Microservices: Decomposing Applications for Deployability and Scalability

Chris Richardson

Author of POJOs in Action

Founder of the original CloudFoundry.com

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http://plainoldobjects.com

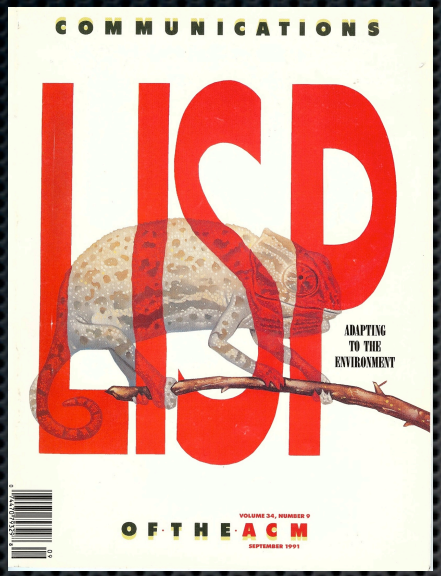
Presentation goal

How decomposing applications improves deployability and scalability

and

simplifies the adoption of new technologies

About Chris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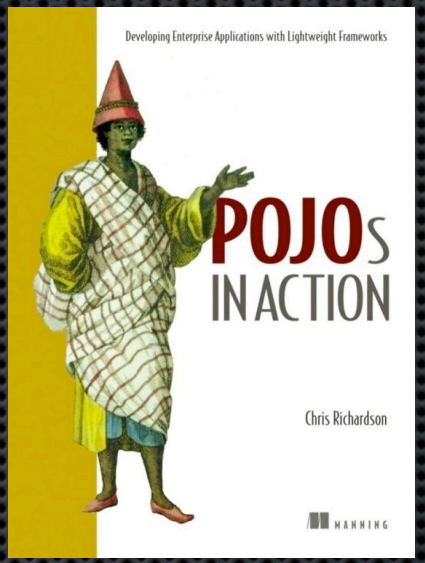
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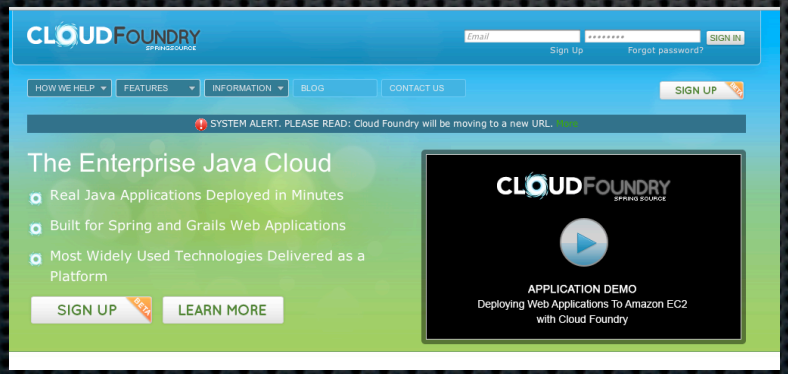
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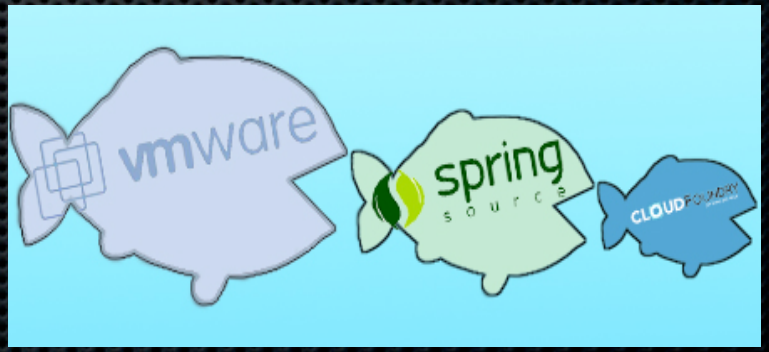
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About Chris

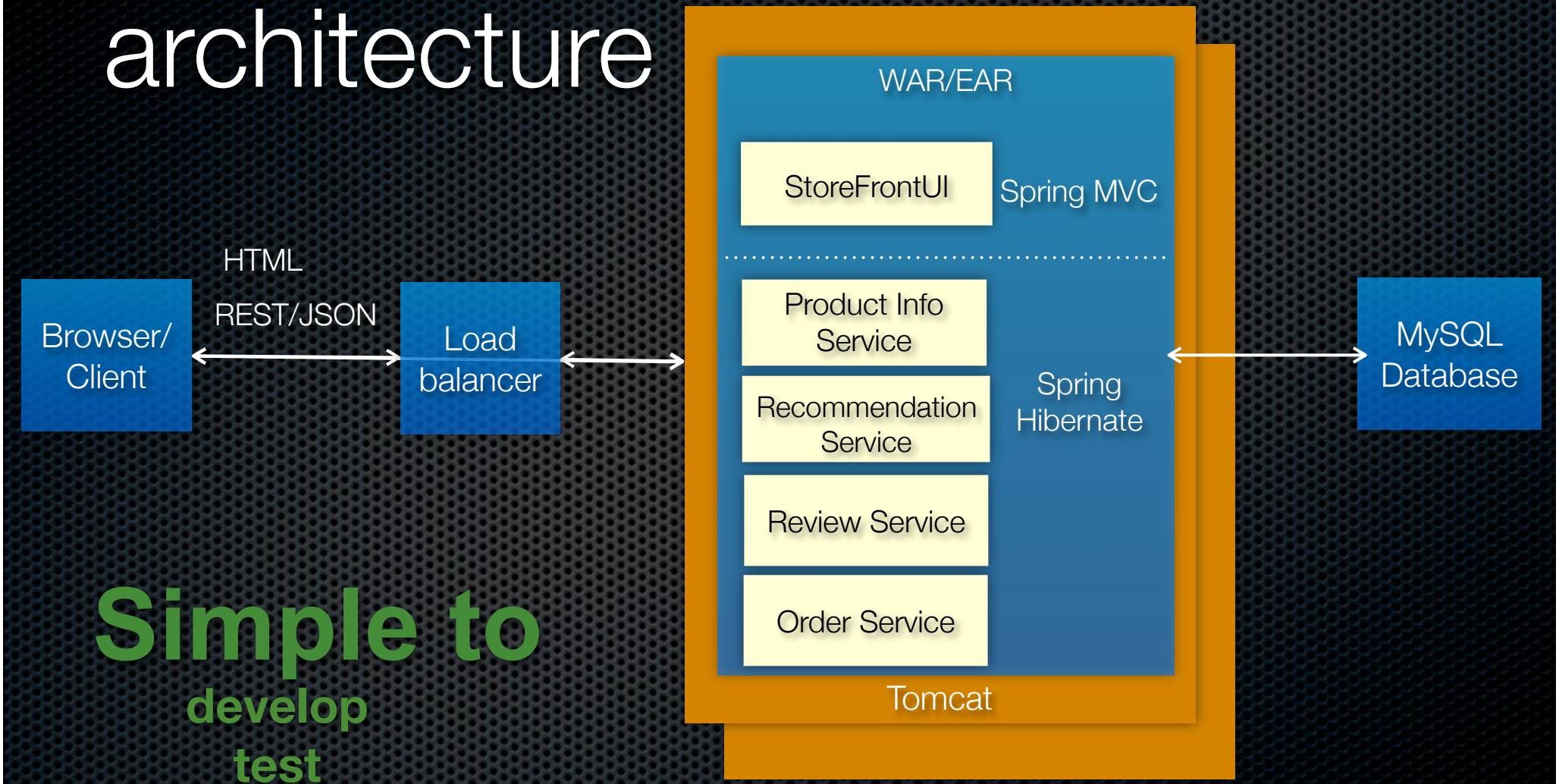
- Founder of a buzzword compliant (stealthy, social, mobile, big data, machine learning, ...) startup
- Consultant helping organizations improve how they architect and deploy applications using cloud computing, micro services, polyglot applications, NoSQL, ...

Agenda

- The (sometimes evil) monolith
- Decomposing applications into services
- Client ⇔ service interaction design
- Decentralized data management

Let’s imagine you are building an online store

Traditional application architecture



Simple to

develop

test

deploy

scale

But large, complex, monolithic applications

⇒

problems

Intimidates developers

Obstacle to frequent deployments

- Need to redeploy everything to change one component
- Interrupts long running background (e.g. Quartz) jobs
- Increases risk of failure

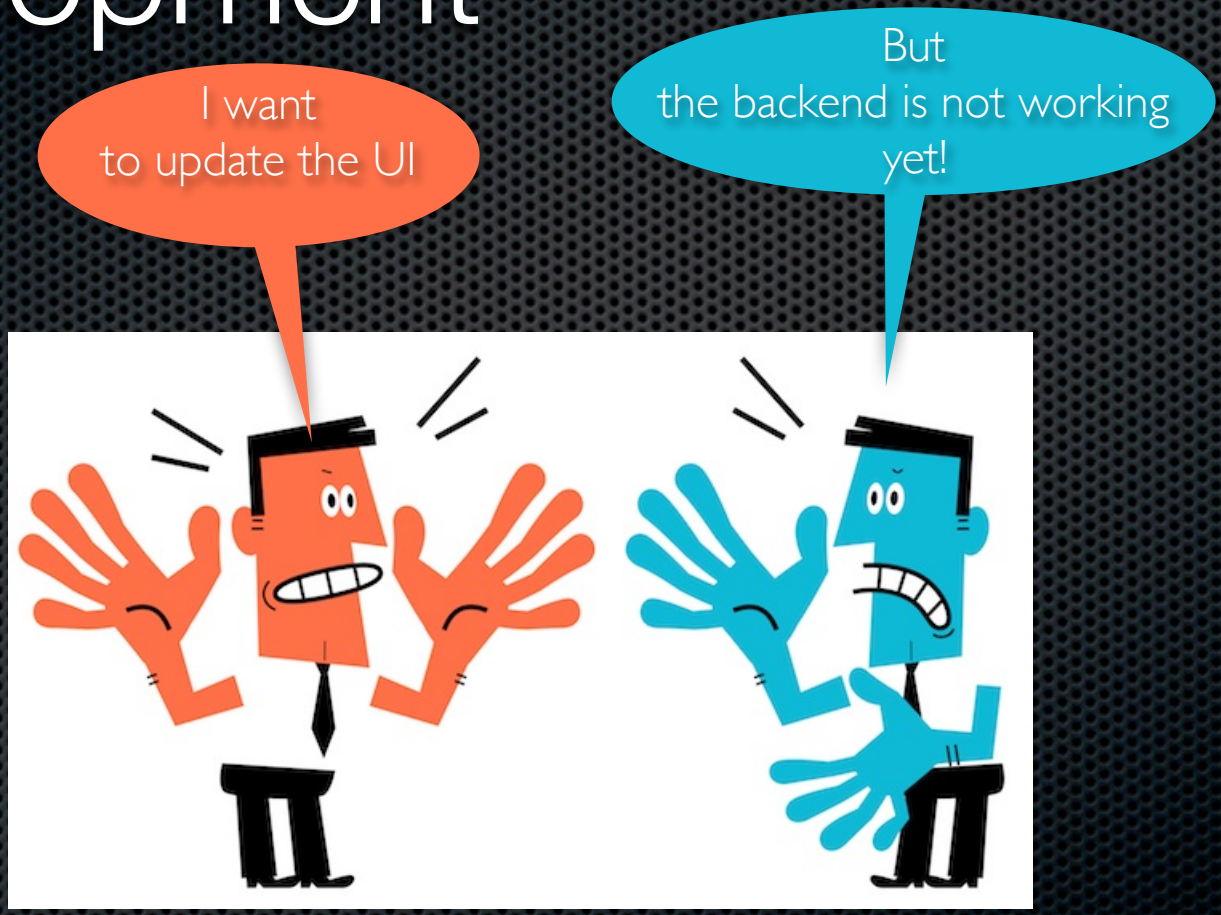
Eggs in one basket

- Updates will happen less often - really long QA cycles
- e.g. Makes A/B testing UI really difficult

Overloads your IDE and container

Slows down development

Obstacle to scaling development



Lots of coordination and communication required

Requires long-term commitment to a technology stack

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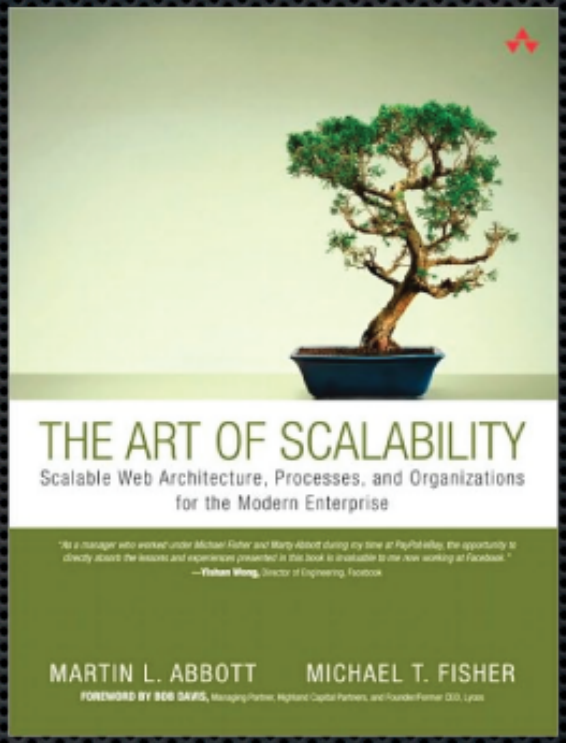
THE ART OF SCALABILITY
Scalable Web Architecture, Processes, and Organizations for the Modern Enterprise
MARTIN L. ABBOTT
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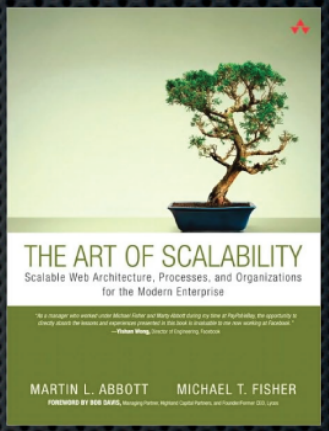
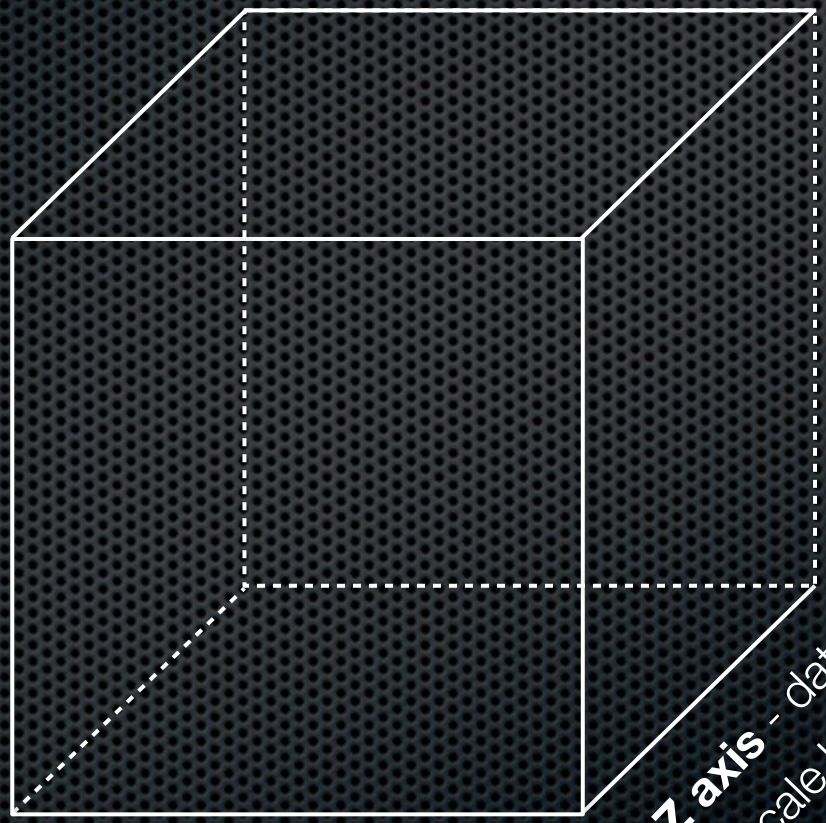
The scale cube



Y axis - functional decomposition

Scale by splitting different things



Z axis - data partitioning
Scale by splitting similar things

X axis
- horizontal duplication

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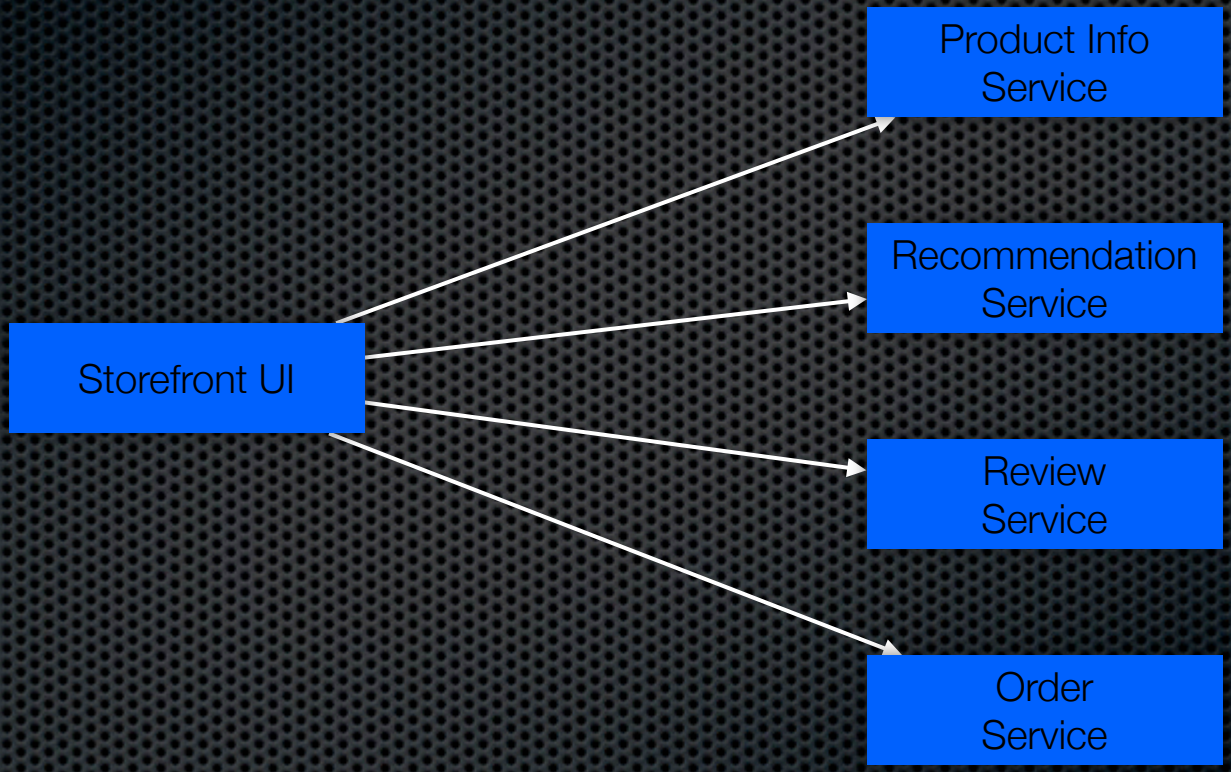
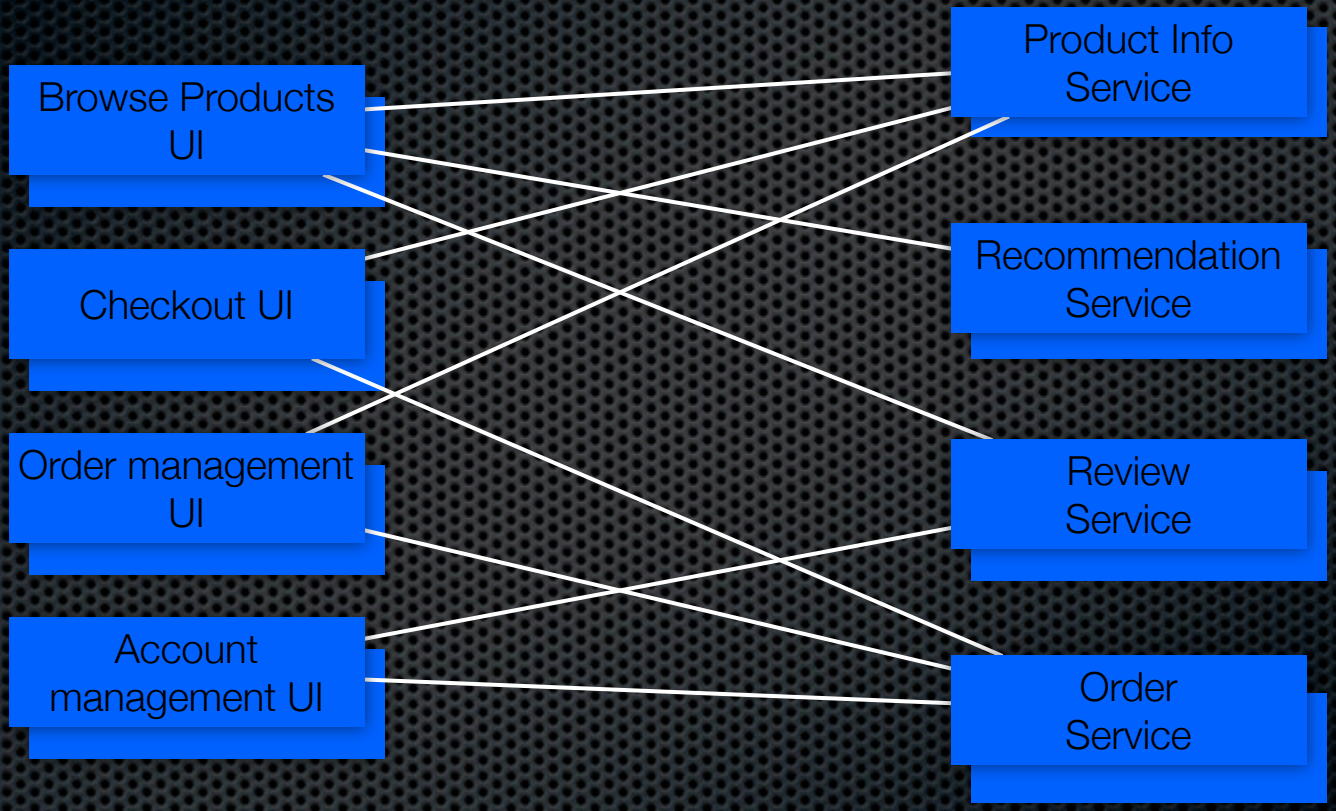
Y-axis scaling - application level

Y-axis scaling - application level



Y-axis scaling - application level



Apply X-axis and Z-axis scaling to each service independently

Service deployment options

Isolation, manageability

- VM or Physical Machine
- Docker/Linux container
- JVM
- JAR/WAR/OSGI bundle/...

Density/efficiency

Partitioning strategies...

- Partition by noun, e.g. product info service
- Partition by verb, e.g. Checkout UI
- Single Responsibility Principle
- Unix utilities - do one focussed thing well

Partitioning strategies

- Too few
  - Drawbacks of the monolithic architecture
- Too many - a.k.a. Nano-service anti-pattern
  - Runtime overhead
  - **Potential** risk of excessive network hops
  - **Potentially** difficult to understand system

Something of an art

Example micro-service using Spring Boot

For more on micro-services see http://microservices.io

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But more realistically...

Focus on building cohesive services that make development and deployment easier

- not just tiny services

Real world examples

http://techblog.netflix.com/

~600 services

http://highscalability.com/amazon-architecture

100-150 services to build a page

http://www.addsimplicity.com/downloads/eBaySDForum2006-11-29.pdf

http://queue.acm.org/detail.cfm?id=1394128

There are drawbacks

Complexity of developing and managing a distributed system

http://contino.co.uk/blog/2013/03/31/microservices-no-free-lunch.html

Using a PaaS can significantly simplify deployment

Multiple databases
&
Transaction management

Deploying features that span multiple services requires careful coordination

When to use it?

In the beginning:

- You don't need it
- It will slow you down

Later on:

- You need it
- Refactoring is painful

But there are many benefits

Smaller, simpler apps

- Easier to understand and develop
- Reduced startup time - important for GAE
- Less jar/classpath hell - who needs OSGI?

Scales development: develop, deploy and scale each service independently

Improves fault isolation

Eliminates long-term commitment to a single technology stack

Modular, polyglot, multi-framework applications

Two levels of architecture

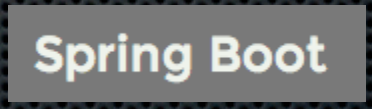
System-level

Services
Inter-service glue: interfaces and communication mechanisms
Slow changing

Service-level

Internal architecture of each service
Each service could use a different technology stack
Pick the best tool for the job
Rapidly evolving

Easily **try** other technologies



... and fail safely

Agenda

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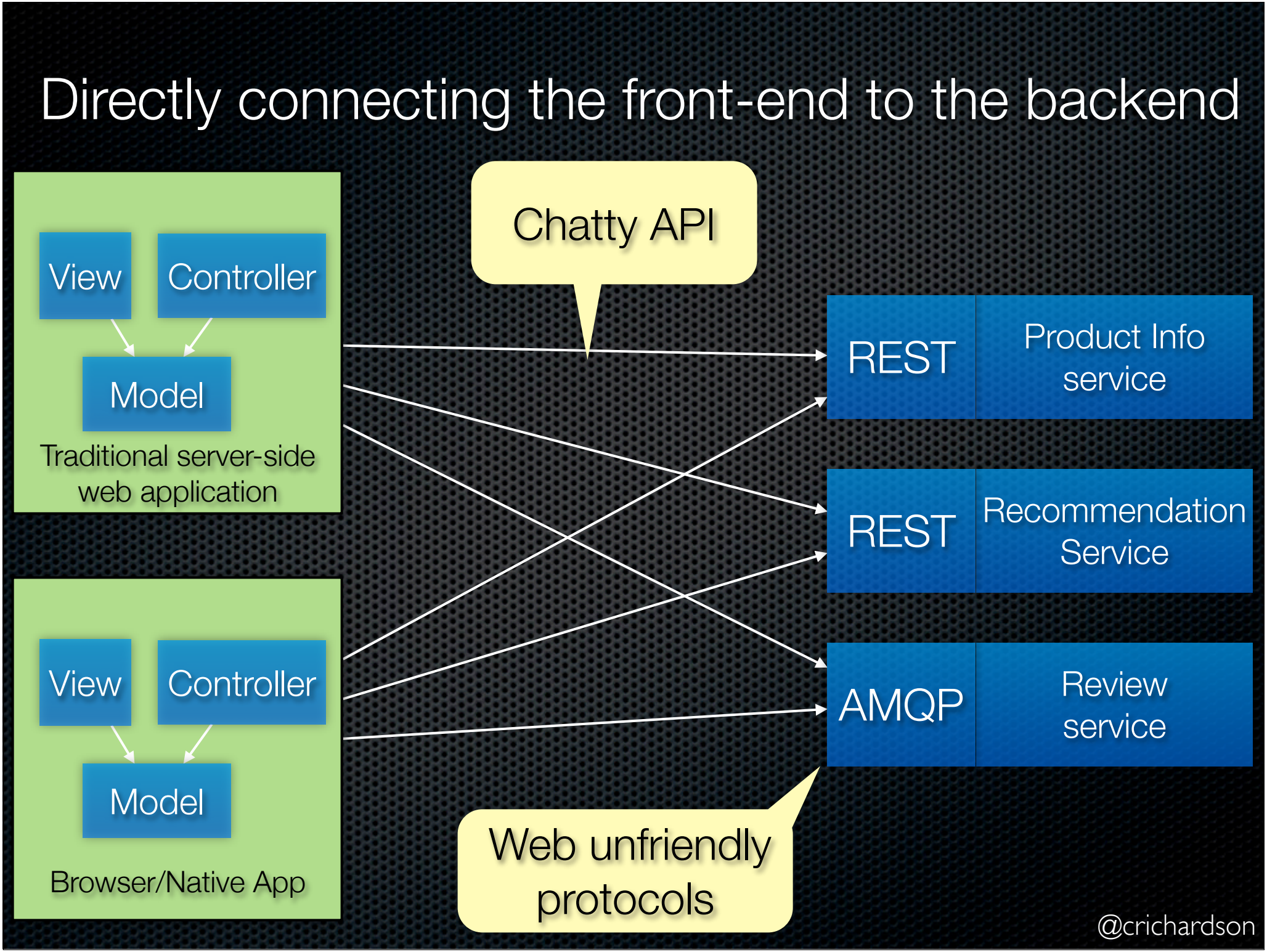
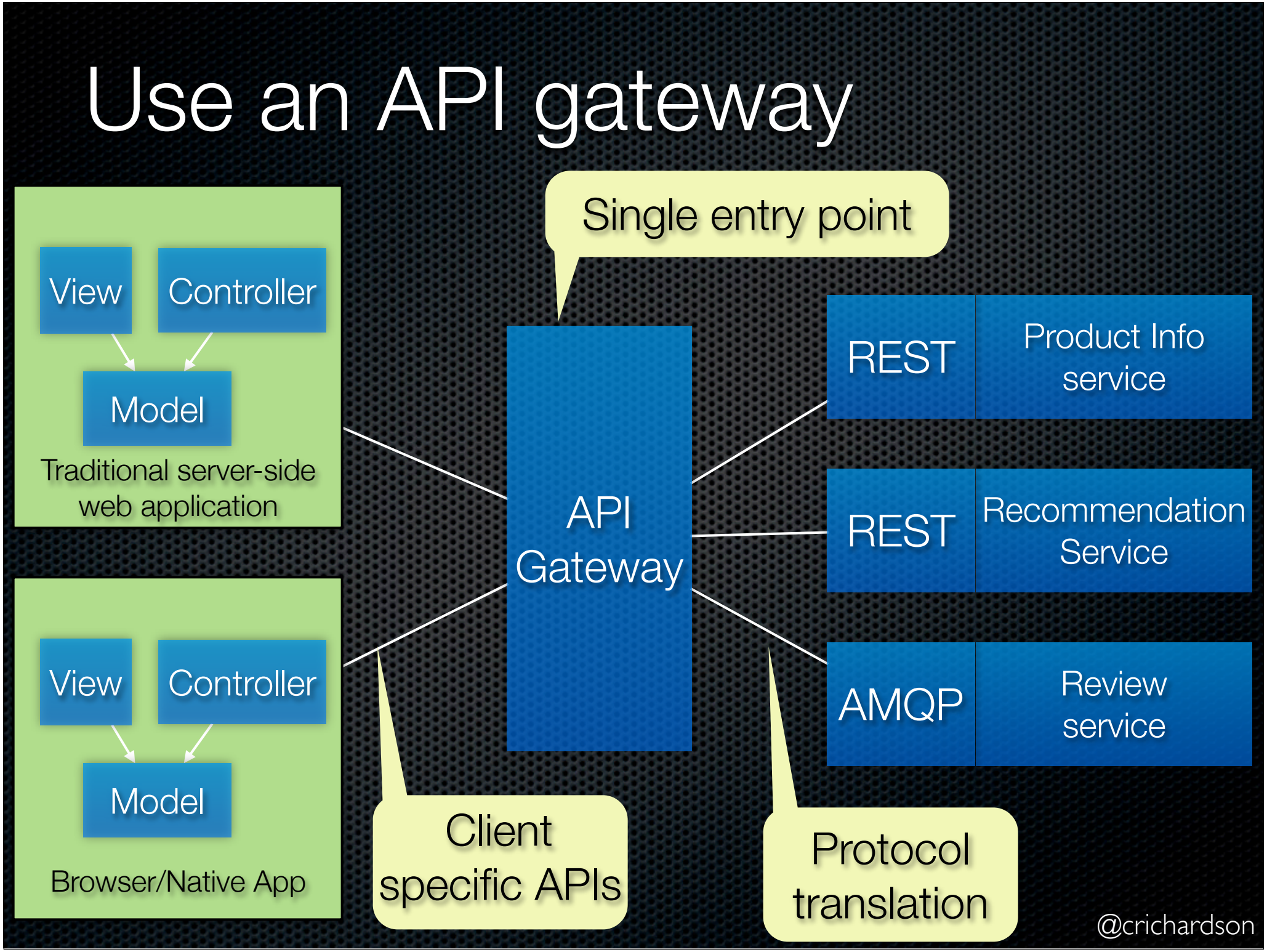
How do clients of the system interact with the services?

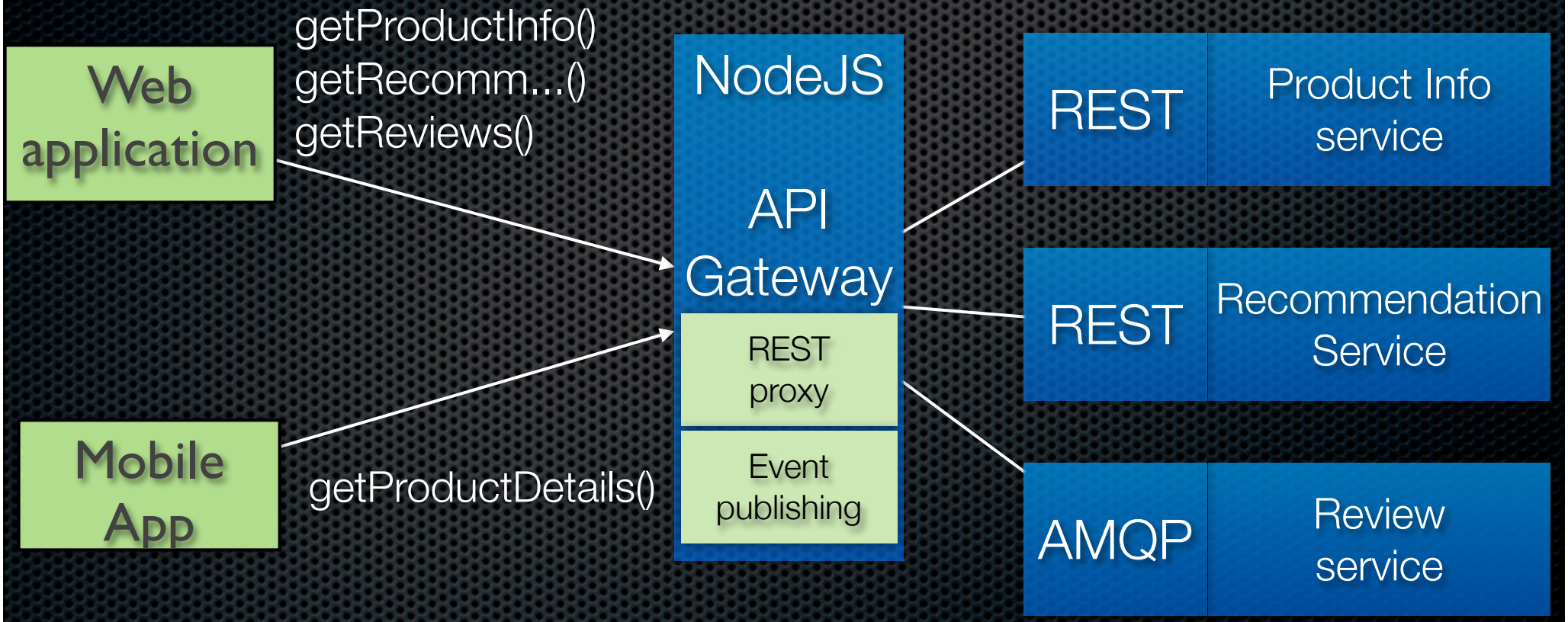
Directly connecting the front-end to the backend



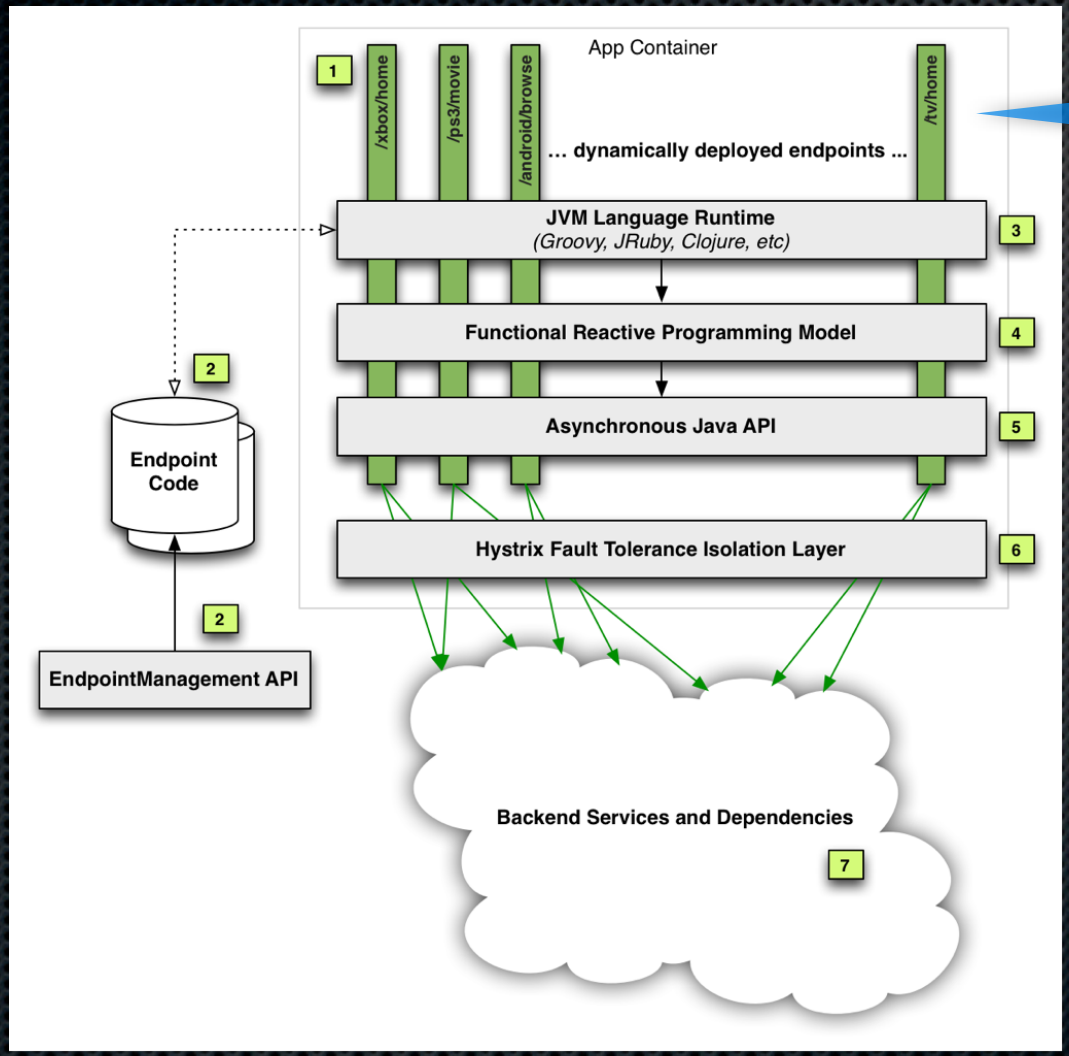
Use an API gateway



Optimized client-specific APIs



Netflix API Gateway



Device specific end points

http://techblog.netflix.com/2013/01/optimizing-netflix-api.html

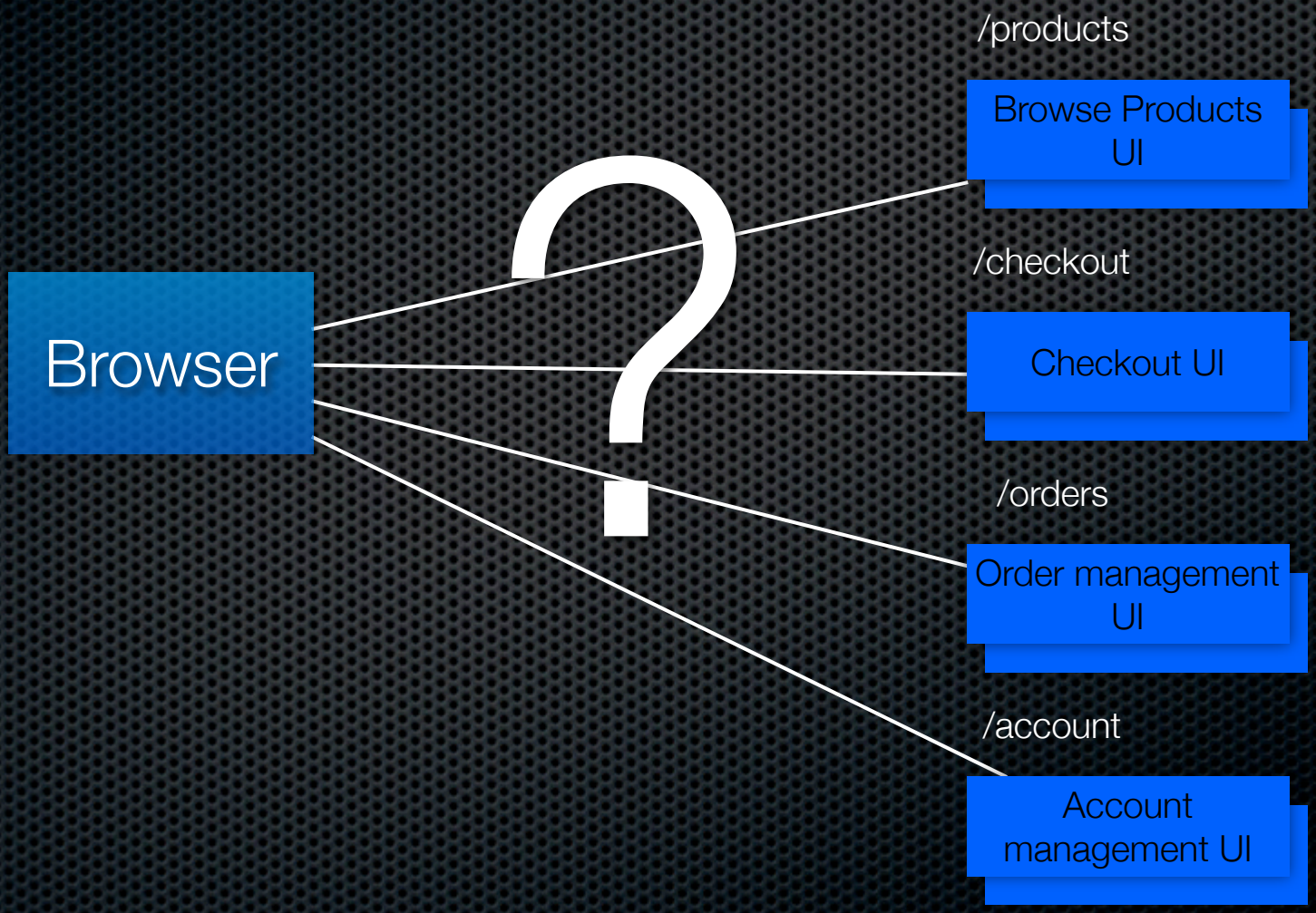
API gateway design challenges

- Performance and scalability
  - Non-blocking I/O
  - Asynchronous, concurrent code
- Handling partial failures
  - ....

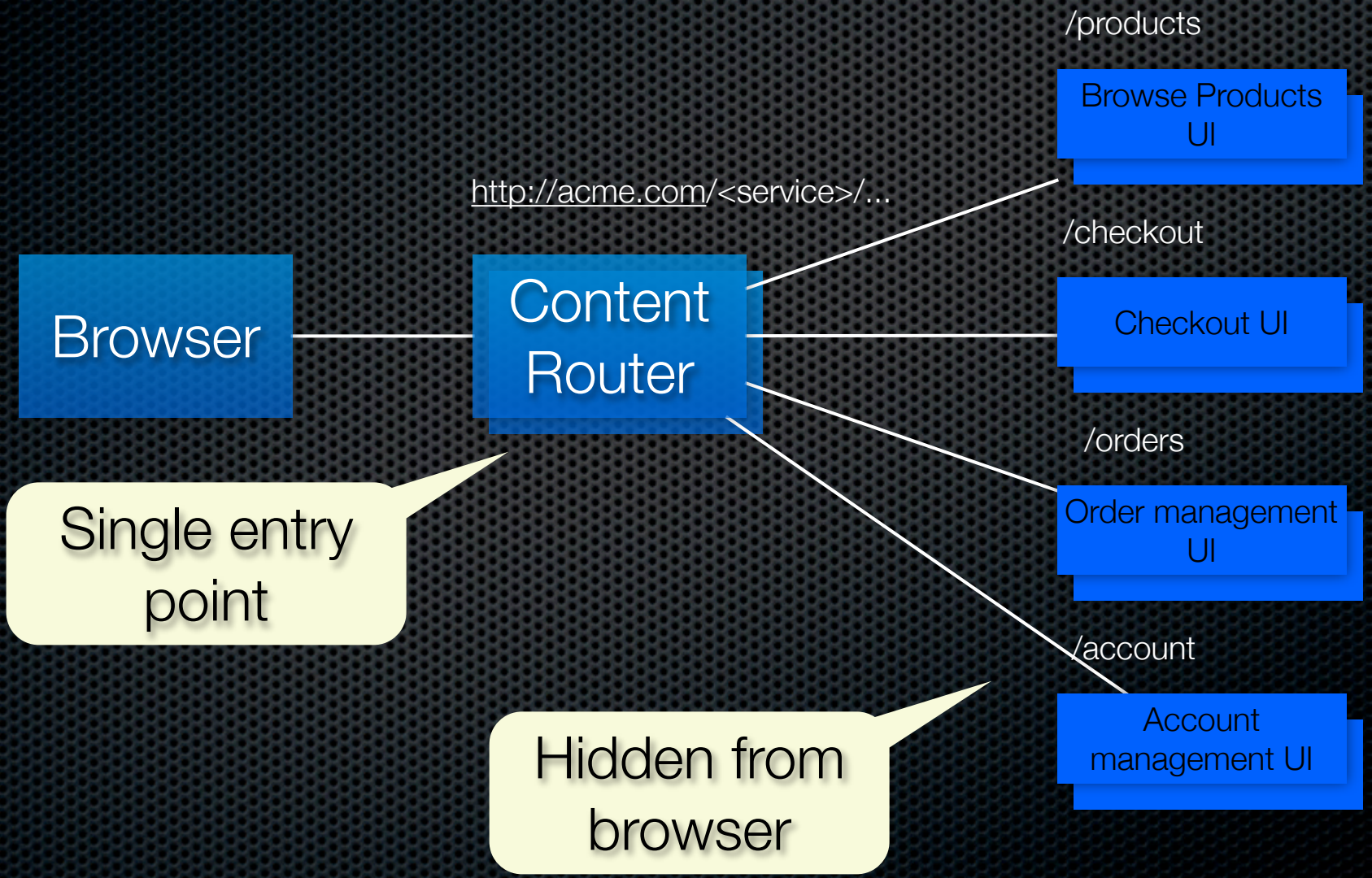
http://techblog.netflix.com/2012/02/fault-tolerance-in-high-volume.html

How does a browser interact with the partitioned web application?

Partitioned web app ⇒ no longer a single base URL



The solution: single entry point that routes based on URL



How do the services communicate?

Inter-service communication options

- Synchronous HTTP ⇔ asynchronous AMQP
- Formats: JSON, XML, Protocol Buffers, Thrift, ...

Asynchronous is preferred
JSON is fashionable but binary format is more efficient

Pros and cons of messaging

Pros

- Decouples client from server
- Message broker buffers messages
- Supports a variety of communication patterns

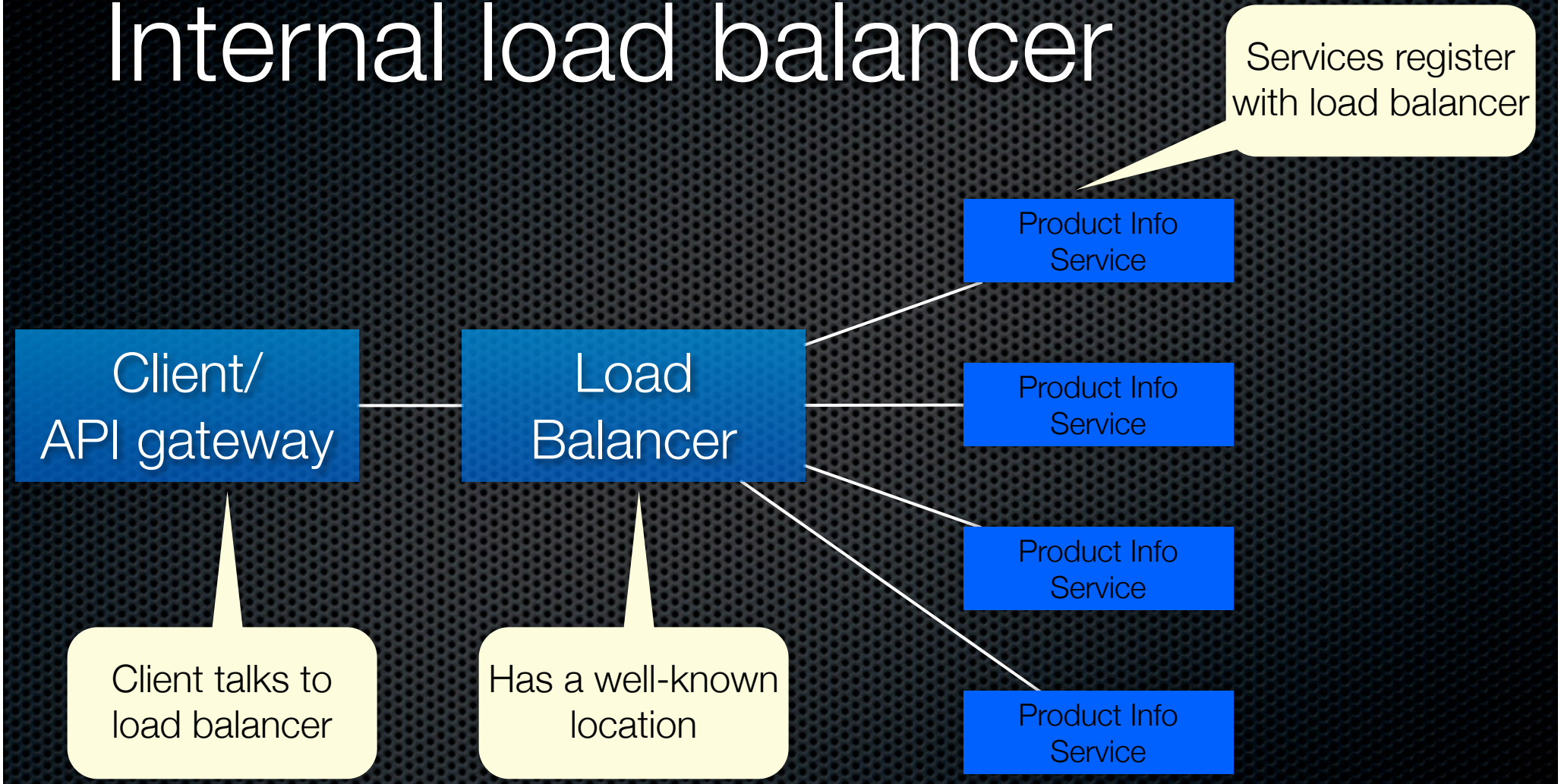
Cons

- Additional complexity of message broker
- Request/reply-style communication is more complex

Pros and cons of HTTP

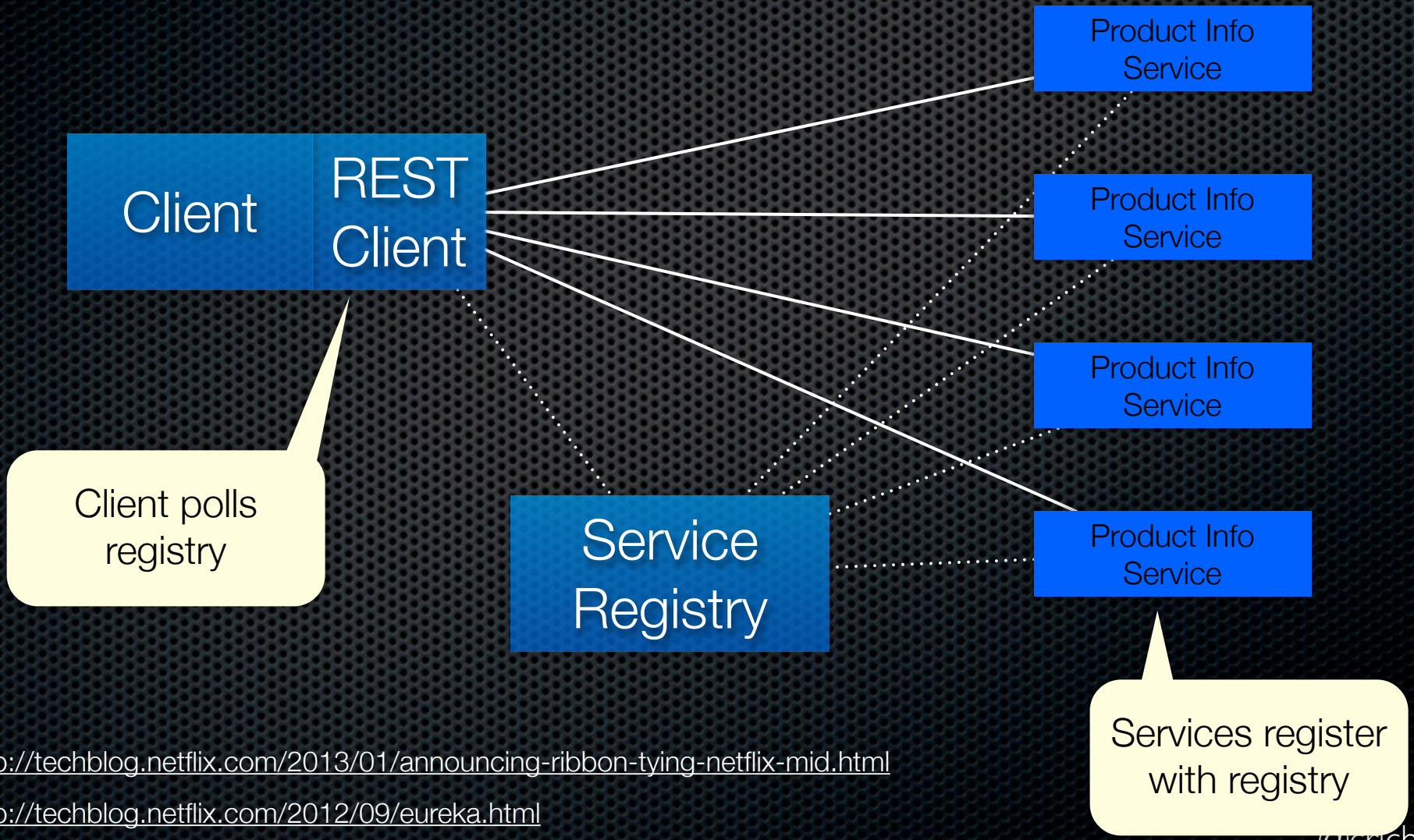
- Pros
  - Simple and familiar
  - Request/reply is easy
  - Firewall friendly
  - No intermediate broker
- Cons
  - Only supports request/reply
  - Server must be available
  - Client needs to discover URL(s) of server(s)

Discovery option #1: Internal load balancer



http://docs.aws.amazon.com/ElasticLoadBalancing/latest/DeveloperGuide/USVPC_creating_basic_lb.html

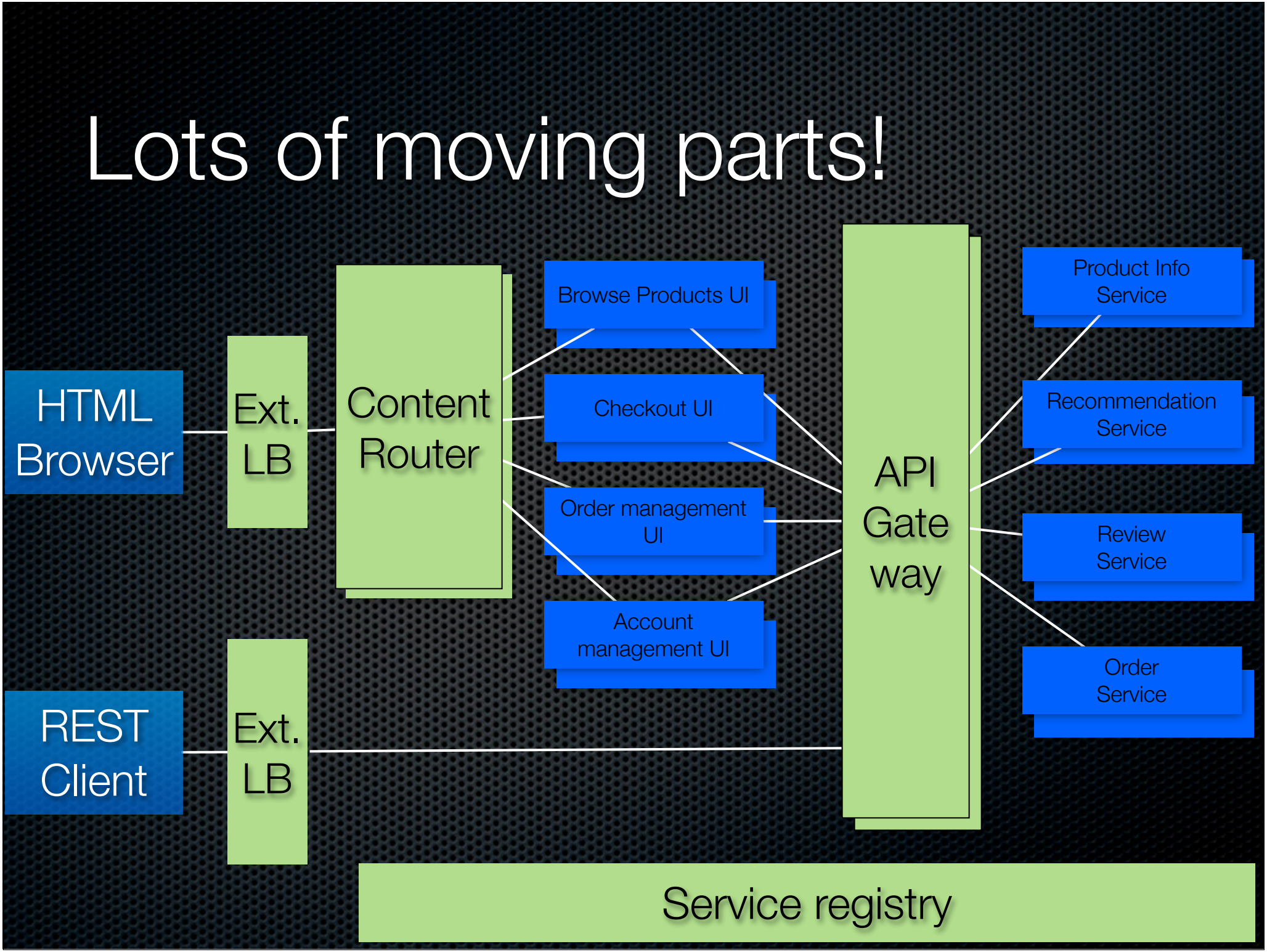
Discovery option #2: client-side load balancing



http://techblog.netflix.com/2013/01/announcing-ribbon-tying-netflix-mid.html

http://techblog.netflix.com/2012/09/eureka.html

Lots of moving parts!



Agenda

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- Decomposing applications into services
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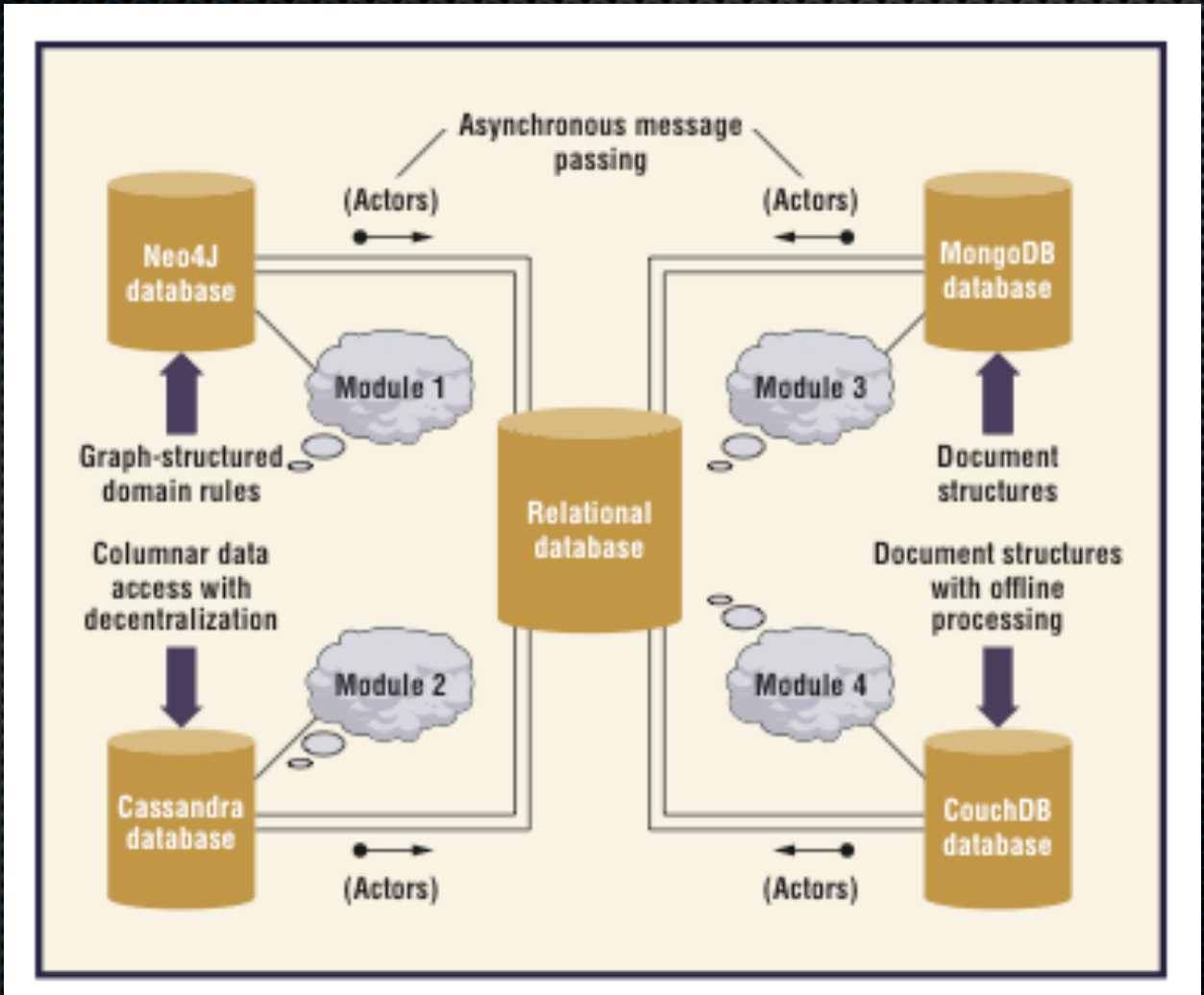
Decomposed services ⇒ decomposed databases

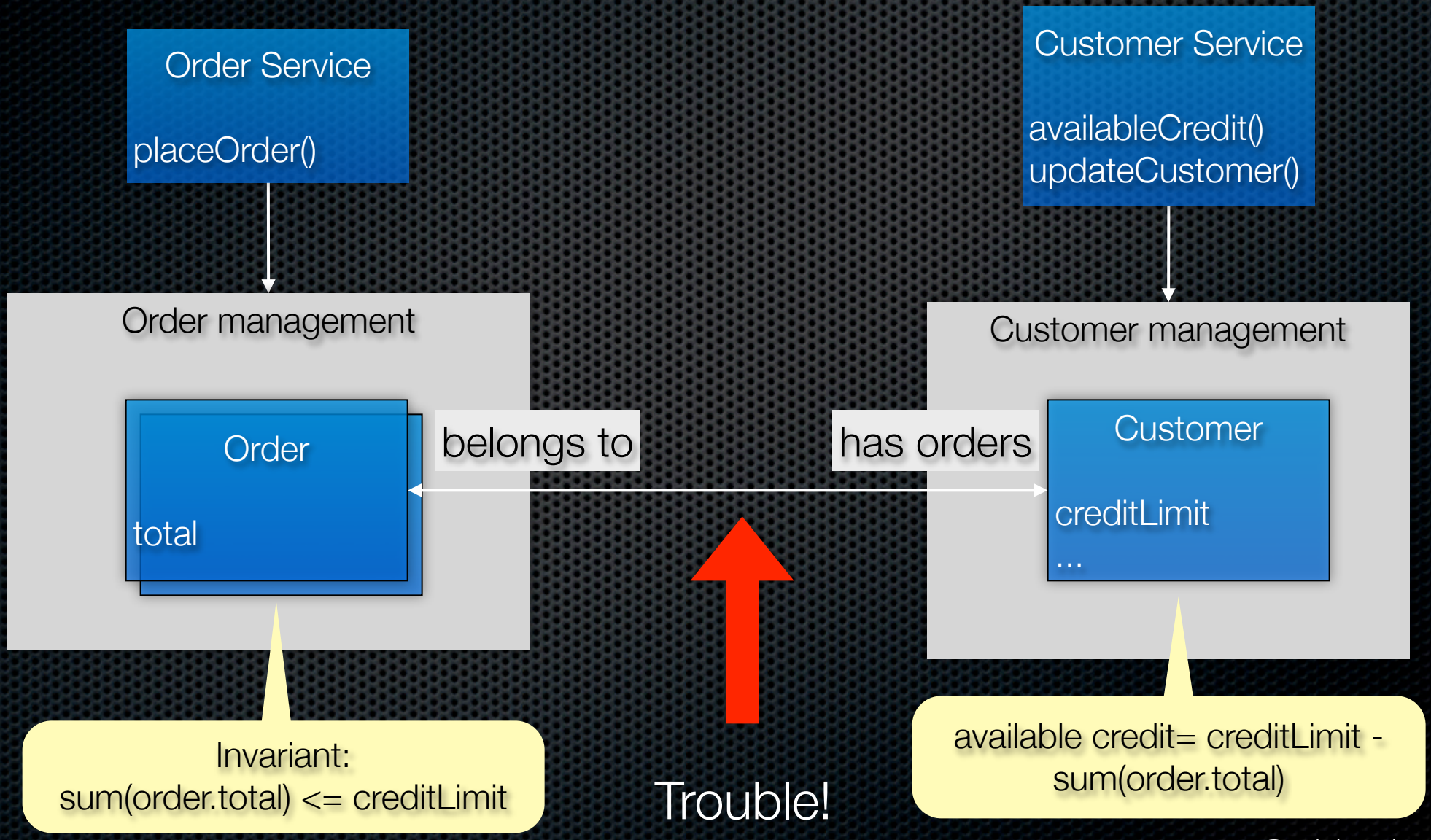
Separate databases ⇒ less coupling

Decomposed databases ⇒ polyglot persistence



IEEE Software Sept/October 2010 - Debasish Ghosh / Twitter @debasishg

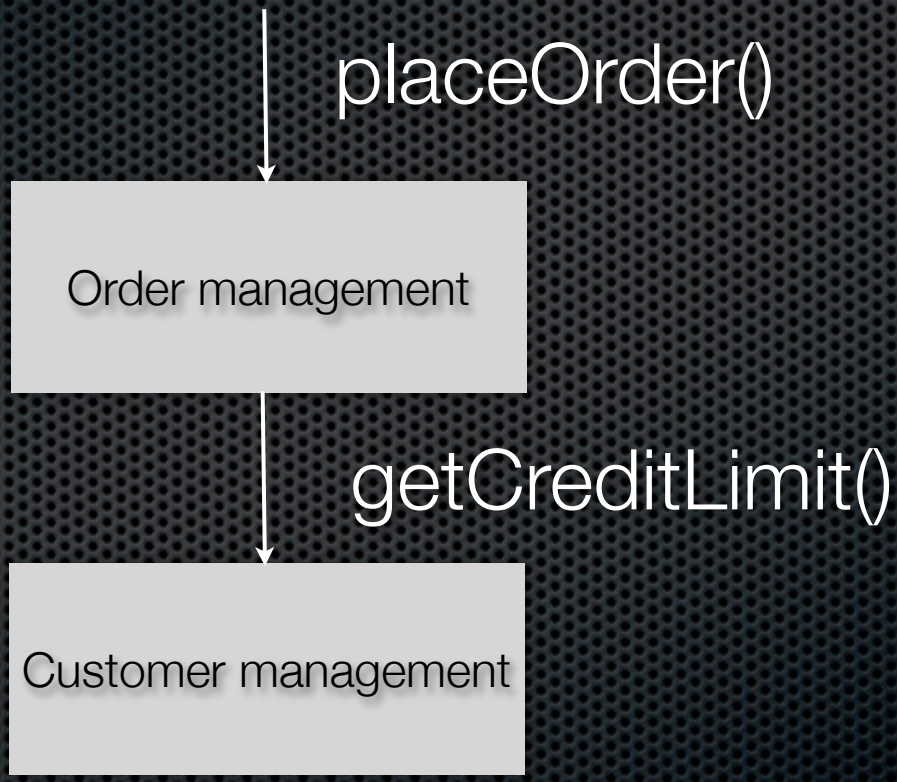
Untangling orders and customers



Problems

- Reads
  - Service A needs to read data owned by service B
- Updates
  - Transaction must update data owned by multiple services

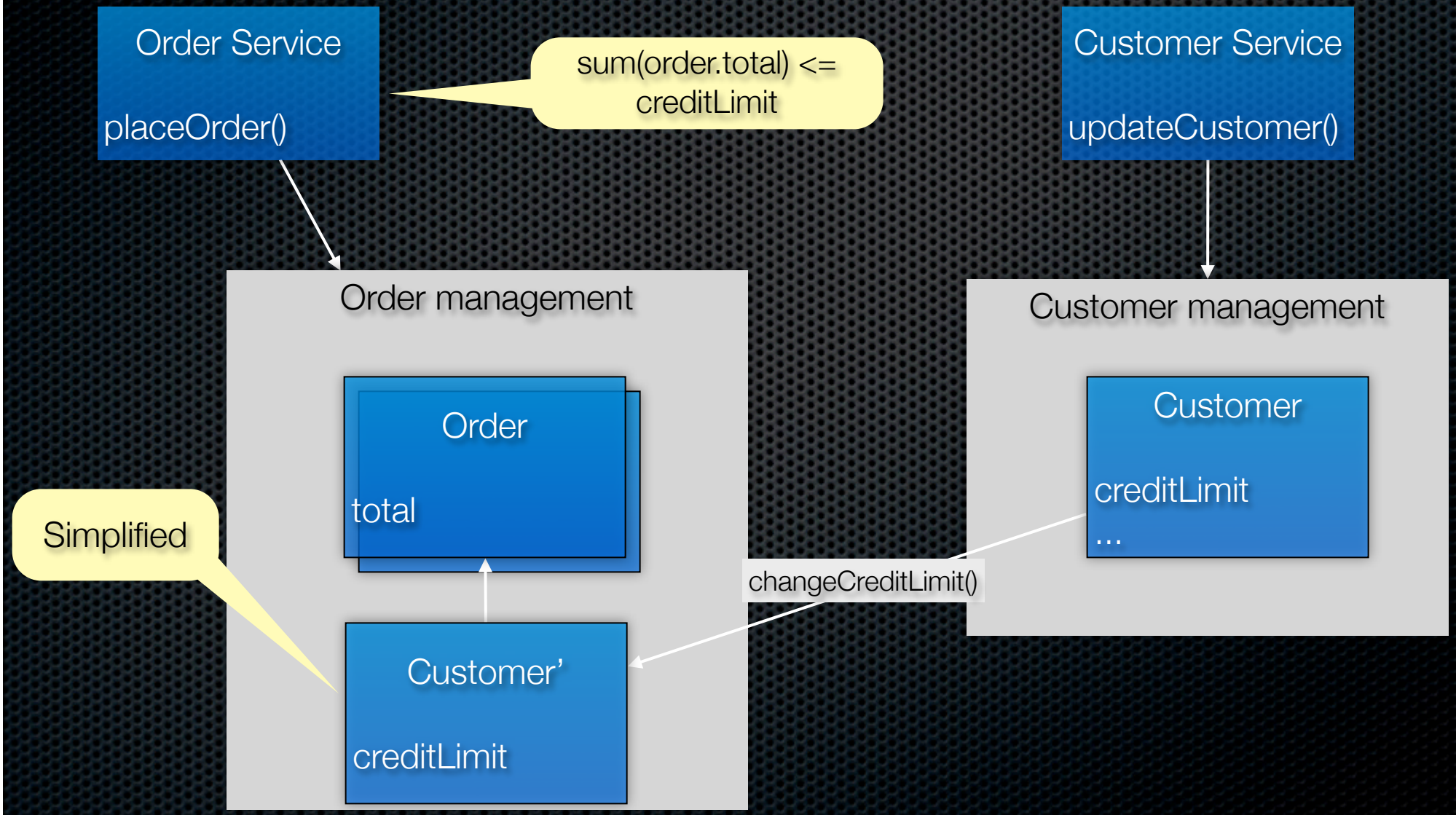
Handling reads: requesting credit limit



Pulling data

- Benefits
  - Simple to implement
  - Ensures data is fresh
- Drawbacks
  - Reduces availability
  - Increases response time

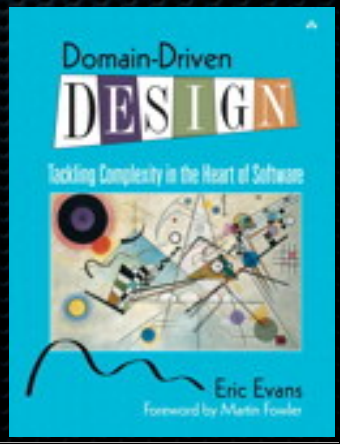
Handling reads: replicating the credit limit



Useful idea: Bounded context

- Different services have a different view of a domain object, e.g.
  - User Management = complex view of user
  - Rest of application: User = PK + ACL + Name

- Different services can have a different domain model



Replicating data

- Benefits
  - Improved availability for reads
  - Improves latency
- Drawbacks
  - Additional complexity of replication mechanism

How to handle updates (including of replicated data)?

Use distributed transactions

- Benefits
  - Guarantees consistency
- Drawbacks
  - Complex
  - Reduced availability

Use eventual consistency

- How
  - Services publish events when data changes
  - Subscribing services update their data
- Benefits:
  - Simpler
  - Better availability
- Drawbacks:
  - Application has to handle inconsistencies

How do services publish events?

To maintain consistency the application must **atomically** publish an event whenever a domain object changes

Change tracking options

- Database triggers
- Hibernate event listener
- Ad hoc event publishing code mixed into business logic
- Domain events - “formal” modeling of events
- Event Sourcing

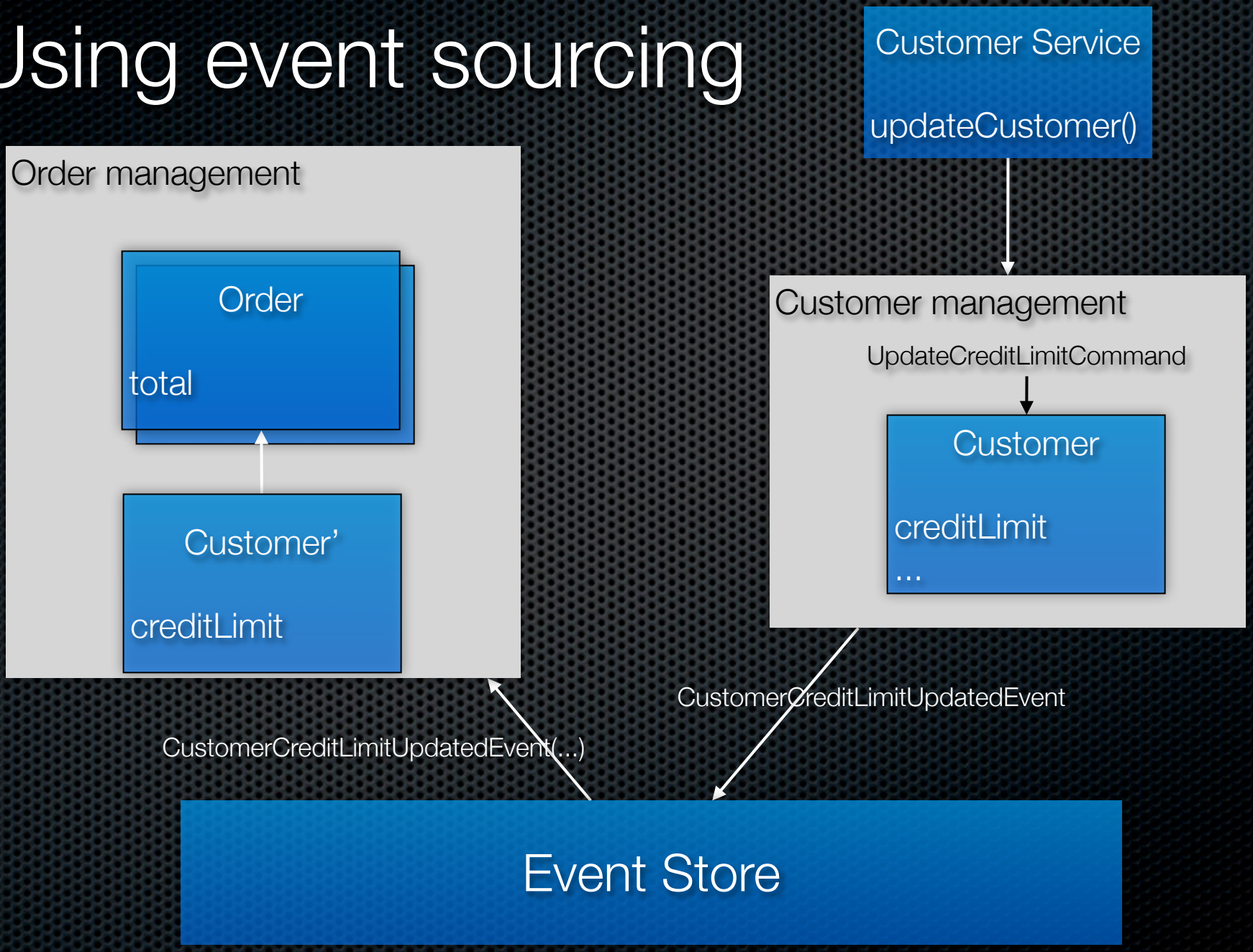
Event sourcing

- An event-centric approach to designing domain models
  - Aggregates handle commands by generating events
  - Apply events update aggregate state
- Persist events **NOT** state
  - Replay events to recreate the current state of an aggregate
- Event Store ≃ database + message broker

EventStore API

```
trait EventStore {

  def save[T](entityId: Id, events: Seq[Event]): T

  def update[T](entityId: Id,
                version: EntityVersion, events: Seq[Event]): T

  def load[T](entityType: Class[T], entityId: EntityId): T

  def subscribe(...) : ...
   ..
}
```

Using event sourcing



Customer aggregate

```
case class Customer(customerId: String, creditLimit: BigDecimal)
  extends ValidatingAggregate[Customer, CustomerCommands.CustomerCommand] {


  def this() = this(null, null)

  override def validate = {
    case CreateCustomerCommand(customerId, creditLimit) =>
          Seq(CustomerCreatedEvent(customerId, creditLimit))

    case UpdateCreditLimitCommand(newLimit) if newLimit >= 0 =>
        Seq(CustomerCreditLimitUpdatedEvent(newLimit))
  }

  override def apply = {

    case CustomerCreatedEvent(customerId, creditLimit) =>
        copy(customerId=customerId, creditLimit=creditLimit)

    case CustomerCreditLimitUpdatedEvent(newLimit) =>
        copy(creditLimit=newLimit)

  }
}
```

Command ⇒ Events

Event ⇒ Updated state

Unfamiliar but it solves many problems

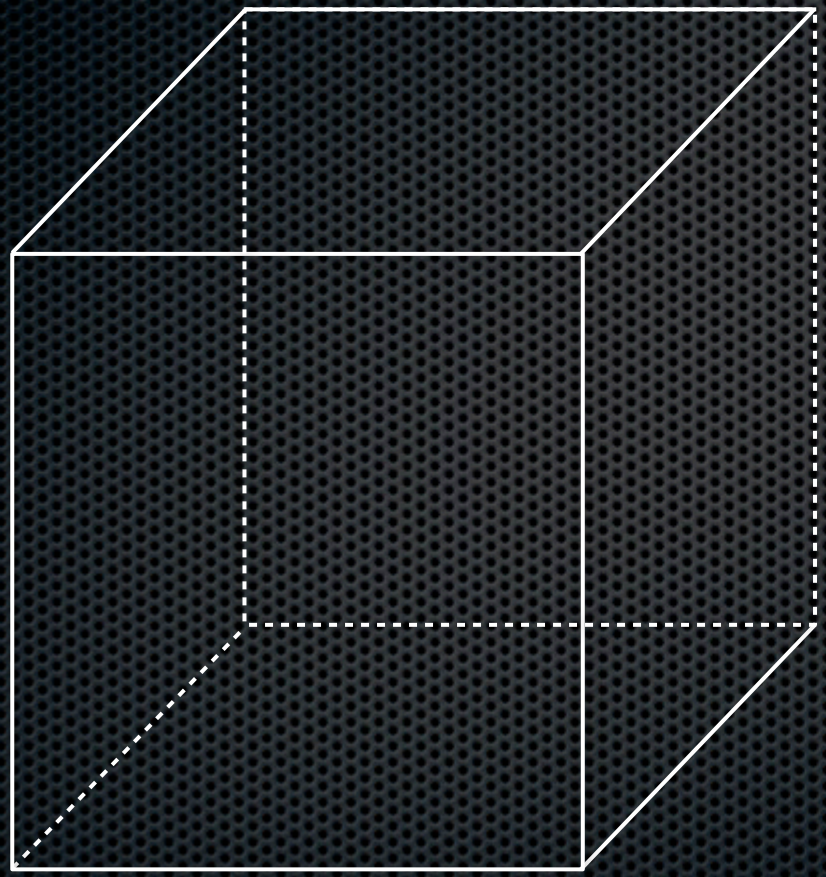
- Eliminates O/R mapping problem
- Supports both SQL and NoSQL databases
- Publishes events reliably
- Reliable eventual consistency framework
- ...

Summary

Monolithic applications are simple to develop and deploy

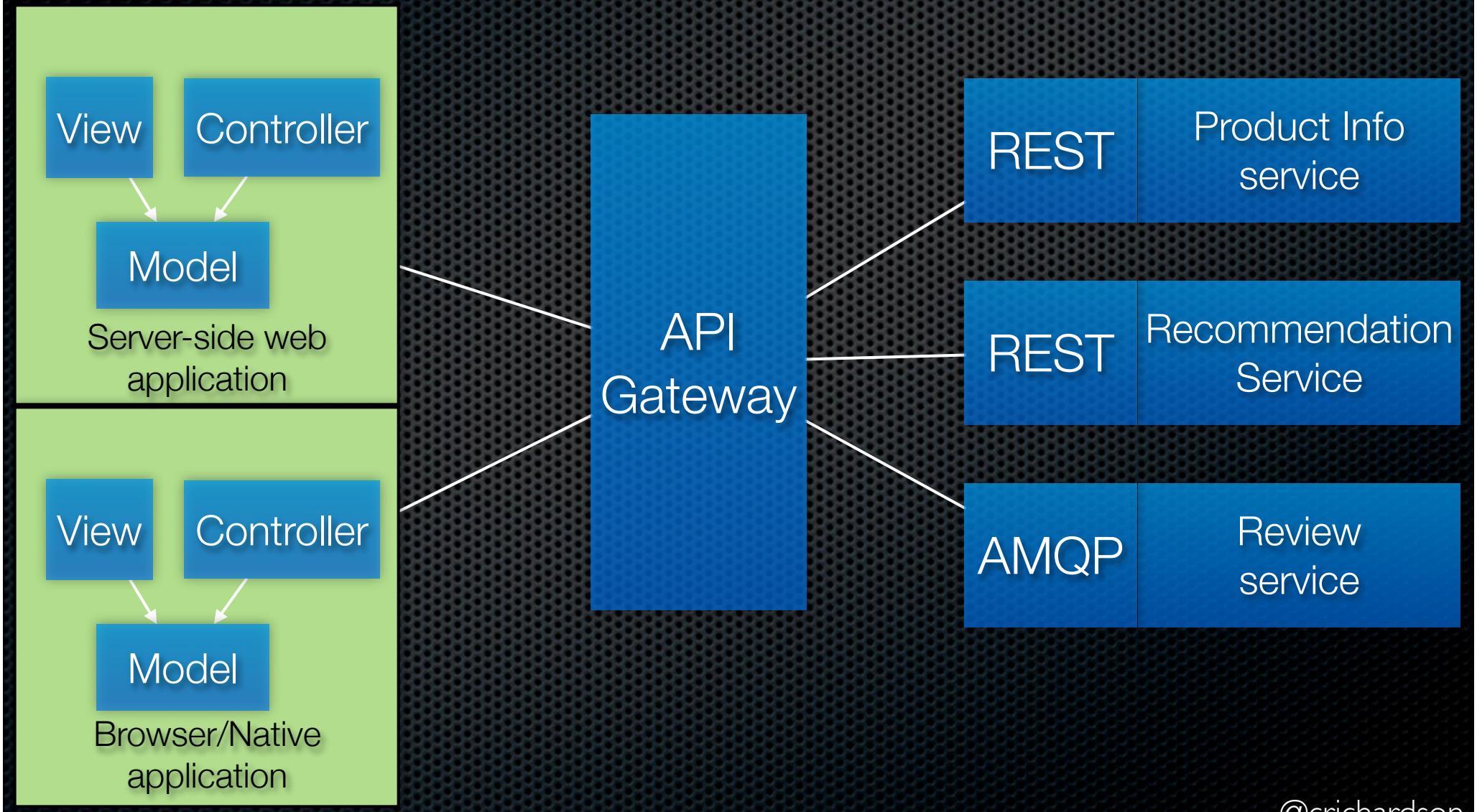
BUT have significant drawbacks

Apply the scale cube

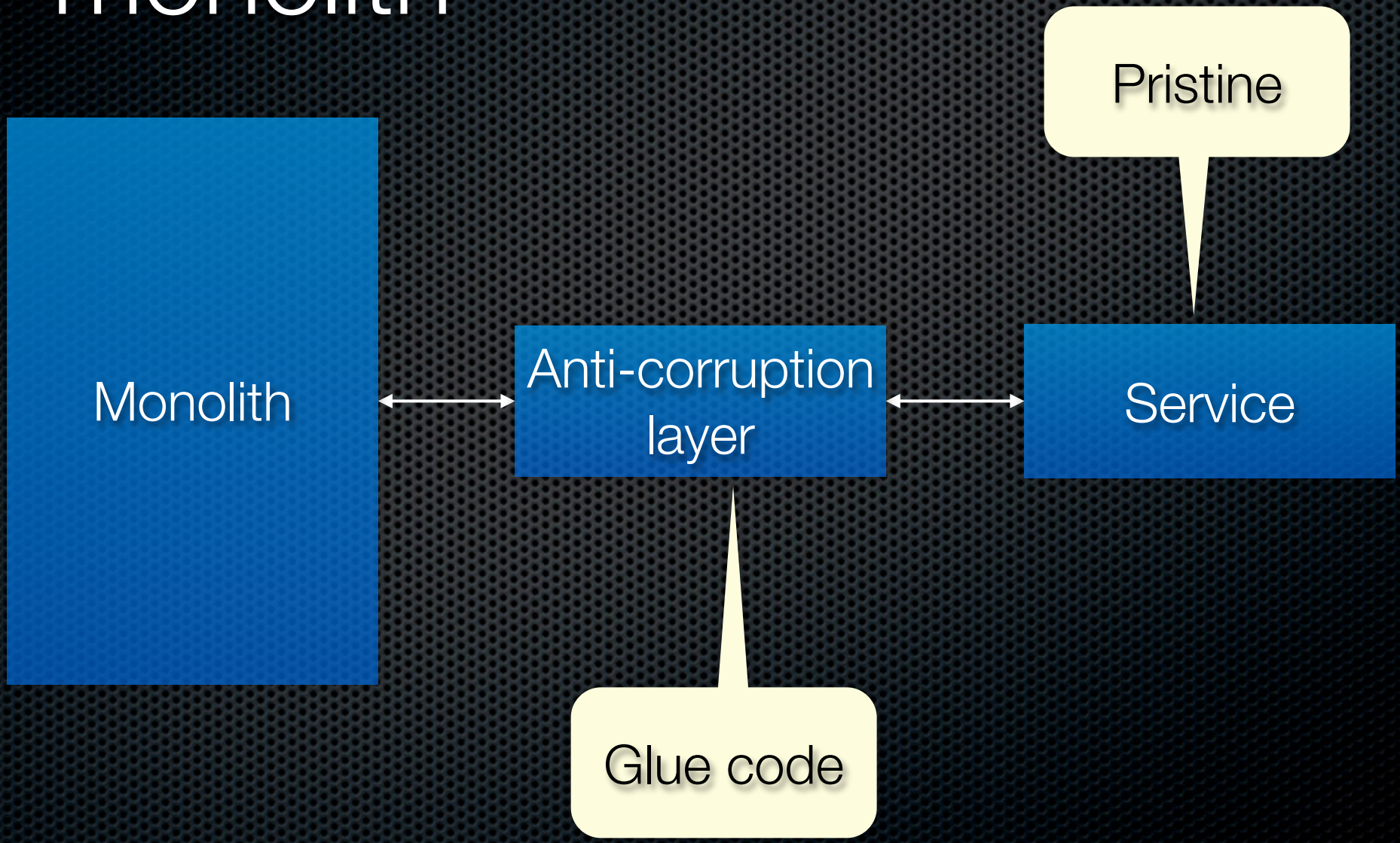


- Modular, polyglot, and scalable applications
- Services developed, deployed and scaled independently

Use a modular, polyglot architecture



Start refactoring your monolith

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