# *Lecture 11 - Microservices*

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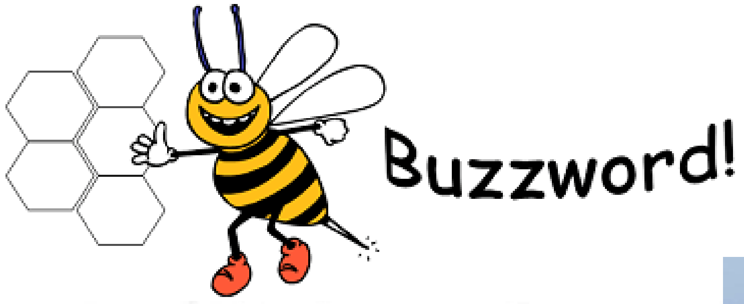
# ‘Microservices’?



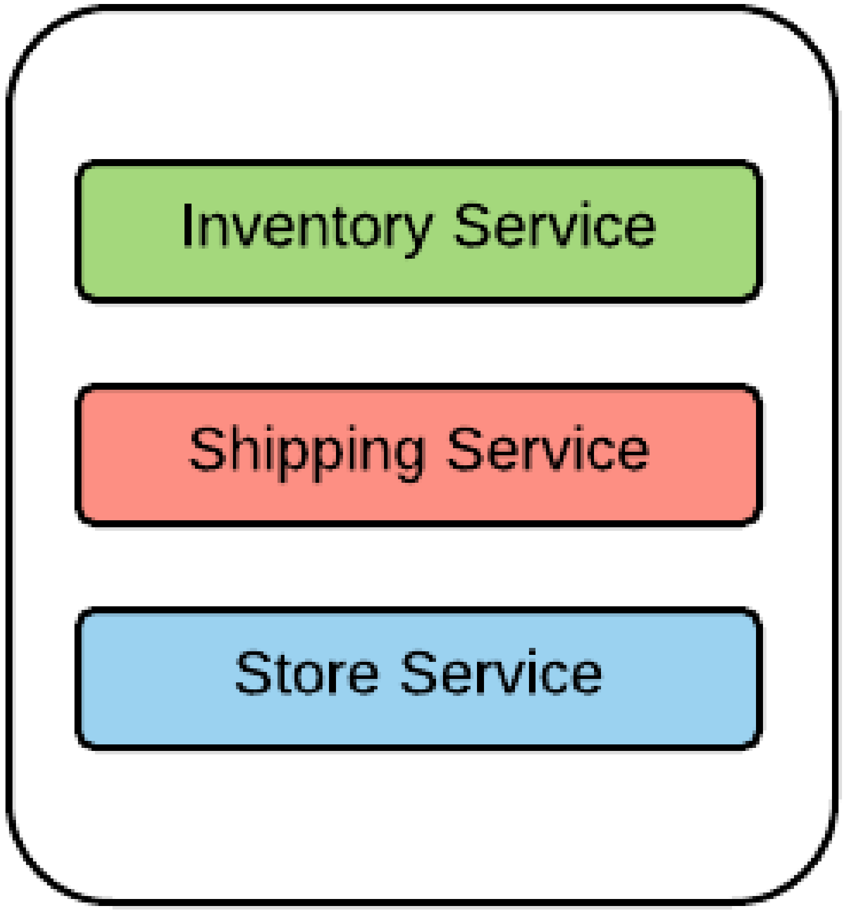
# ‘Monolithic’ Architecture

# Monolithic Architecture

- All functionalities are implemented/deployed into a single software application.
- Enterprise software applications - ERPs, CRMs etc.
- SOA/web services: 'coarse-grained' services, broad scope, mammoth services with several dozens of operations and complex message formats

# Monolithic Architecture

- Use case : Online *Retail software application with which comprises of multiple business functionalities.*



# Monolithic Architecture

- Developed and deployed as a single unit.
- Overwhelmingly complex; which leads to nightmares in maintaining, upgrading and adding new features.
- Redeploy the entire application, in order to update a part of it.
- Scaling : scaled as a single application and difficult to scale with conflicting resource requirements
- Reliability - One unstable service can bring the whole application down.
- Hard to innovate, practice agile development and delivery methodologies

# ‘Microservices’ Architecture

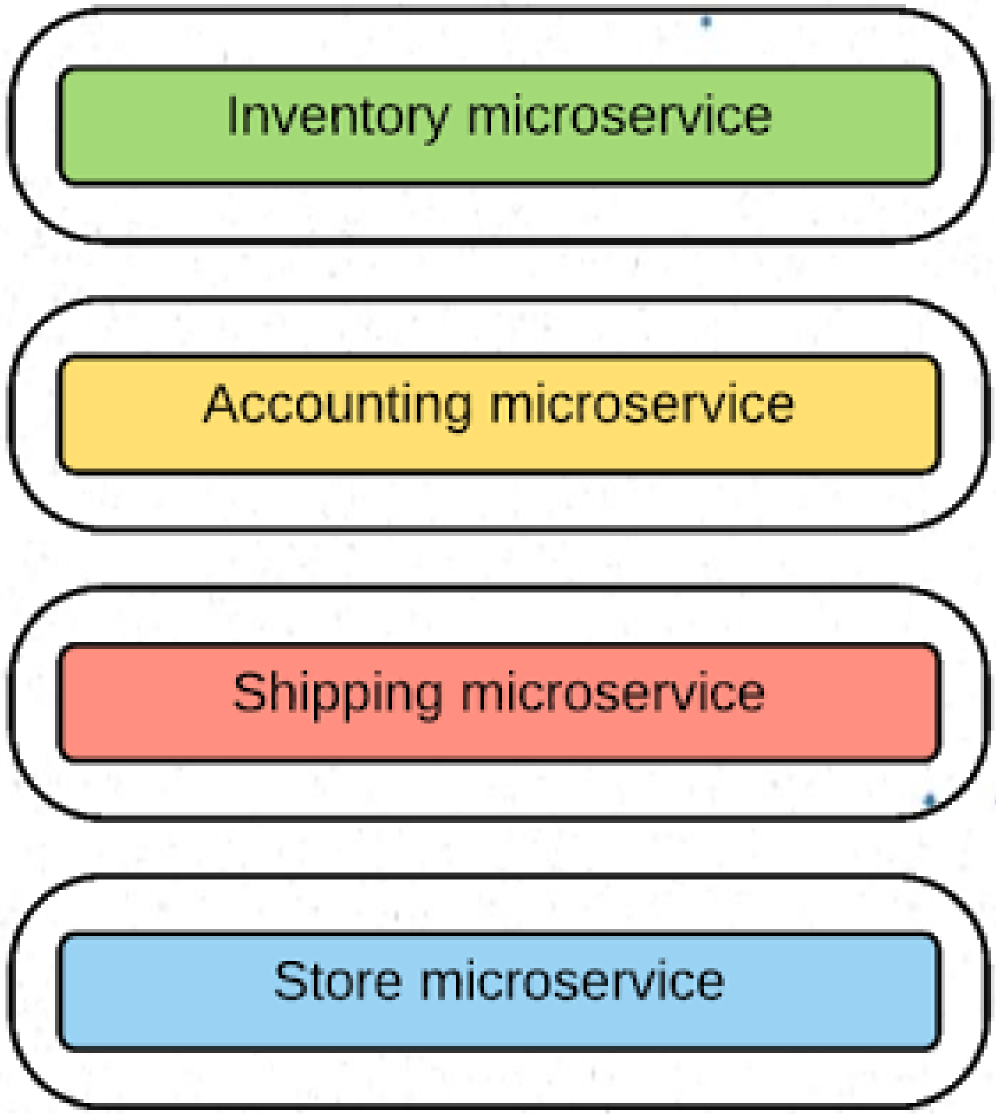
# Microservices Architecture

- *The foundation of microservices architecture(MSA) is about developing a single application as a* ***suite of fine-grained*** *and* ***independent services*** *that are  running in its own process,* ***developed*** *and* ***deployed independently***

- Its just more than segregating the services in a monolith.

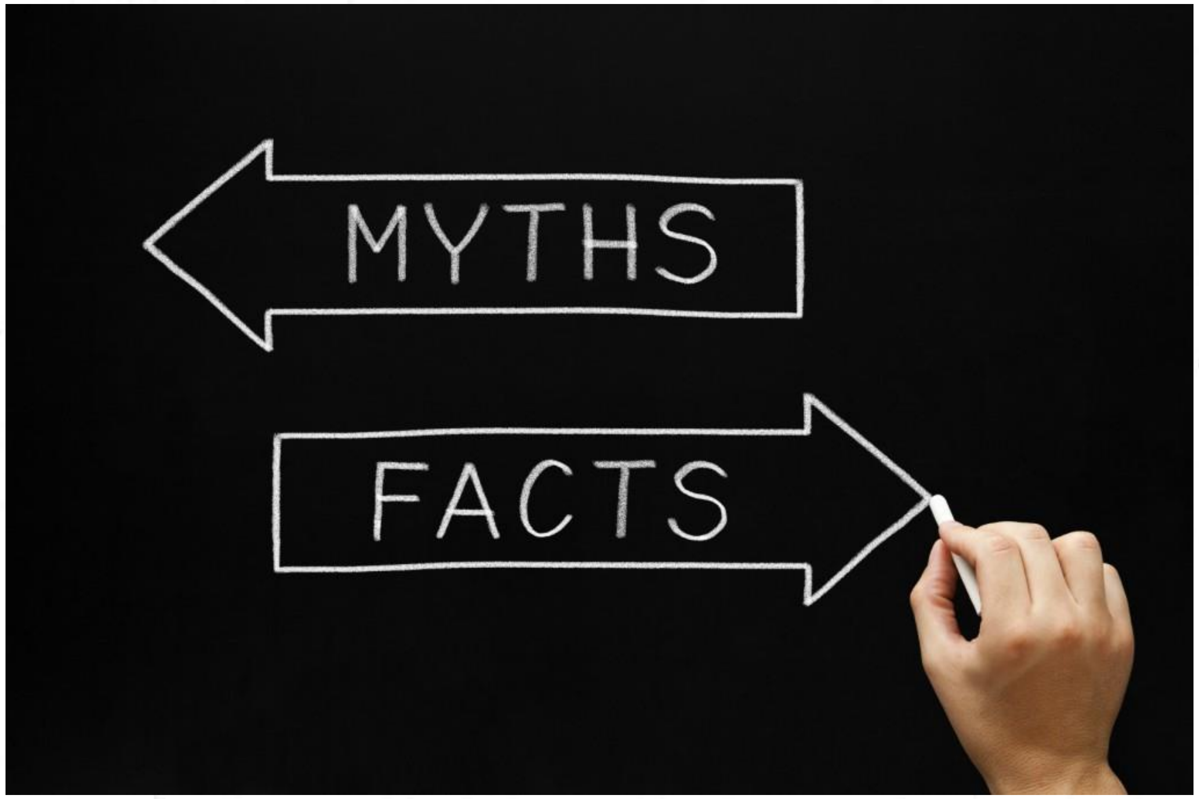
# Microservices Architecture

- **Use case** : Online retail application can be implemented with a suite of microservices



# Designing Microservices : Size, scope and capabilities

- **Common Misconceptions**
  - Lines of Code
  - Team size
  - 'Micro' is a bit misleading term
  - Use web services and rebranding them as microservices



# Designing Microservices : Size, scope and capabilities

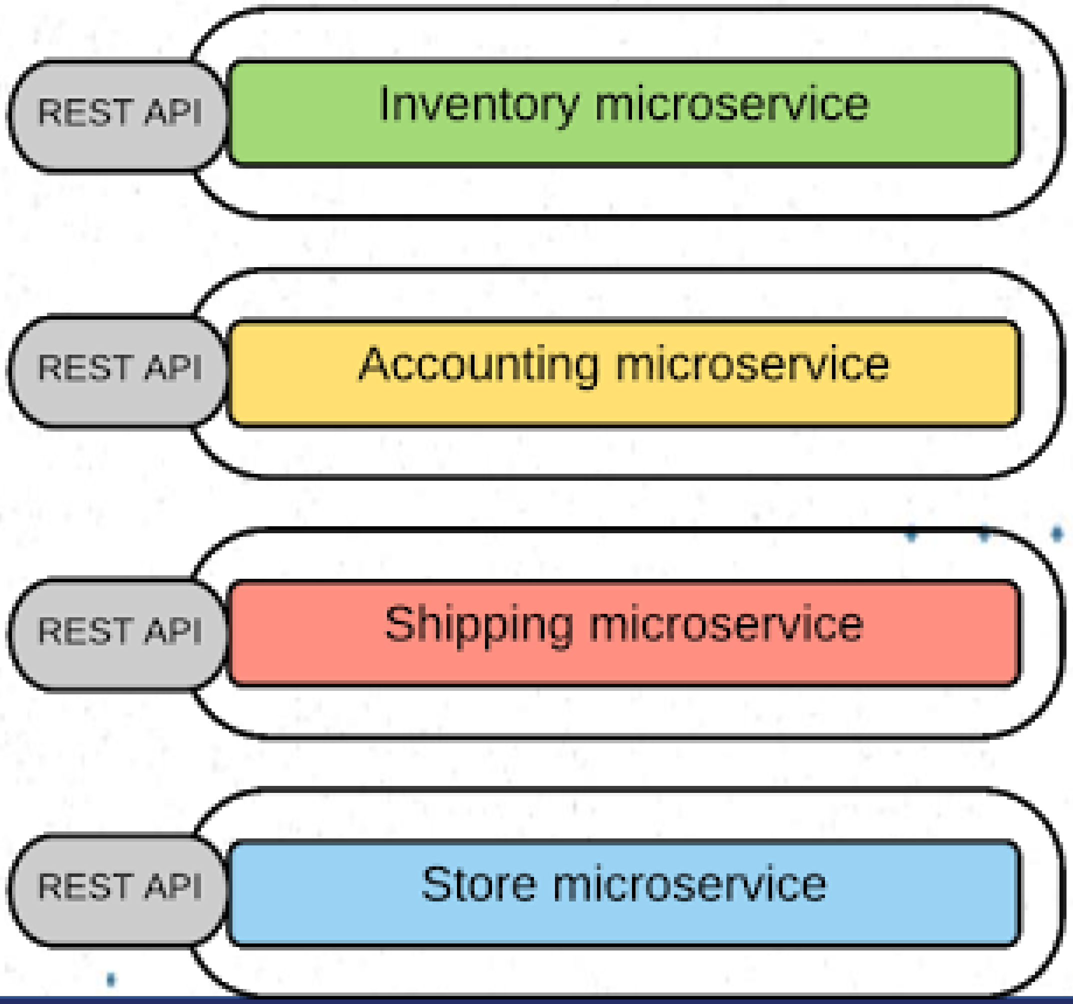
- Single Responsibility Principle(SRP): Having a limited and a focused business scope.
- Find the service boundaries and align them with the business capabilities .
- Make sure the microservices design ensures the agile/independent development and deployment of the service.
- Focus on scope of the microservice, but not about making the the service smaller- righted sized services
- Unlike service in web services, a given microservice should have a very few operations/functionalities and simple message format.
- Start with relatively broad service boundaries to begin with, refactoring to smaller ones (based on business requirements) as time goes on.

# Messaging in Microservices

- In **Monolithic architecture**:
  - Function calls or language-level method calls
  - SOA/web services : SOAP and WS* with HTTP, JMS etc.
  - Webservices with several dozens of operations and complex message schemas
- In **Microservice architecture**:
  - Simple and lightweight messaging mechanism.

# Messaging in Microservices

- **Synchronous Messaging**
  - *Client expects a timely response from the service and waits till it get it.*
  - REST, Thrift



# Messaging in Microservices

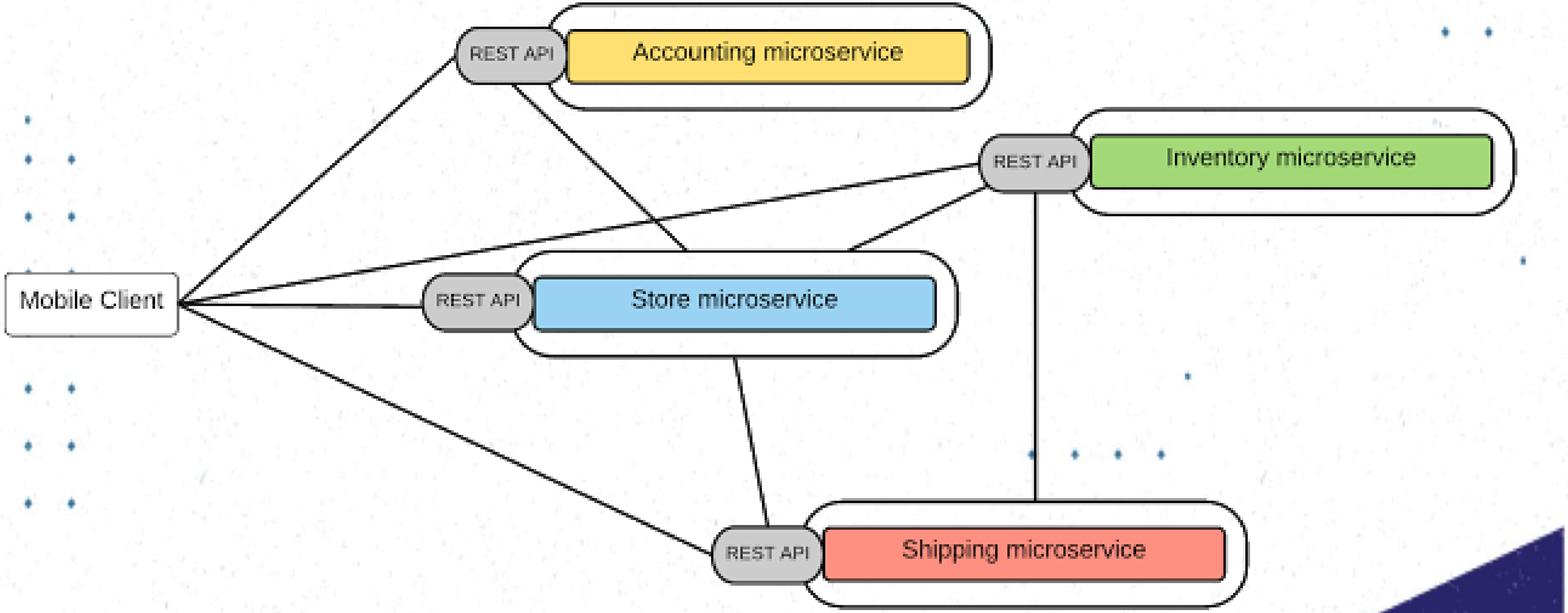
- **Asynchronous Messaging**
  - Client doesn't expects a response immediately, or not accepts a response at all
  - AMQP, STOMP, MQTT
- **Message Formats**
  - JSON, XML, Thrift, ProtoBuf, Avro
- **Service Contracts**
  - Defining the service interfaces - Swagger, RAML, Thrift IDL

# Integrating Microservices (Inter-service Communication)

- Required to have the communication structures between different microservices.
- SOA/web services used ESB.
- Microservices promotes to eliminate the central message bus/ESB and move the 'smart-ness' or business logic to the services and client(known as 'Smart Endpoints').
- Connect services through ‘dumb’ pipes.

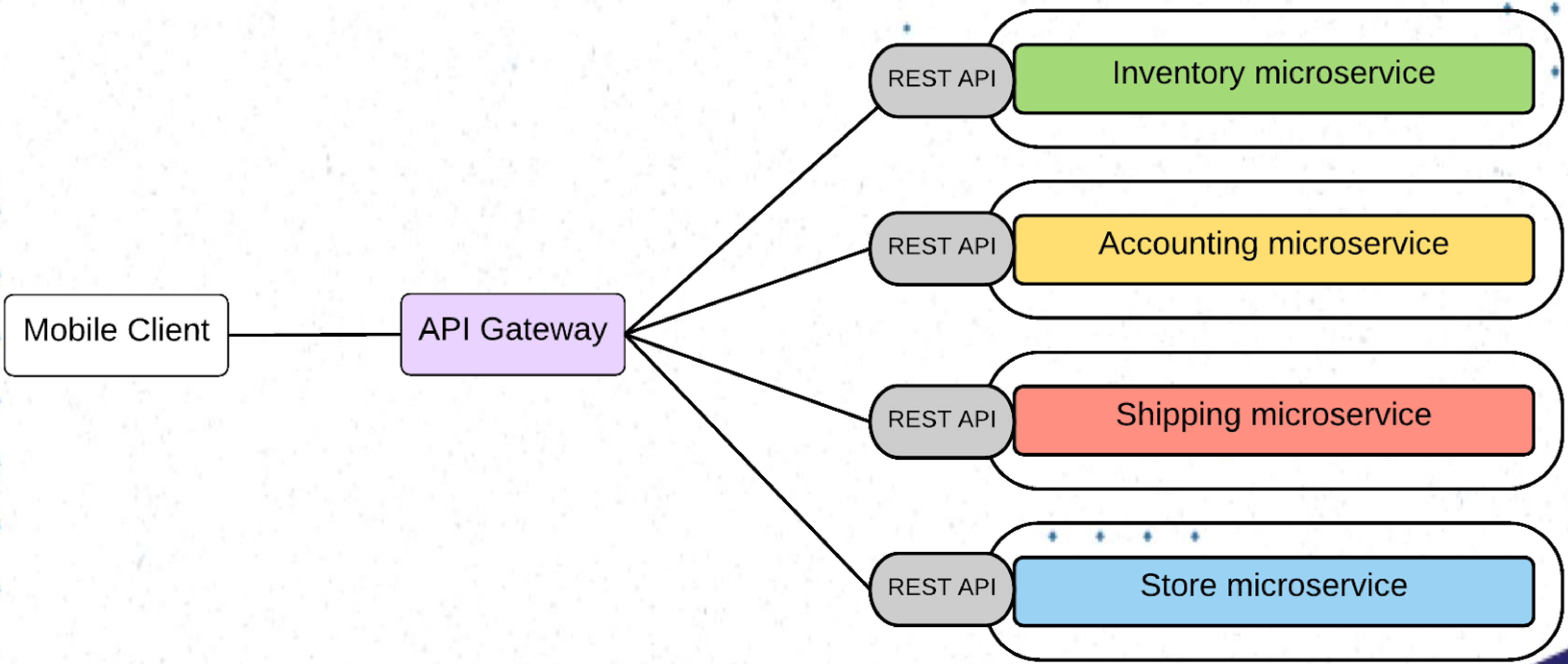
# Integrating Microservices (Inter-service Communication)

- **Point-to-point style - Invoking services directly**



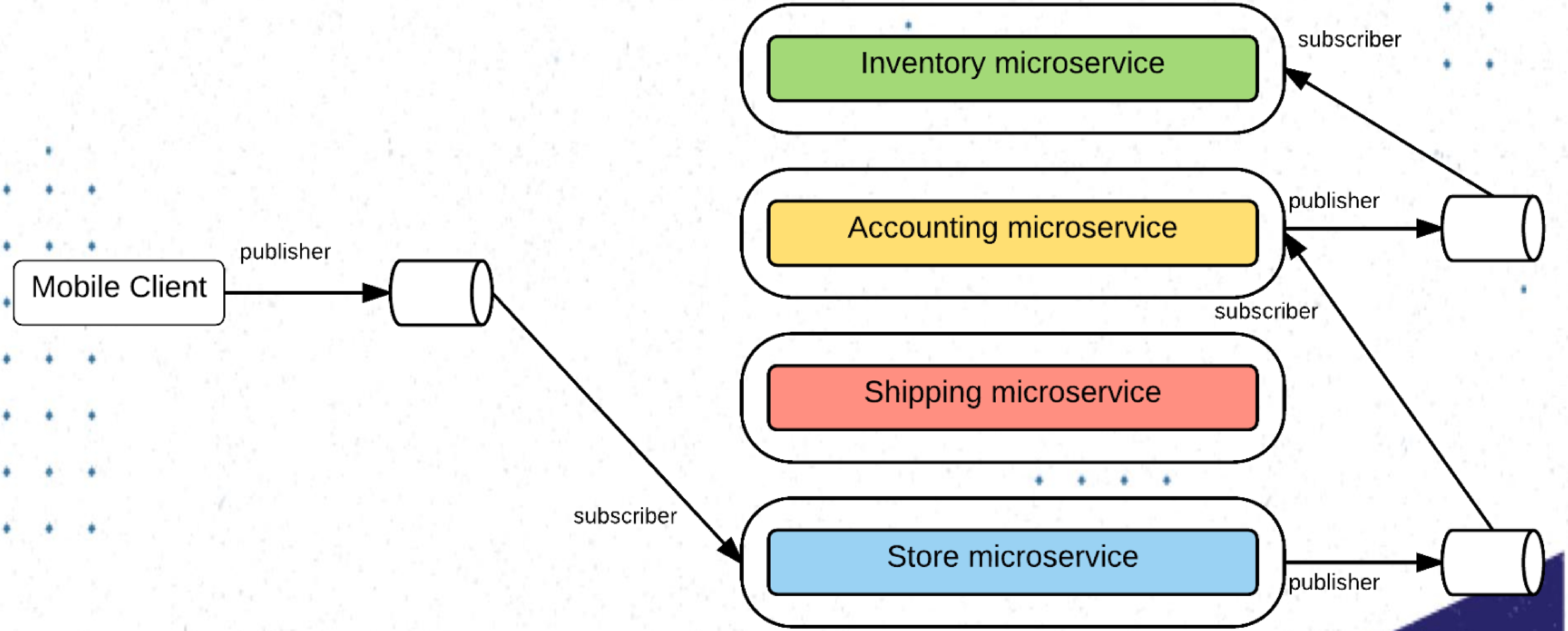
# Integrating Microservices (Inter-service Communication)

- **API-Gateway style**



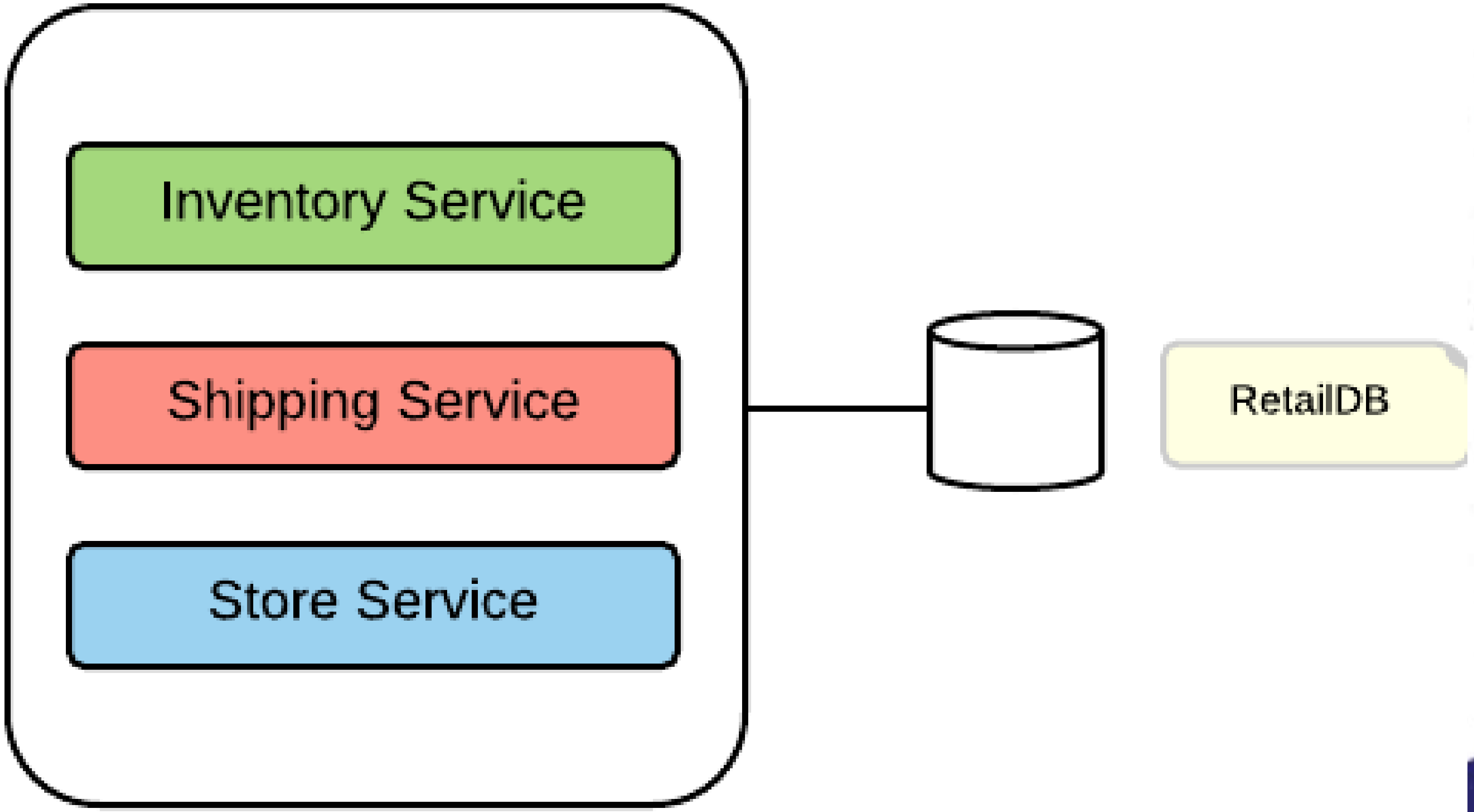
# Integrating Microservices (Inter-service Communication)

- **Message Broker style**



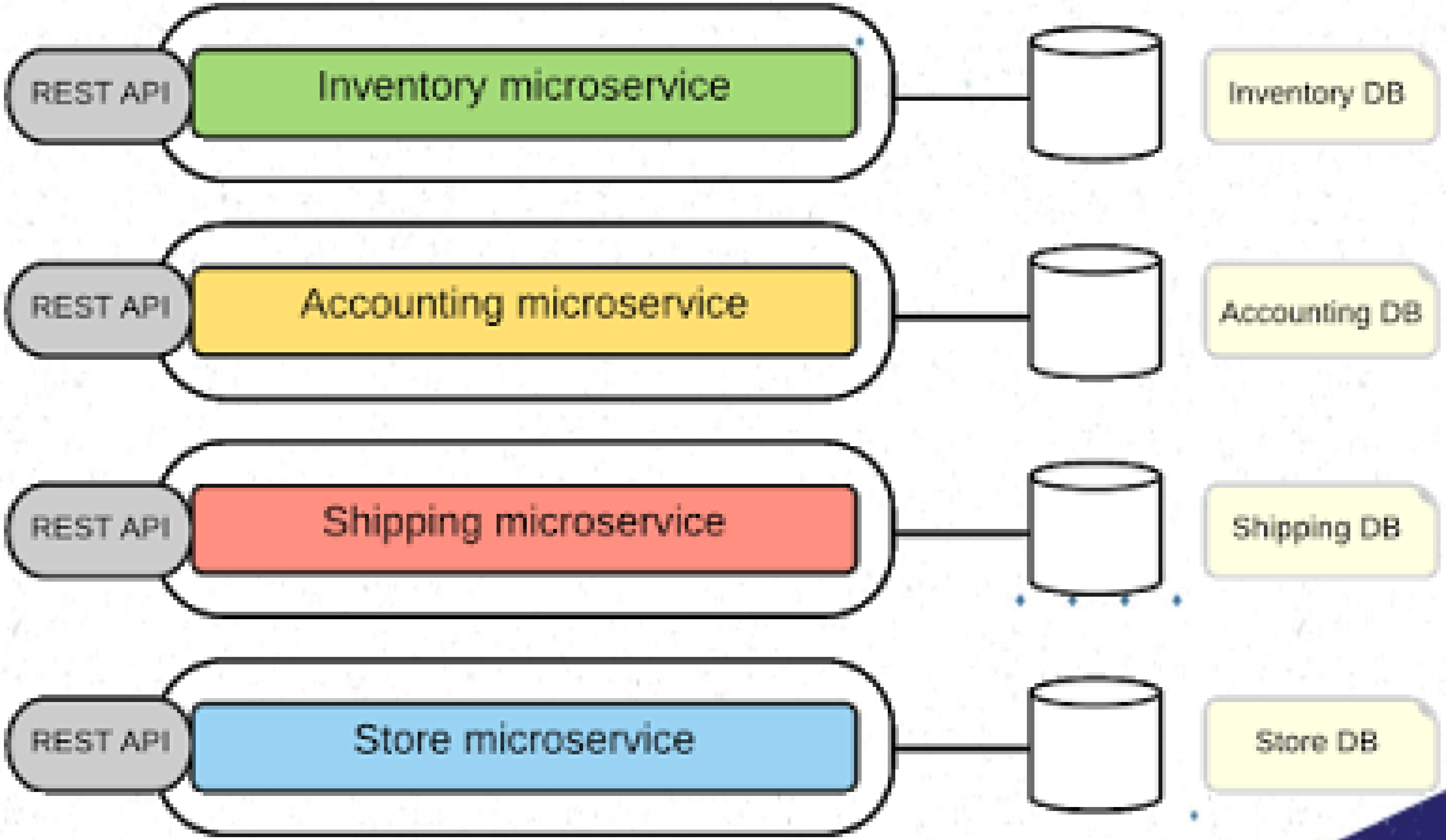
# Data Management

- **Monolithic applications use a centralized database**



# Data Management

- **Decentralized Data manangement with Microservices**



# Data Management

- **Decentralized Data manangement with Microservices**
  - Each microservice can have a private database to persist the data that requires to implement the business functionality offered from it.
  - A given microservice can only access the dedicated private database but not the databases of other microservices.
  - In some business scenarios, you might have to update several database for a single transaction. In such scenarios, the databases of other microservices should be updated through its service API only

# Decentralized Governance

- ***Governance*** - establishing and enforcing how people and solutions work together to achieve organizational objectives
  - Design and runtime governance.
- In Microservices Architecture:
  - No centralized design-time governance.
  - Make their own decisions about its design and implementation.
  - Foster the sharing of common/reusable services.
  - Run-time governance aspects such as SLAs, throttling, monitoring, common security requirements and service discovery may be implemented at API-GW level.

# Service Registry and Service Discovery

- ***Service Registry*** - Holds the microservices instances and their locations
- ***Service Discovery*** - find the available microservices and their location

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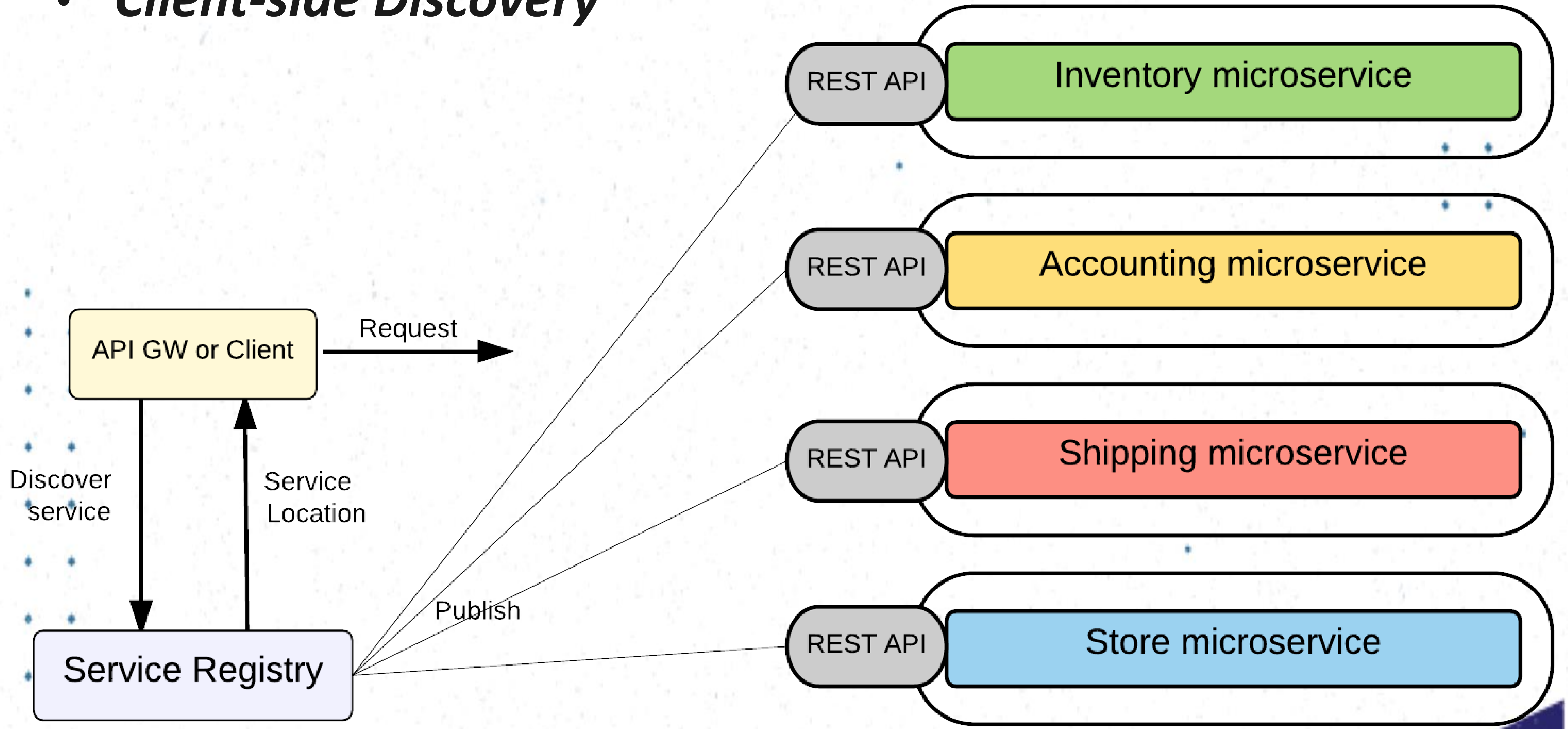
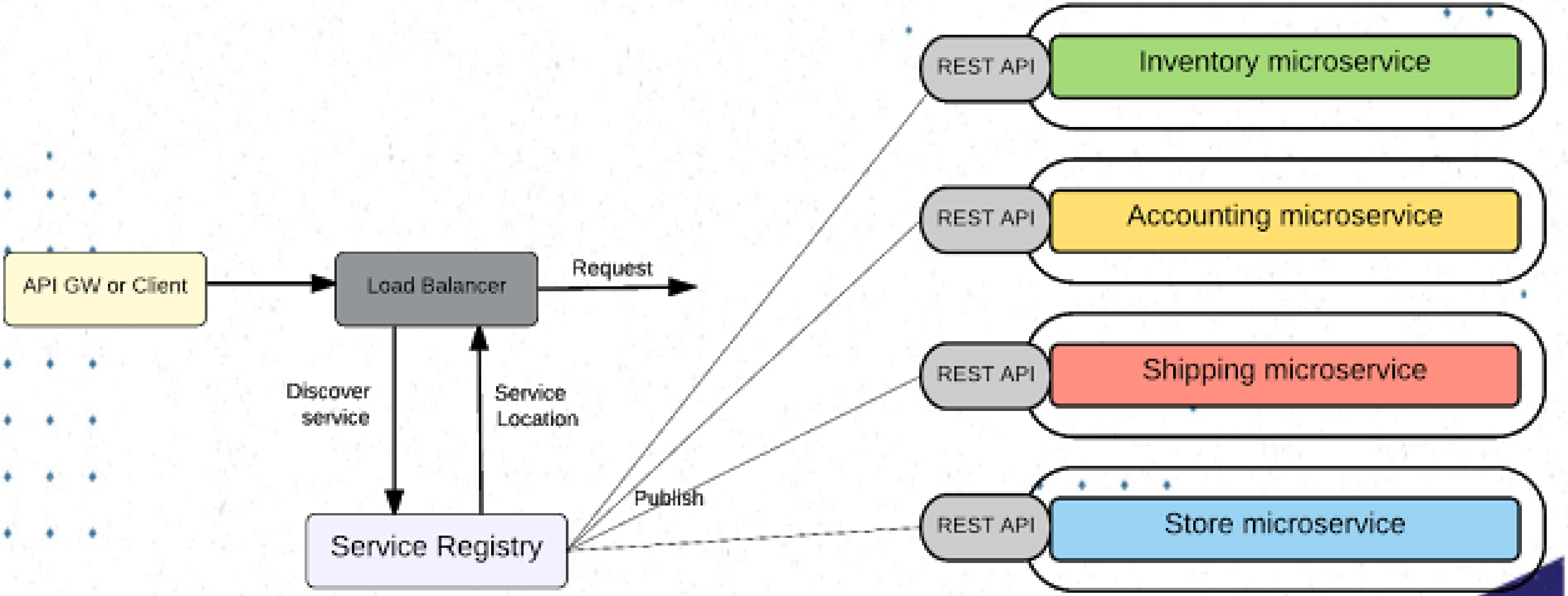
# Service Discovery

- ***Client-side Discovery***



# Service Discovery

- ***Server-side Discovery***

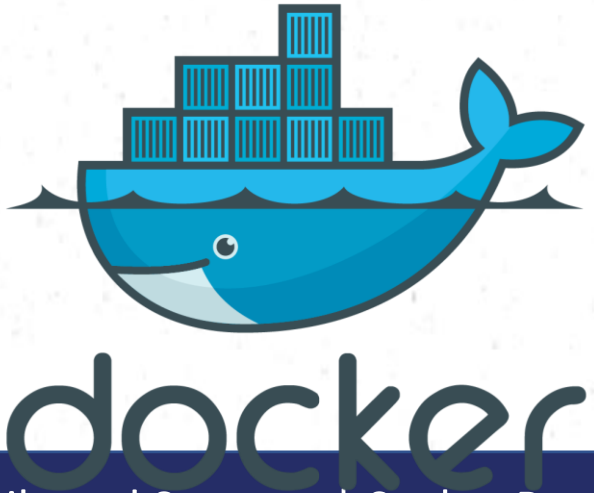


# Microservice Deployment

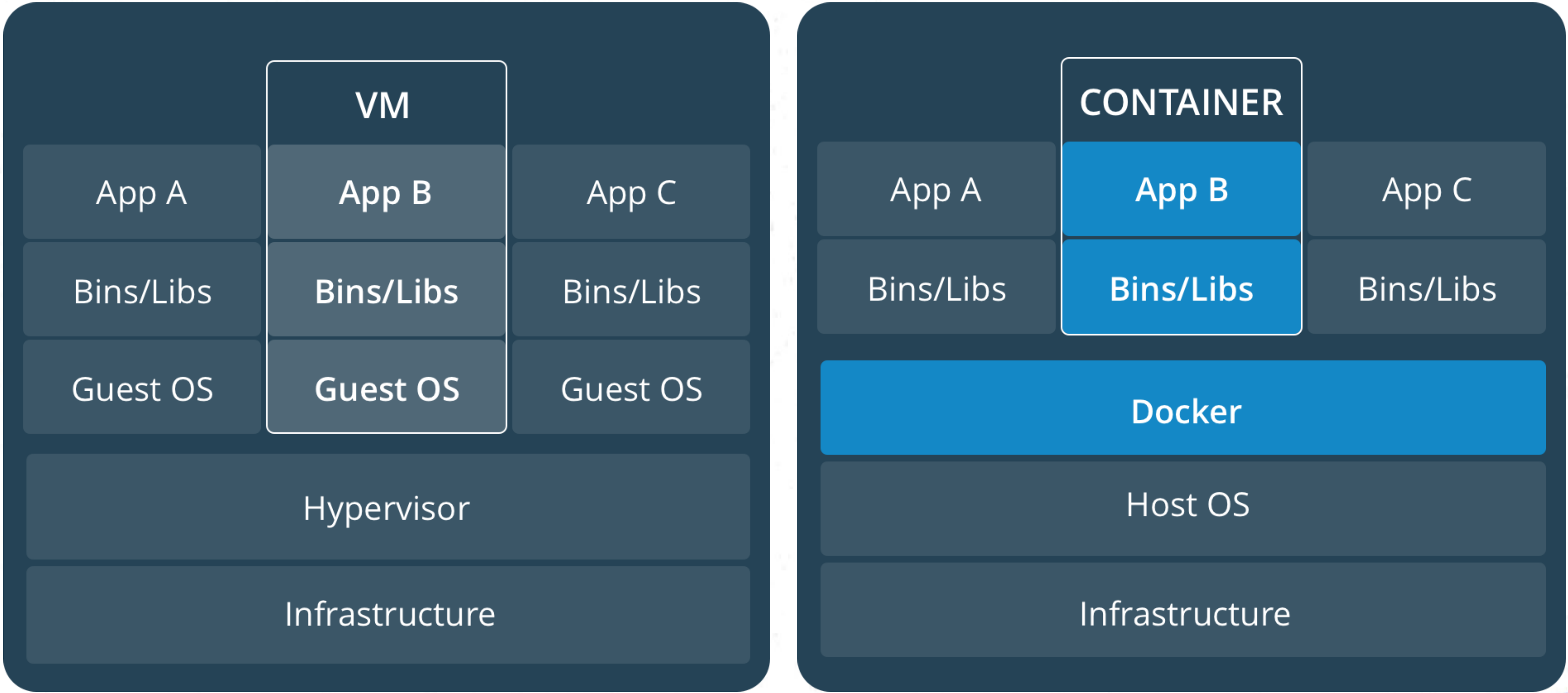
- Ability to deploy/un-deploy independently of other microservices.
- Must be able to scale at each microservices level.
- Building and deploying microservices quickly.
- Failure in one microservice must not affect any of the other services.

# Microservice Deployment

- Docker
  - *Docker is becoming an extremely popular way of packaging and deploying services.*
  - Package the microservice as a (Docker) container image.
  - Deploy each service instance as a container.
  - Scaling is done based on changing the number of container instances.
  - Building, deploying and starting microservice will be much faster as we are using docker containers



# Virtual Machines Vs. Docker

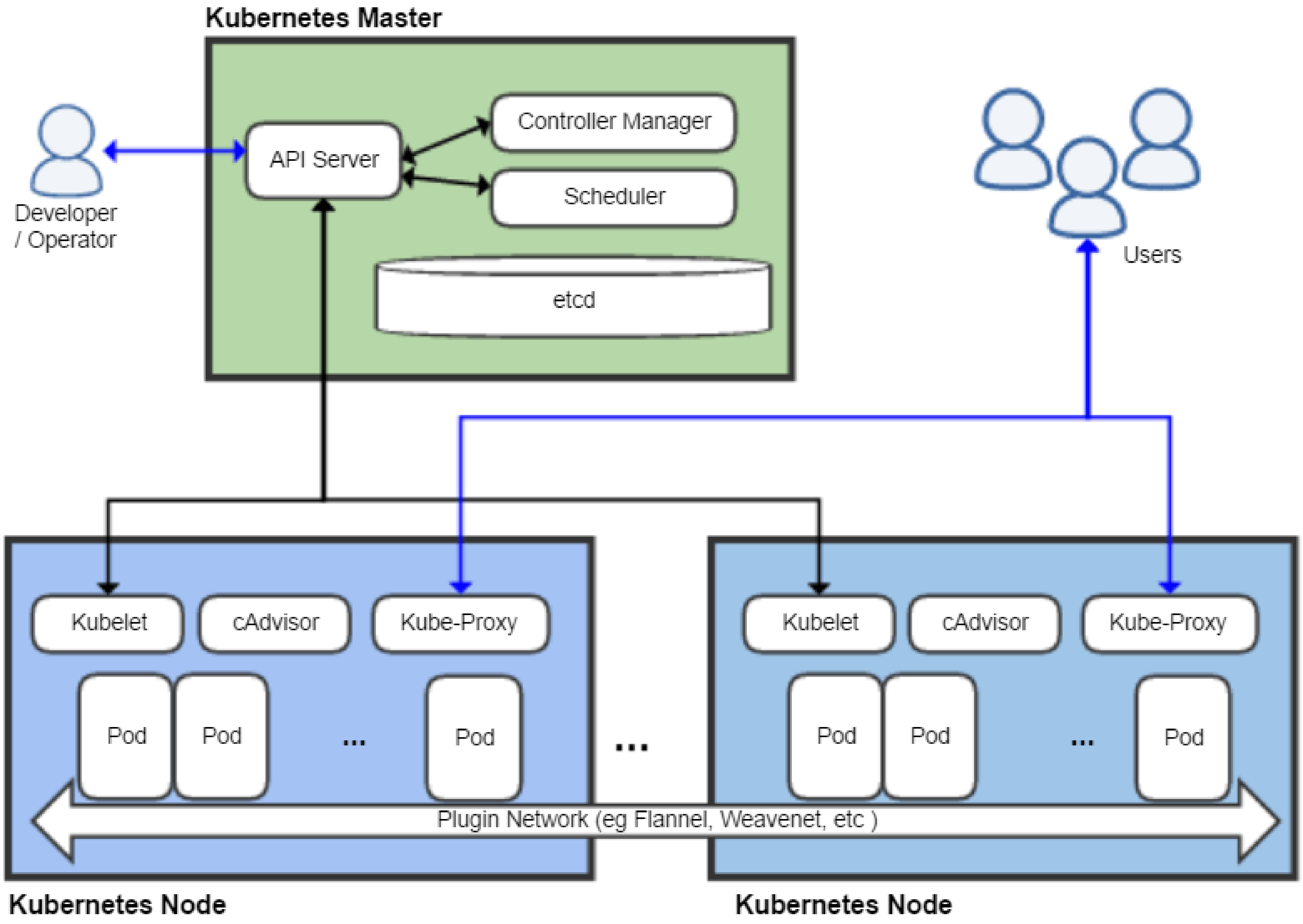


# Microservice Deployment

- Kubernetes
  - Extending Docker's capabilities by allowing to manage a cluster of Linux containers as a single system, managing and running Docker containers across multiple hosts, offering co-location of containers, service discovery and replication control.

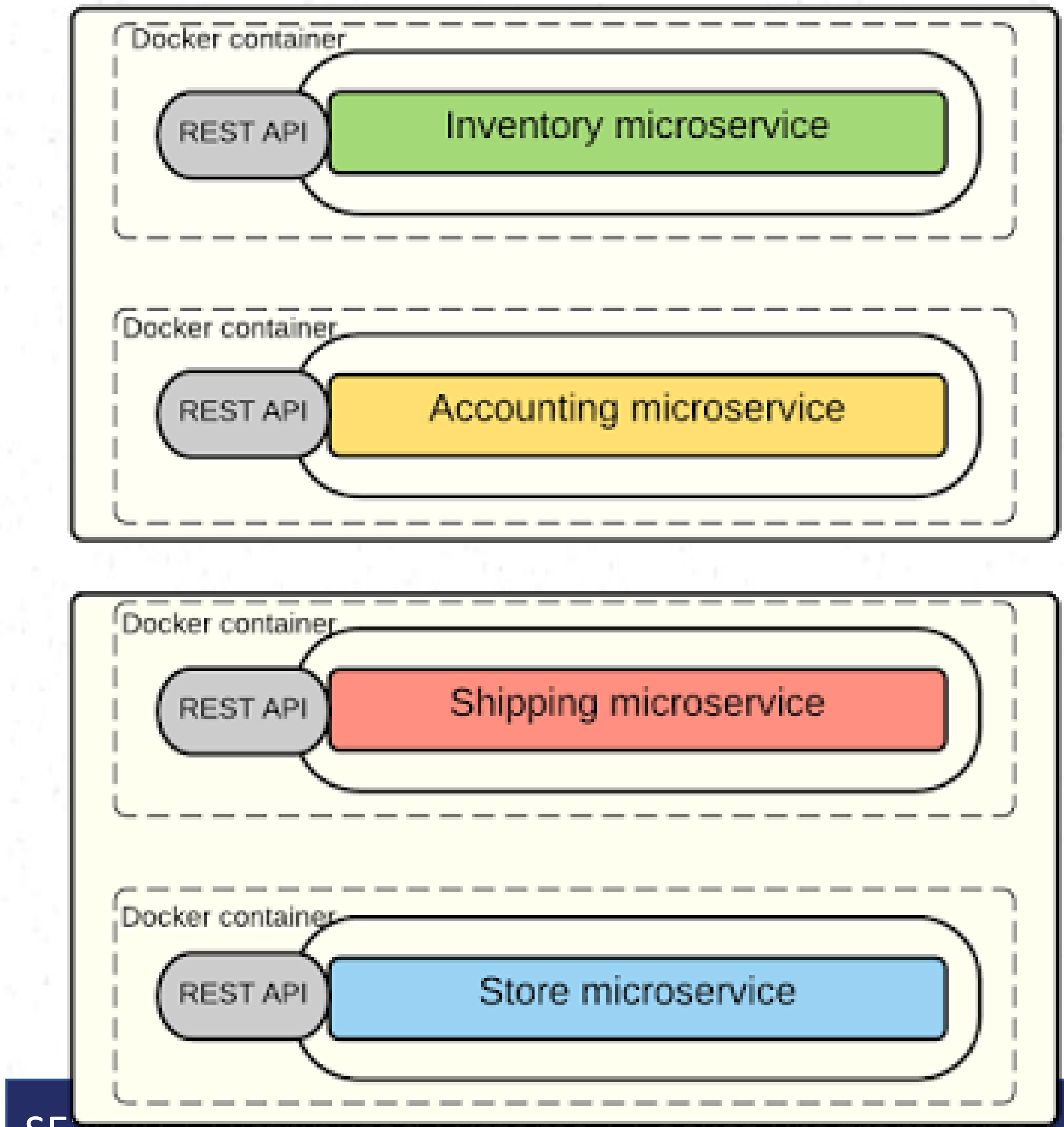
kubernetes

# Kubernetes


Kubernetes Master
Developer / Operator
API Server
Controller Manager
Scheduler
etcd
Users
Kubelet
cAdvisor
Kube-Proxy
Pod
Pod
...
Pod
...
Kubelet
cAdvisor
Kube-Proxy
Pod
Pod
...
Pod
Plugin Network (eg Flannel, Weavenet, etc )
Kubernetes Node
Kubernetes Node

# Microservice Deployment

- Use case : The microservices of Online *Retail software application with can be deployed and scaled with Docker and* Kubernetes.



# Security with Microservice

- Security in Monolithic applications
  - Its about '*who is the caller*', '*what can the caller do*' and '*how do we propagate that information*'.
  - Often implemented at a common security component which is at the beginning of the request handling chain and that component populates the required information with the use of an underlying user repository

- Security in Microservices
  - a security component implemented at each microservice's level that uses a central user repository/store.
  - Leverage the widely used API-Security standards such as OAuth2 and OpenID Connect

# Security with Microservice

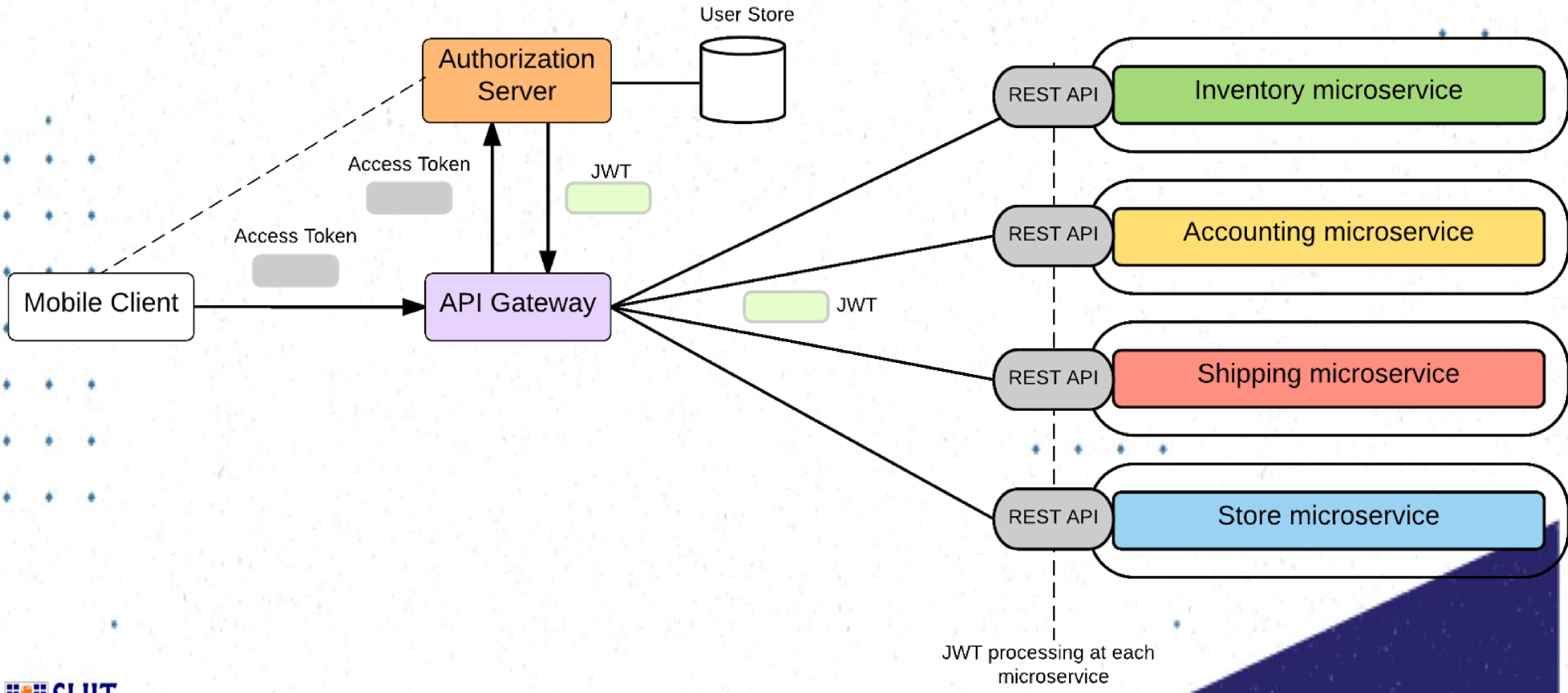
- OAuth 2.0
  - The client authenticates with authorization server and get an opaque token which is known as 'Access token'. Access token has zero information about the user/client.
  - It only has a reference to the user information that can only be retrieved by the Authorization server. Hence this is known as a 'by-reference token' and it is safe to use this token even in the public network/internet.

# Security with Microservice

- OpenID Connect
  - OpenID Connect behaves similar to OAuth but in addition to the Access token, the authorization server issues an ID token which contains information about the user.
  - Implement with a JWT (JSON Web Token) and that is signed by authorization server. So, this ensures the trust between the authorization server and the client.
  - JWT token is therefore known as a 'By-value token' as it contains the information of the user and obviously it is not safe to use it outside the internal network.

# Security with Microservice

- Microservice security with OAuth2 and OpenID Connect



# Transactions

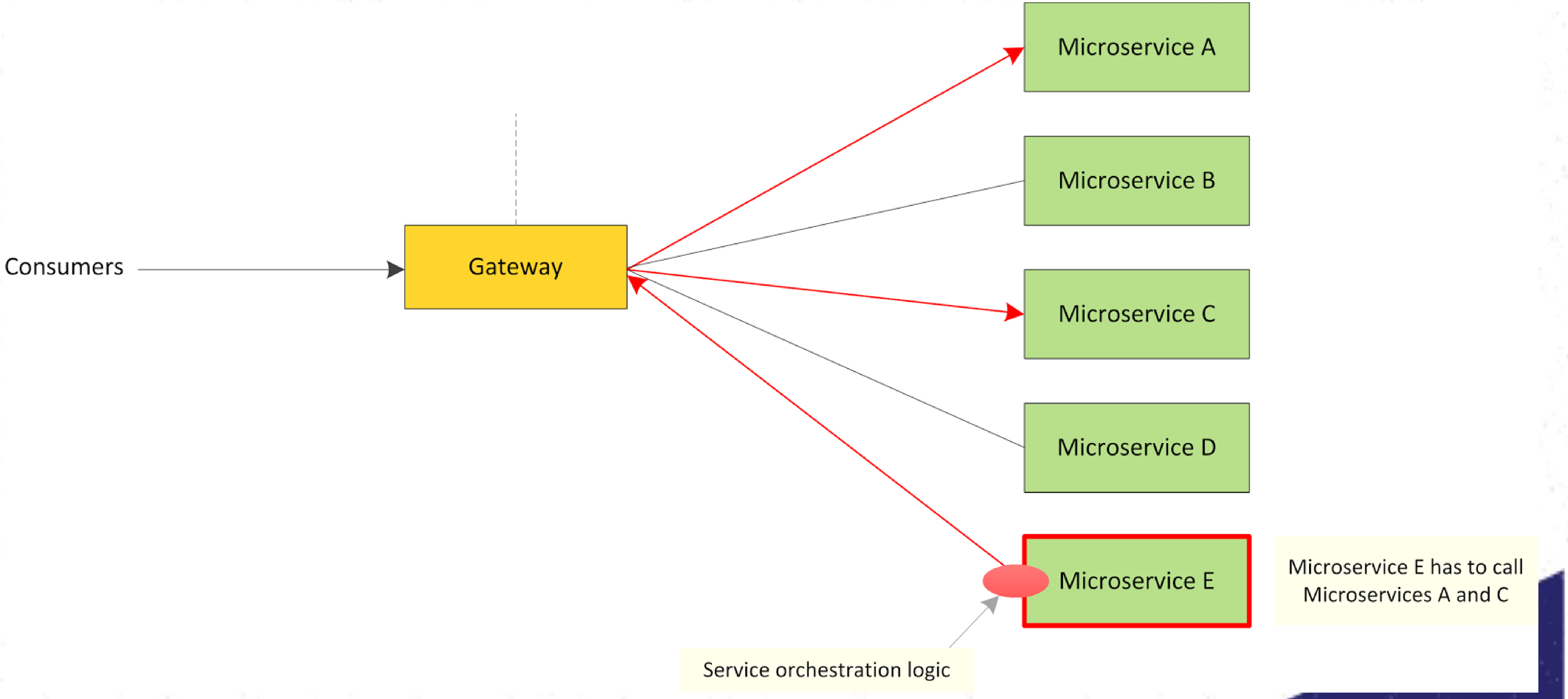
- Supporting distributed transactions across multiple microservices – Too complex.
- Microservice architecture itself encourages the transaction-less coordination between services.
- Mandatory transaction requirements can be fulfilled with 'compensating operations'

# Design for Failures

- Increases the possibility of having failures at each service level
- Unavailable or unresponsive microservice should not bring the whole system down
- Microservices should be fault tolerant, be able to recover when that is possible and the client has to handle it gracefully.
- Error handling patterns
  - Circuit Breaker
  - Timeout
  - Bulkhead

# Orchestrating Microservices

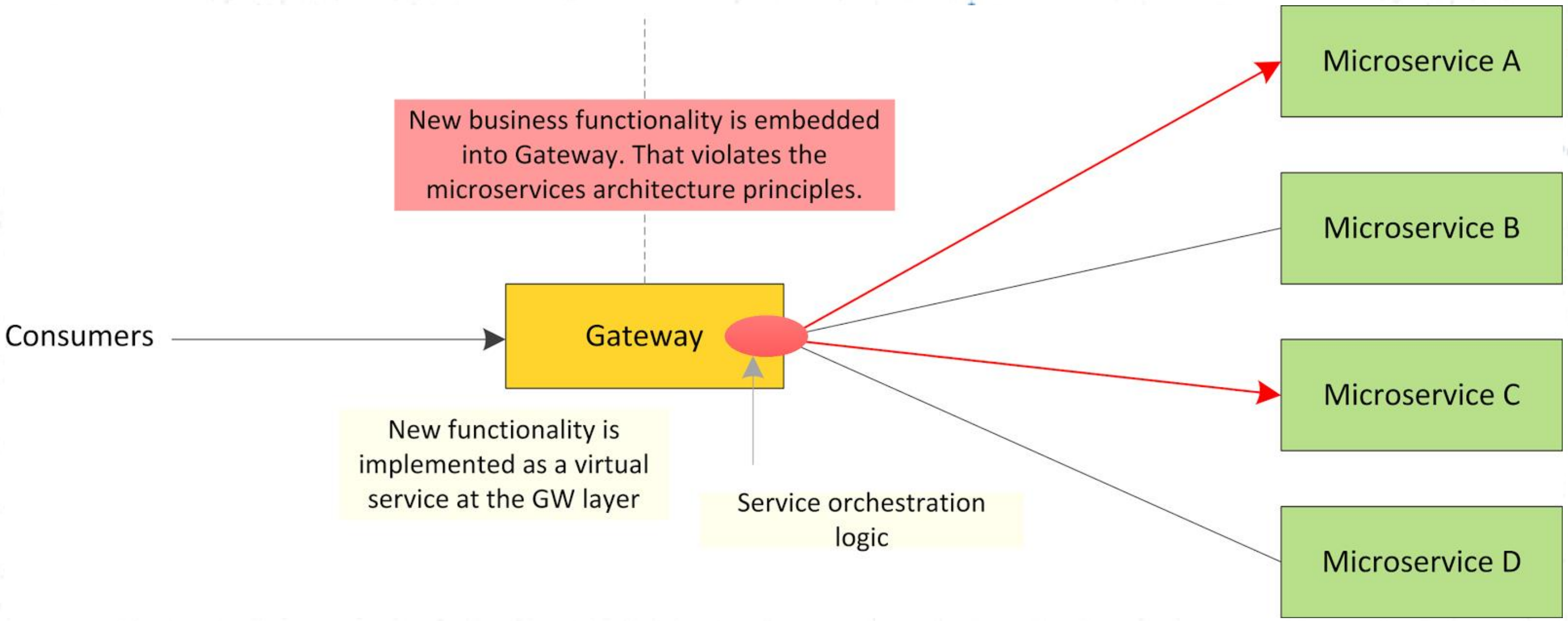
- Orchestration at Microservices Layer



Microservice E has to call Microservices A and C

# Orchestrating Microservices

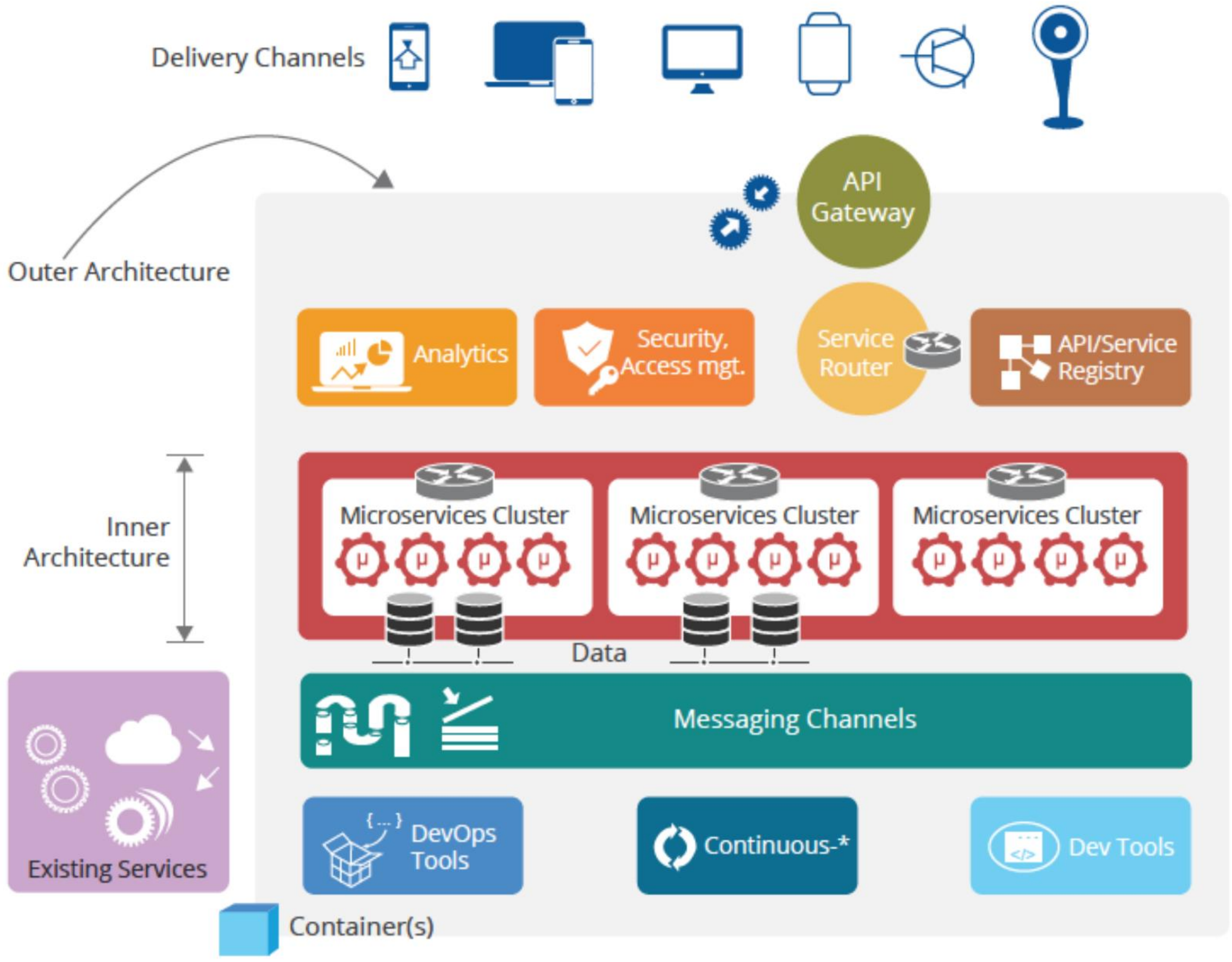
- Orchestration at the Gateway Layer



New business functionality is embedded into Gateway. That violates the microservices architecture principles.
Consumers
Gateway
New functionality is implemented as a virtual service at the GW layer
Service orchestration logic
Microservice A
Microservice B
Microservice C
Microservice D

# Microservices in Modern Enterprises

- Inner and Outer Architecture

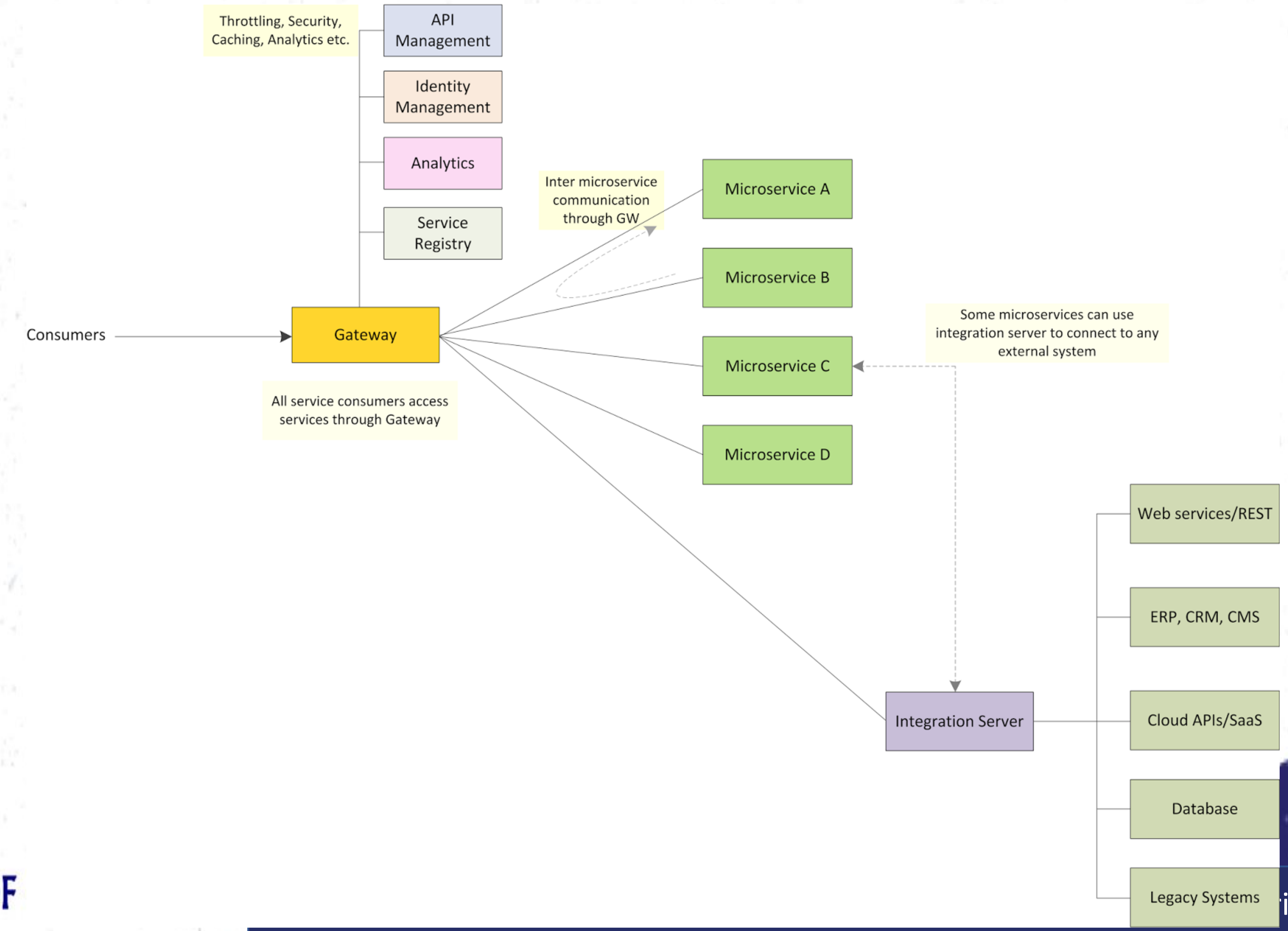


# Microservices in Modern Enterprises

- **Inner and Outer Architecture**
  - ***Inner Architecture*** : The pure microservices components which is less complex are categorized under 'Inner Architecture'
  - ***Outer Architecture*** : This delivers the platform capabilities that are required to build a solution around the microservices that we build.

# Microservices in Modern Enterprises

- Modern Enterprise Architecture with Microservices, Enterprise Integration and API Management


Throttling, Security, Caching, Analytics etc.
API Management
Identity Management
Analytics
Service Registry
Inter microservice communication through GW
Microservice A
Microservice B
Microservice C
Microservice D
Consumers
Gateway
All service consumers access services through Gateway
Some microservices can use integration server to connect to any external system
Web services/REST
ERP, CRM, CMS
Cloud APIs/SaaS
Database
Legacy Systems
Integration Server

# Microservices – Conclusion

- Microservices is not a panacea : It won't solve all your enterprise IT needs
- ‘SOA done right’?
- Most enterprises won't be able to convert their entire enterprise IT systems to microservices.
- Enterprise Integration never goes away.
- Microservices are exposed as APIs.
- Interaction between microservices should be support via a lightweight orchestration engine/Gateway or inside another microservice.

# References

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