Modular Monoliths

@simonbrown

Simon Brown
@simonbrown

I'll keep saying this ... if people can't build monoliths properly, microservices won't help. #qconlondon #DesignThinking #Modularity

10:49 AM - 4 Mar 2015

305 Retweets **185** Likes

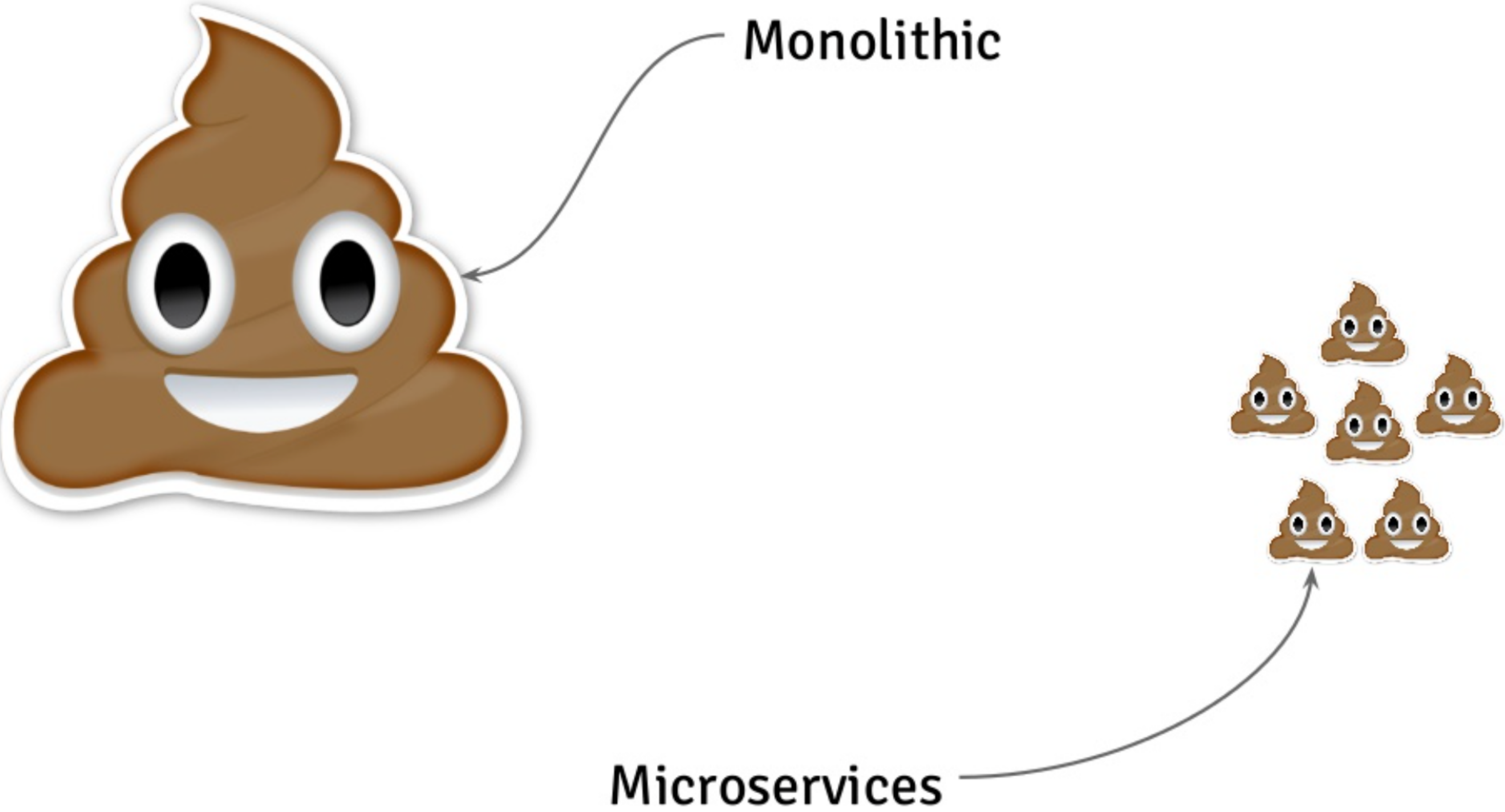
Architect Clippy
@architectclippy

I see you have a poorly structured monolith. Would you like me to convert it into a poorly structured set of microservices?

12:59 AM - 24 Feb 2015

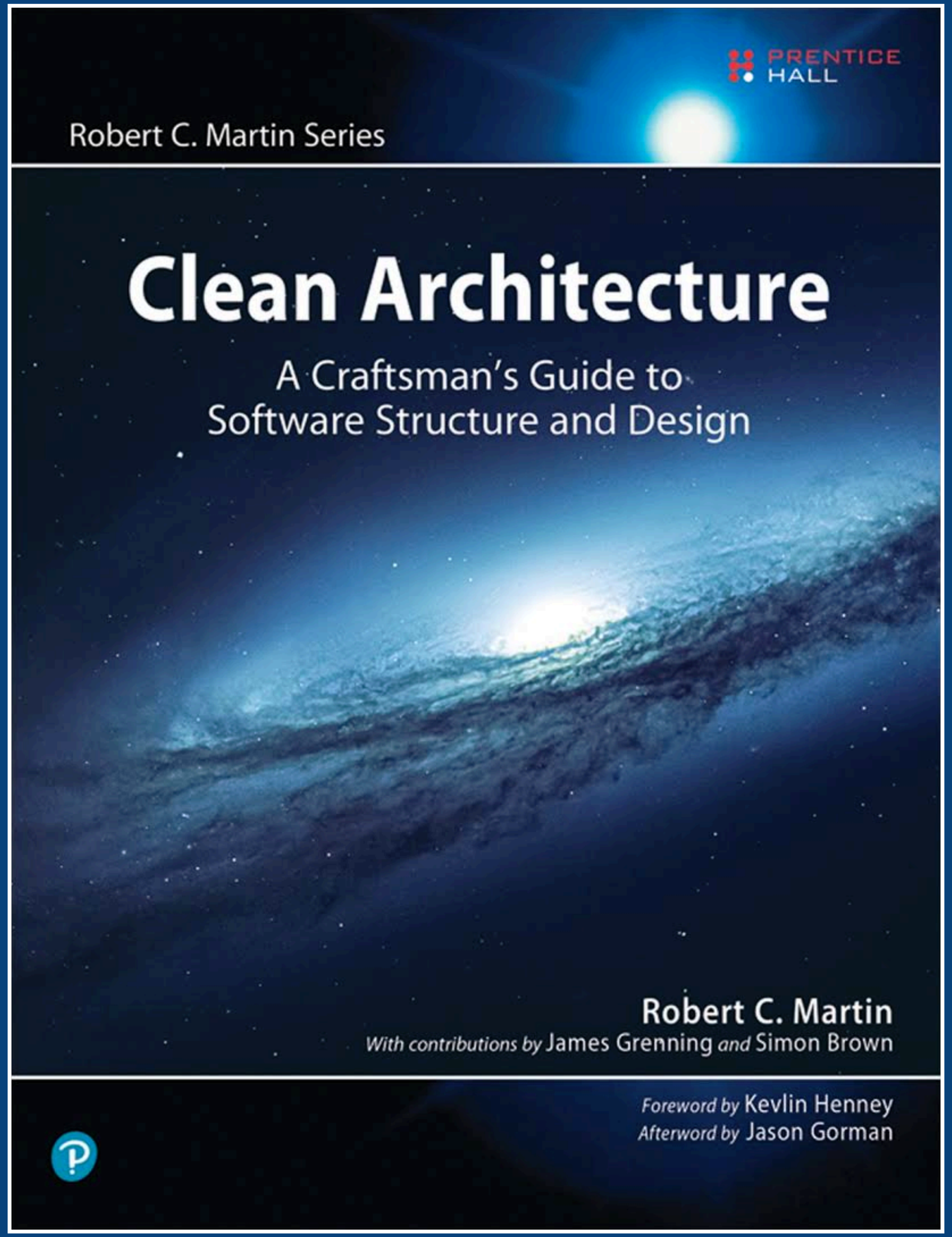
4,413 Retweets **2,815** Likes

Monolithic vs Microservices

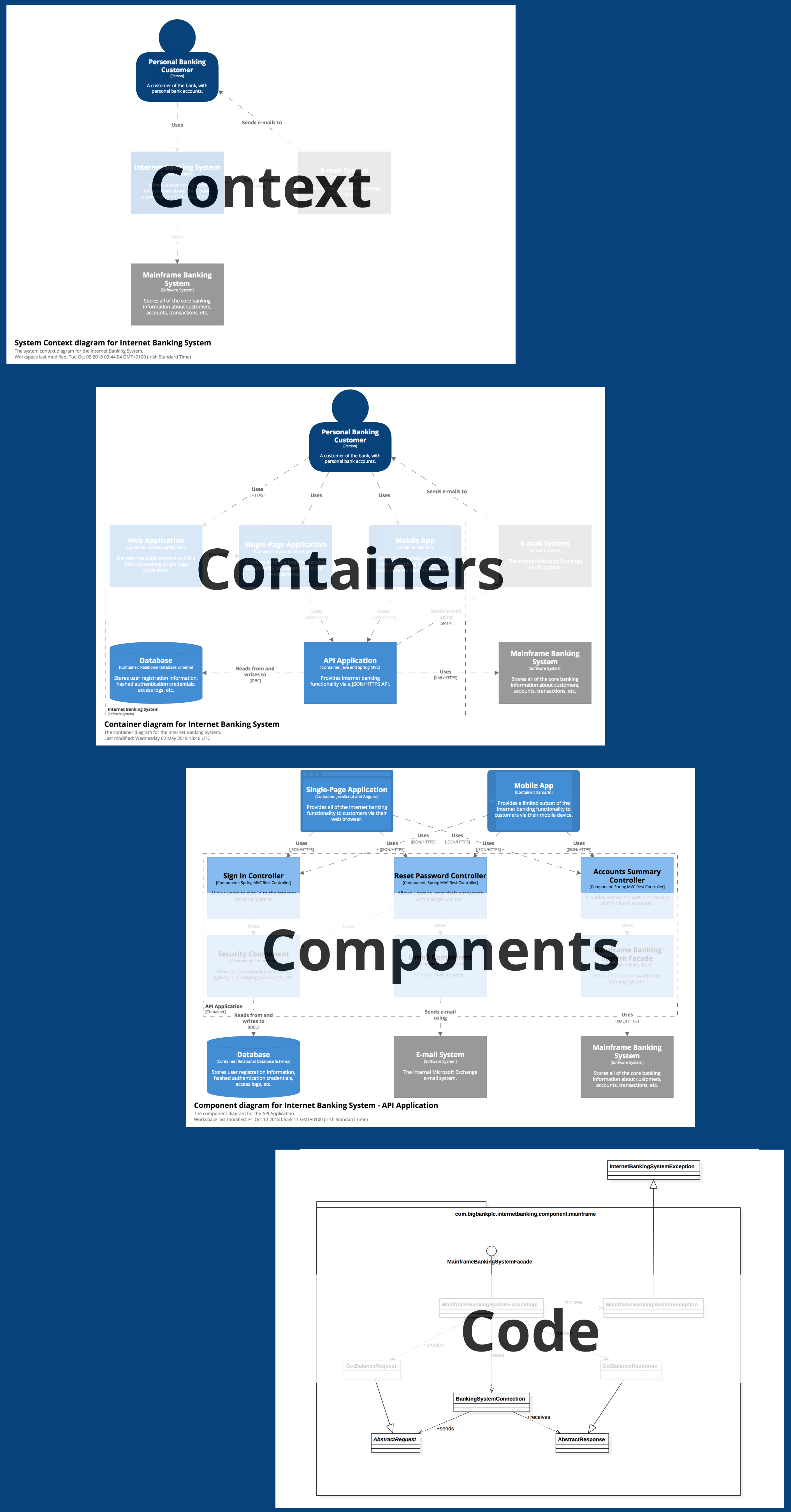


An independent consultant specialising in software architecture

“The Missing Chapter”



Also the creator of the C4 model, and Structurizr



The server-side of Structurizr is two Java/Spring **modular monoliths**, running on Pivotal Web Services' Cloud Foundry PaaS

(i.e. no Docker, Kubernetes, etc)

A well structured codebase is easy to **visualise**

C4

Context, Containers, Components and Code - c4model.com

Context diagram

(level 1)

Container diagram

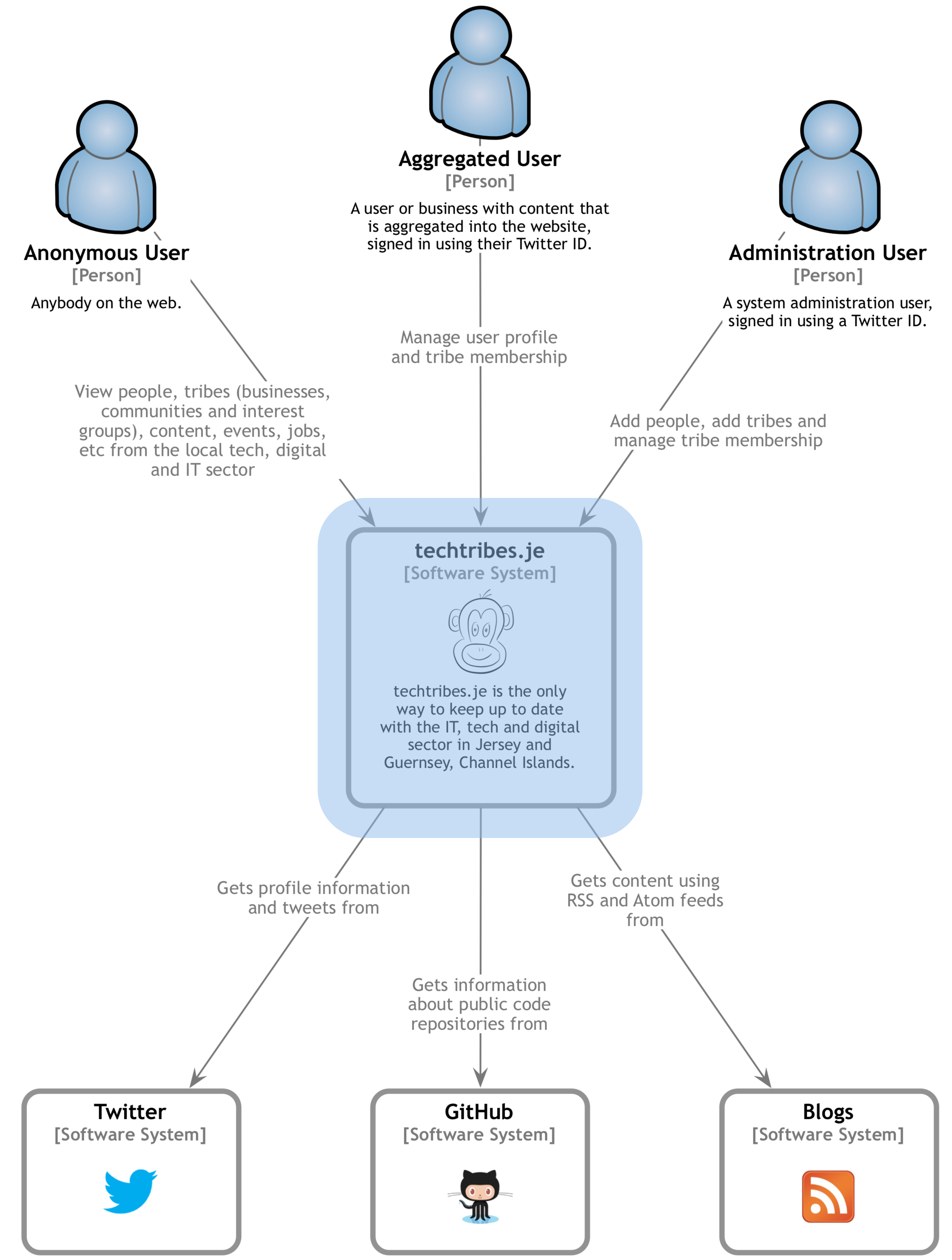
(level 2)

Component diagram

(level 3)

Class diagram

(level 4)



techtribes.je - Context

Context diagram

(level 1)

Container diagram

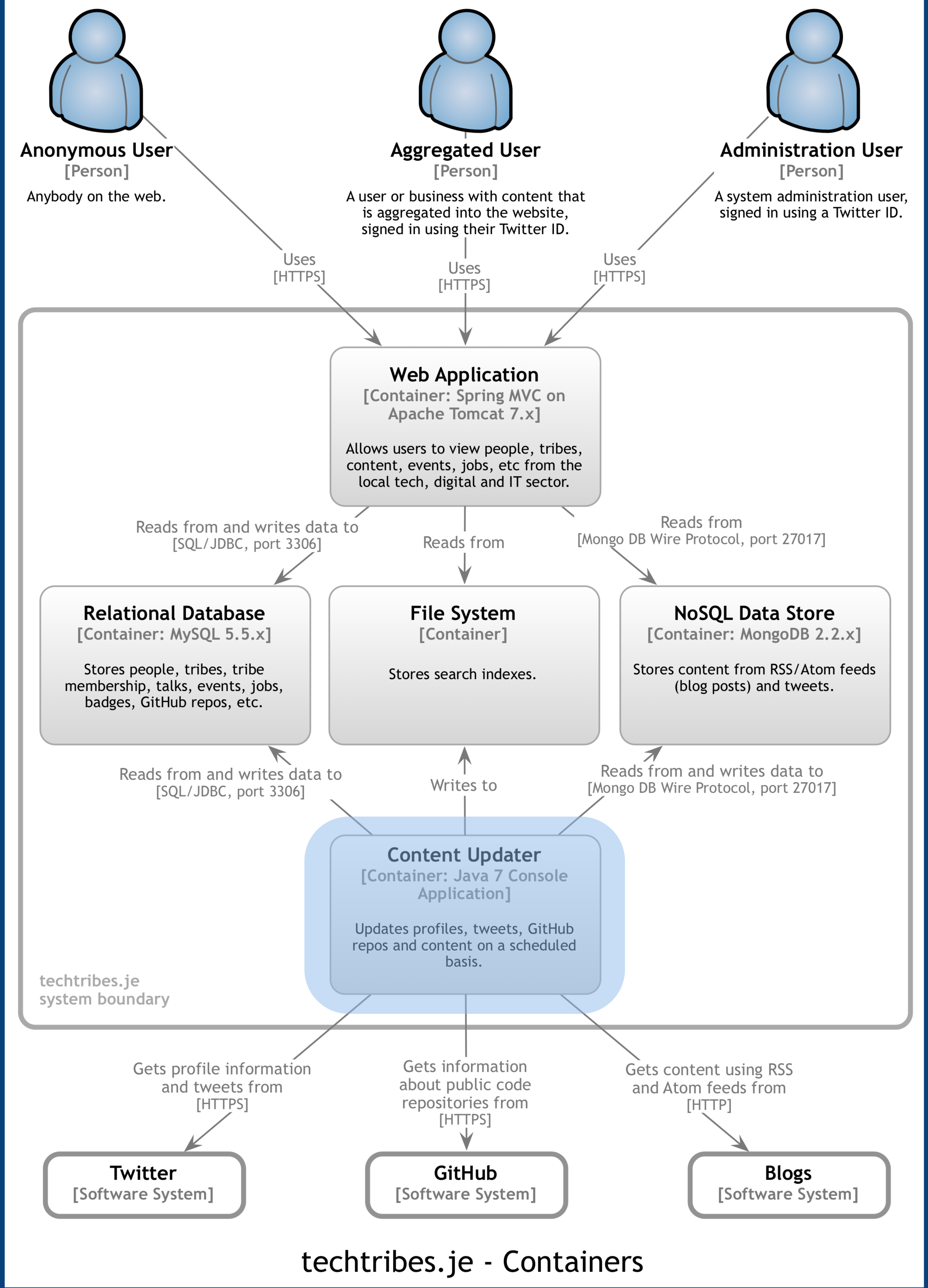
(level 2)

Component diagram

(level 3)

Class diagram

(level 4)



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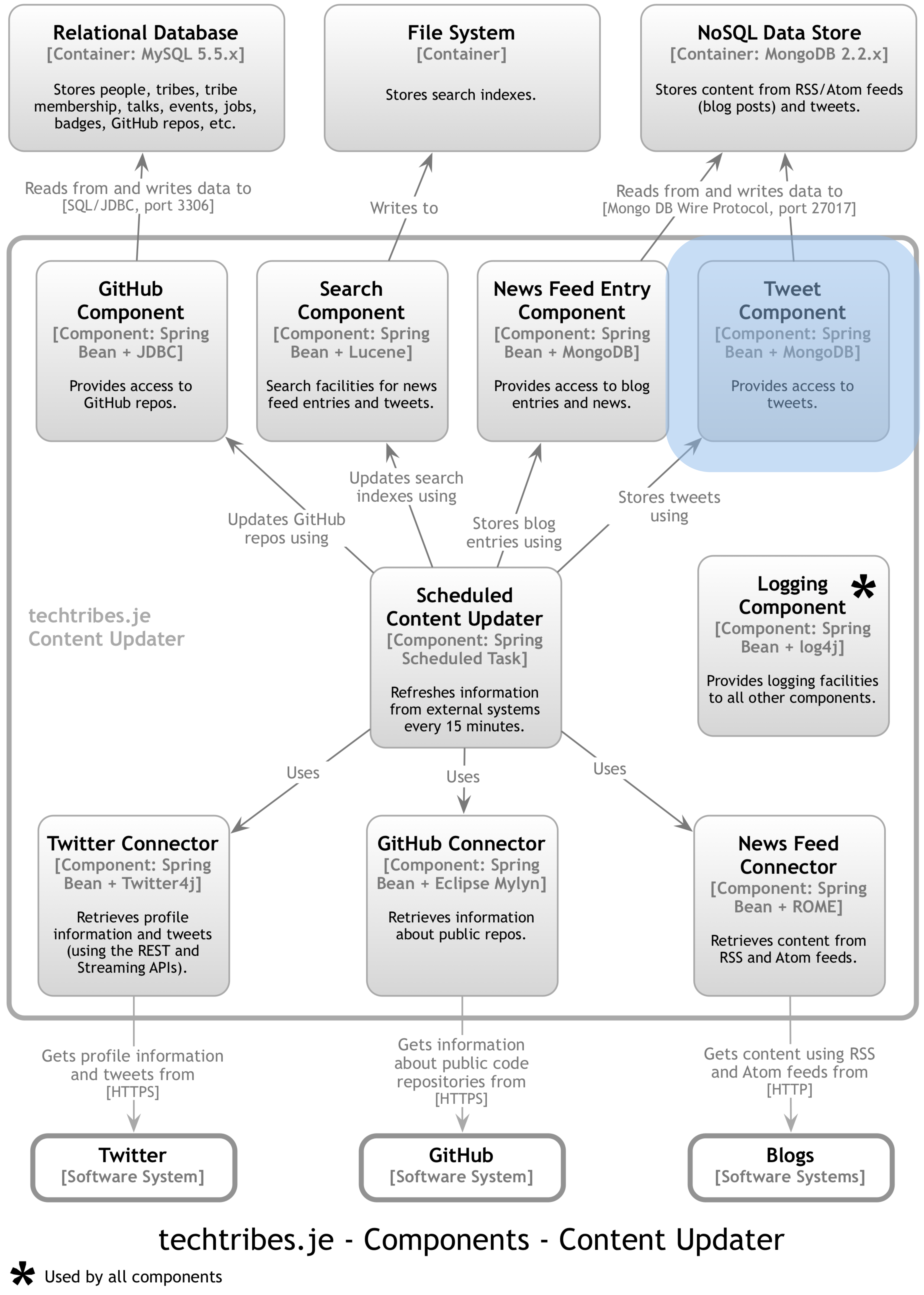

Context diagram
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Container diagram
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Class diagram
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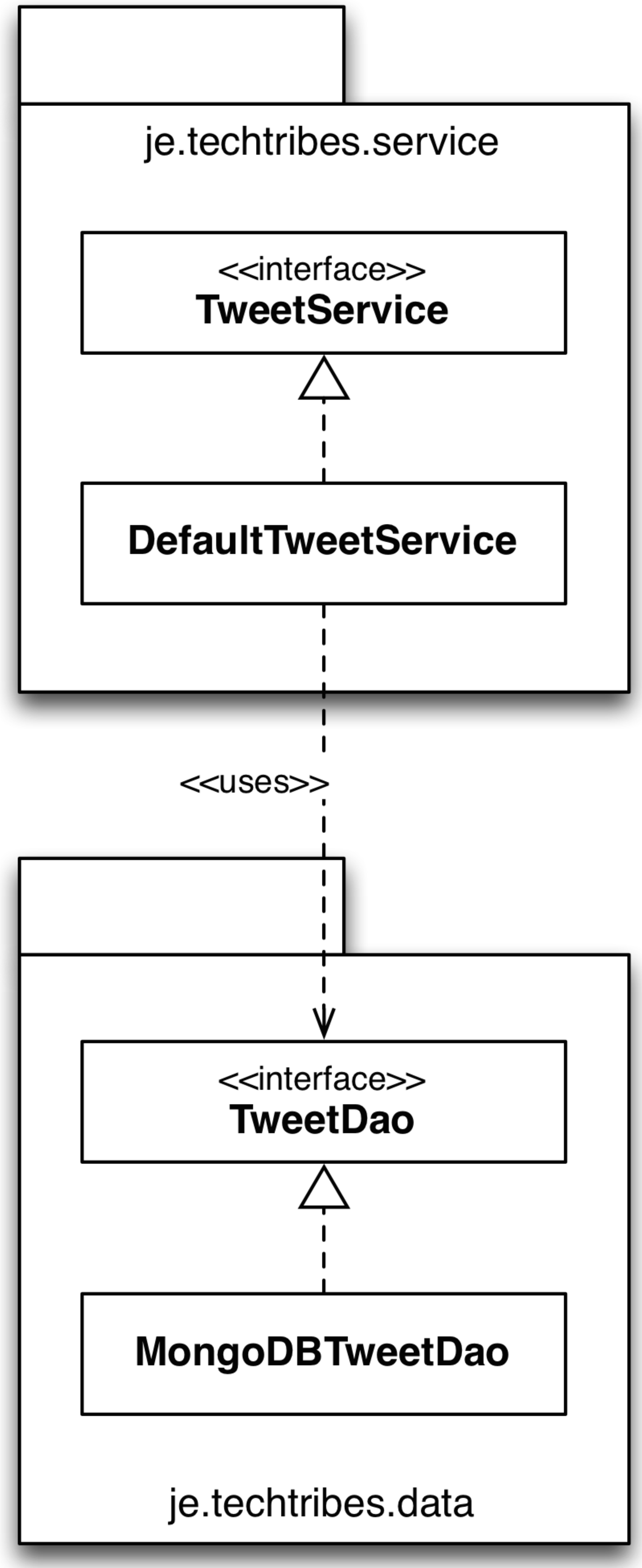
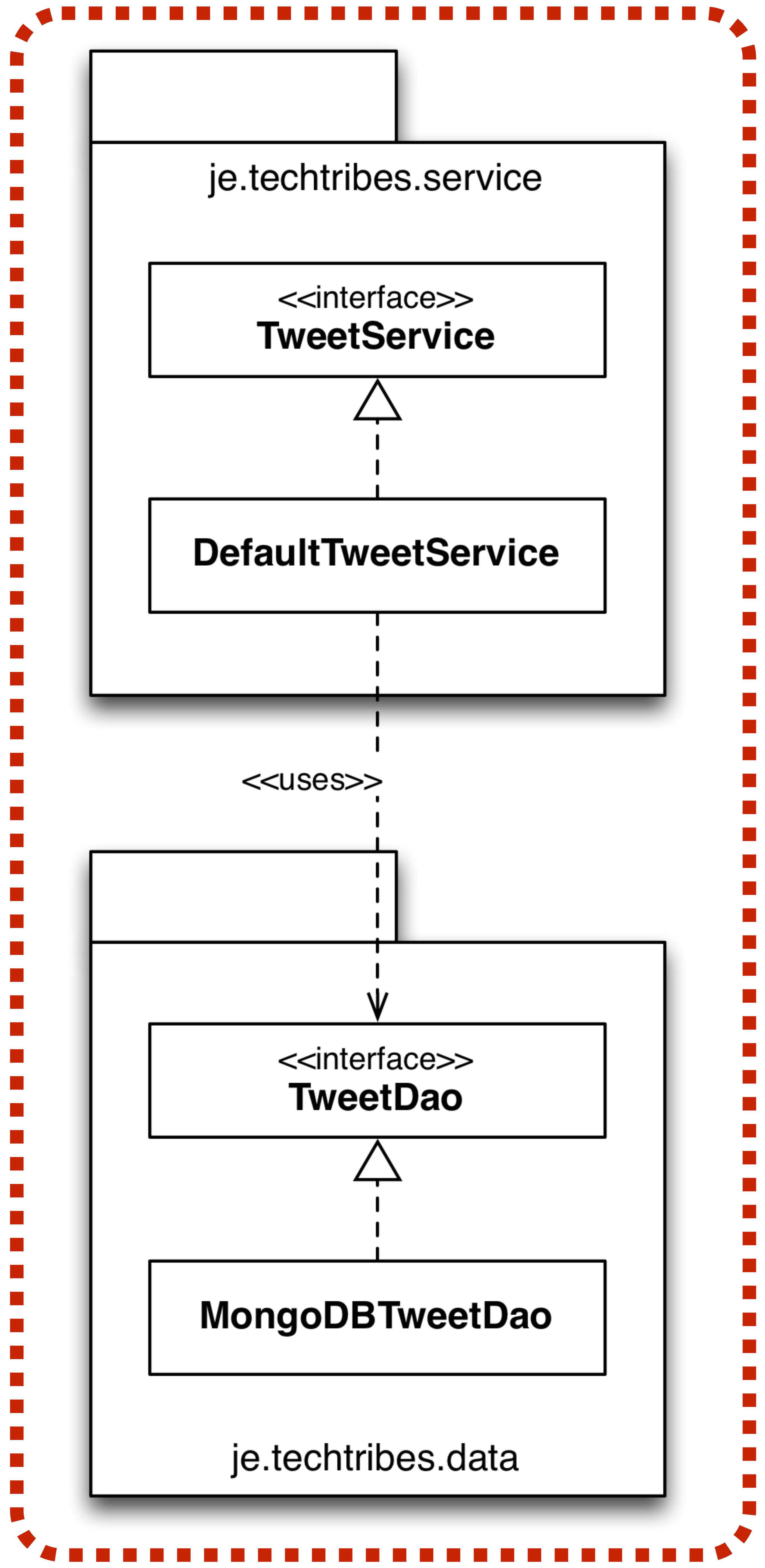


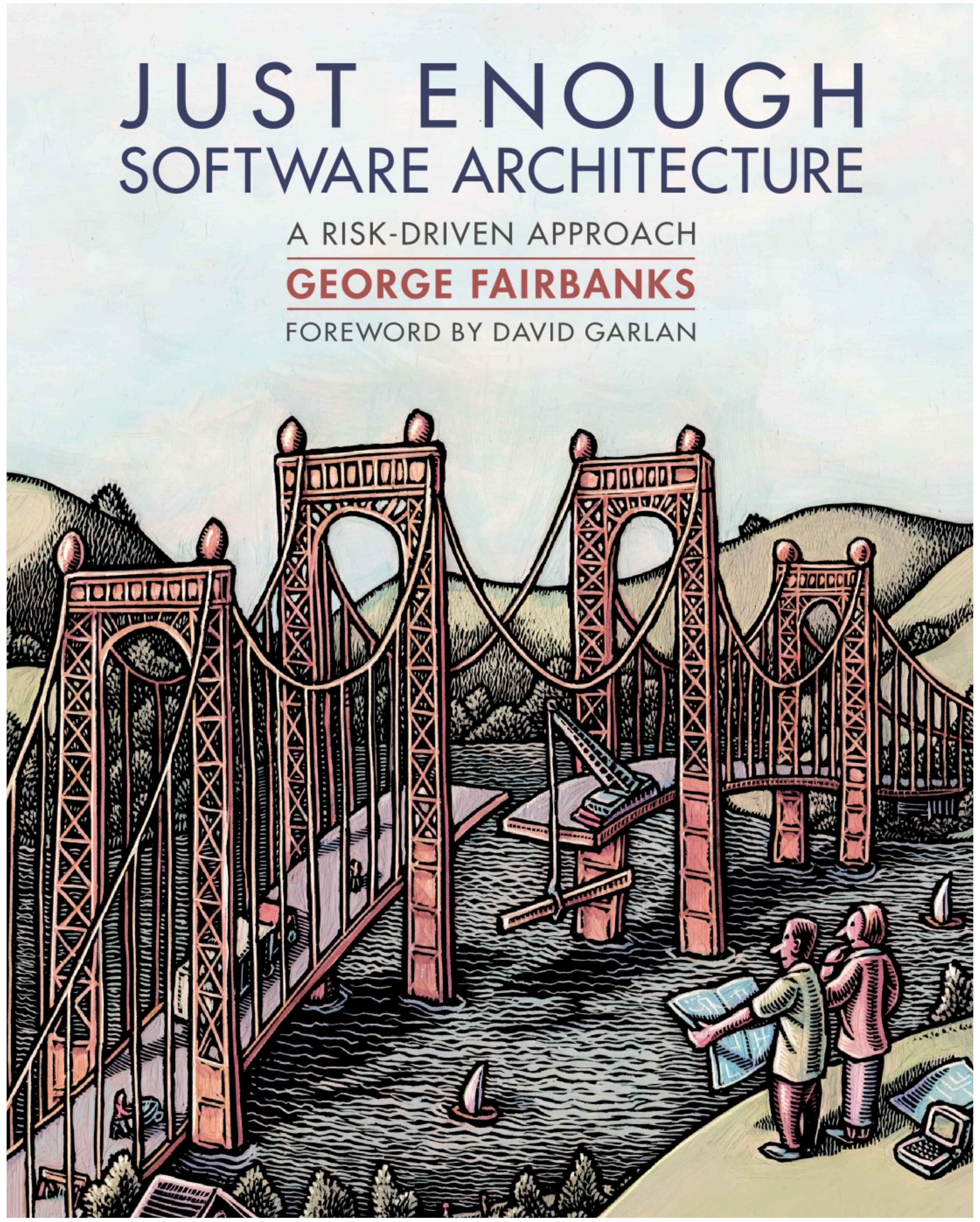
Where’s my “component”?

(the “Tweet Component” doesn’t exist as a single thing; it’s a combination of interfaces and classes across a layered architecture)



“the component exists **conceptually**”

Abstractions should reflect the code



Model-code gap. Your architecture models and your source code will not show the same things. The difference between them is the *model-code gap*. Your architecture models include some abstract concepts, like components, that your programming language does not, but could. Beyond that, architecture models include intensional elements, like design decisions and constraints, that cannot be expressed in procedural source code at all.

Consequently, the relationship between the architecture model and source code is complicated. It is mostly a refinement relationship, where the extensional elements in the architecture model are refined into extensional elements in source code. This is shown in Figure 10.3. However, intensional elements are not refined into corresponding elements in source code.

Upon learning about the model-code gap, your first instinct may be to avoid it. But reflecting on the origins of the gap gives little hope of a general solution in the short term: architecture models help you reason about complexity and scale because they are abstract and intensional; source code executes on machines because it is concrete and extensional.

“model-code gap”

Software Reflexion Models: Bridging the Gap between Source and High-Level Models*

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Abstract

Software engineers often use high-level models (for instance, box and arrow sketches) to reason and communicate about an existing software system. One problem with high-level models is that they are almost always inaccurate with respect to the system's source code. We have developed an approach that helps an engineer use a high-level model of the structure of an existing software system as a lens through which to see a model of that system's source code. In particular, an engineer defines a high-level model and specifies how the model maps to the source. A tool then computes a software reflexion model that shows where the engineer's high-level model agrees with and where it differs from a model of the source.

The paper provides a formal characterization of reflexion models, discusses practical aspects of the approach, and relates experiences of applying the approach and tools to a number of different systems. The illustrative example used in the paper describes the application of reflexion models to NetBSD, an implementation of Unix comprised of 250,000 lines of C code. In only a few hours, an engineer computed several reflexion models that provided him with a useful, global overview of the structure of the NetBSD virtual memory subsystem. The approach has also been applied to aid in the understanding and experimental reengineering of the Microsoft Excel spreadsheet product.

*This research was funded in part by the NSF grant CCR-8858804 and a Canadian NSERC post-graduate scholarship.

SIGSOFT '95 Washington, D.C., USA

1 Introduction

Software engineers often think about an existing software system in terms of high-level models. Box and arrow sketches of a system, for instance, are often found on engineers' whiteboards. Although these models are commonly used, reasoning about the system in terms of such models can be dangerous because the models are almost always inaccurate with respect to the system's source.

Current reverse engineering systems derive high-level models from the source code. These derived models are useful because they are, by their very nature, accurate representations of the source. Although accurate, the models created by these reverse engineering systems may differ from the models sketched by engineers; an example of this is reported by Wong et al. [WTMS95].

We have developed an approach, illustrated in Figure 1, that enables an engineer to produce sufficiently accurate high-level models in a different way. The engineer defines a high-level model of interest, extracts a source model (such as a call graph or an inheritance hierarchy) from the source code, and defines a declarative mapping between the two models. A *software reflexion model* is then computed to determine where the engineer's high-level model does and does not agree with the source model.[1] An engineer interprets the reflexion model and, as necessary, modifies the input to iteratively compute additional reflexion models.

[1]The old English spelling differentiates our use of "reflexion" from the field of reflective computing [Smi84].

1 Introduction

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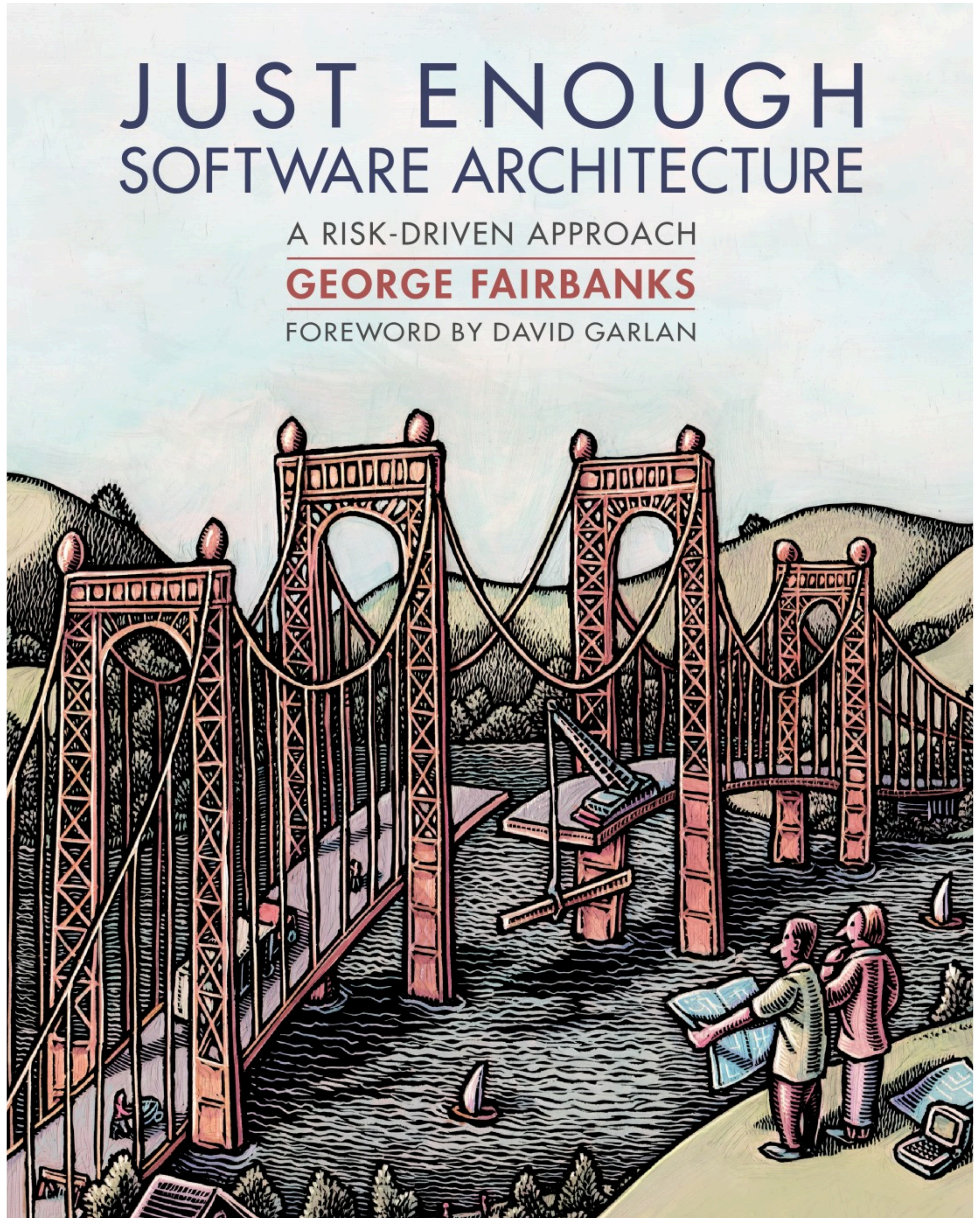
Our architecture diagrams don’t match the code.



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“architecturally-evident coding style”

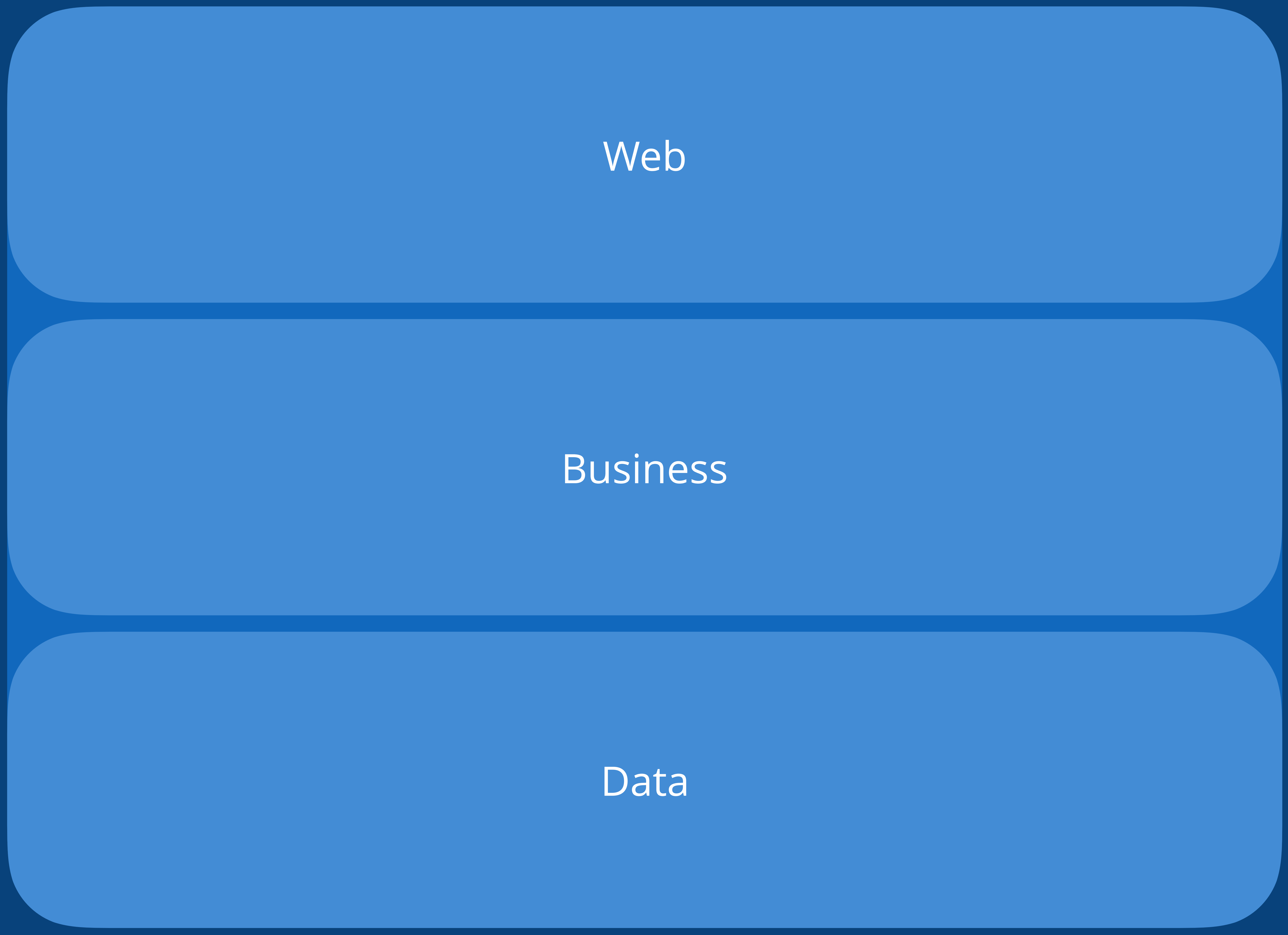
The code structure should reflect the architectural intent

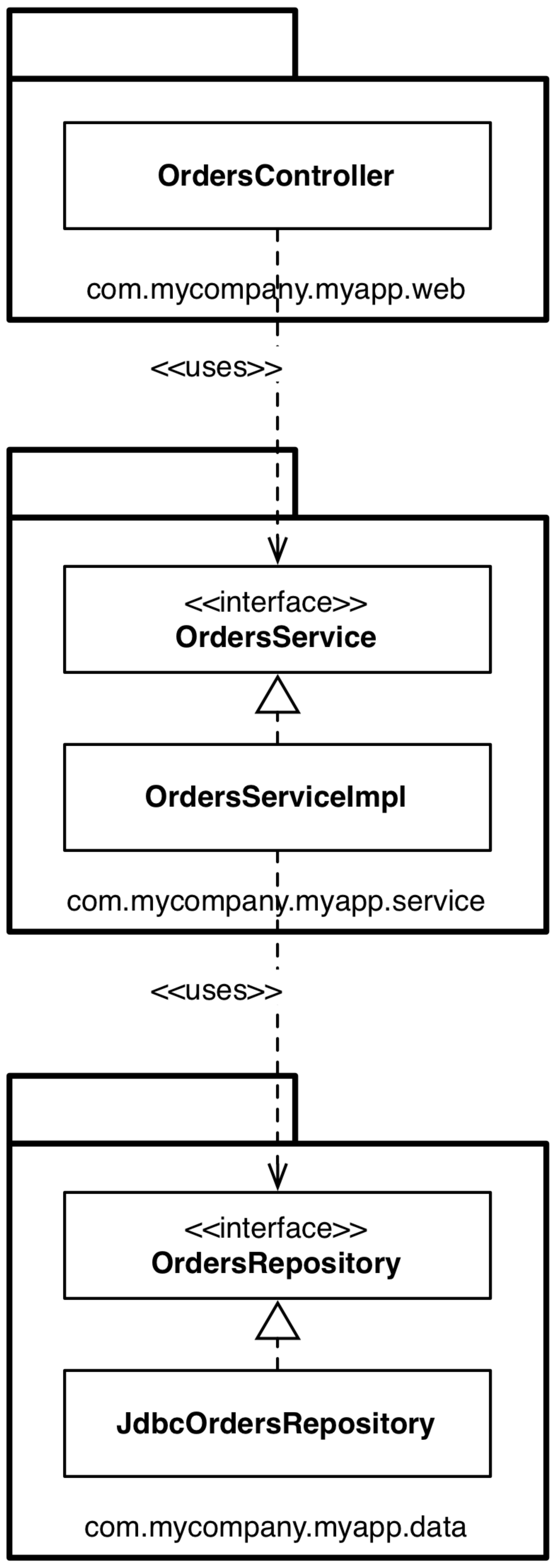
Package by layer

Organise code based upon what the code does from a technical perspective

Package by layer

is a “**horizontal**” slicing


Web
Business
Data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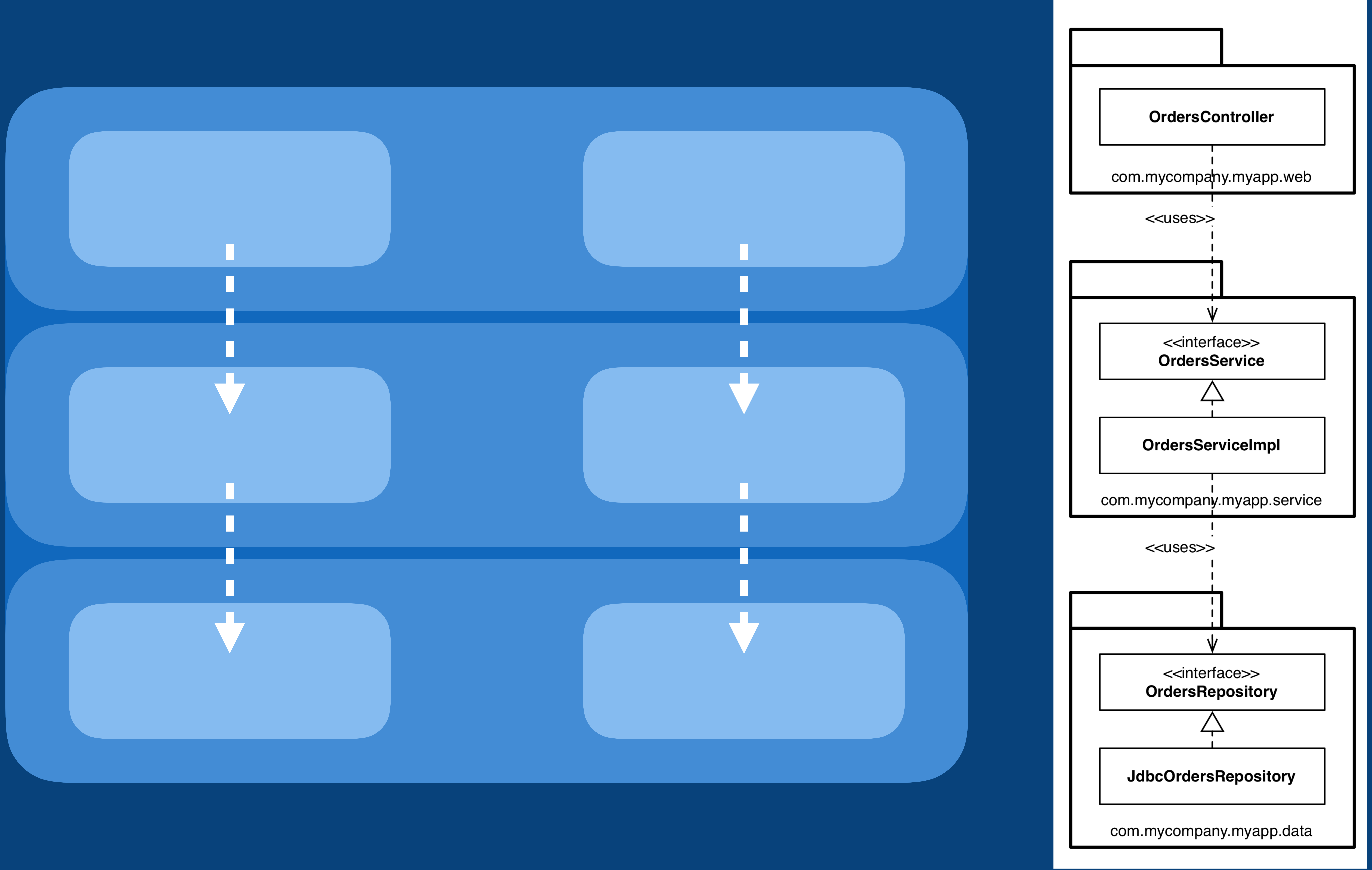
Relaxed vs strict layering



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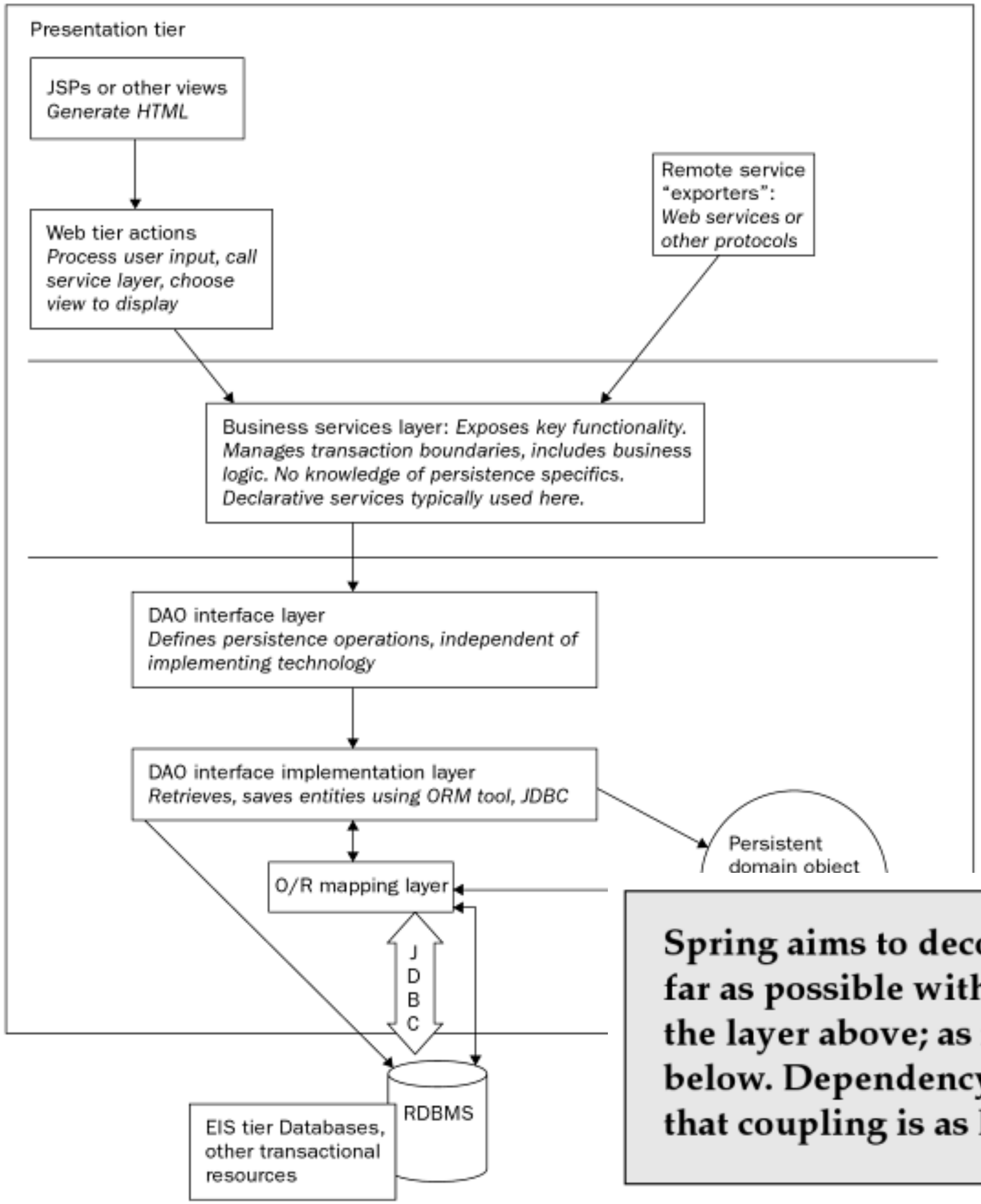

Let's summarize each layer and its responsibilities, beginning closest to the database or other enterprise resources:

- **Presentation layer:** This is most likely to be a web tier. This layer should be as thin as possible. It should be possible to have alternative presentation layers — such as a web tier or remote web services facade — on a single, well-designed middle tier.
- **Business services layer:** This is responsible for transactional boundaries and providing an entry point for operations on the system as a whole. This layer should have no knowledge of presentation concerns, and should be reusable.
- **DAO interface layer:** This is a layer of interfaces *independent of any data access technology* that is used to find and persist persistent objects. This layer effectively consists of *Strategy* interfaces for the Business services layer. This layer should not contain business logic. Implementations of these interfaces will normally use an O/R mapping technology or Spring's JDBC abstraction.
- **Persistent domain objects:** These model real objects or concepts such as a bank account.
- **Databases and legacy systems:** By far the most common case is a single RDBMS. However, there may be multiple databases, or a mix of databases and other transactional or non-transactional legacy systems or other enterprise resources. The same fundamental architecture is applicable in either case. This is often referred to as the *EIS* (*Enterprise Information System*) tier.

In a J2EE application, all layers except the EIS tier will run in the application server or web container. Domain objects will typically be passed up to the presentation layer, which will display data they contain, *but not modify them*, which will occur only within the transactional boundaries defined by the business services layer. Thus there is no need for distinct Transfer Objects, as used in traditional J2EE architecture.

In the following sections we'll discuss each of these layers in turn, beginning closest to the database.

Spring aims to decouple architectural layers, so that each layer can be modified as far as possible without impacting other layers. No layer is aware of the concerns of the layer above; as far as possible, dependency is purely on the layer immediately below. Dependency between layers is normally in the form of interfaces, ensuring that coupling is as loose as possible.

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Also sample codebases,
starter projects, demos
at conferences, etc…

Cargo cult programming can also refer to the results of applying a design pattern or coding style blindly without understanding the reasons behind that design principle.

https://en.wikipedia.org/wiki/Cargo_cult_programming

Screaming Architecture

Uncle Bob / 30 Sep 2011 Architecture

Share Tweet Share

Imagine that you are looking at the blueprints of a building. This document, prepared by an architect, tells you the plans for the building. What do these plans tell you?

If the plans you are looking at are for a single family residence, then you'll likely see a front entrance, a foyer leading to a living room and perhaps a dining room. There'll likely be a kitchen a short distance away, close to the dining room. Perhaps a dinette area next to the kitchen, and probably a family room close to that. As you looked at those plans, there'd be no question that you were looking at a *house*. The architecture would *scream*: **house**.

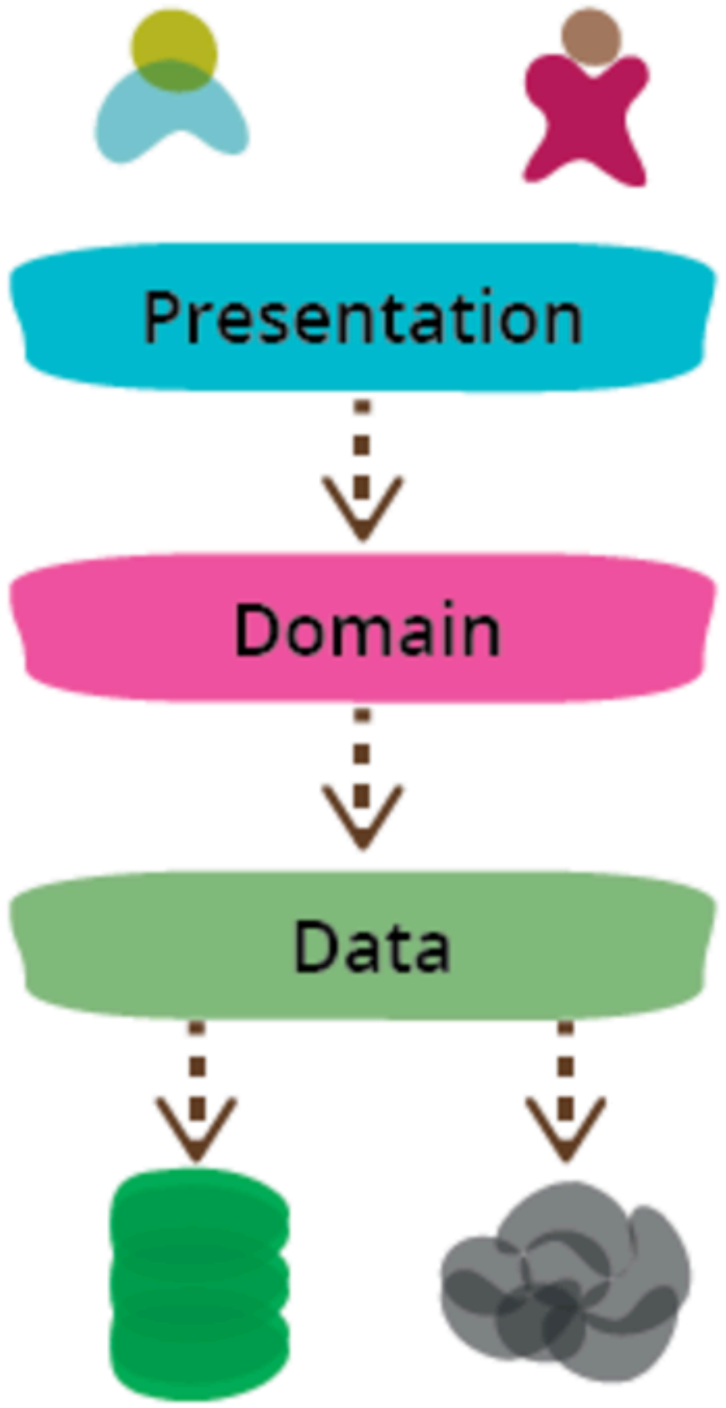
Or if you were looking at the architecture of a library, you'd likely see a grand entrance, an area for check-in-out clerks, reading areas, small conference rooms, and gallery after gallery capable of holding bookshelves for all the books in the library. That architecture would *scream*: **Library**.

So what does the architecture of your application scream? When you look at the top level directory structure, and the source files in the highest level package; do they scream: **Health Care System**, or **Accounting System**, or **Inventory Management System**? Or do they scream: **Rails**, or **Spring/Hibernate**, or **ASP**?

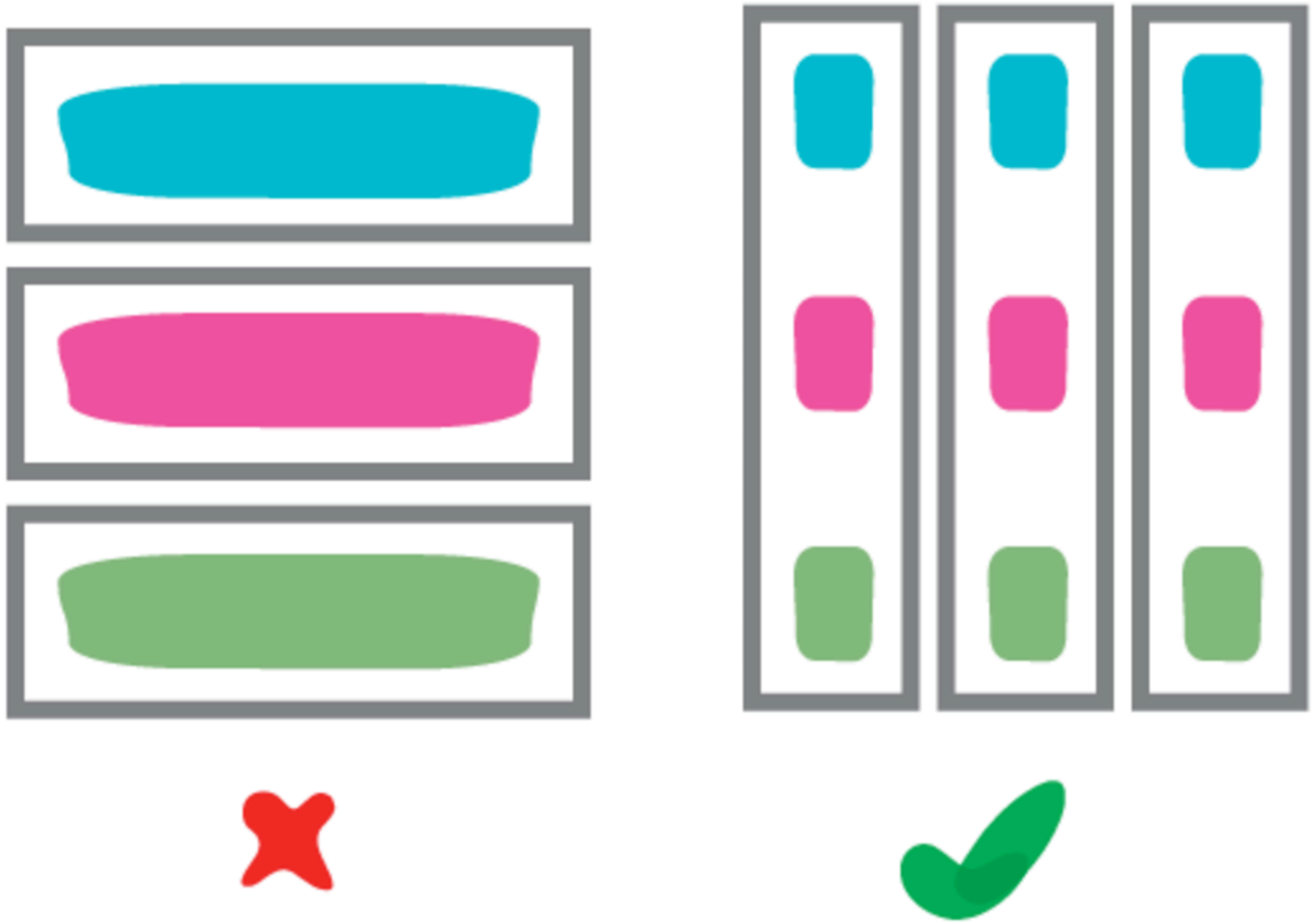
PresentationDomainDataLayering

Martin Fowler
26 August 2015

One of the most common ways to modularize an information-rich program is to separate it into three broad layers: presentation (UI), domain logic (aka business logic), and data access. So you often see web applications divided into a web layer that knows about handling http requests and rendering HTML, a business logic layer that contains validations and calculations, and a data access layer that sorts out how to manage persistant data in a database or remote services.



Although presentation-domain-data separation is a common approach, it should only be applied at a relatively small granularity. As an application grows, each layer can get sufficiently complex on its own that you need to modularize further. When this happens it's usually not best to use presentation-domain-data as the higher level of modules. Often frameworks encourage you to have something like view-model-data as the top level namespaces; that's ok for smaller systems, but once any of these layers gets too big you should split your top level into domain oriented modules which are internally layered.



Changes to a layered architecture
usually result in changes
across all layers

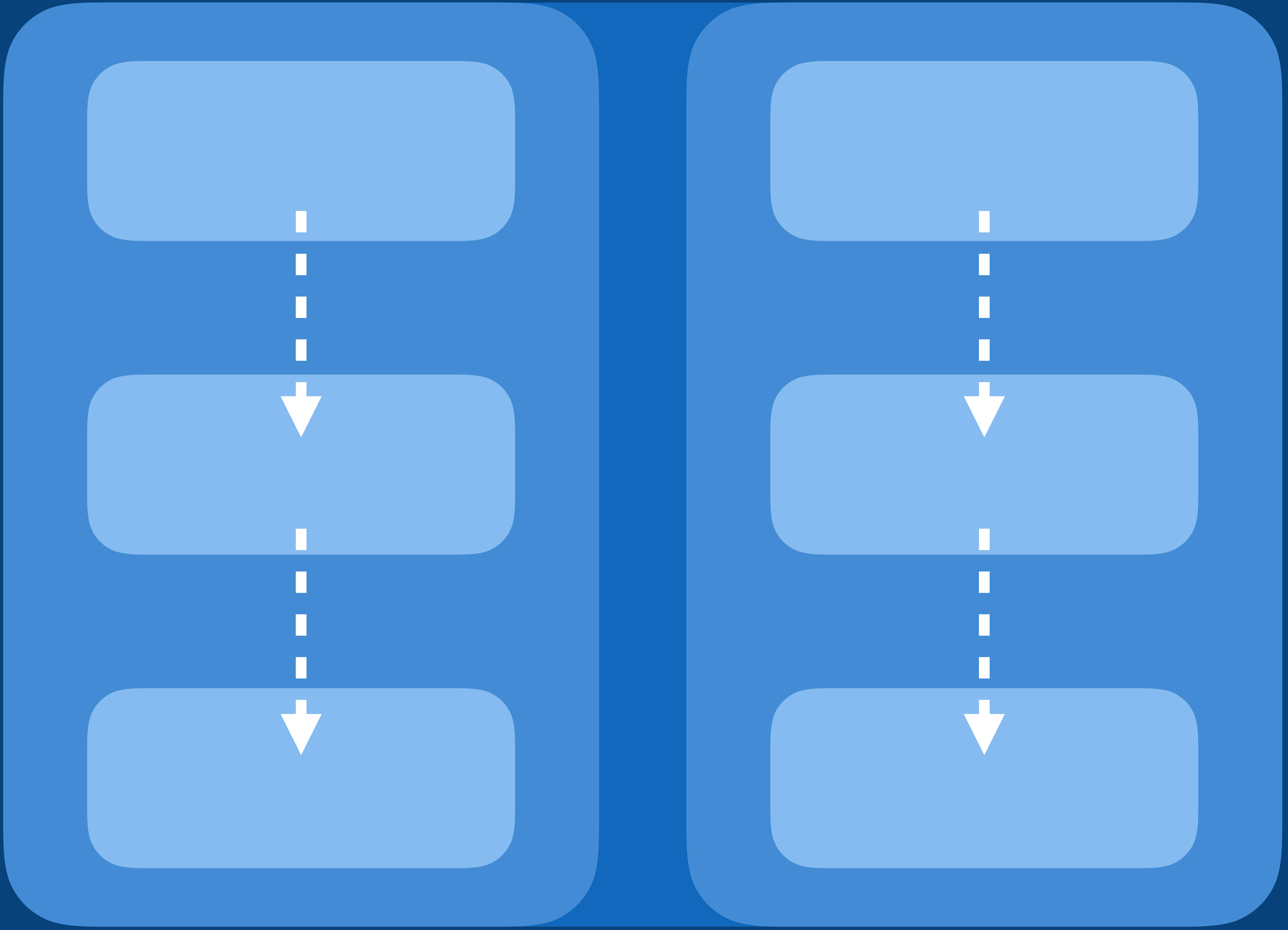
Package by feature

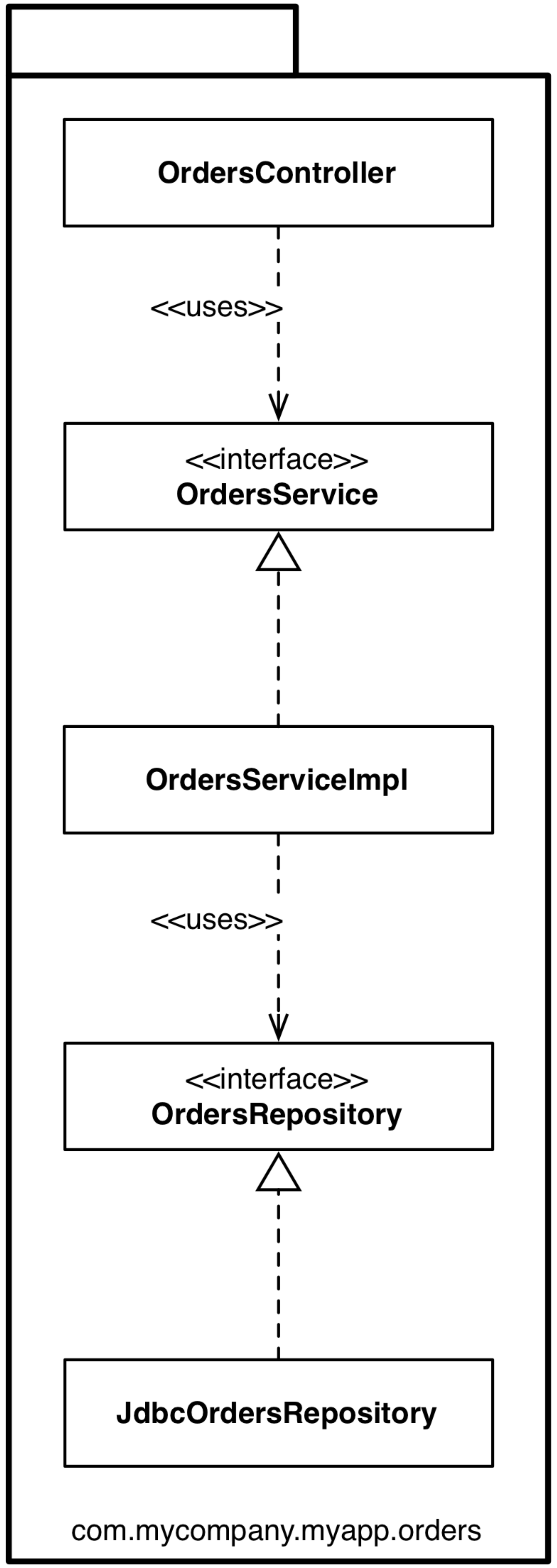
Organise code based upon
what the code does from
a functional perspective

Features, domain concepts, aggregate roots, etc

Package by feature

is a “**vertical**” slicing

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com.mycompany.myapp.orders

Cited benefits include higher cohesion, lower coupling, and related code is easier to find

Ports and adapters

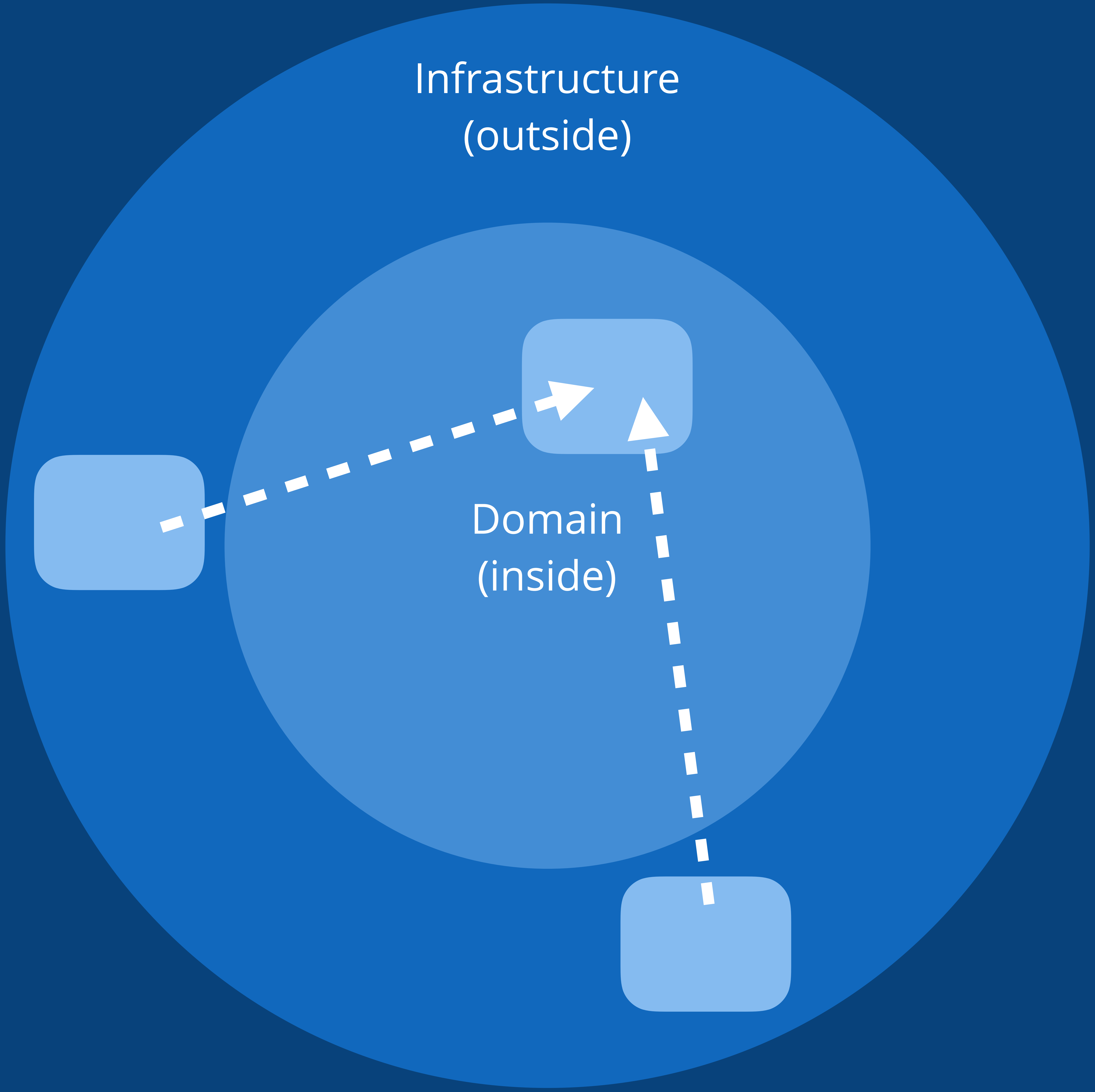
Keep domain related code separate from technical details

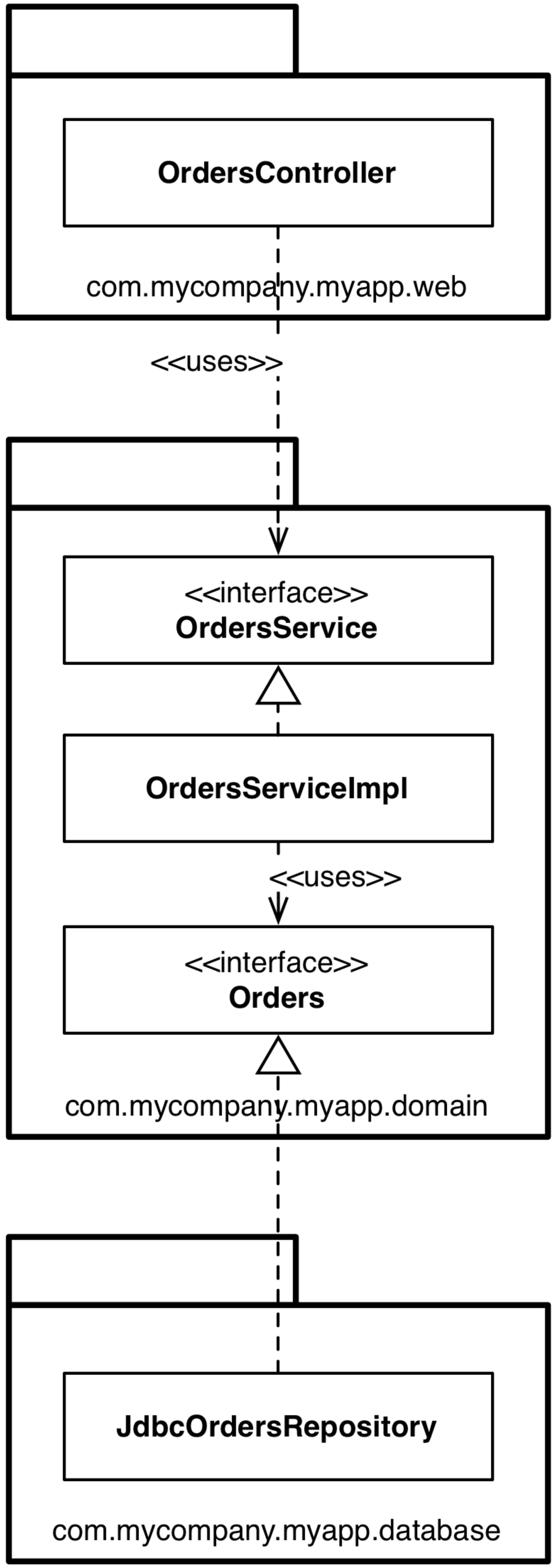
Variations on this theme include
“hexagonal architecture”,
“clean architecture”,
“onion architecture”, etc

The “inside” is technology agnostic, and is often described in terms of a **ubiquitous language**

The “outside” is technology specific

The “outside” depends upon the “inside”


Infrastructure
(outside)
Domain
(inside)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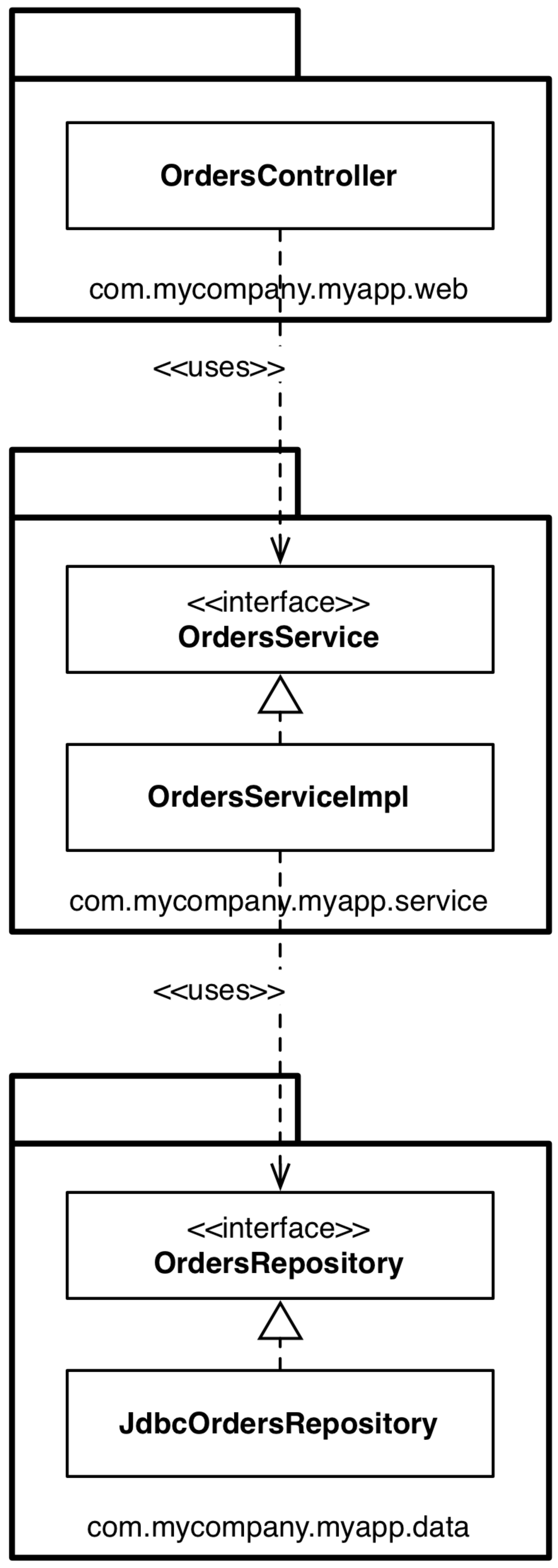
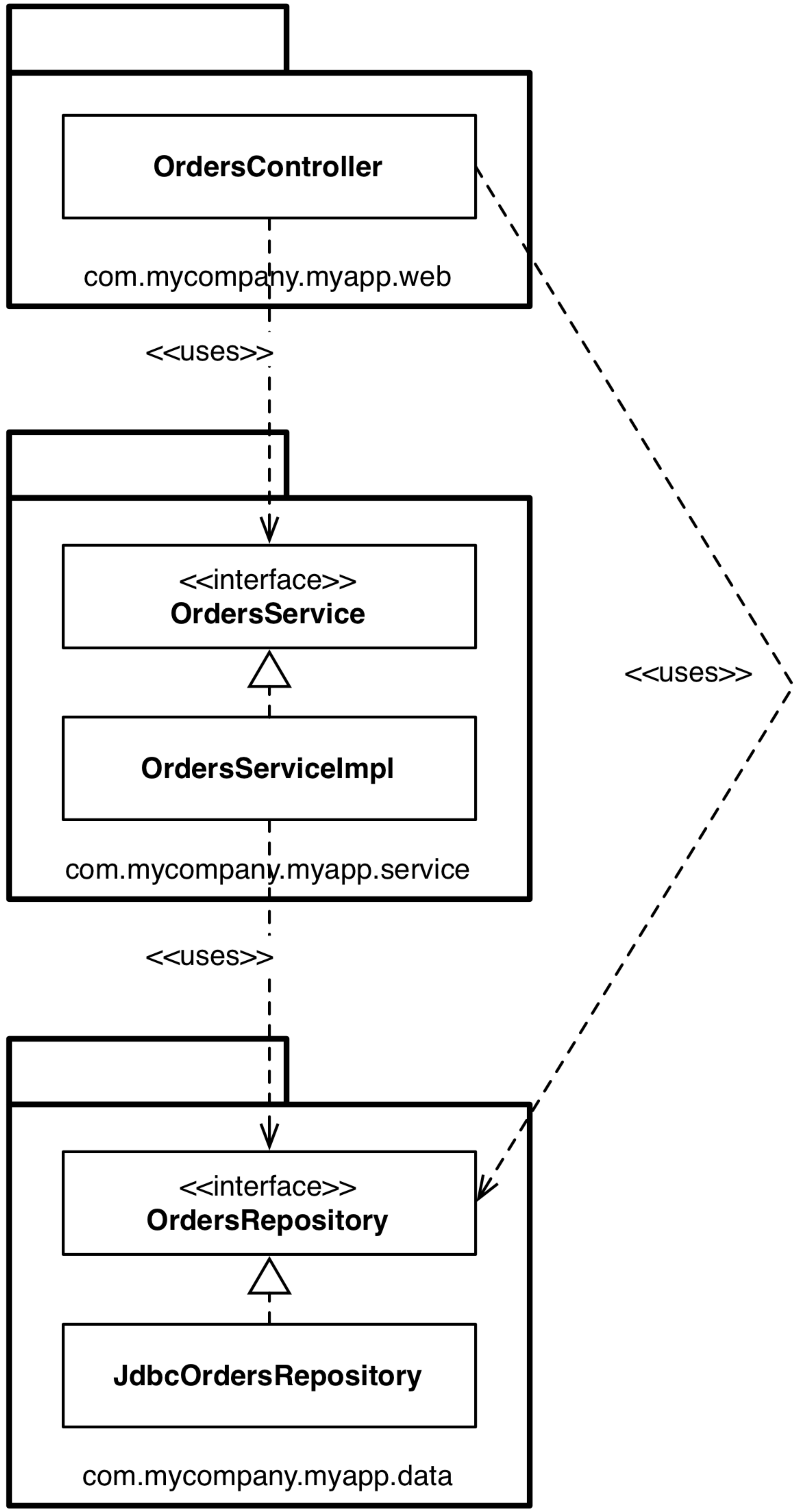
This approach is also "cargo culted", yet not all frameworks are equal

But...

Hi, can you add feature X to the orders functionality?



Sure!



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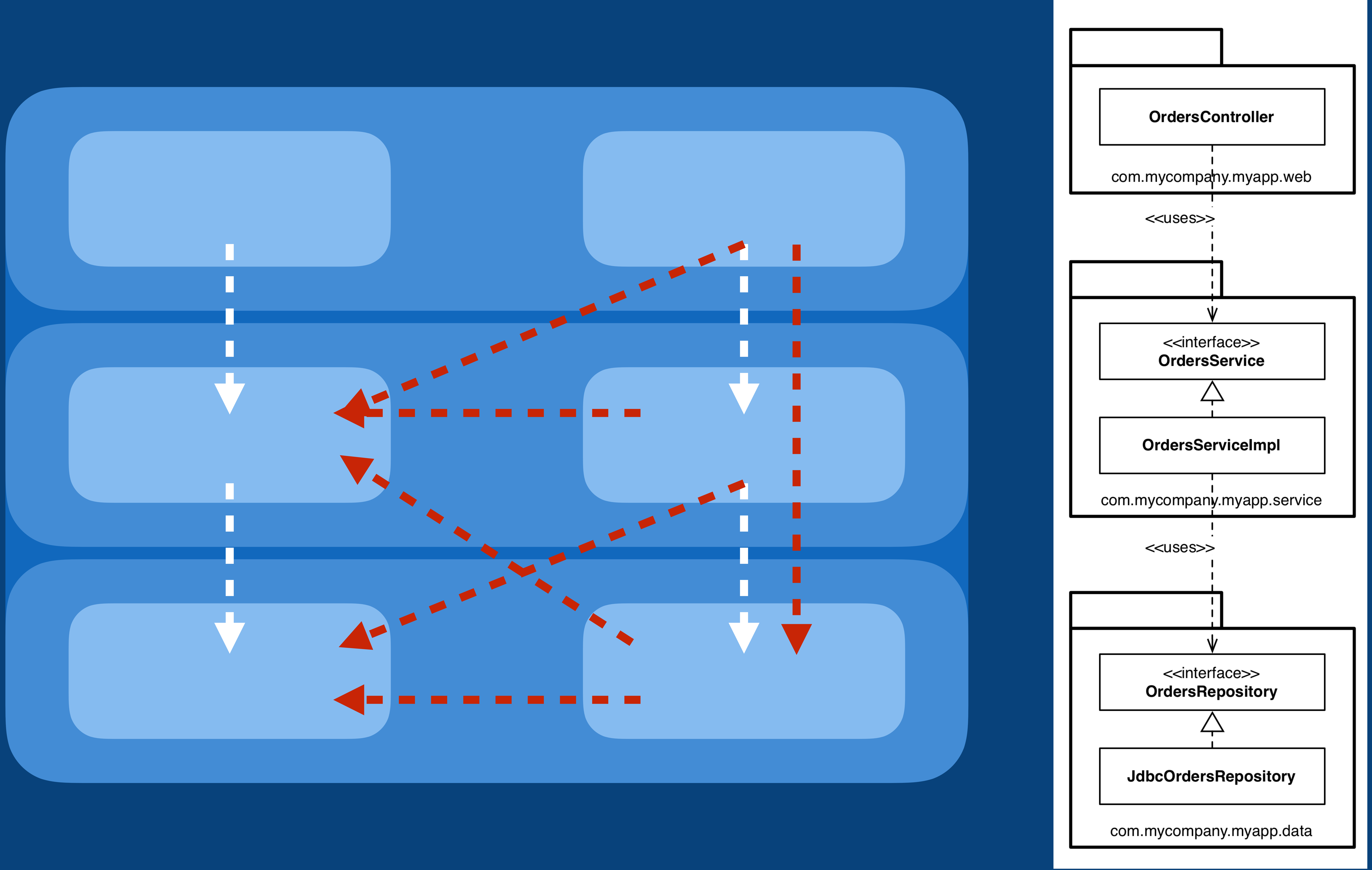

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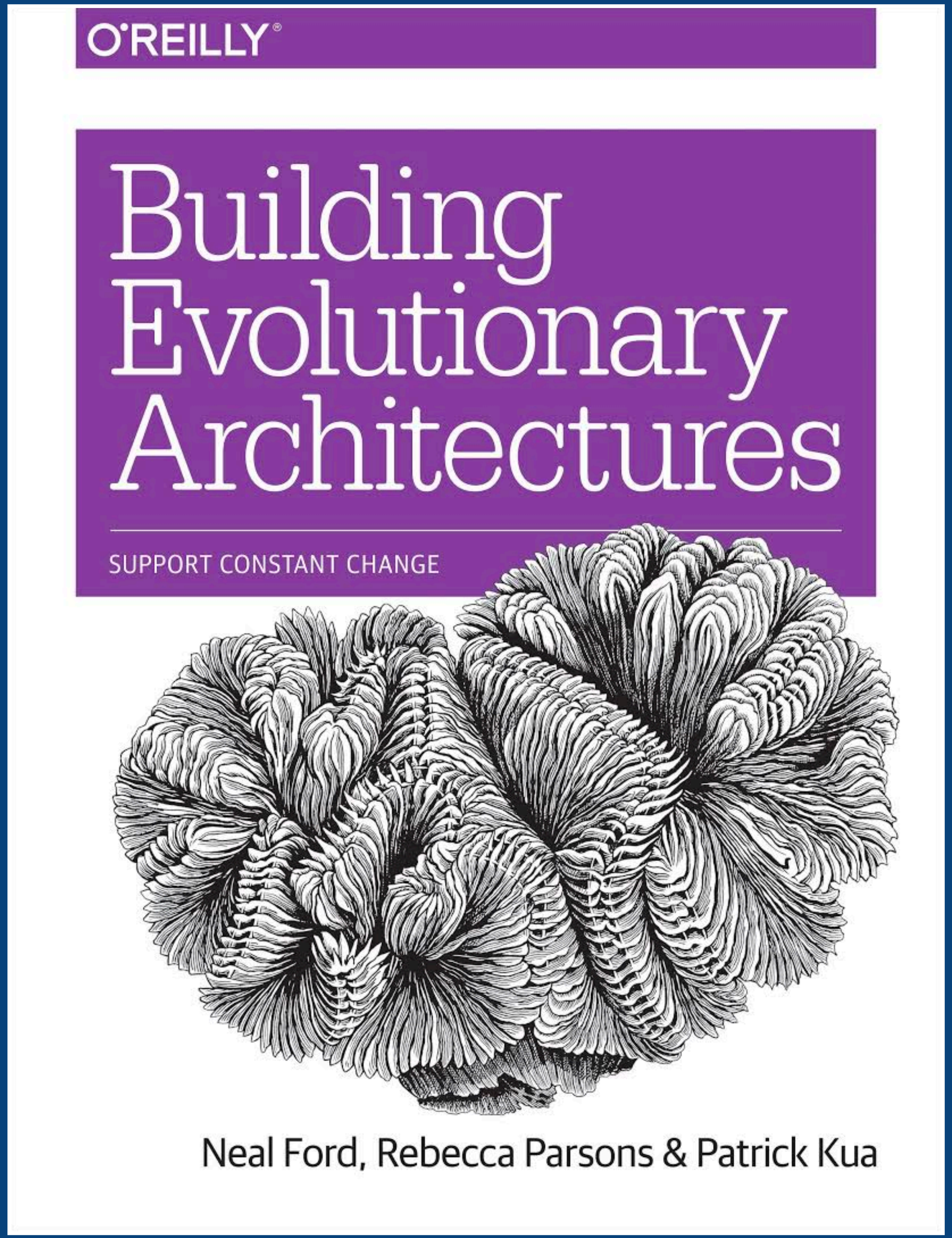
A big ball of mud is a casually, even haphazardly, structured system. Its organization, if one can call it that, is dictated more by expediency than design.

Big Ball of Mud
Brian Foote and Joseph Yoder

Architectural principles introduce consistency via constraints and guidelines web controllers should never access repositories directly we enforce this principle through good discipline and code reviews, because we trust our developers

Responsible, professional software developers are still human :-)

It’s 2018! In a world of artificial intelligence and machine learning, why don’t we use **tools** to help us build “good” software?



"Fitness functions"

(e.g. cyclic complexity, coupling, etc)

Tooling?

Static analysis tools, architecture violation checking, etc types in package `**/web` should not access types in `**/data`

Using tools to assert good code structure seems like a hack

But Java’s access modifiers are flawed…

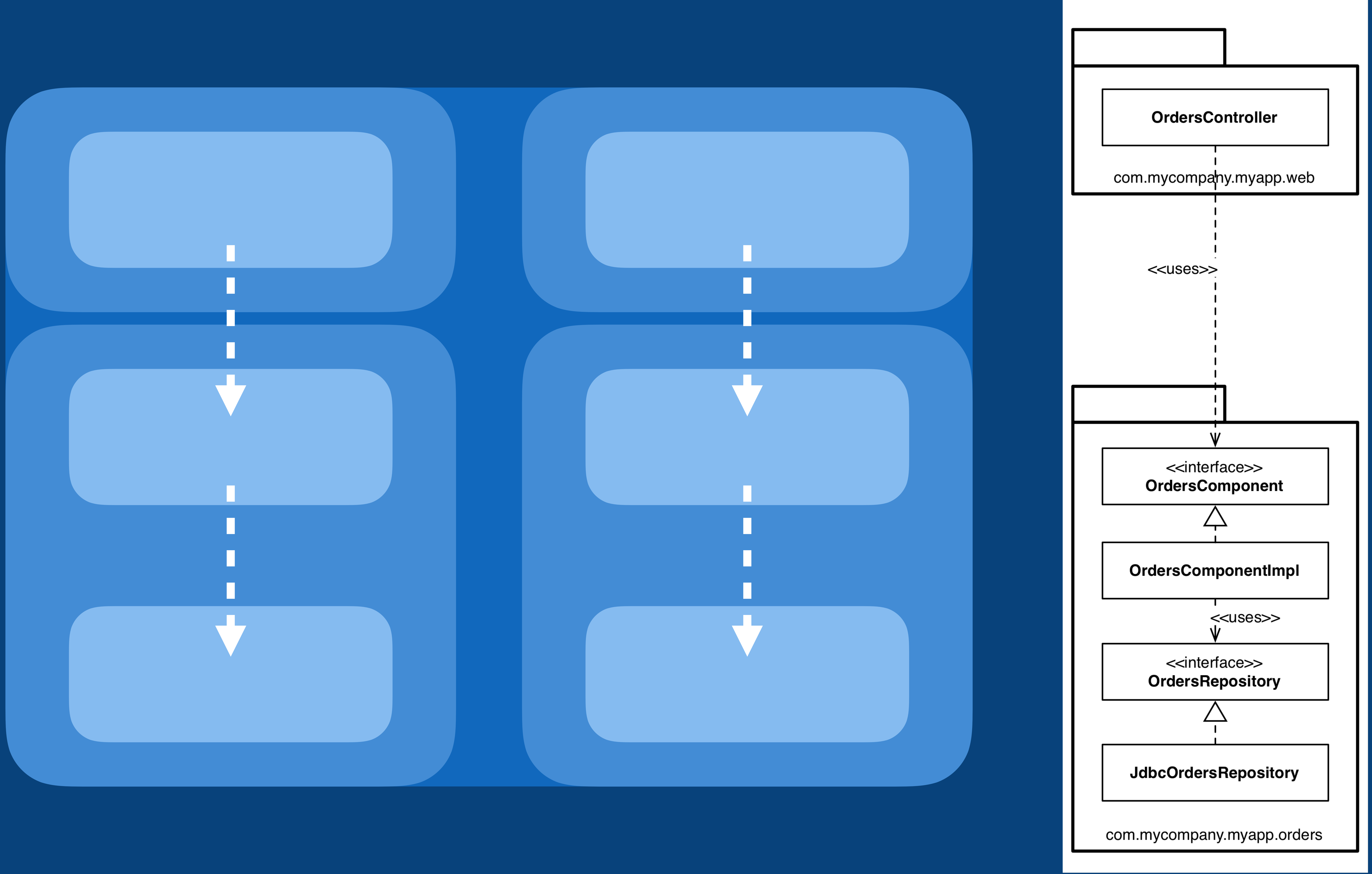
Package by component

Organise code by bundling together everything related to a “component”

Component?

a grouping of related functionality behind a nice clean interface, which resides inside an execution environment like an application

A **software system** is made up of one or more **containers**,
each of which contains one or more **components**,
which in turn are implemented by one or more **code elements**.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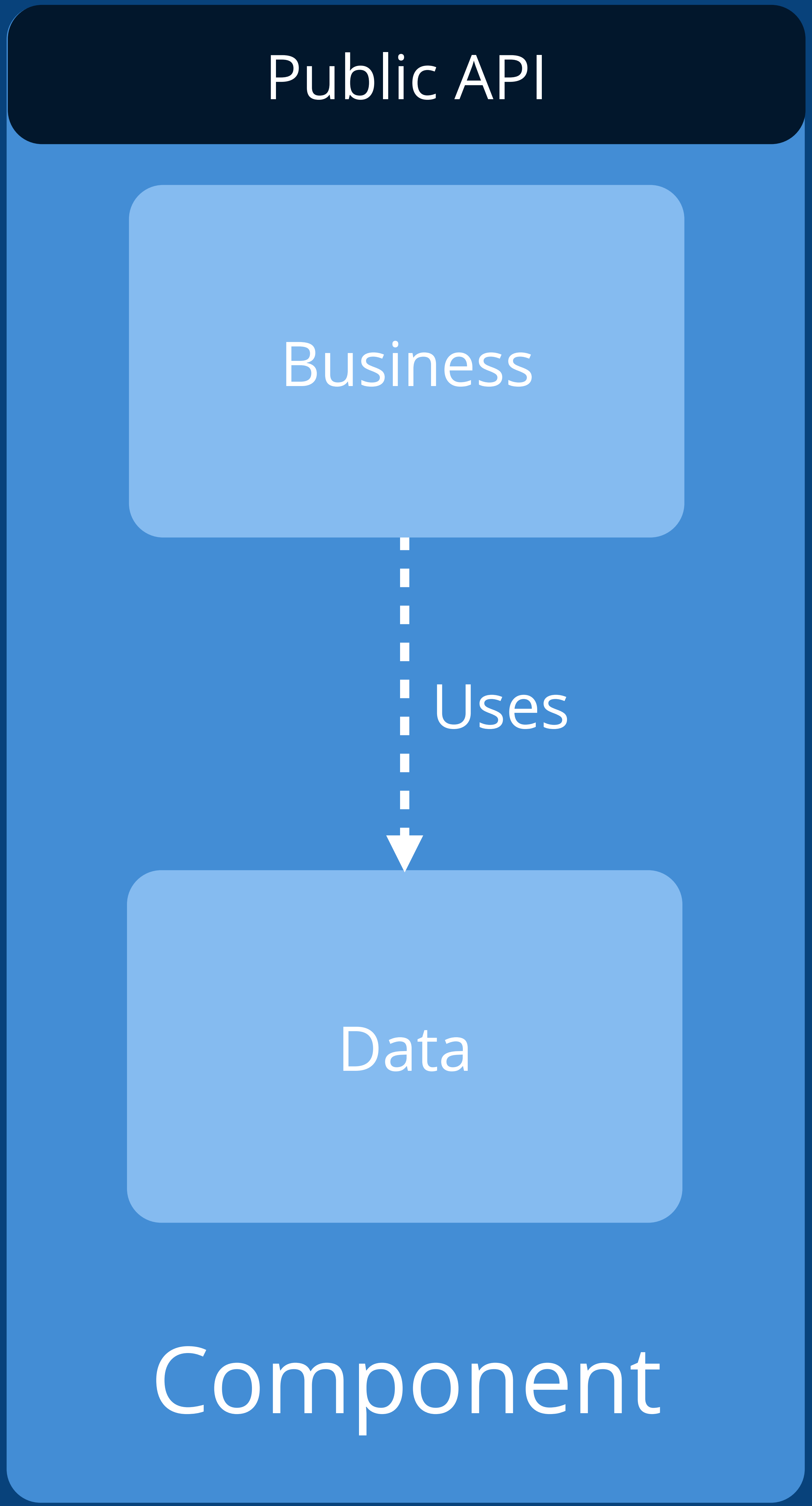
Package by component is about applying **component-based** or **service-oriented** design thinking to a monolithic codebase

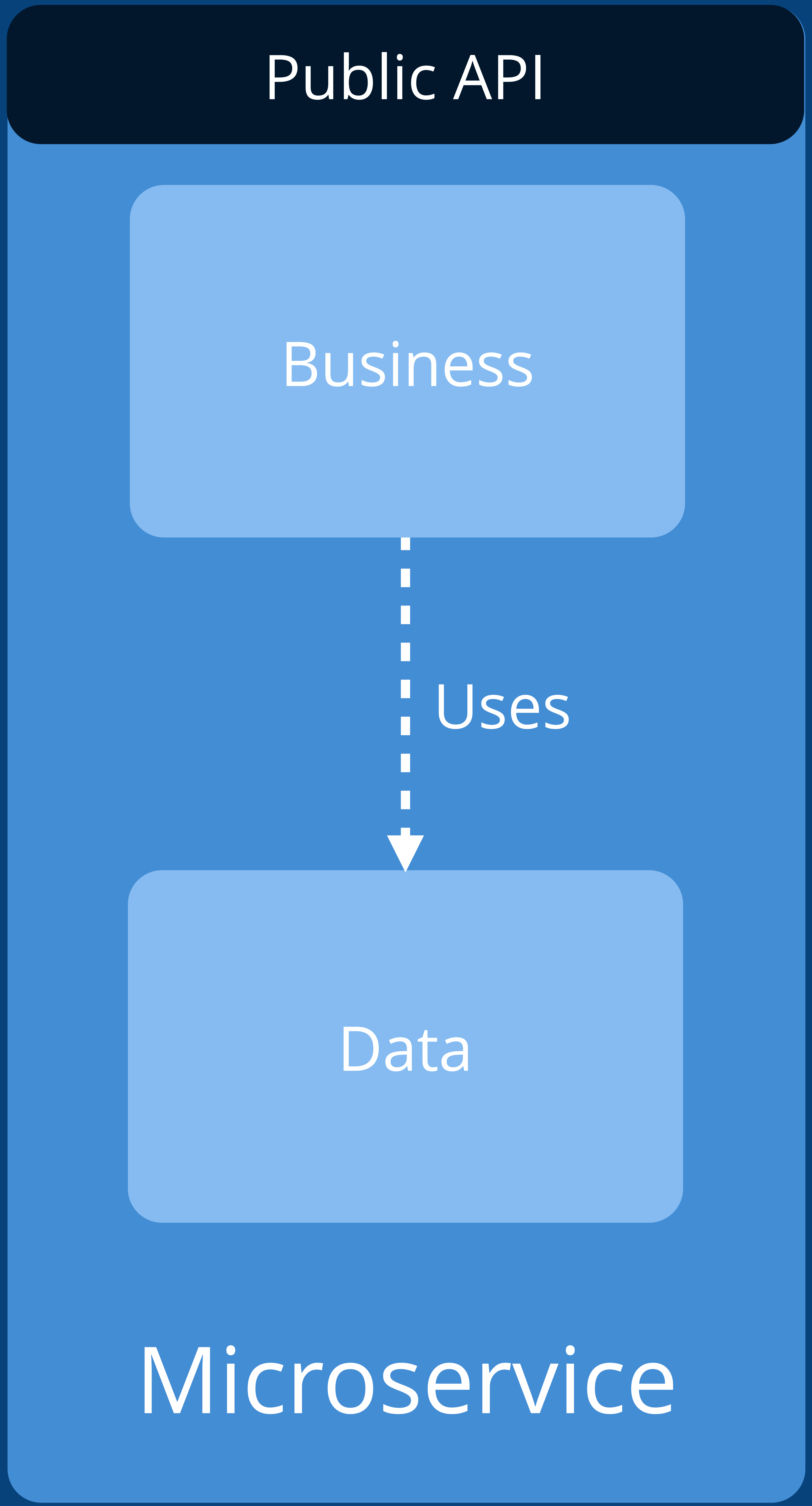
Modularity as a principle

Separating interface from implementation



Impermeable boundaries

Access modifiers vs network boundaries

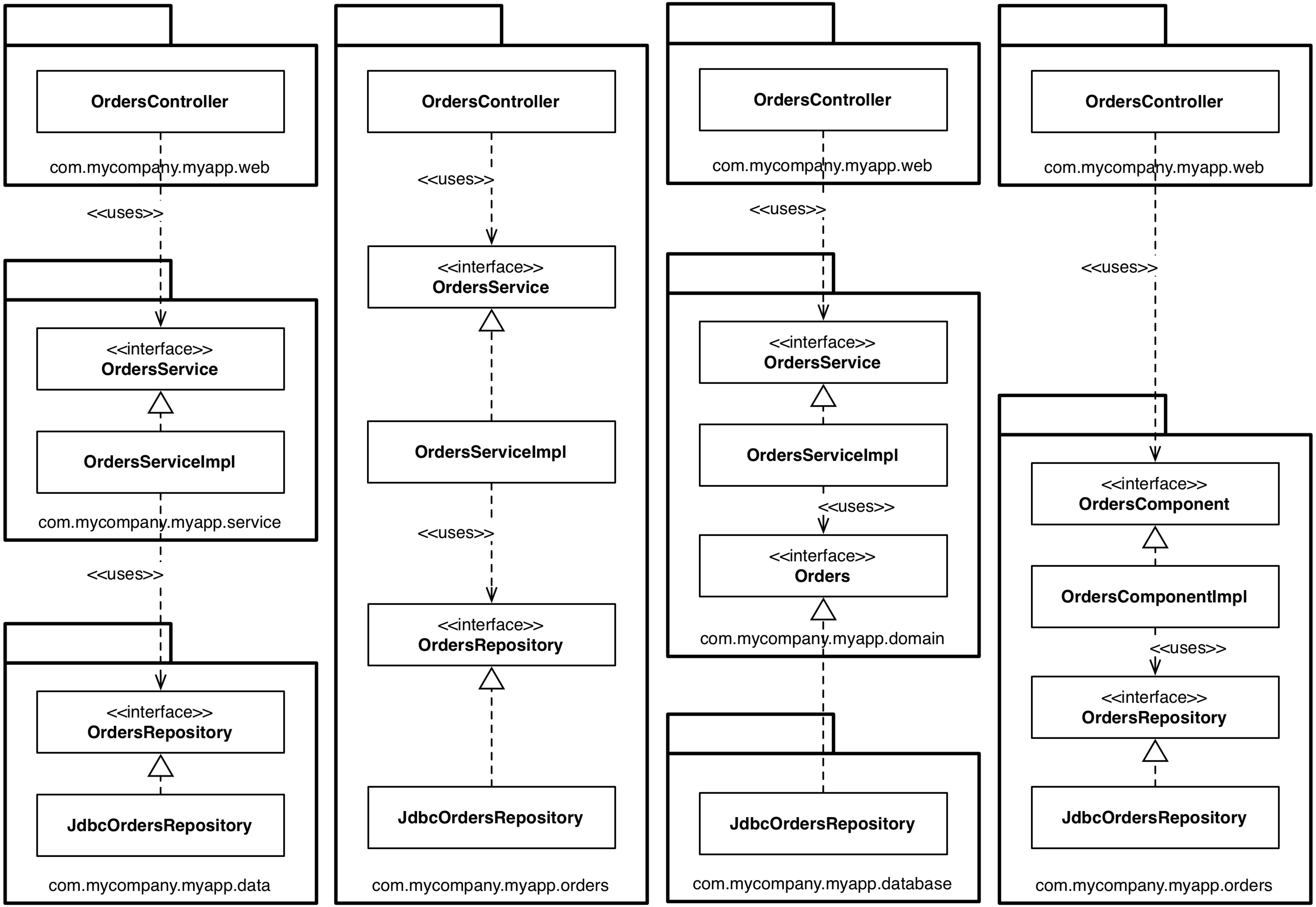


The devil is in the implementation details

public

Organisation vs encapsulation

If you make all types `public`,
architectural styles
can be **conceptually different**,
but **syntactically identical**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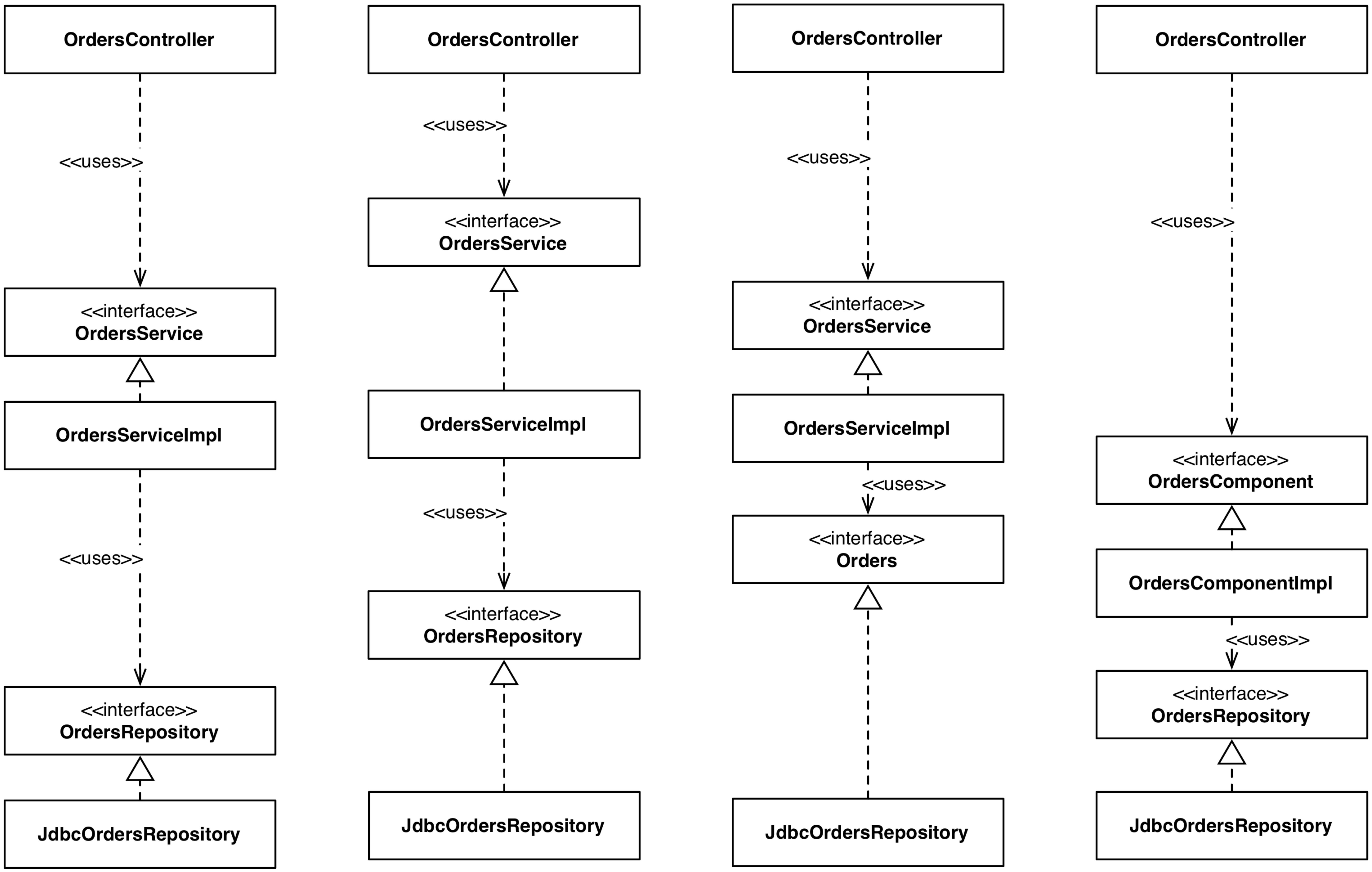
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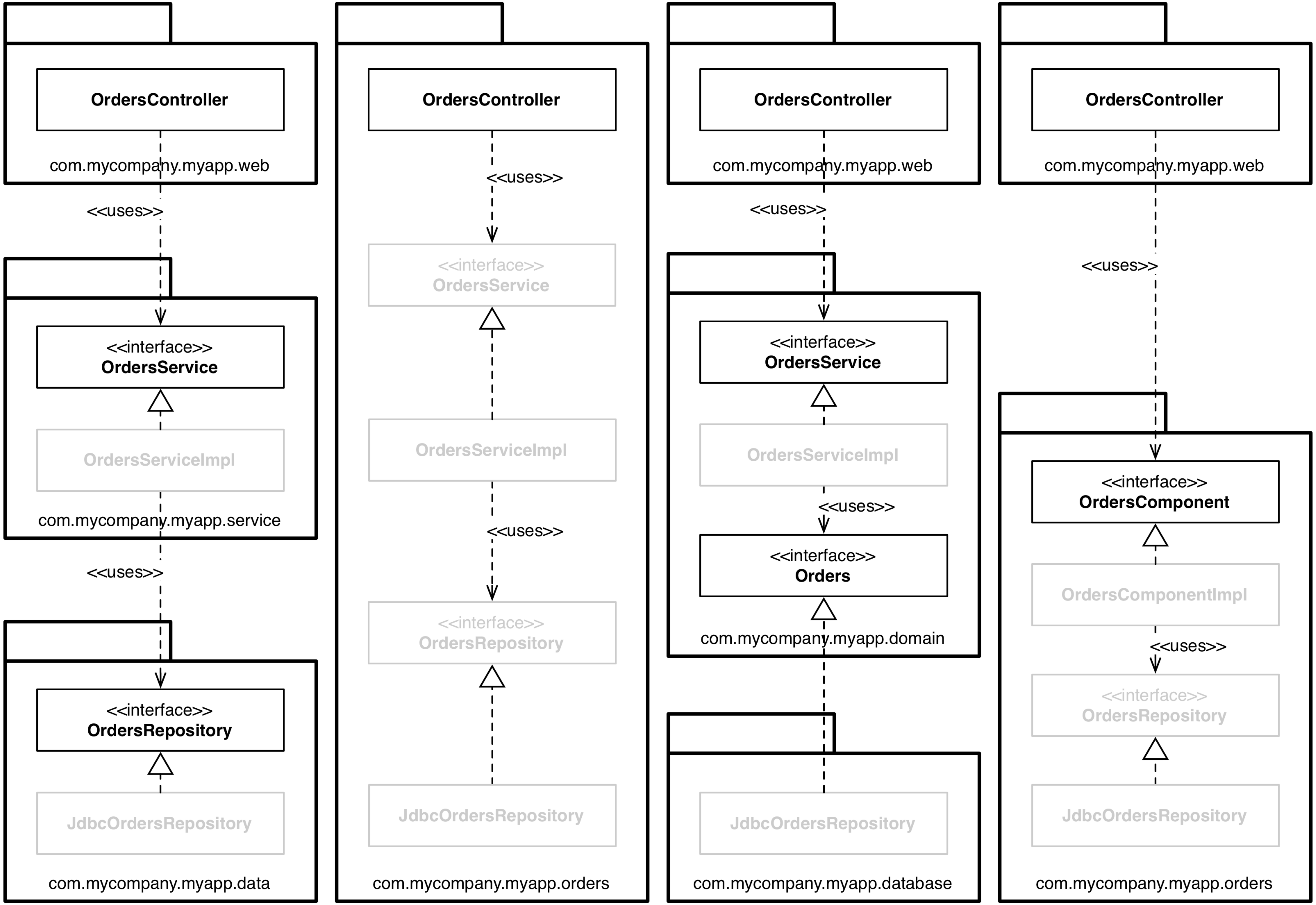
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JdbcOrdersRepository
com.mycompany.myapp.orders

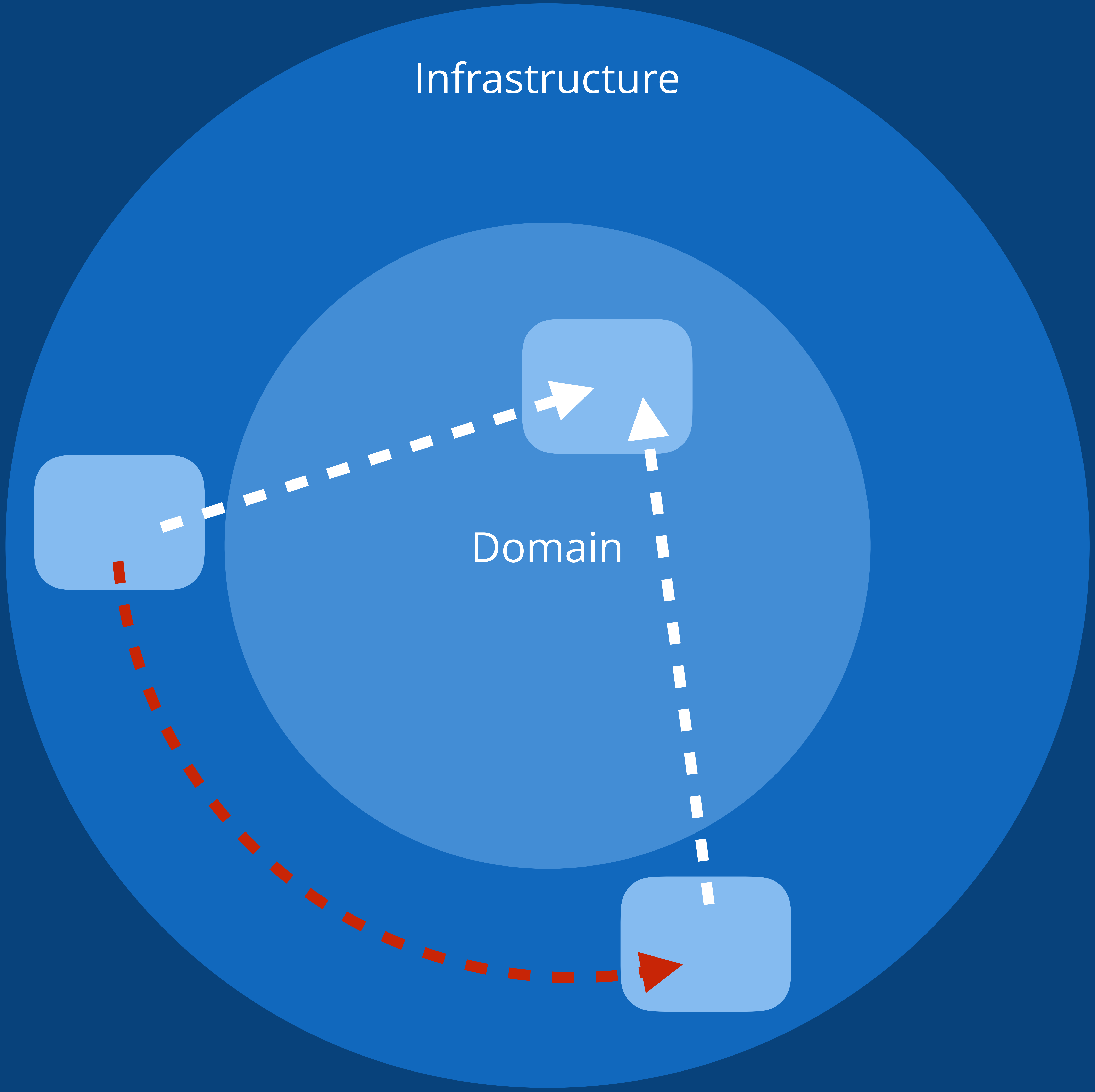
Use encapsulation to **minimise** the number of potential **dependencies**

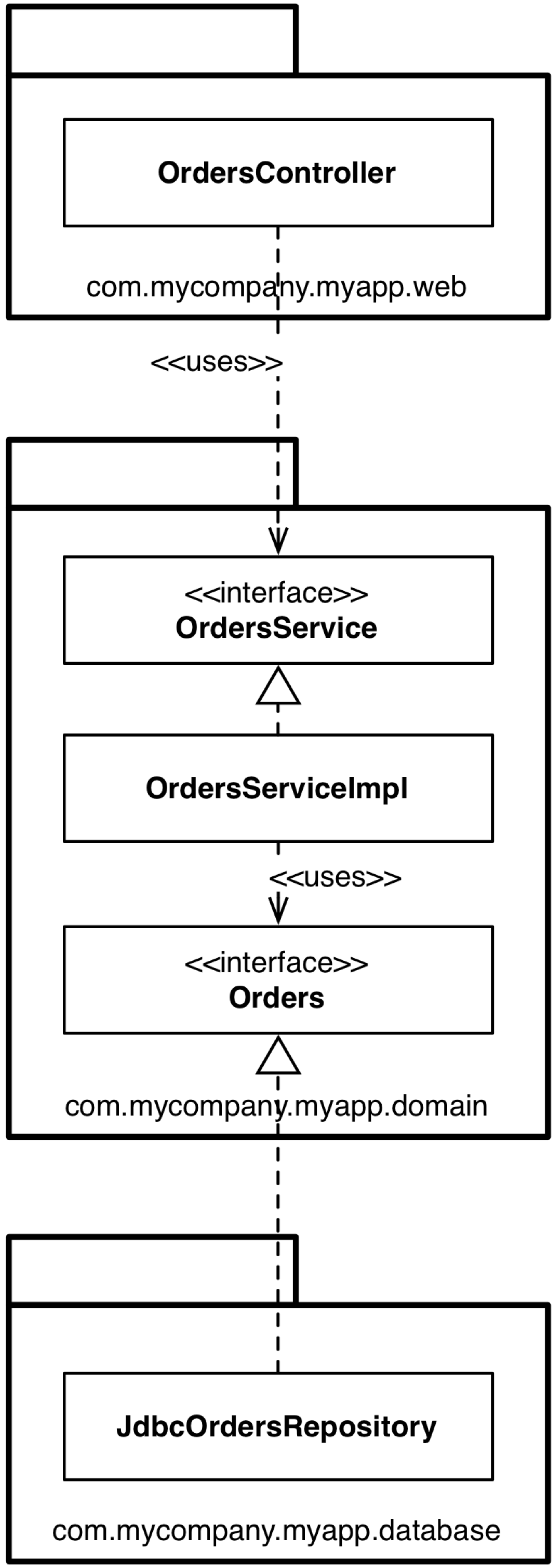
The surface area of your internal public APIs should match your **architectural intent**

If you’re building a monolithic application with a single codebase, **try to use the compiler to enforce boundaries**

Or other decoupling modes such as a module framework that differentiates **public** from **published** types

Or **split the source code tree**
into multiple parts

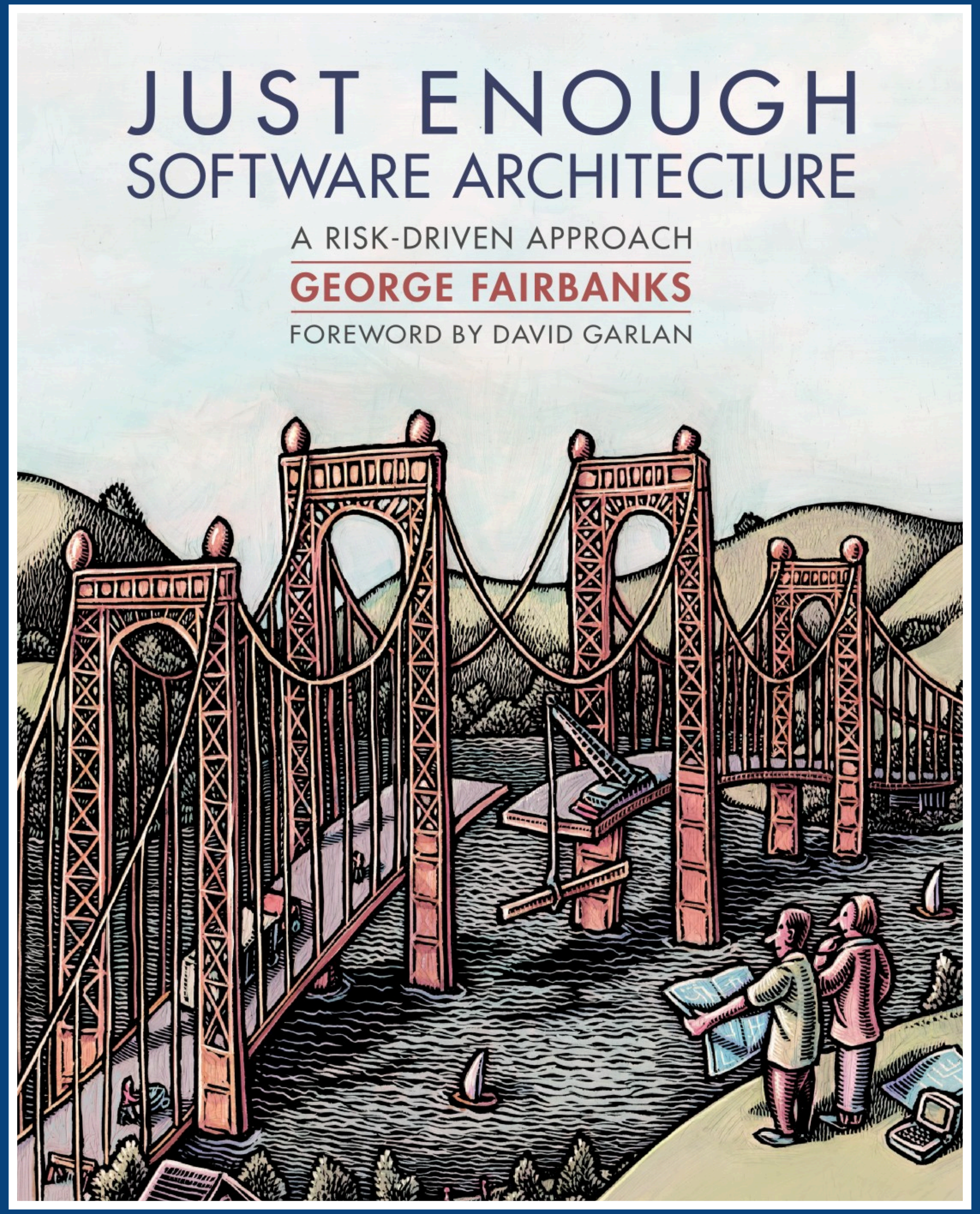

Infrastructure
Domain


OrdersController
com.mycompany.myapp.web
<<uses>>
<<interface>>
OrdersService
OrdersServiceImpl
<<uses>>
<<interface>>
Orders
com.mycompany.myapp.domain
JdbcOrdersRepository
com.mycompany.myapp.database

There are real-world trade-offs with many source code trees

And, more generally, each decoupling mode has different trade-offs

(modular monoliths vs microservices)



A good architecture rarely happens through **architecture-indifferent design**

Agility is a
quality attribute

A good architecture enables agility


Modular monolith
Microservices
Monolithic big ball of mud
Distributed big ball of mud
Modularity
Number of deployment units

Decomposition (computer science)

From Wikipedia, the free encyclopedia

Decomposition in computer science, also known as **factoring**, is breaking a complex problem or system into parts that are easier to conceive, understand, program, and maintain.

Contents [hide]

Decomposition paradigm [edit]

A decomposition paradigm in computer programming is a strategy for organizing a program as a number of parts, and it usually implies a specific way to organize a program text. Usually the aim of using a decomposition paradigm is to optimize some metric related to program complexity, for example the modularity of the program or its maintainability.

Most decomposition paradigms suggest breaking down a program into parts so as to minimize the static dependencies among those parts, and to maximize the cohesiveness of each part. Some popular decomposition paradigms are the procedural, modules, abstract data type and object oriented ones.

On the Criteria To Be Used in Decomposing Systems into Modules

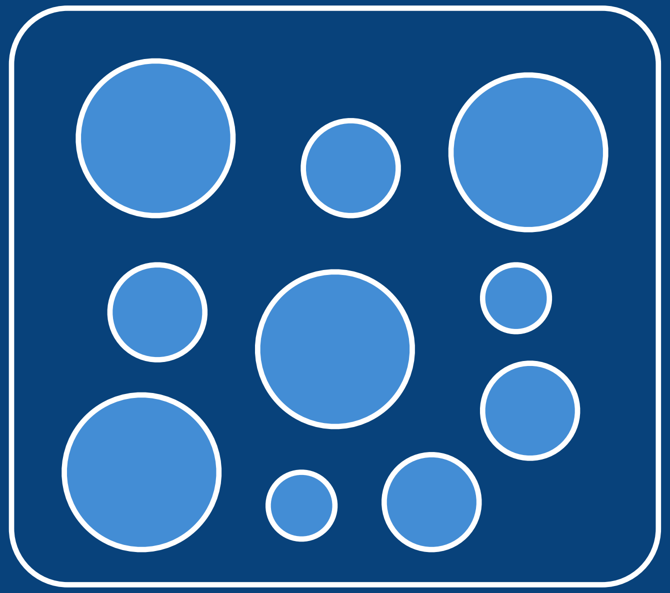
Expected Benefits of Modular Programming

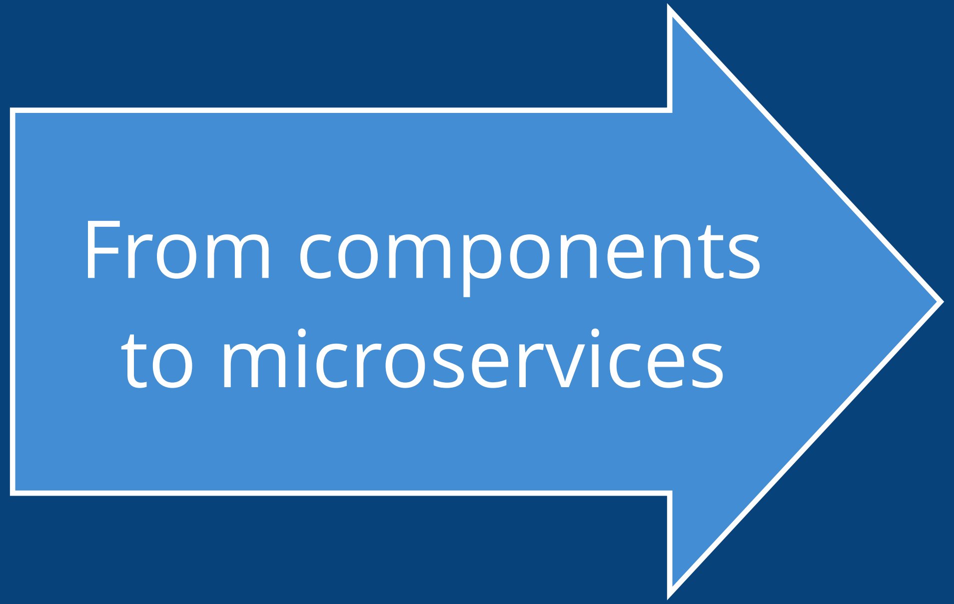
The benefits expected of modular programming are: (1) managerial—development time should be shortened because separate groups would work on each module with little need for communication: (2) product flexibility—it should be possible to make drastic changes to one module without a need to change others; (3) comprehensibility—it should be possible to study the system one module at a time. The whole system can therefore be better designed because it is better understood.

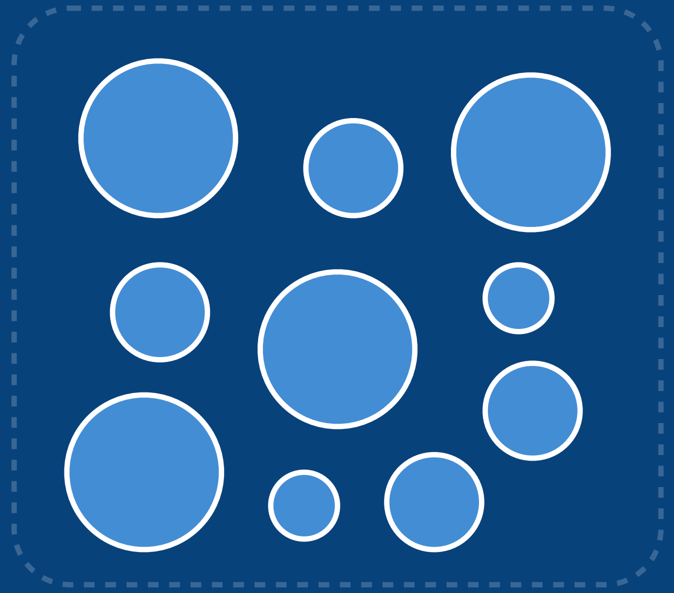
Class-Responsibility-Collaboration

Well-defined, in-process components is a stepping stone to out-of-process components

(i.e. microservices)







High cohesion

Low coupling

Focussed on a business capability

Bounded context or aggregate

Encapsulated data

Substitutable

Composable

< All of that plus

Individually deployable

Individually upgradeable

Individually replaceable

Individually scalable

Heterogeneous technology stacks

Choose microservices for the benefits, not because your monolithic codebase is a mess

Whatever architectural approach you choose, don't forget about the **implementation details**

Beware of the

model-code gap

Thank you!

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@simonbrown