Microservice Architectures (and more)

Michael Hilton **Rohan Padhye**

Inspirations:
Martin Fowler (http://martinfowler.com/articles/microservices.html)
Josh Evans @ Netflix (https://www.youtube.com/watch?v=CZ3wIuvmHeM)
Matt Ranney @ Uber (https://www.youtube.com/watch?v=kb-m2fasdDY)
Christopher Meiklejohn & Filibuster (http://filibuster.cloud)

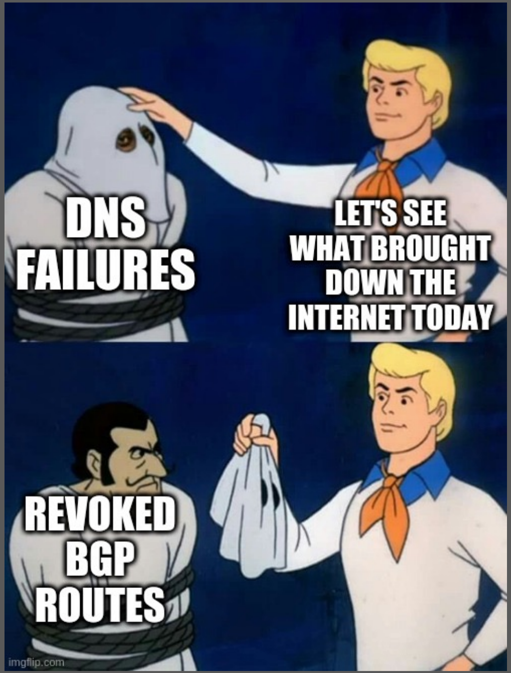
Administrativia

- Homework 2 due Thursday (Oct 7).
- Recitation this week: midterm review (**come prepared**!)
  - Work through problems on the previous midterms – many students found this helpful.
  - Any questions on the previous midterm questions – bring them to recitation to discuss as a class.
- Midterm on October 12th (in class, regular timing).

Learning Goals

- Contrast the monolithic application design with a modular design based on microservices.
- Reason about how architectural choices affect software quality and process attributes.
- Reason about tradeoffs of microservices architectures.

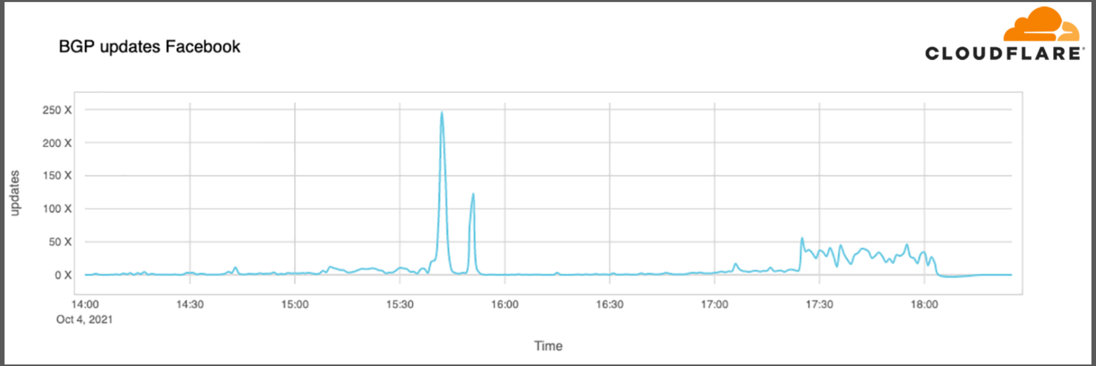
There has been a failure
on the INTERNETS

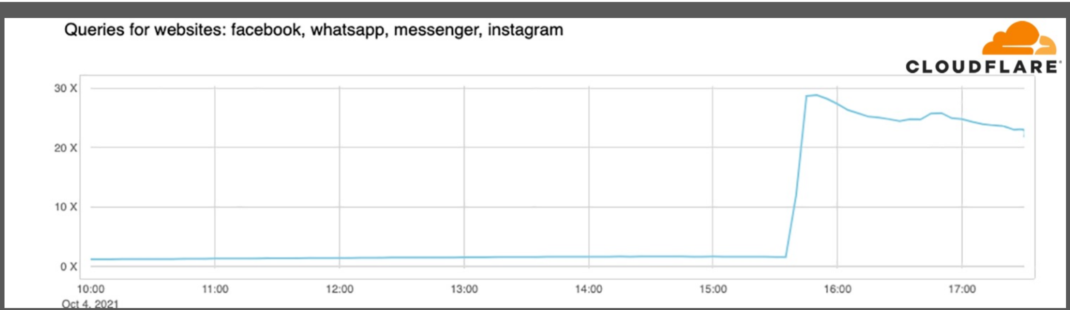

DNS FAILURES
LET'S SEE WHAT BROUGHT DOWN THE INTERNET TODAY
REVOKED BGP ROUTES
imgflip.com

Facebook Network Engineering Team after doing `git push` of BGP changes:
This little maneuvre is gonna cost us 6 billion

Facebook on Oct 4, 2021

Source: https://blog.cloudflare.com/october-2021-facebook-outage/





Facebook on Oct 4, 2021

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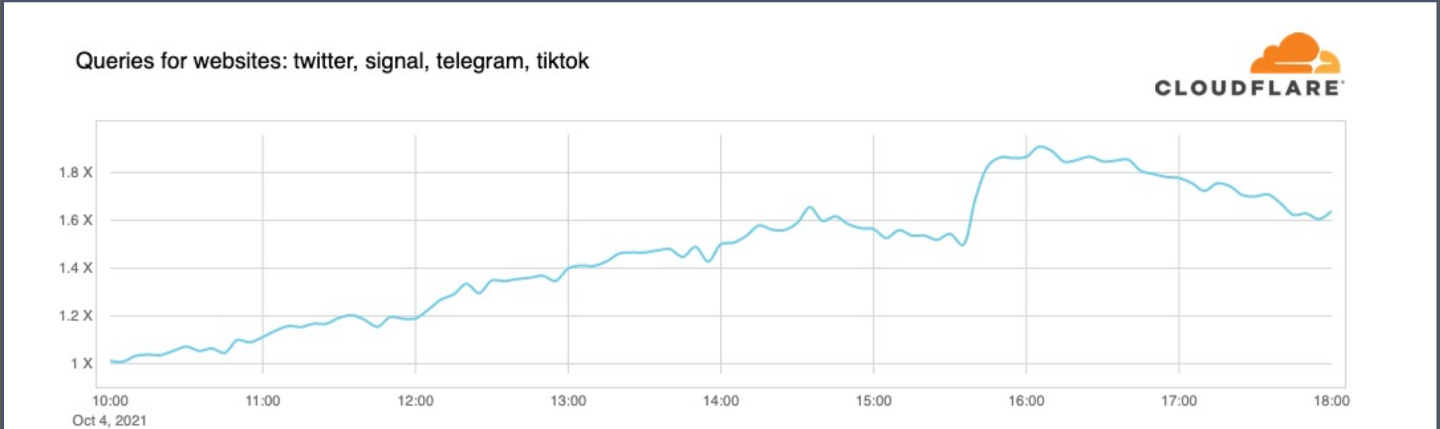
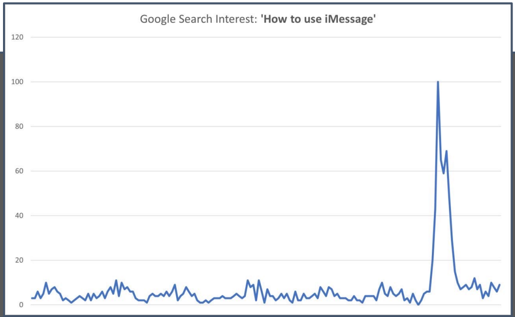


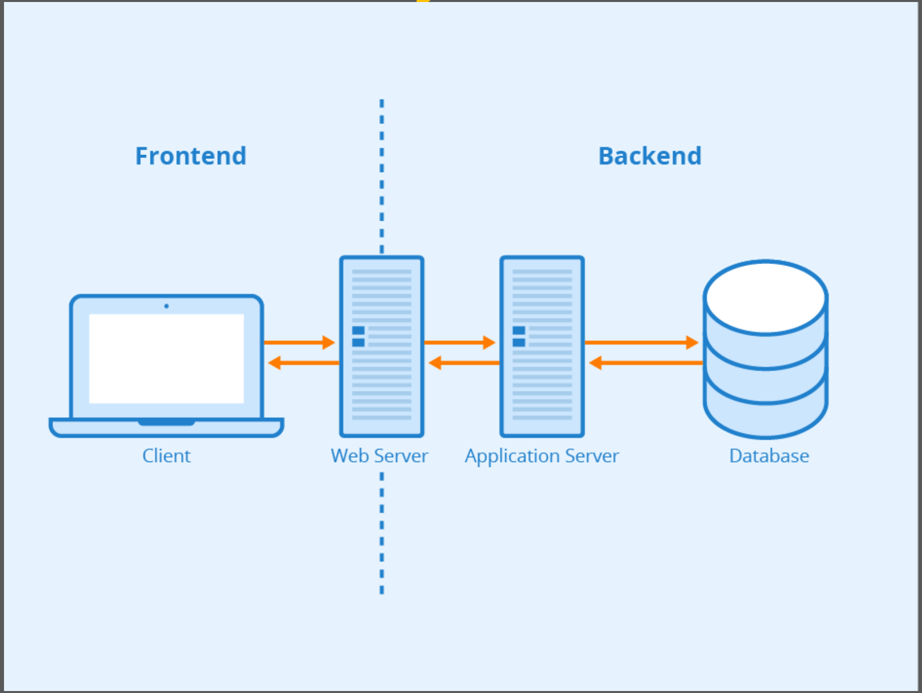


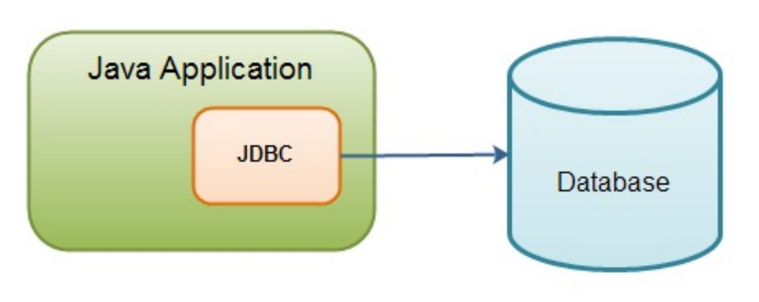
Some interesting insights about the dependency web of the Web:
https://www.synergylabs.org/yuvraj/docs/Kashaf_IMC2020_WebDep.pdf

Microservice architectures

MONOLITHS

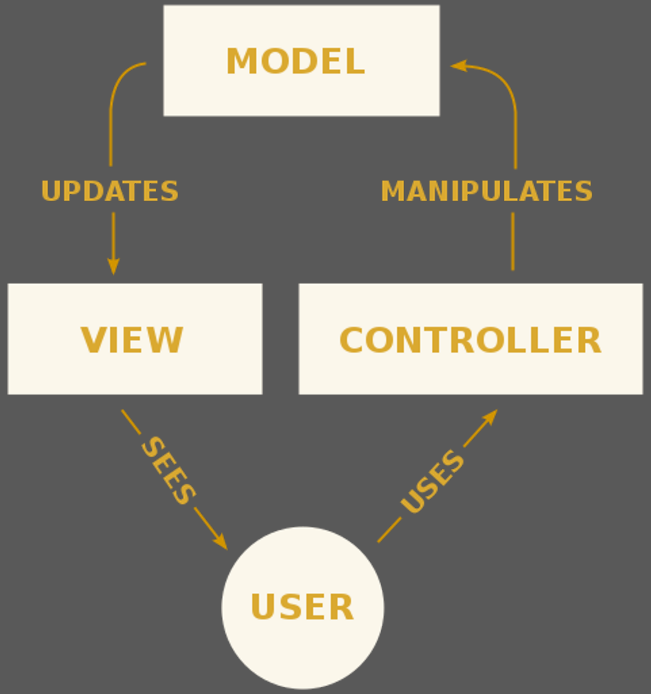
Monolithic styles





Source: https://www.seobility.net (CC BY-SA 4.0)

Monolithic styles: MVC Pattern (e.g. Mayan)



Monoliths

What are the consequences of this architecture? On:

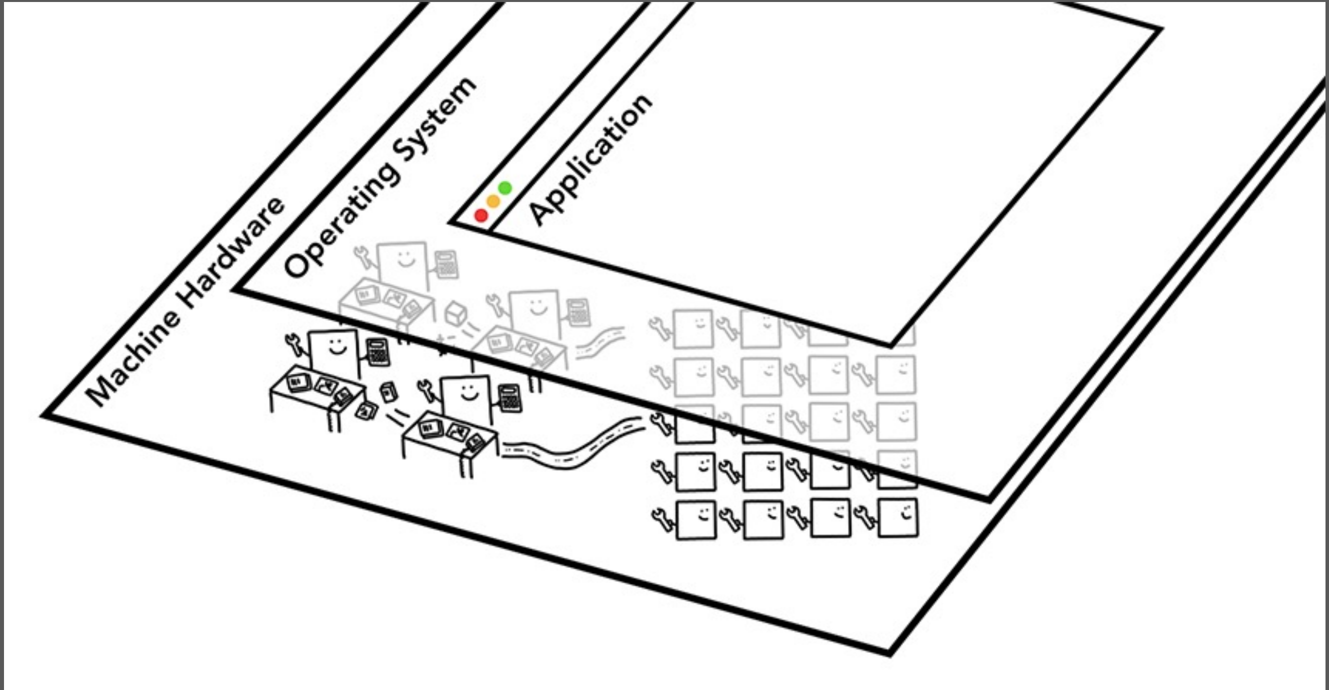
- Scalability
- Reliability
- Performance
- Development
- Maintainability
- Evolution
- Testability
- Ownership
- Data Consistency

Separation of concerns

SERVICE-BASED ARCHITECTURE

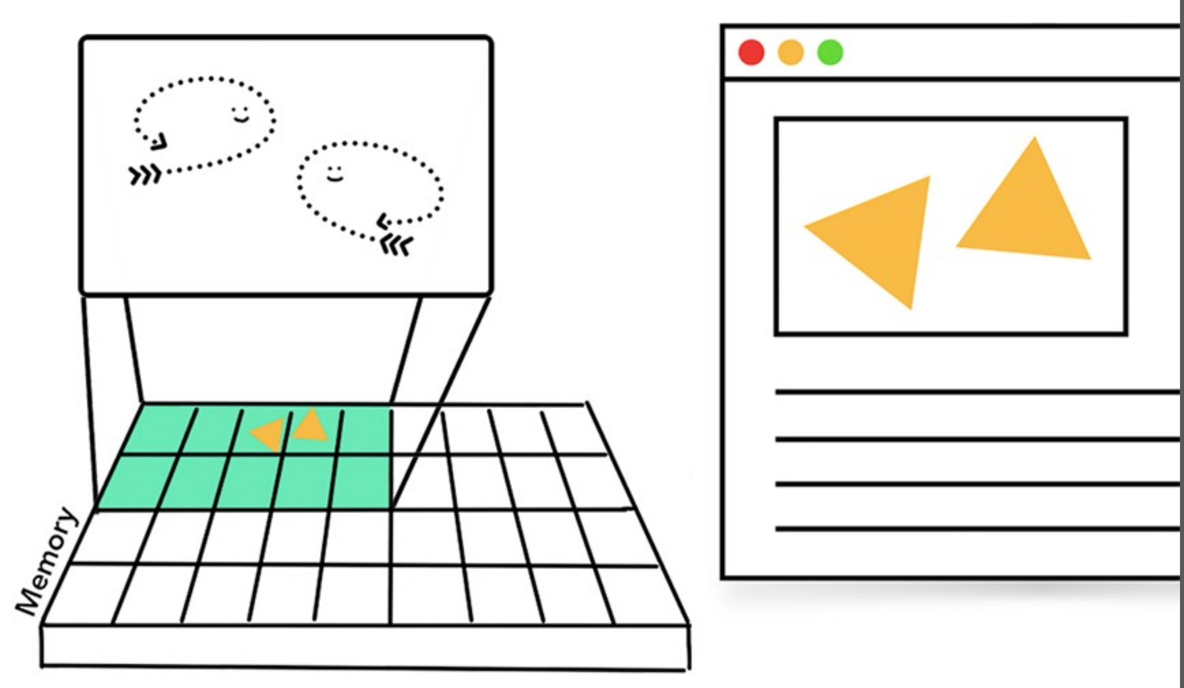
Chrome

Web Browsers



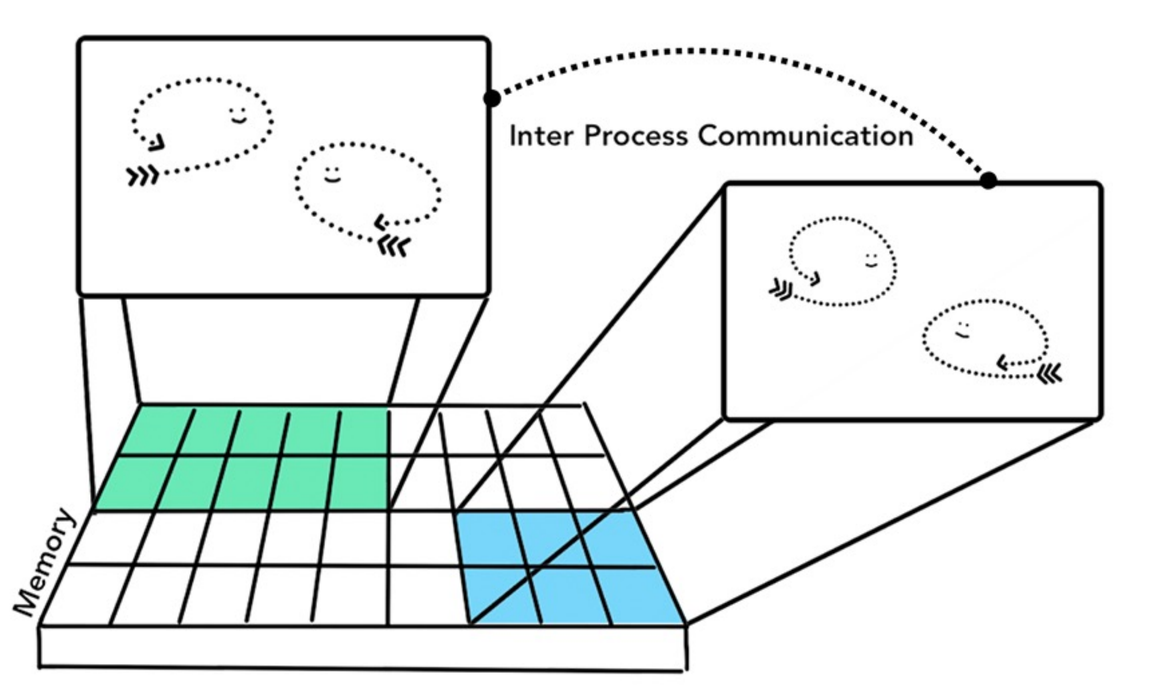
Source: https://developers.google.com/web/updates/2018/09/inside-browser-part1 (CC BY 4.0)

Browser: A multi-threaded process



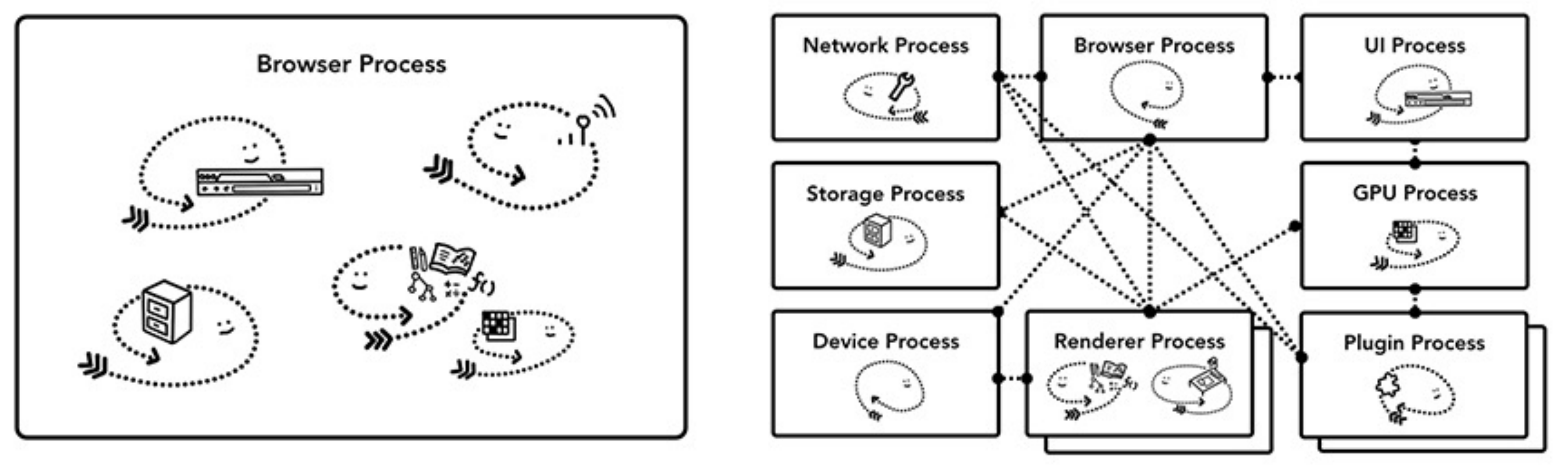
Source: https://developers.google.com/web/updates/2018/09/inside-browser-part1 (CC BY 4.0)

Multi-process browser with IPC



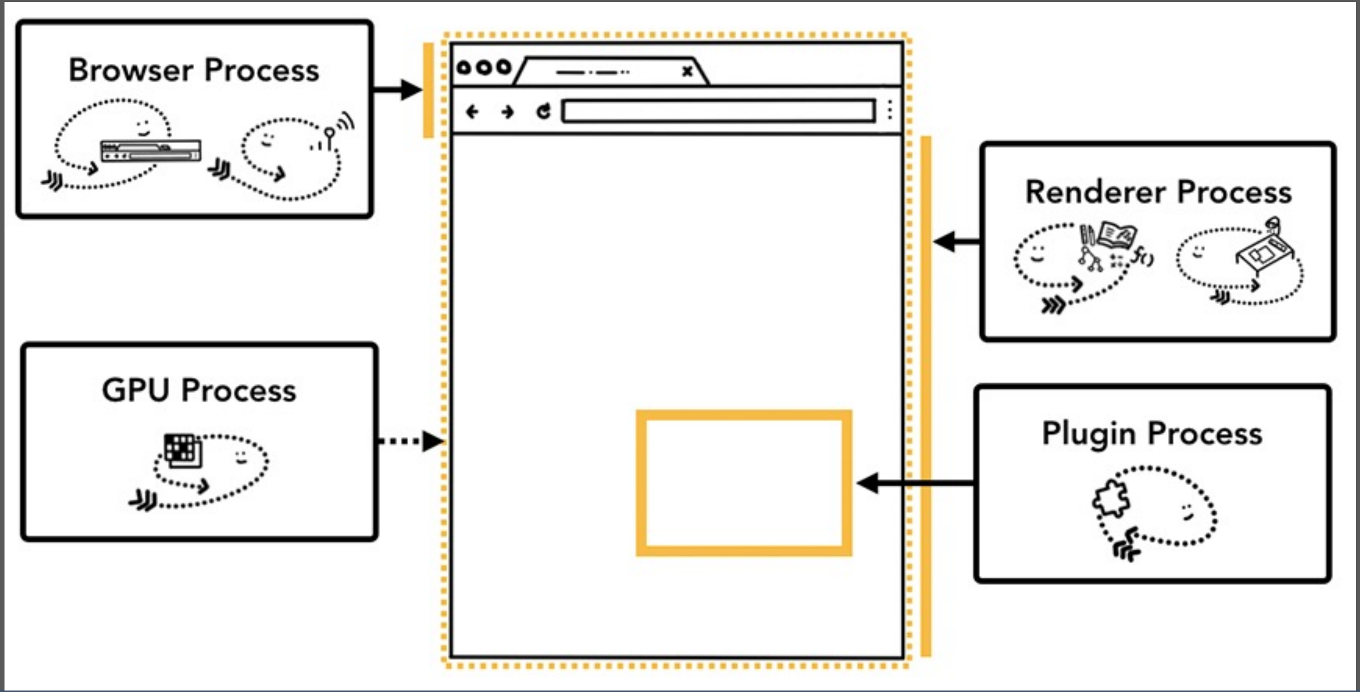
Source: https://developers.google.com/web/updates/2018/09/inside-browser-part1 (CC BY 4.0)

Browser Architectures



Source: https://developers.google.com/web/updates/2018/09/inside-browser-part1 (CC BY 4.0)

Service-based browser architecture



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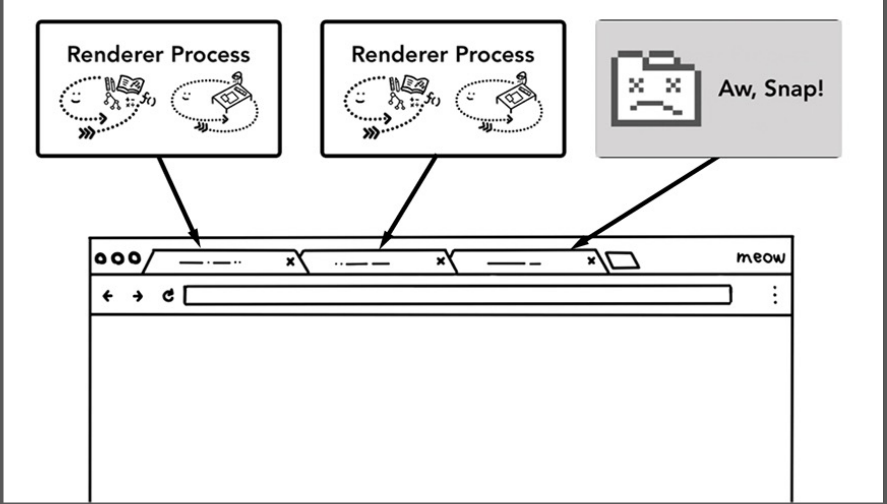
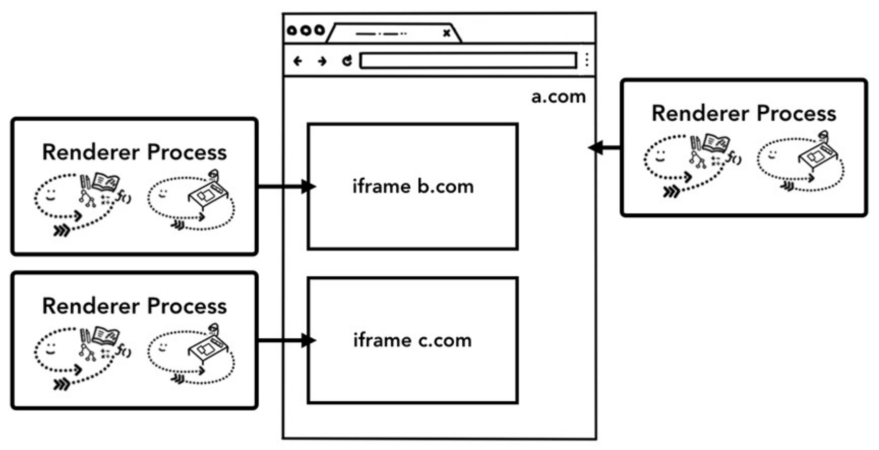
Service-based browser architecture





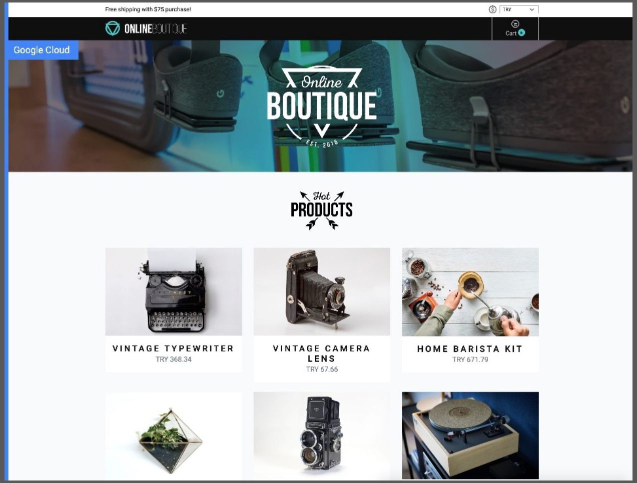
Source: https://developers.google.com/web/updates/2018/09/inside-browser-part1 (CC BY 4.0)

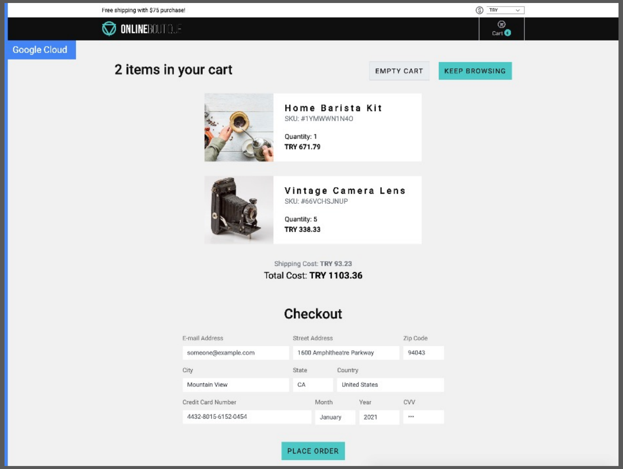
Taking it further

MICROSERVICES

Hipster Shop

Hipster Shop User Interface





2 items in your cart

Home Barista Kit
SKU: #1YMWWN1N4O
Quantity: 1
TRY 671.79

Vintage Camera Lens
SKU: #66VCHSJNUP
Quantity: 5
TRY 338.33

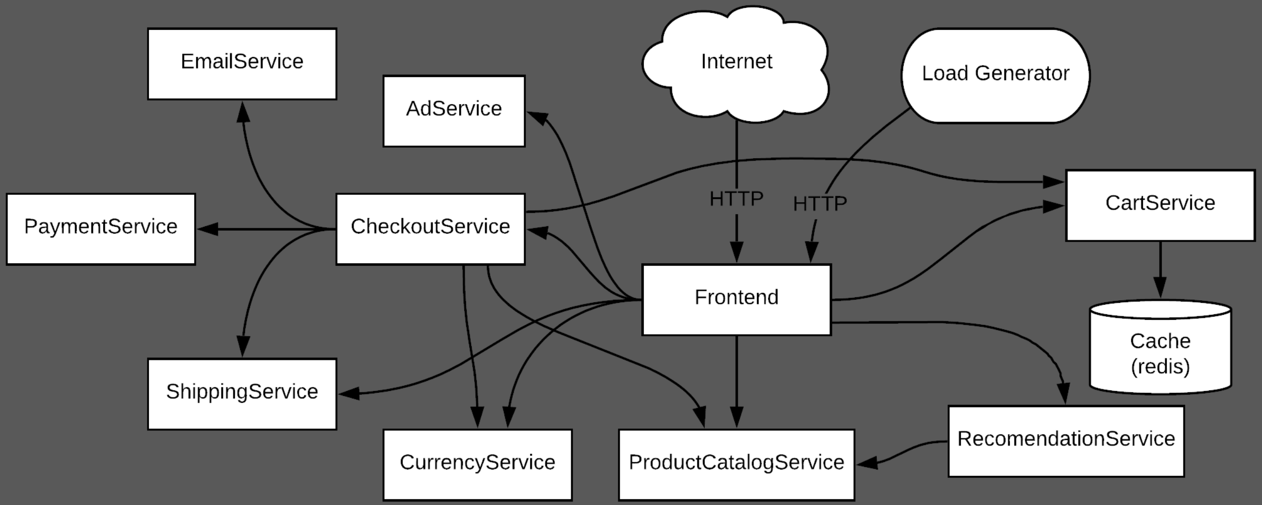
Shipping Cost: **TRY 93.23**
Total Cost: **TRY 1103.36**

Checkout

E-mail Address: someone@example.com
Street Address: 1600 Amphitheatre Parkway
Zip Code: 94043
City: Mountain View
State: CA
Country: United States
Credit Card Number: 4432-8015-6152-0454
Month: January
Year: 2021
CVV: •••

https://github.com/GoogleCloudPlatform/microservices-demo

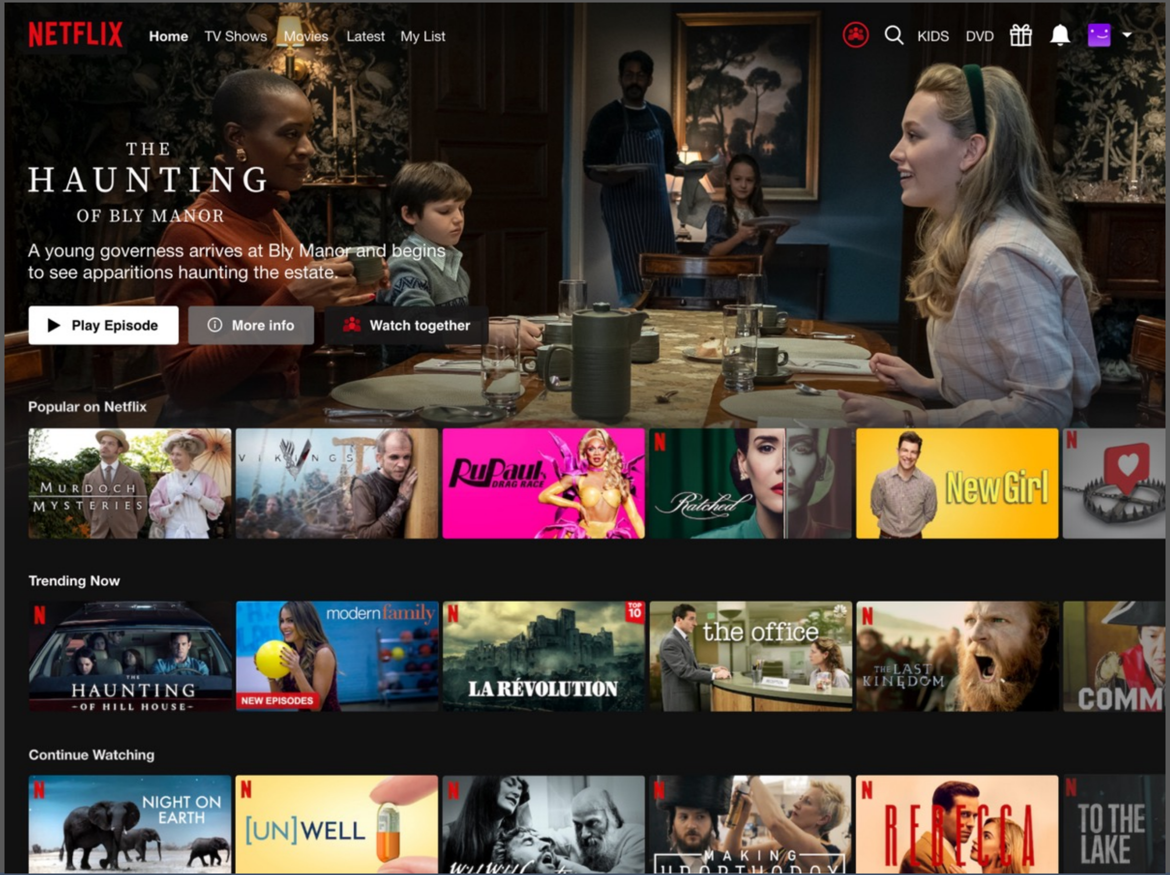
Hipster Shop Microservice Architecture



https://github.com/GoogleCloudPlatform/microservices-demo

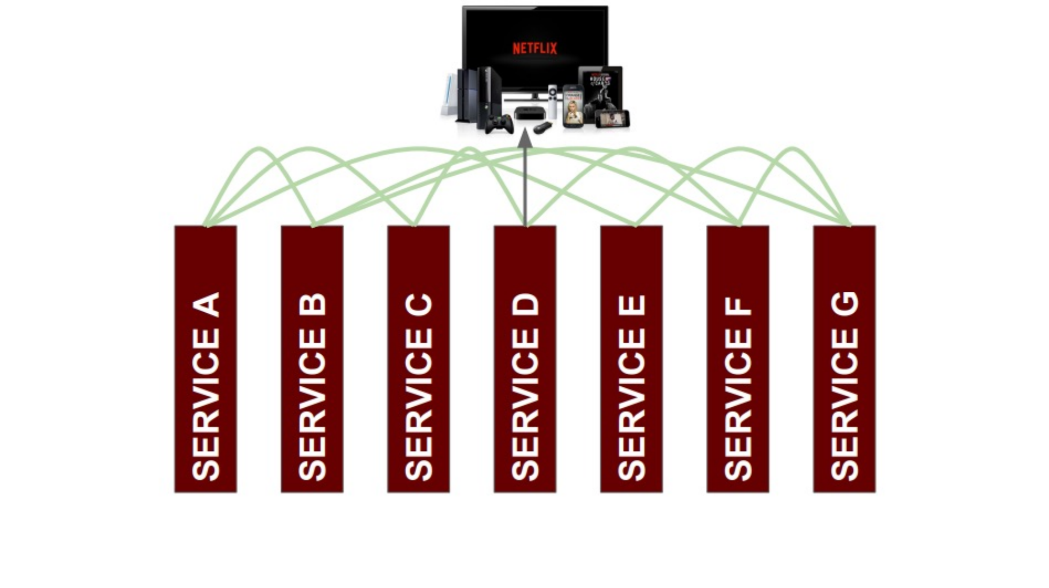
Netflix

Netflix



A young governess arrives at Bly Manor and begins to see apparitions haunting the estate.

AppBoot



Bookmarks

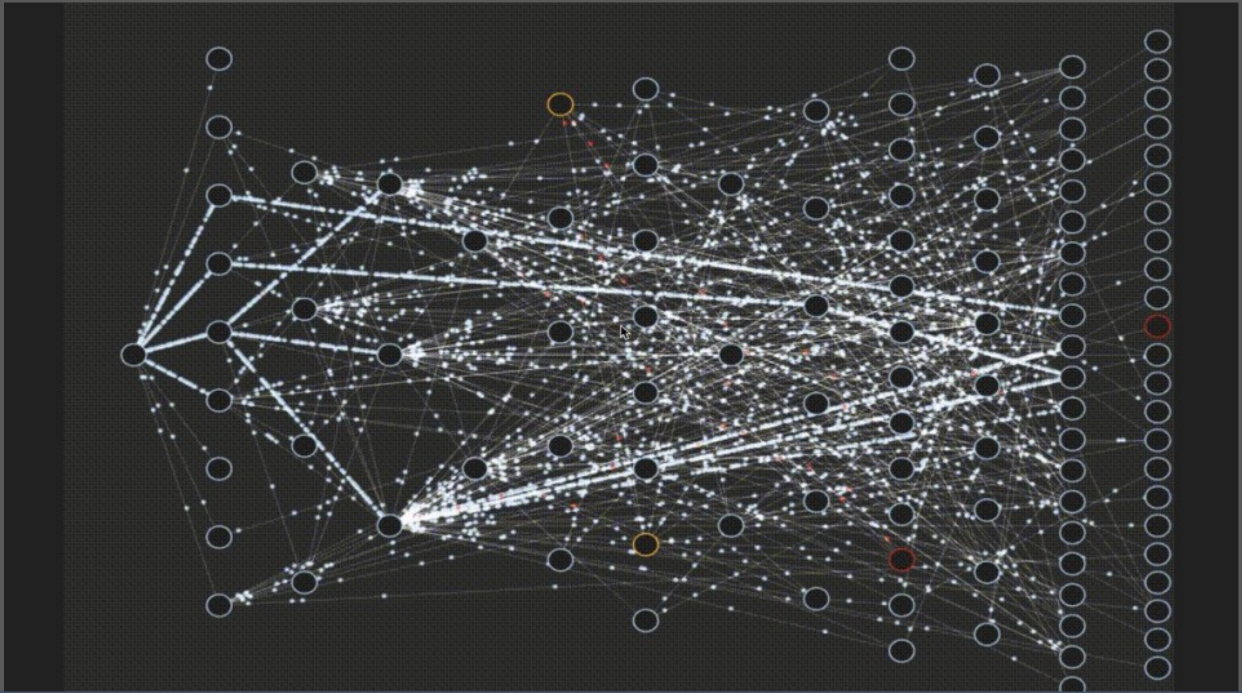
Recommendations

My List

Metrics

(as of 2016)

Netflix Microservices



(as of 2016)

https://www.youtube.com/watch?v=CZ3wIuvmHeM

Who uses Microservices?

COMCAST

NETFLIX

ebay

UBER

GROUPON

Microservices

What are the consequences of this architecture? On:

- Scalability
- Reliability
- Performance
- Development
- Maintainability
- Evolution
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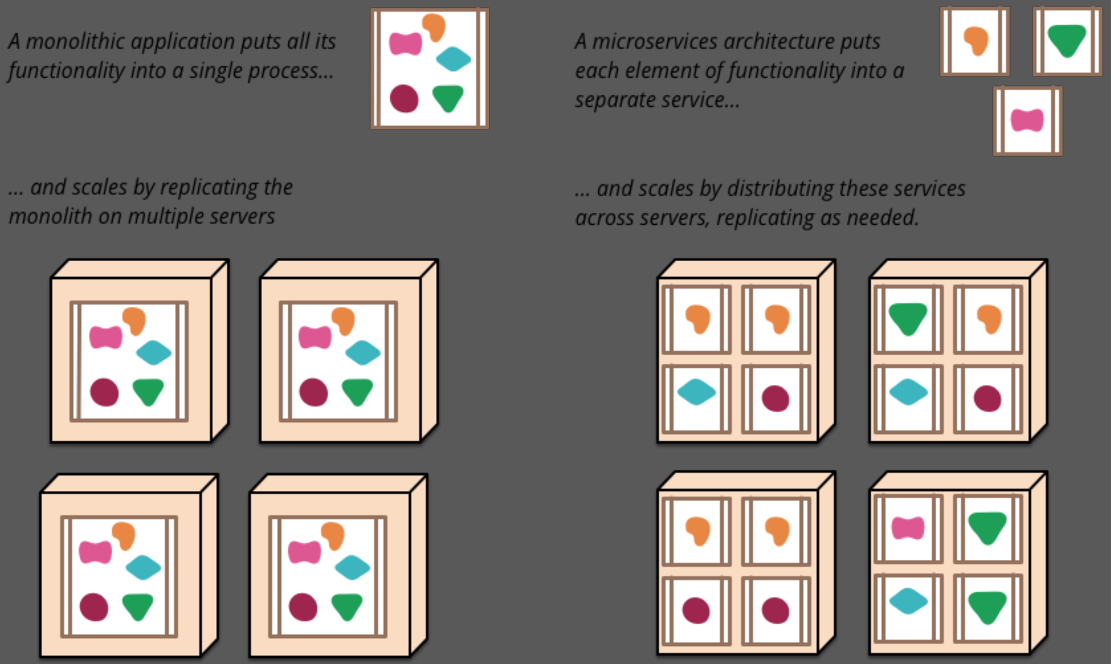
- Ownership
- Data Consistency

Scalability



A monolithic application puts all its functionality into a single process...

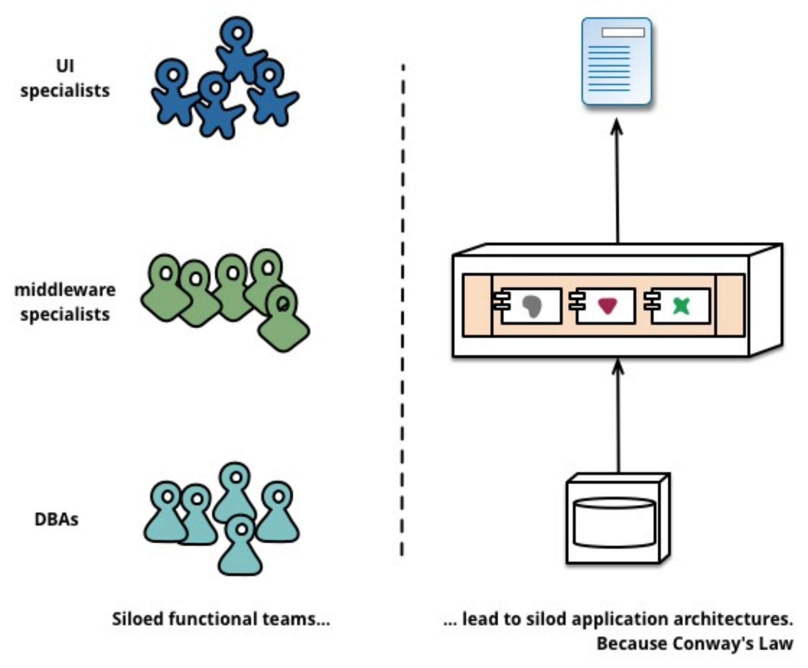
... and scales by replicating the monolith on multiple servers

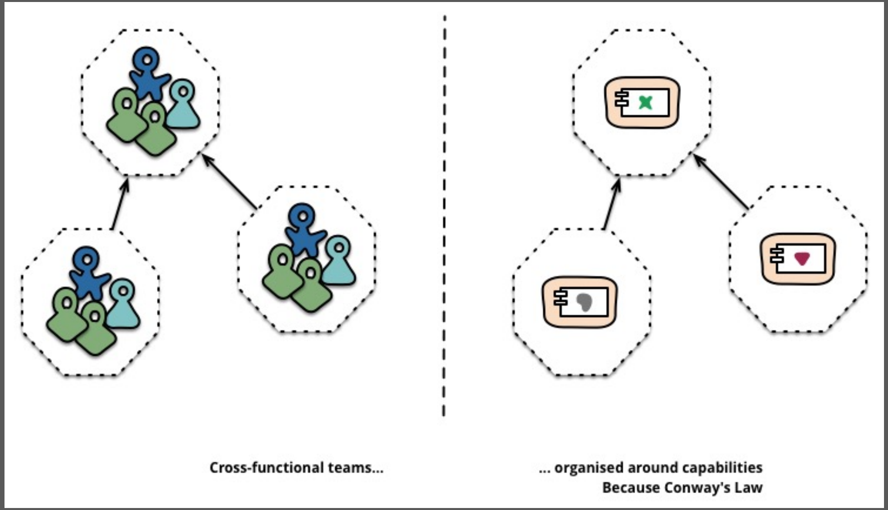
A microservices architecture puts each element of functionality into a separate service...

... and scales by distributing these services across servers, replicating as needed.

Source: http://martinfowler.com/articles/microservices.html

Team Organization (Conway's Law)

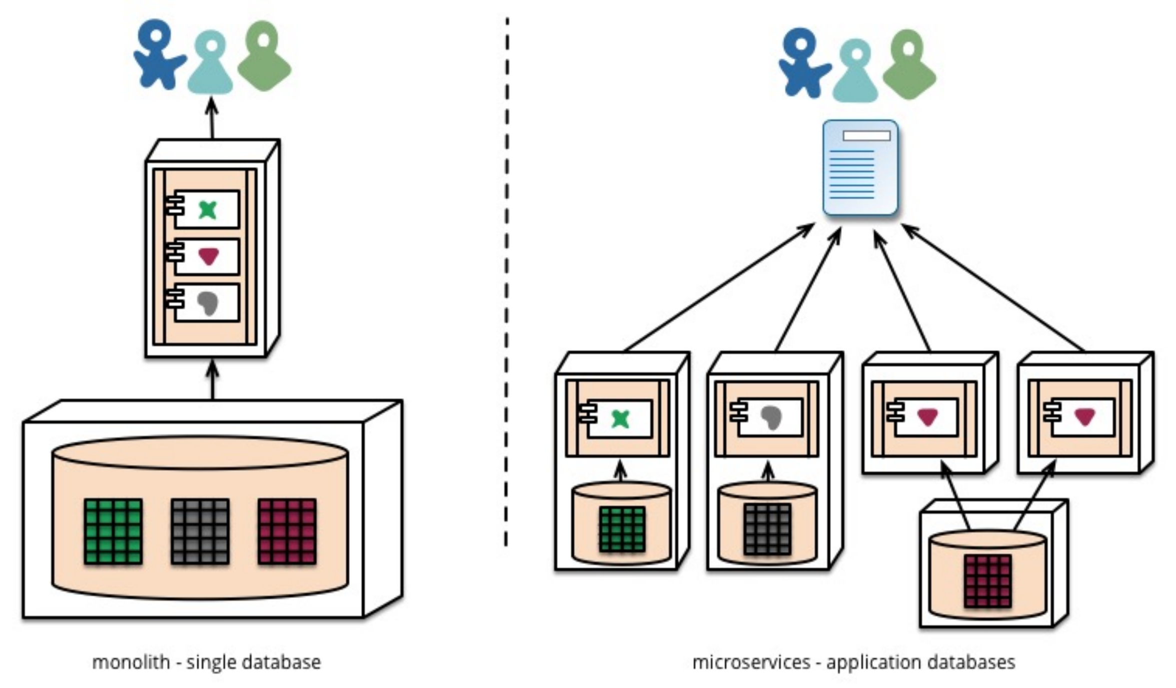

UI specialists
middleware specialists
DBAs
Siloed functional teams...
... lead to silod application architectures.
Because Conway's Law



"Products" not "Projects"

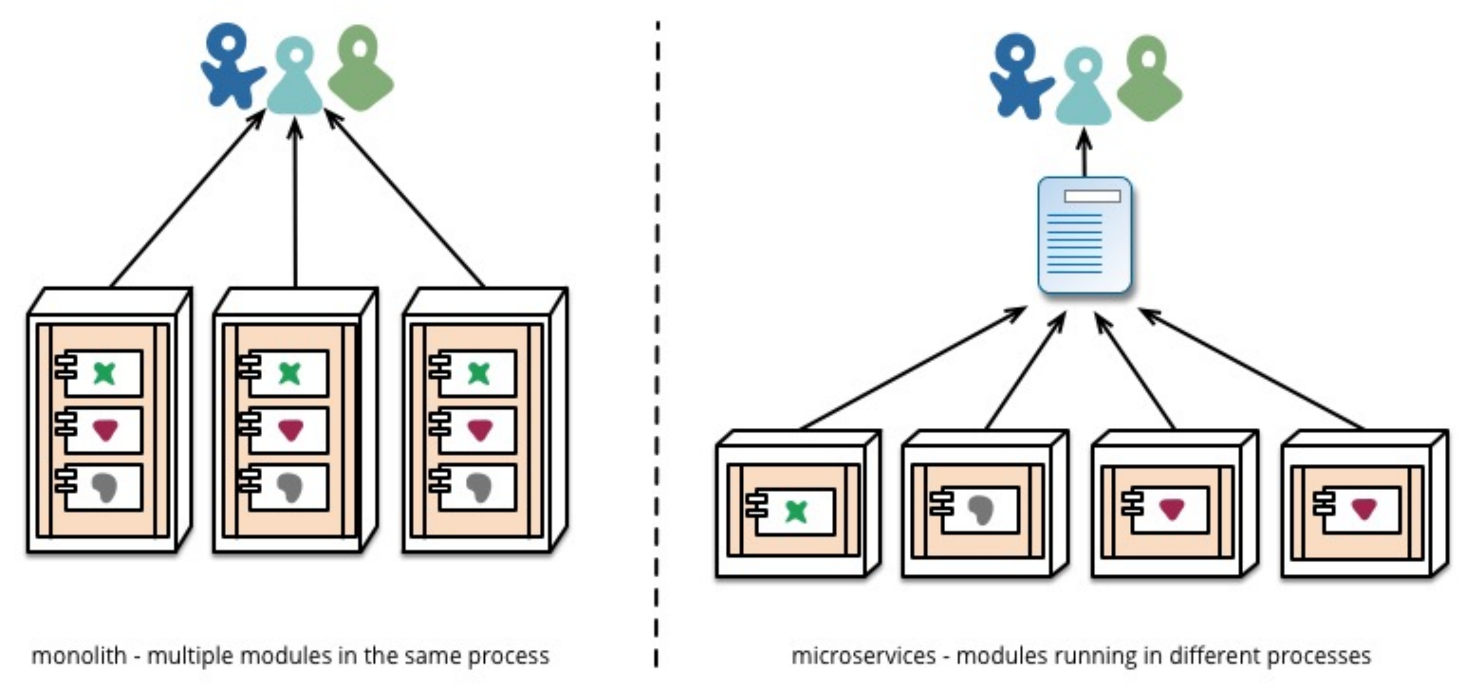
Source: http://martinfowler.com/articles/microservices.html

Data Management and Consistency


monolith - single database
microservices - application databases

Source: http://martinfowler.com/articles/microservices.html

Deployment and Evolution



monolith - multiple modules in the same process

microservices - modules running in different processes

Source: http://martinfowler.com/articles/microservices.html

Microservices

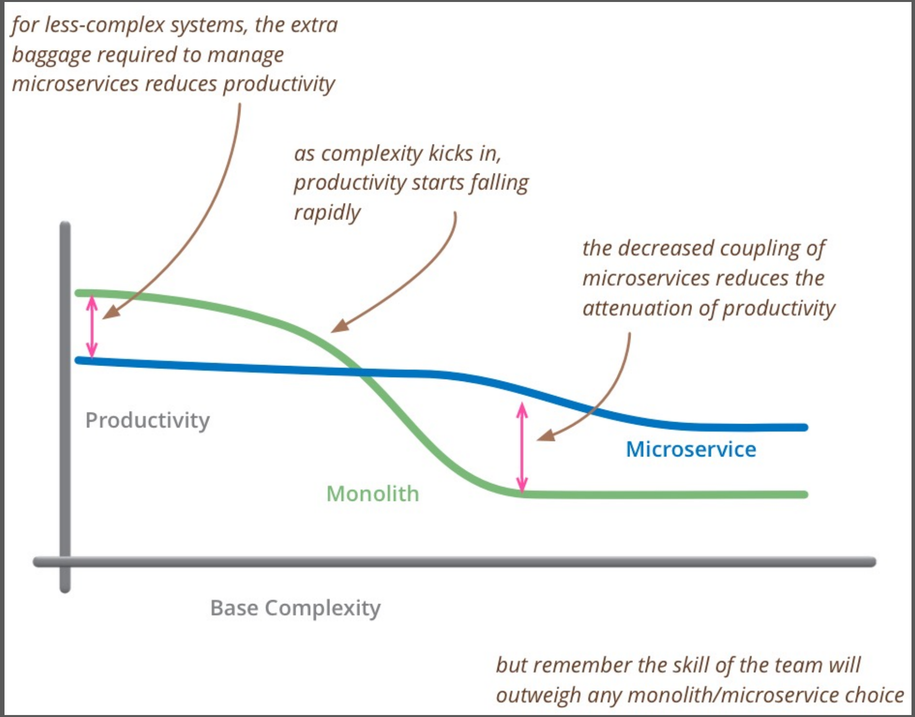
- Building applications as suite of small and easy to replace services
  - fine grained, one functionality per service (sometimes 3-5 classes)
  - composable
  - easy to develop, test, and understand
  - fast (re)start, fault isolation
  - modelled around business domain
- Interplay of different systems and languages
- Easily deployable and replicable
- Embrace automation, embrace faults
- Highly observable

Technical Considerations

- HTTP/REST/JSON/GRPC/etc. communication
- Independent development and deployment
- Self-contained services (e.g., each with own database)
  - multiple instances behind load-balancer
- Streamline deployment

Are microservices always the right choice?

Microservices overhead



for less-complex systems, the extra baggage required to manage microservices reduces productivity

as complexity kicks in, productivity starts falling rapidly

the decreased coupling of microservices reduces the attenuation of productivity

but remember the skill of the team will outweigh any monolith/microservice choice

Microservice challenges

- Complexities of distributed systems
  - network latency, faults, inconsistencies
  - testing challenges
- Resource overhead, RPCs
  - Requires more thoughtful design (avoid ”chatty” APIs, be more coarse-grained)_
- Shifting complexities to the network
- Operational complexity
- Frequently adopted by breaking down monolithic application
- HTTP/REST/JSON communication
  - Schemas?

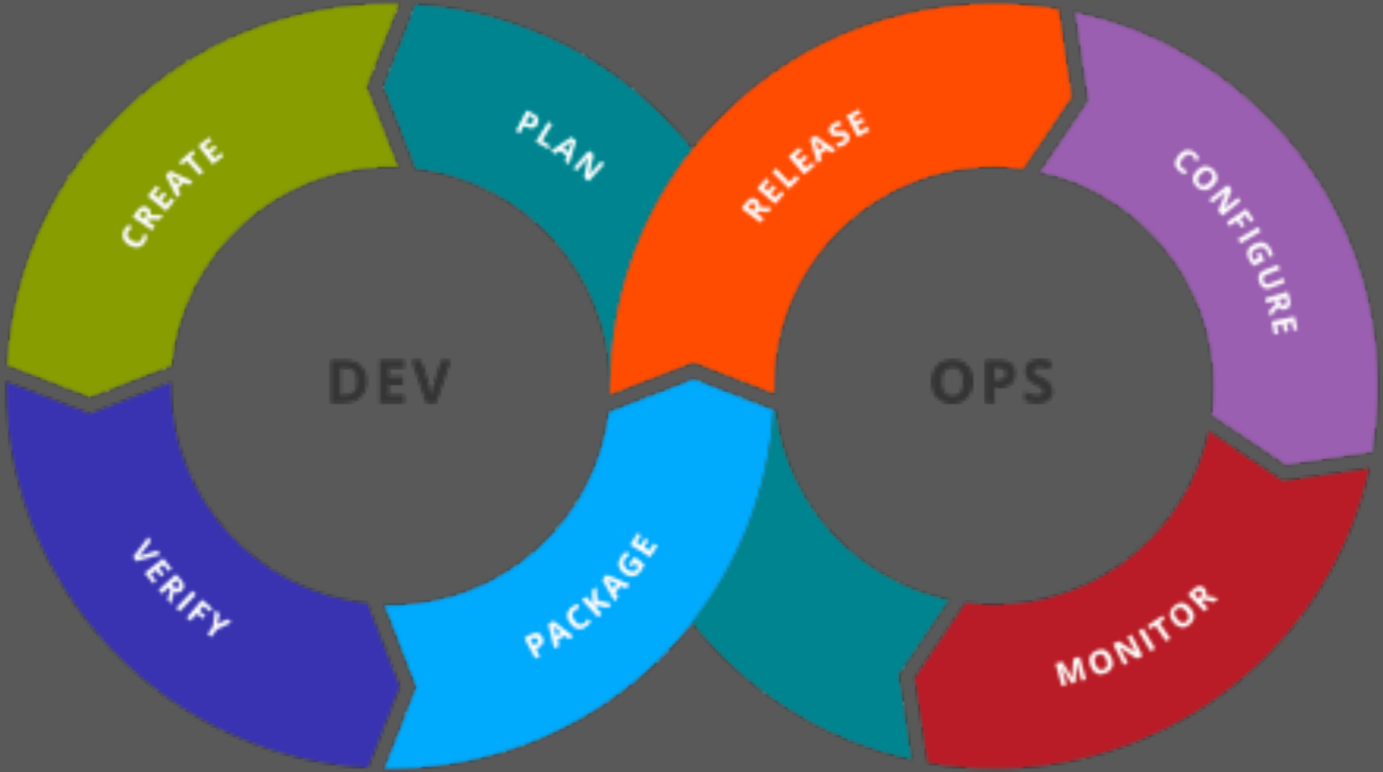
Taking it to the extreme

SERVERLESS

Serverless (Functions-as-a-Service)

- Instead of writing minimal services, write just functions
- No state, rely completely on cloud storage or other cloud services
- Pay-per-invocation billing with elastic scalability
- Drawback: more ways things can fail, state is expensive
- Examples:
  AWS lambda, CloudFlare workers, Azure Functions
- What might this be good for?

- (New in 2019/20) Stateful Functions:
  Azure Durable Entities, CloudFlare Durable Objects


DEV
OPS
PLAN
CREATE
VERIFY
PACKAGE
RELEASE
CONFIGURE
MONITOR