Microservices Architecture

Software Architecture

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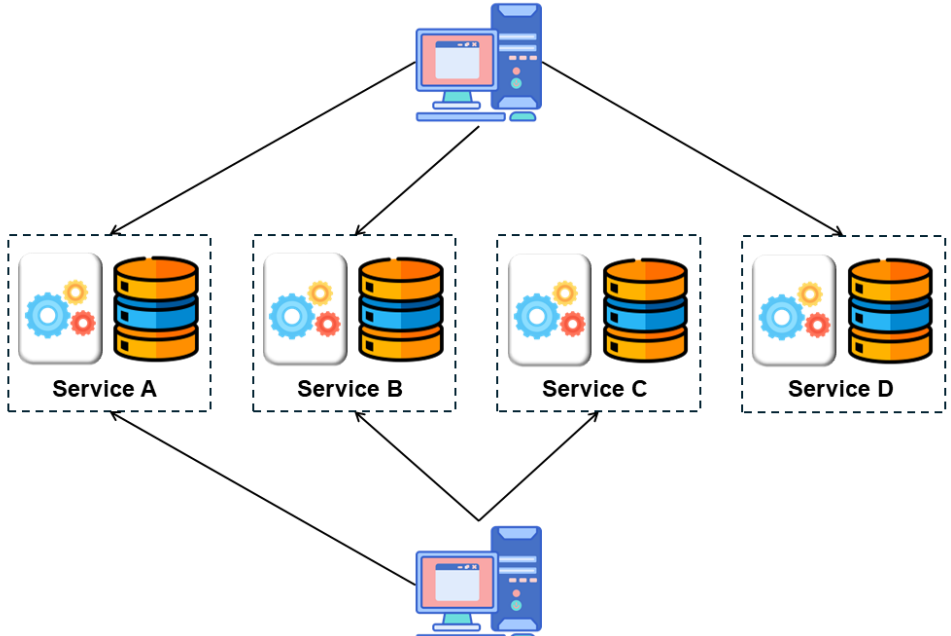
April 7, 2025

History

- Service Oriented Architecture (SOA)
- Enterprise Service Bus (ESB)
- RESTful APIs
- Microservices

REST – REpresentational State Transfer

SOA



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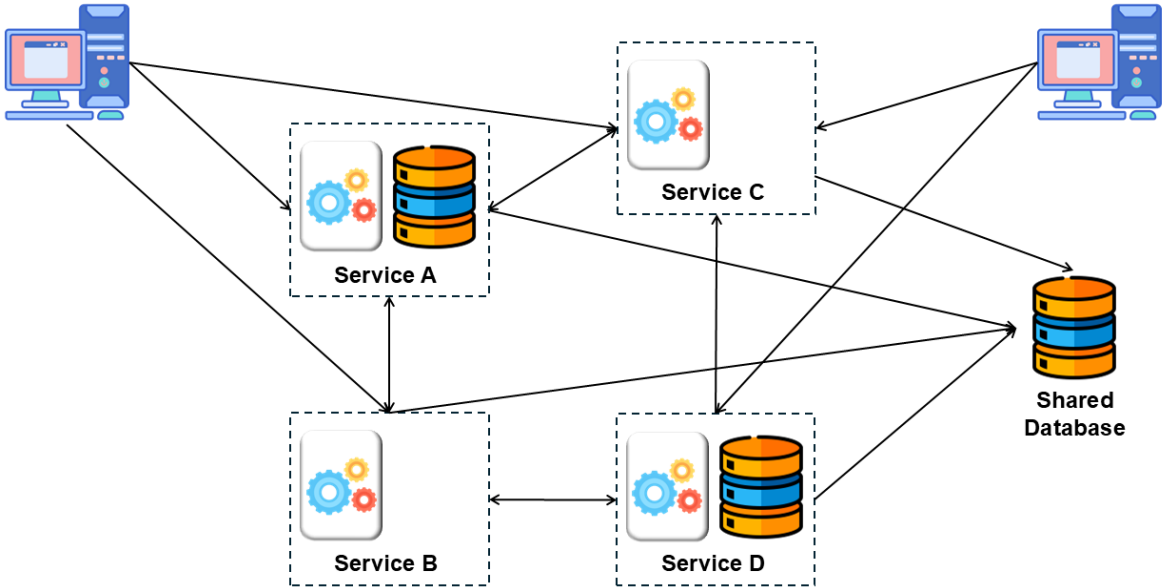
SOA Circumvented



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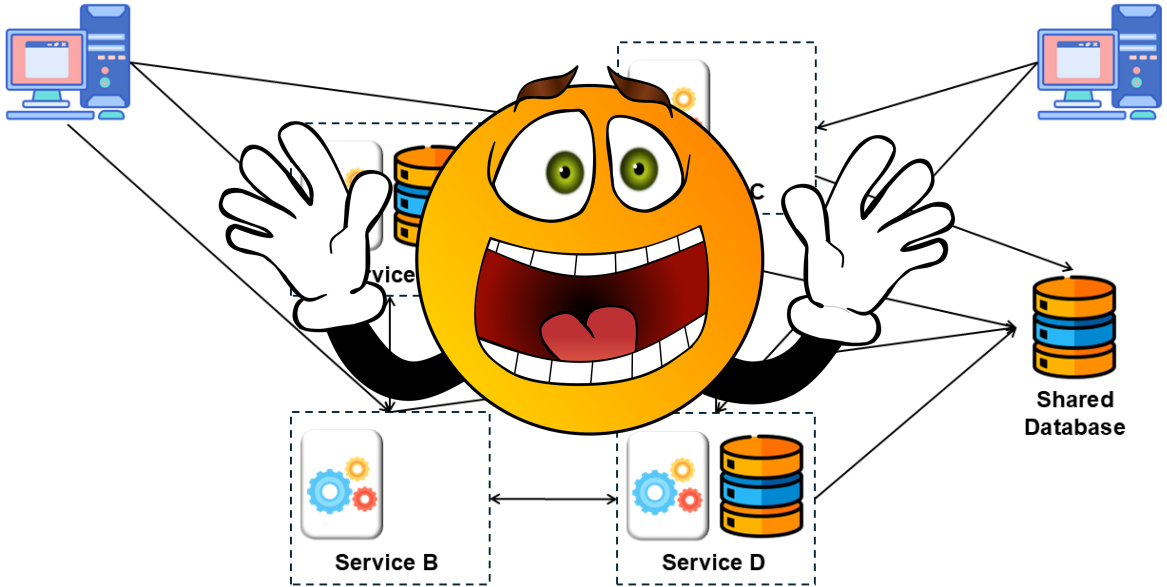
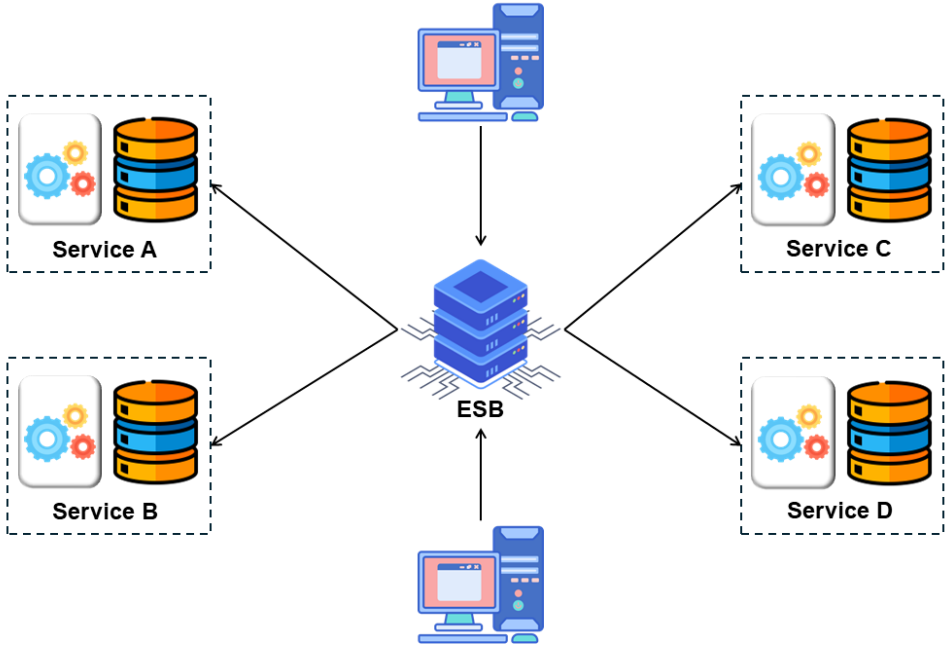


ESB



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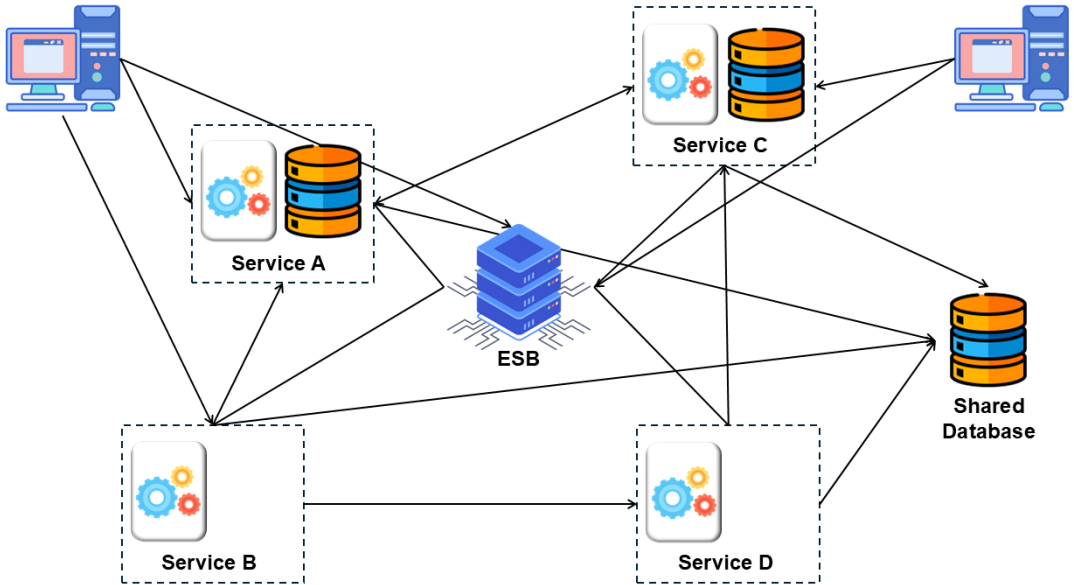
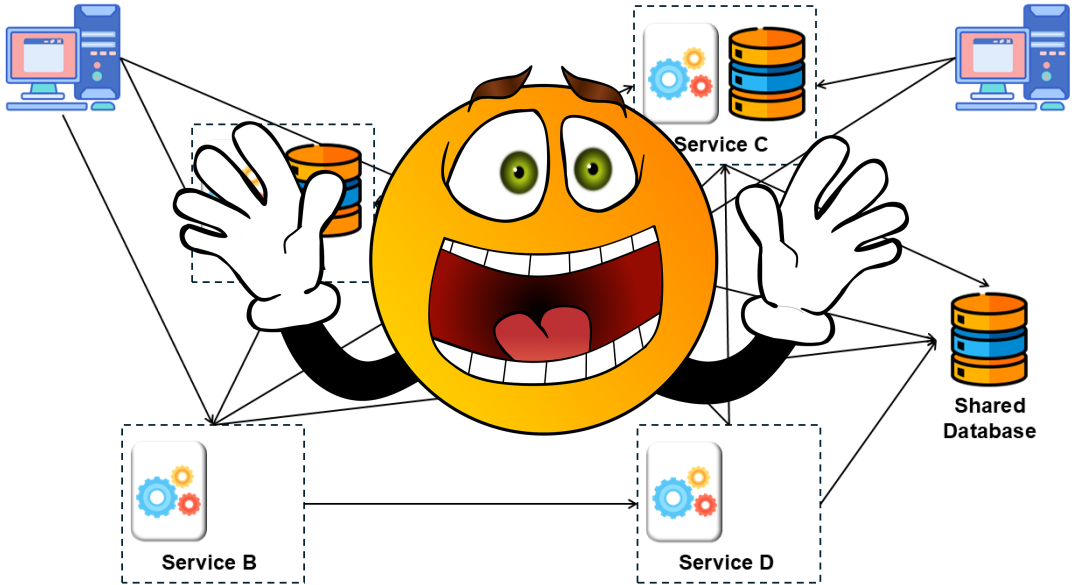
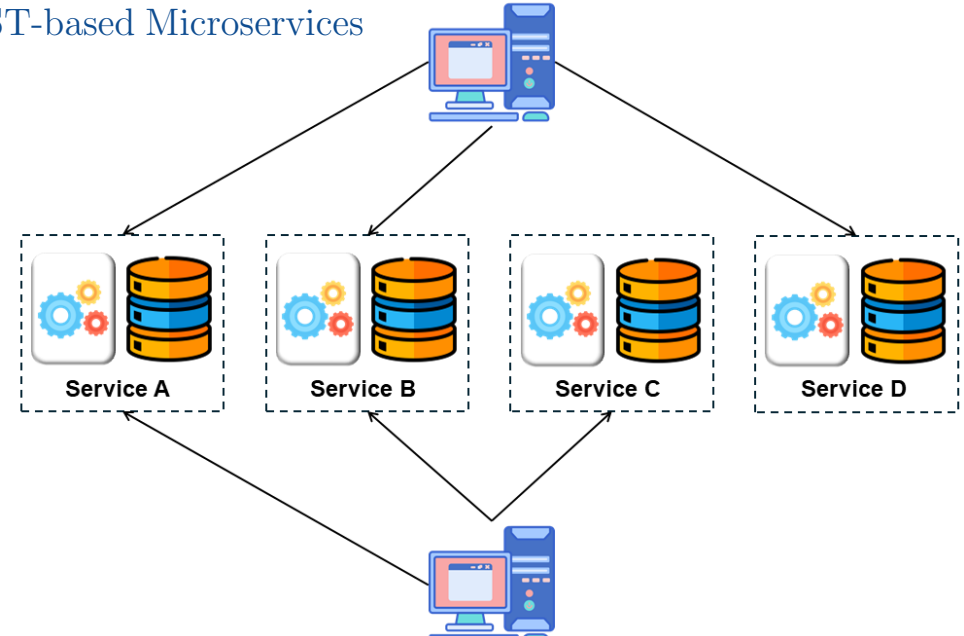
ESB Circumvented



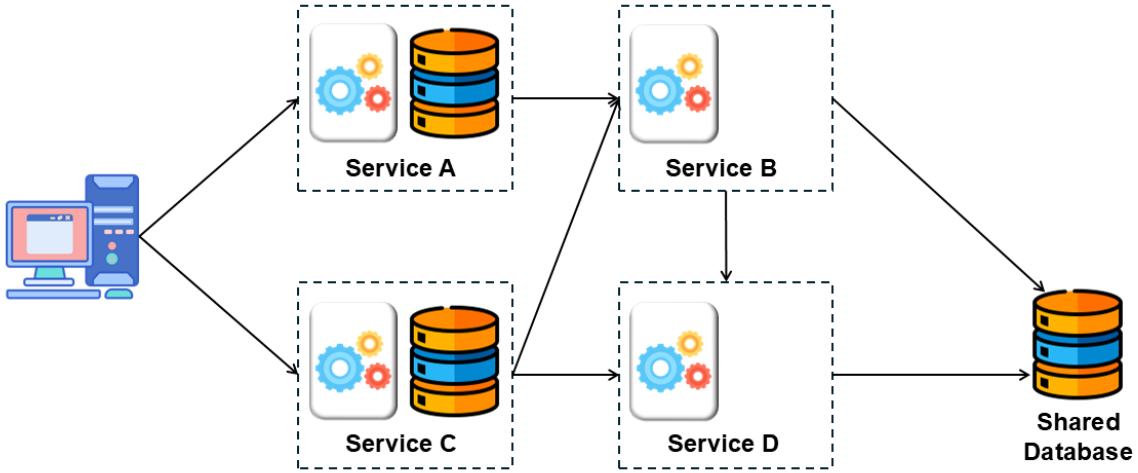
ESB Circumvented



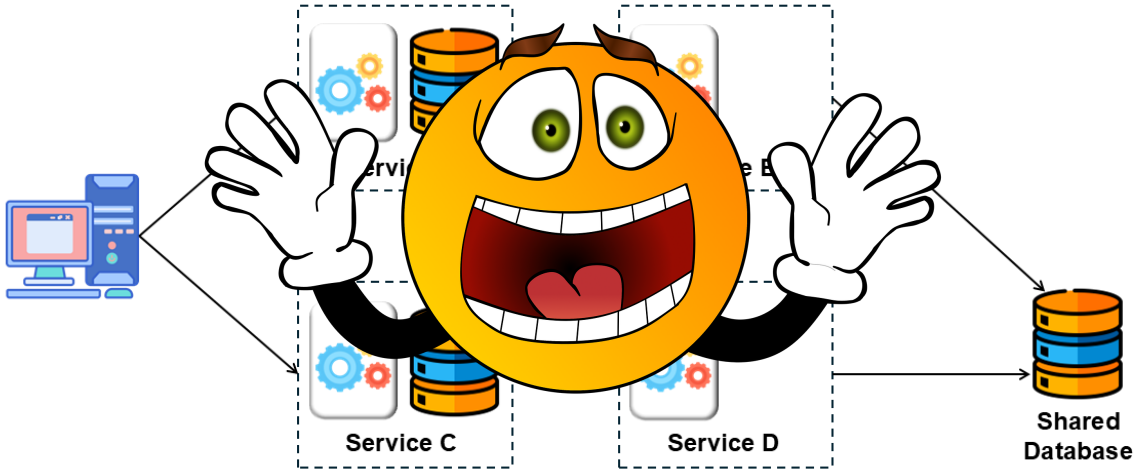
REST-based Microservices



REST-based Microservices Circumvented



REST-based Microservices Circumvented



Question

Why does it go wrong?

Question

Why does it go wrong?

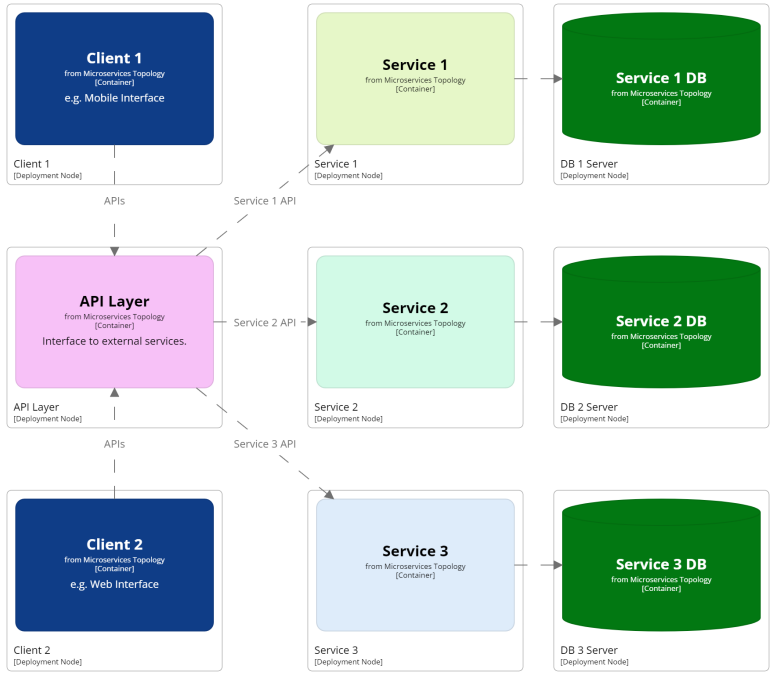
Answer

Getting caught up in the technology!

If you haven't shipped *one* service.
How will you ship a *dozen*?

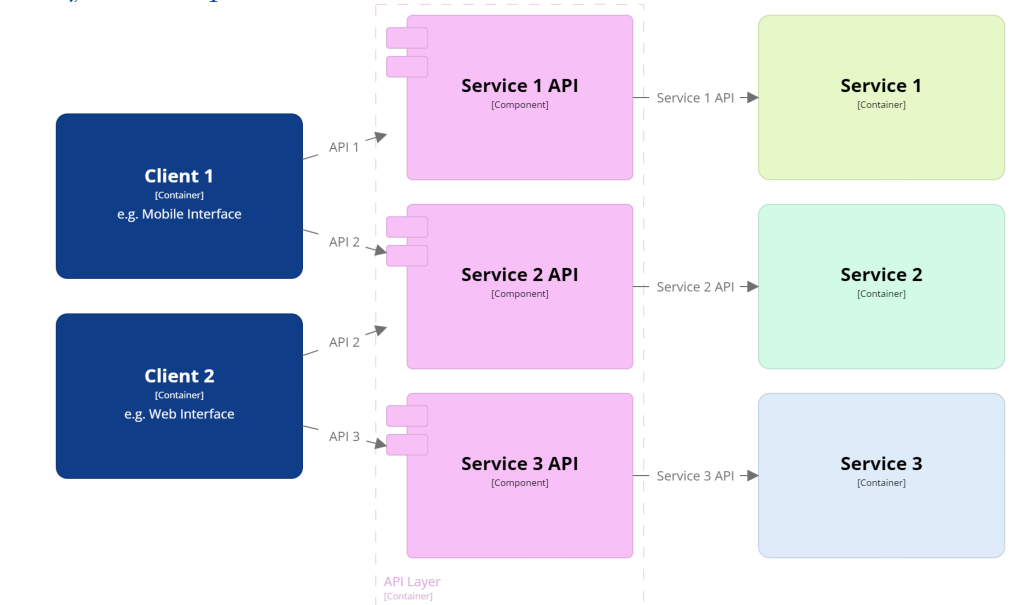
§ Microservices Architecture

Microservices General Topology



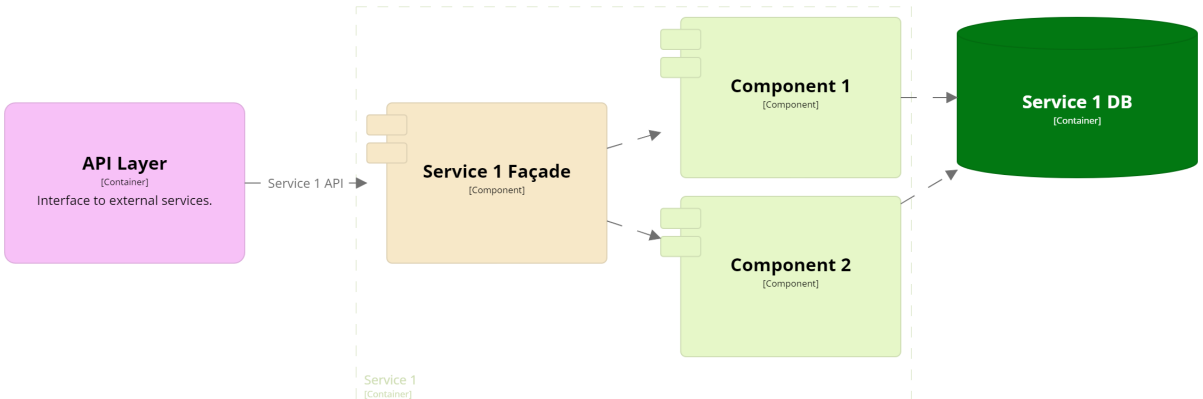
- Multiple clients demonstrates common scenario of multiple interfaces to system (e.g. mobile, web).
- Client UIs may be monolithic to provide a rich interface.

API Layer Components



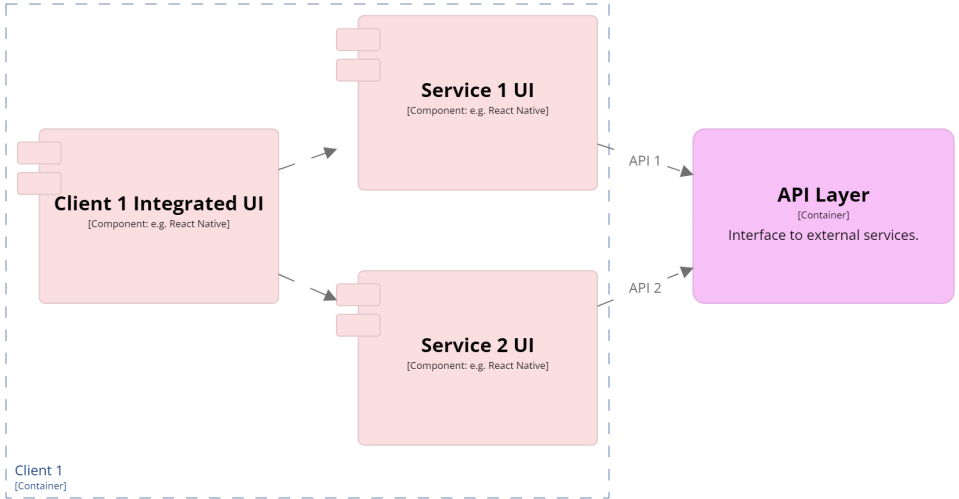
- Each client may use a *different* combination of services
- API layer provides reverse proxy or gateway services
  - See Service-Based Architecture notes & slides
- Typically, Service APIs in the API layer have a one-to-one relationship with Services and are *designed* by the Service teams
- Routing behaviour may not be required

Service 1 Components



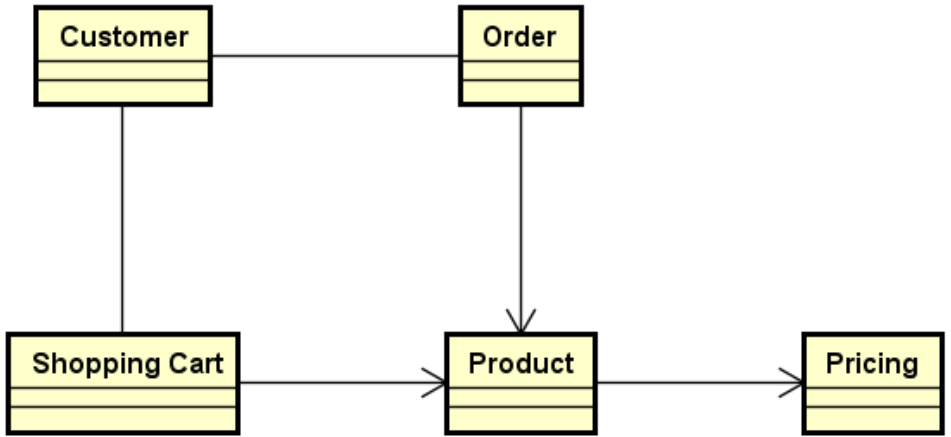
Services 2 & 3 are essentially the same.

Client with Monolithic UI



- Purist Microservices architecture
  - Each service development team builds their service's UI(s)
- Typically needs some *coordinating activity* in the UI
  - Shown as *Client 1 Integrated UI* in model
- Can still have multiple UIs (e.g. web, mobile, ...)

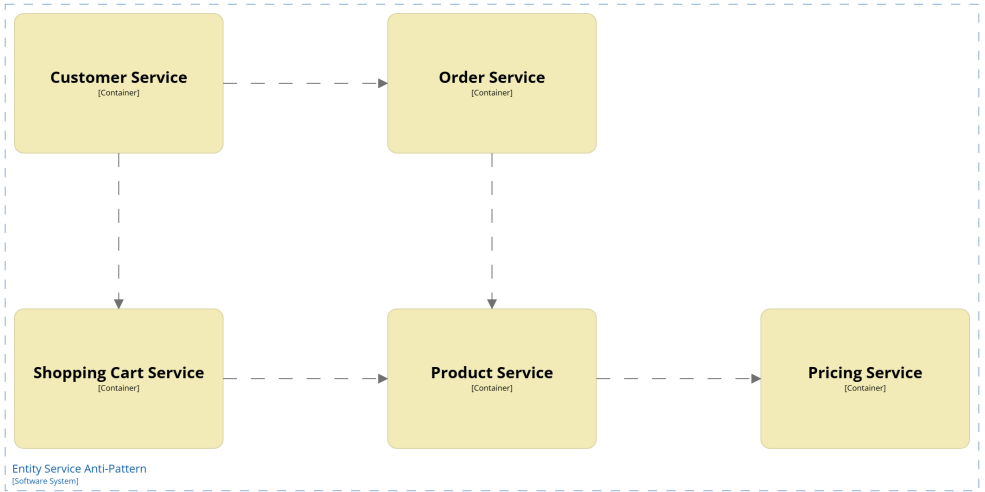
Entity Service Anti-Pattern



OO Modelling – Identify entities in the problem domain

- Tend to be stabler / longer-lived parts of the problem domain

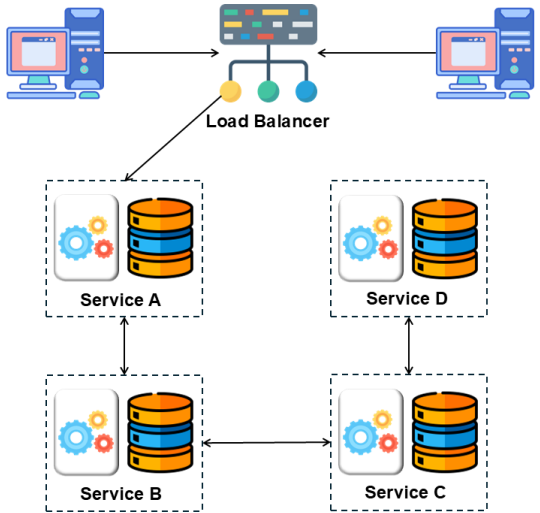
Entity Service Anti-Pattern



- Intuitive approach – Design services around main entities
- Usually introduces *synchronous* flow of logic between services
  1. Customer places an Order
  2. Order calls Product to get details
  3. Product calls Pricing to determine price

Problem with Synchronous Logic

- Potential chain of failure
- Failures are multiplied
- Latency is multiplied
- Deployment is hard
- Scaling is hard
- Lazy design



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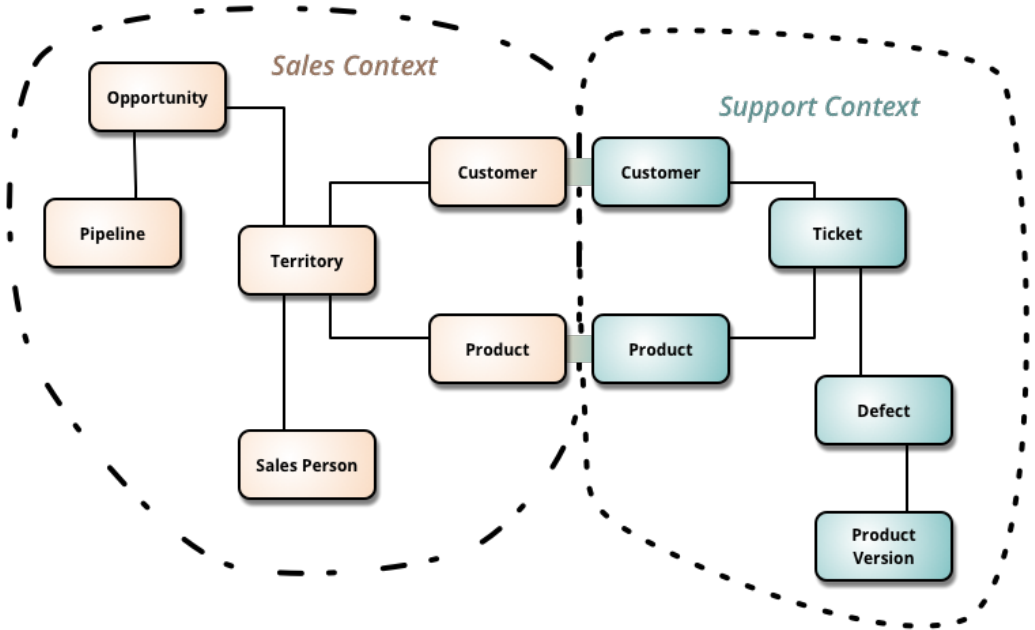
- Chains of request (synchronous logical flow) don't scale.

§ Domain Driven Design

Definition 0. Bounded Context

Logical boundary of a domain where particular terms and rules apply consistently.



From https://martinfowler.com/bliki/BoundedContext.html

Definition 0. Service Cohesion Principle

Services are cohesive business processes.

DDD Consideration

Services are *bounded contexts*.

Bounded contexts are not necessarily *services*.

Large Bounded Contexts

Bounded context may be too large to be a single service.

Split it into services that are *independent* sub-processes.

Definition 0. Service Independence Principle

Services should not depend on the implementation of other services.

Corollary 0. Low Coupling

There should be minimal coupling between services.

Corollary 0. No Reuse

Avoid dependencies between services.

Do not reuse components between services.

Restaurant Examples

Bad Restaurant

- Arrive: Wait in queue to be seated
- Wait for menu: Server has to go get board with menu
- Ask about special: Server has to go ask chef
- Order items: Server takes order to kitchen
- Server returns, an item is not available
- Change order: Server takes order to kitchen
- Server waits for order – constantly asking if its ready
- Server brings everything to table together
  - Drinks, Entrée, Main, Dessert, ...
- ...

Restaurant Examples

Bad Restaurant

Good Restaurant

- Describe normal experience at a restaurant

Lessons Learnt

Chains of request don't *scale*.

People who have the *information* to do their job are more effective.

Service boundaries that follow these *principles* work better.

Human Shaped Microservices

Look at *behaviour* rather than entities.

- Who & How
- Not the Thing

From Damian McLennan

What would people *do*?

How would they *communicate*?

Bounded Domains Implications

- Duplication
  - Entities specialised for domain
    - Requires mapping of entity data between domains

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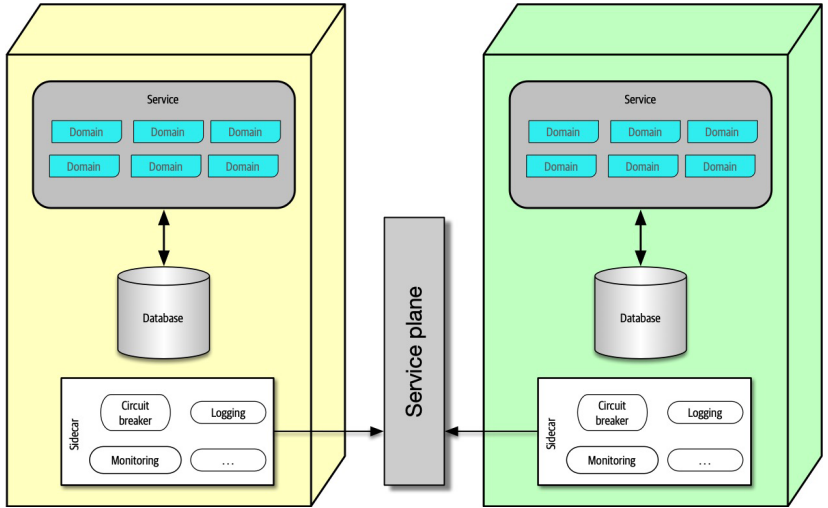
  - Should everything be duplicated?
    - What about common services (e.g. logging, ...)?
- Heterogeneity
  - Services can use different implementation technologies

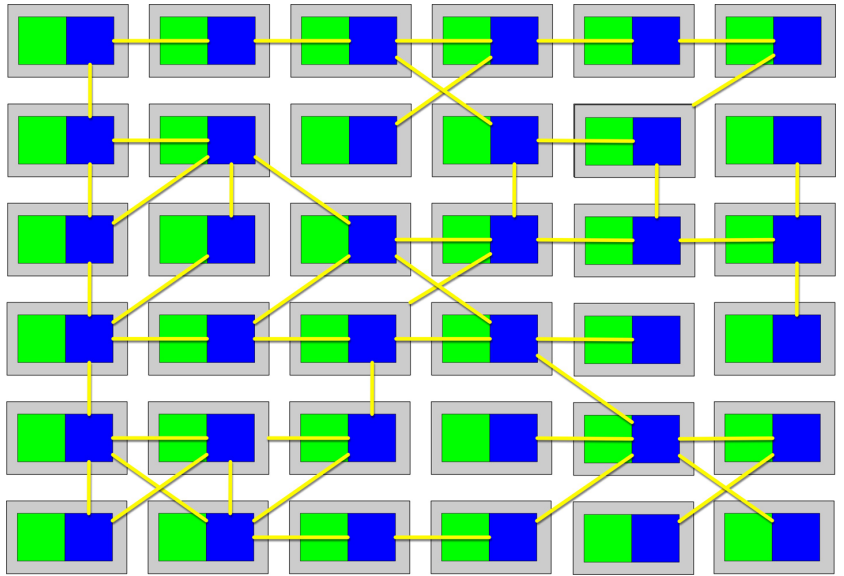
§ Microservices Design Options

Service Plane



From *Fundamentals of Software Architecture*

Service Mesh



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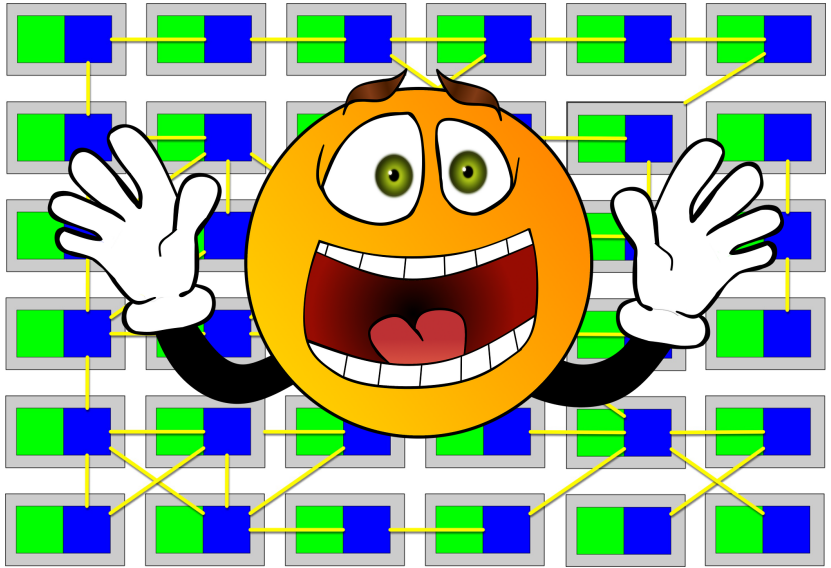


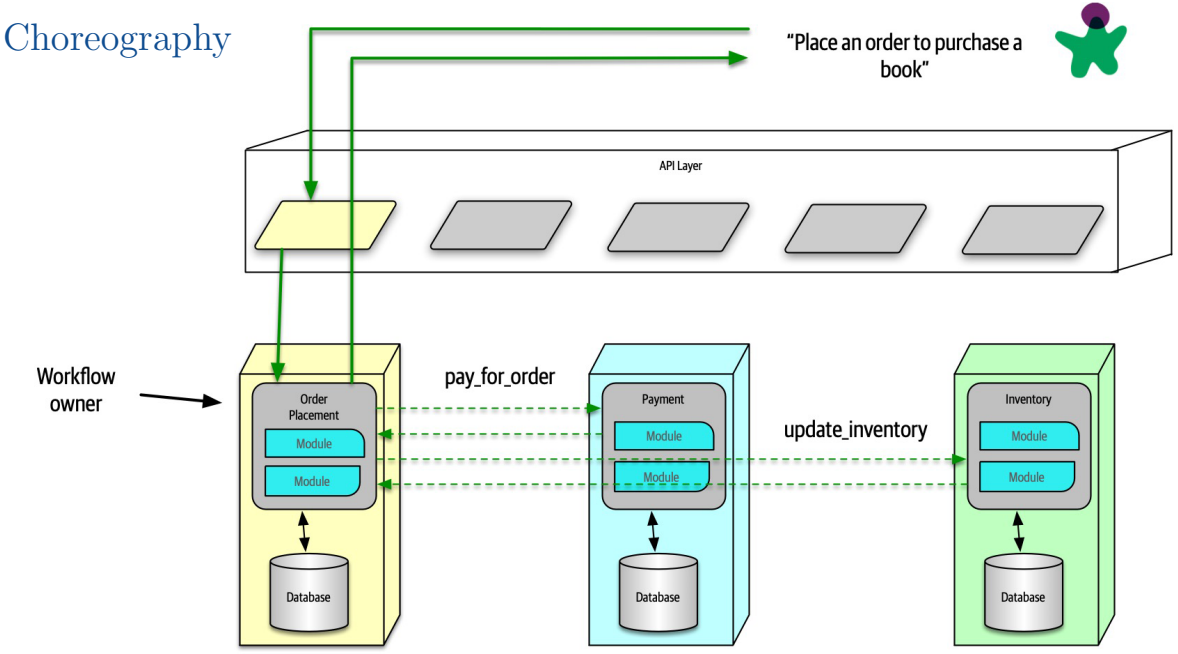
From *Fundamentals of Software Architecture*

Choreography & Orchestration

Choreography Similar to event-driven *broker*

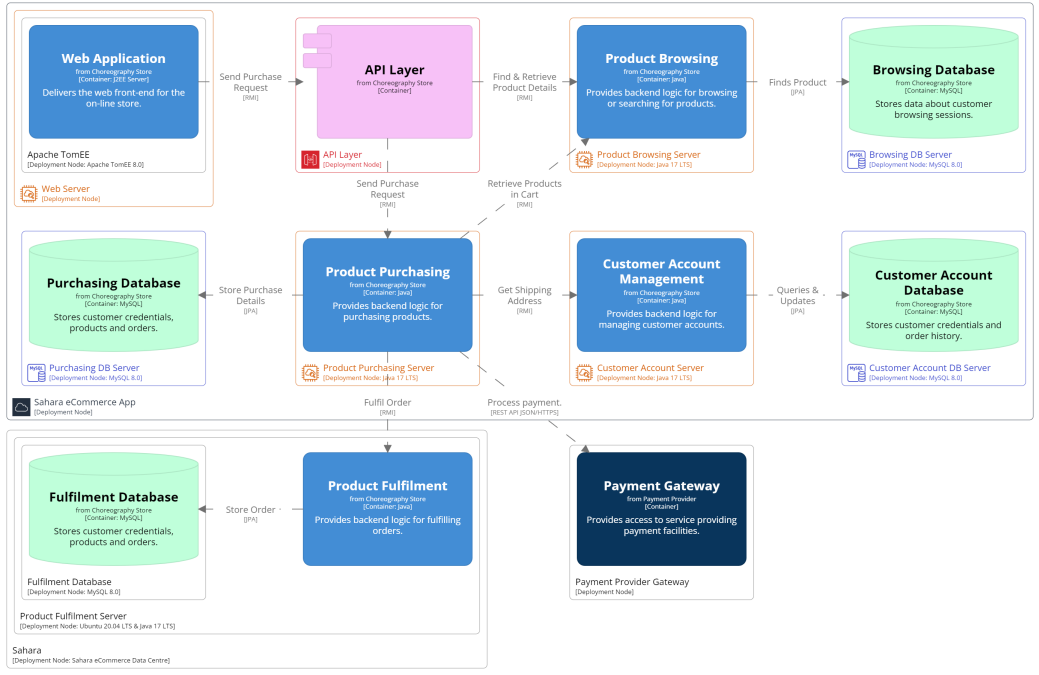
Orchestration Similar to event-driven *mediator*

Choreography

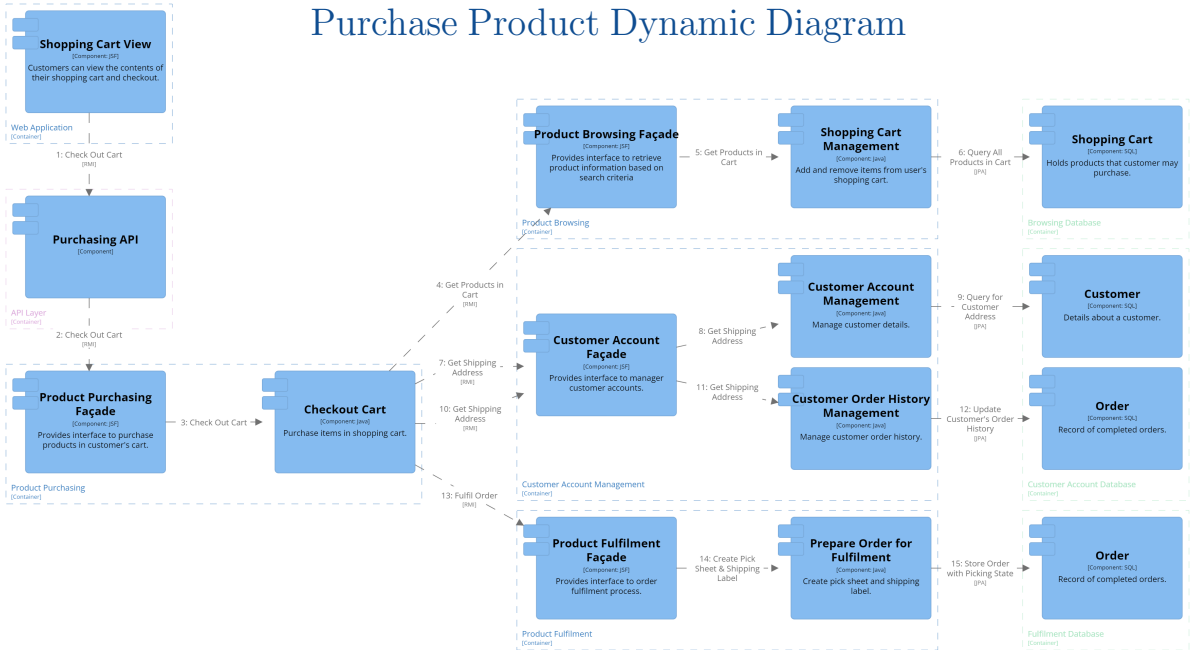


From *Fundamentals of Software Architecture*

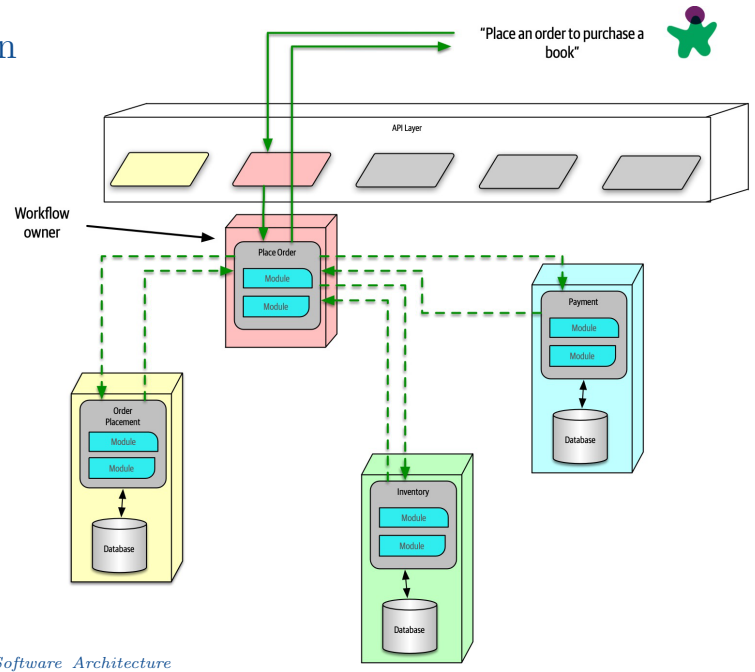
Sahara using Choreography



Purchase Product Dynamic Diagram



Orchestration



From *Fundamentals of Software Architecture*

Question

How bad is coupling with choreography or orchestration?

Question

How bad is coupling with choreography or orchestration?

Answer

For a large system, *very bad*.

In 2017, Uber had over 1400 services ... consider how bad coupling would be with either approach.

Question

How do we scale large microservices-based systems?

Question

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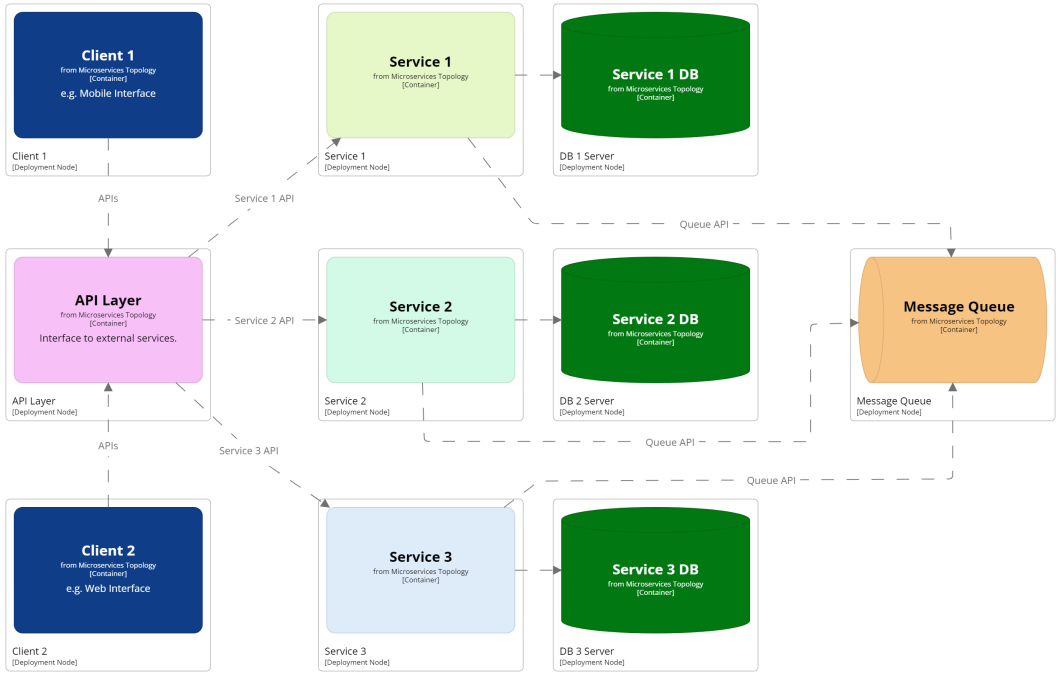
Answer

Combine architectural patterns

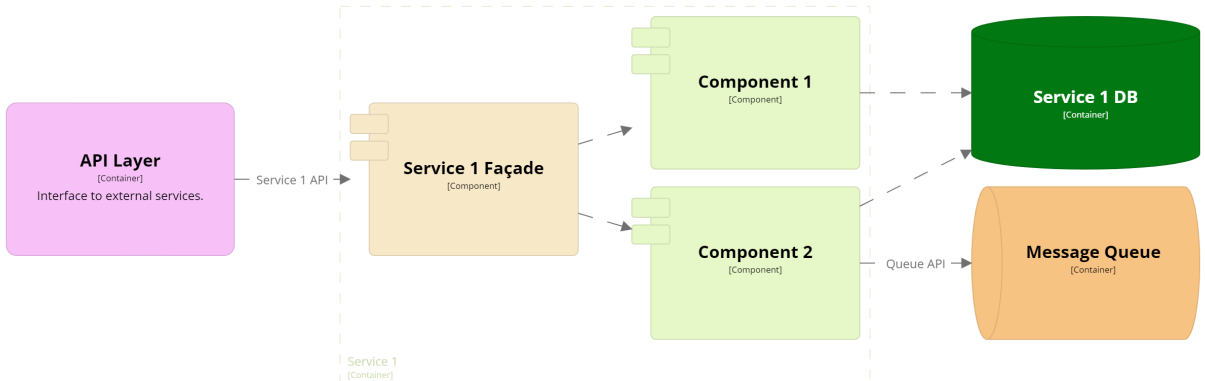
- Event-Driven Microservices

Microservices with Event Queue



- Use the tried and true *Observer* pattern, with the *Event-Driven Architecture* pattern.
- Clients send *commands* telling services to do something.
- Services *publish events* indicating what they have done.
- Services *listen for events* to decide how to coordinate their part of the system behaviour.

Service 1 Components with Event Queue



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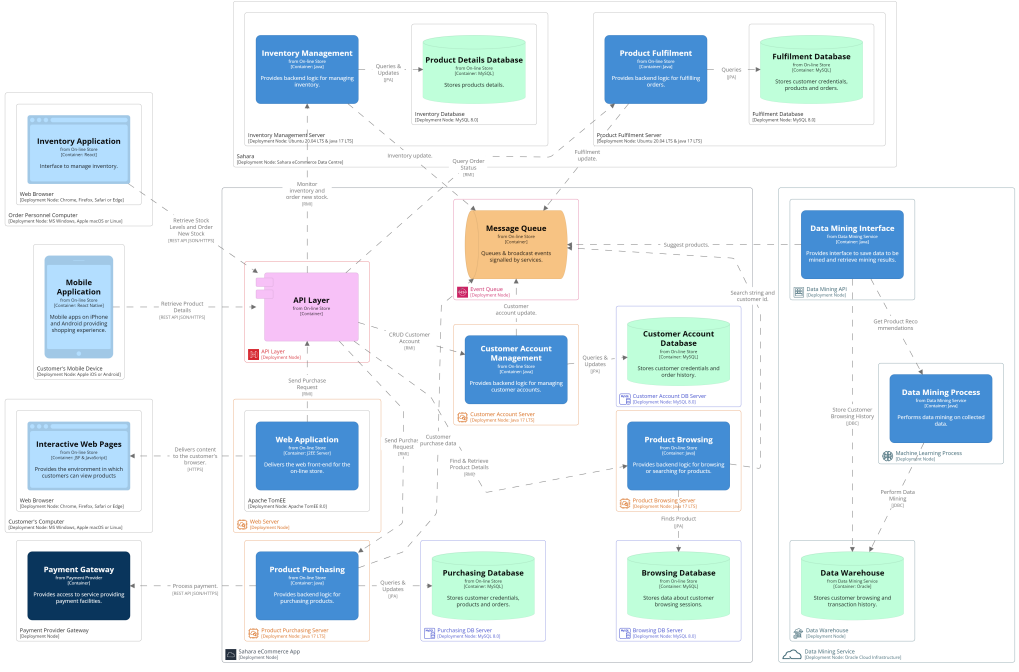
Sahara using an Event Queue



- Sahara eCommerce system as a simple microservices architecture, using event-driven messaging between services.
- Services publish events indicating what they have done.
- Also an example of a multi-tenanted system built across in-house servers, AWS and OCI.

Question

Are *browsing* and *purchasing* separate contexts?

Question

Are *browsing* and *purchasing* separate contexts?

Answer

- Are they a single business process or different processes?
- Do they share much or little data?

- Probably different business processes, but possibly the same context.
- If separate services, browse needs to send an event for every change to the shopping cart, and purchase needs to listen for these.
- Possibly merge into one service, as one context.

Question

- What about *inventory management* and *browse*?
- How do they maintain a consistent product database?

Model Behaviour

- *Commands* & *Events* describe *behaviour*
- They will help you better model your *domain*
- Leading to *independent*, *scalable* services

Pros & Cons

- Modularity 
- Extensibility 
- Reliability 
- Interoperability 
- Scalability 
- Security 
- Deployability 
- Testability 
- Simplicity