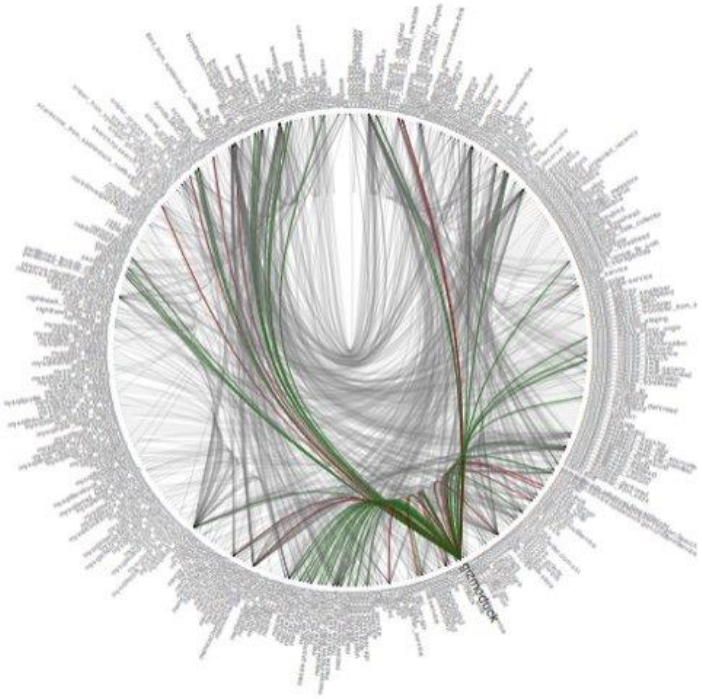
... and scales by distributing these services across servers, replicating as needed.

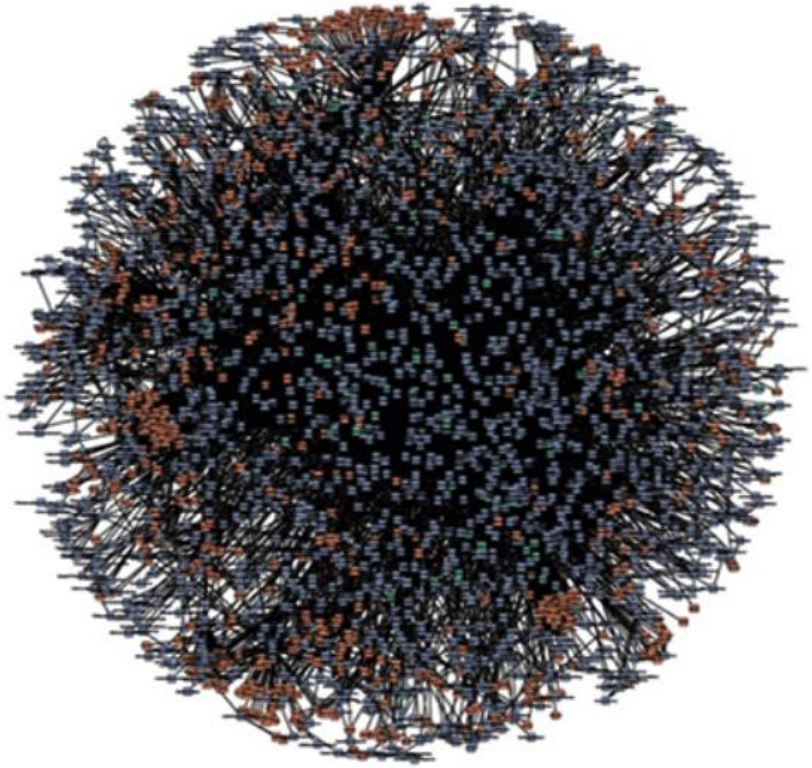


Source: https://martinfowler.com/articles/microservices.html

Microservices: Who Uses Them?







NETFLIX

amazon.com

Source: http://tinyurl.com/3kswbtak, Google images, Twitter

Amazon's API Mandate

Jeff Bezos,
Founder and President, Amazon

1. All teams will henceforth expose their data and functionality through service interfaces.
2. Teams must communicate with each other through these interfaces.
3. There will be no other form of interprocess communication allowed: no direct linking, no direct reads of another team's data store, no shared-memory model, no back-doors whatsoever. The only communication allowed is via service interface calls over the network.
4. It doesn't matter what technology they use. HTTP, Corba, Pubsub, custom protocols – doesn't matter.
5. All service interfaces, without exception, must be designed from the ground up to be externalizable. That is to say, the team must plan and design to be able to expose the interface to developers in the outside world. No exceptions.
6. Anyone who doesn't do this will be fired.
7. Thank you; have a nice day!

Letter from Jeff Bezos in 2002: https://nordicapis.com/the-bezos-api-mandate-amazons-manifesto-for-externalization/

Microservices: Key Advantages

Scaling is Easy

- Scale only the required microservices
- Adding a new feature can be just adding one another microservice

Heterogeneity

- Each microservice can be developed in different technologies
- Experimenting with new technology is easy

Resilience

- Only specific microservices goes down
- Grouping microservices as critical and non-critical can be done to add more resilience

Microservices: Key Advantages

Organizational Alignment

- Easily distribute teams around microservices - eg: Amazon 2 pizza rule
- Minimize people working on one less codebase

Composability

- Easily compose microservices to get new functionality

Replaceability

- Cost of replacement is small - should not take more than 2 weeks
- Imagine replacing a 25 year old legacy system !!

Ease of Deployment

- Check and rollback easily
- Continuous integration and deployment is easier - DevOps!!!

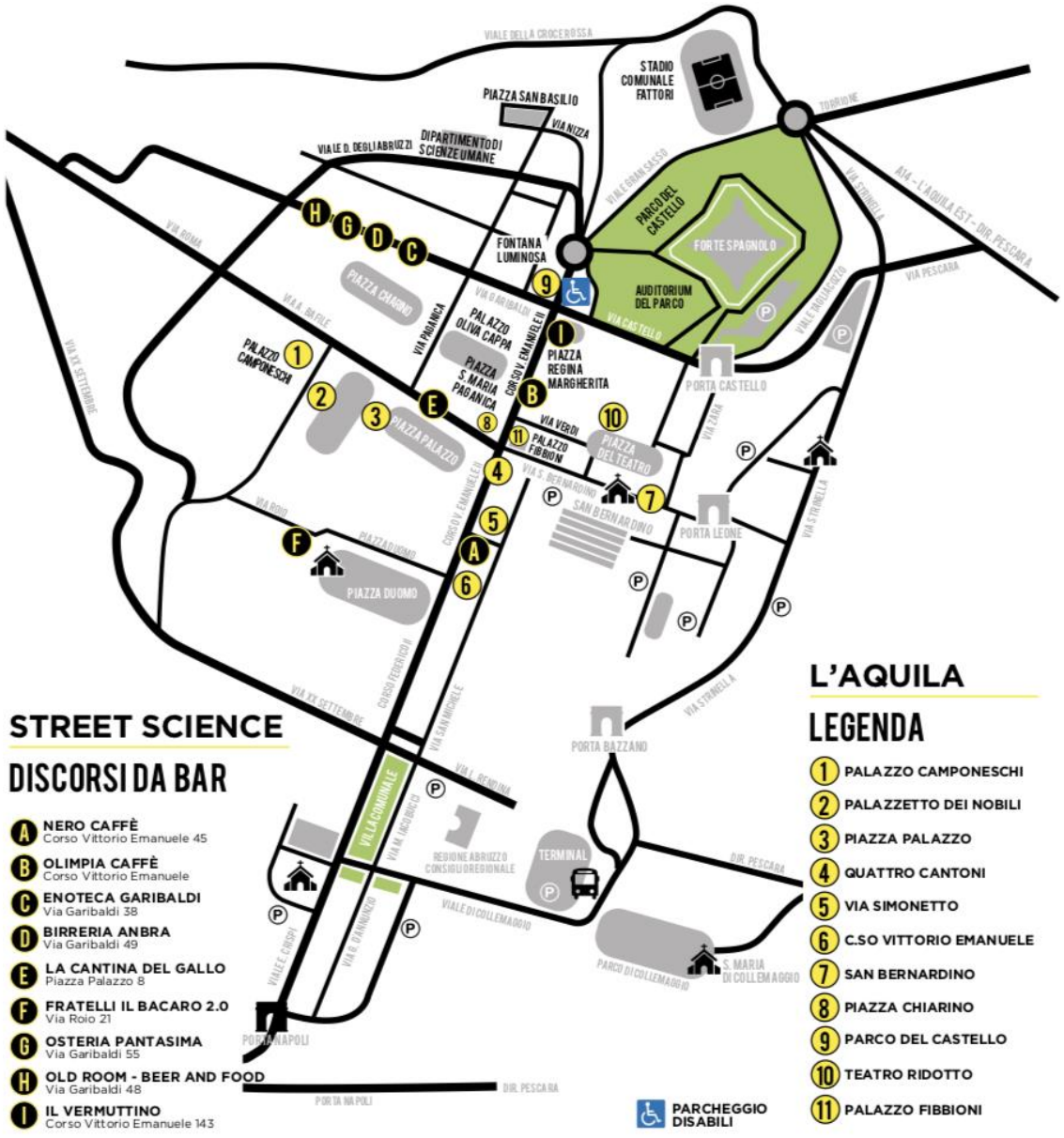
How to identify Microservices?

Main Takeaways

- Architectural Pattern serves as guidelines
- Always be aware of trade-offs
- A complex system can consists of multiple architectur
- Think about an IoT system, e-commerce system or any production system

How to identify Microservices? – Lets go back to NdR Case

NdR Case Study



https://www.streetscience.it

NdR Case Study

Goal: Develop a microservice based AI-powered event management system for NdR

Features: User registration, book venues, book parking lots, provide venue and parking lot recommendation, priority booking based on small payment, check weather

Data Sources:

- Parking mats at entrances and exits of parking lot to get count of cars
- Handheld RFID readers to capture the count of people entering venue
- Cameras at different locations to provide real-time video feed
- People counter at venue exits to count people exiting venue

Microservices – How to Design?

How to design?

Follow the principle of bounded contexts

- Identify different contexts inside the main domain [organizational boundary]
- Only share what is important rest remains within context

Ensure loose coupling

- Minimize coupling between microservices
- Should be easy to change and deploy one without affecting others
- Each microservice needs to know as little as possible about others

Maintain high cohesion

- Bundle one end to end feature or complete part of it inside one microservice
- Promotes robustness and reliability
- One change should never require change in 10 different places

What are the contexts in NdR?

Contexts within NdR

IoT

User

Booking

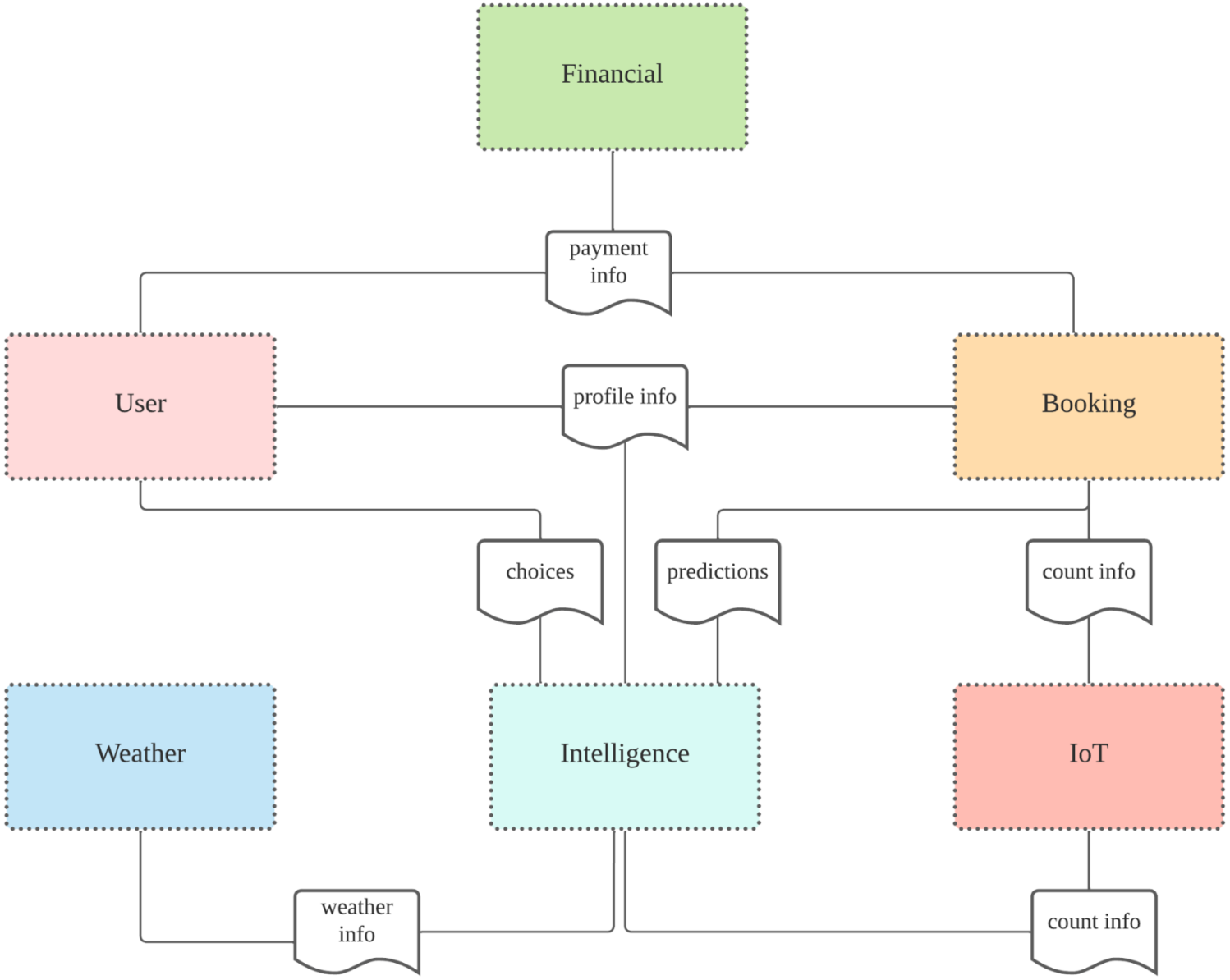
Weather

Intelligence

Financial

Hidden and Shared Models

Hidden and Shared Models

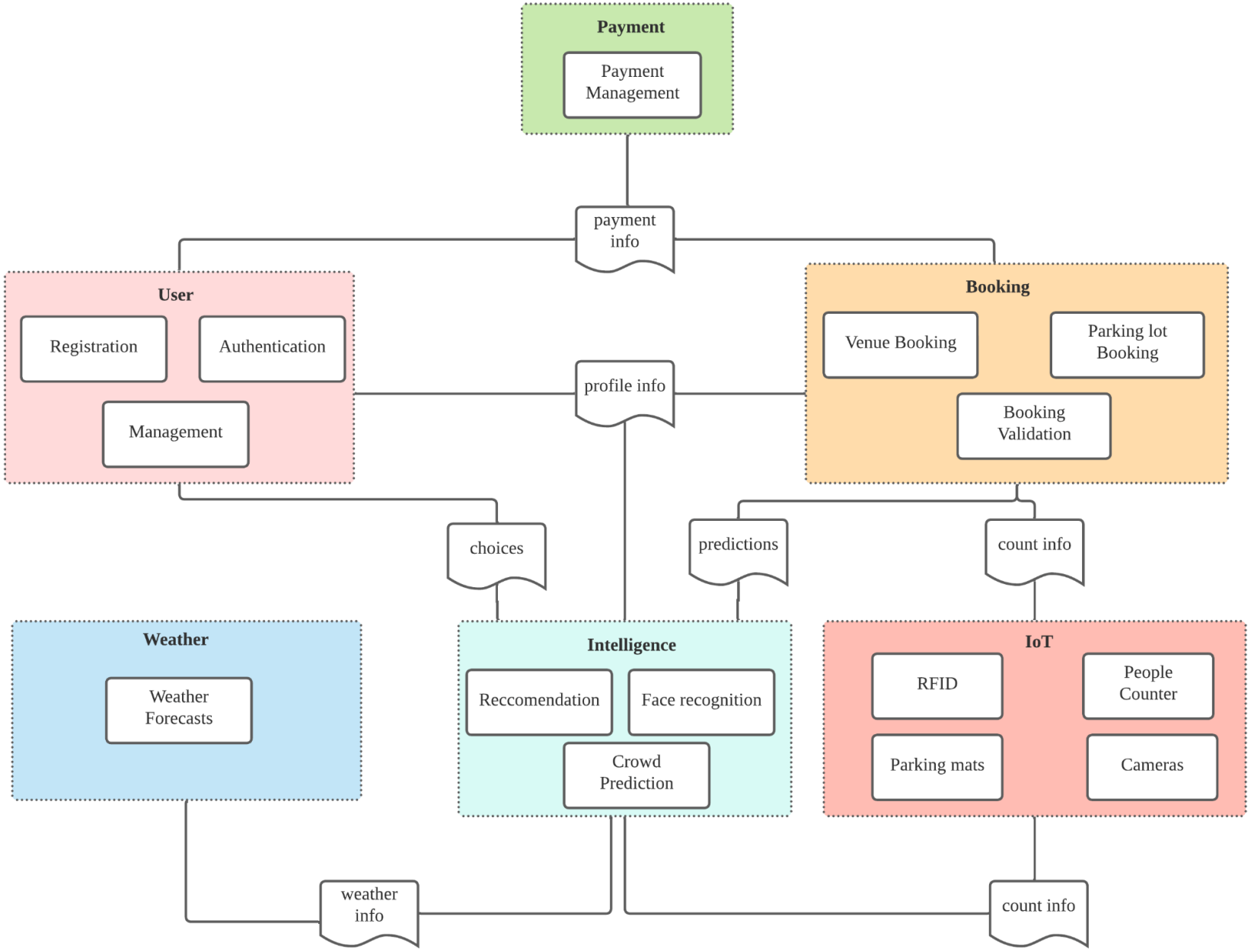


Shared and Hidden Models

- Identify what needs to be shared
  - Eg: Sharing of information on people and car count to booking context
- Same things may have different meaning in different contexts
  - Eg: Sensor data in IoT context and booking context
- This process will facilitate avoiding of high coupling (Pitfall !!)
- Microservices should never be chatty!
  - Adds to performance issues
  - Lack of cohesion
  - Eg: too many back and forth communication between two microservices

Modules and Services

Modules and Services in NdR

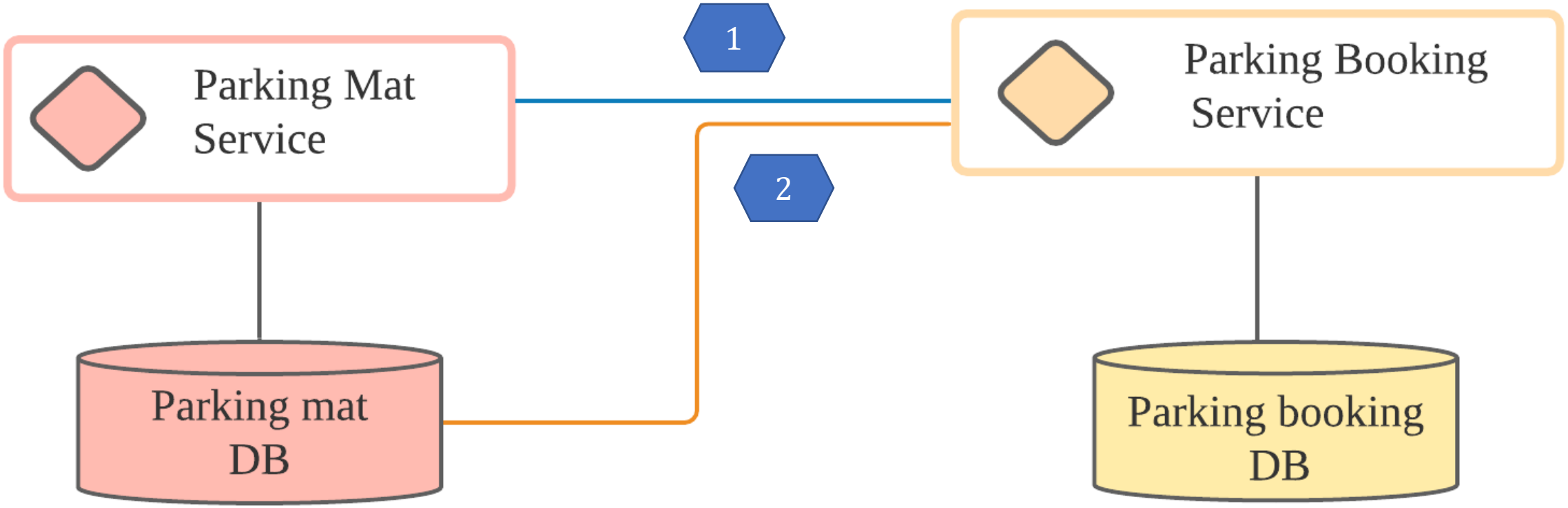


Shared and Hidden Models

- Seperate the contexts into modules
  - Eg: Recommendation and prediction inside intelligence
- Use the help of hidden and shared models
  - Shared becomes the bridge and hidden becomes the separation points
- The modules becomes candidates for microservices
  - High Cohesion - Everything stays within context and modules are independant
  - Loose Coupling - Only what is needed is shared
- Avoid premature decomposition
  - Early decisions can be costly (eg: entire IoT as one module)
  - Re-decomposition may take time, effort and expenditure

Microservices Integration: Overview

Integration with Shared DB?



1 or 2 ?

Shared DB Integration?

Avoid integration with shared db as much as possible:

- Changing DB schema based on one microservice need affects others
- Affects evolution of system eg: changing from relational to non-relational
- Choice of DB might constrain the choice of language for implementing microservice eg: Java might have more db driver available for MySQL
- Goodbye high cohesion and loose coupling !!!

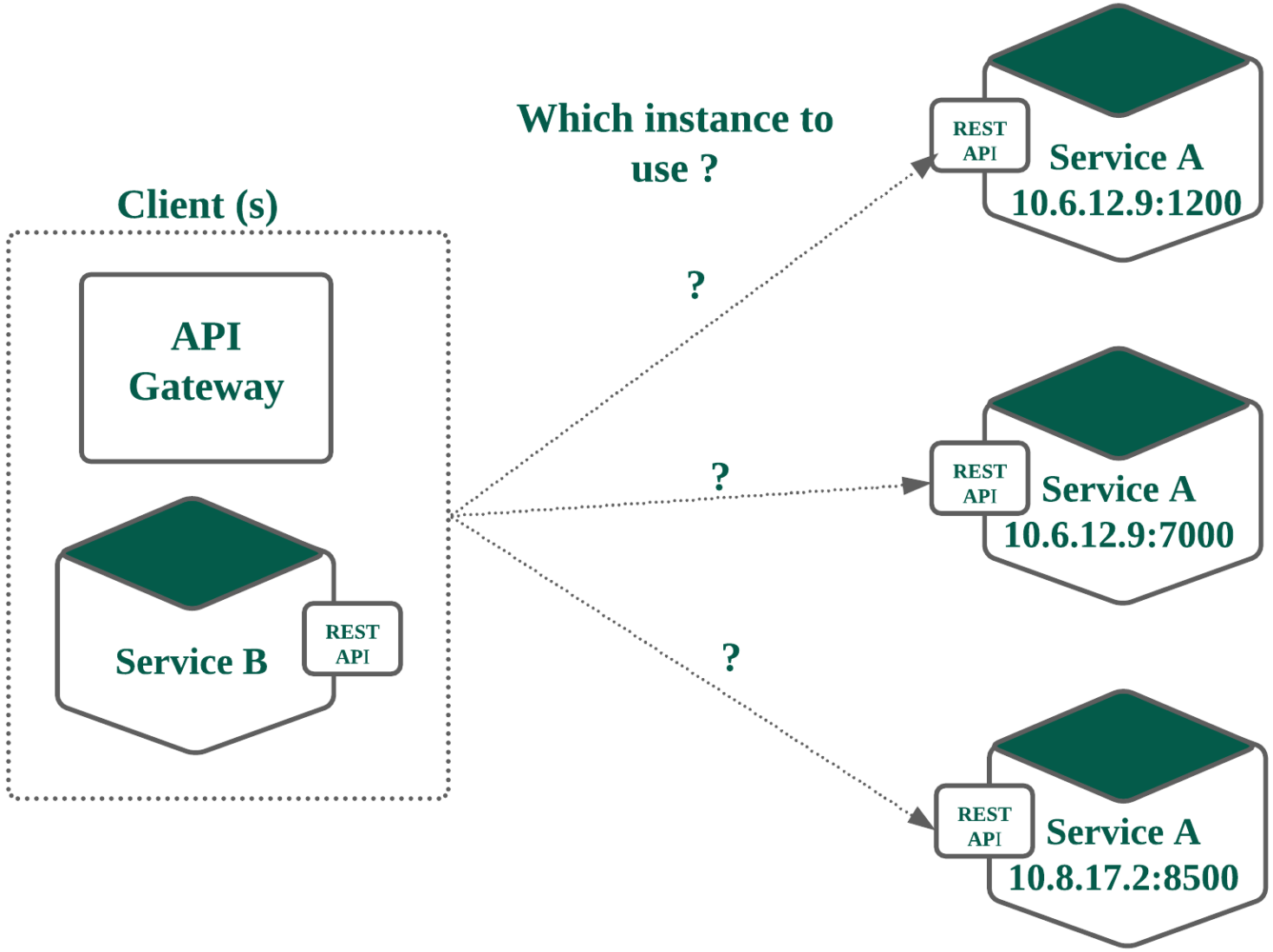
Microservices Communication

Many things to Consider

- Synchronous Vs Asynchronous
- Orchestration v Choreography
- REST vs GraphQL
  - JSON vs XML vs Protobuf
- Communication Patterns exist

How do services discover other service instances?

Service Discovery

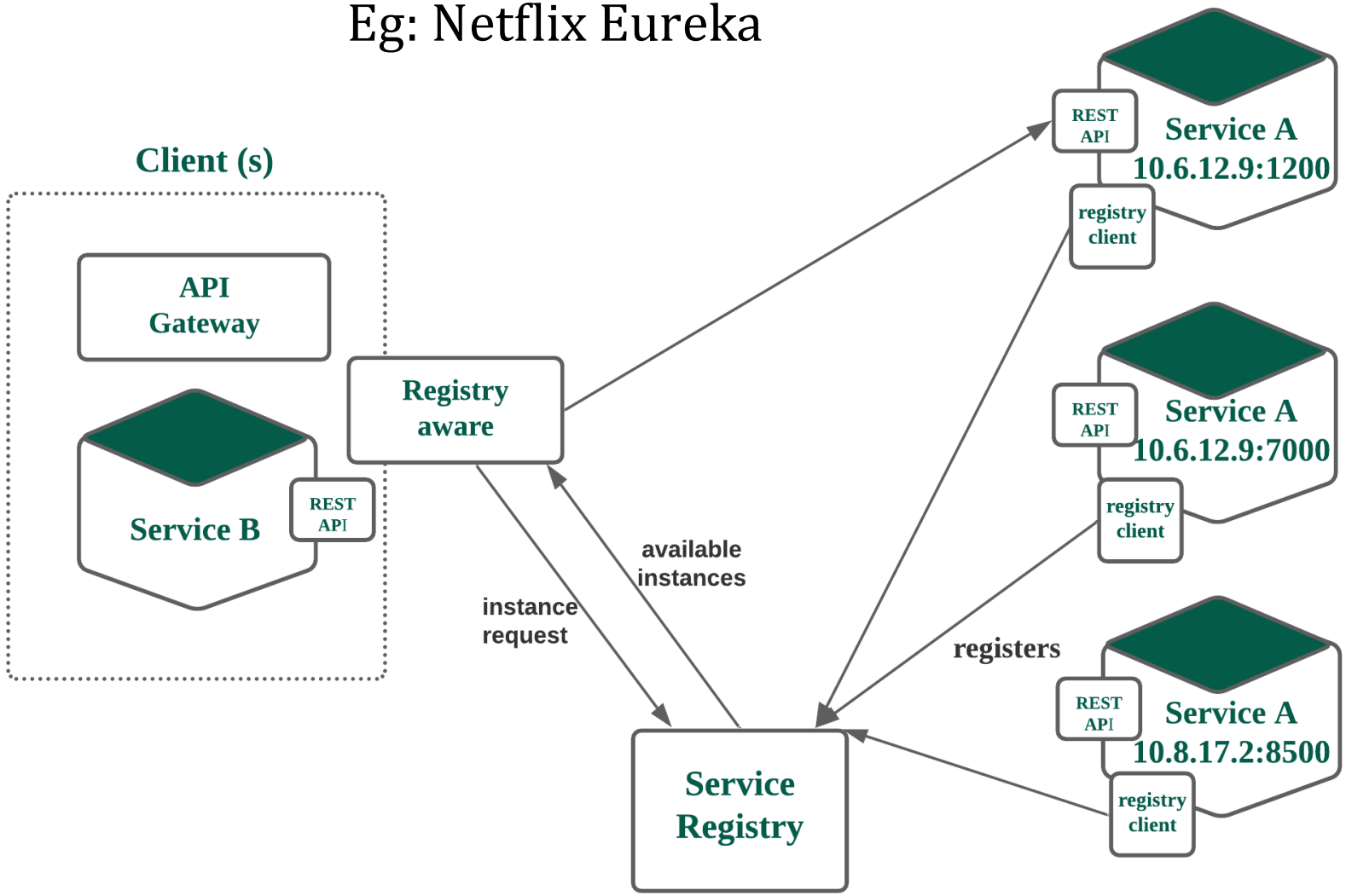


Use Service Registry!!

Client-side Service Discovery

- Each microservice registers itself to service registry (as and when they are available)
- Service registry responds with the instance of the requested service to client
- Fewer network calls (just query service registry)
- Coupling between client and service registry

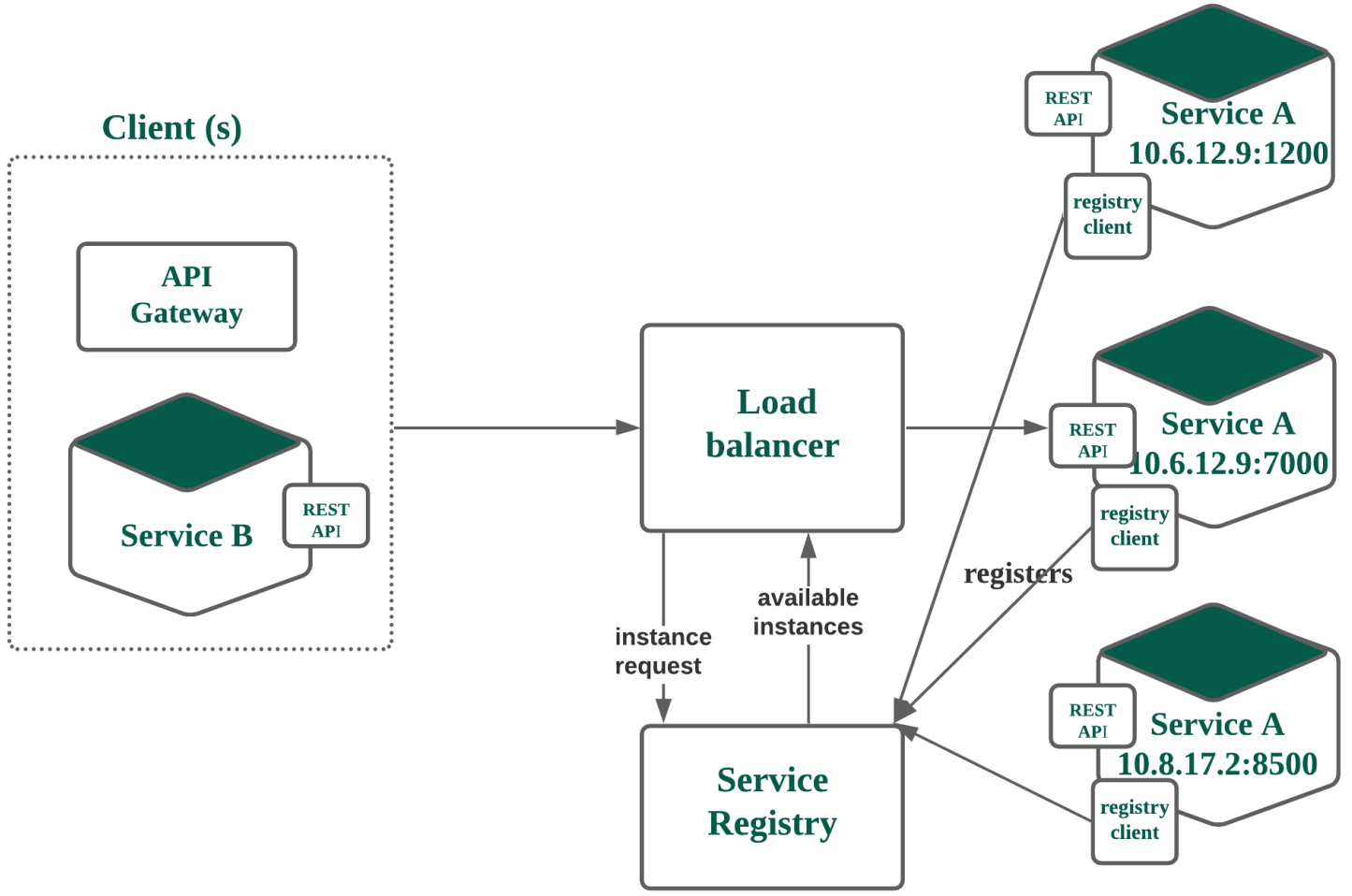
Eg: Netflix Eureka



Server-side Service Discovery

- Client (s) sends request to API gateway or load balancer
- The load balancer or API gateway uses Service registry to discover services
- Separation of logic from client
- Load balancer needs to be managed and replicated
- Additional network hop

Eg: Amazon ELB, Zookeeper



Is Microservice the holy grail?

Some Funny Quotes but makes sense

Honest Status Page @honest_update · Oct 8, 2015

We replaced our monolith with micro services so that every outage could be more like a murder mystery.

21 3K 2.6K

Gert de Pagter @BackEndTea · Jan 7

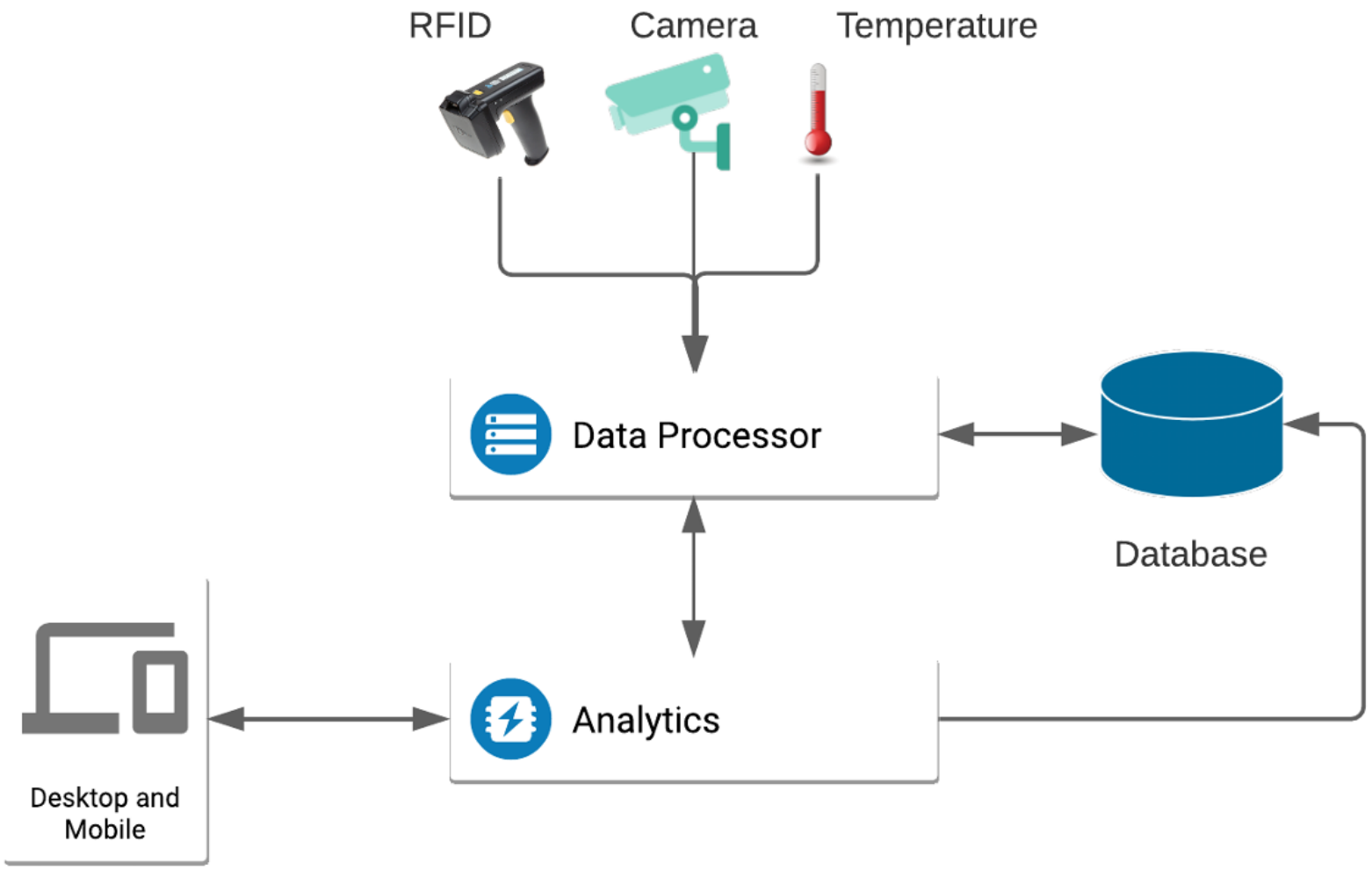
Thanks to **microservices**, our JOINS are now over HTTP.

39 345 1.4K

Monolith -> microservice but then we need docker, kubernetes, monitoring and what not !!!!

image source: twitter

EDA: An Intuition



What can be the issues with the above design?

Thank You

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