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Microservices and DevOps

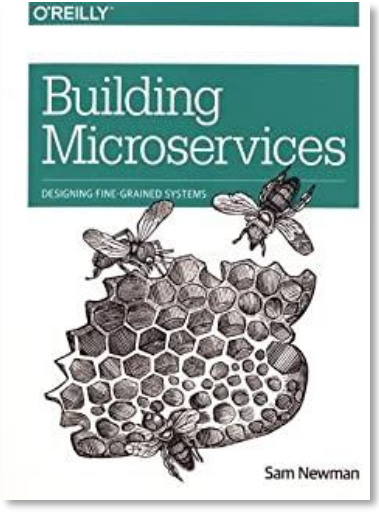
Scalable Microservices

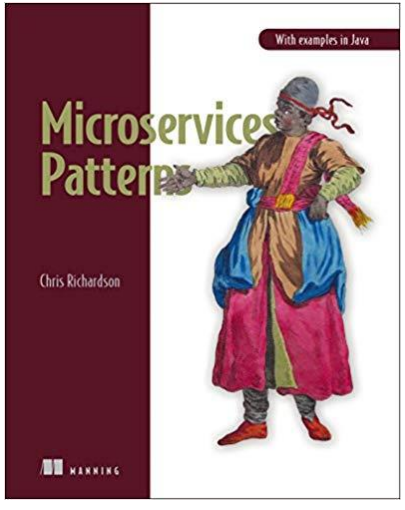
Splitting the Monolith aka.
Application Modernization

Henrik Bærbak Christensen

Introduction

- Making these slides took some effort to structure…
  - Newman talks a bit here and there …
- Using Newman §5 + GOTO stuff, and Richardson §13





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Context

- OK, so we have this monolith
  - that is busting at the seams, **or**
  - the sensible starting point for our MS architecture
- We want to *start the process of splitting it into sensible microservices.*
  - Entails:
  - *What process do we use to split the monolith*
  - *What boundaries in the monolith shall we split along*
    - *Or do we need to make them first?*
  - *What tactics/patterns to use for each 'extraction'*

Context

- We want to *start the process of splitting it into sensible microservices.*
  - **Splitting Process**
  - **Splitting Boundaries: Seams**
  - **Extraction Tactics**

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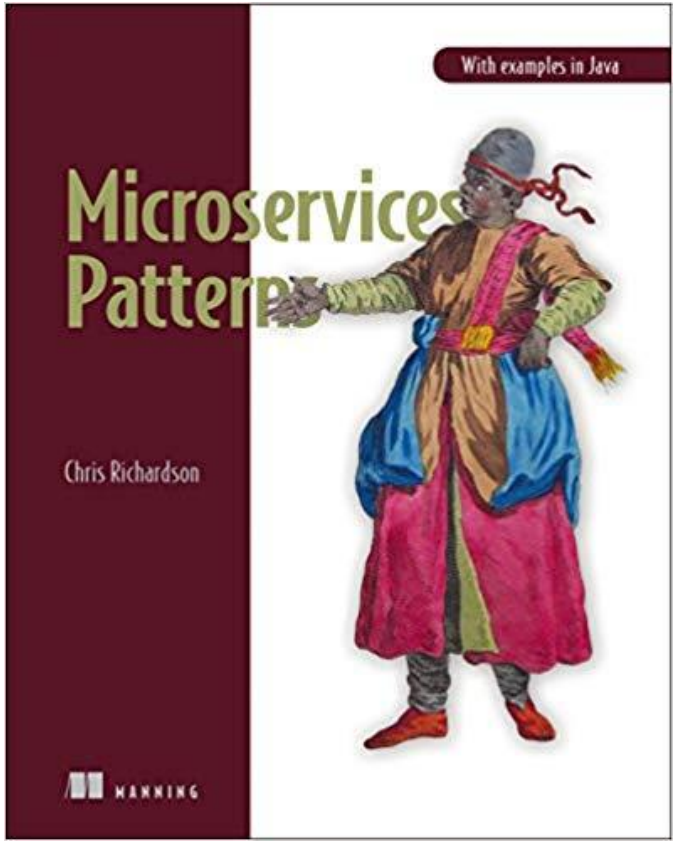
Splitting Process

Based primarily on Richardson

Appl. Modernization

- Source:
  - Chris Richardson

- **Application Modernization**: The process of converting a legacy application to one having a modern architecture and technology stack.



Rule #1

Do not do a big bang rewrite!

Strangler Pattern

- Strangler Application Pattern:
  - *Modernize an application by developing a new (strangler) application around the legacy application*
- Typically takes months/years

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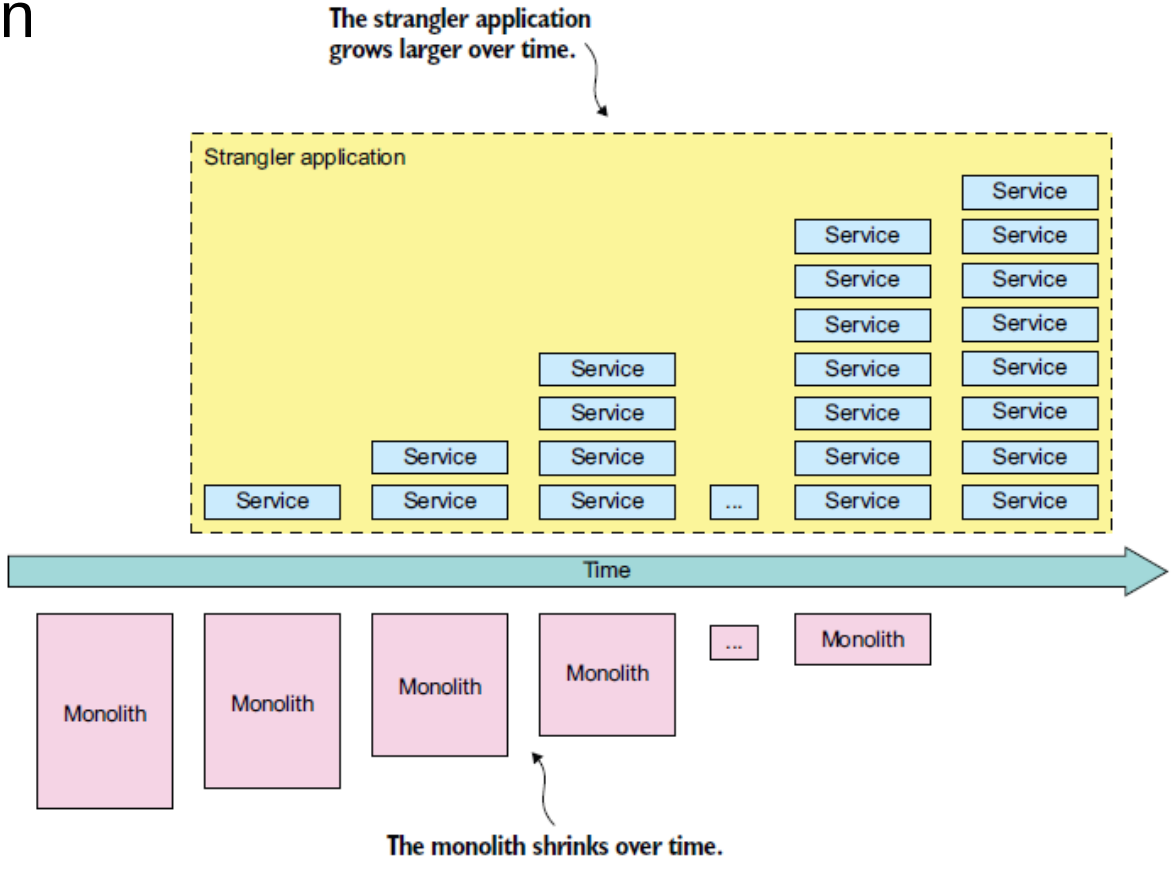
Strangling the Monolith

- From Richardson



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Testing is Central…

- ”The only thing you can’t live without, is a deployment pipeline that performs automated testing.”

[Richardson, p 433]

Software Vise

- Testing is central, because…

Software Vise: Automated tests around our software unit, fixating the behavior, and early detect any behavioral changes.

- … it creates confidence that we do not introduce defects while refactoring the architecture…

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Strangler Appl

- Benefits
  - Demonstrate value early and often
  - Minimize changes to the monolith
  - Evolve the Tech Deployment Infrastructure as you go
    - Aka: ‘You do not need it all now’…
  - And *you learn as you go!*
    - How to containerize, deploy, release, test, …

Refactoring Strategies

- Proposed strategies for strangling:
  - Implement *new* features as services
  - Separate presentation tier from backend tier
  - Break monolith by extracting business capabilities into services
    - That is: The real strangling

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New Features as Services

- *Law of Holes: If you find yourself in a hole, stop digging*
  - If you horse is dead, then dismount

- New features of the Monolith that is ‘ball of mud’ should be developed as microservices
  - Get experience with the MS paradigm
  - Stops the monolith growth
  - Does not invalidate current monolith behavior
    - Lessening the risk

Presentation Tier Splitting

- Often the Presentation tier is a feasible boundary to do a split

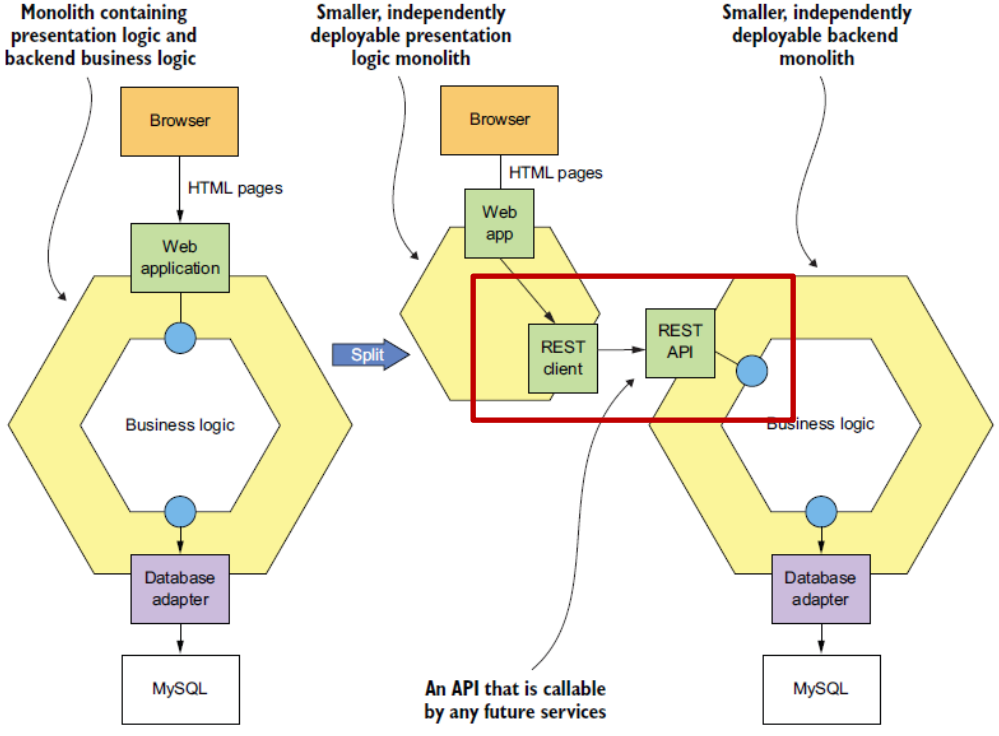

Figure 13.3 Splitting the frontend from the backend enables each to be deployed independently. It also exposes an API for services to invoke.

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Extract Business Capabilities

- Extract one business capability at a time
  - Applying the strangler pattern
- Entails
  - Splitting the domain model
  - Refactoring the database
- … Which leads to the next headline…

Splitting Boundaries: Seams

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Seams (?)

- *Seam*: Portion of code that can be changed without impacting the rest of the code (Newman)
- Feather himself:

> **Seam**
> A seam is a place where you can alter behavior in your program without editing in that place.

- Merriam-Webster dictionary

Definition of *seam* (Entry 1 of 2)

1 **a** : the joining of two pieces (as of cloth or leather) by sewing usually near the edge

b : the stitching used in such a joining

2 : the space between adjacent planks or strakes of a ship

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Seamless Confusion

- Seams is a good analogy, but in my mind, authors each have their own understanding of what it means
  - *Two independent 'things' are joined by a seam, making them form a bigger and more relevant 'whole.'*
  - But Feathers/Newman define the seam to be the 'things' ???
- Anyway – *software architecture is about cutting the whole into 'the right' pieces (creating the seams the right places) and use a suitable technique for joining them.*
  - Joining techniques:
    - API calls (in-process),
    - API calls (out-of-process)
    - Using a zillion different techniques: MQ, shared variable, methods,…

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Better Terminology

- Component – Connector Viewpoint

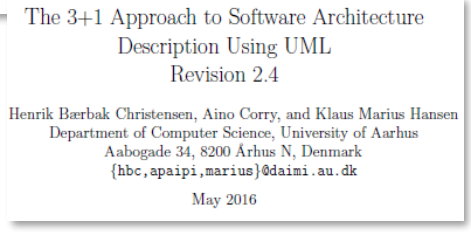
3.2.3 Elements and Relations

The C&C viewpoint has one element type and one relation type:

Component: A functional unit that has a well-defined behavioural responsibility.

Connector: A communication relation between components that defines how control and data is exchanged.

- Component (Newman seam)
  - A microservice, a process
- Connector (what I would call a seam…)
  - The communication: MQ, REST, …


The 3+1 Approach to Software Architecture Description Using UML
Revision 2.4

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Monolith and Coupling

- Coupling and cohesion have non-code aspects: The deployment aspect
  - It may be that my code change is highly cohesive and decoupled from the rest of the codebase, but…
  - … if I have a monolith, then I have to *redeploy the full monolith due to that single code change*
  - **High coupling in the deployment viewpoint/aspect ☹**

- Microservices enable decoupling in the deployment space *as well* as in the code space

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BC as Seam

- Newman argue (or postulate?) that bounded contexts work well as seams
- Process
  - Break apart as modules first *kind of ‘monolith first’ pattern*
  - ‘Microservicize’ modules next…
- In which order? Consider
  - Pace of change: Pick the one which changes fast
  - Team structure: Pick the one whose team is out-of-house
  - Security: Pick the one that has stricter security concerns
  - Technology: Pick the one that has specialized tech requirements

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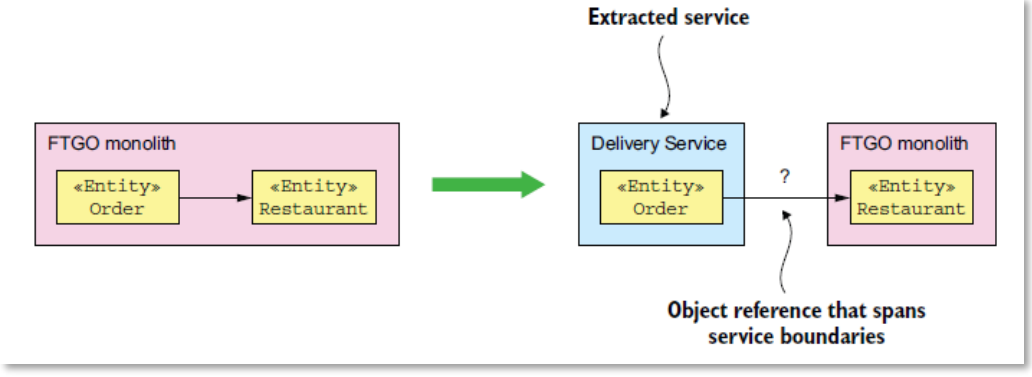
Extraction Tactics

Newman focus: The Database

The Issue

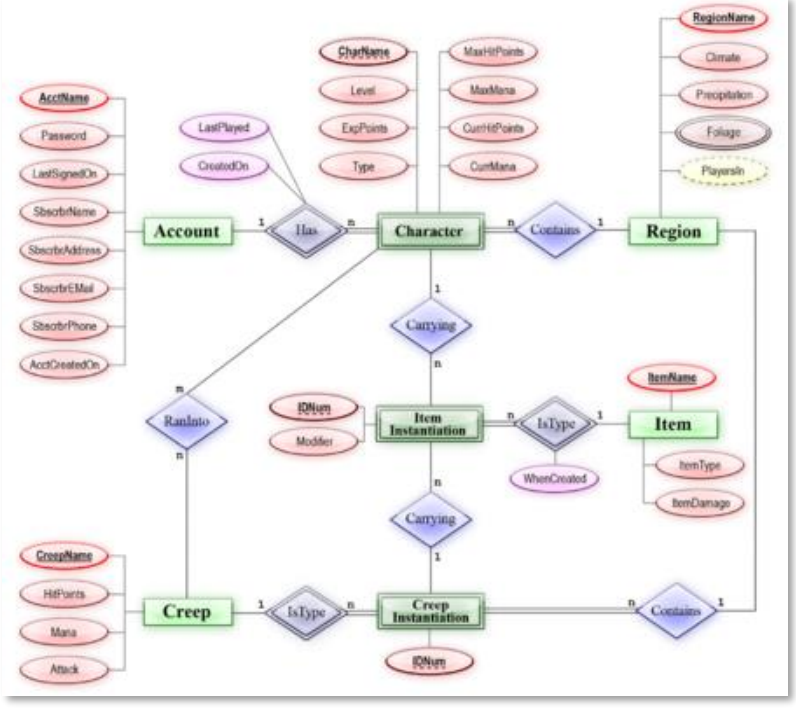
- Breaking a component/module into two microservices means handling those *references* that cross the connector
- Many forms of coupling
  - Object method call
  - Shared data (the database!)
  - …



The Database

- Classic Three-Tier systems all share the same database
  - The breeding ground for a ‘big ball of mud’/Spaghetti structure ☹

- Problem # 1
  - Understanding the table structure
    - Create an ER diagram ☺
  - Can be a major undertaking by itself…
    - Foreign key relations
  - Tools may help…



Foreign Keys

- Ex: Finance
  - Instead of ‘400 copies of sku-185, made 1300$’ we want
  - ‘400 copies of “Matas/hand sanitizer”, made 1300$’
  - Require lookup in ‘catalog’ for key ‘sku-185’ to get item name…
    - Aka ‘join tables’
- However, splitting into two services now…

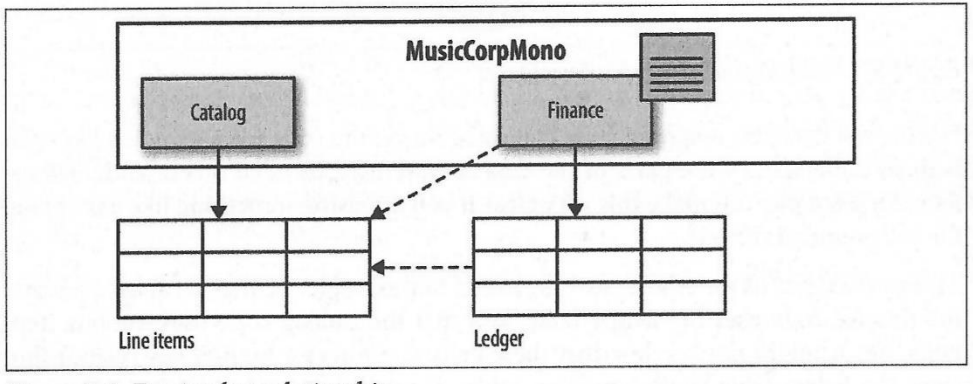


Figure 5-2. Foreign key relationship

Foreign Keys

- Two step breaking (if part of a ‘strangling effort’)
  - Step 1: Replace ‘join’ at database level with API call
    - String itemName = catalog.getNameOf(“sku-185”);
  - Step 2: Replace API call with out-of-service calls
    - Alas, make ‘catalog’ a connector implementation
      - Replace catalogServant with catalogProxy, OR
      - Replace catalogServant with catalogRESTConnector ☺

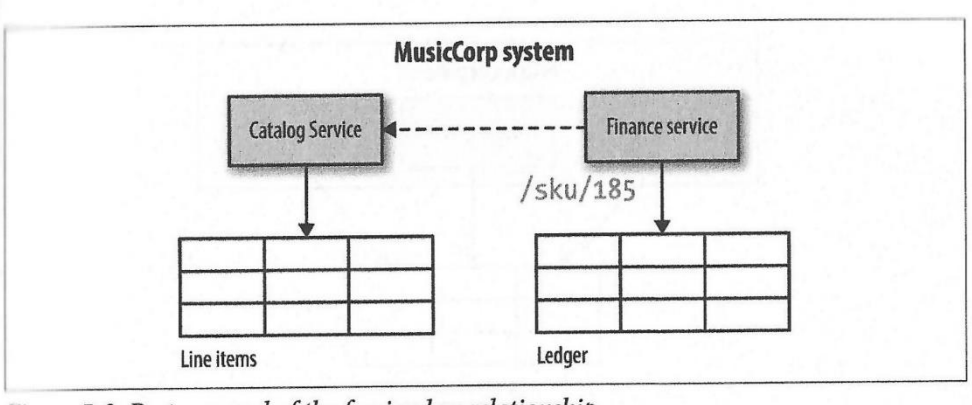


Figure 5-3. Post removal of the foreign key relationship

Compare

- Ring a bell?
  - *This is the NoSQL paradigm. No support for joins in the database, replace it with client side (manual) joins*
- The trade-off discussion is the same…
  - One server call is now two server calls
  - Constraint checking (foreign key relations) are now the duty of the clients

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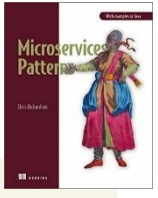
Transactions

- What about transactions?
  - Commit and rollback / all-or-nothing are strong concepts
- We are getting outside the scope of this course
  - I know rather little of the subject ☺
- General rule
  - Either you *live without transactions*
    - Eventual consistency, correctional events, SAGA
  - Or you *make bigger services*
    - If transaction is vital, and cross boundary of service A and B, then merge them into a single service.



Pattern: Saga
Maintain data consistency across services using a sequence of local transactions that are coordinated using asynchronous messaging. See http://microservices.io/patterns/data/saga.html.

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Shared Static Data

- Example: Country code table in shared DB
- Solutions:
  - Duplicate the table in all *distributed data management layers*
    - Consistency issue – duplicated data ☹
  - Data as Code – read a property file instead of DB access
    - Consistency issue – but easier than DB changes
      - Easier to push a new property file into a set of code bases
  - Own service – REST call to get data
    - Often overkill, but consistency now in place

Shared Mutable Data

- Two modules both write/read from **shared data**

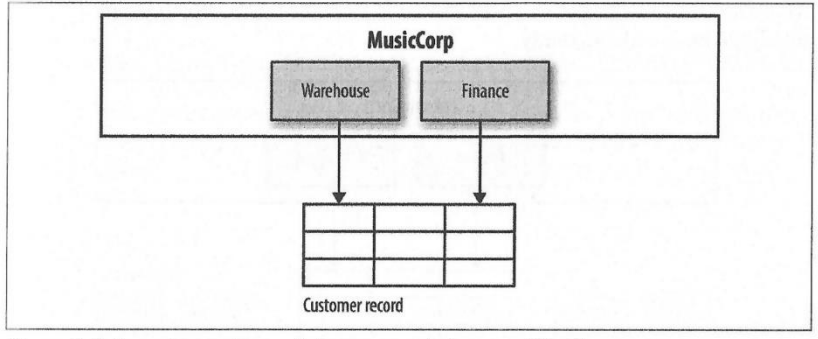

Figure 5-5. Accessing customer data: are we missing something?

- Often because the modeling has missed a BC
  - Solution: Make it ☺

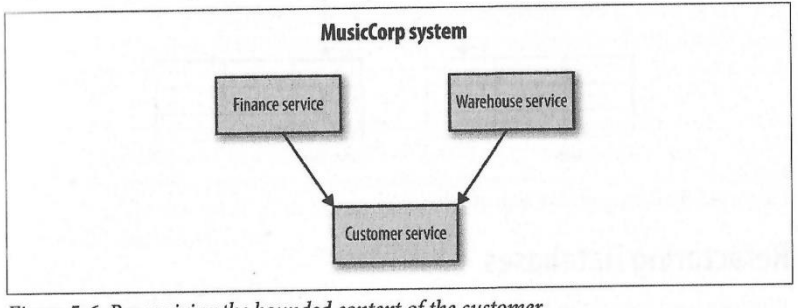

Figure 5-6. Recognizing the bounded context of the customer

Shared Table

- Example: Catalog and Warehouse read/write different columns in a shared table
  - Accidental architectural flaw?

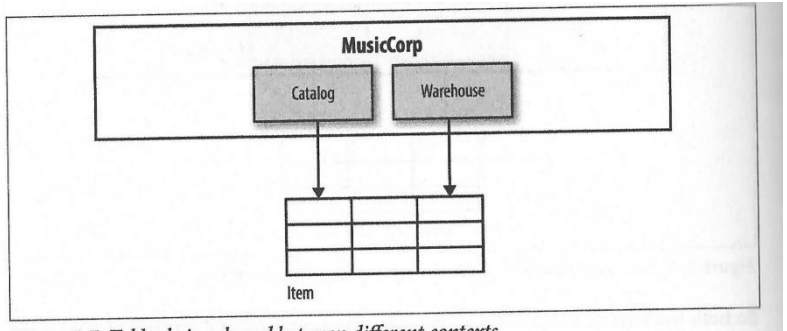

Figure 5-7. Tables being shared between different contexts

- Solution: Break the table
  - Nygard talks more in-detail about that…
    - Shims, trickle-then-batch, etc.

NoSQL?

- How does this relate to NoSQL?
- Well – a lot, basically we have many of the same issues
- The Foreign Key issue is non-existent
  - As we have none of them in a ‘by-the-book’ NoSQL usage
- Potentially we have a worse issue
  - Document paradigm – splitting out embedded documents!
    - { room: “You are in…”, position:”(0,0,0)”, messages: [{…},{…}]}
    - Moving messages to other service is a non-trivial exercise!
- The Shared Data/Table issue is the same

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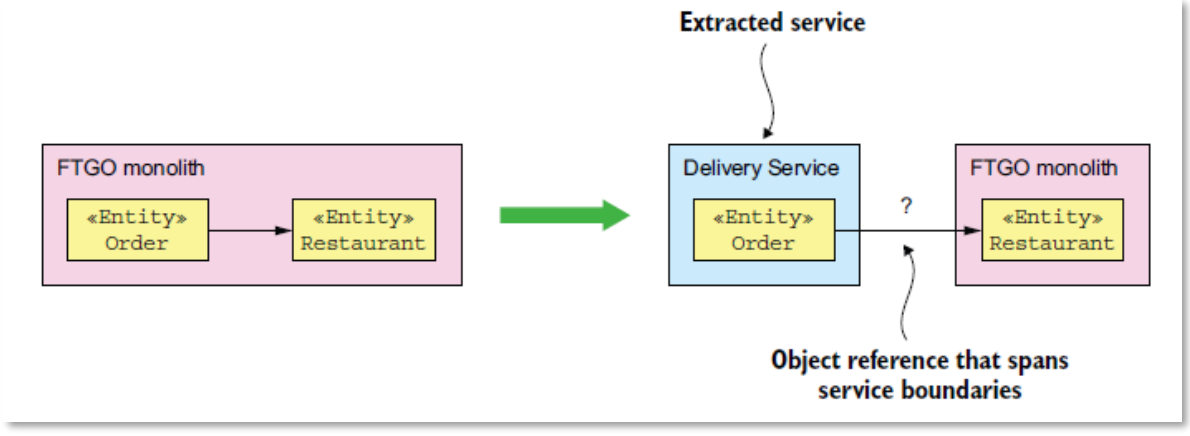
Extraction Tactics

But what about API calls?

Newman Forgot?

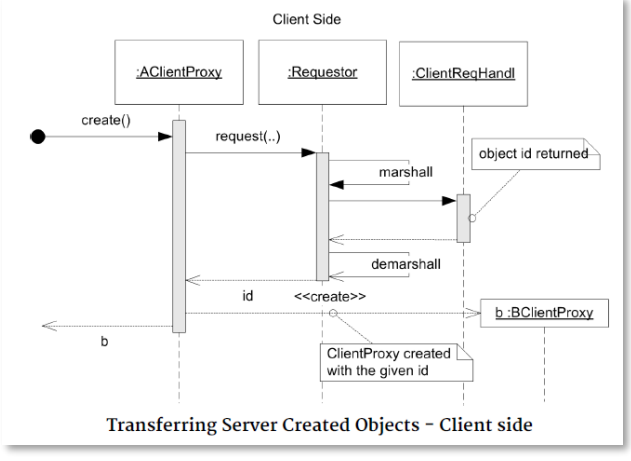
- What about simple API calls using references?
  - myRestaurant.placeOrder(table13Order);



- *In-process object references* makes no sense across process boundaries…

FRDS Broker

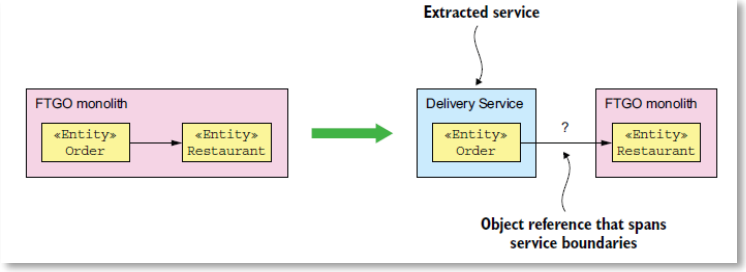
- The very same problem is discussed in my FRDS book regarding the Broker pattern
  - Basic idea: **Replace object reference with a unique ID, which the object owner service can use to access the underlying object, using a name service.**
  - Client side, we create a proxy, that just stores this ID, and then call servant object using this ID
    - Server translate id to servant object

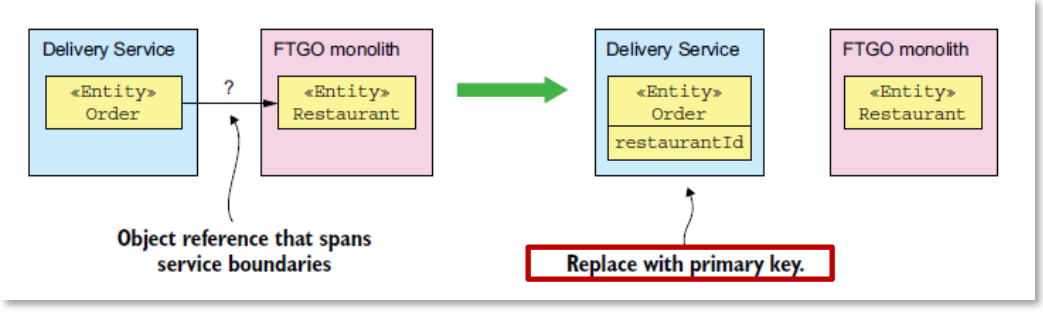


Transferring Server Created Objects – Client side

MicroService Context

- Microservices have to do the same:
  - **Replace object references with unique IDs (“primary keys”)**





- *Aggregates reference each other using primary keys rather than object references*

Sidebar: Aggregates

- *Aggregate:* Collection of domain objects, that are treated as a unit. A domain model is a collection of aggregates.

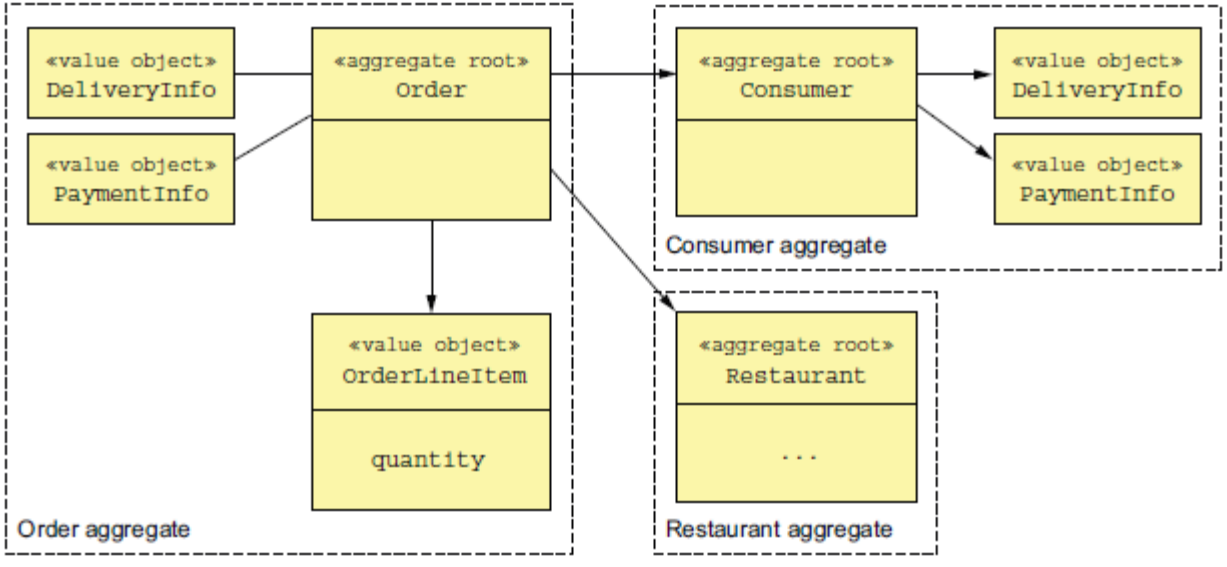


Figure 5.5 Structuring a domain model as a set of aggregates makes the boundaries explicit.

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REST Context

- In REST
  - A Create is a POST message which must return a Location

```
HTTP/1.1 201 Created
Date: Mon, 07 May 2018 12:16:51 GMT
Content-Type: application/json
Location: http://telemed.baerbak.com/bloodpressure/251248-1234/id73564827

{
  patientId:  "251248-1234",
  systolic:   144.0,
  diastolic:  87.0,
  time: "20180515T094804Z"
}
```

  - So URI's path-segment is an obvious unique ID candidate

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Branch By Abstraction

If the seams are not clear

(From a Newman's GOTO Workshop)

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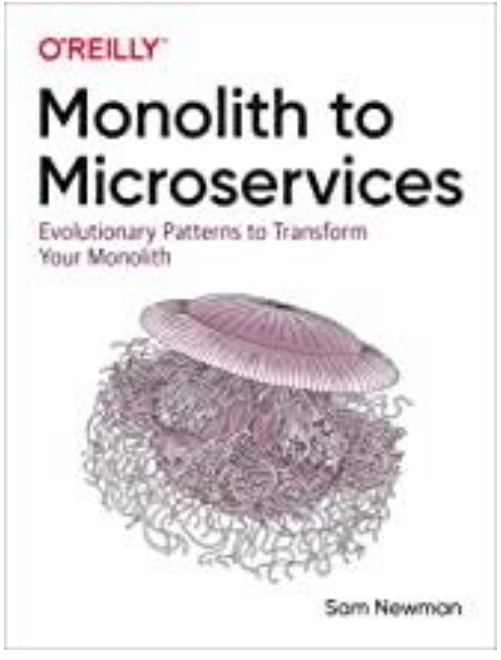
Newman's New Book

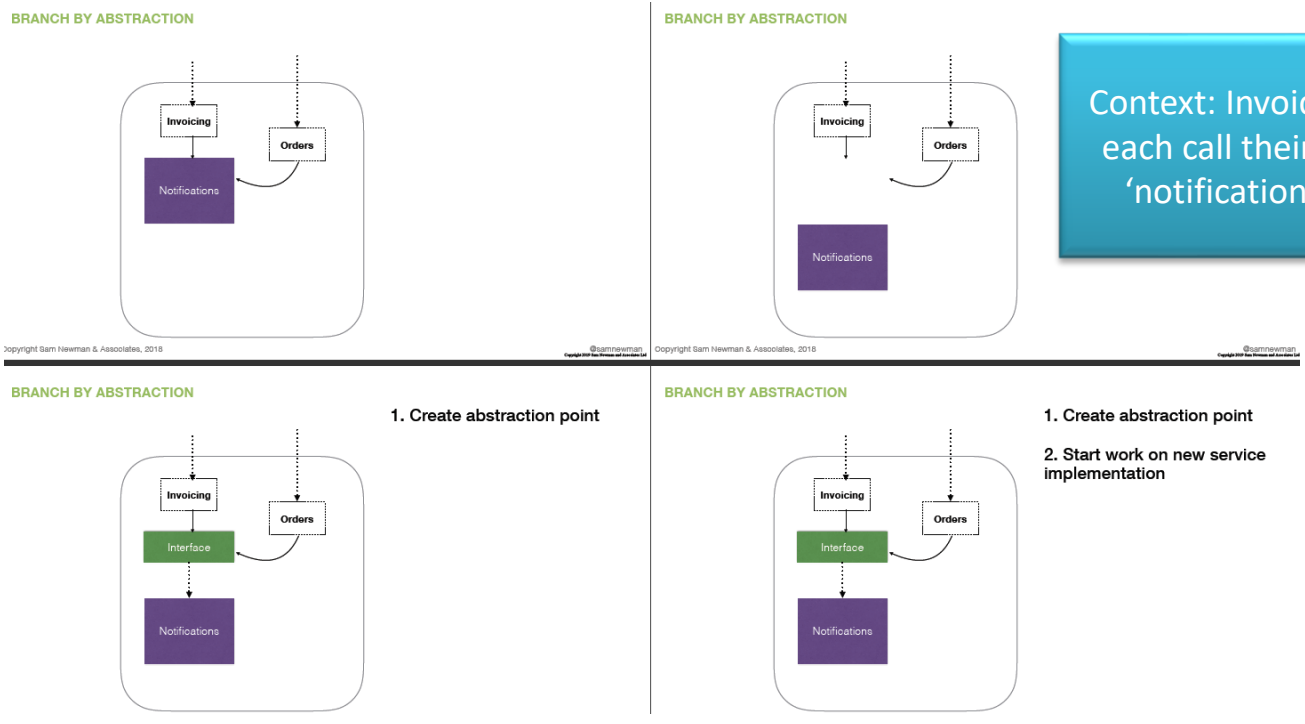
- Slides are from before Newman published his book

- Essential set of patterns, if you are in that situation…



Goto2019 Workshop

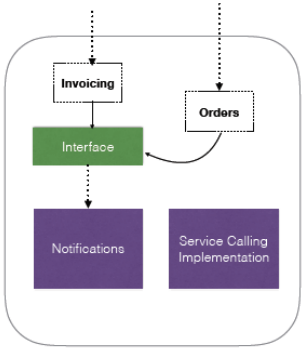
- One very concrete pattern
  - *Monolith Splitting Pattern:* ***Branch By Abstraction***



BRANCH BY ABSTRACTION

1. Create abstraction point

2. Start work on new service implementation



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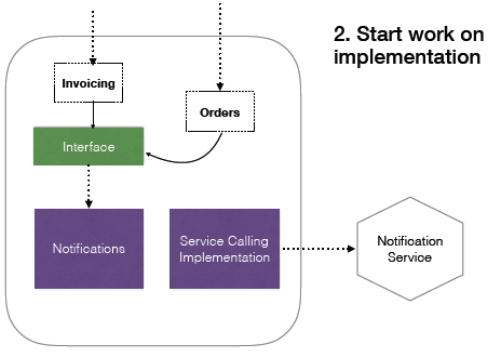
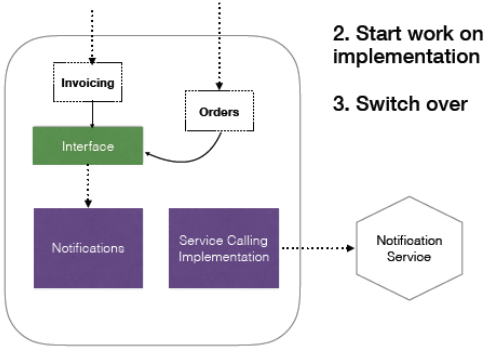


BRANCH BY ABSTRACTION

1. Create abstraction point

2. Start work on new service implementation

3. Switch over



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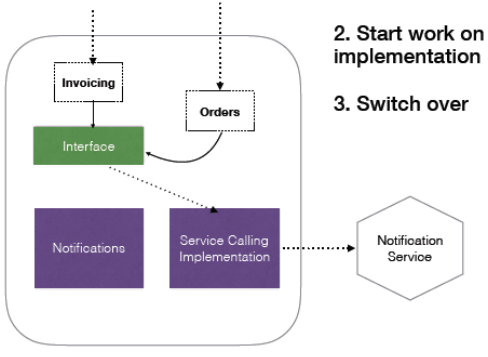

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BottomLine

- We need to refactor our notification services so you
  - 3) Encapsulate what varies
  - 1) Program to an interface
  - 2) Favor object composition

  Notification

  All that use Notifi…

  - And then let *dependency injection* determine if you use the old legacy code or use the new µ-service

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Extraction Tactics

A Testability tactic
for major rework

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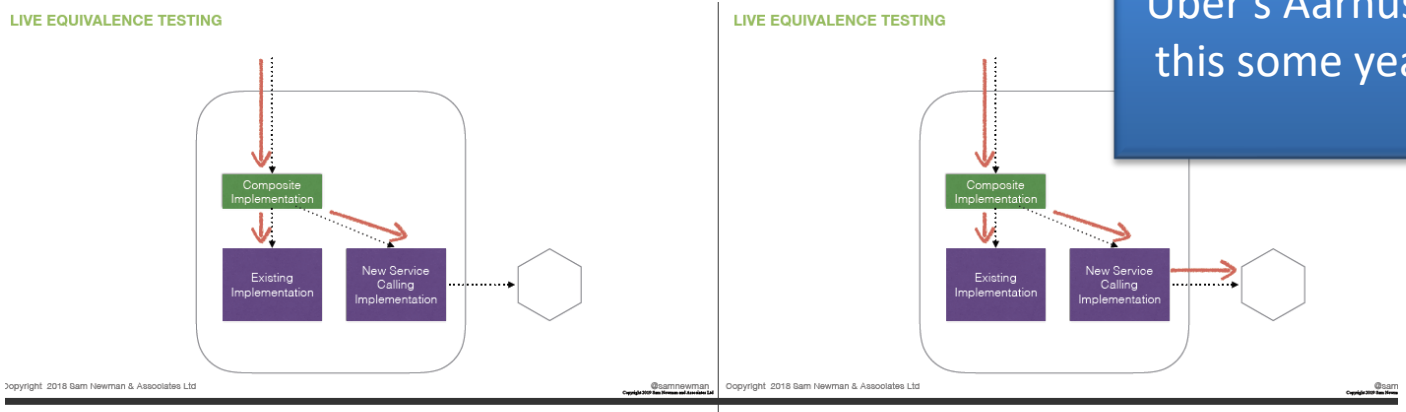
Migration Pattern

- *Live Equivalence Testing*



Uber's Aarhus unit did this some years ago…

Call both implementations & compare

Divert proportion of traffic to test new implementation (canary release)

CANARY RELEASING

https://cloudplatform.googleblog.com/2017/03/how-release-canaries-can-save-your-bacon-CRE-life-lessons.html

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Reporting

Cross Service Data

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Reporting

- Reporting: Group together data from across multiple parts of our organization to generate useful output
  - Typically a managerial perspective
    - Purchase patterns, browsing patterns, optimization, sales distribution, …
- Monolith / Three tier case is ‘easy case’
  - Select * from * where({85 lines here})
- But what now?

Reporting

- Retrieval via Service Calls
  - Pull the data by pulling from each service
    - Often require a special ‘reporting API’, to avoid overhead of a zillion GET requests, interfering with normal processing
- Data Pumps
  - Push data to reporting system
    - HTTP calls, or (better) standalone programs with direct DB access
      - (Now we have a shared database, relying on the schema!)
- Event Data Pump
  - Subscribe to ‘state change events’
    - We will return to the ‘event sourcing’ tactics for databases later
- And – Monitoring… Stay tuned…

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Code Level Legacy Refactoring

Just mentioning …

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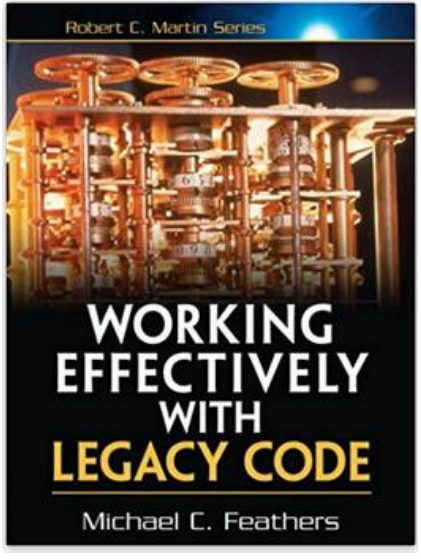
Incremental Testability

- An *incremental* refactoring process to ***introduce*** testability
- Primary Source
  - Martin C. Feathers



Our goal today:
A few key points!

Software Vise

- Approaches
  - **Edit and Pray ☹**
    - Carefully plan changes, ensure you understand the code, make changes, run system and poke around to make you did not break anything…
  - **Cover and Modify ☺**
    - Idea: Make a *safety net* that cloaks our code of interest and ensure no bad changes leak out into the surrounding code.
      - *Covering = Covering with Automated Tests !*
      - Tests as tools to *identify behavioral changes*

Software Vise: Automated tests around our software unit, fixating the behavior, and early detect any behavioral changes.

Summary

- Avoid big-bang rewrites, have strong testing (the ‘vise’), and do it one small step at a time
  - The strangler pattern
  - Lots of extraction tactics
    - For the database
    - For the components and connectors