

# Architectural Skills

*CSSE6400*

Richard Thomas

May 29, 2023

*Quote*

Architecture is the stuff you can't Google.

– Mark Richards *[Richards and Ford, 2020]*

*Quote*

There are no right or wrong answers in architecture—only trade-offs.

— Neal Ford *[Richards and Ford, 2020]*

### *Architectural Design*

Architects use knowledge and experience to analyse trade-offs to design architectures appropriate to the system context.

Developers – Technical Depth *[Richards and Ford, 2020]*



## Architects – Technical Breadth *[Richards and Ford, 2020]*



- Architects need greater technical breadth than depth.
- Breadth allows better consideration of trade-offs.
- Avoid trying to become an expert across many areas – you'll fail.
- Don't stop learning – increase your breadth – don't let your knowledge become stale.

*Question*

What are the benefits of a monolith architecture?

*Question*

What are the benefits of a monolith architecture?

*Answer*

- Simple deployment



*Question*

What are the benefits of a monolith architecture?

*Answer*

- Simple deployment
- Simple communication between modules

*Question*

What are the benefits of a monolith architecture?

*Answer*

- Simple deployment
- Simple communication between modules
- Simple system testing & debugging

*Question*

Why do monoliths have a bad name?

*Question*

Why do monoliths have a bad name?

*Answer*

- Many legacy system nightmares were monoliths

### *Question*

Why do monoliths have a bad name?

### *Answer*

- Many legacy system nightmares were monoliths
- Easy to defeat modularity

*Question*

Why do monoliths have a bad name?

*Answer*

- Many legacy system nightmares were monoliths
- Easy to defeat modularity
- Cannot scale components of system

### *Question*

Why do monoliths have a bad name?

### *Answer*

- Many legacy system nightmares were monoliths
- Easy to defeat modularity
- Cannot scale components of system
- Monolith databases scale poorly

### *Question*

What can be done if a monolith architecture is no longer suitable?



*Question*

What can be done if a monolith architecture is no longer suitable?

*Answer*

- Greenfields replacement

### *Question*

What can be done if a monolith architecture is no longer suitable?

### *Answer*

- Greenfields replacement
- Migrate to another architecture
- Replacement: Can choose any suitable architecture. Risky, as you're developing a new system and maintaining existing.
- Migration: Adaptive maintenance, changing architecture slowly. Some limitation on choice of architecture, but most sophisticated architecture can be used.

*Question*

How do I migrate a monolith to a new architecture?

*Question*

How do I migrate a monolith to a new architecture?

*Answer*

Decompose the monolith into services.

Implies a service-based or microservices architecture.

## Strangler Fig Pattern

- Develop API for application's UI
- Proxy intercepts API calls
  - Proxy directs calls to application or new services
- Implement a service
  - Redirect calls to service
- Progressively replace monolith
- Shadow & Blue-Green Deployment



- May already have an API if the UI is a web or mobile app.
- Initially deploy proxy and new interface into production, with only existing monolith. Test it works as expected.
- Use shadow deployment to test service with application, before making available to end users.

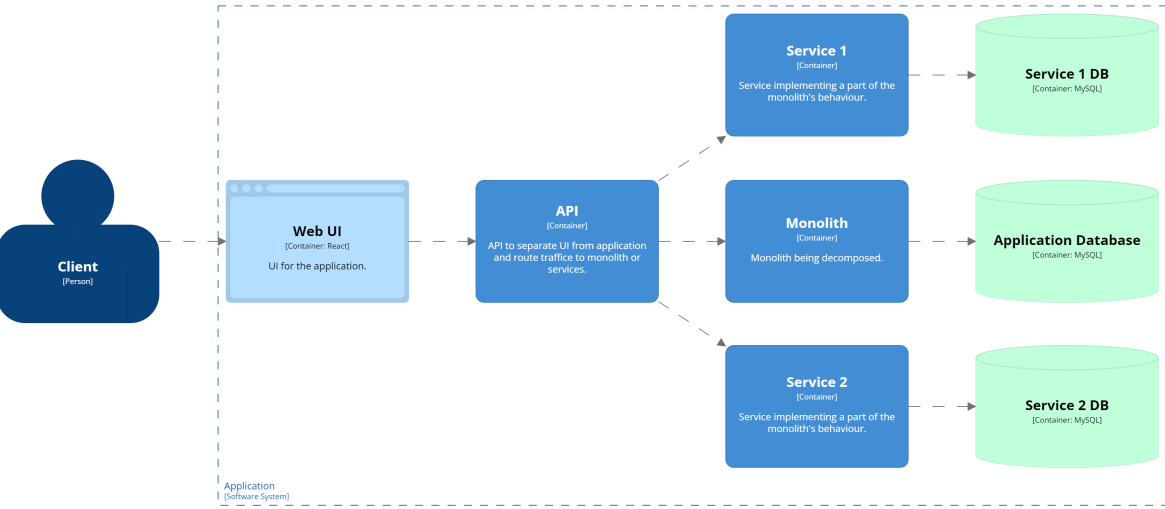
# Monolith Deployment



# Monolith Decompose: Step 1



# Monolith Decompose: Step 2





## Decomposition Process

- Identify bounded-contexts
  - Simple first service
    - e.g. Authentication
  - Minimise dependency from services to monolith
    - Monolith may use services
- Use first service (or first few) to validate approach and deployment infrastructure.
  - Minimise changes required in monolith.

## Decomposition Process

- Reduce coupling between bounded- contexts
    - e.g. Customer account management
      - Profile, Wish List, Payment Preferences – separate services
  - Decouple vertically
    - Service delivers entire bounded-context
      - Data is decoupled from monolith
- Account management may be tightly coupled in monolith. Separate each aspect (context), one at a time.
  - Do not focus only on UI or internal components, service needs to implement all parts of the business process.
  - Data management needs to be decentralised.

## Decomposition Process

- Focus on pain points
  - Bottlenecks
  - Frequently changing behaviour
- Rewrite, don't reuse
  - Redesign for new infrastructure
  - Reuse complex logic
    - e.g. Discounts based on customer loyalty and behaviour, bundle offers, ...
- Extract services that deliver highest value.
- What contexts may need to scale more than others?
- What contexts change more frequently and benefit from separate deployment?
- Services deliver capabilities provided by monolith.
- Most often it is better to rewrite the capability to take advantage of new infrastructure.
- Only reuse code that has complex logic that will be difficult to duplicate and test fully.

## Atomic Decomposition

- Refactor monolith
  - Use service to deliver application functionality
    - Monolith may need to invoke service
  - Remove service logic from monolith
- Atomic replacement of monolith behaviour by service's behaviour.
- Don't deploy production code with service behaviour left in monolith. Leads to a maintenance nightmare determining where behaviour is used, or it may be used in both the monolith and service.

### *Stepwise Decomposition*

Replace application functionality one service at a time.

*Definition 1. Macroservice*

Separate service, but may span more than one domain or share a database with the monolith or other services.

- Similar scalability and deployment issues to a monolith, but grouped by clusters of macroservices if they share a database.
- Interim step to build microservices.

*Definition 2. Nanoservice*

Service that depends on other services and cannot be deployed independently – its context is too small.

- Anti-pattern where services are too fine grained and need to be coupled to deliver business processes.
- Some use the term “nanoservice” to refer to independently deployable functions, similar to serverless architecture.

### *Definition 3. Conway's Law*

Organisations design systems whose structure is inevitably a copy of the organisation's communication structure *[Conway, 1968] [MacCormack et al., 2012]*.

- First citation is original article.
- Second citation is one of several about MIT and Harvard research into the phenomenon, calling it the “mirroring hypothesis”.
- Elaborate on this point and Coplien's research into organisational sociology.



### *Conway's Law Consequences*

- Business Process Management
  - Microservices to reflect organisation structure
  - Teams formed around services
- BPM: Redesign organisation structure to reflect system you want.
  - Microservices: Design system to reflect your organisation.
  - Elaborate on benefits of both approaches.
  - Comment on benefits of small focussed teams.

### *Conway's Law Consequences*

Team insularity – more loyal to team than organisation.

- Amazon example from week 11, negotiation difficulties with other teams.
- Need to ensure inter-team cooperation.
- Possibly move people between teams.
- Cloud platforms, and microservices, also support this and with larger teams.
- Intra-team communication becomes more difficult with large teams.

## Conway's Law Issues

- Cross-cutting concerns
    - e.g. Security
  - Organisation structure should align with market structure
  - Physical location of teams
- Cross-cutting concerns span services, and consequently teams.
  - Can't have a "security" service. It has to be part of every service.
  - Teams solely based around Conway's law and services may not deliver some cross-cutting concerns.
  - Cooperation, documentation and audits may be necessary.
  - Market structure may complement team structure to place teams closer to their end users.
  - Global development and outsourcing mean different teams are likely to be in different locations.
  - Requires additional overhead and documentation for cooperation between teams.

*Evidenced-Based Software Engineering*

Don't follow fads, seek evidence for good practice.

Elaborate on finding reliable sources of information and confirming facts yourself.

*Let's hear from an expert*

## Software Engineering's Greatest Hits

**what we actually know about software development  
and why we believe it's true**



**Greg Wilson**

<http://third-bit.com/talks/greatest-hits/>



1 / 47

## References

- [Conway, 1968] Conway, M. E. (1968).  
How do committees invent?  
*Datamation*.
- [MacCormack et al., 2012] MacCormack, A., Baldwin, C., and Rusnak, J. (2012).  
Exploring the duality between product and organizational architectures: A test  
of the “mirroring” hypothesis.  
*Research Policy*, 41(8):1309–1324.
- [Richards and Ford, 2020] Richards, M. and Ford, N. (2020).  
*Fundamentals of Software Architecture: An Engineering Approach*.  
O’Reilly Media, Inc.