Workshop

µ-services

Microservices

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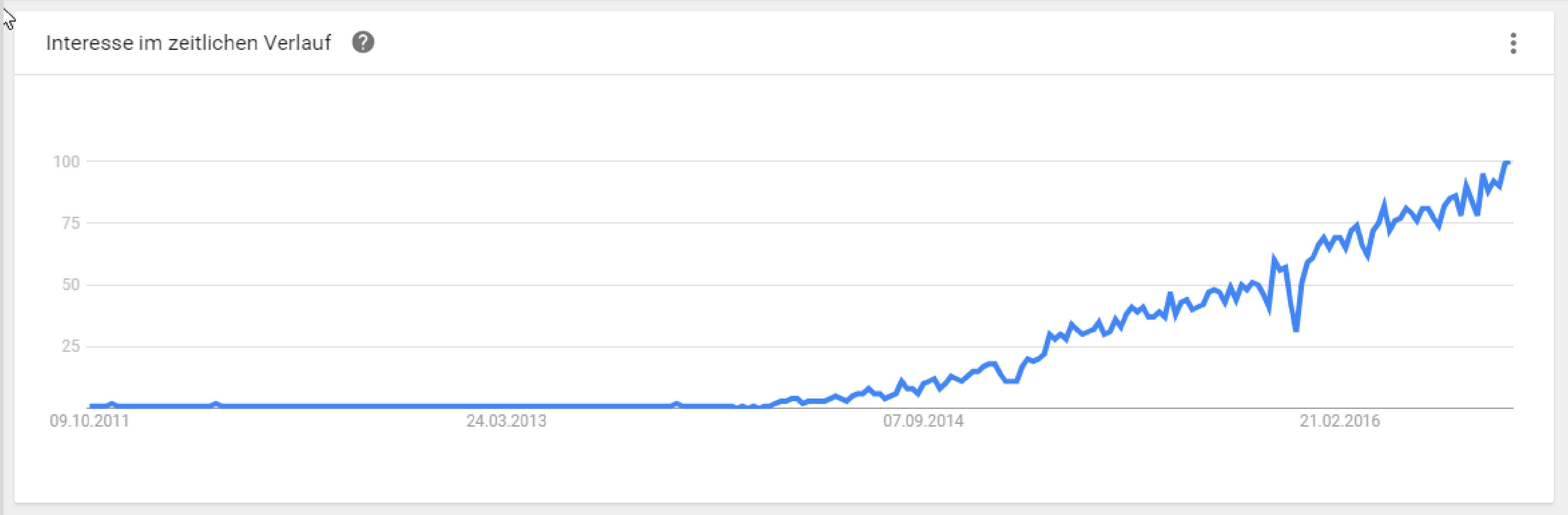
time cockpit

Saves the day.



Microservices are currently hot!

Source: https://www.google.com/trends/explore?q=Microservices, 2016-10-03

Introduction

Basic Concepts of Microservices

What are Microservices?

Small, autonomous services working together

- Single responsibility principle applied to SOA
- See also concept of Bounded Context

Best used with DevOps and continuous deployment

- Enhance cohesion, decrease coupling, enable incremental evolvement

How small are Microservices?

- It depends (e.g. team structure, DevOps maturity, etc.)
- "… one agile team can build and run it", "… can be rebuilt by a small team in two weeks"
- Find an individual balance

Autonomous = deploy changes without affecting others

- Technology- and platform-agnostic APIs

See also https://en.wikipedia.org/wiki/Microservices

Loose Coupling

Tight Coupling

- A change in one module usually forces a ripple effect of changes in other modules
- See also Disadvantages of Tight Coupling

Loose Coupling

- Components have little or no knowledge of the definitions of other components
- Coupling is reduced by e.g. standards, queues, etc.

Microservices = loose coupling wanted

- Single change → single deployment
- No timing issues (if system A is deployed, system B needs update at the same time)

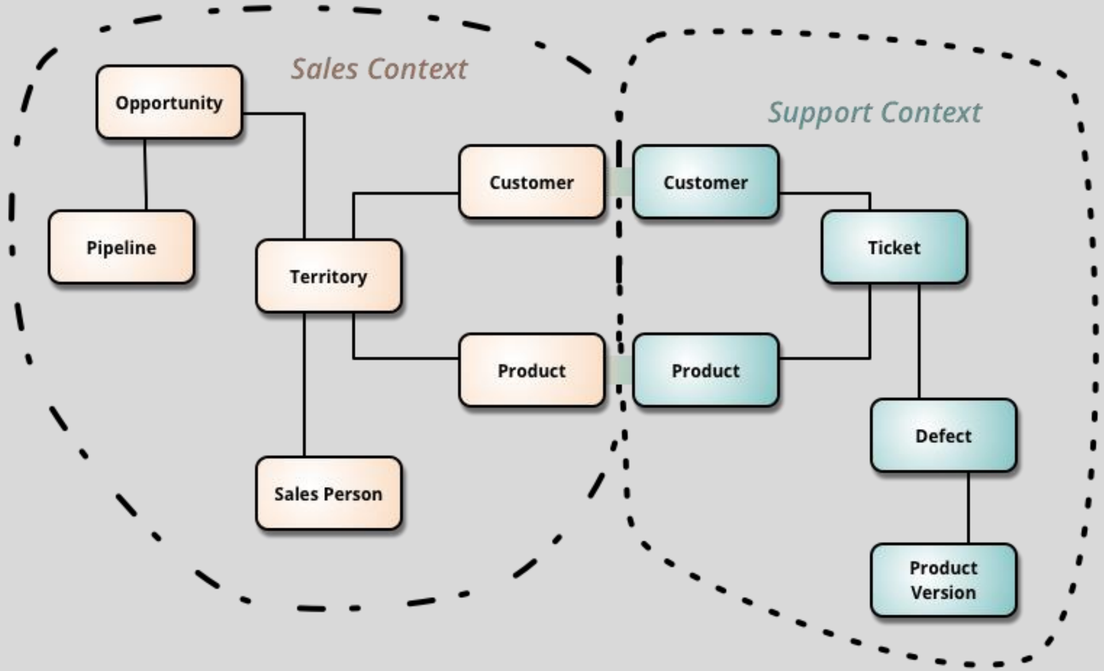
Cohesion

Highly cohesive systems

- Functionality is strongly related
- Modules belong together

Microservices = high cohesion wanted

- Functions grouped in a services because all contribute to a single well-defined task
- Reduce risk that a requirement concerns many different system components



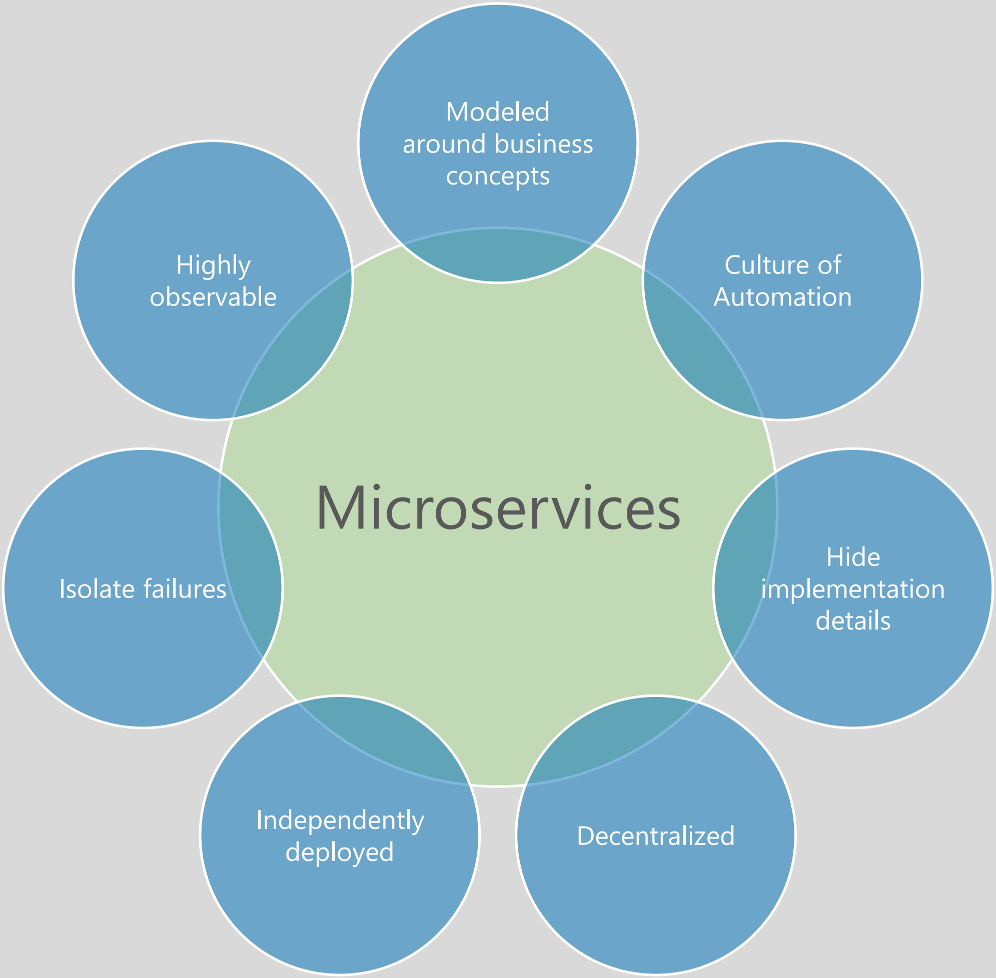
Bounded Context

Microservices often represent bounded contexts

Business-focused design

Less technical-focused design based on technical layers

Source: http://martinfowler.com/bliki/BoundedContext.html



Microservices

Fundamental ideas

- Work alongside many state-of-the-art approaches for software development
  - Agile development techniques
  - Continuous Integration/Delivery
  - DevOps
  - Cloud Computing
  - Containers

Why? Why not?

Why Microservices?

Work well in heterogeneous environments

- Right tool for the job
- Available skills of team members
- Grown environment (e.g. M&A, changing policies, changing overall designs)

Easier to test/adopt new technologies

- Reduce risk and cost of failure
- New platforms (e.g. Node.js instead of .NET), new versions (e.g. .NET Core),

Resilience

- Reduce single point of failures
- Support different SLAs for difference modules (costs, agility)
- Separation of services add complexity (e.g. network) → criticism of Micrservices

Why Microservices?

Let people take responsibility

- Teams “own” their services
- You build it, you run it

Scaling

- Fine-grained scaling is possible

Simplify deployment of services

- Overall, deployment of many Microservices might be more complex → criticism
- Deployment patterns: https://www.nginx.com/blog/deploying-microservices/

Why Microservices?

Composability

- Hexagonal architecture

Ability to replace system components

- Outdated technology
- Changed business requirements

Why Not? (Examples)

Harder to debug and troubleshoot

- Distributed system
- Possible mitigation: Mature logging and telemetry system

Performance penalty

- Network calls are relatively slow
- Possible mitigation: Remote calls for larger units of work instead of chatty protocols

No strong consistency

- We are going to miss transactions!
- Possible mitigation: Idempotent retries

Why Not? (Examples)

Harder to manage

- You have to manage lots of services which are redeployed regularly
- Possible mitigation: DevOps, Automation

System is too small

- For small systems, monolithic approach is often more productive
- Cannot manage a monolith (e.g. deployment)? You will have troubles with Microservices!

Environment with lots of restrictions

- Microservices need a high level of autonomy

Team Organization

Conway's Law

„Any organization that designs a system will inevitably produce a design whose structure is a copy of the organization's communication structure"

Organizational hurdles for Microservices

- Tightly-coupled organizations
- Geographically distributed teams
- Missing tools (e.g. self-service cloud infrastructure, CI/CD tools)
- Unstable or immature service that frequently changes
- Missing culture of taking ownership (need someone to blame)
- Cope with many different and new technologies

Source: Conway, How Do Committees Invent, Datamation magazine, April 1968

Organisational Helpers

- Co-locate teams
  - One team responsible for a single service should be co-located
- Embrace open source development style
  - Works internally, too
- Internal consultants, custodians and trusted committers
  - Quality gateways
  - Servant leaders
- Step-by-step approach
- Be clear in communication
  - E.g. responsibilities, long-term goals, changing roles

Microservices Architects…

…don‘t create perfect end products

…help creating “a framework in which the right systems can emerge, and continue to grow”

…understand the consequences of their decisions

…code with the team (“architects should code”, “coding architect”)

…aims for a balance between standardization and freedom

Build skills for a certain technology vs. right tool for the right job

…create guiding principals and practices

Example for principals (largely technology-independent): https://12factor.net/
Example for practices (often technology-dependent): .NET Core Coding Guildelines

Recommended reading: Newman, Sam. Building Microservices, O'Reilly Media

Guidance, Governance

Samples

Small code samples vs. *perfect* examples from real world

Templates, code generators

Examples: Visual Studio Templates, .NET Core CLI, Angular CLI

Shared libraries

Be careful about tight coupling!

Example: Cross-platform libraries based on .NET Standard Library for cross-cutting concerns

Handle and track exceptions from principals and practices

Remember goal of Microservices: Optimize autonomy

→ Exceptions should be allowed

Shift to DevOps

Old World

Focus on planning
Compete, not collaborate
Static hierarchies
Individual productivity
Efficiency of process
Assumptions, not data

New World

Focus on delivering
Collaborate to win
Fluent and flexible teams
Collective value creation
Effectiveness of outcomes
Experiment, learn and respond

DevOps habits and practices

FLOW OF CUSTOMER VALUE

PRACTICES

Automated Testing
Continuous Integration
Continuous Deployment
Release Management

TEAM AUTONOMY & ENTERPRISE ALIGNMENT

PRACTICES

Enterprise Agile
Continuous Integration
Continuous Deployment
Release Management

BACKLOG refined with LEARNING

PRACTICES

Usage Monitoring
Telemetry Collection
Testing in Production
Stakeholder Feedback

EVIDENCE gathered in PRODUCTION

PRACTICES

Testing in Production
Usage Monitoring
User Telemetry
Stakeholder feedback
Feature flags

MANAGED TECHNICAL DEBT

PRACTICES

Code Reviews
Automated Testing
Continuous Measurement

PRODUCTION FIRST MINDSET

PRACTICES

Application Performance Management
Infrastructure as Code
Continuous Delivery
Release Management
Configuration Management
Automated Recovery

INFRASTRUCTURE is a FLEXIBLE RESOURCE

PRACTICES

Application Performance Management
Infrastructure as Code
Continuous Deployment
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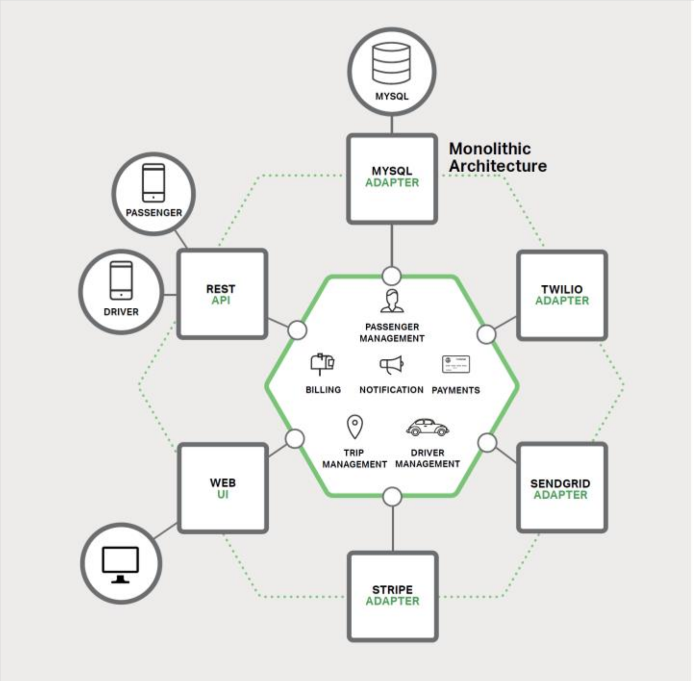
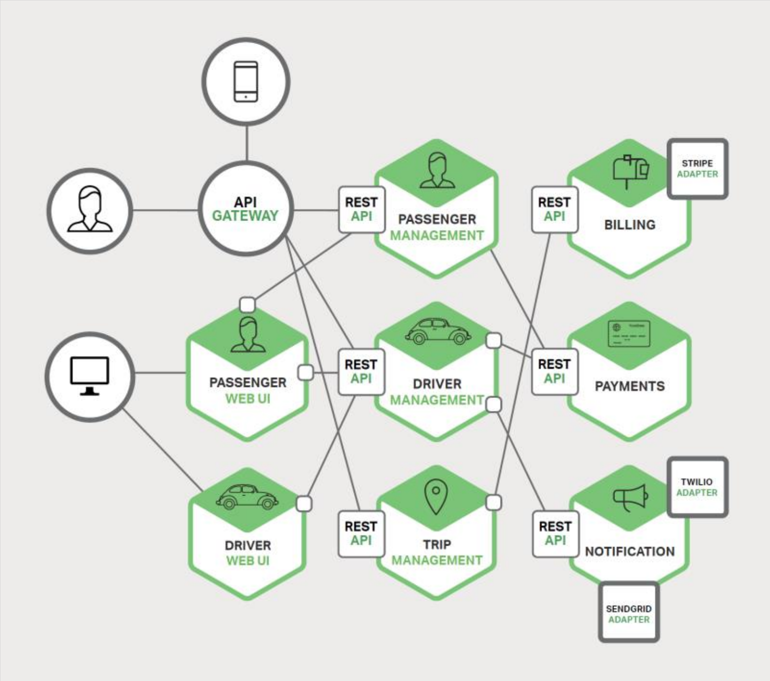
Technical Aspects

Microservice Interfaces





From Monolith to Microservices

Image Source: Chris Richardson, Microservices – From Design to Deployment, NGINX, 2016

Interfaces

Small number of communication standards

- Examples: HTTP/REST, OData, GraphQL, OpenID Connect
- Goals: Interoperability, productivity (economy of scope), detect malfunctions

Practices and principles for typical use-cases needed

- Status Codes
- Data encoding
- Paging
- Dynamic filtering
- Sorting
- Long-running operations
- …

See also https://speakerdeck.com/rstropek/restful-web-api-design

Interface Technology

Tolerant against changes

See also Breaking Change in Microsoft's REST API Guidelines

Technology-agnostic

Simple to use and provide

Availability of tools, libraries, frameworks, knowledge

Hide implementation details

Shared Database anti-pattern

Interface Design

Synchronous communication

- Request/response pattern
- Bidirectional communication
- Example: RESTful Web API, WebSockets

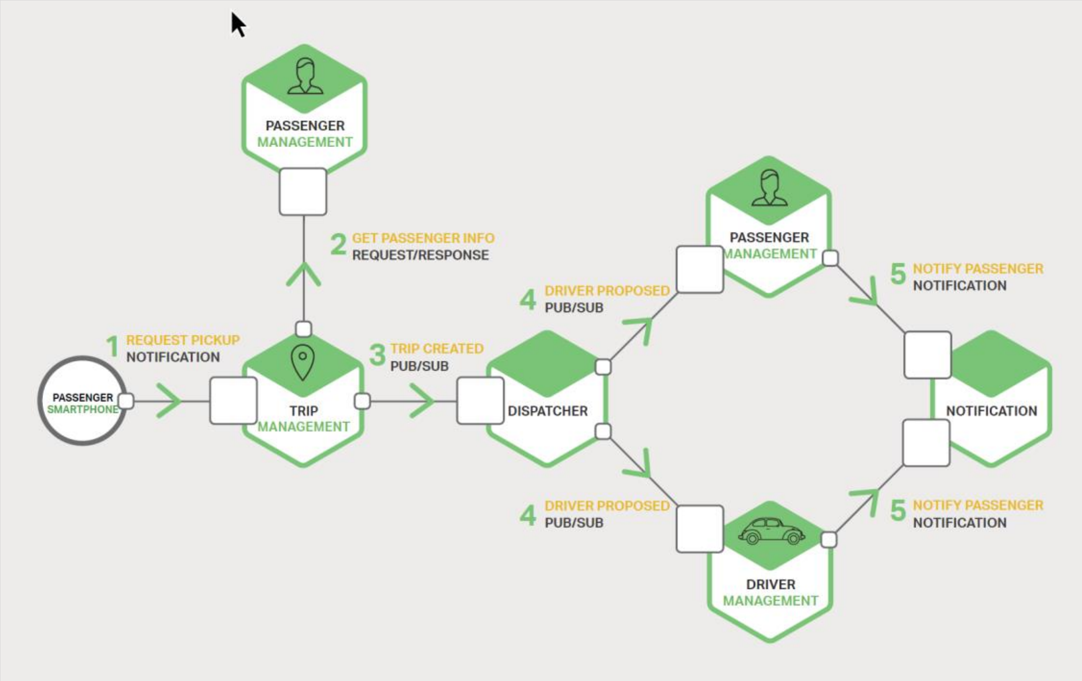
Asynchronous communication

- Event-driven
- Examples: Service Bus, RabbitMQ, Apache Kafka, Webhooks

Central orchestration or autonomy?

- Example: Business Process Modelling and Execution

Further reading: https://www.nginx.com/blog/event-driven-data-management-microservices/



Interface Mechanisms

Image Source: Chris Richardson, Microservices – From Design to Deployment, NGINX, 2016

Handling Failures

Partial failures

- Single service must not kill entire system

Outage vs. degradation

- Performance degradation
- Single dependent service not available

Circuit breaker pattern

- Track success of requests
- Stop trying if error rate/performance exceeds threshold
- Regular health check or retry

Versioning

Semantic Versioning (SemVer)

Raise awareness for breaking changes

- Definition of a breaking change is necessary

Avoid breaking changes

- Discussion point: JSON vs. XAML deserializer in C#

Offer multiple versions in parallel

- Give consumers time to move
- Use telemetry to identify slow movers

Libraries vs. Microservices

Goal: Don't Repeat Yourself (DRY)

- Contraction to Microservices architecture?

Good for…

- …cross-cutting concerns (use existing, wide-spread libraries)
- …sharing code inside a service boundary

Client libraries

- Hide complexity of communication protocol
- Implement best practices (e.g. retry policy)
- Example: Azure Active Directory Authentication Libraries

UI components

- Service provides UI fragments (e.g. WebComponents)

Automation

Continuous Integration and Deployment, Tests

Mobile app CI and CD

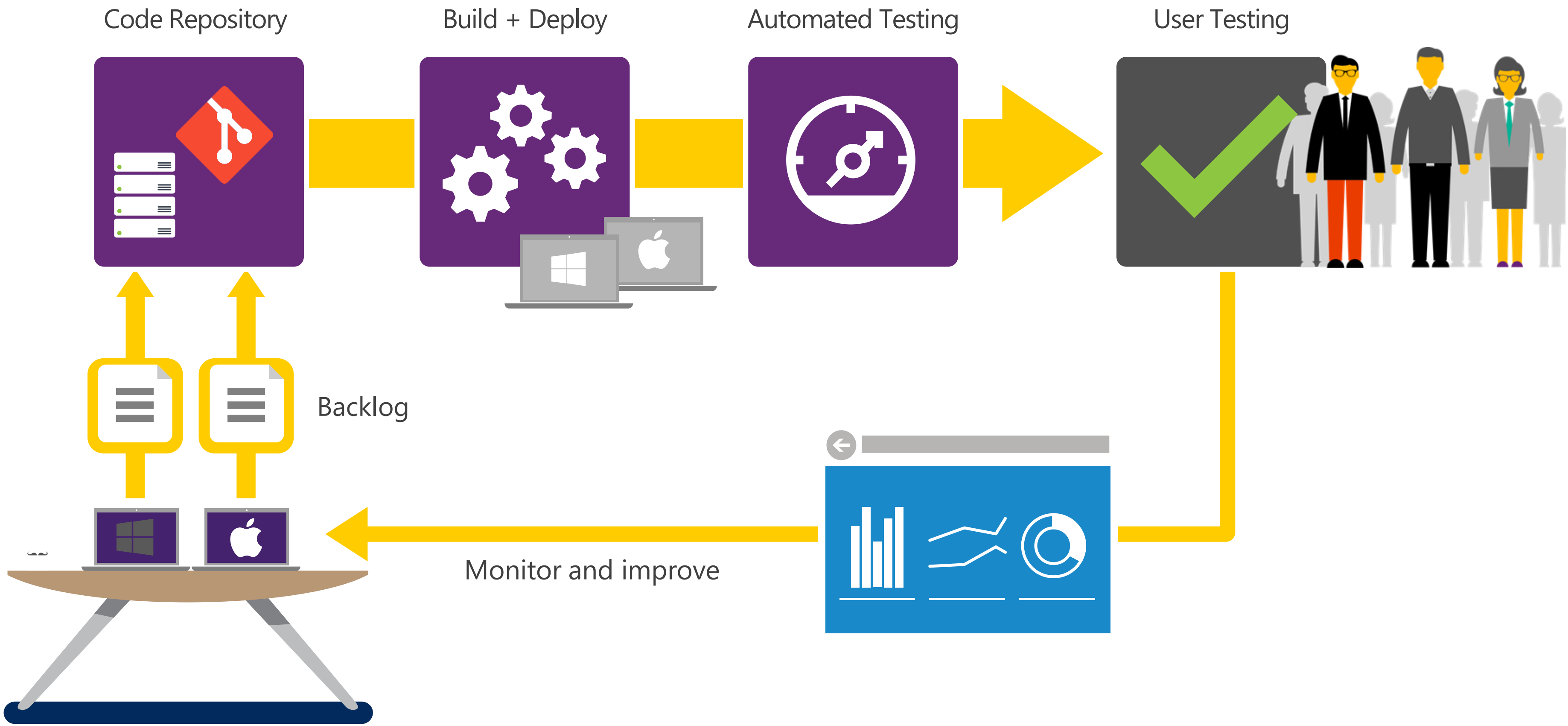


Image Source: Microsoft

CI/CD

One code repository and CI/CD build per service

- Possible: Common infrastructure for economy of scope and scale

Build and deployment pipeline

- Compile and fast tests (unit tests)
- Slow tests
- UAT (manual tests, explorative tests)
- Performance testing (e.g. cloud load testing)

Separate deployment from release

- E.g. Azure App Service stages with swapping

Canary releasing

- Direct portion of your traffic against new release and monitor stability

Monitoring

System-wide view of our system's health

- Contains data from all services
- Logging
- Telemetry (e.g. CPU and memory usage, response times, dependent requests, etc.)

Microsoft's solutions

- Visual Studio Application Insights
- Hockeyapp

3rd party solutions

- Log analysis with Elastic Stack
- Dynatrace (leader in Gartner Magic Quadrant)

Manual Testing

Manual testing: try the program and see if it works!

Tester plays the role of a user

- Checks to see if there is any unexpected or undesirable behavior

Test plans with specified test cases

Drawbacks

- Slow
- Requires lots of resources → expensive
- Cannot be performed frequently

Heavy manual testing is a showstopper for Microservices

Testing Level

Unit Test

- Test single function or class

Service Tests

- Bypass UI and test service directly
- Stubs or mockups for dependent services/resources (e.g. Mountbank)

End-to-End Tests

- Hard in a Microservice environment (e.g. which versions to test?)
- Tend to be flaky and brittle
- Good approach: Test a few customer-driven “journeys”

Deployment

Deployment Strategies

Single service instance per host

- Inefficient

Multiple service instances per host

- Efficient in terms of resource usage
- No isolation → no resource limitation, no isolated environments, no sandboxes

Service instance per VM

- Based on a common image
- Complete isolation
- Uses resources less efficient → expensive
- Requires mature virtualization environment

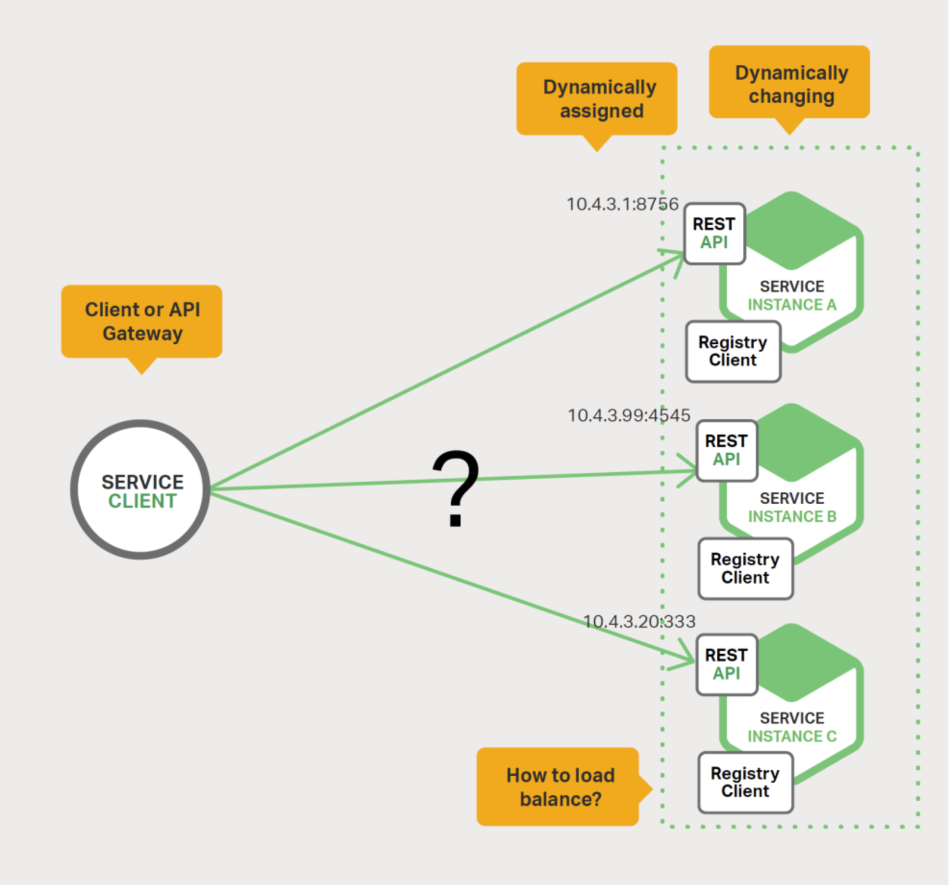
Deployment Strategies

Service instance per container

- Based on a common image (automatically created)
- High level of isolation (like VMs if you use e.g. Windows Hyper-V Container)
- Requires running container environment (e.g. Docker Cloud, Azure Container Services)

Serverless deployments

- E.g. Azure App Service, Azure Functions
- Reduce operations to a minimum



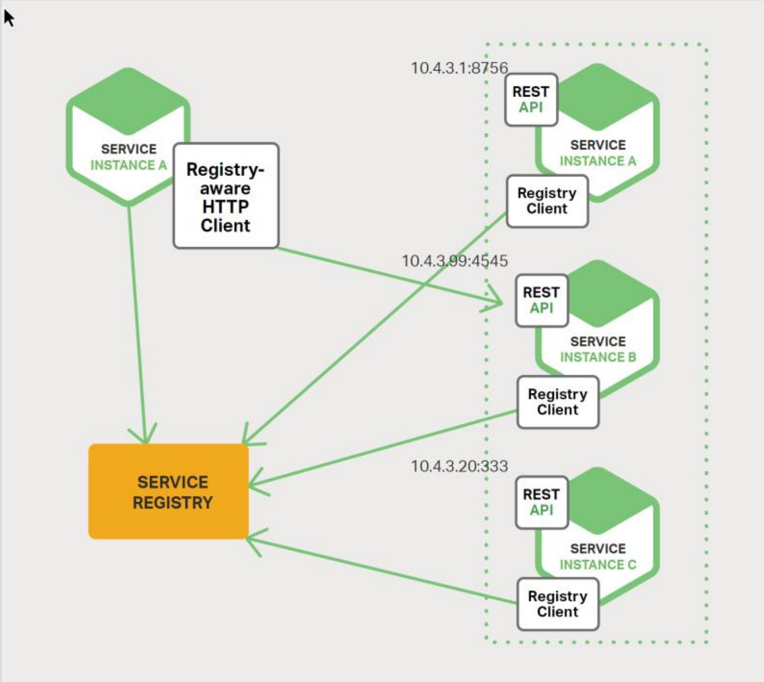
Service Discovery

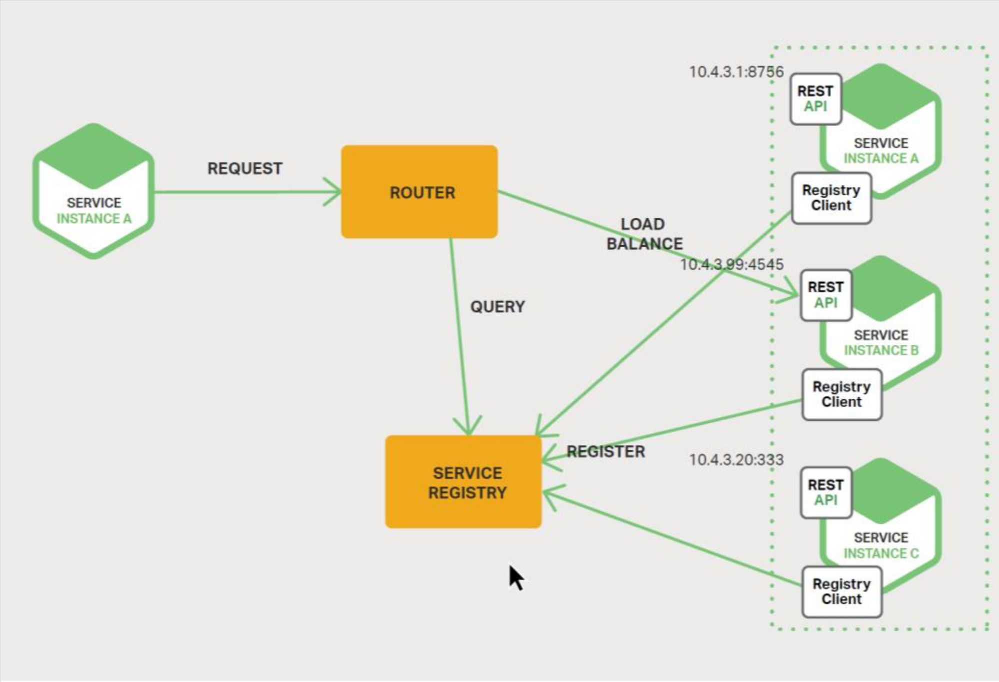
Dynamically assigned addresses

Changing environment
- Failures
- Scaling
- New versions

Tools
- DNS (e.g. Azure DNS)
- Load Balancer (e.g. Azure LB)
- Discovery and config tools (e.g. Consul)

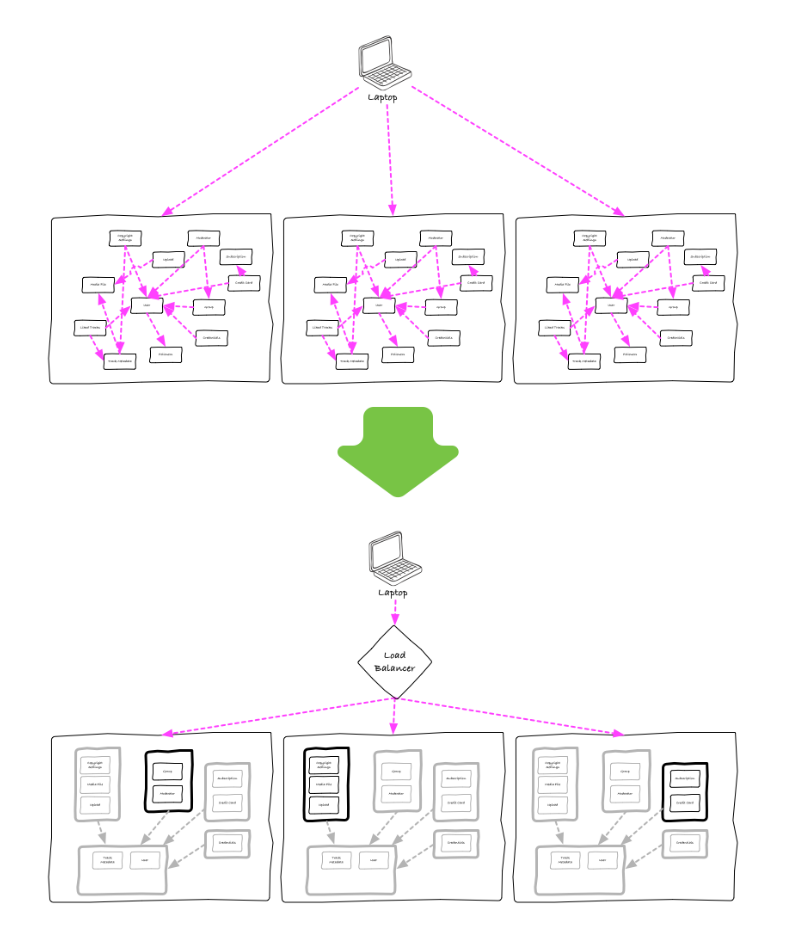
Image Source: Chris Richardson, Microservices – From Design to Deployment, NGINX, 2016





Client vs. server-side discovery

Image Source: Chris Richardson, Microservices – From Design to Deployment, NGINX, 2016



Deployment

Architecture

- Old: Each node contains entire system
- New: Unrelated modules behind load balancer/reverse proxy

API Gateways

- Marshal backend calls
- Aggregate content
- Example: [Azure API Management]

Source: [How we ended up with microservices]

Data Management

Data Management

Each Microservice has its own data

- No transactions
- No distributed queries
- Duplicated data to a certain extent

Event-driven architecture

- Requires service bus or message broker (e.g. Service Bus, RabbitMQ, Apache Kafka)
- Option: Use DB transaction log

Event sourcing and CQRS

- Read more in MSDN, Martin Fowler

Transactions

Question and avoid ACID transactions across services

- Perfectly fine inside service boundaries
- Has consequences on API design (e.g. Azure Storage Entity Group Transactions)

Idempotent retry

- Gather data, try again later

Use compensating transactions

Further Readings

Further Readings

Martin Fowler on Microservices

Newman, Sam. Building Microservices, O'Reilly Media

NGINX

- Tech Blog
- Microservices: From Design to Deployment

Workshop

Q&A

Thank your for coming!

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