

# MicroServices

2017

People matter, results count.

# Agenda

- 1 What are MicroServices
- 2 Challenges
- 3 MicroServices Architecture
- 4 Java MicroServices with Spring Cloud



# What are MicroServices

# Outline

1 What are MicroServices?

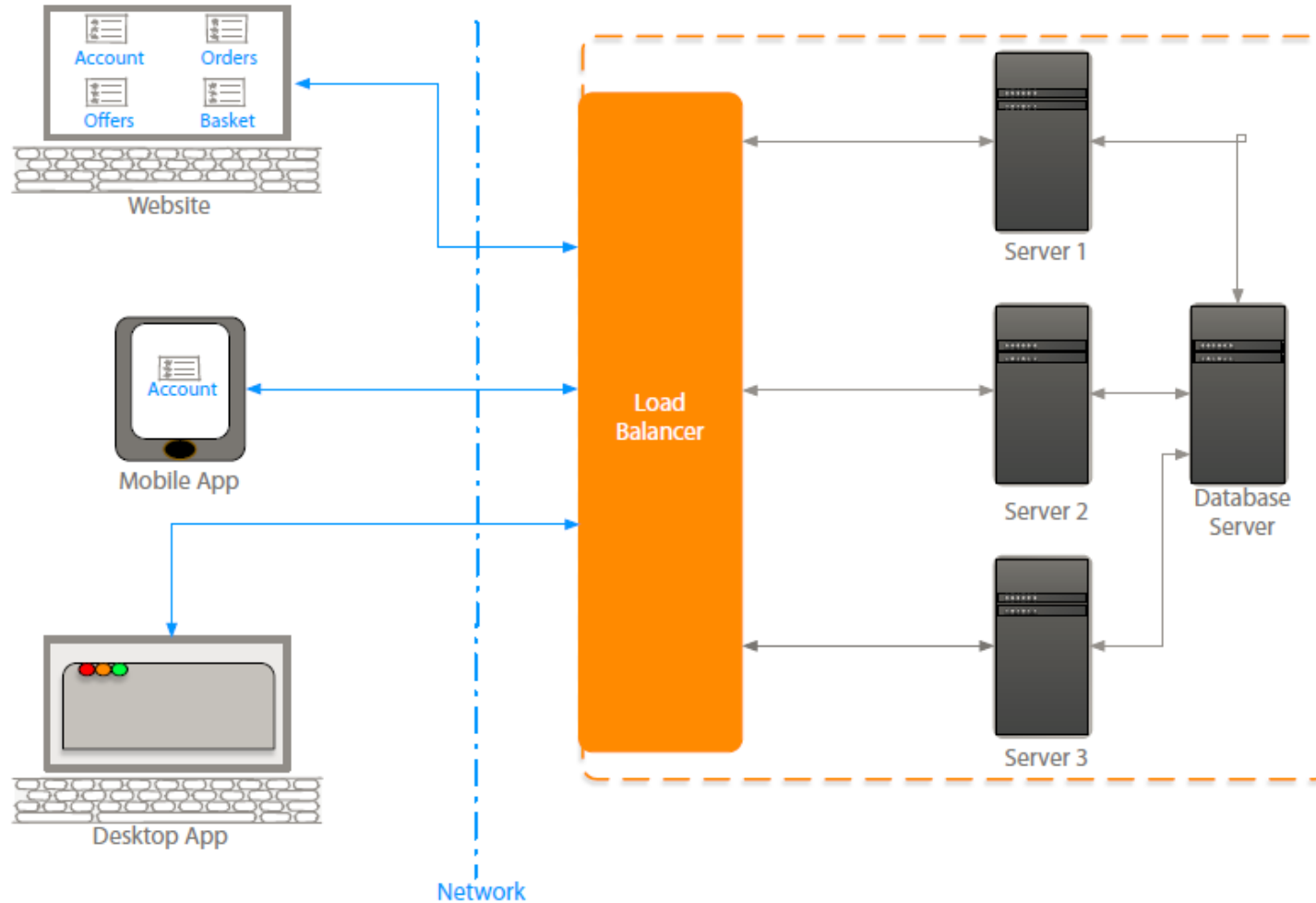
2 Bounded Concepts

# What are MicroServices?

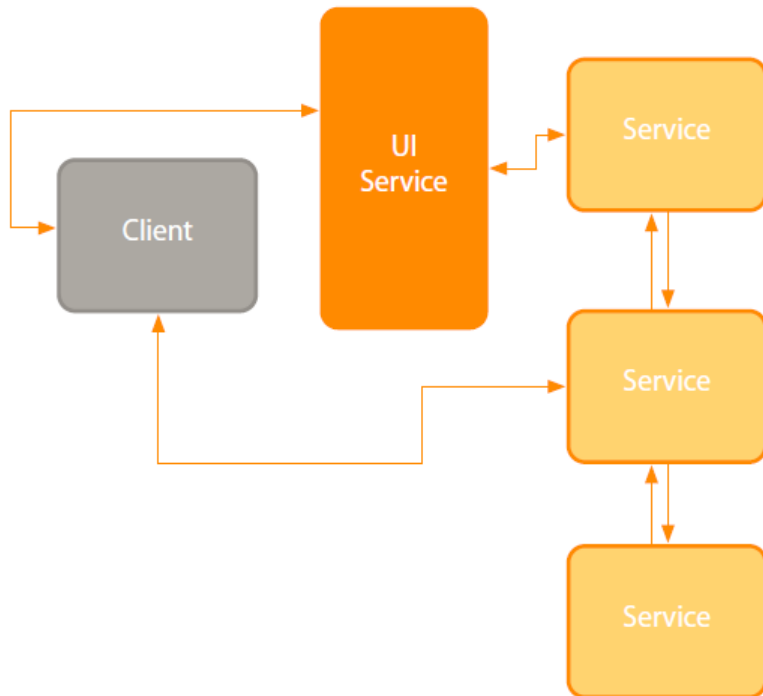
- Loosely Coupled, Service Oriented Architecture (SOA) with Bounded Contexts
  - *Adrian Cockcroft(Netflix)*
- Familiar concepts, reimagined
  - Loosely coupled
    - Deploy any time, no dependencies on anything else
    - SOA with an ESB is not loosely coupled
- Service Oriented Architecture
  - Inherently distributed system
  - But using simpler components (Services)
  - Designed that way, not a reuse mechanism for Silos



# What is a Service?

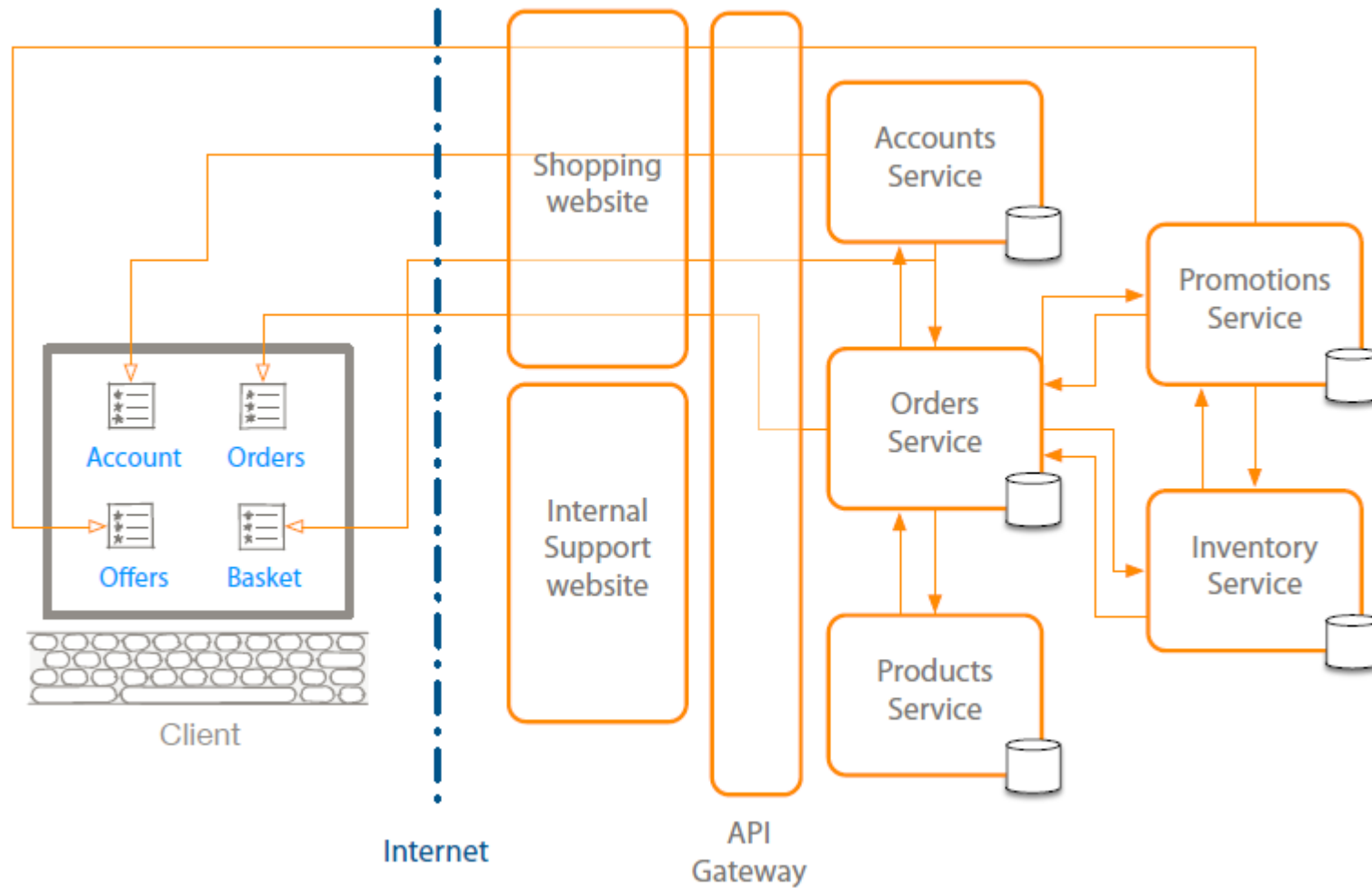


# What is a Service?



- SOA done well
  - Knowing how to size a service
  - Traditional SOA resulted in monolithic services
- Micro sized services provide
  - Efficiently scalable applications
  - Flexible applications
  - High performance applications
- Application(s) powered by multiple services
- Small service with a single focus
- Lightweight communication mechanism
  - Both client to service and service to service
- Technology agnostic API
- Independent data storage
- Independently changeable
- Independently deployable
- Distributed transactions
- Centralized tooling for management

# MicroServices





# Bounded Concepts

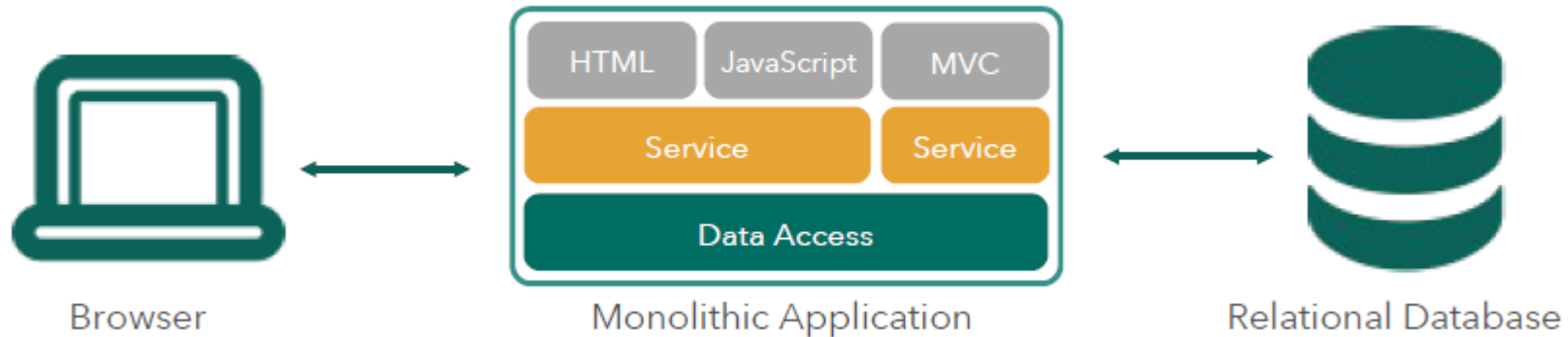
- From Eric Evan's "Domain-Driven Design" book
  - The setting in which a word or a statement appears that determines its meaning
- Given a central concept, each use is a separate context
  - Example: "reservation" in an airline booking system
- Difficult in an single "monolithic" application
  - Easier with microservices
    - Each can implement the same concept to suit their use of it
    - Each is free to have its own independent representation
- A self-consistent subset of the domain used by a micro-service

# Three Tenets of MicroServices

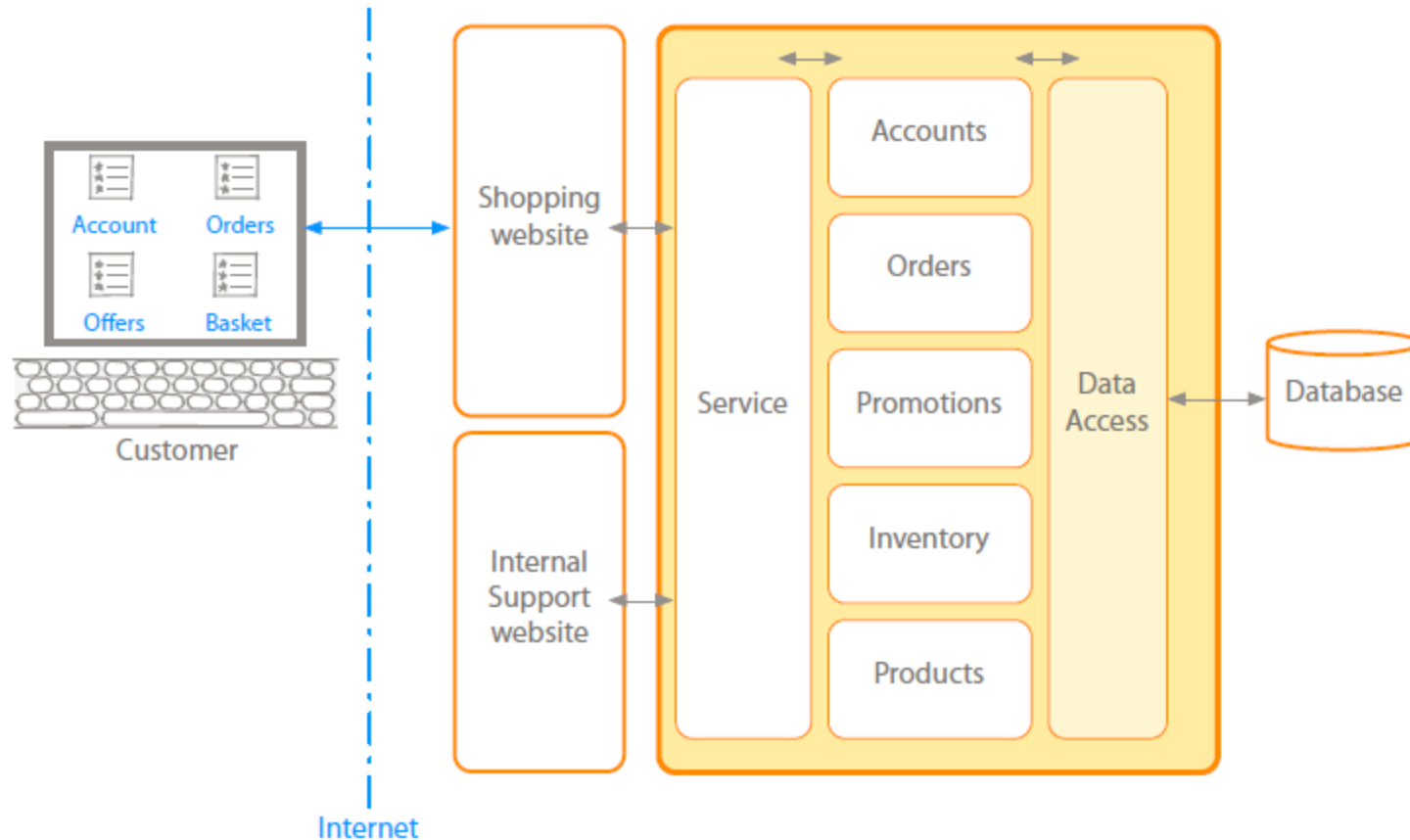
- Gary Ollifee, research director at Gartner
  - Consuming services separate from provisioning services
  - Separating infrastructure management from the delivery of the application capability
    - Using a PaaS like Cloud Foundry
  - Separating teams and decoupling services
    - Each can be built, enhanced and deployed separately
    - Embrace Dev Ops to do this successfully

# Monolithic Architecture

- How apps have traditionally been developed
  - Large, involved code-base
  - Infrequent updates
  - Risky to make small changes



# MicroServices: Monolithic

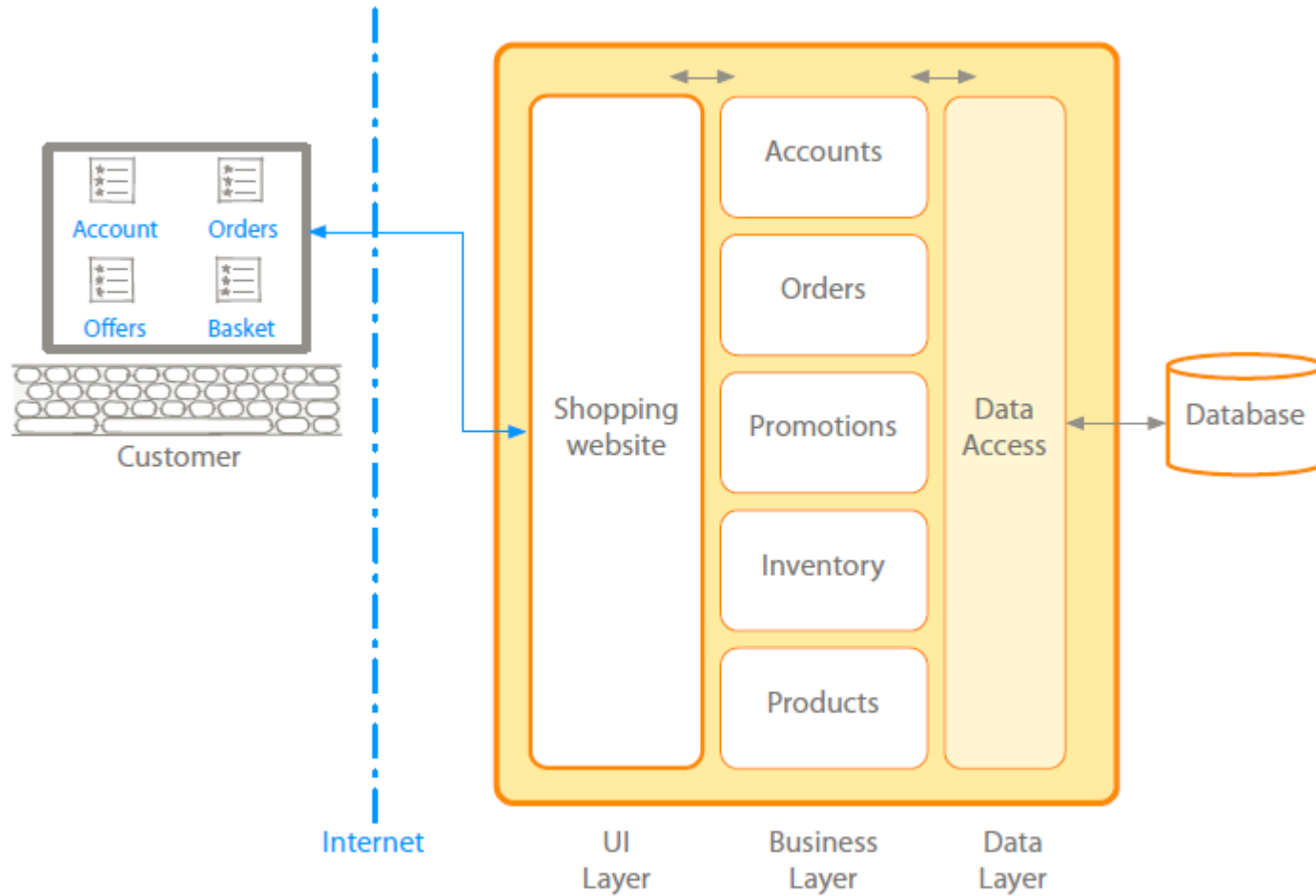


# MicroServices: Monolithic

## Typical enterprise application

- No restriction on size
- Large codebase
- Longer development times
- Challenging deployment
- Inaccessible features
- Fixed technology stack
- High levels of coupling
  - Between modules
  - Between services
- Failure could affect whole system
- Scaling requires duplication of the whole
- Single service on server
- Minor change could result in complete rebuild
- Easy to replicate environment

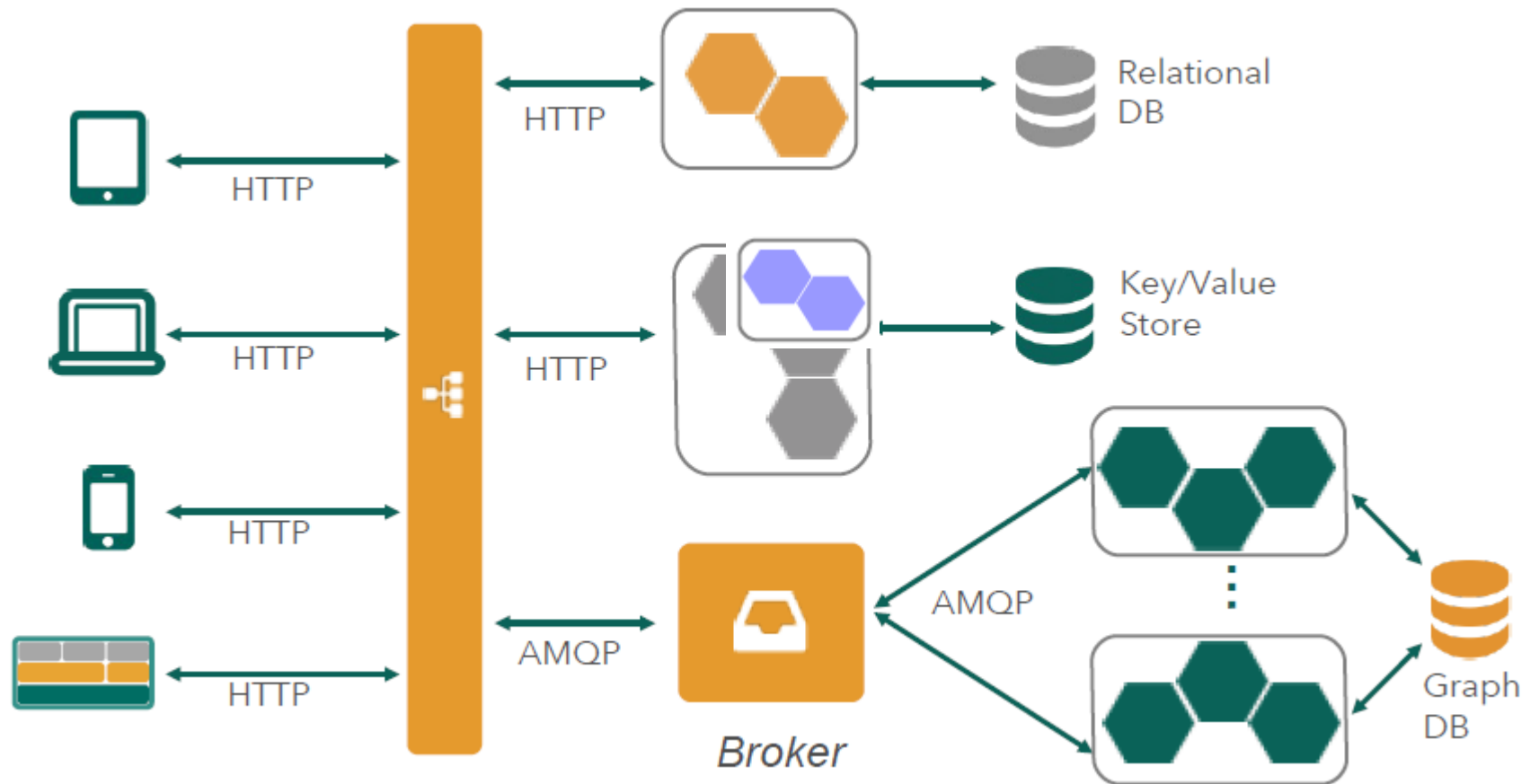
# MicroServices: Monolithic



# Microservices Architecture



- Decompose into collaborating components



# Trade-Off

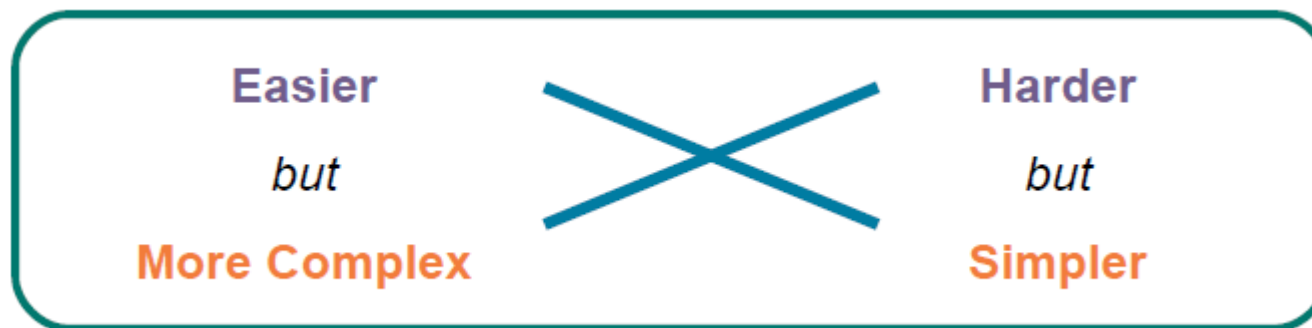


## ■ Monolith

- Easier to build
- But ultimately more complex to enhance and maintain
- Scaling Up (bigger processors) limited

## ■ Microservices

- Harder to build
- But ultimately simpler to extend, enhance and maintain
- Scaling Out (more processes) easier





# Summary

**Bounded Concepts**

**Monolithic Architecture**

**Microservices Architecture**

**Trade-Off**



# Challenges

# Outline

- 1 Qualification Test
- 2 Route To Microservices: Existing App
- 3 Decomposing the Monolith
- 4 Refactoring to Microservices Architecture
- 5 Route To Microservices: New App
- 6 Transactions
- 7 Deployment Challenges
- 8 Microservices and Cloud Foundry

# Qualification Test

- Microservices are not for everyone
  - It's as much how you develop as what you develop

• "You must be this tall" to "ride"

## Microservices

- Rapid provisioning
- Basic monitoring
- Rapid Application Development
- Devops culture

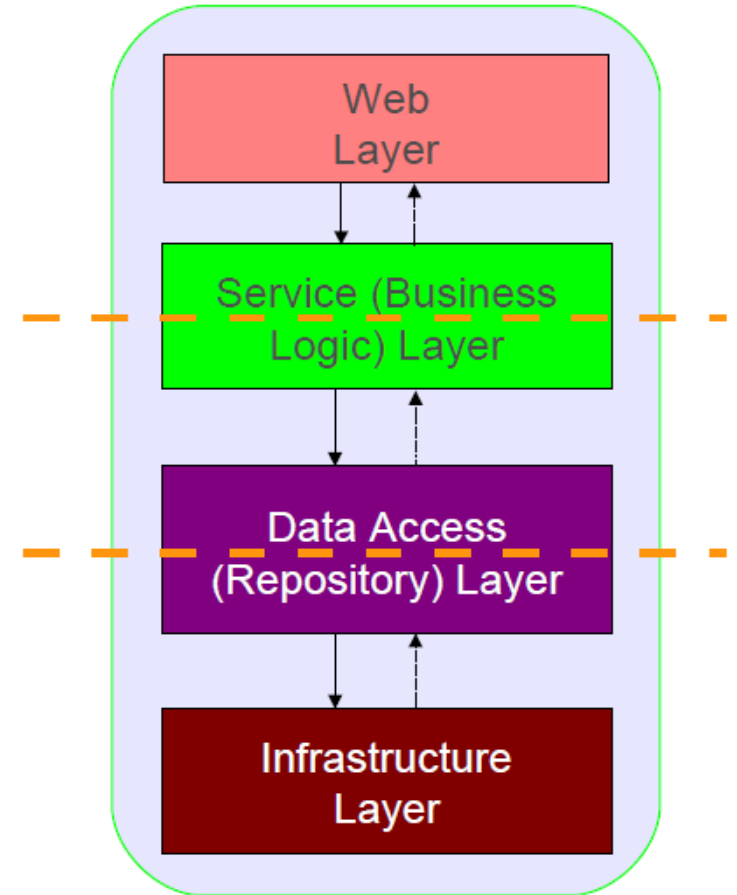


# Route To Microservices: Existing App

- Develop new functionality as microservice(S) around existing Monolith
  - Use Facades/Adapters/Translators to integrate them
- Strangle the Monolith
  - Refactor existing monolith functionality into new microservice(s)
  - Long-term evolution:
    - Monolith wither to nothing
    - Or is reduced to a solid, reliable core that is not worth refactoring (becuase we know it works)

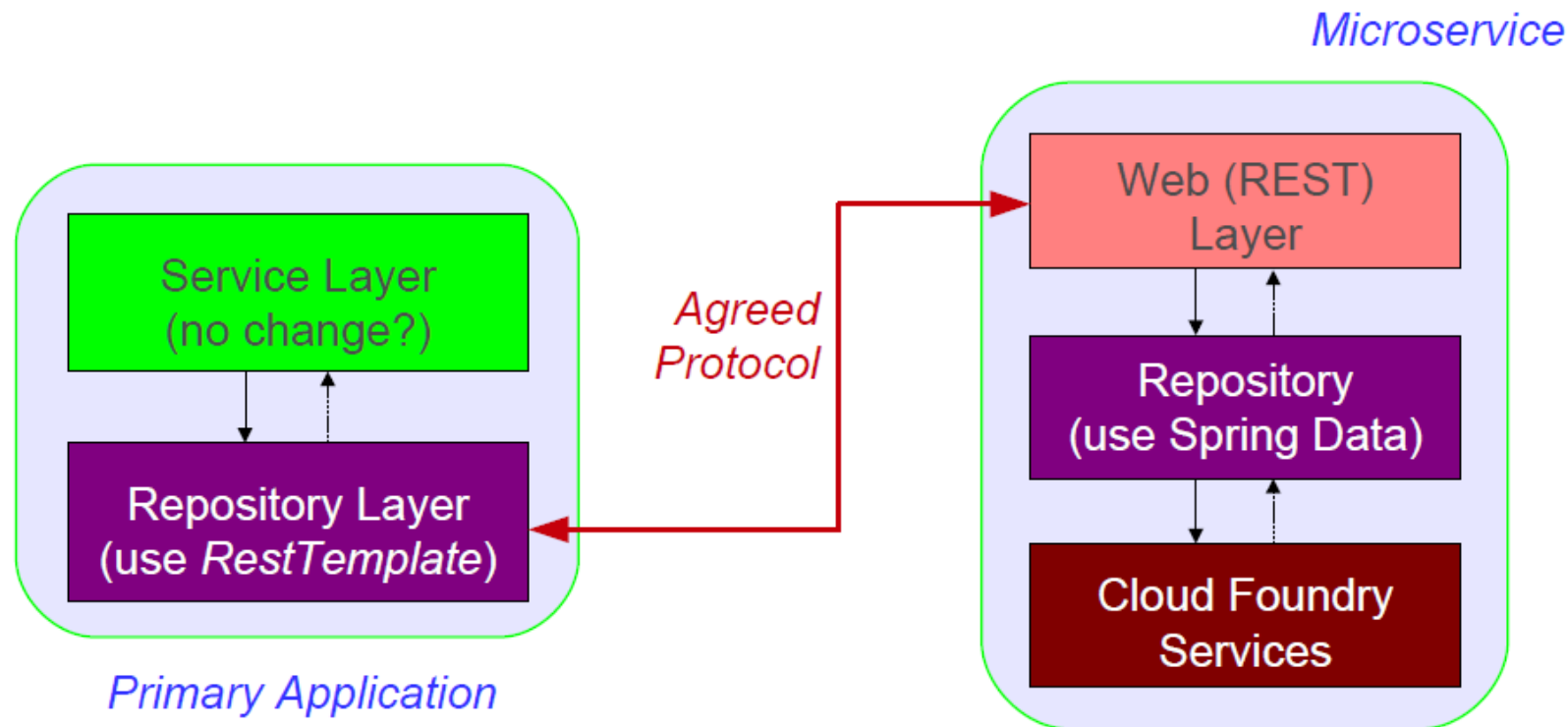
# Decomposing the Monolith

- Many Java applications use the classic three layer architecture
  - Services (business logic)
  - Repositories (data access)
  - Infrastructure (interface to external resources)
  - Web-layer(optional), other interfaces possible
- Refactor into two processes



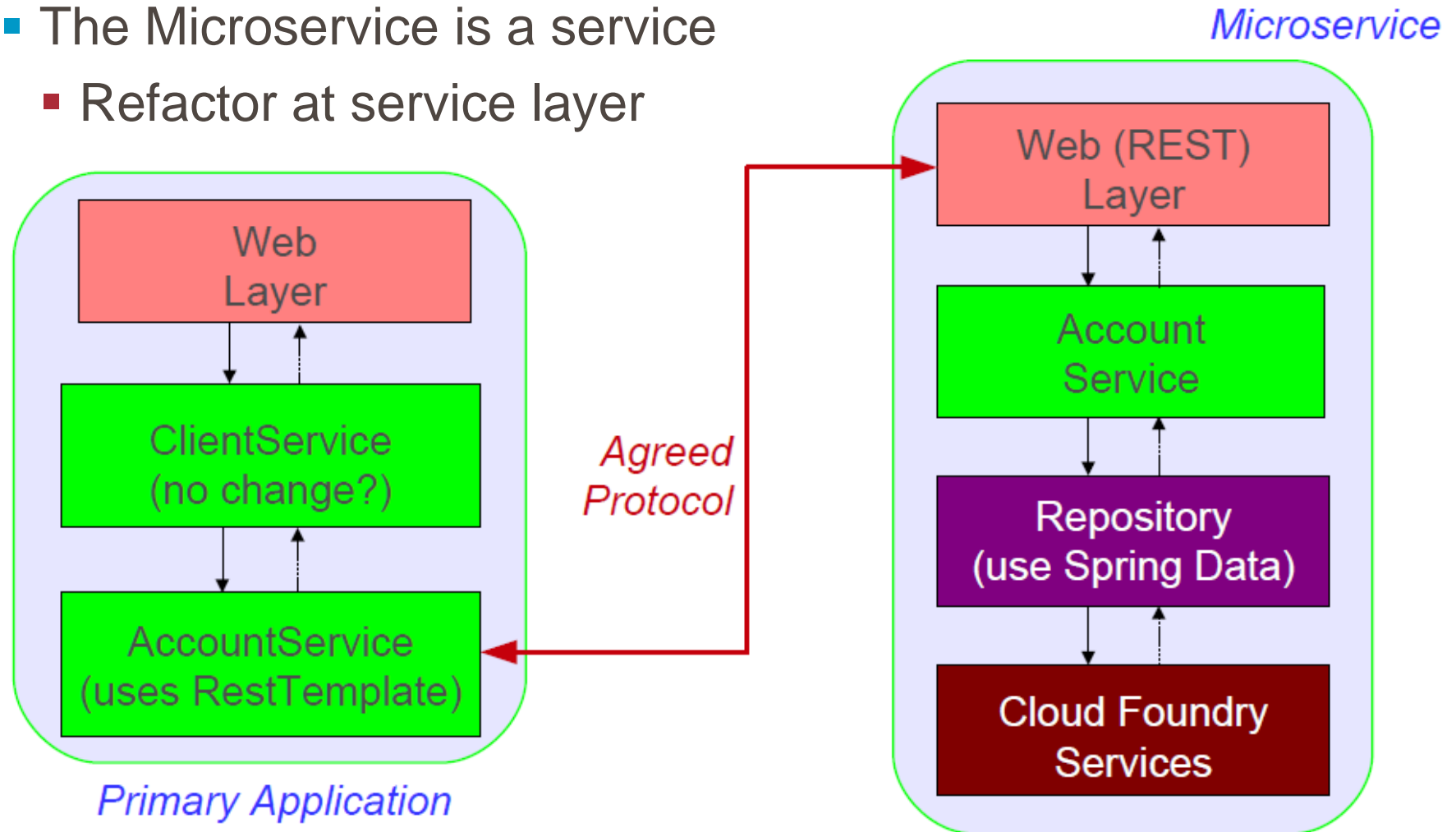
# Refactoring to Microservices Architecture

- Refactor the repository to talk to the microservice
  - Any protocol you like, here using REST
  - Microservices talks to CF Services



# Refactoring to Microservices Architecture

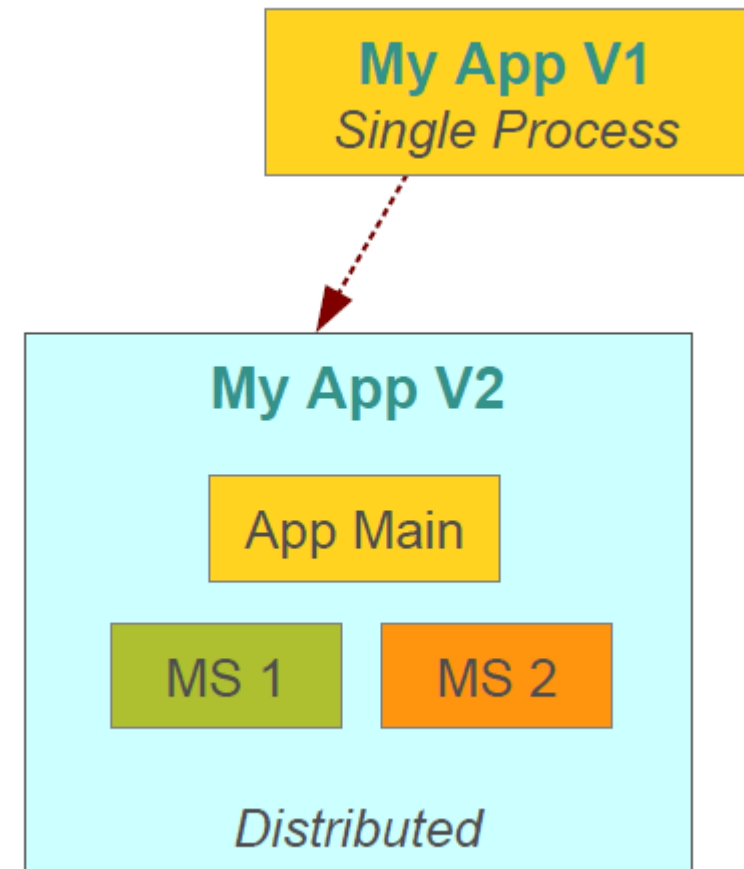
- The Microservice is a service
  - Refactor at service layer





# Route To Microservices: New App

- Start with a "Monolith"
  - Keep it simple, at first
  - Single process application
  - Apply 12-factor patterns
  - Cloud-ready even at this stage
- As it grows
  - Decompose into micro-services
  - Enables separately manageable and deployable units
  - Each can use own storage solution (polyglot persistence)



# Transactions - I

- What happens if I need to co-ordinate a change to multiple microservices at the same time?
  - Transactions help with consistency, but force significant temporal coupling
  - Distributed transactions are notoriously difficult to implement
- Microservice architecture emphasize transaction less coordination between services,
  - Eventual consistency is all you can guarantee
  - Problems are dealt with by "compensating" operations.
    - A transaction to undo a previous transaction

# Transactions - II

- Many business already do this
  - But it's new to developers
- Business may choose to handle a degree of inconsistency in order to respond quickly to demand
  - Define a reversal process to deal with mistakes
  - Trade-Off is worth it if cost of fixing mistakes is less than the cost of lost business

# Deployment Challenges - I

- Inherently more complex, distributed architecture
- We need to support
  - Configuration management
  - Service registration and discovery
  - Routing and load balancing
  - Fault tolerance
  - Monitoring the individual components
  - And also need a global/consolidated view

# Deployment Challenges - II

- No microservice is an island- Dr Dave Syer (Pivotal)
  - Must be part of an "archipelago"
- How to handle a whole (composite) system?
  - The "Big A" app
  - CF manifest does some of this, but its static
  - Static vs. dynamic - need "BOSH for microservices" = PCF
  - Decentralized, autonomous capability required
    - Different teams can deploy at any time
    - You own it, you write it, you run it!

# Microservices and Cloud Foundry

- what does a microservice application require?
  - Environment provisioning
  - On-demand scaling
  - Failover and resilience
  - Routing and Load balancing
  - Data services ops (BOSH)
- Cloud Foundry gives you all these
  - Don't have to deploy to a Paas, but it works well
  - A naturally symbiotic relationship

# Summary

**Refactoring to Microservices Architecture**

**Route to Microservices – New App**

**Transactions.**

**Deployment Challenges**

**Microservices and Cloud Foundry.**



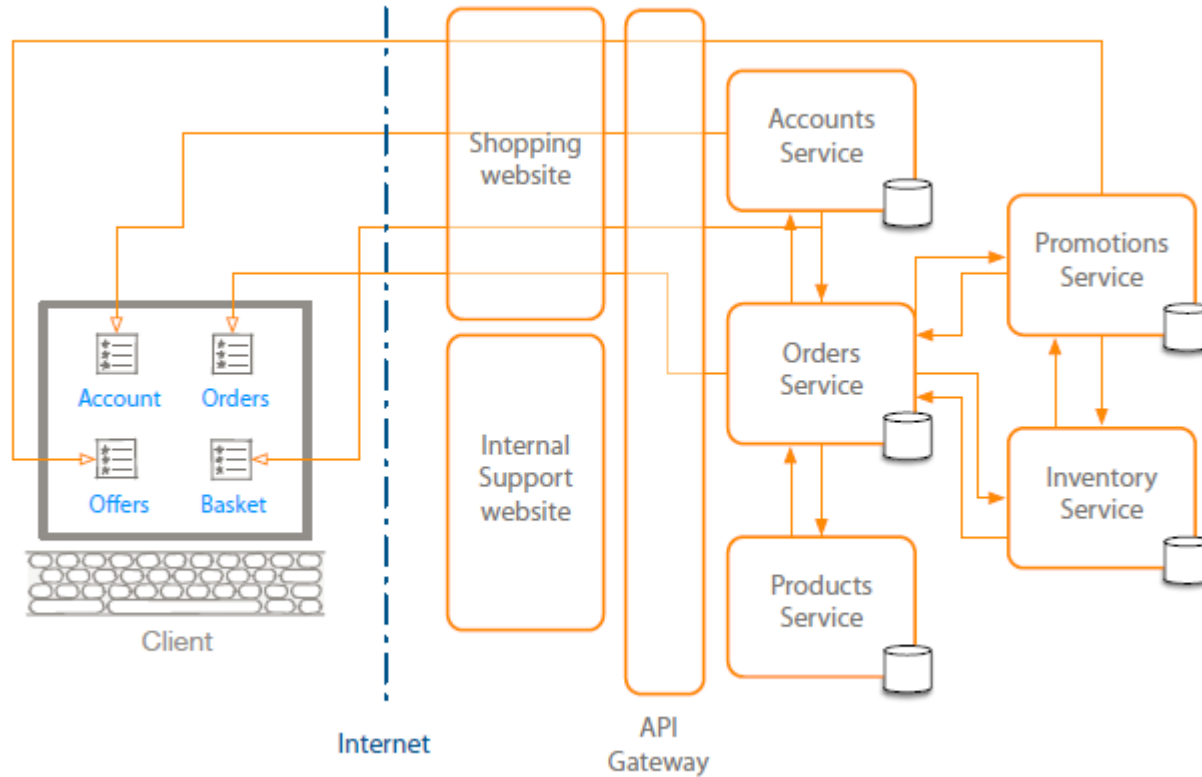
# MicroServices Architecture



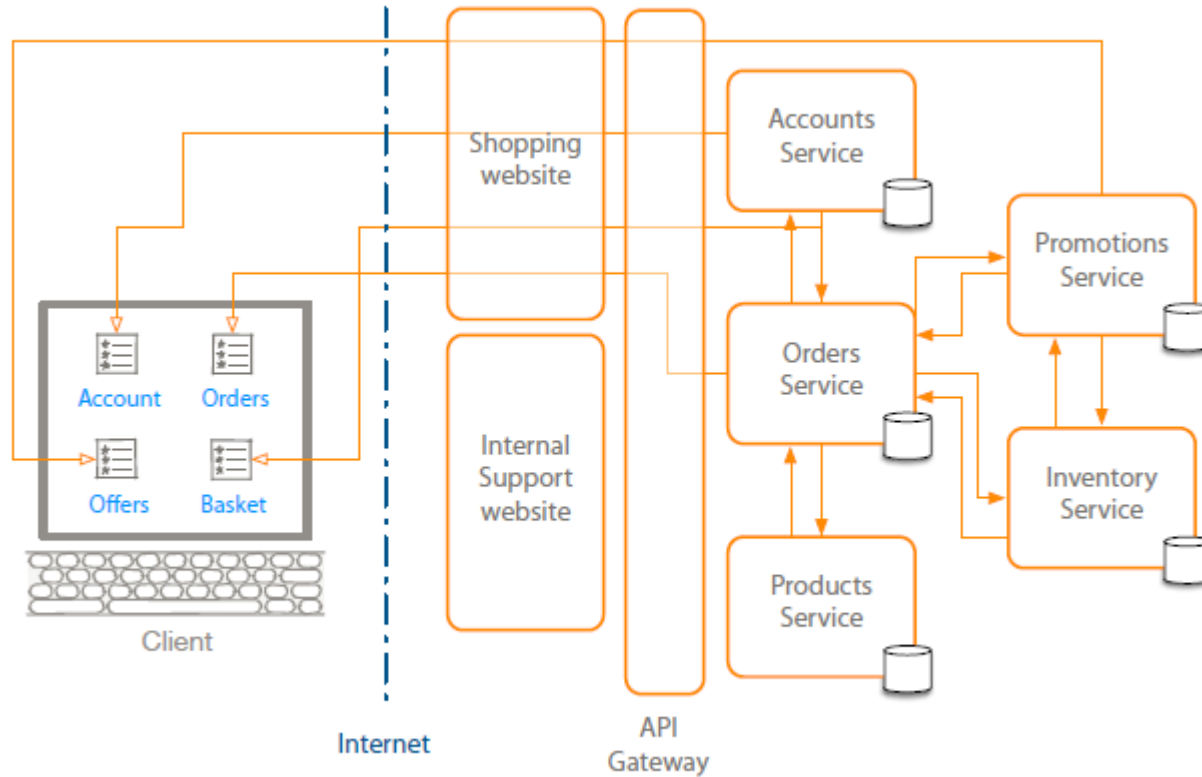
# Outline

- 1 Emergence of MicroServices
- 2 Design Principles Of MicroServices
- 3 Approaches of MicroServices
- 4 Technology for Microservices
- 5 Moving Forwards with MicroServices

# Emergence of MicroServices



# Emergence of MicroServices

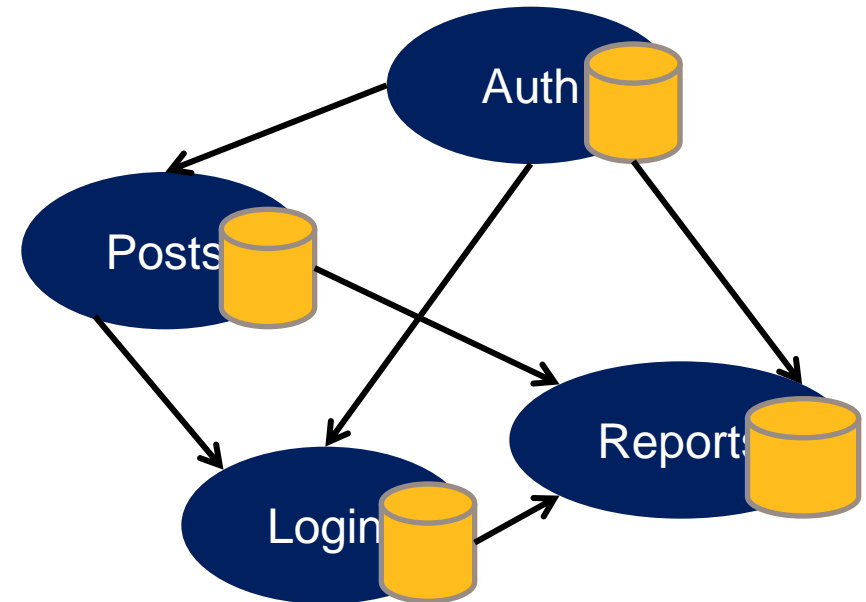
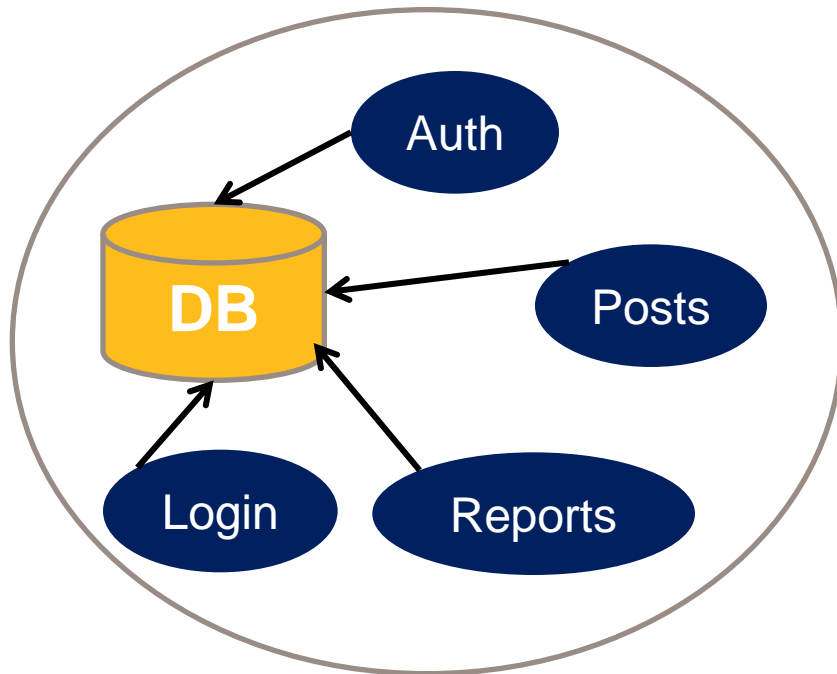


# Emergence of MicroServices

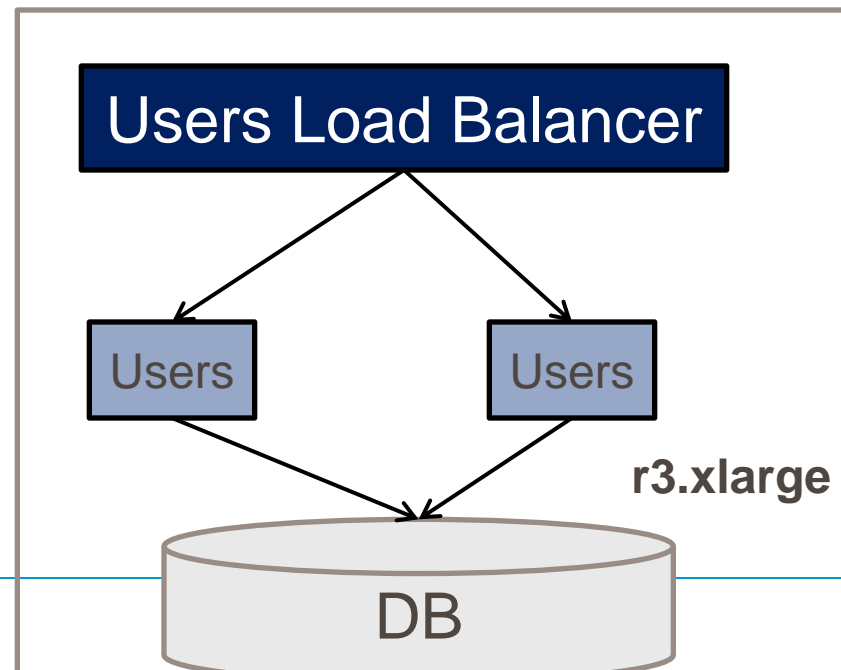
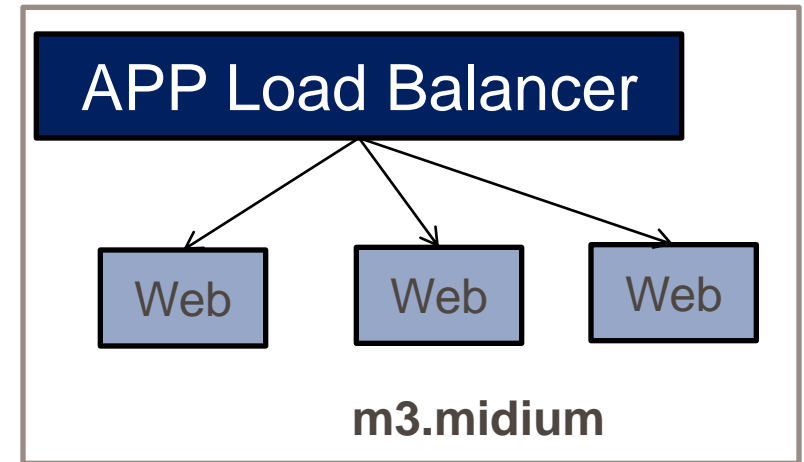
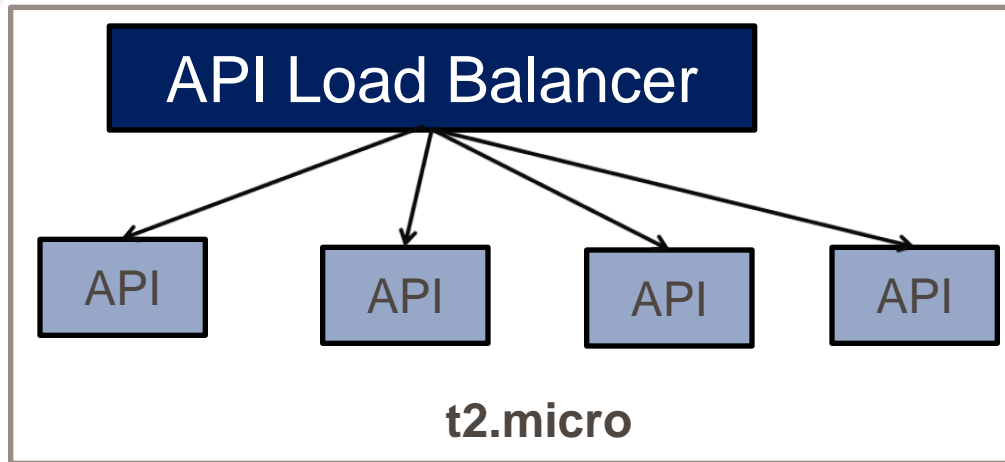
## Shorter development times

- Reliable and faster deployment
- Enables frequent updates
- Decouple the changeable parts
- Security
- Increased uptime
- Fast issue resolution
- Highly scalable and better performance
- Better ownership and knowledge
- Right technology
- Enables distributed teams

# Monolithic Vs MicroServices



## Better Hardware Utilization



# MicroServices Vs SOA

- **Microservices**

- Single distributed System
- Accelerated Realization of Benefits
- Specialization of SOA
- Application Centric
- Business Ambitious

- **SOA**

- Large Distributed System
- Overall Business Transformation
- Large Scope
- Spanning Multiple System
- Enterprise wide changes
- Business Goals

# Design Principles Of MicroServices

**High Cohesion**

**Autonomous**

**Business Domain  
Centric**

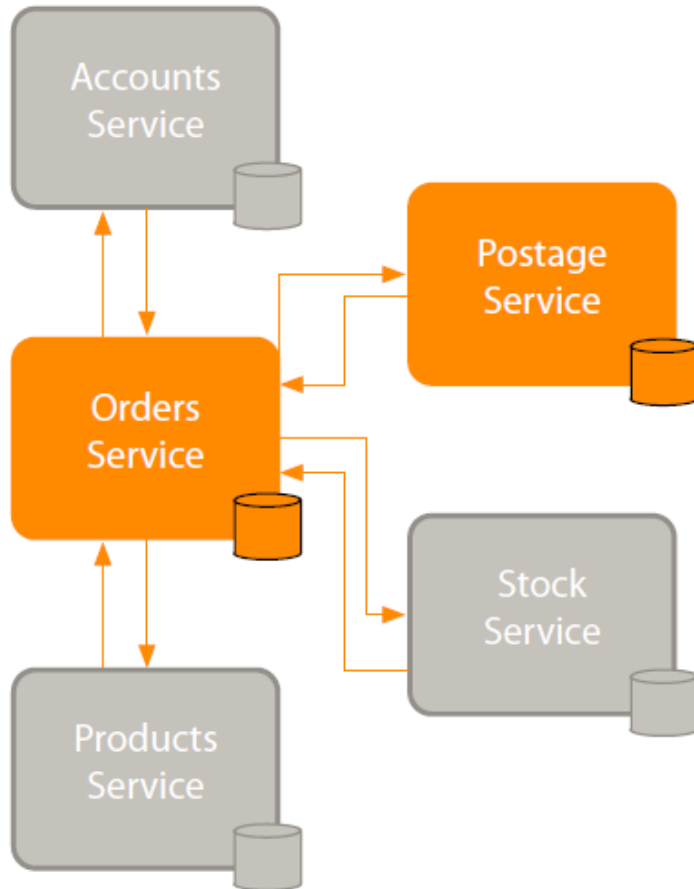
**Resilience**

**Observable**

**Automation**

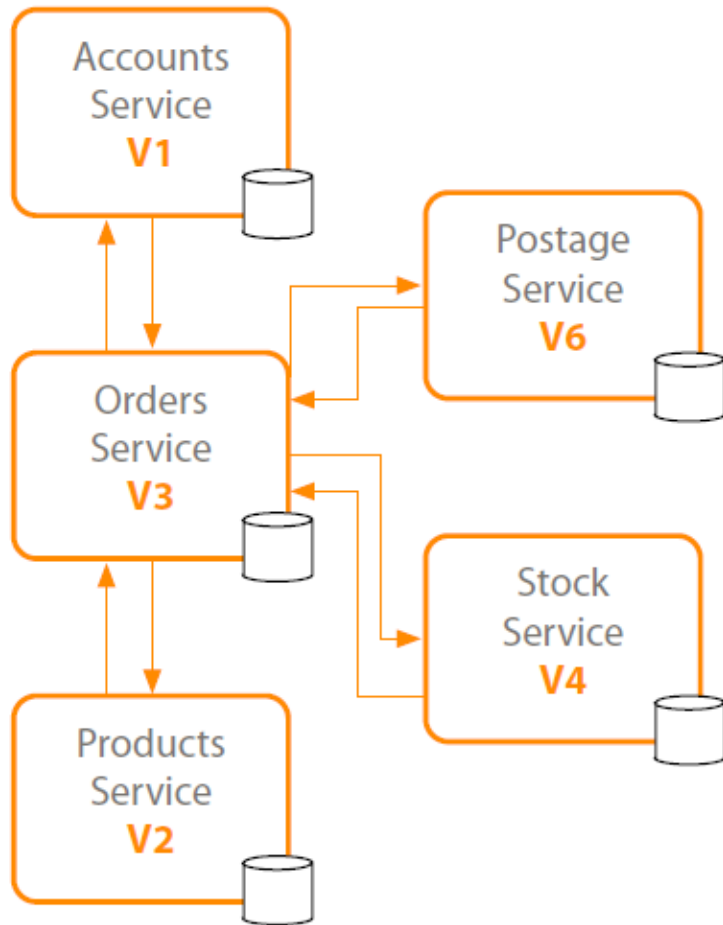


# Design Principles Of MicroServices : High Cohesion



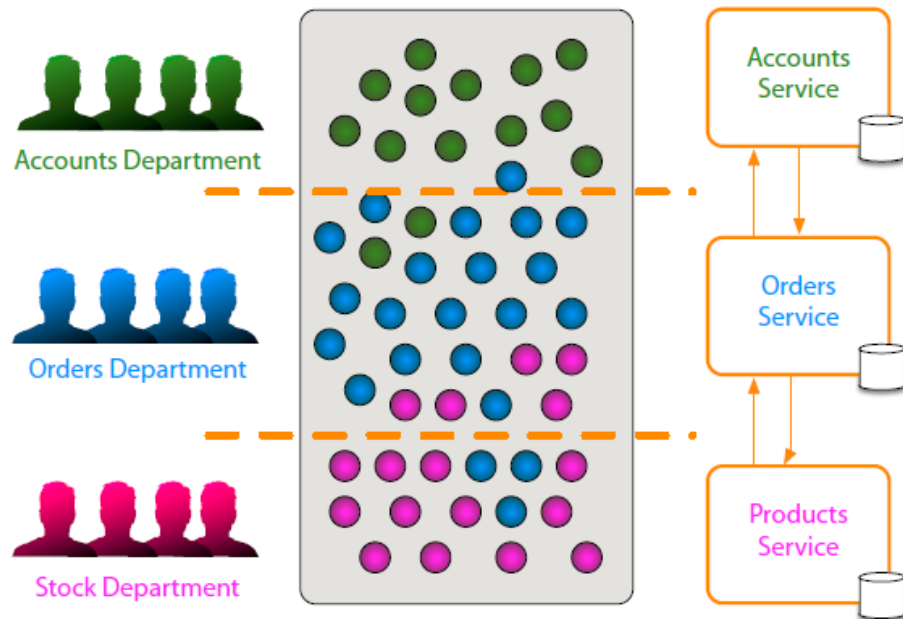
- Single focus
- Single responsibility
  - SOLID principle
  - Only change for one reason
- Reason represents
  - A business function
  - A business domain
- Encapsulation principle
  - OOP principle
- Easily rewritable code
- Why
  - Scalability
  - Flexibility
  - Reliability

# Design Principles Of MicroServices : Autonomous



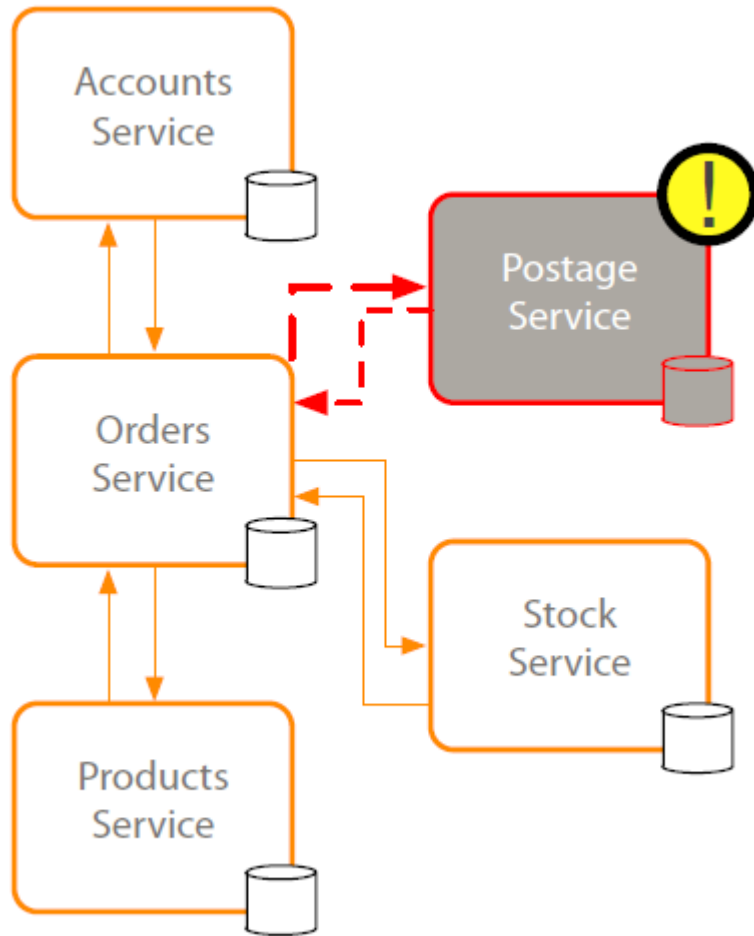
- Loose coupling
- Honor contracts and interfaces
- Stateless
- Independently changeable
- Independently deployable
- Backwards compatible
- Concurrent development

# Design Principles Of MicroServices : Business Domain Centric



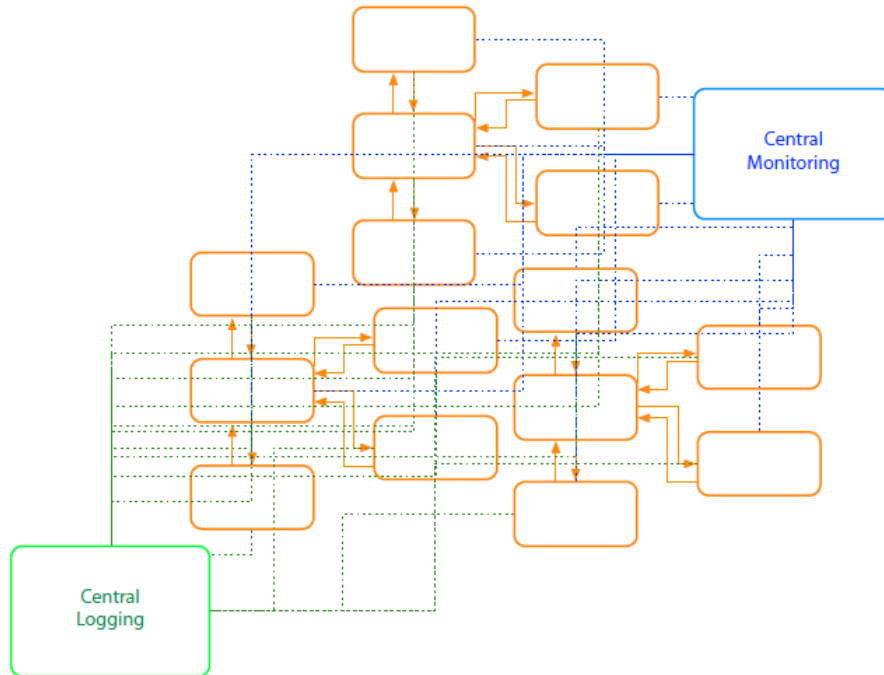
- Service represents business function
  - Accounts Department
  - Postage calculator
- Scope of service
- Bounded context from DDD
- Identify boundaries\seams
- Shuffle code if required
  - Group related code into a service
  - Aim for high cohesion
- Responsive to business change

# Design Principles Of MicroServices : Resilience



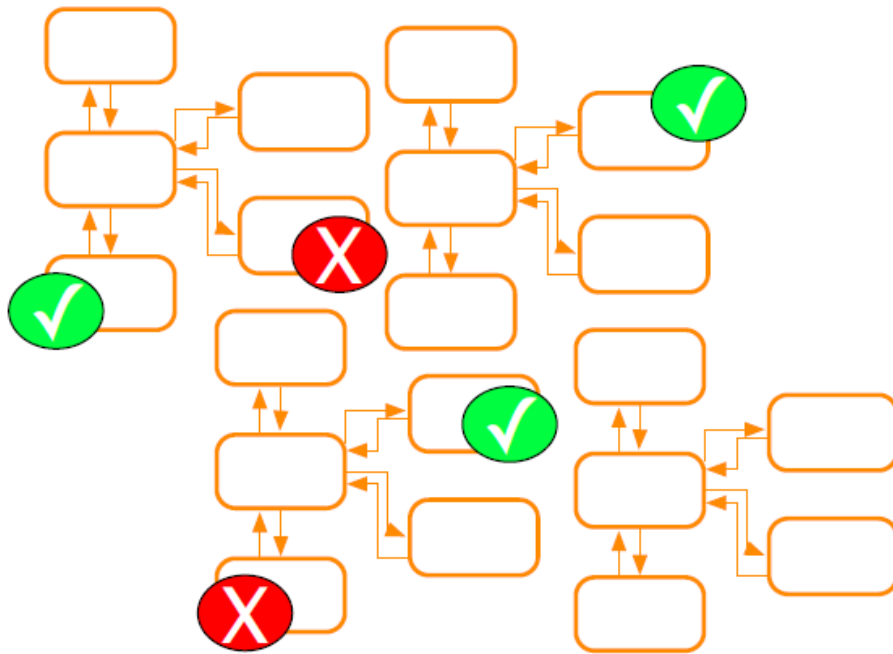
- Embrace failure
  - Another service
  - Specific connection
  - Third-party system
- Degrade functionality
- Default functionality
- Multiple instances
  - Register on startup
  - Deregister on failure
- Types of failure
  - Exceptions\Errors
  - Delays
  - Unavailability
- Network issues
  - Delay
  - Unavailability
- Validate input
  - Service to service
  - Client to service

# Design Principles Of MicroServices : Observable



- System Health
  - Status
  - Logs
  - Errors
- Centralized monitoring
- Centralized logging
- Why
  - Distributed transactions
  - Quick problem solving
  - Quick deployment requires feedback
  - Data used for capacity planning
  - Data used for scaling
  - Whats actually used
  - Monitor business data

# Design Principles Of MicroServices : Automation

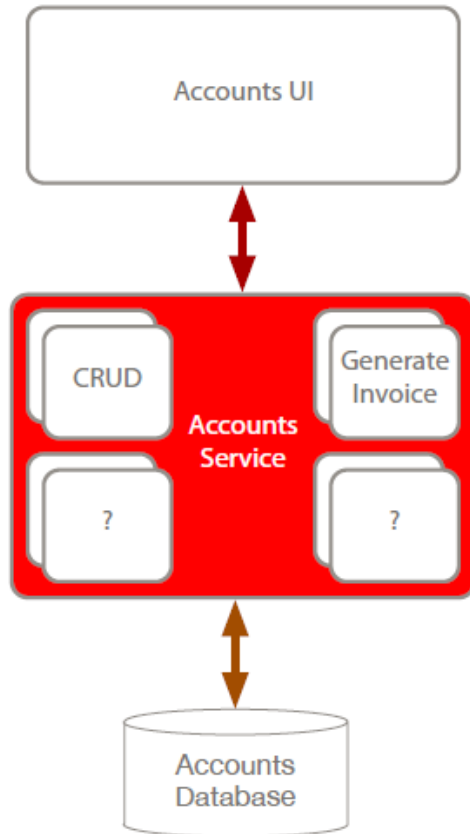


- Tools to reduce testing
  - Manual regression testing
  - Time taken on testing integration
  - Environment setup for testing
- Tools to provide quick feedback
  - Integration feedback on check in
  - Continuous Integration
- Tools to provide quick deployment
  - Pipeline to deployment
  - Deployment ready status
  - Automated deployment
  - Reliable deployment
  - Continuous Deployment
- Why
  - Distributed system
  - Multiple instances of services
  - Manual integration testing too time consuming
  - Manual deployment time consuming and unreliable



# Approaches of MicroServices

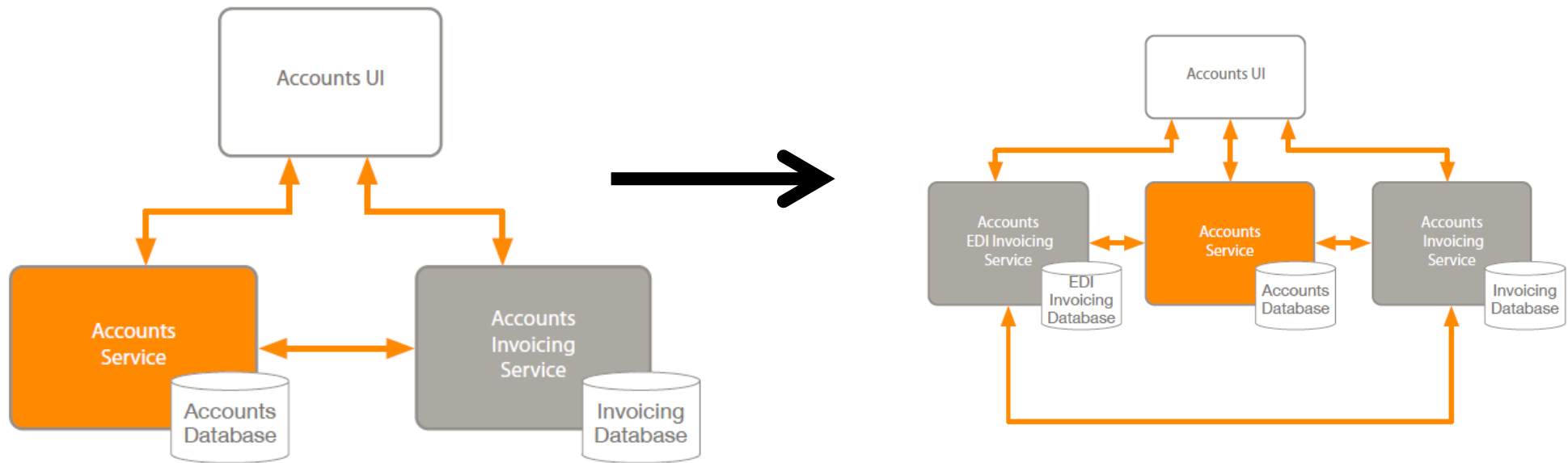
# Approach: High Cohesion



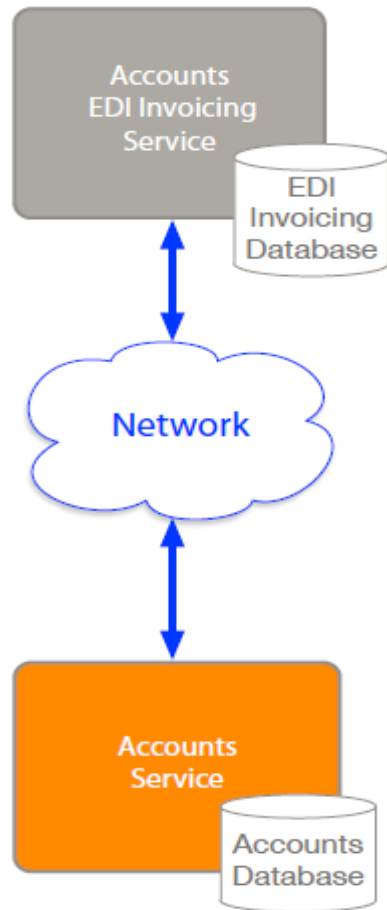
- Identify a single focus
  - Business function
  - Business domain
- Split into finer grained services
- Avoid “Is kind of the same”
- Open to create many Services
- Question in code\peer reviews
  - Can this change for more than one reason



# Approach: High Cohesion

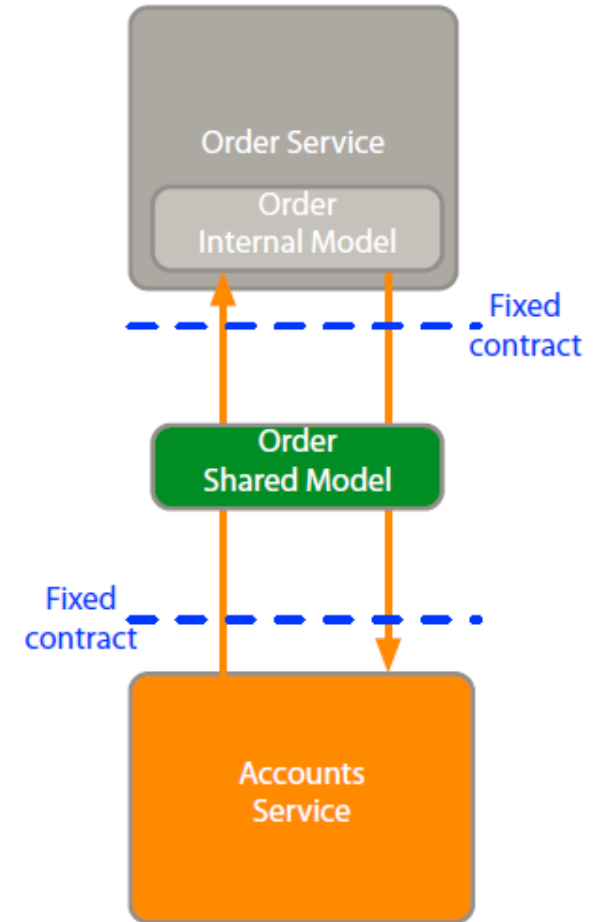
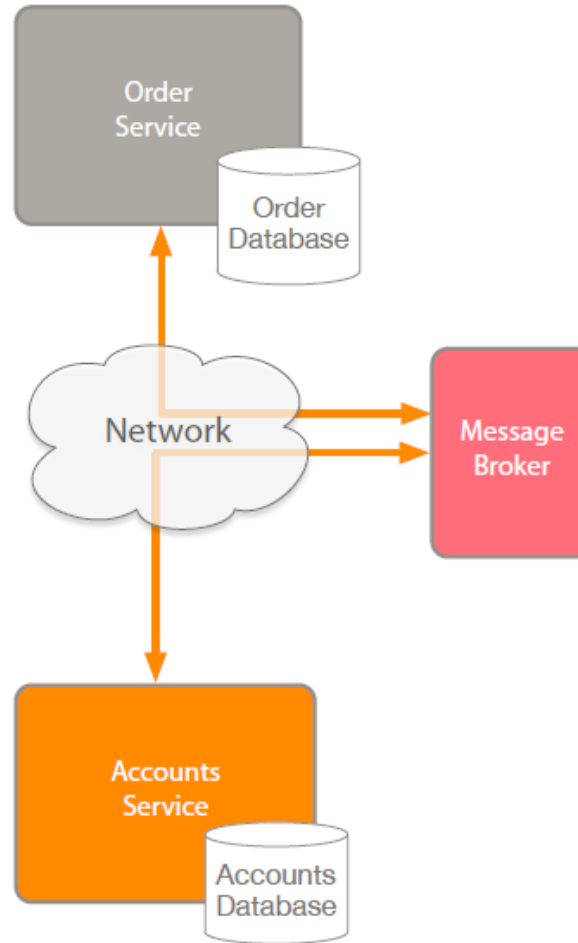
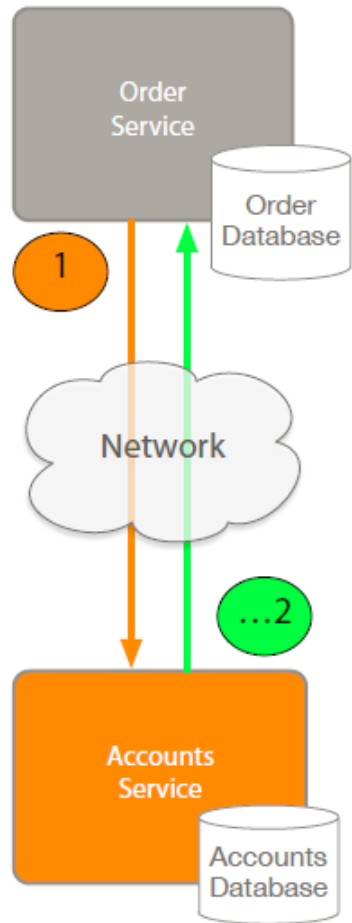


# Approach: Autonomous

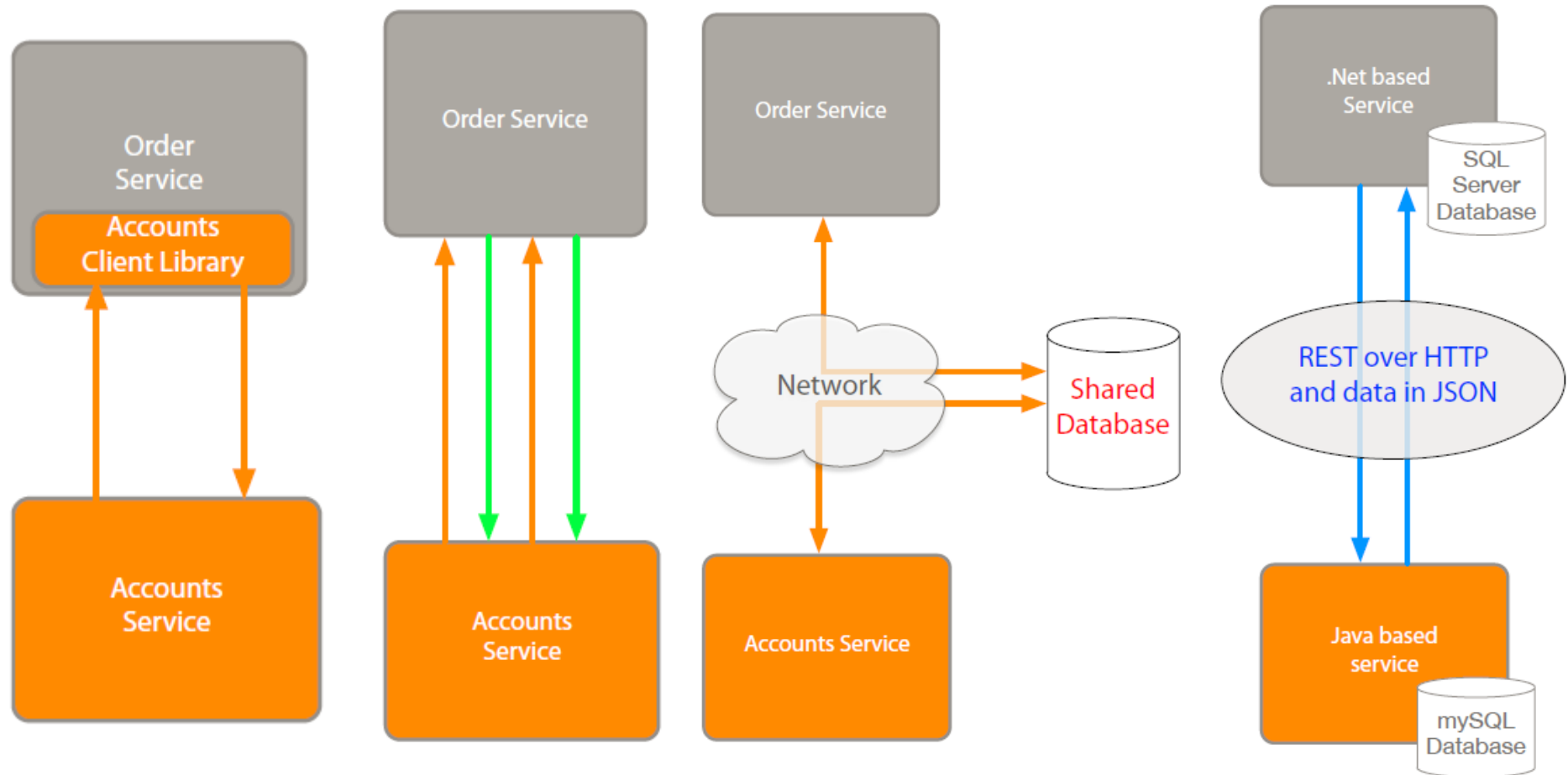


- Loosely coupled
  - Communication by network
    - Synchronous
    - Asynchronous
      - Publish events
      - Subscribe to events
- Technology agnostic API
- Avoid client libraries
- Contracts between services
  - Fixed and agreed interfaces
  - Shared models
  - Clear input and output
- Avoid chatty exchanges between services
- Avoid sharing between services
  - Databases
  - Shared libraries

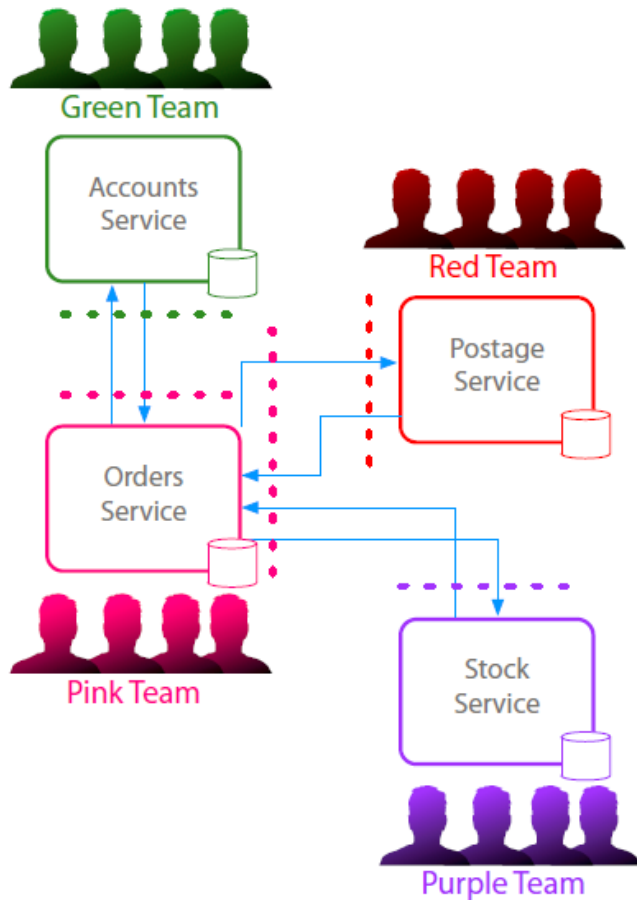
# Approach: Autonomous



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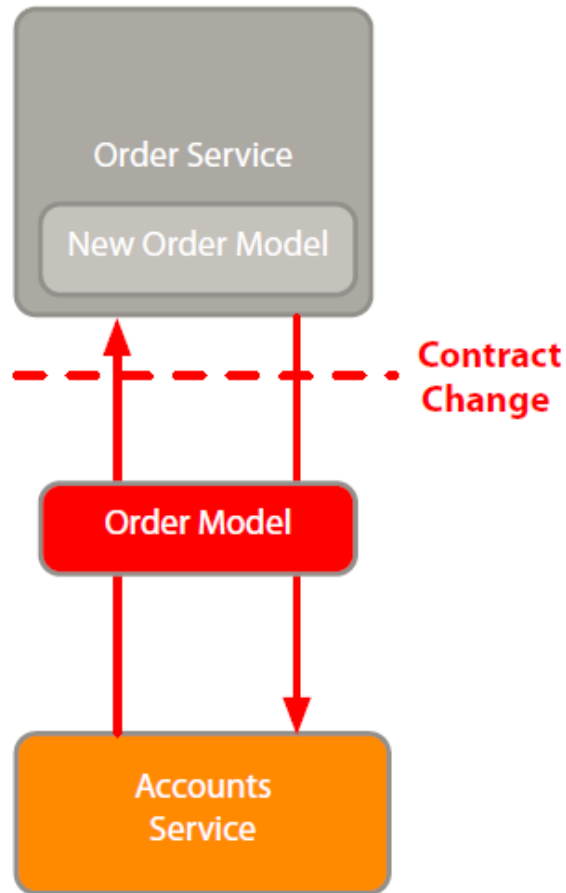


# Approach: Autonomous



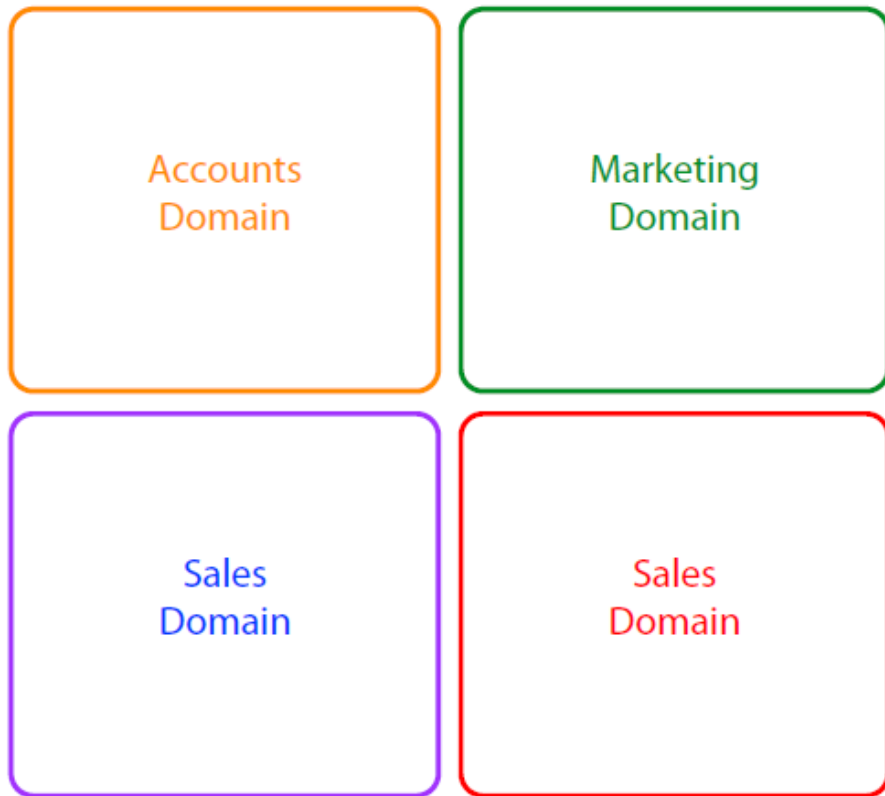
- •Microservice ownership by team
  - Responsibility to make autonomous
  - Agreeing contracts between teams
  - Responsible for long-term maintenance
  - Collaborative development
    - Communicate contract requirements
    - Communicate data requirements
  - Concurrent development

# Approach: Autonomous



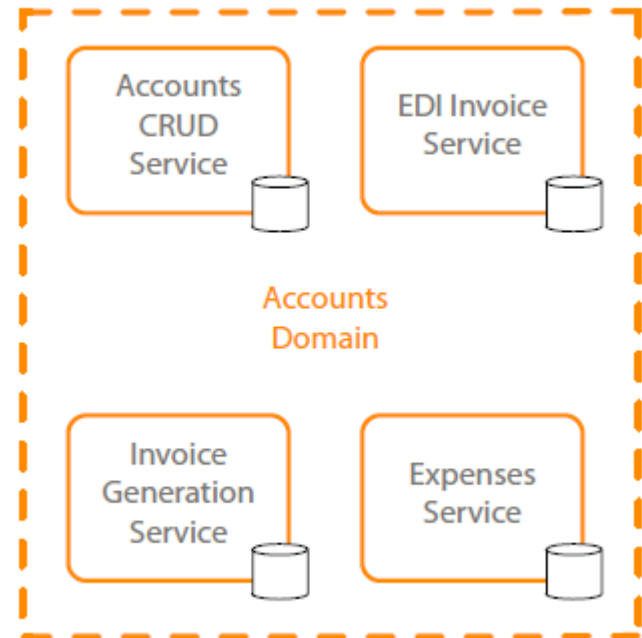
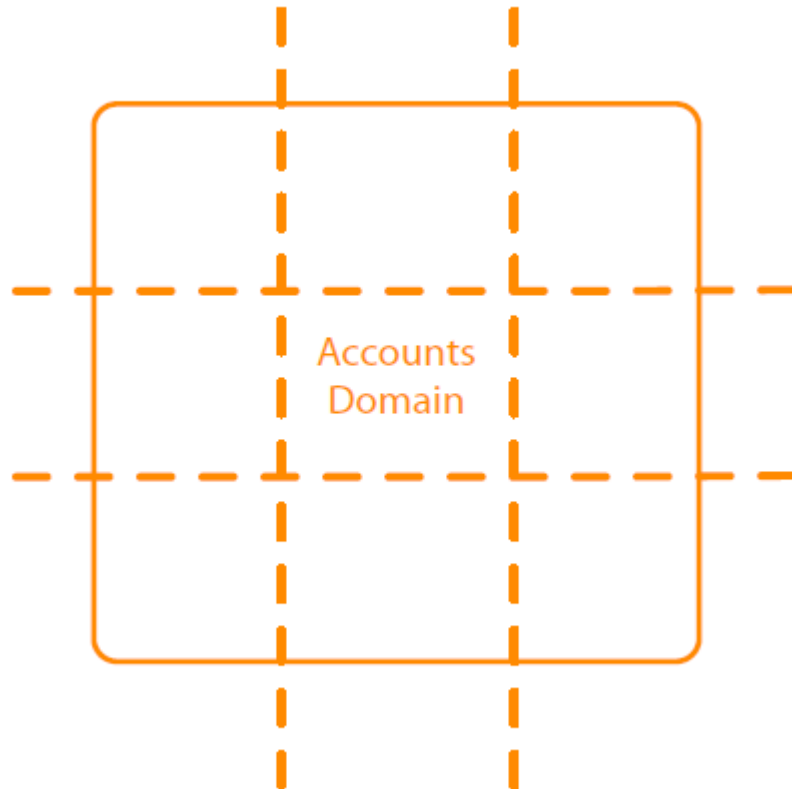
- Versioning
  - Avoid breaking changes
  - Backwards compatibility
  - Integration tests
  - Have a versioning strategy
    - Concurrent versions
    - Old and new
    - Semantic versioning
    - Major.Minor.Patch (e.g. 15.1.2)
    - Coexisting endpoints
    - /V2/customer/

# Approach: Business Domain Centric



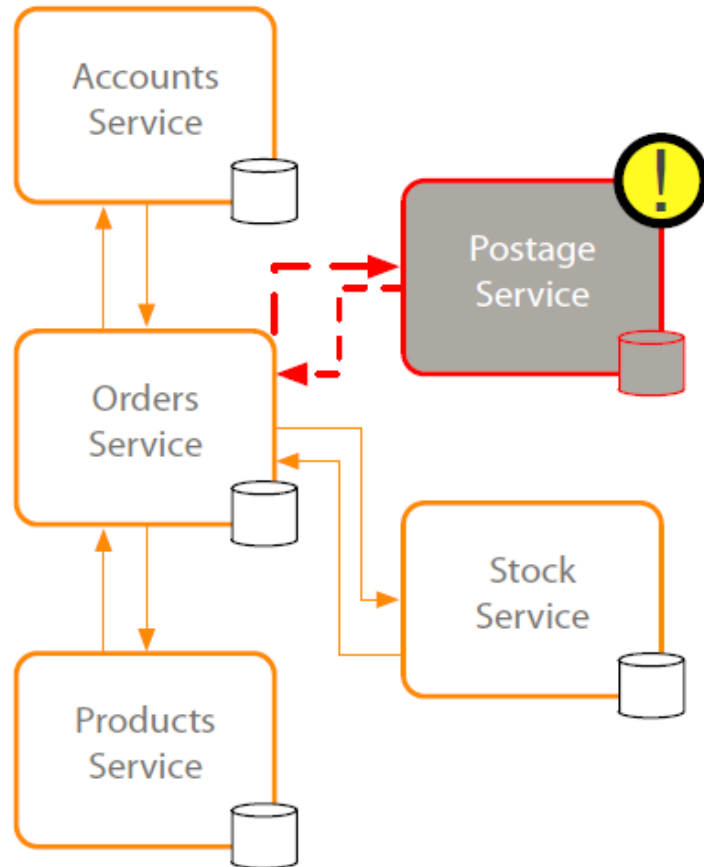
- Business function or business domain approach
  - Identify business domains in a coarse manner
  - Review sub groups of business functions or areas
  - Review benefits of splitting further
  - Agree a common language
- Microservices for data (CRUD) or functions
- Fix incorrect boundaries
  - Merge or split
- •Explicit interfaces for outside world
- •Splitting using technical boundaries
  - Service to access archive data
  - For performance tuning

# Approach: Business Domain Centric



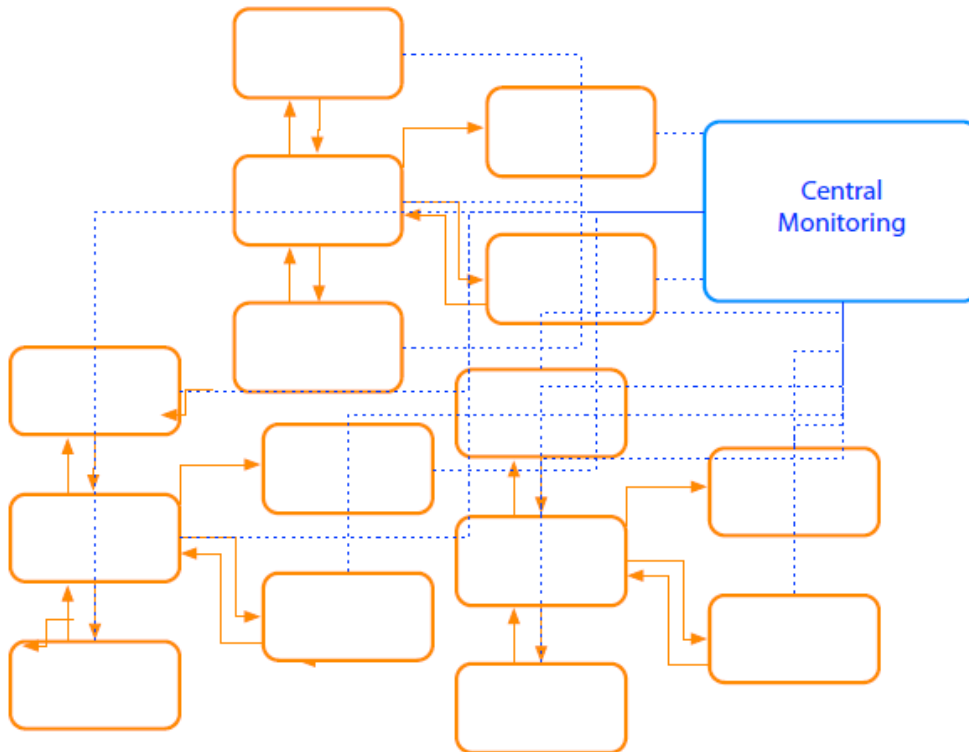


# Approach: Resilience



- Design for known failures
- Failure of downstream systems
  - Other services internal or external
- Degrade functionality on failure detection
- Default functionality on failure detection
- Design system to fail fast
- Use timeouts
  - Use for connected systems
  - Timeout our requests after a threshold
  - Service to service
  - Service to other systems
  - Standard timeout length
  - Adjust length on a case by case basis
- Network outages and latency
- Monitor timeouts
- Log timeouts

# Approach: Observable



- Centralized monitoring

- Real-time monitoring

Monitor the host

- CPU, memory, disk usage, etc.

Expose metrics within the services

- Response times
    - Timeouts
    - Exceptions and errors

Business data related metrics

- Number of orders
    - Average time from basket to checkout

Collect and aggregate monitoring data

- Monitoring tools that provide aggregation
    - Monitoring tools that provide drill down options

- Monitoring tool that can help visualise trends

- Monitoring tool that can compare data across servers

- Monitoring tool that can trigger alerts

# Approach: Observable

## ■ Centralized Logging

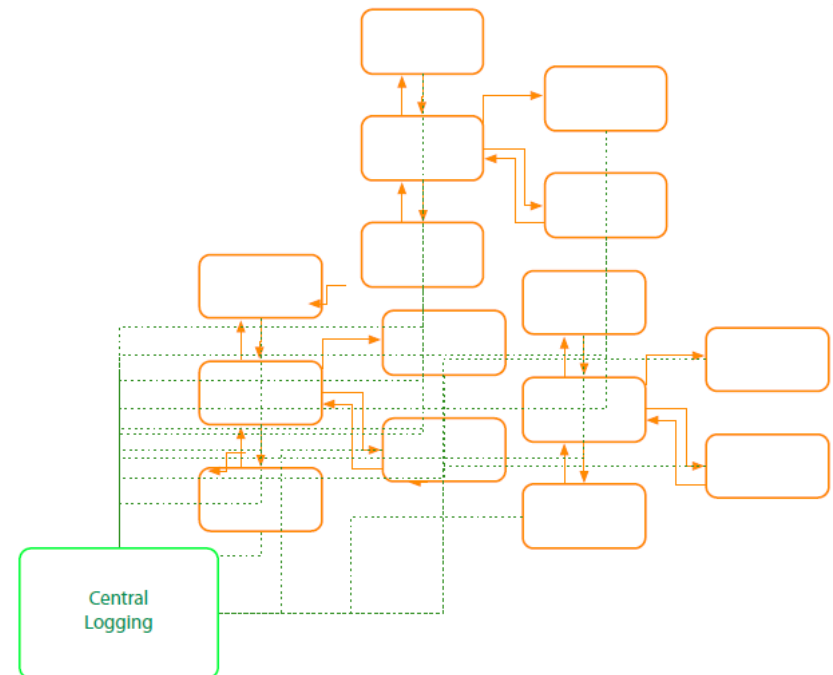
- When to log
  - Startup or shutdown
  - Code path milestones
    - Requests, responses and decisions
  - Timeouts, exceptions and errors

## ■ Structured logging

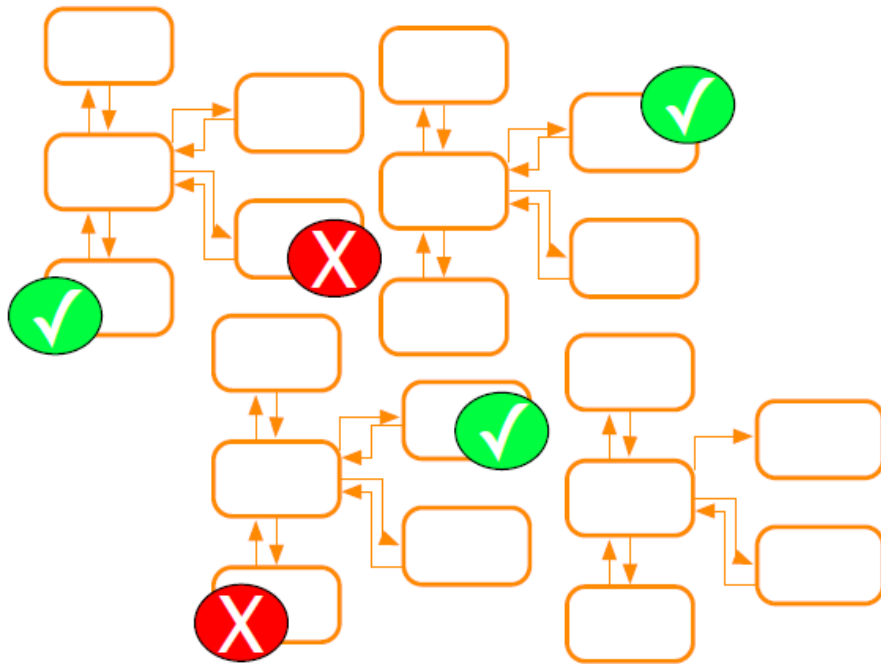
- Level
  - Information
  - Error
  - Debug
  - Statistic
- Date and time
- Correlation ID
- Host name
- Service name and service instance
- Message

## • Traceable distributed transactions

- Correlation ID
- Passed service to service



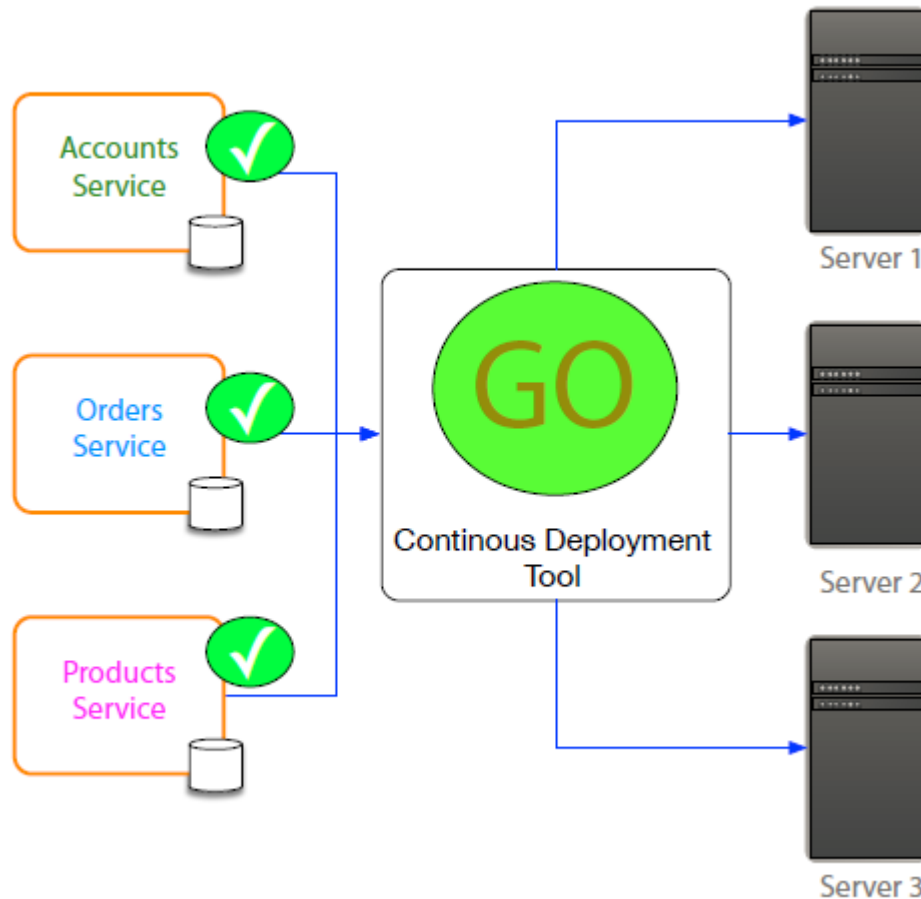
# Approach: Automation



## ■ Continuous Integration Tools

- Work with source control systems
- Automatic after check-in
- Unit tests and integration tests required
- Ensure quality of check-in
  - Code compiles
  - Tests pass
  - Changes integrate
  - Quick feedback
- Urgency to fix quickly
- Creation of build
- Build ready for test team
- Build ready for deployment

# Approach: Automation



## ■ Continuous Deployment Tools

- Automate software deployment
  - Configure once
  - Works with CI tools
  - Deployable after check in
  - Reliably released at anytime
- Benefits
  - Quick to market
  - Reliable deployment
  - Better customer experience

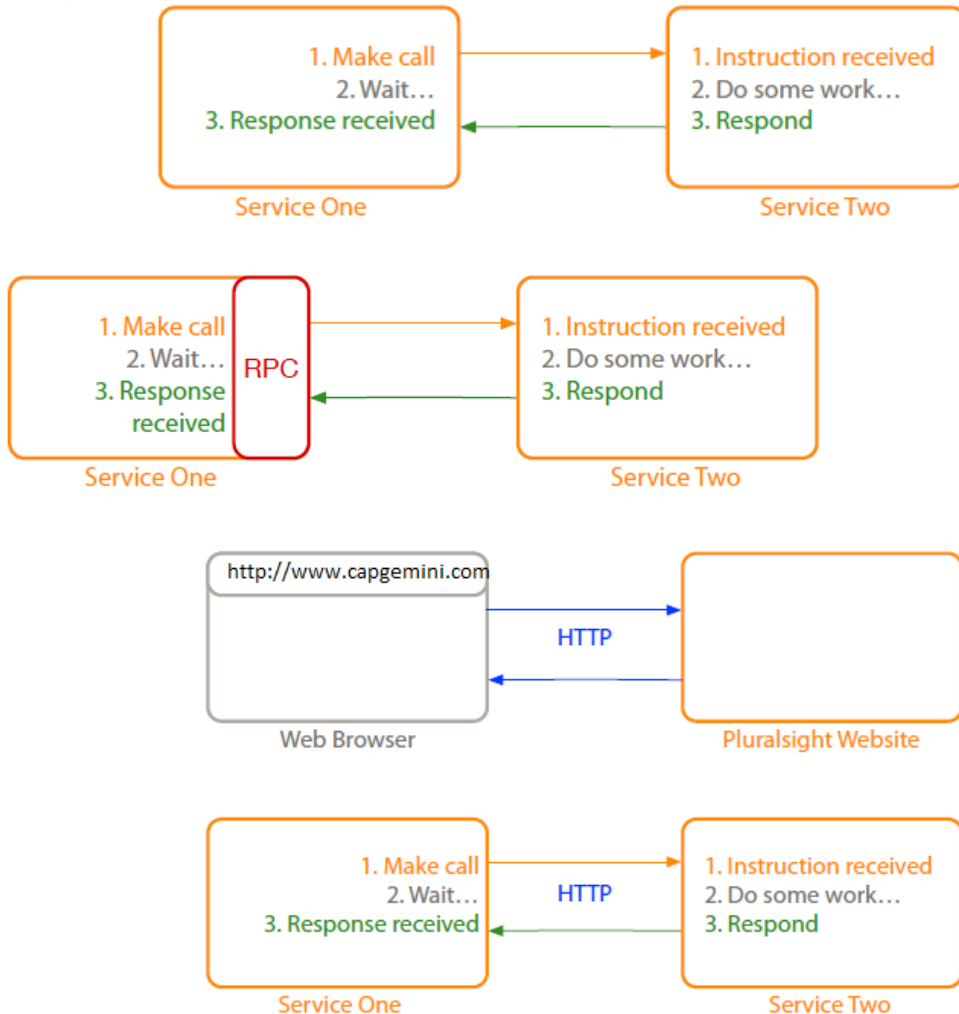


# Technology for Microservices

# Technology for Microservices

- Communication
  - Synchronous | Asynchronous
- Hosting Platforms
- Observable Microservices
- Performance
- Automation Tools

# Communication: Synchronous



## Request response communication

- Client to service
- Service to service
- Service to external

## Remote procedure call

- Sensitive to change

## HTTP

- Work across the internet
- Firewall friendly

## REST

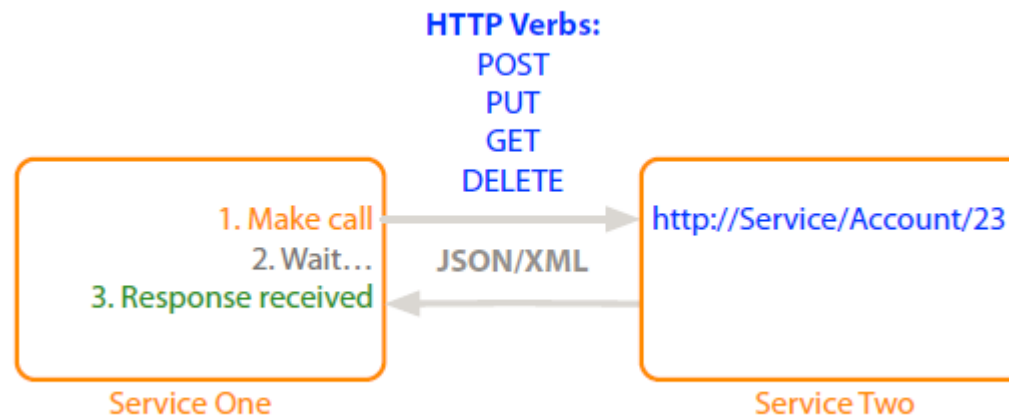
- CRUD using HTTP verbs
- Natural decoupling
- Open communication protocol
- REST with HATEOS

## Synchronous issues

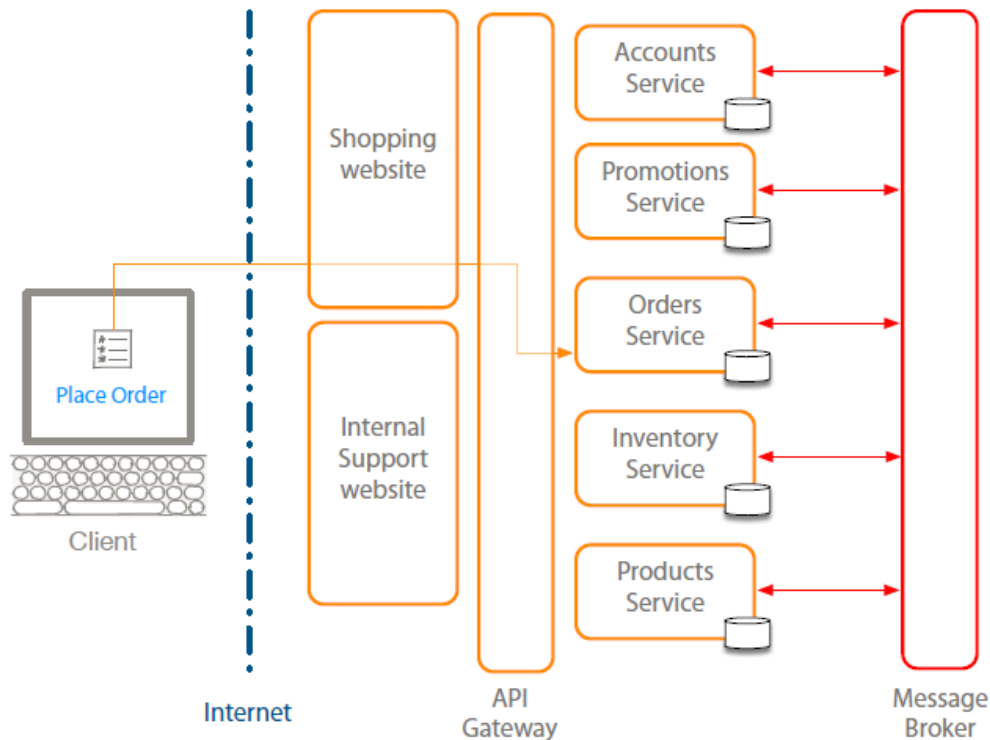
- Both parties have to be available
- Performance subject to network quality
- Clients must know location of service (host\port)



# Communication: Synchronous

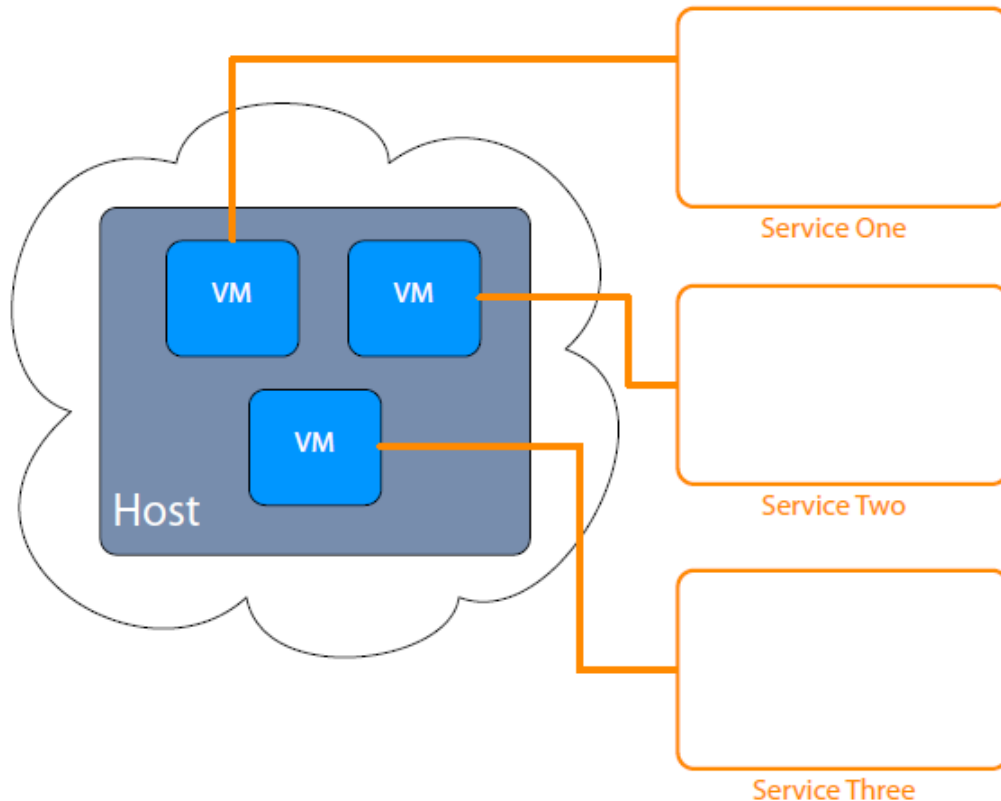


# Communication: Asynchronous



- **Event based**
  - Mitigates the need of client and service availability
  - Decouples client and service
- **Message queuing protocol**
  - Message Brokers
  - Subscriber and publisher are decoupled
  - Microsoft message queuing (MSMQ)
  - **RabbitMQ**
  - ATOM (HTTP to propagate events)
- **Asynchronous challenge**
  - Complicated
  - Reliance on message broker
  - Visibility of the transaction
  - Managing the messaging queue
- **Real world systems**
  - Would use both synchronous and asynchronous

# Hosting Platforms - Virtualization



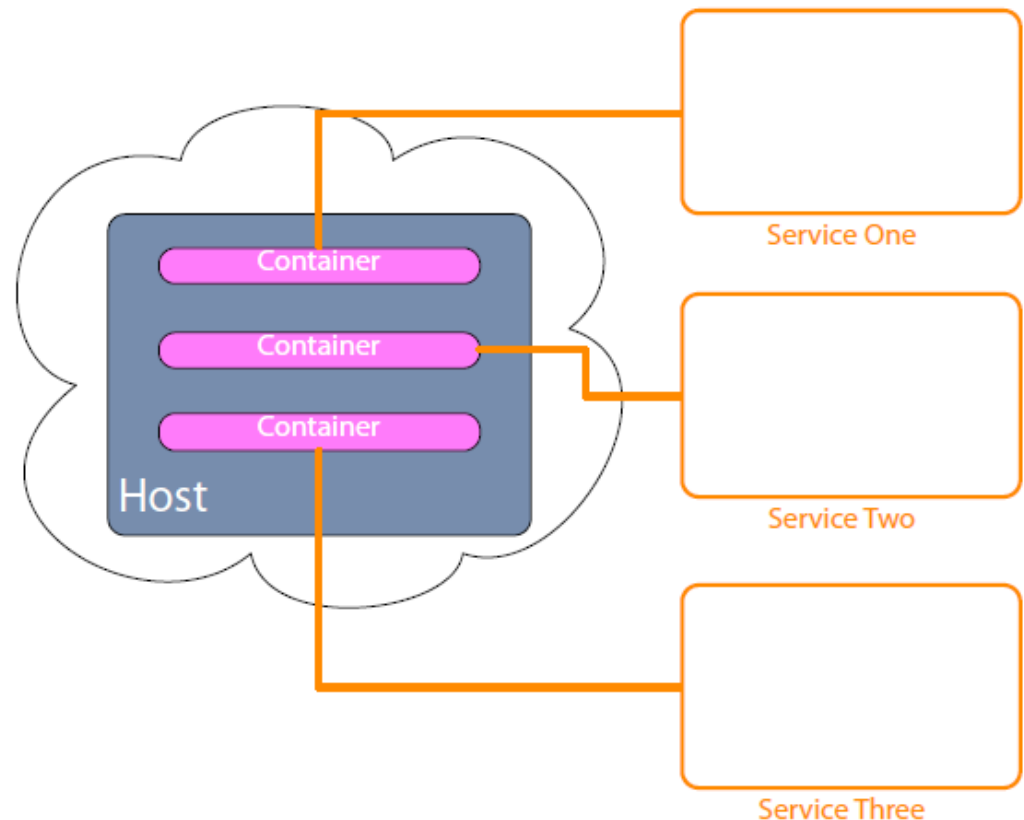
- **A virtual machine as a host**
- **Foundation of cloud platforms**
  - Platform as a service (PAAS)
    - Microsoft Azure
    - Amazon web services
    - Your own cloud (for example vSphere)
- **Could be more efficient**
  - Takes time to setup
  - Takes time to load
  - Take quite a bit of resource
- **Unique features**
  - Take snapshot
  - Clone instances
- **Standardized and mature**

# Hosting Platforms: Containers

## Examples

Docker  
Rocker  
Glassware

- **Type of virtualization**
- **Isolate services from each other**
- **Single service per container**
- **Different to a virtual machine**
  - Use less resource than VM
  - Faster than VM
  - Quicker to create new instances
- **Future of hosted apps**
- **Cloud platform support growing**
- **Mainly Linux based**
- **Not as established as virtual machines**
  - Not standardised
  - Limited features and tooling
  - Infrastructure support in its infancy
  - Complex to setup

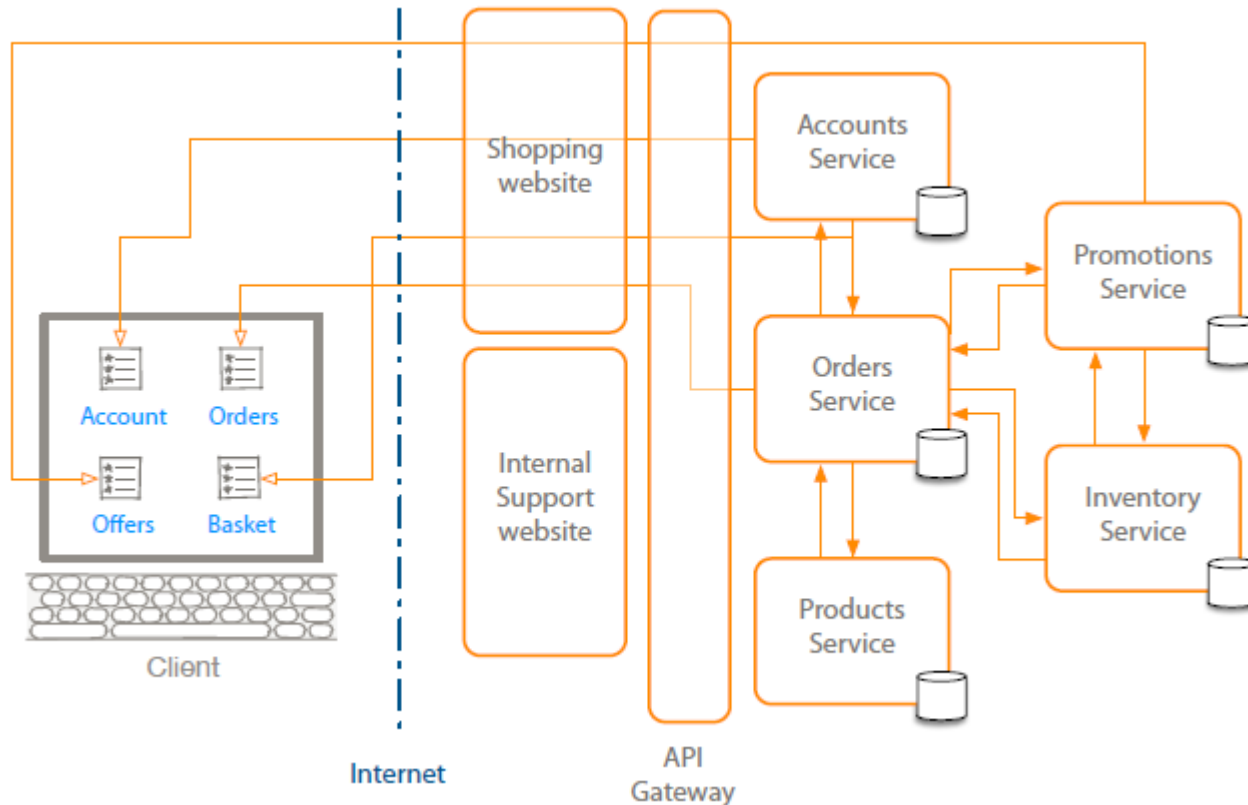


# Hosting Platforms: Self Hosting



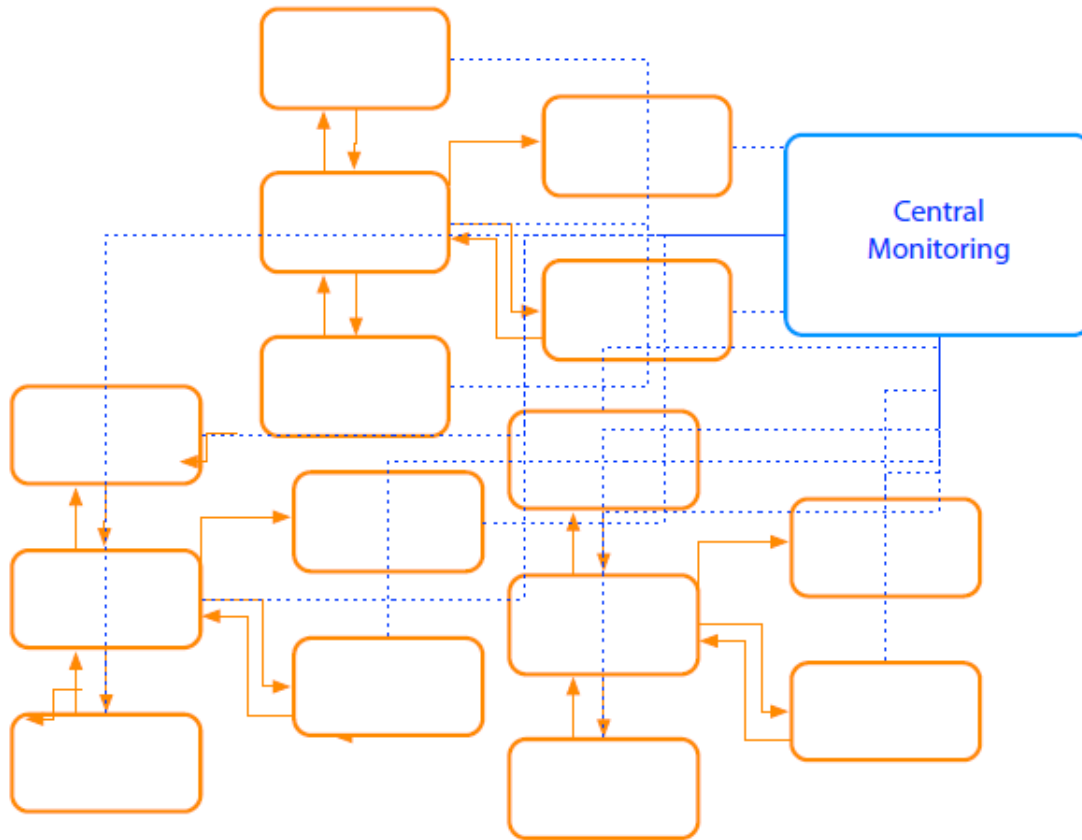
- **Implement your own cloud**
  - Virtualization platform
  - Implement containers
- **Use of physical machines**
  - Single service on a server
  - Multiple services on a server
- **Challenges**
  - Long-term maintenance
  - Need for technicians
  - Training
  - Need for space
  - Scaling is not as immediate

# Hosting Platforms: Registration and Discovery



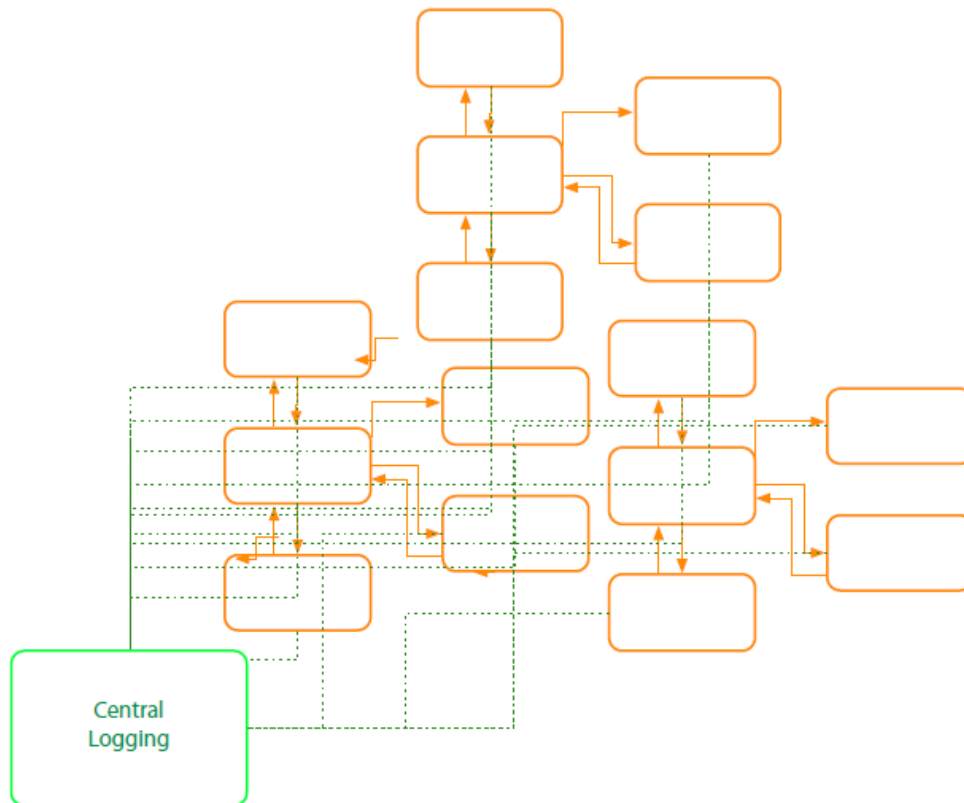
- Where?
  - Host, port and version
- Service registry database
- Register on startup
- Deregister service on failure
- Cloud platforms make it easy
- Local platform registration options
  - Self registration
  - Third-party registration
- Local platform discovery options
  - Client-side discovery
  - Server-side discovery

# Observable Microservices: Monitoring Tech



- Centralized tools
  - Nagios
  - PRTG
  - Load balancers
  - New Relic
- Desired features
  - Metrics across servers
  - Automatic or minimal configuration
  - Client libraries to send metrics
  - Test transactions support
  - Alerting
- Network monitoring
- Standardize monitoring
  - Central tool
  - Preconfigured virtual machines or containers
- Real-time monitoring

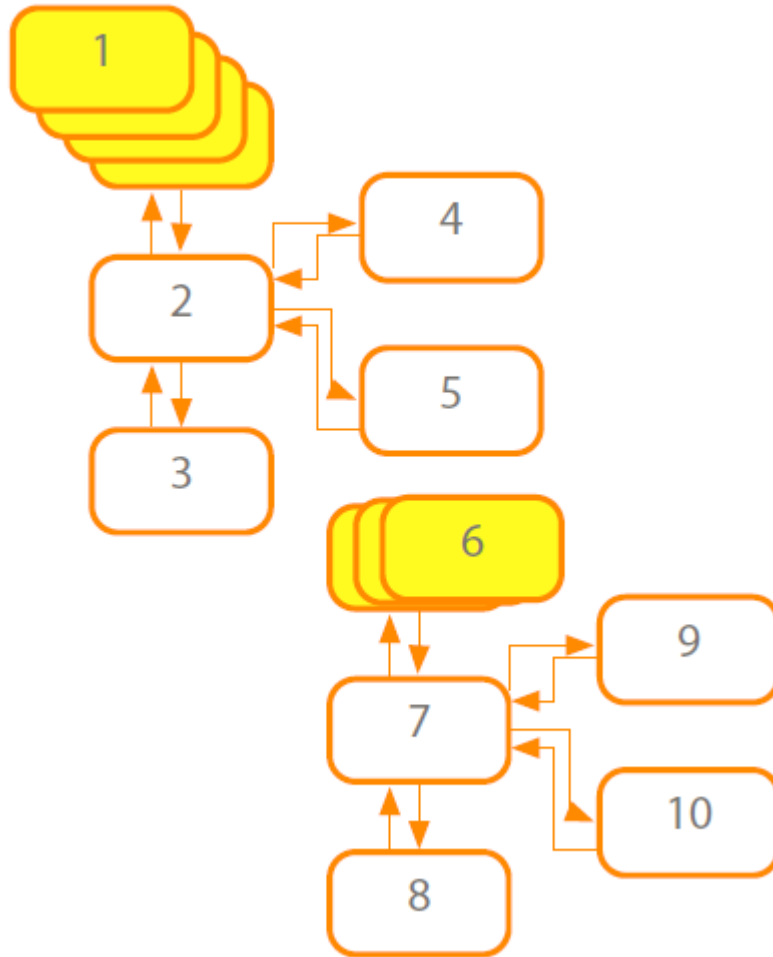
# Observable Microservices: Logging Tech



- **Portal for centralized logging data**
  - Elastic log
  - Log stash
  - Splunk
  - Kibana
  - Graphite
- **Client logging libraries**
  - Serilog and many more...
- **Desired features**
  - Structured logging
  - Logging across servers
  - Automatic or minimal configuration
  - Correlation\Context ID for transactions
- **Standardize logging**
  - Central tool
  - Template for client library

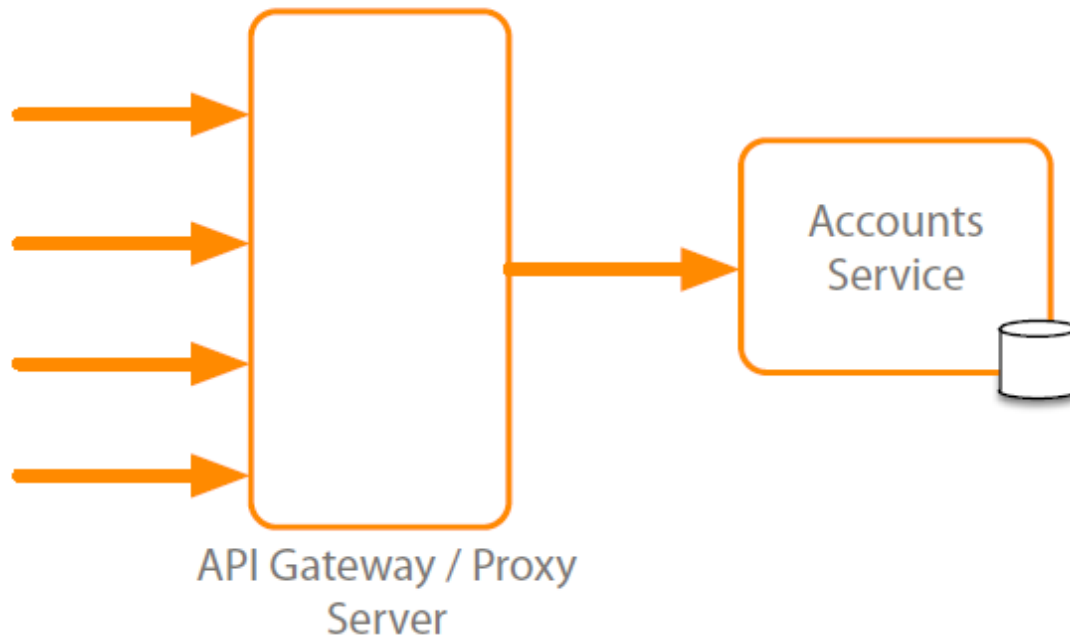


# Microservices Performance: Scaling



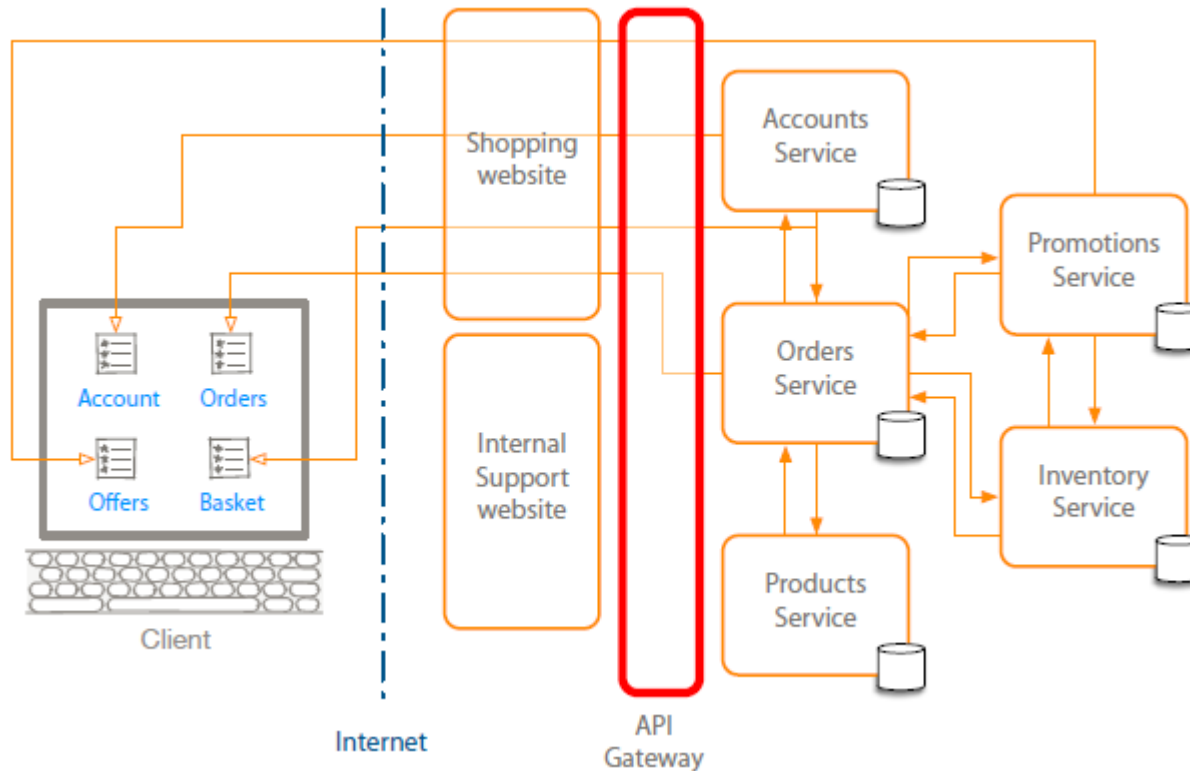
- **How**
  - Creating multiple instances of service
  - Adding resource to existing service
- **Automated or on-demand**
- **PAAS auto scaling options**
- **Virtualization and containers**
- **Physical host servers**
- **Load balancers**
  - API Gateway
- **When to scale up**
  - Performance issues
  - Monitoring data
  - Capacity planning

# Microservices Performance: Caching



- **Caching to reduce**
  - Client calls to services
  - Service calls to databases
  - Service to service calls
- **API Gateway\Proxy level**
- **Client side**
- **Service level**
- **Considerations**
  - Simple to setup and manage
  - Data leaks

# Microservices Performance: API Gateway



## ■ Help with performance

- Load balancing
- Caching

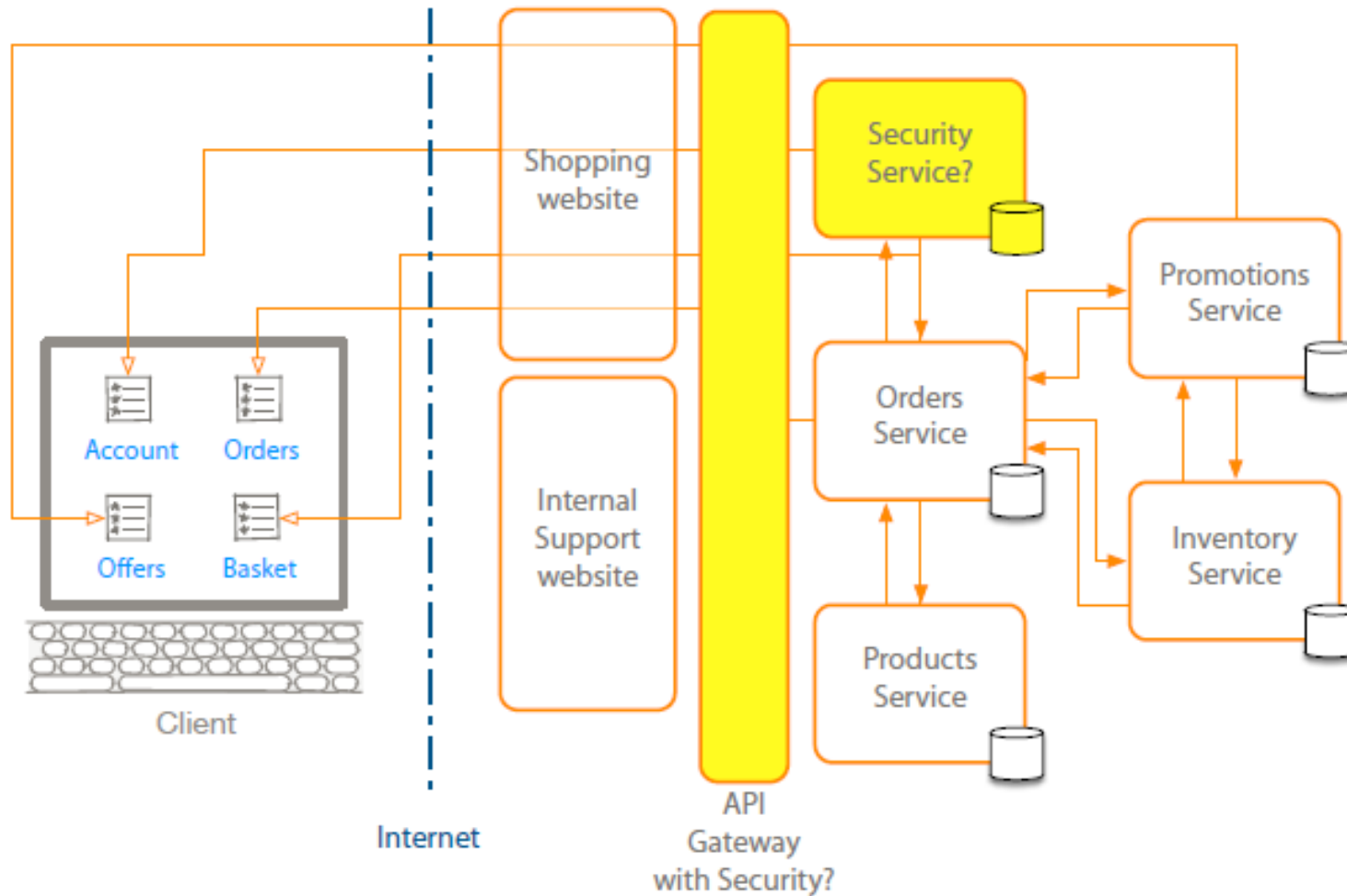
## Help with

- Creating central entry point
- Exposing services to clients
- One interface to many services
- Dynamic location of services
- Routing to specific instance of service
- Service registry database

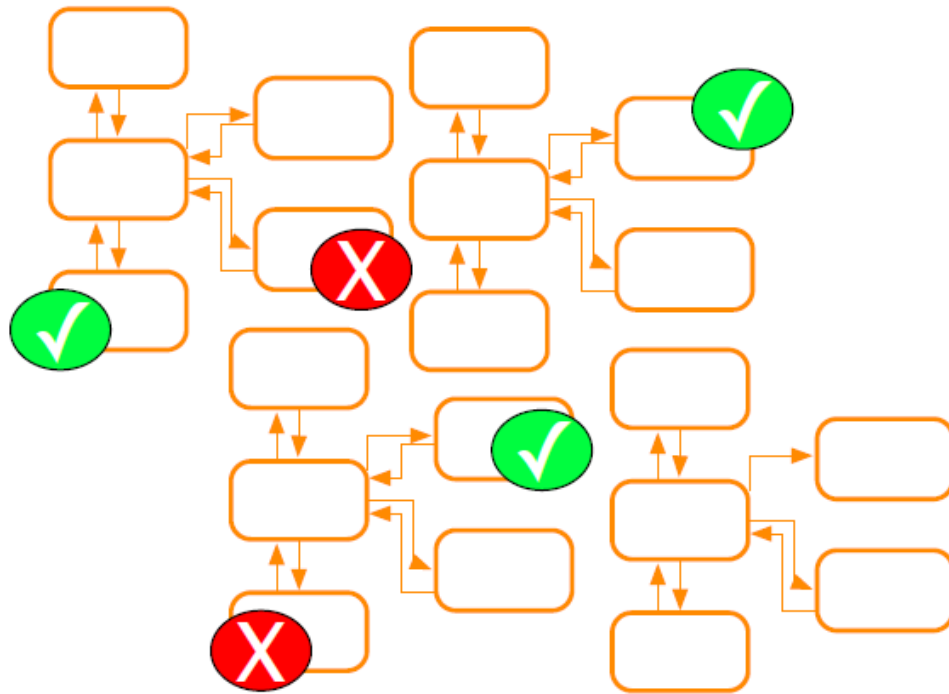
## Security

- API Gateway
- Dedicated security service
- Central security vs service level

# Microservices Performance: API Gateway



# Automation Tools: Continuous Integration



- **Many CI tools**

- Team Foundation Server
- TeamCity and Many more!

- **Desired features**

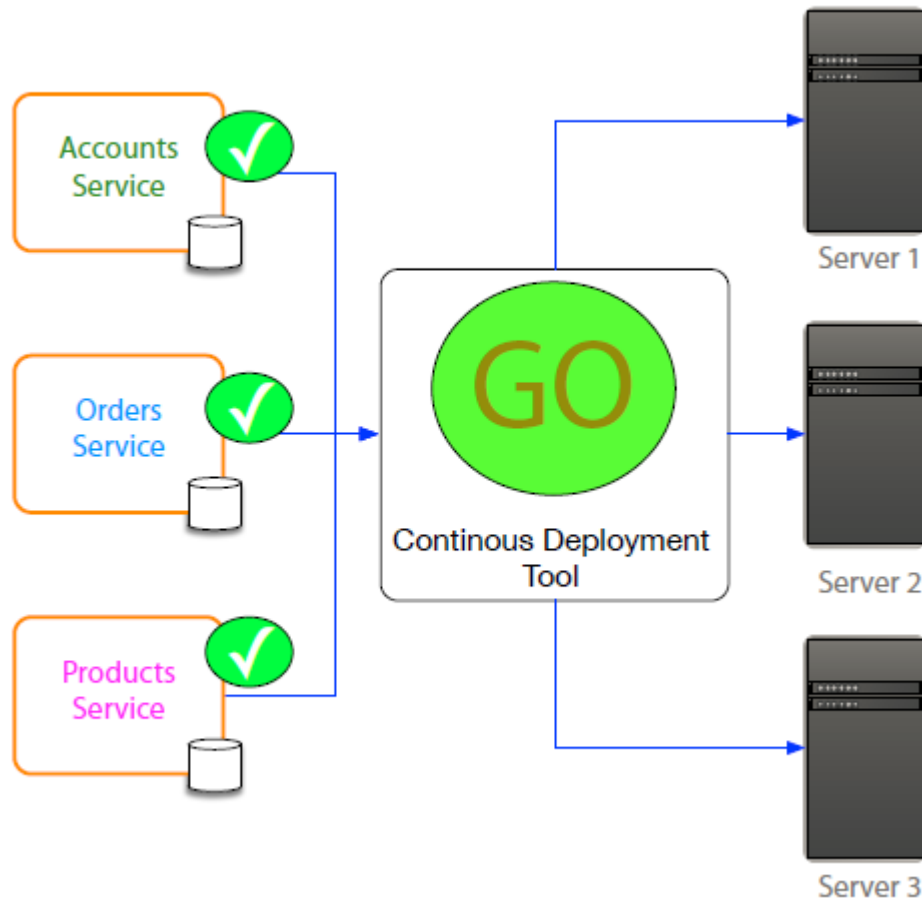
- Cross platform
  - Windows builders, Java builders and others
- Source control integration
- Notifications
- IDE Integration (optional)

- **Map a microservice to a CI build**

- Code change triggers build of specific service
- Feedback just received on that service
- Builds and tests run quicker
- Separate code repository for service
- End product is in one place
- CI builds to test database changes
- Both microservice build and database upgrade are ready

- **Avoid one CI build for all services**

# Automation Tools: Continuous Deployment



- **Many CD tools**
  - Aim for cross platform tools
- **Desired features**
  - Central control panel
  - Simple to add deployment targets
  - Support for scripting
  - Support for build statuses
  - Integration with CI tool
  - Support for multiple environments
  - Support for PAAS

# Moving Forwards with MicroServices

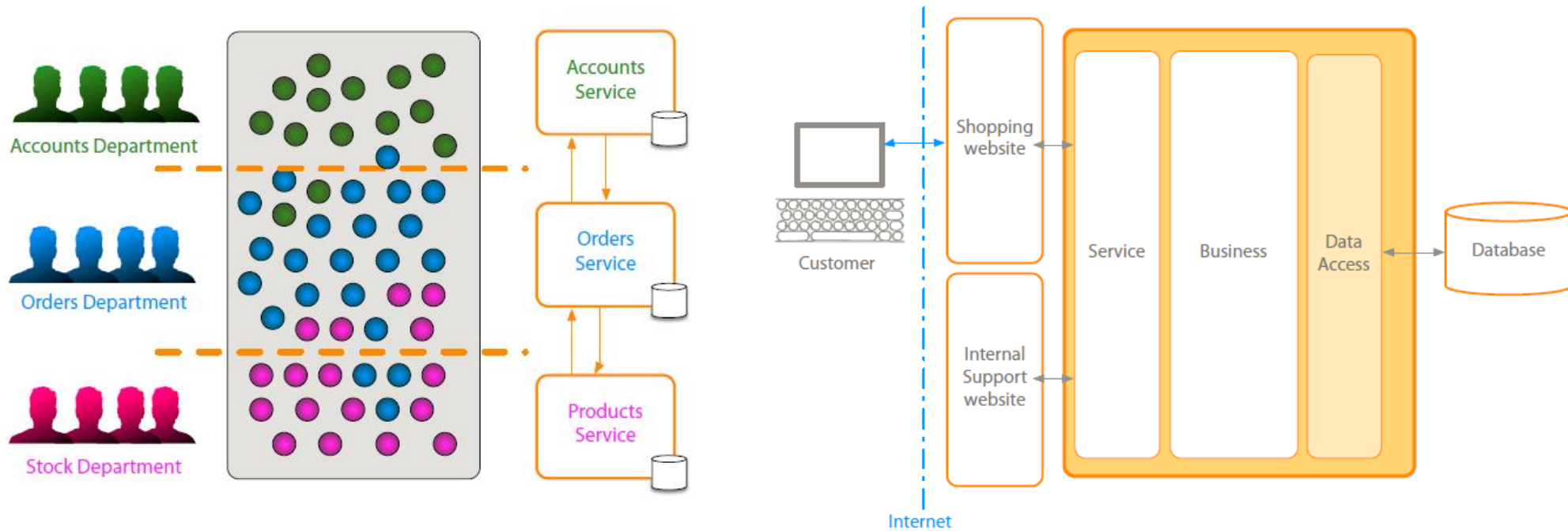
- Brownfield Microservices
  - Approach
  - Migration
  - Database Migration
  - Transactions
  - Reporting
- Greenfield Microservices
- Microservices Provisos

# Brownfield Microservices: Approach

- **Existing system**
  - Monolithic system
  - Organically grown
  - Seems too large to split
- **Lacks microservices design principles**
- **Identify seams**
  - Separation that reflects domains
  - Identify bounded contexts
- **Start modularising the bounded contexts**
  - Move code incrementally
  - Tidy up a section per release
  - Take your time
  - Existing functionality needs to remain intact
  - Run unit tests and integration tests to validate change
  - Keep reviewing
- **Seams are future microservice boundaries**



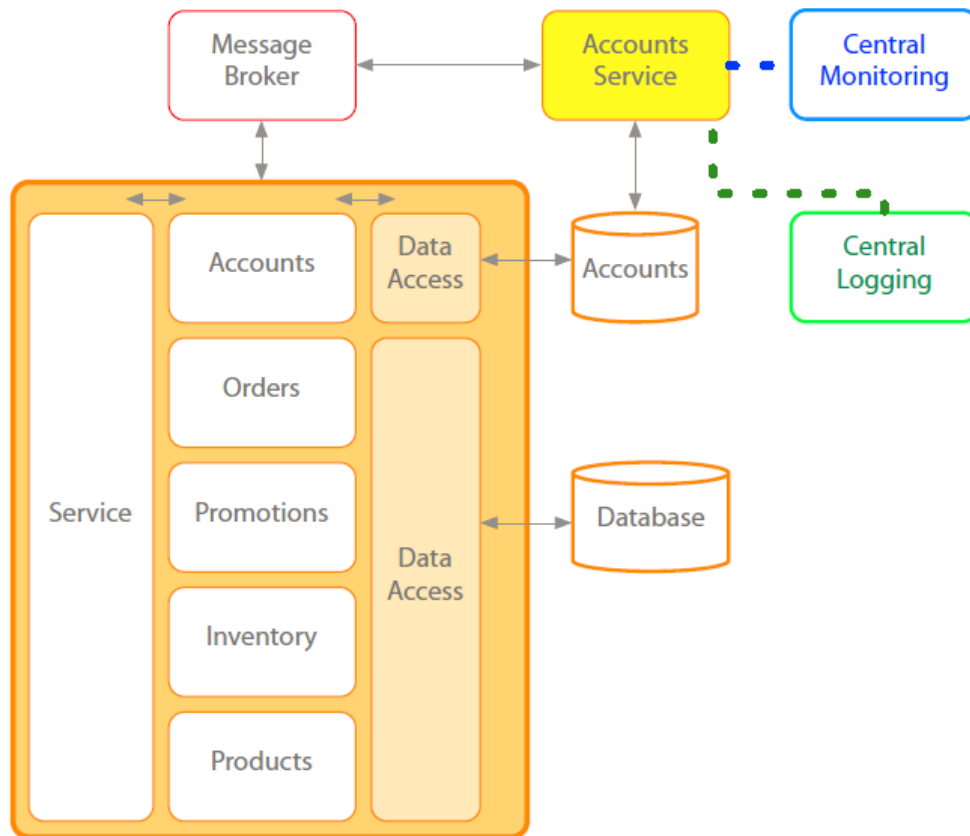
# Brownfield Microservices: Approach



# Brownfield Microservices: Migration

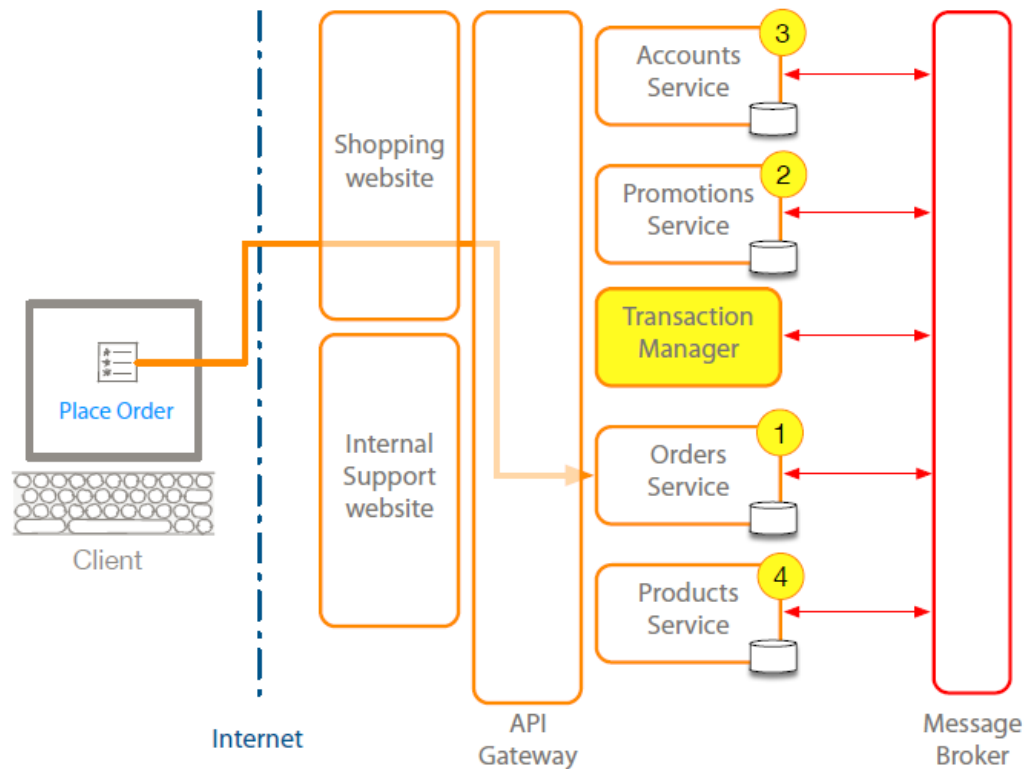
- Code is organized into bounded contexts
    - Code related to a business domain or function is in one place
    - Clear boundaries with clear interfaces between each
  - Convert **bounded contexts** into microservices
    - Start off with one
      - Use to get comfortable
    - Make it switchable
      - Maintain two versions of the code
  - How to prioritise what to split?
    - By risk
    - By technology
    - By dependencies
- Incremental approach
  - Integrating with the monolithic
    - Monitor both for impact
    - Monitor operations that talk to microservices
    - Review and improve infrastructure
    - Incrementally the monolithic will be converted

# Brownfield Microservices: Database Migration



- Avoid shared databases
- Split databases using seams
  - Relate tables to code seams
- Supporting the existing application
  - Data layer that connects to multiple database
- Tables that link across seams
  - API calls that can fetch that data for a relationship
- Refactor database into multiple databases
- Data referential integrity
- Static data tables
- Shared data

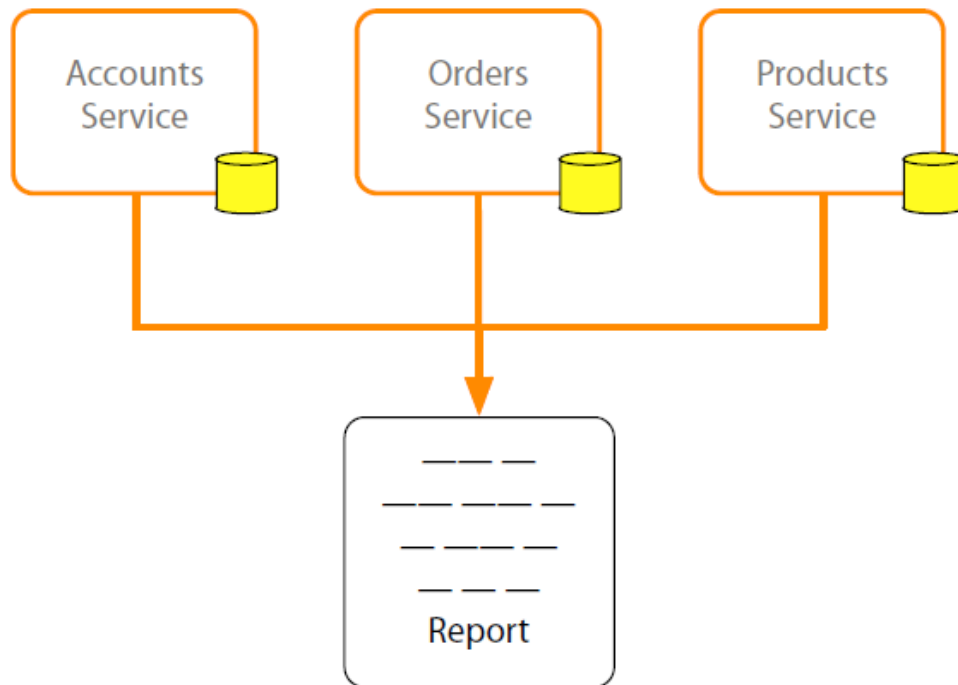
# Brownfield Microservices: Transactions



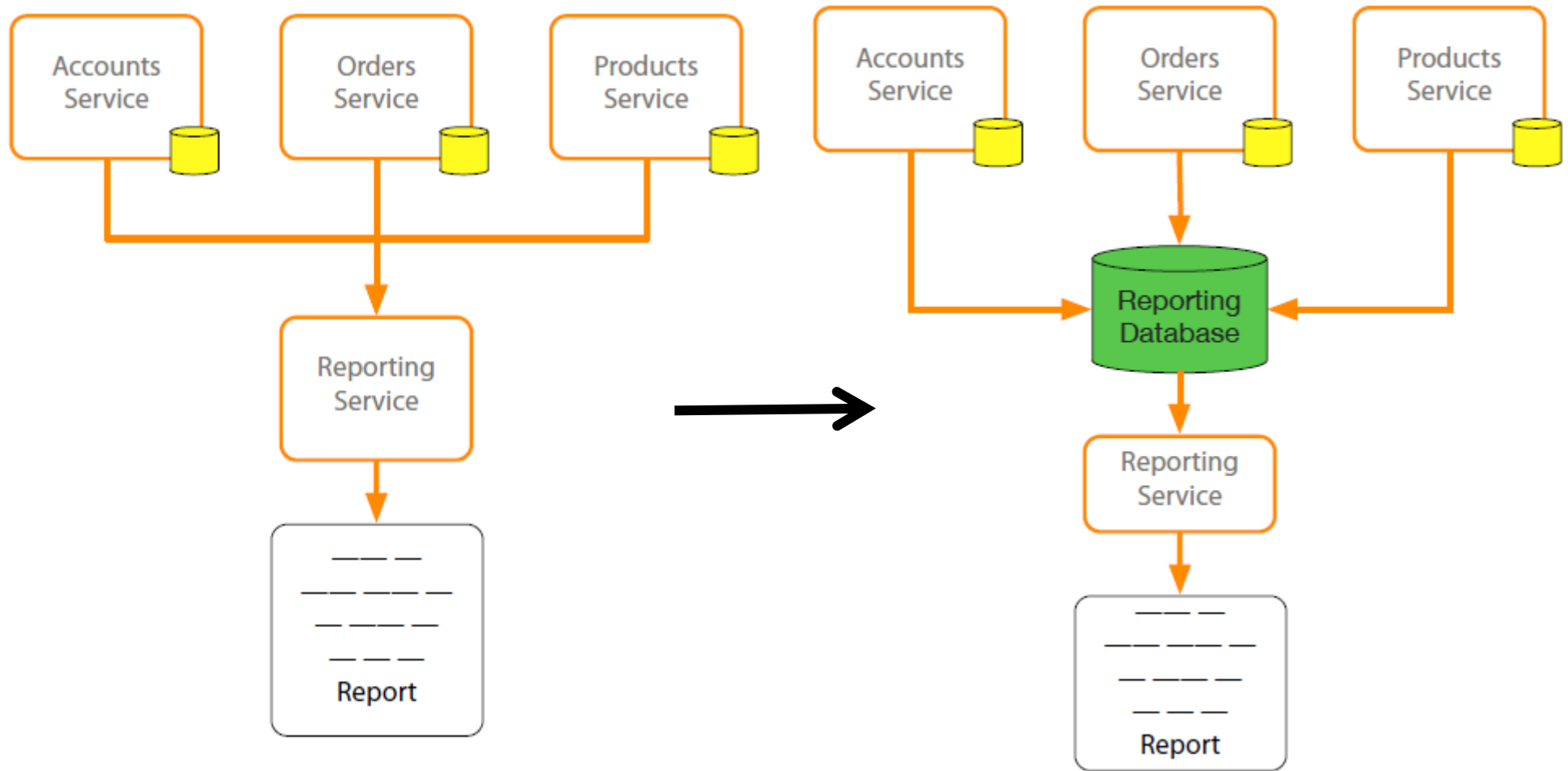
- Transactions ensure data integrity
- Transactions are simple in monolithic applications
- Transactions spanning microservices are complex
  - Complex to observe
  - Complex to problem solve
  - Complex to rollback
- Options for failed transactions
  - Try again later
  - Abort entire transaction
  - Use a transaction manager
    - Two phase commit
  - Disadvantage of transaction manager
    - Reliance on transaction manager
    - Delay in processing
    - Potential bottleneck
    - Complex to implement
- Distributed transaction compatibility
  - Completed message for the monolith

# Brownfield Microservices: Reporting

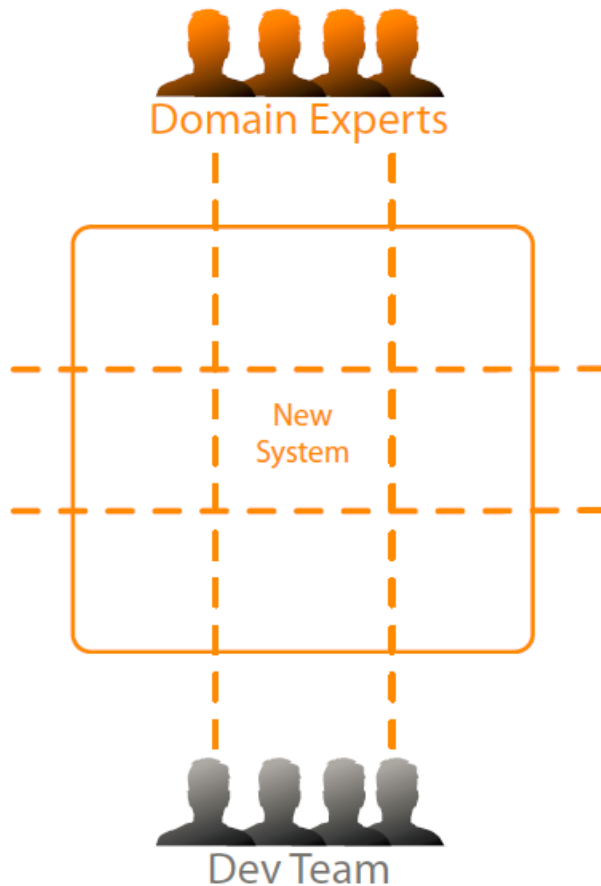
- Microservices complicate reporting
  - Data split across microservices
  - No central database
  - Joining data across databases
  - Slower reporting
  - Complicate report development
- Possible solutions
  - Service calls for report data
  - Data dumps
  - Consolidation environment



# Brownfield Microservices: Reporting



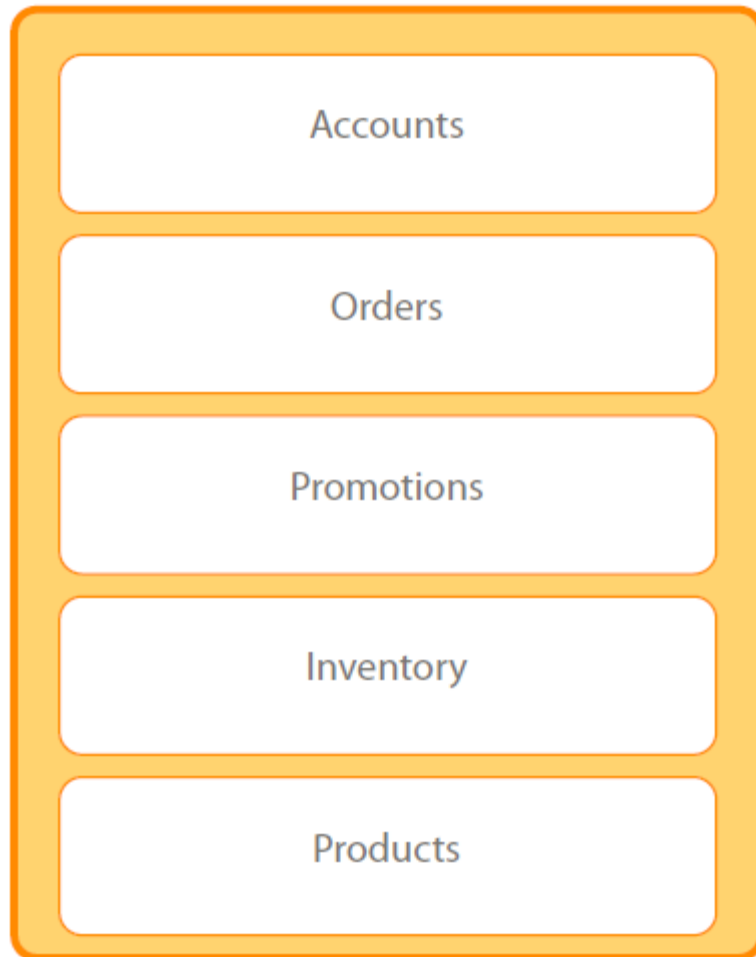
# Greenfield Microservices



## Greenfield Microservices: Introduction

- New project
- Evolving requirements
- Business domain
  - Not fully understood
  - Getting domain experts involved
  - System boundaries will evolve
- Teams experience
  - First microservice
  - Experienced with microservices
- Existing system integration
  - Monolithic system
  - Established microservices architecture
- Push for change
  - Changes to apply microservice principles

# Greenfield Microservices

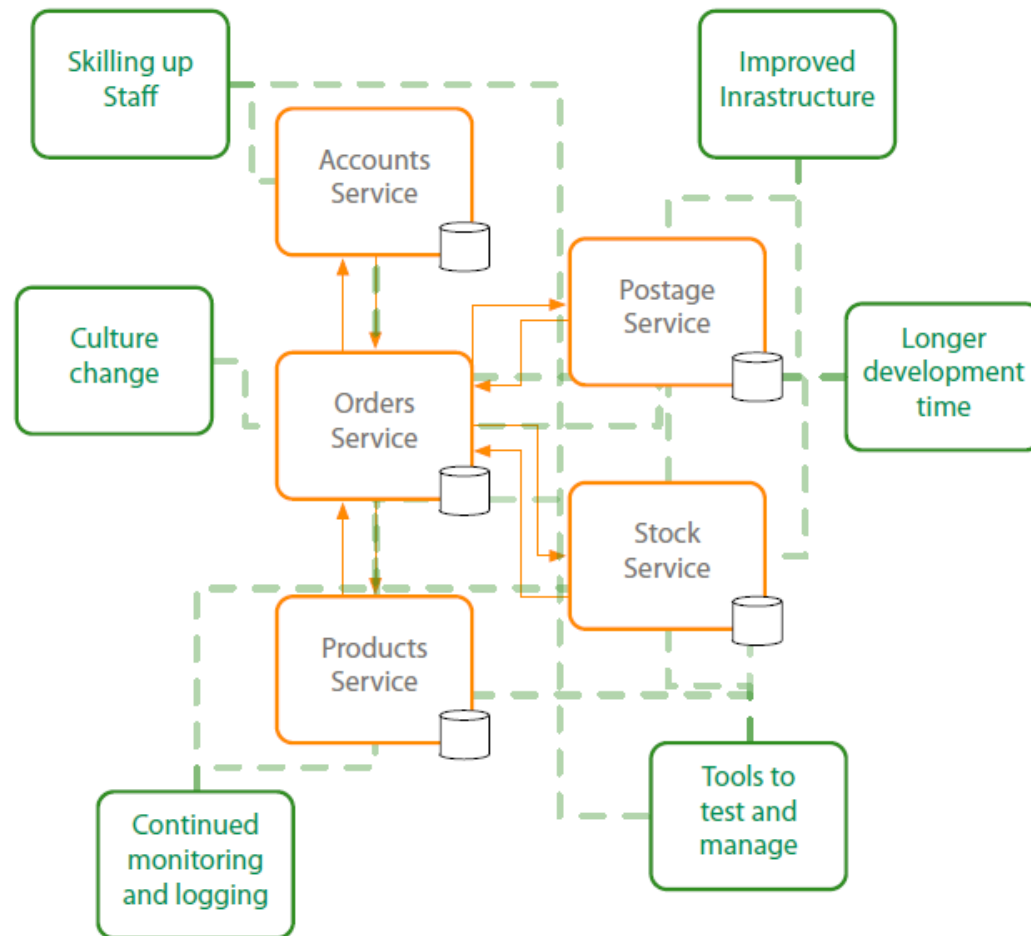


## Greenfield Microservices: Approach

- Start off with monolithic design
  - High level
  - Evolving seams
  - Develop areas into modules
  - Boundaries start to become clearer
  - Refine and refactor design
  - Split further when required
- Modules become services
- Shareable code libraries promote to service
- Review microservice principles at each stage
- Prioritise by
  - Minimal viable product
  - Customer needs and demand



# Microservices Provisos



## Microservices Provisos

- Accepting initial expense
  - Longer development times
  - Cost and training for tools and new skills
- Skilling up for distributed systems
  - Handling distributed transactions
  - Handling reporting
- Additional testing resource
  - Latency and performance testing
  - Testing for resilience
- Improving infrastructure
  - Security
  - Performance
  - Reliance
- Overhead to manage microservices
- Cloud technologies
- Culture change

**THANK YOU**

People matter, results count.

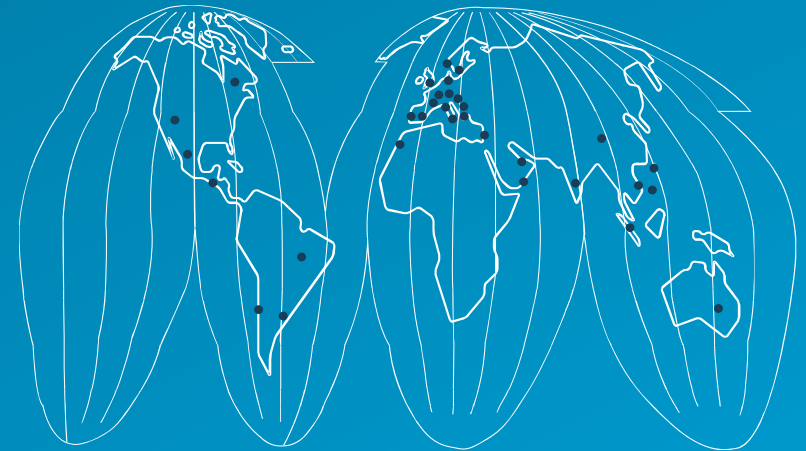


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