Lecture 11 - Microservices

‘Microservices’?

hype.

‘Monolithic’ Architecture

Monolithic Architecture

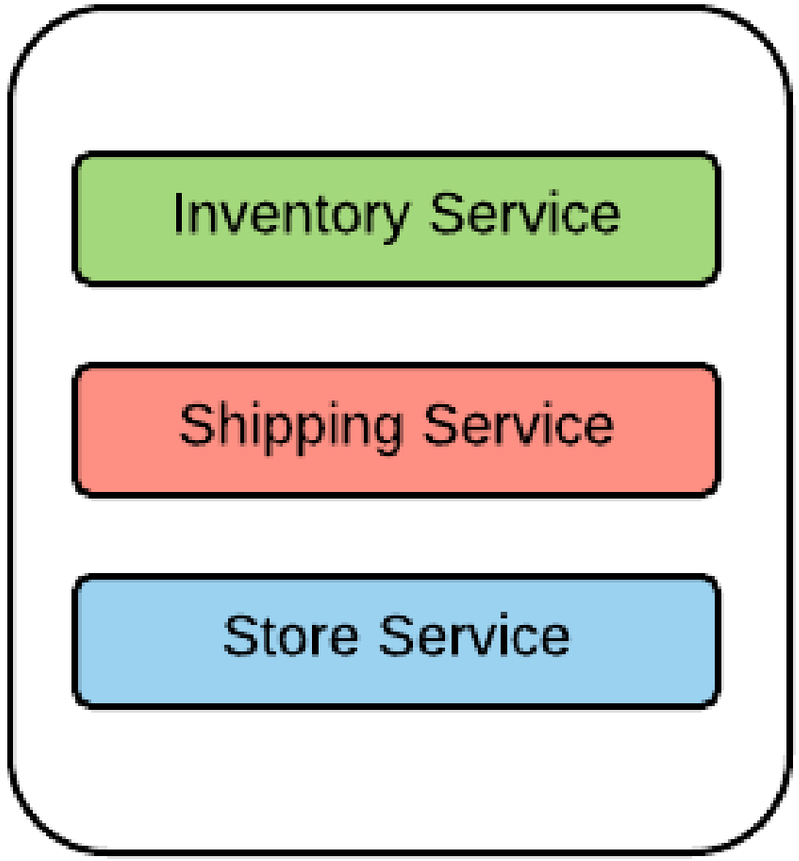
- All functionalities are implemented/deployed into a single software application.
- Enterprise software applications - ERPs, CRMs etc.
- SOA/web services: 'coarse-grained' services, broad scope, mammoth services with several dozens of operations and complex message formats

SOA / Web Services in Monolithic Architecture

- **Coarse-grained services:**
  Each service handles **large chunks of business logic** rather than focusing on small, specific tasks.
- **Broad scope:**
  Services often cover **multiple business functionalities** in a single interface.
- **Mammoth services:**
  Services become **bloated**, containing **dozens of operations**, which increases complexity.
- **Complex message formats:**
  Communication between services often uses **heavy XML or SOAP messages**, with **rich schemas** and **nested structures**.

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

tightly coupled structure.

‘Microservices’ Architecture

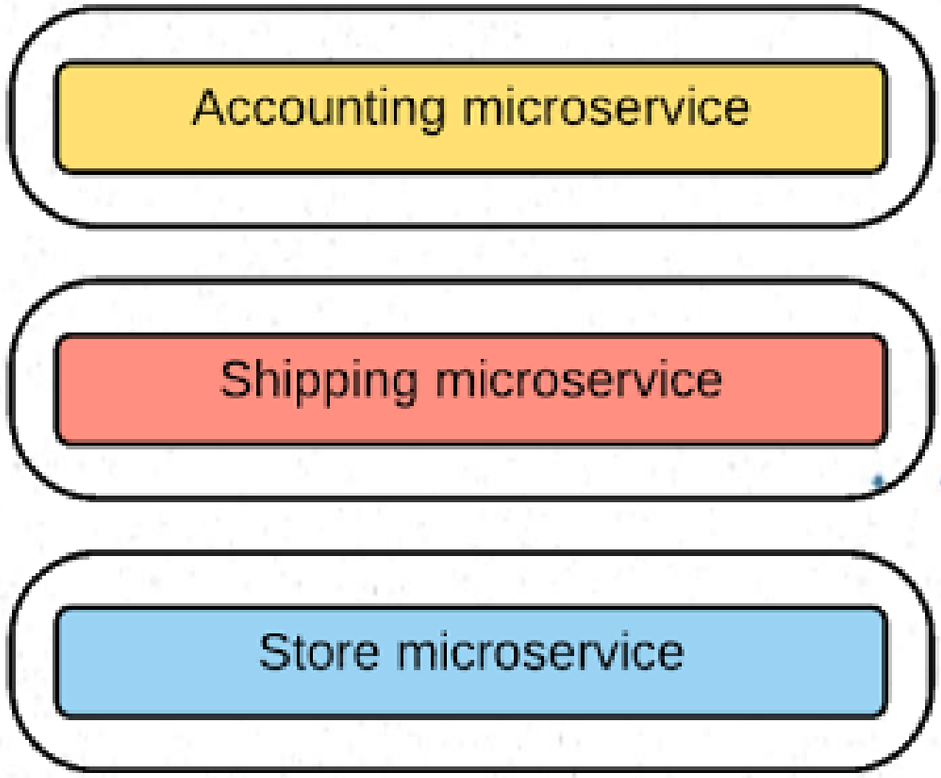
Microservices Architecture

- *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

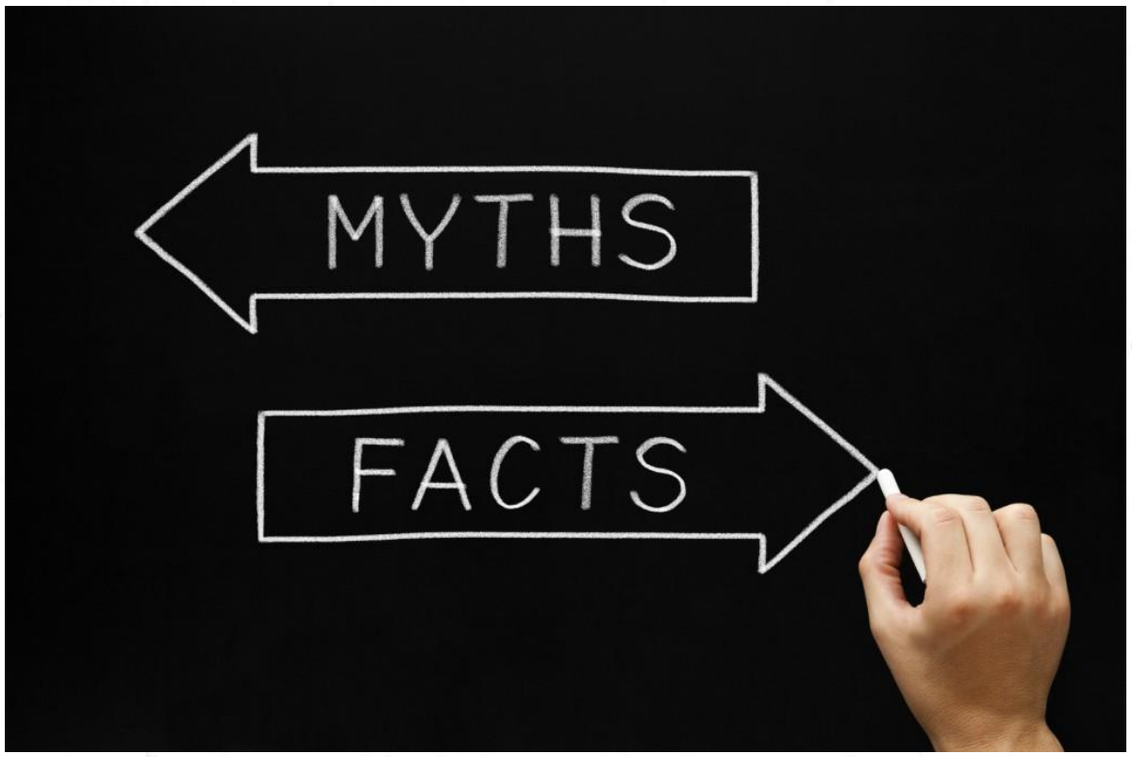


Designing Microservices : Size, scope and capabilities

- **Misconceptions:**
  - Not about **lines of code**
  - Not defined by **team size**
  - The term "**micro**" can be **misleading**
  - It's not just **rebranding web services** as microservices

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

It's not just rebranding web services as microservices



Designing Microservices : Size, scope and capabilities

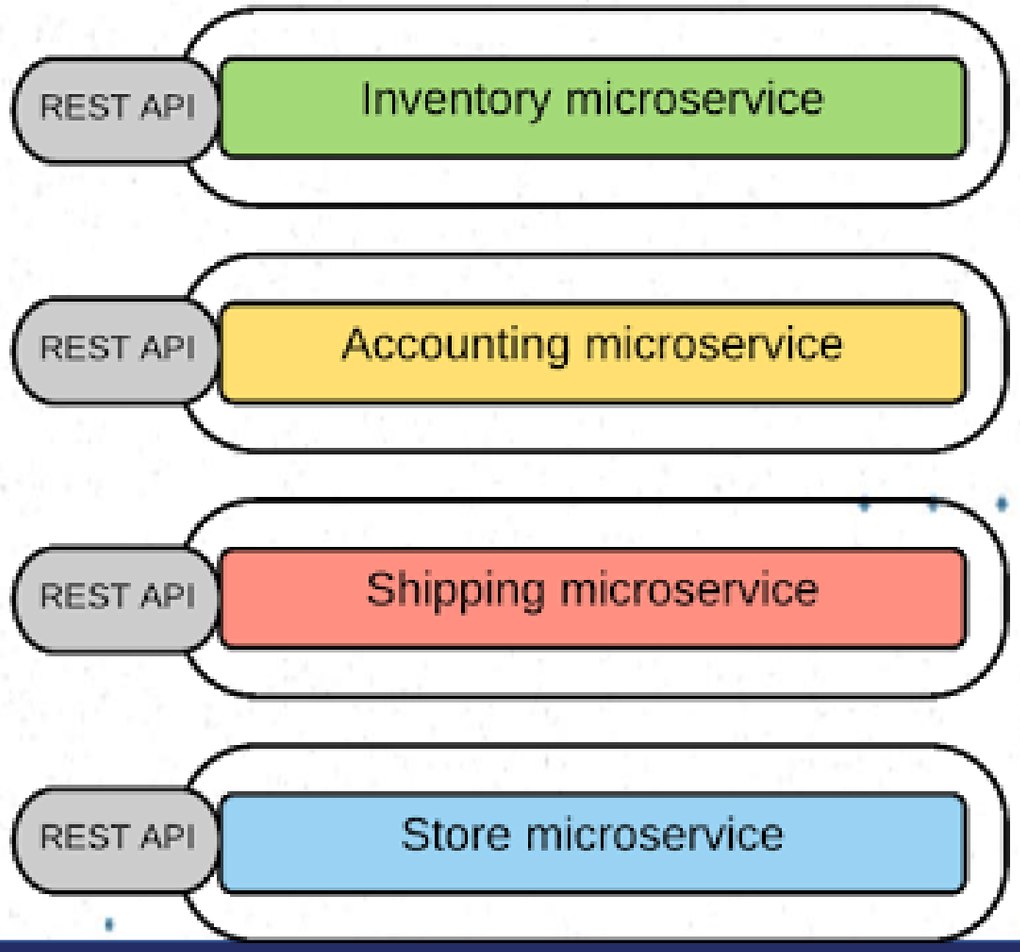
- Single Responsibility Principle(SRP): Having a limited and a focused business scope.
- Find the service boundaries and align them with the business capabilities .
- Make sure the microservices design ensures the agile/independent development and deployment of the service.
- Focus on scope of the microservice, 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

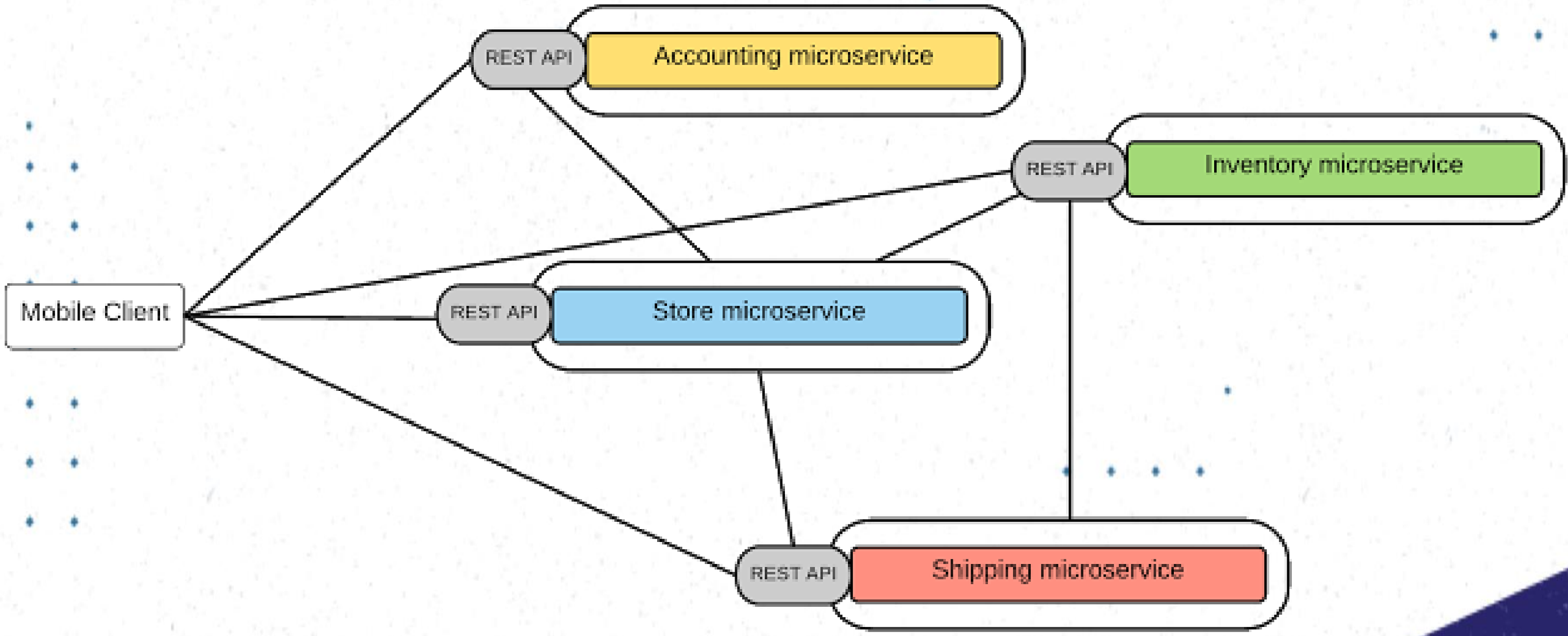
- **Asynchronous Messaging**
  - Client doesn't expects a response immediately, or not accepts a response at all
  - AMQP, STOMP, MQTT
- **Message Formats**
  - JSON, XML, Thrift, ProtoBuf, Avro
- **Service Contracts**
  - Defining the service interfaces - Swagger, RAML, Thrift IDL

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.

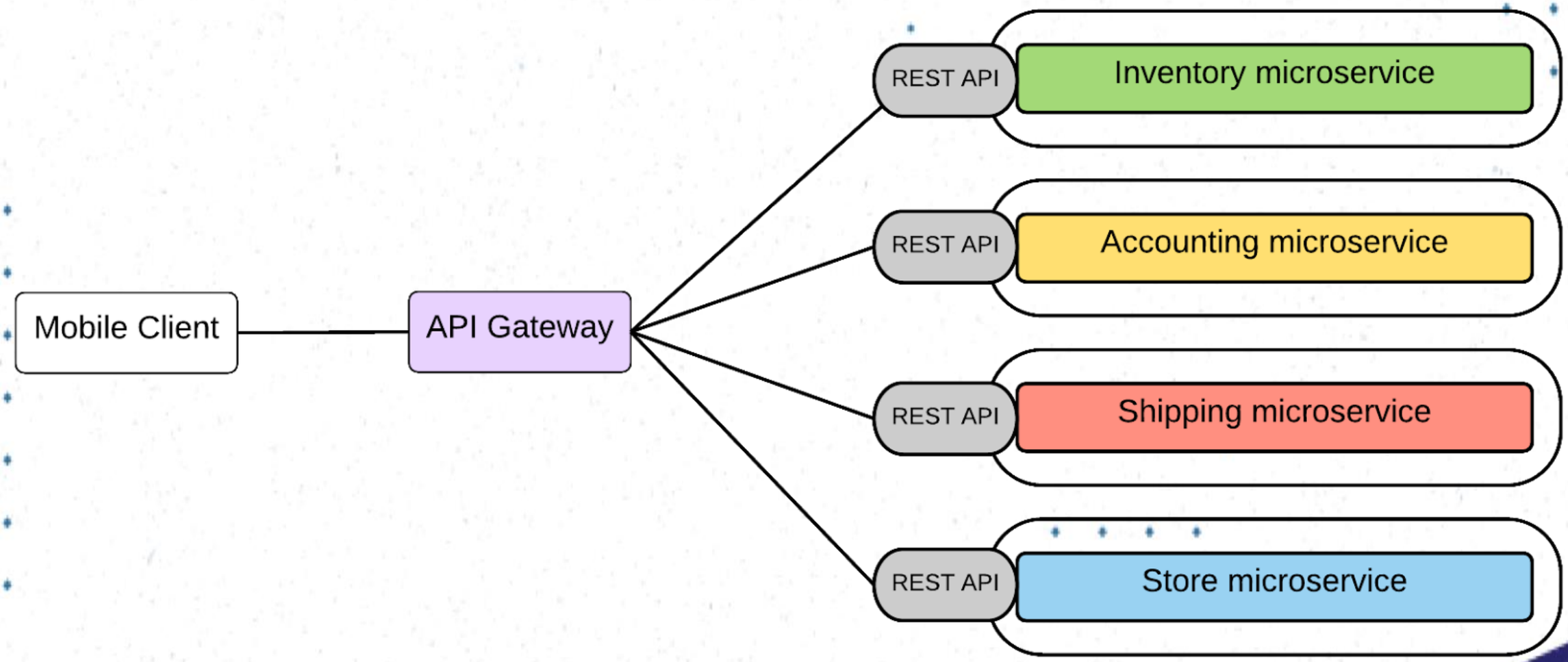
Integrating Microservices (Inter-service Communication)

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



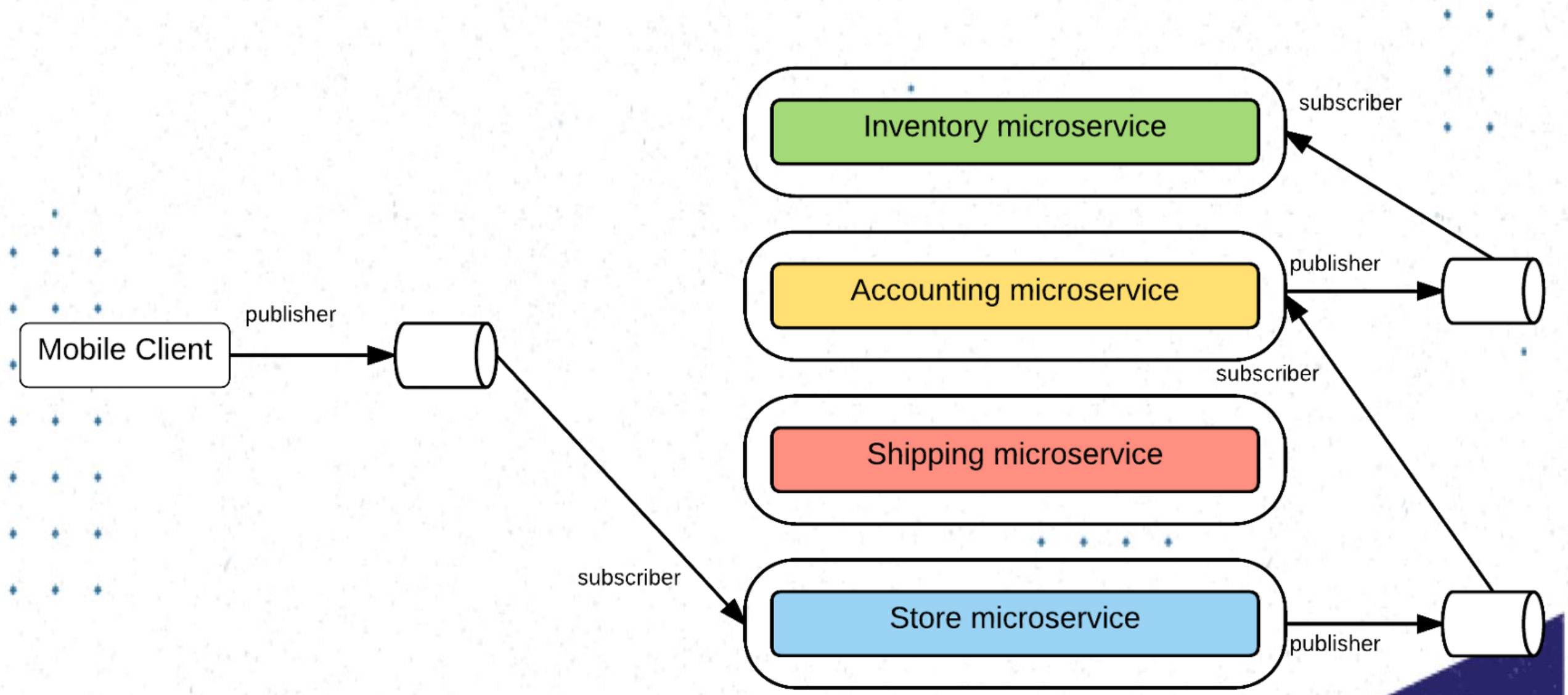
Integrating Microservices (Inter-service Communication)

- **API-Gateway style**



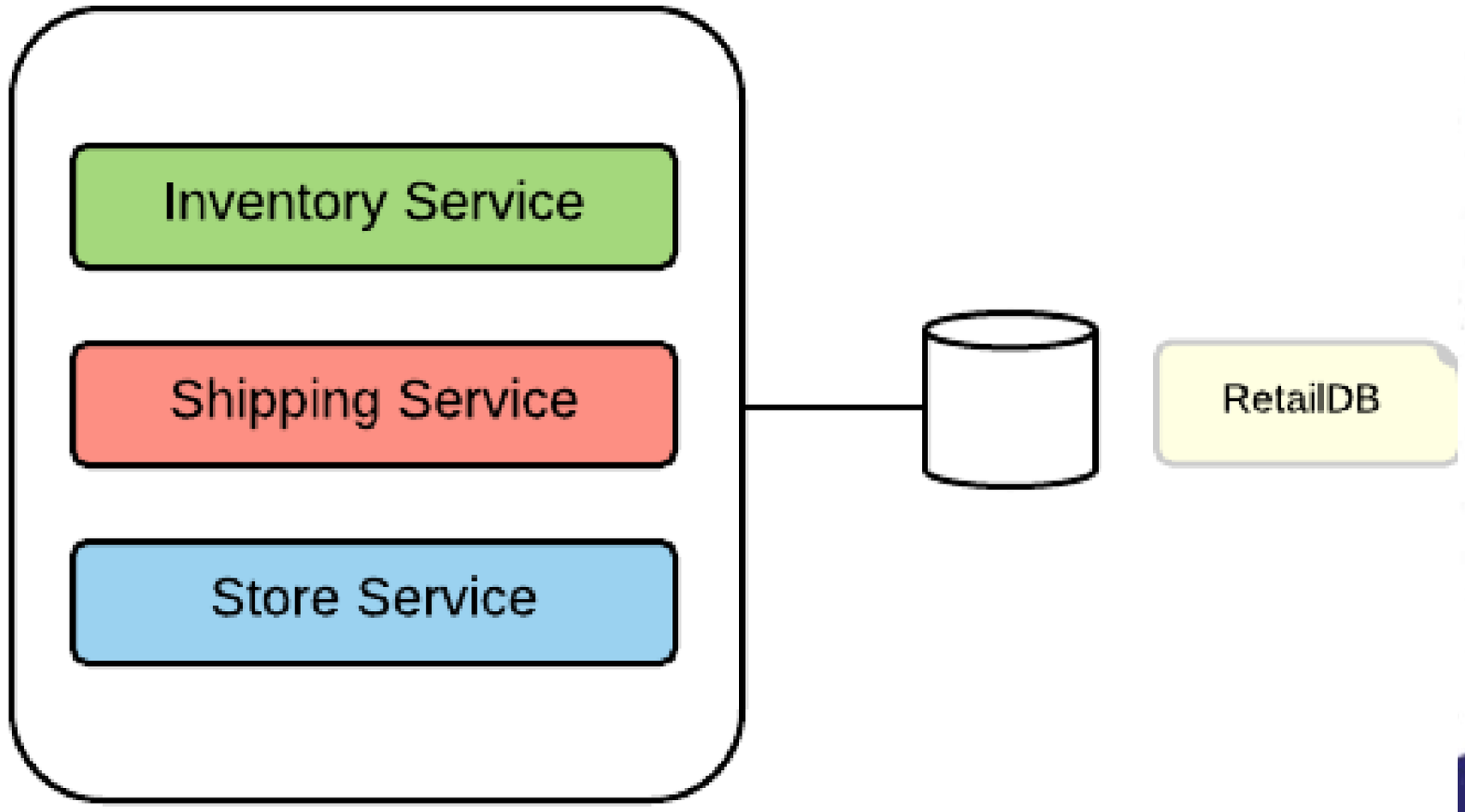
Integrating Microservices (Inter-service Communication)

- **Message Broker style**



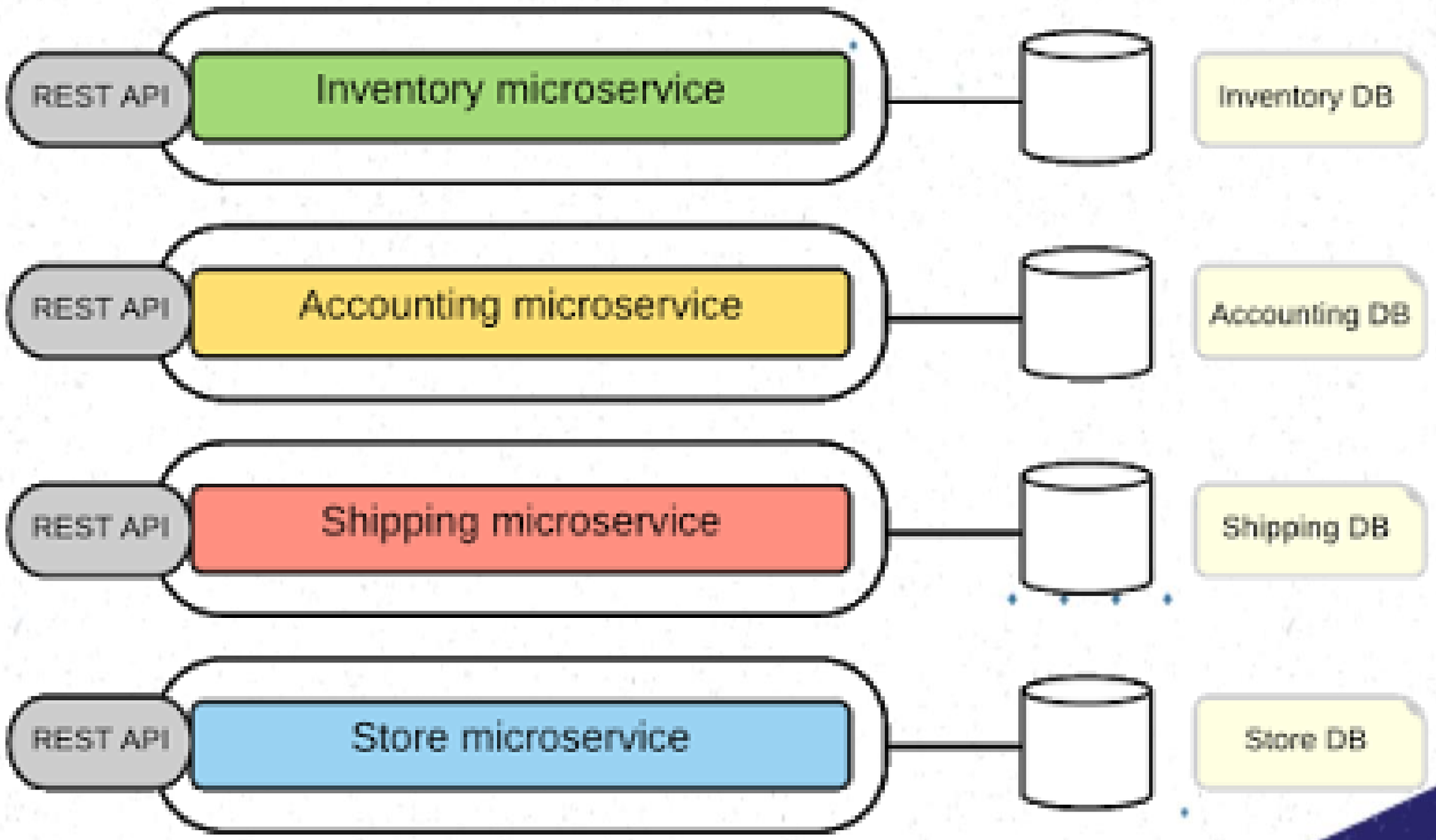
Data Management

- **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.

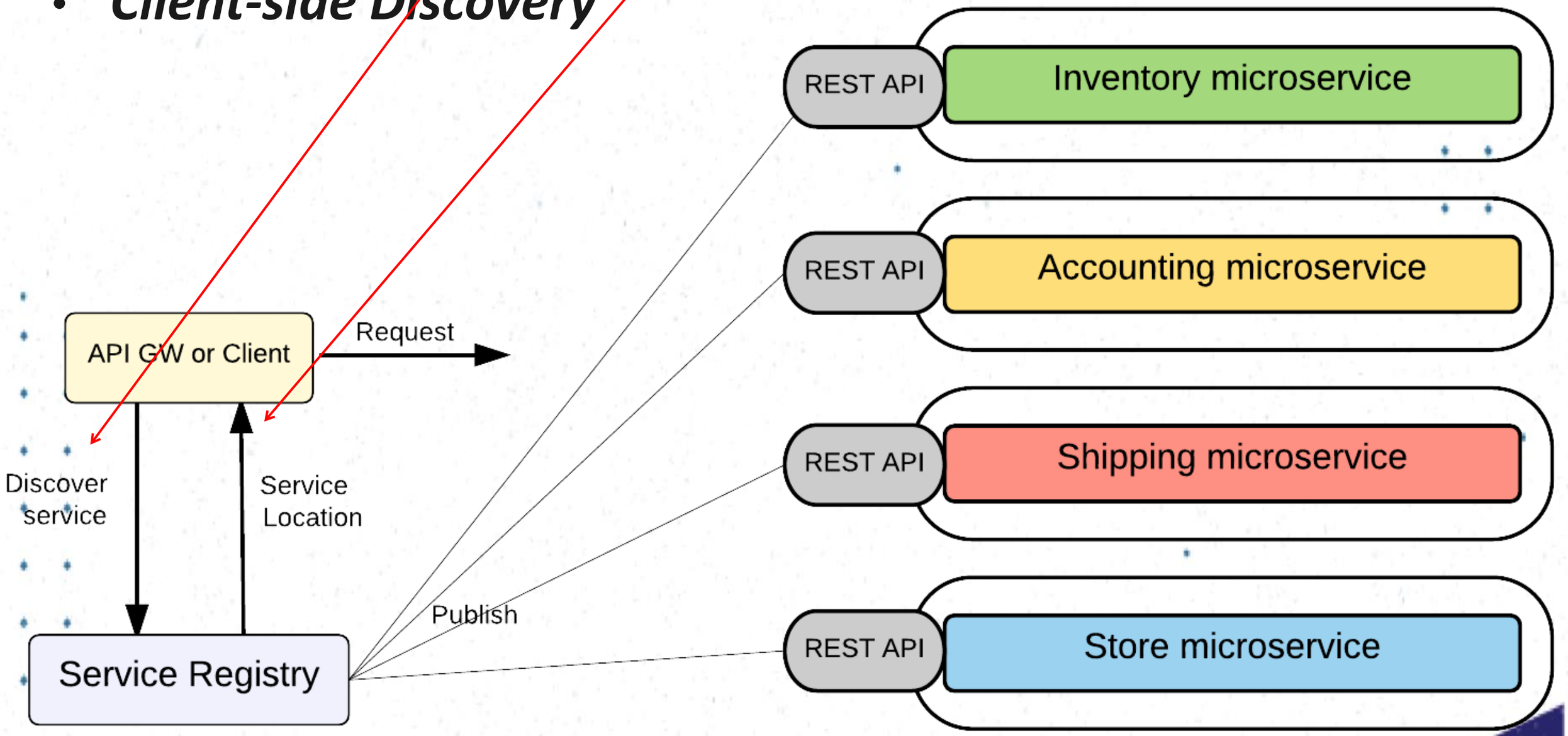
Service Registry and Service Discovery

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

Service Discovery

- ***Client-side Discovery***

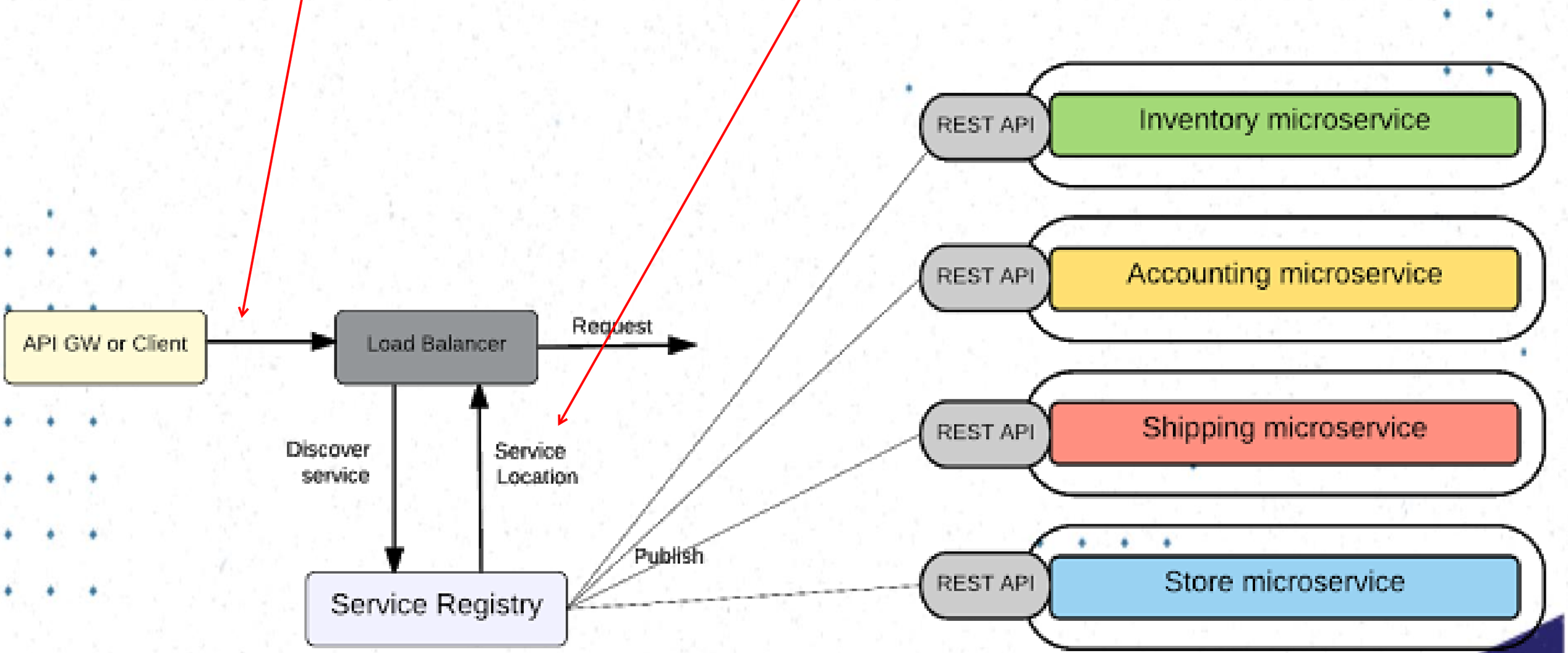
The client queries the Service Registry directly to locate the service.
After getting the service instance, it sends the request directly to the selected service.



Service Discovery

Client sends the request to a router/load balancer (e.g., API Gateway).
The router performs service discovery and forwards the request to the appropriate service instance.

- ***Server-side Discovery***

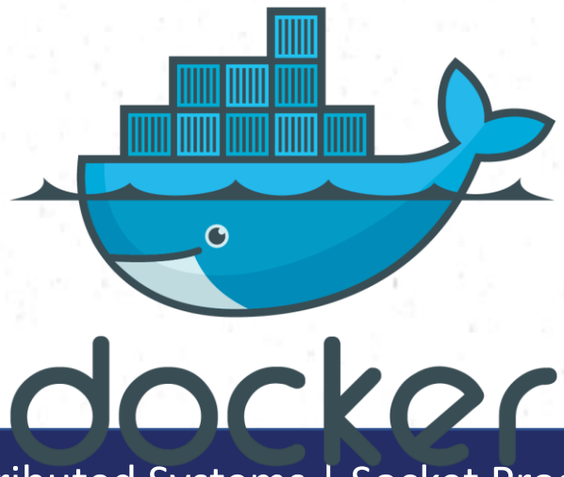


Microservice Deployment

- 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.

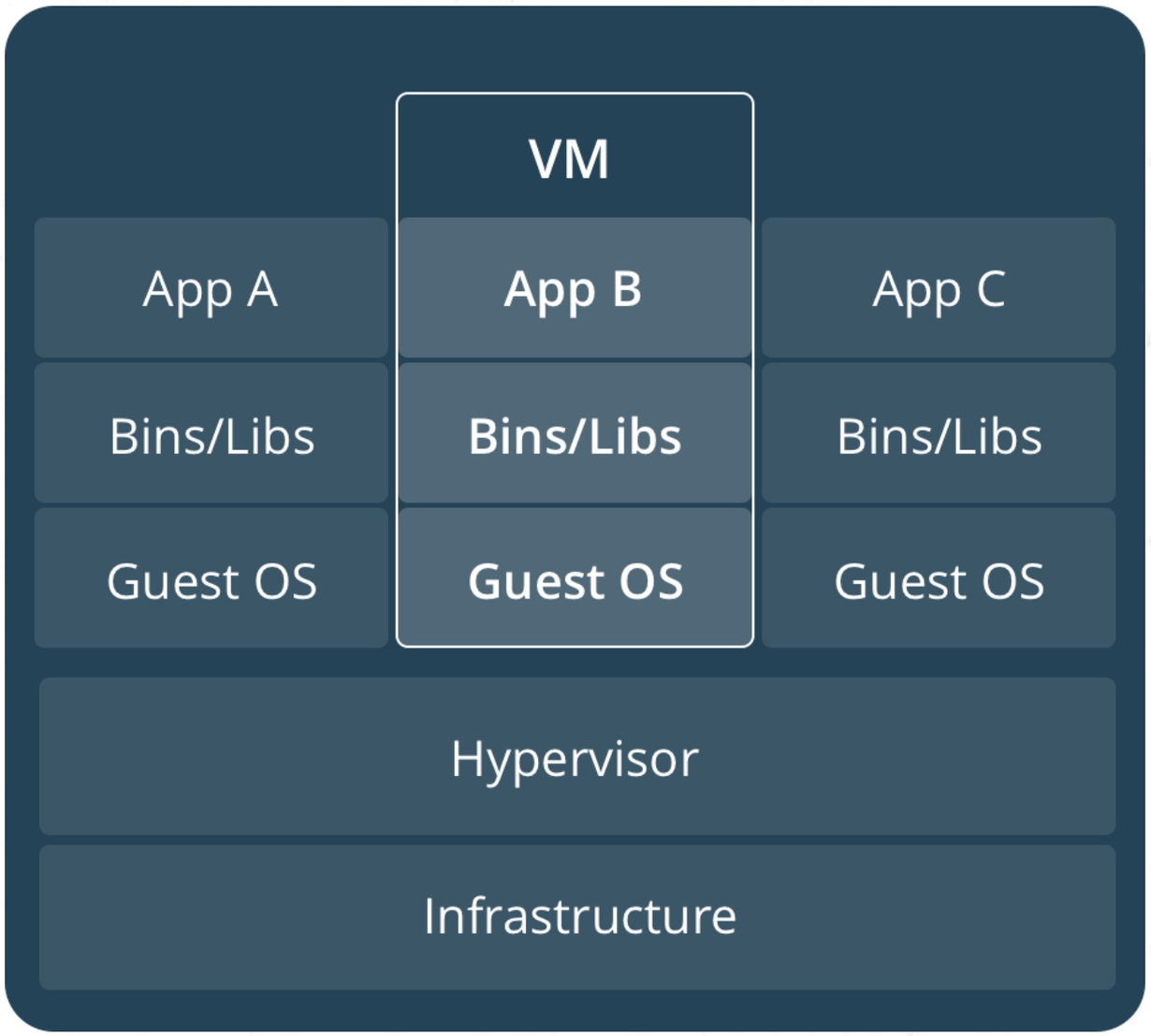
Microservice Deployment

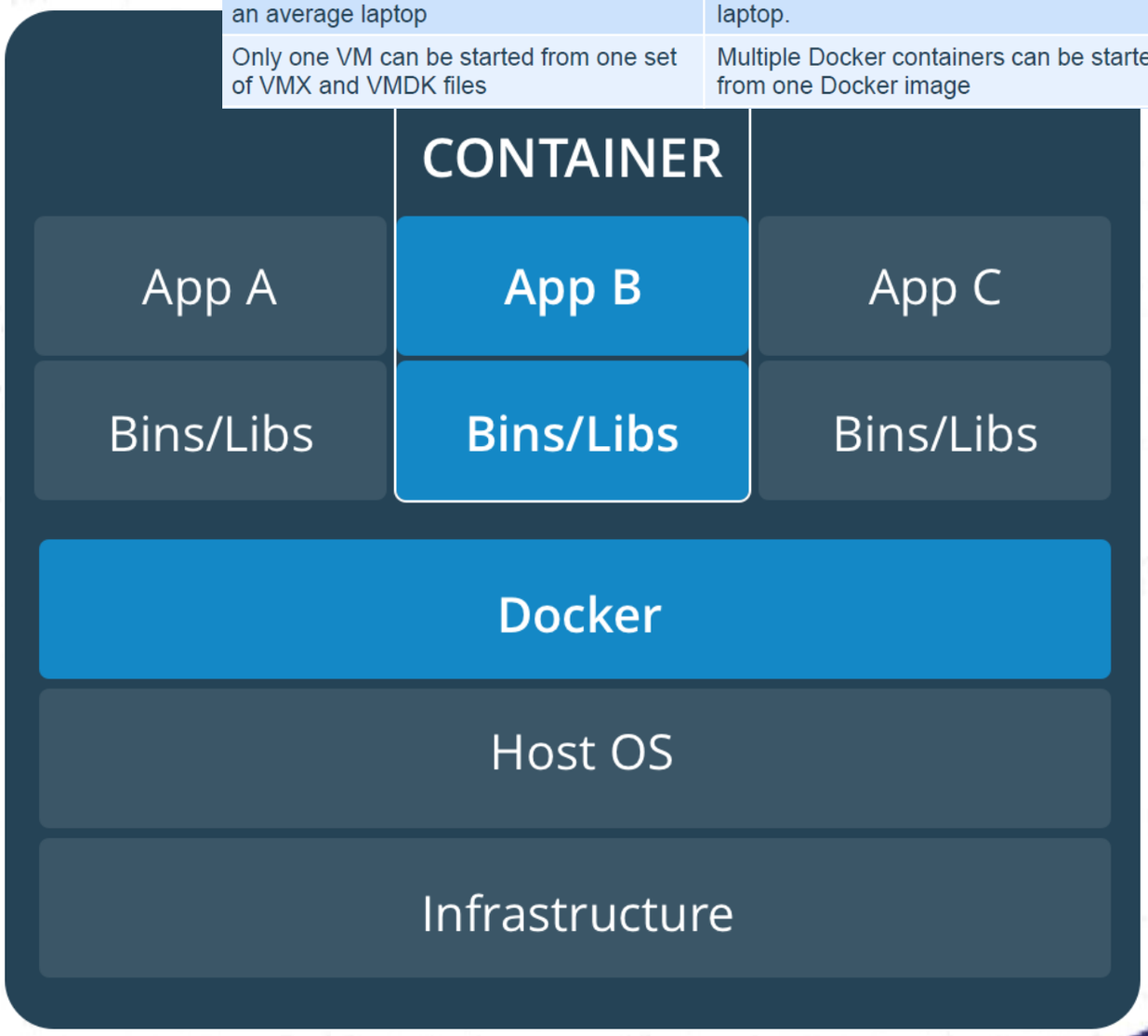
- Docker
  - *Docker is becoming an extremely popular way of packaging and deploying services.*
  - Package the microservice as a (Docker) container image.
  - Deploy each service instance as a container.
  - Scaling is done based on changing the number of container instances.
  - Building, deploying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



Virtual Machines Vs. Docker

Virtual Machines	Docker
Each VM runs its own OS	All containers share the same Kernel of the host
Boot up time is in minutes	Containers instantiate in seconds
VMs snapshots are used sparingly	Images are built incrementally on top of another like layers. Lots of images/snapshots
Not effective diffs. Not version controlled	Images can be diffed and can be version controlled. Dockerhub is like GITHUB
Cannot run more than couple of VMs on an average laptop	Can run many Docker containers in a laptop.
Only one VM can be started from one set of VMX and VMDK files	Multiple Docker containers can be started from one Docker image

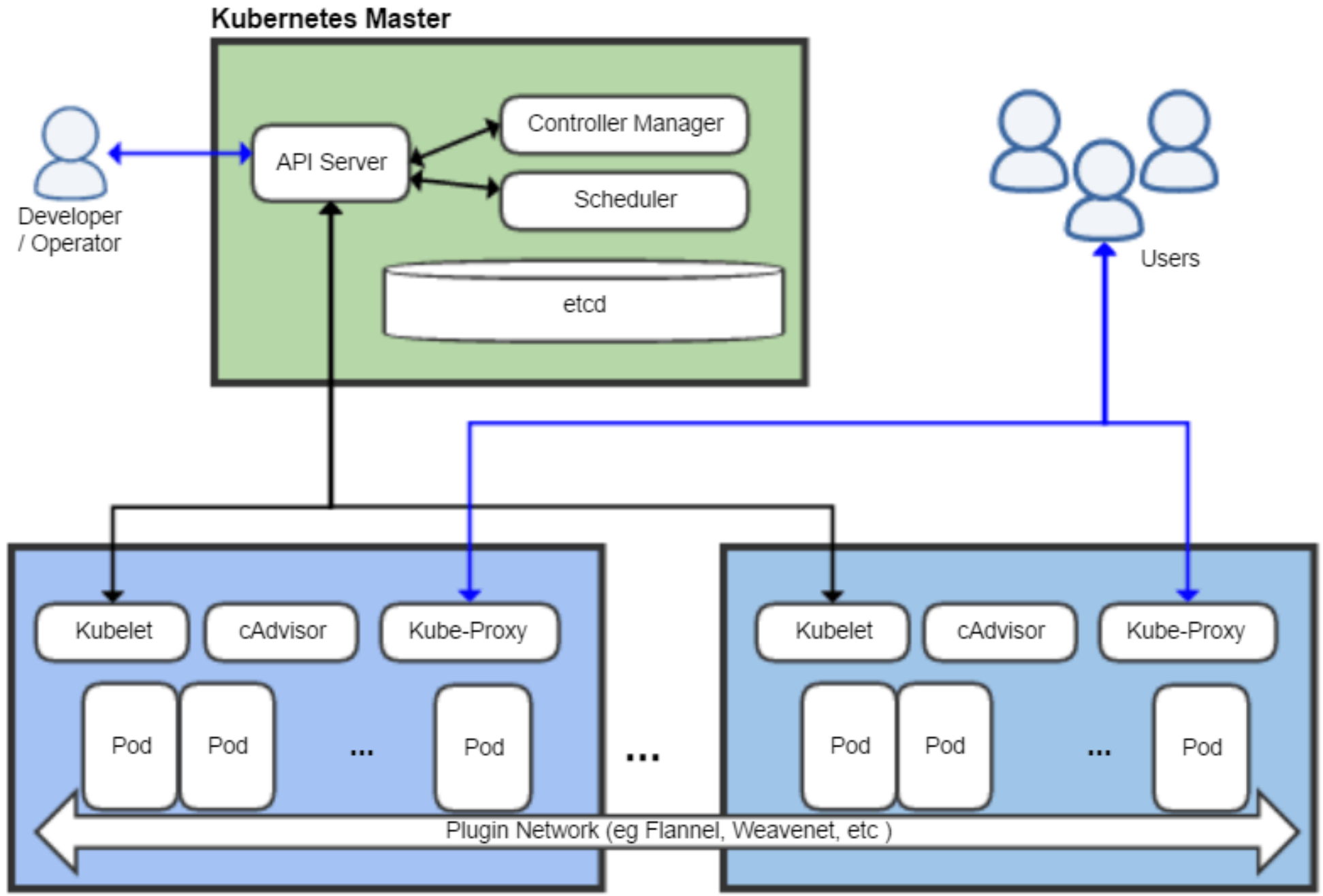




Microservice Deployment

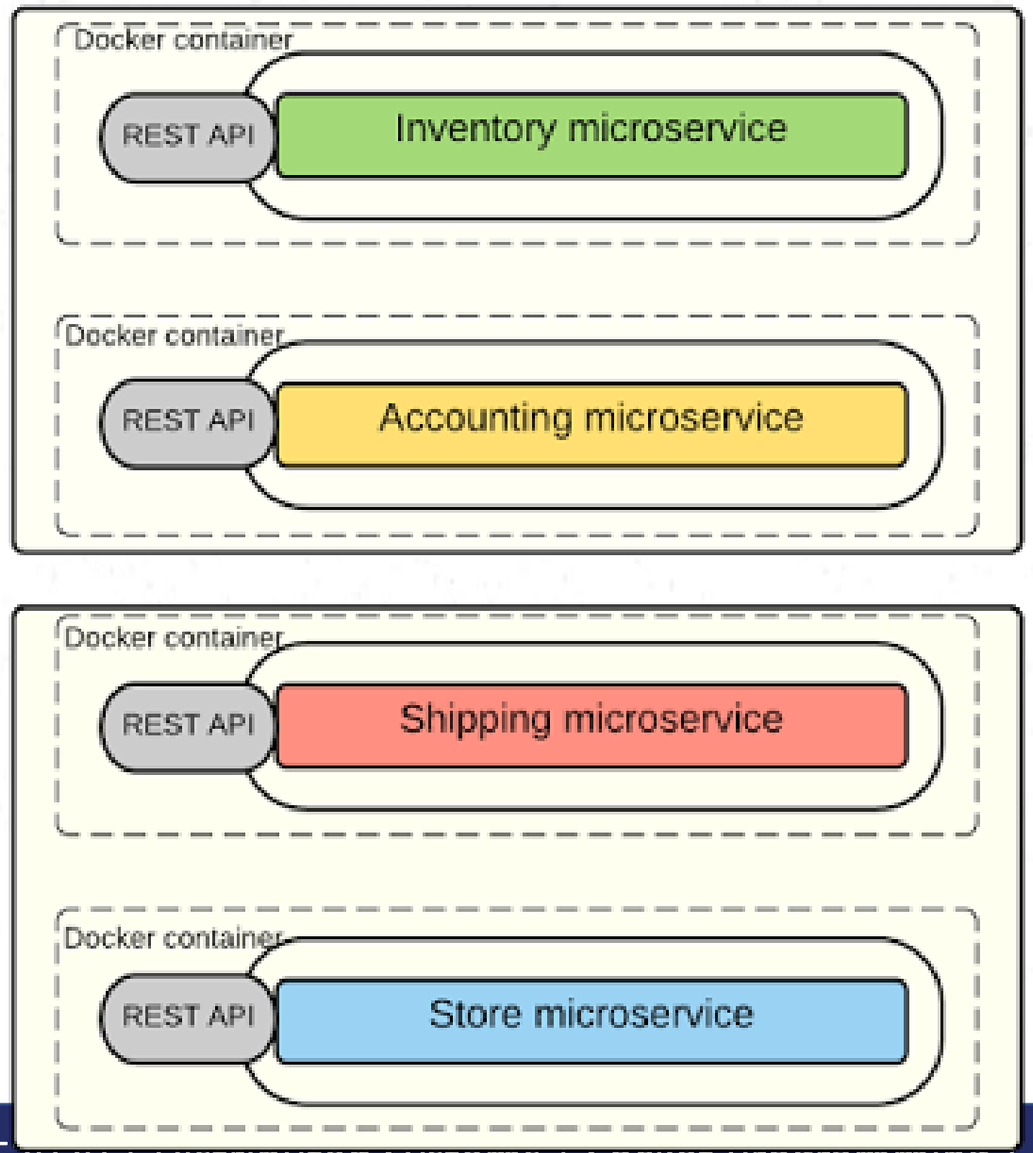
- Kubernetes
  - Extending Docker's capabilities by allowing to manage a cluster of Linux containers as a single system, managing and running Docker containers across multiple hosts, offering co-location of containers, service discovery and replication control.

Kubernetes


Kubernetes Master
API Server
Controller Manager
Scheduler
etcd
Developer
/ Operator
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

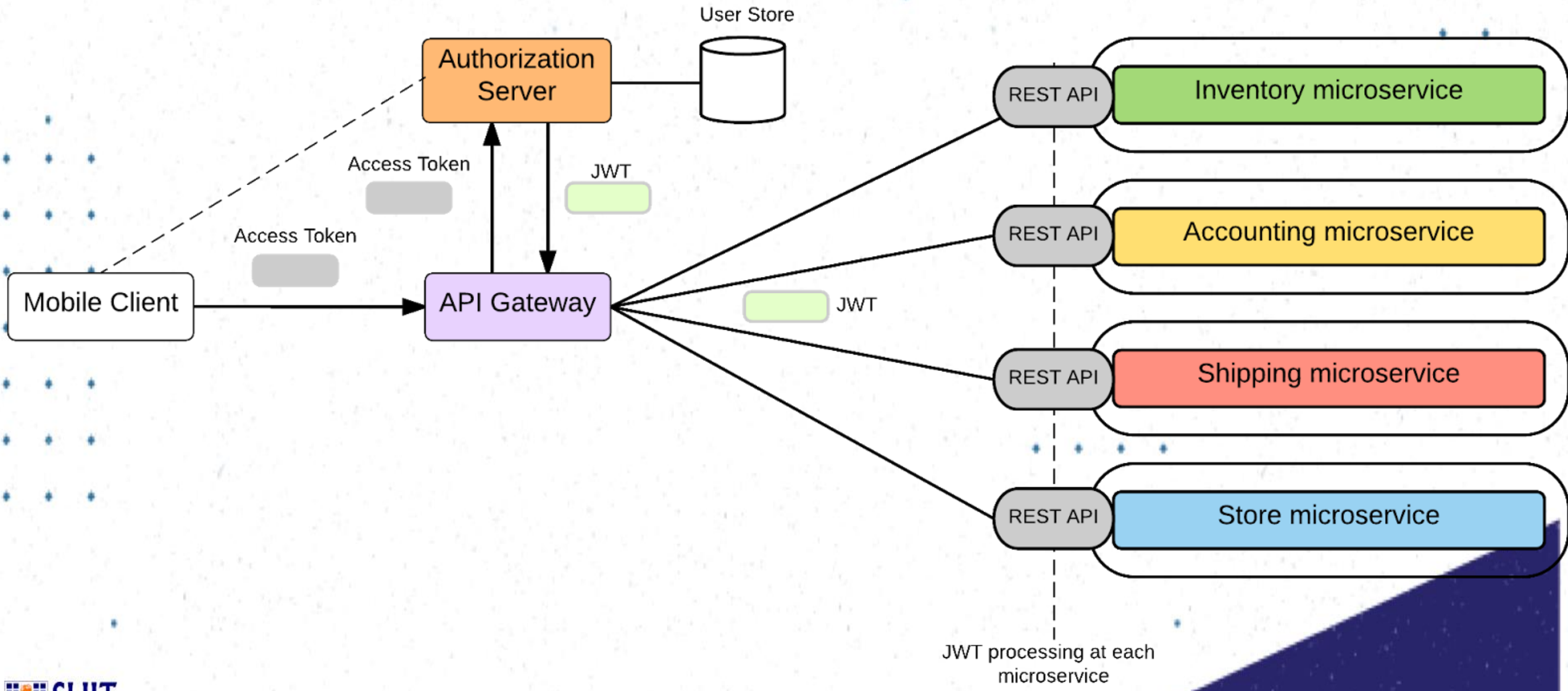
- OAuth 2.0
  - The client authenticates with authorization server and get an opaque token which is known as 'Access token'. Access token has zero information about the user/client.
  - It only has a reference to the user information that can only be retrieved by the Authorization server. Hence this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

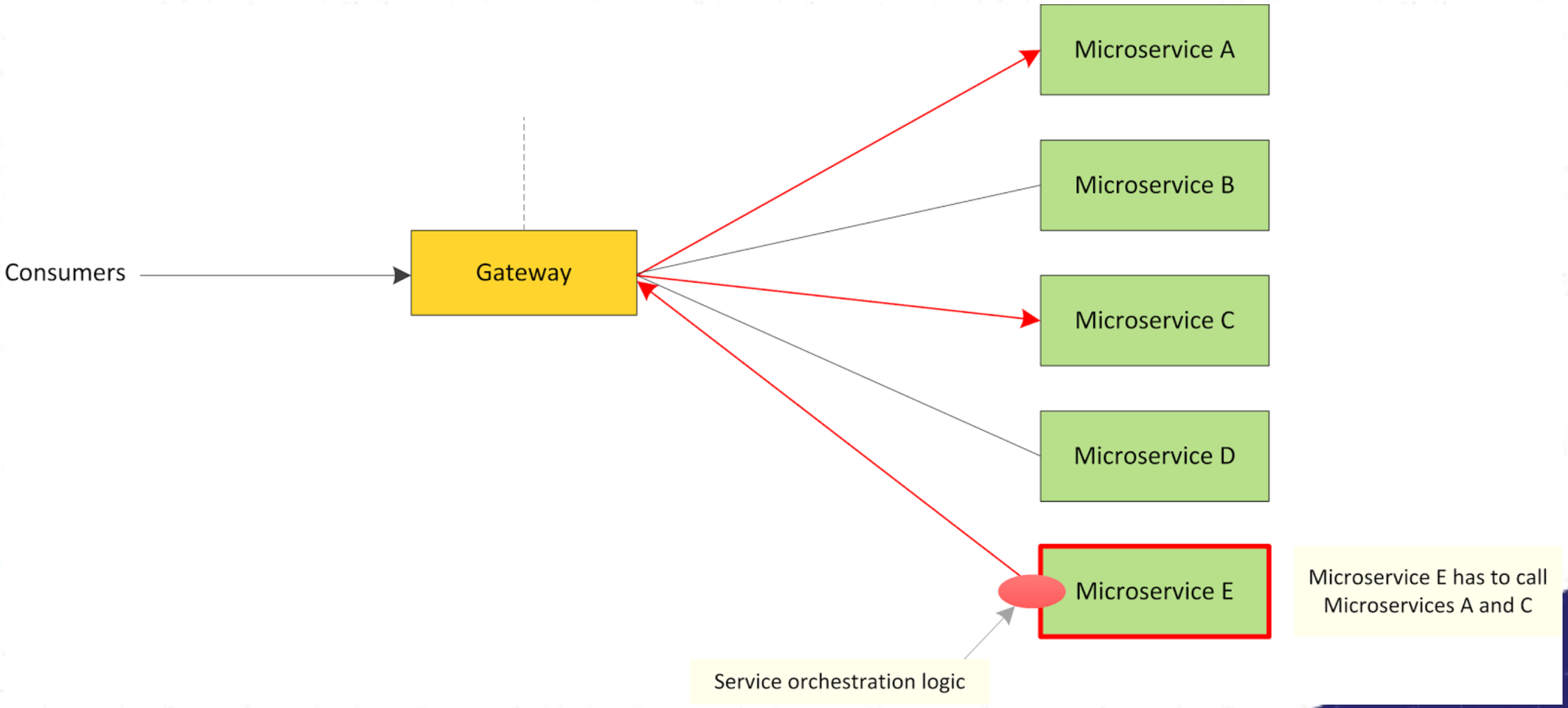
- Supporting distributed transactions across multiple microservices – Too complex.
- Microservice architecture itself encourages the transaction-less coordination between services.
- Mandatory transaction requirements can be fulfilled with 'compensating operations'

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

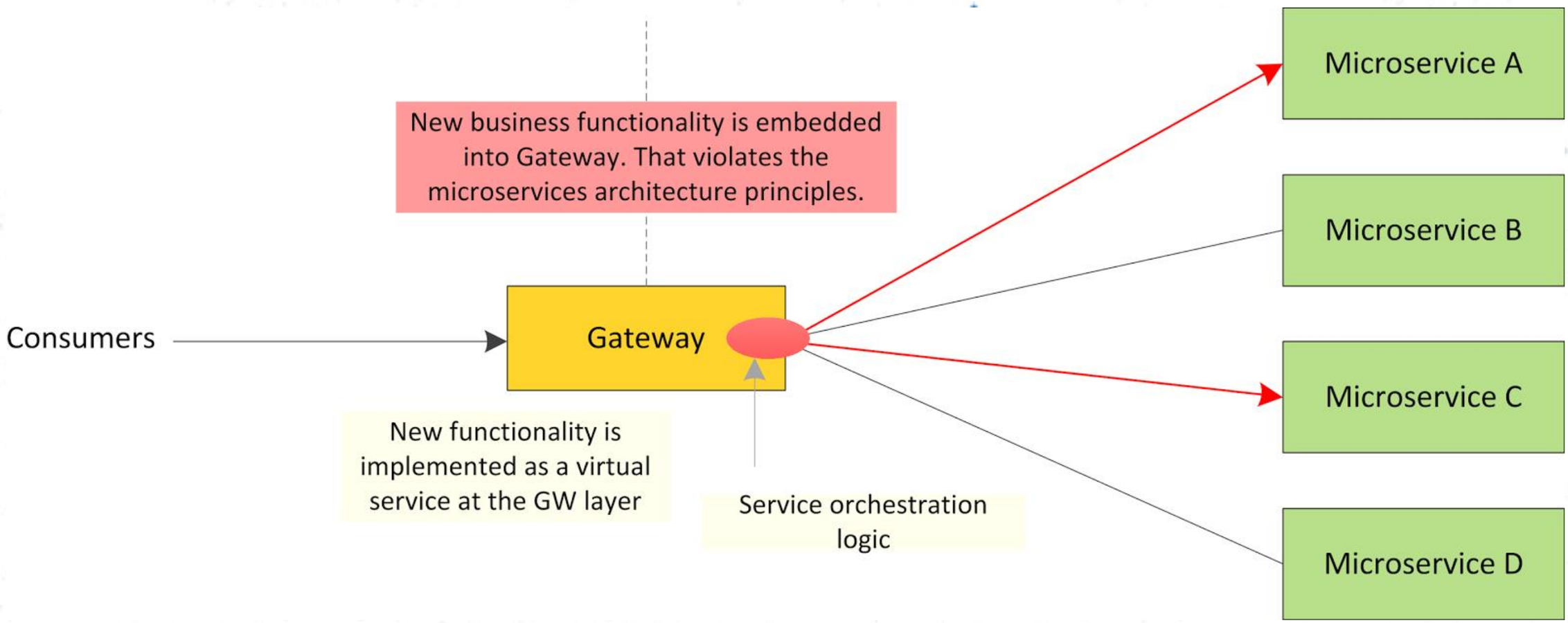
Orchestrating Microservices

- Orchestration at Microservices Layer



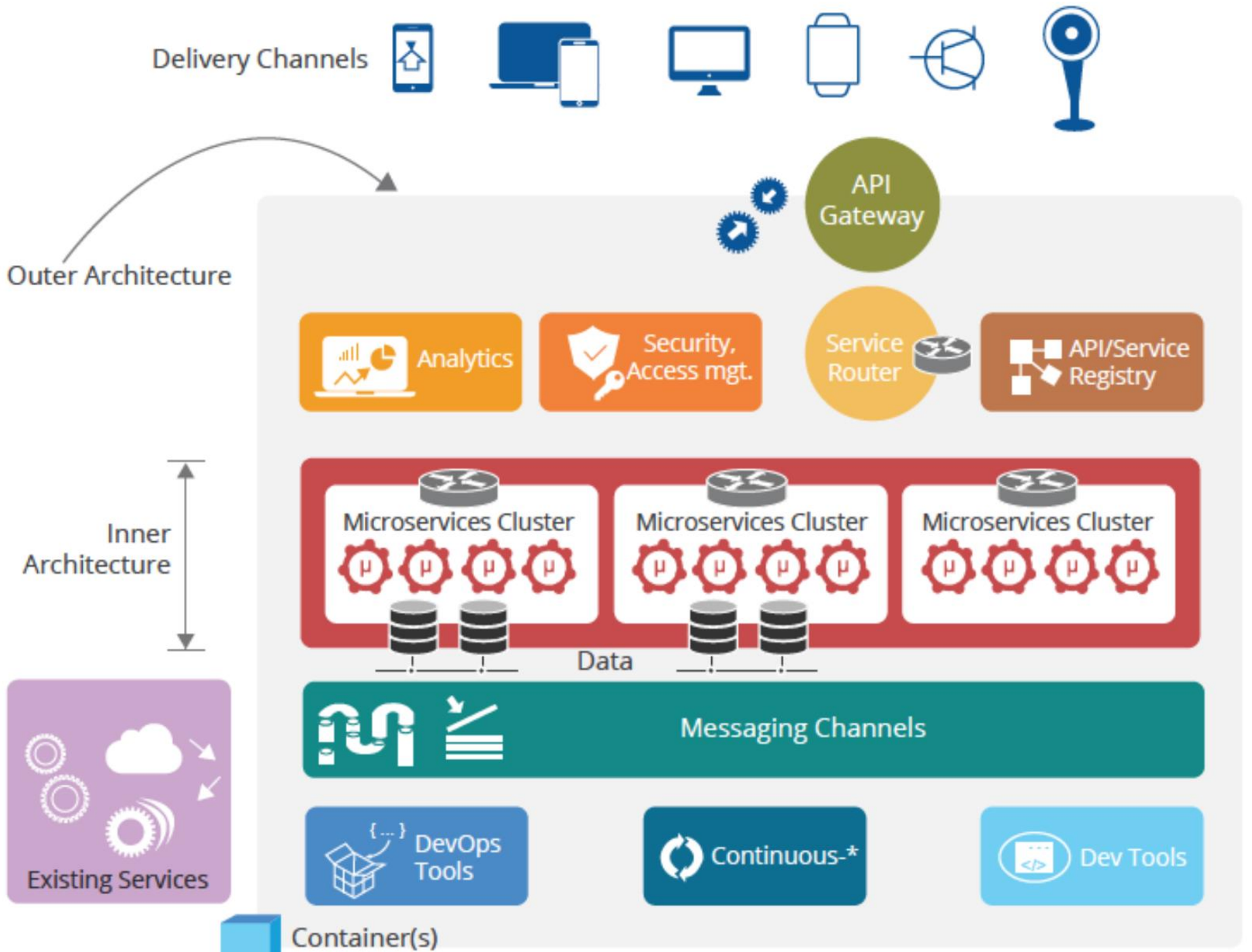
Orchestrating Microservices

- Orchestration at the Gateway Layer



Microservices in Modern Enterprises

- Inner and Outer Architecture

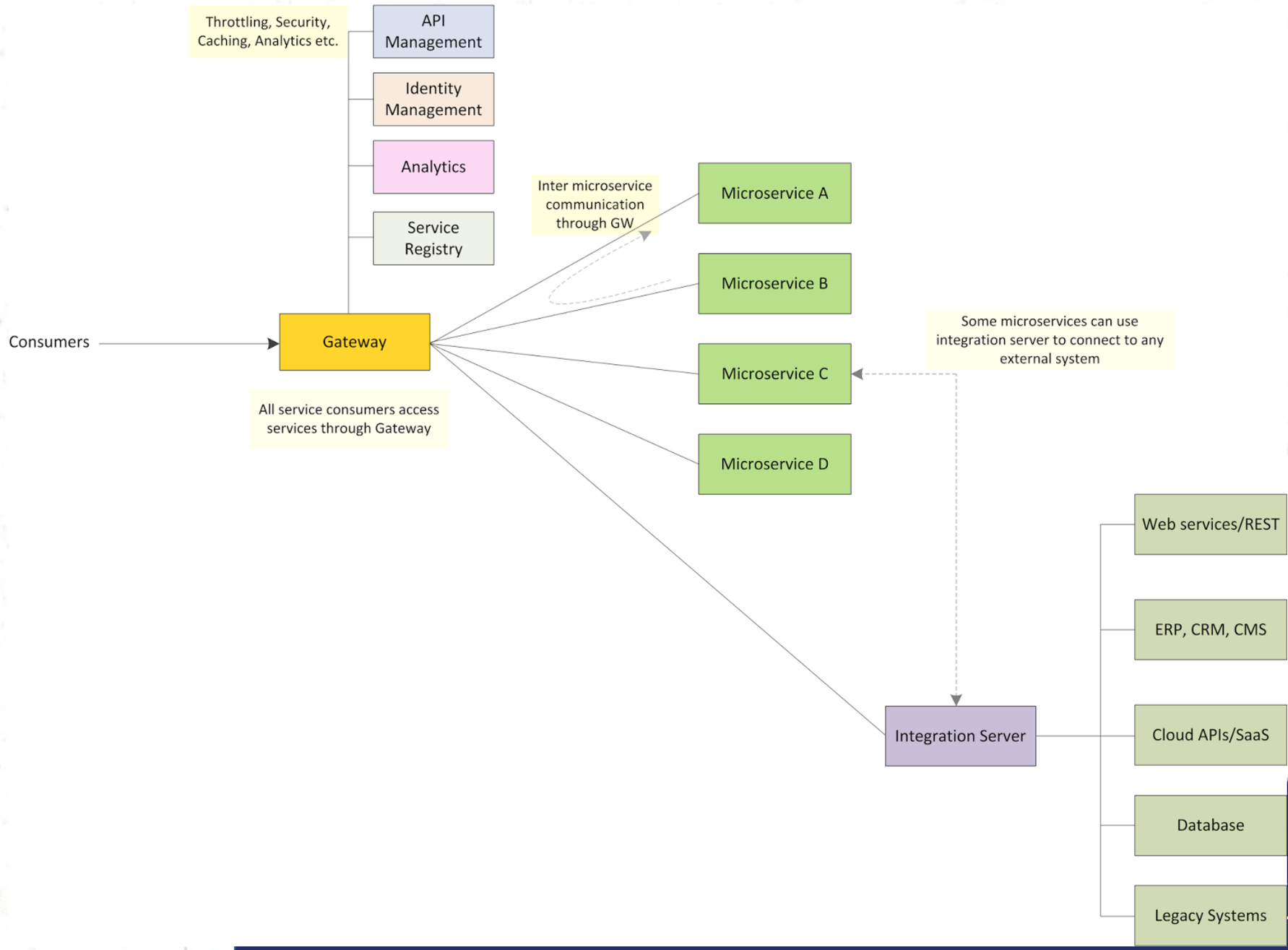


Microservices in Modern Enterprises

- **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



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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