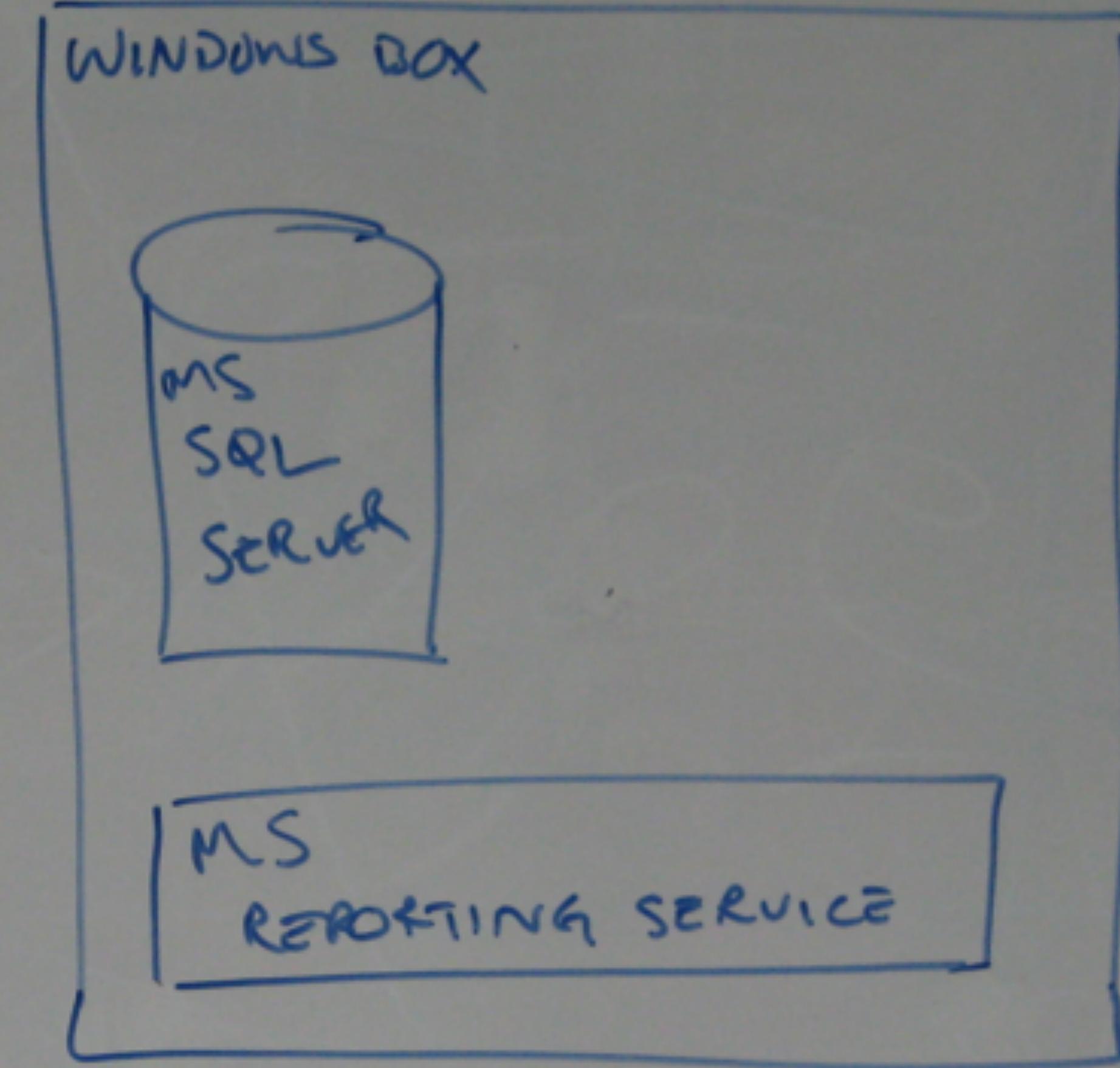
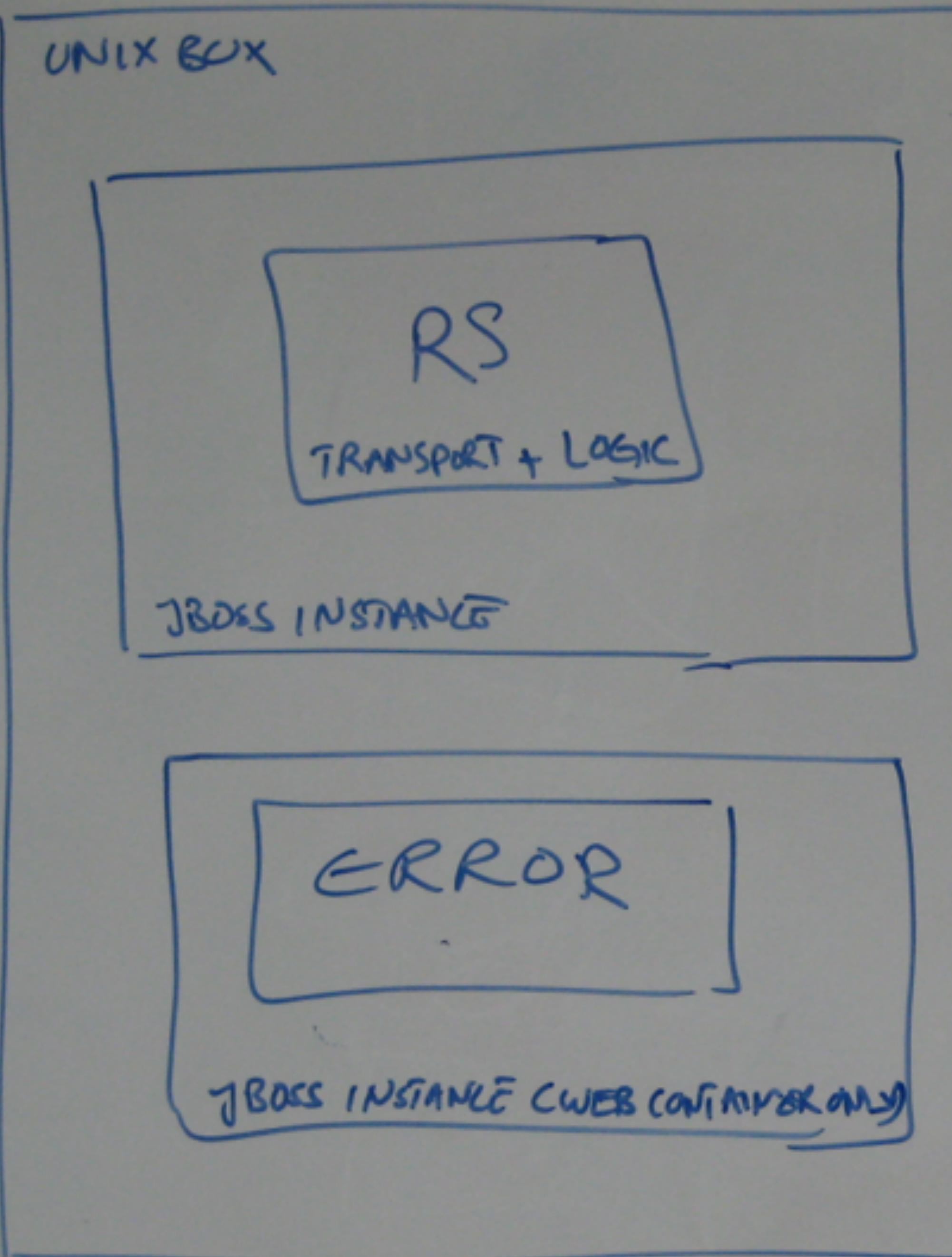
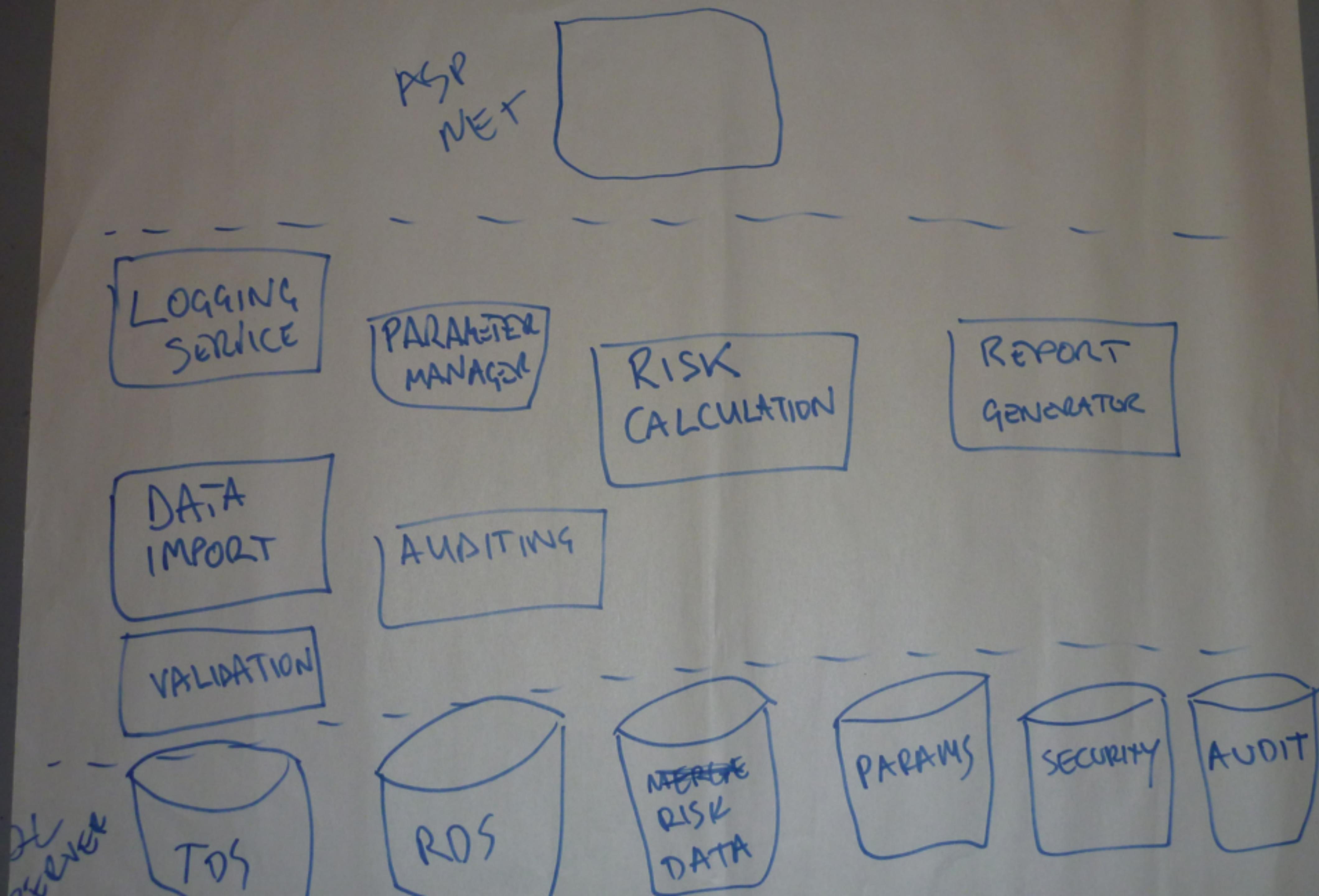


Software architecture as code

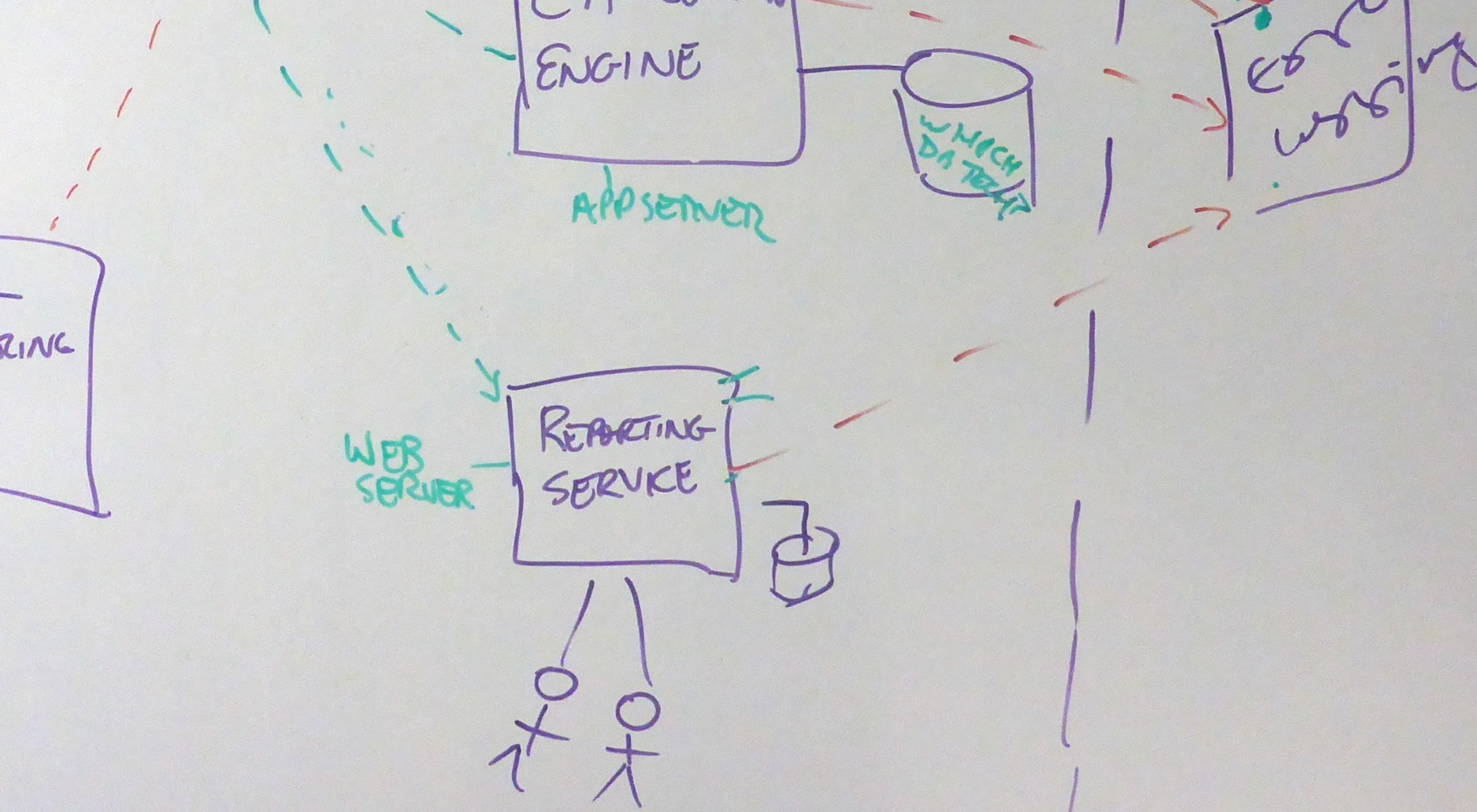
@simonbrown

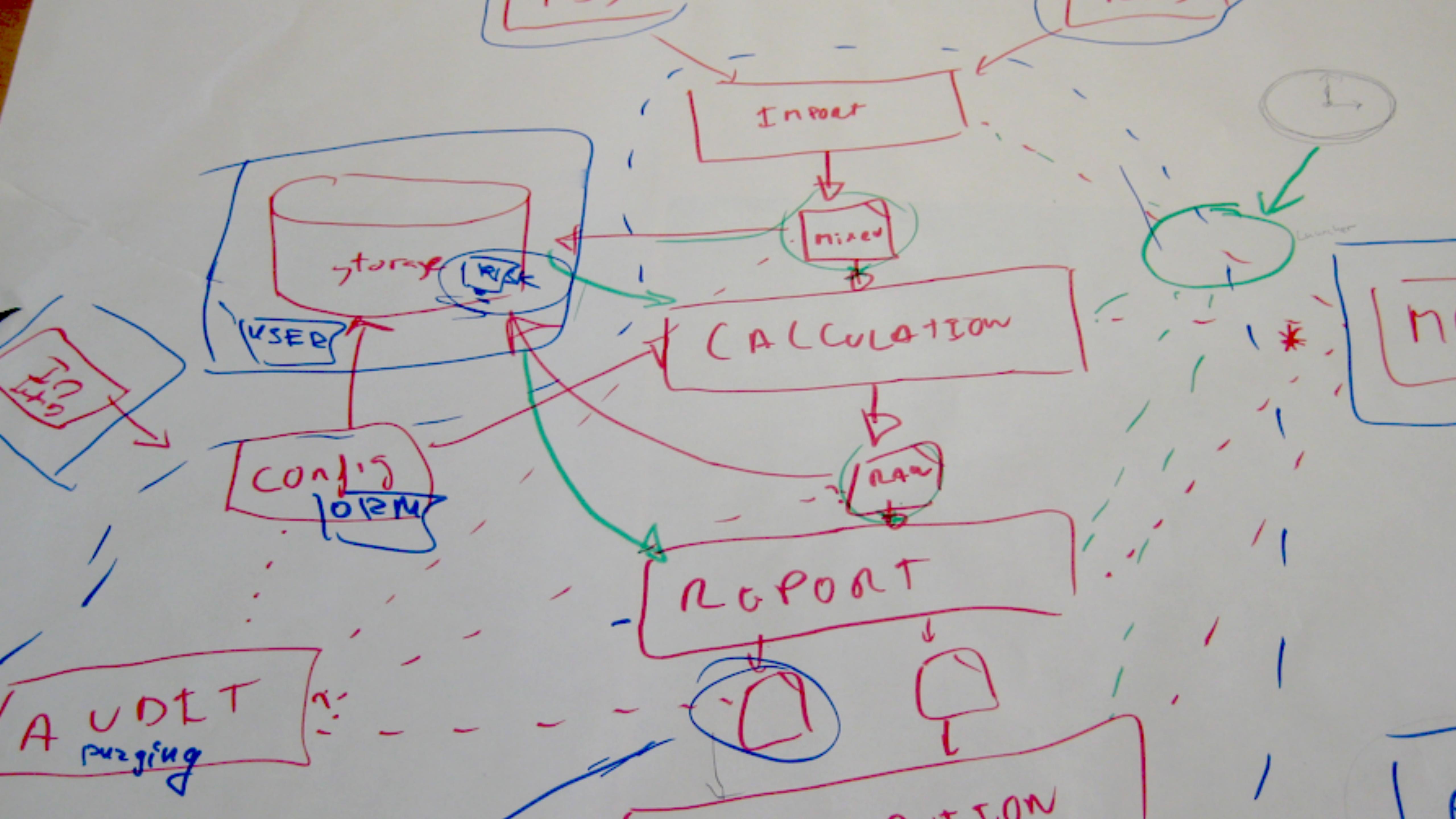


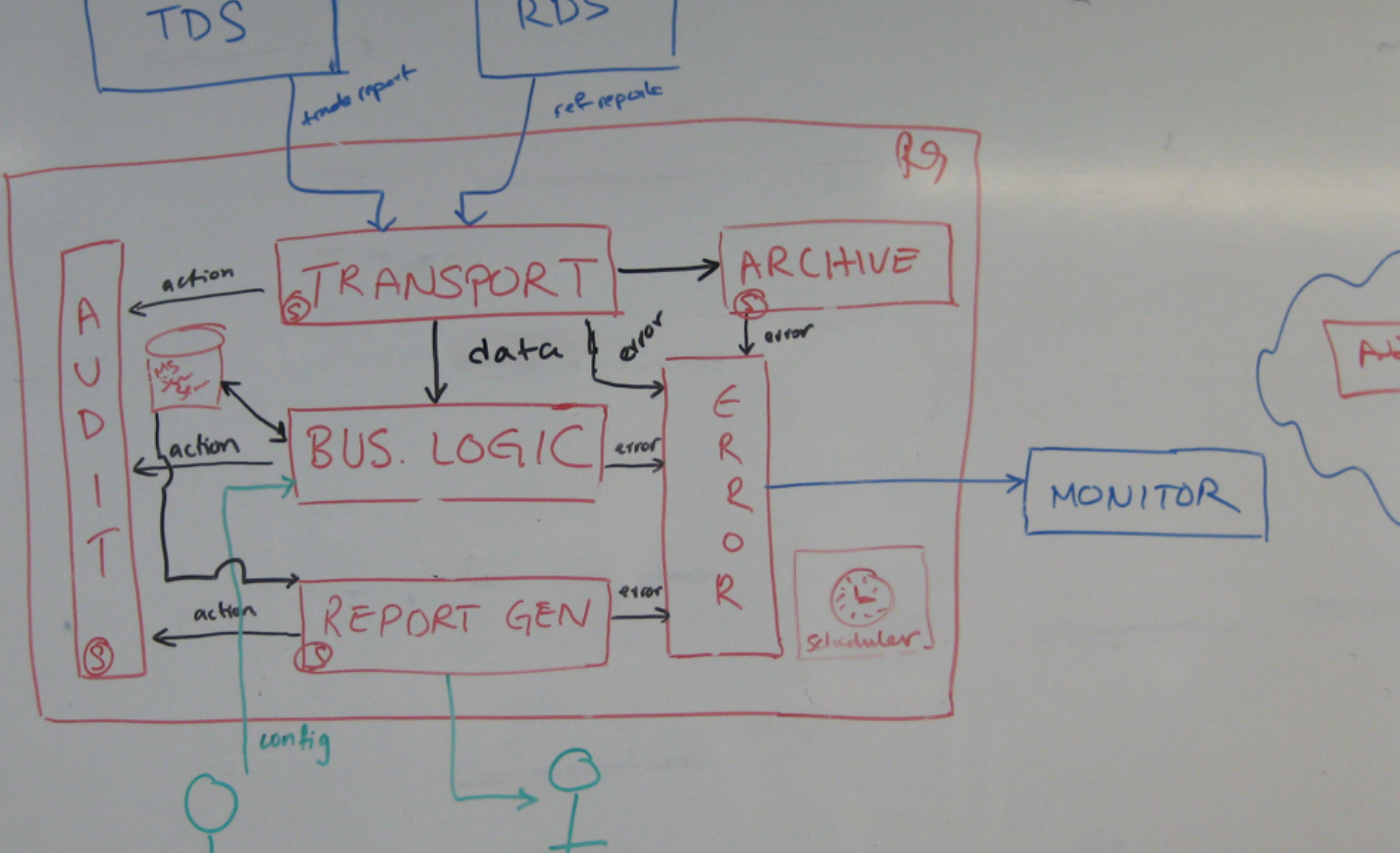


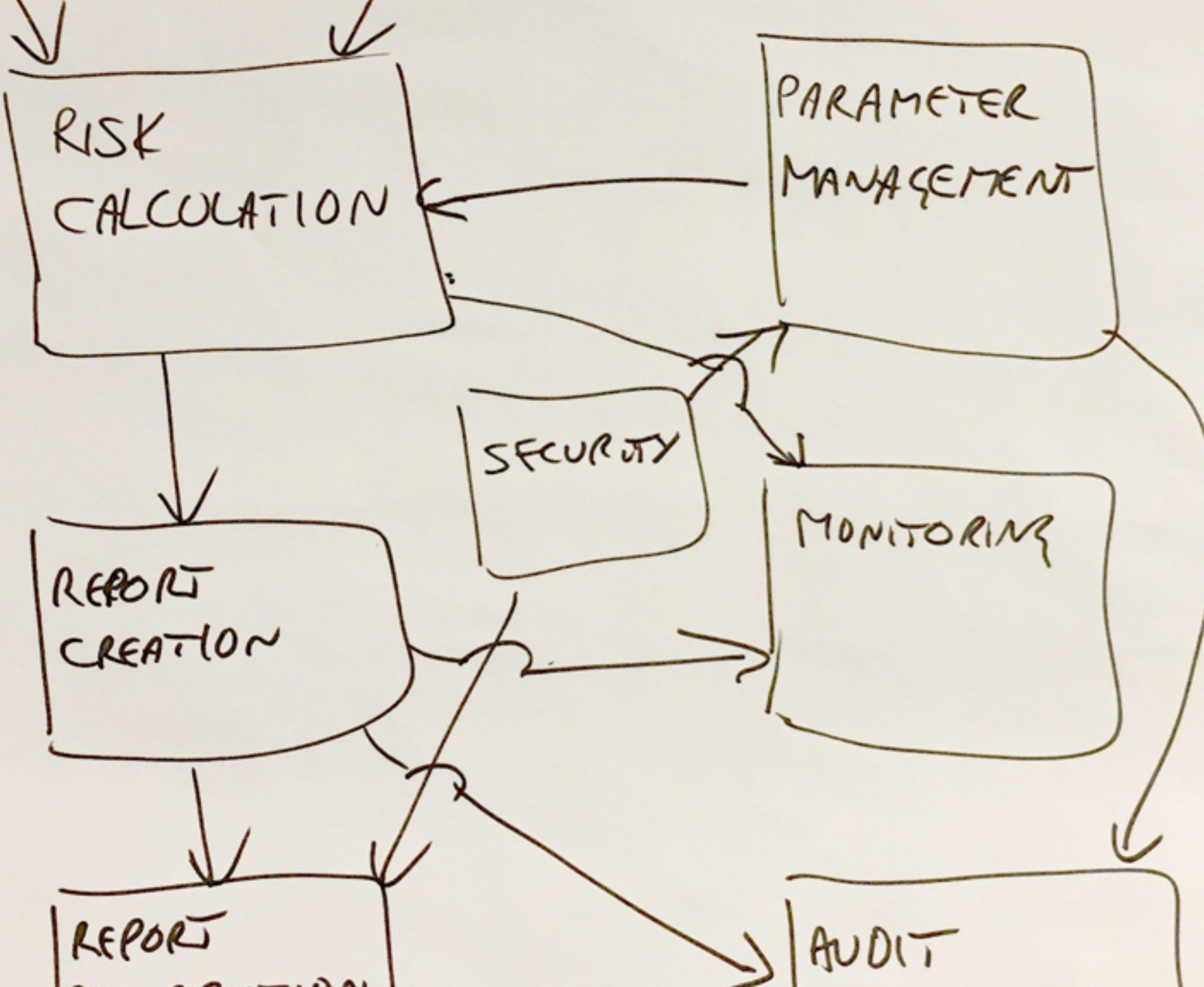
FUNCTIONAL VIEW

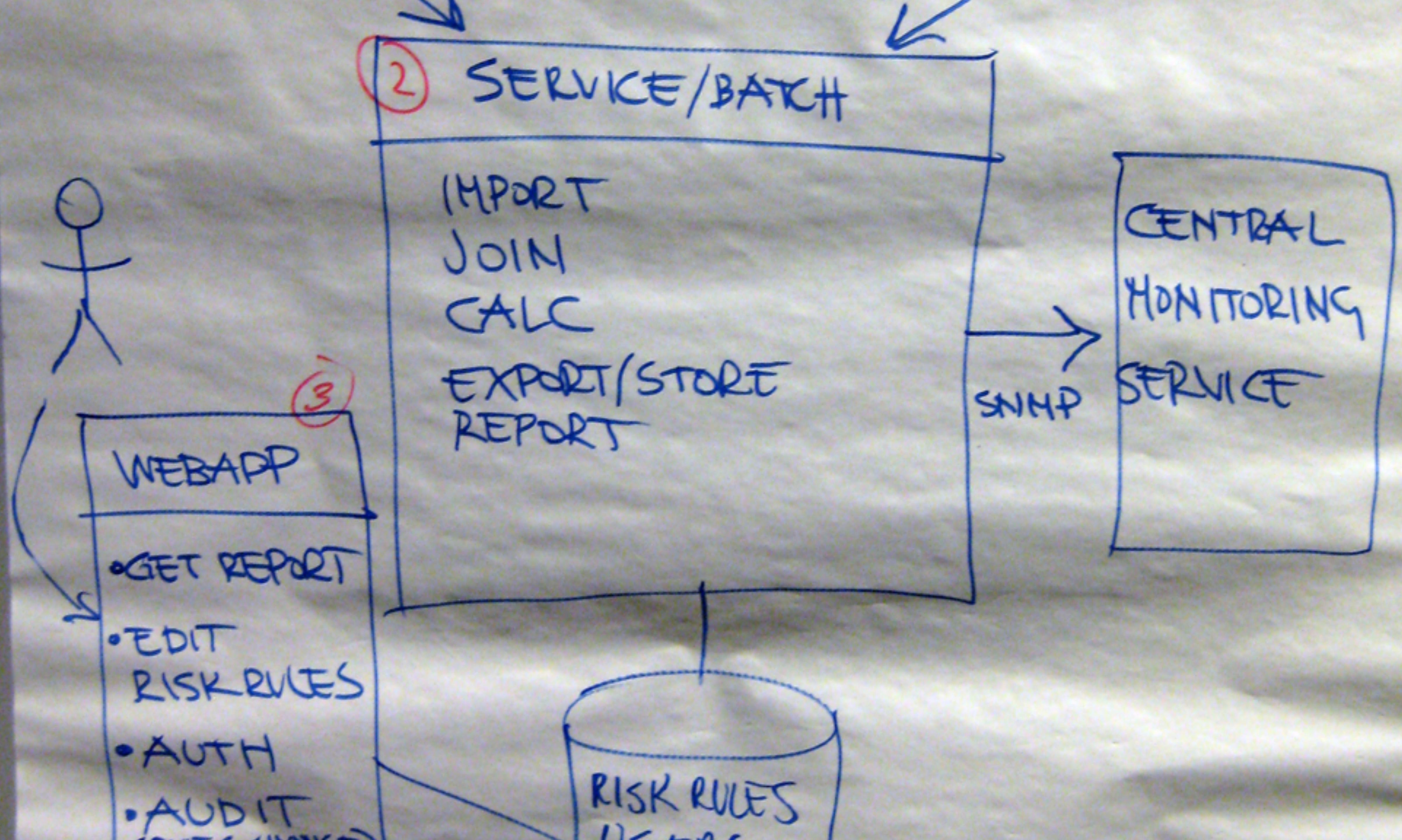


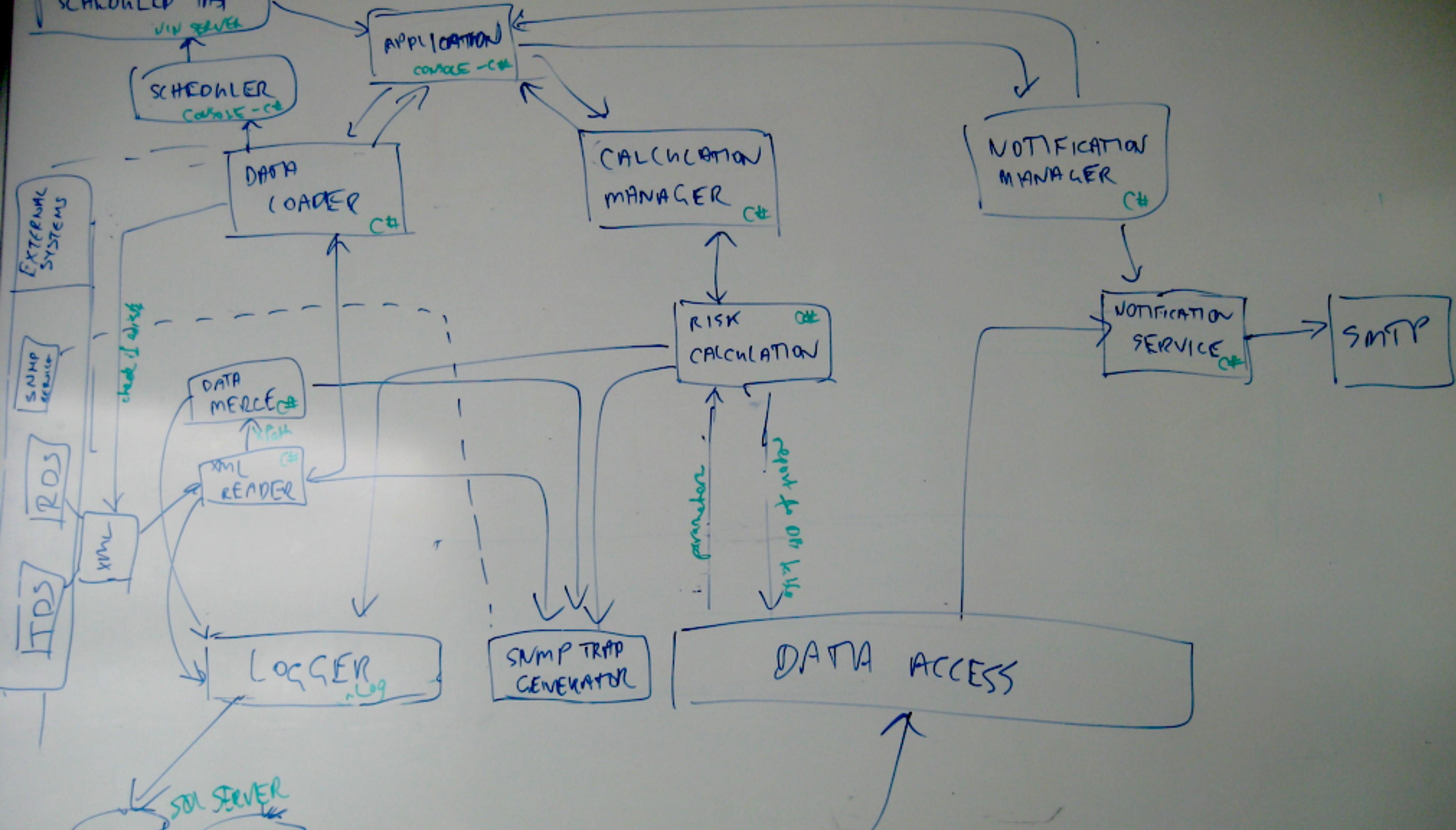


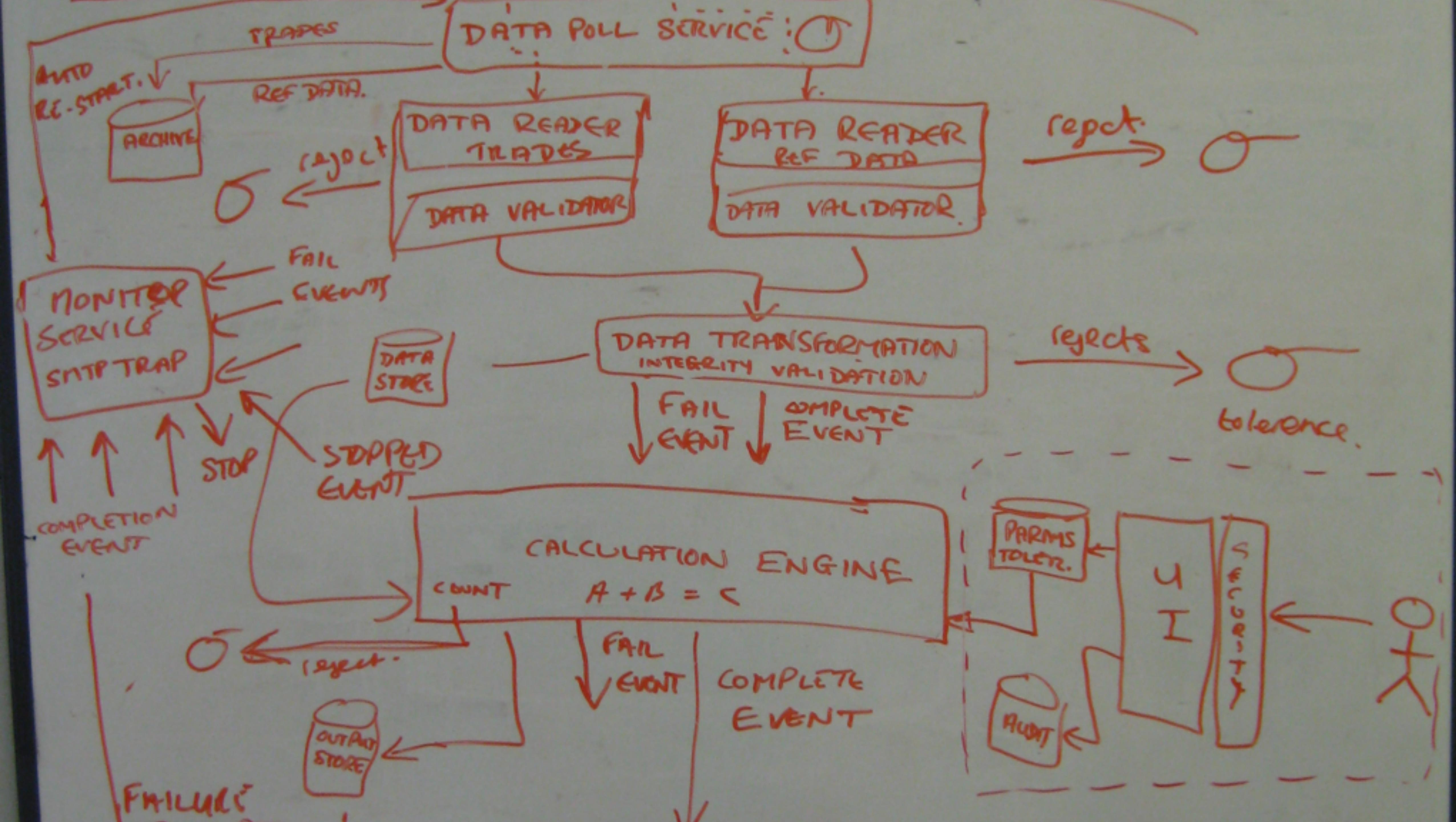
















This doesn't make sense,
but we'll explain it.

I've run this workshop
in 25+ countries
for 10,000+ people

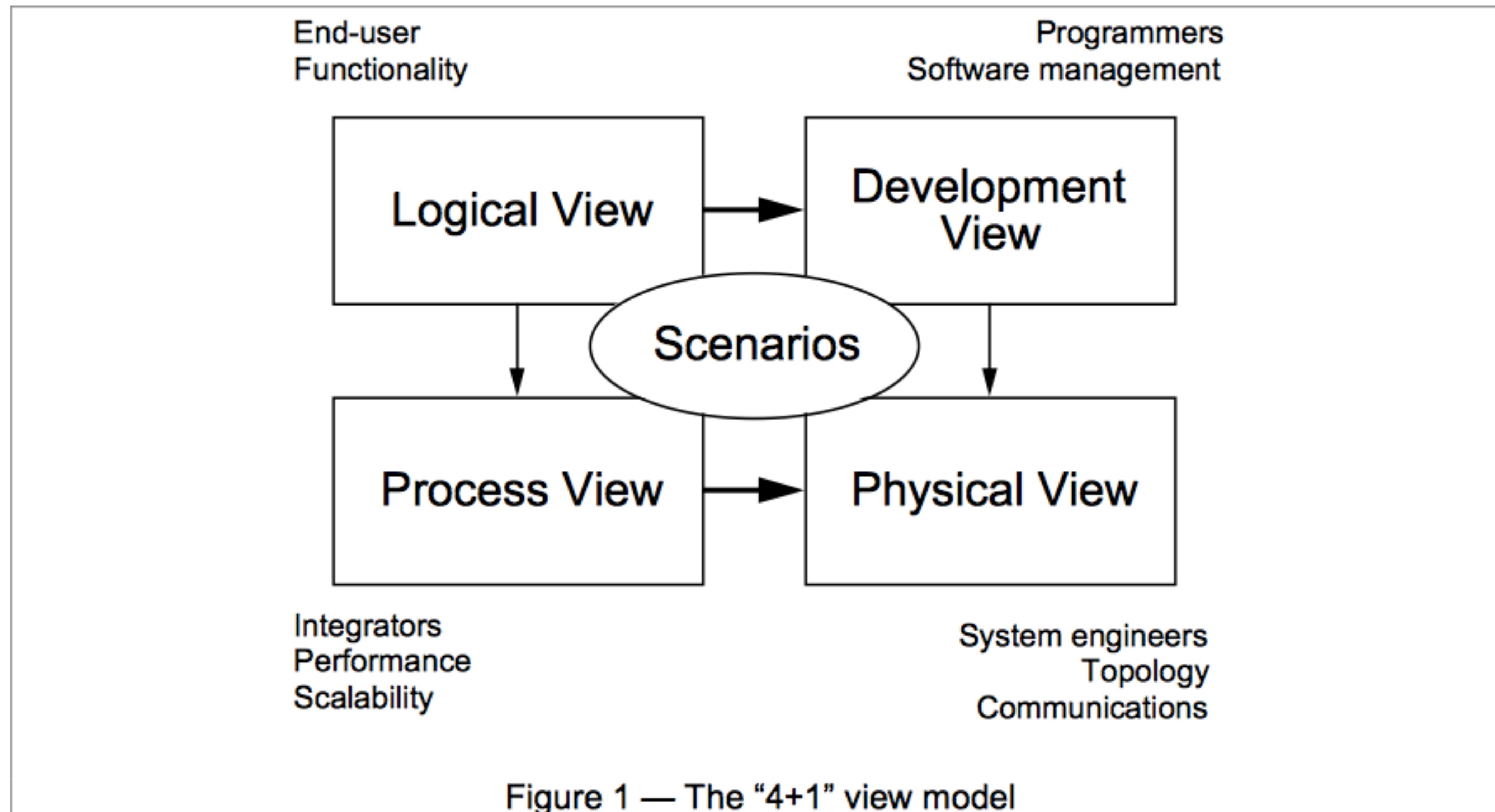


Software architects
struggle to communicate
software architecture

To describe a software architecture,
we use a model composed of
multiple views or perspectives.

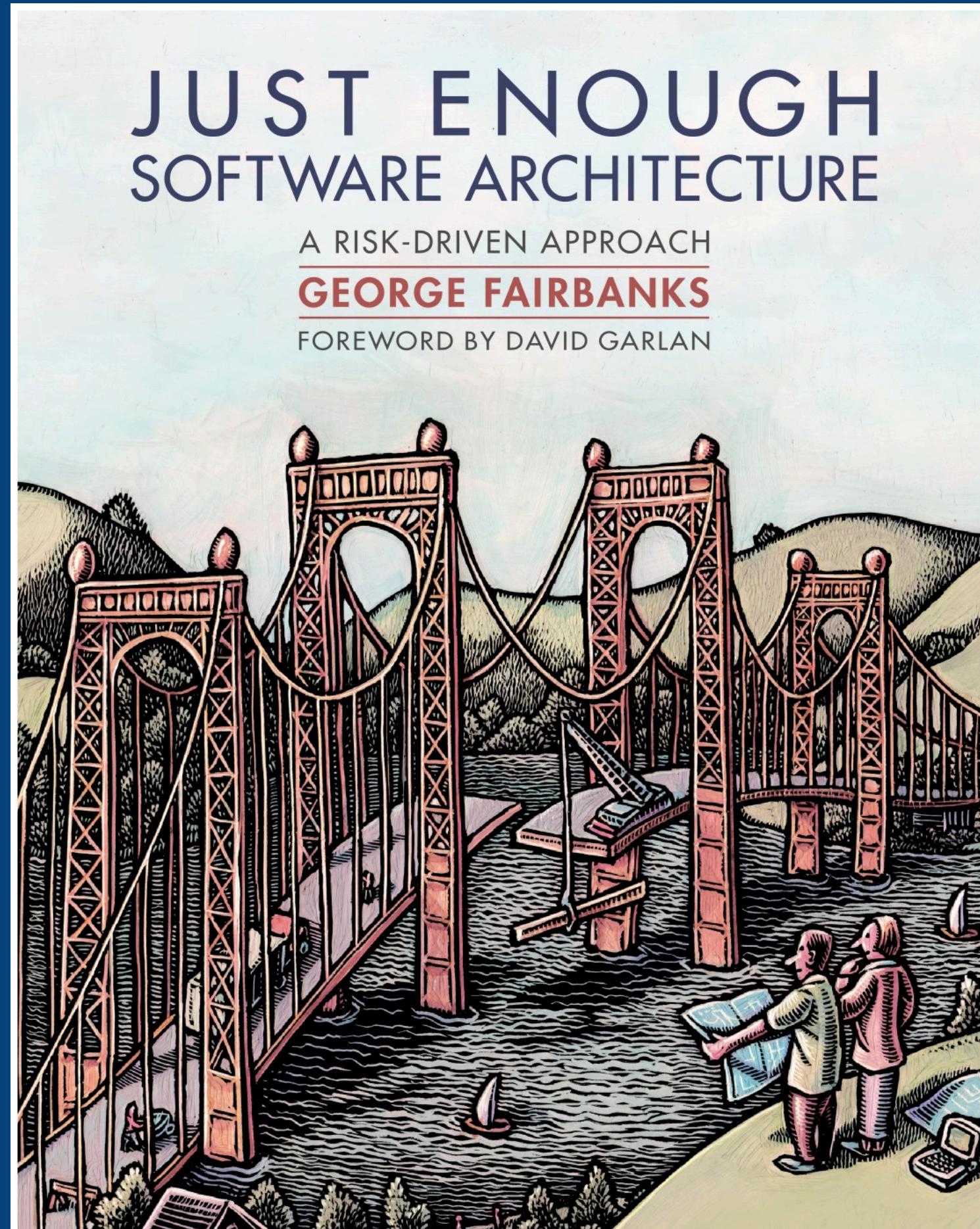
Architectural Blueprints - The “4+1” View Model of Software Architecture
Philippe Kruchten

The description of an architecture—the decisions made—can be organized around these four views, and then illustrated by a few selected *use cases*, or *scenarios* which become a fifth view. The architecture is in fact partially evolved from these scenarios as we will see later.



Why is there a separation
between the logical and
development views?

Our architecture diagrams
don't match the code.



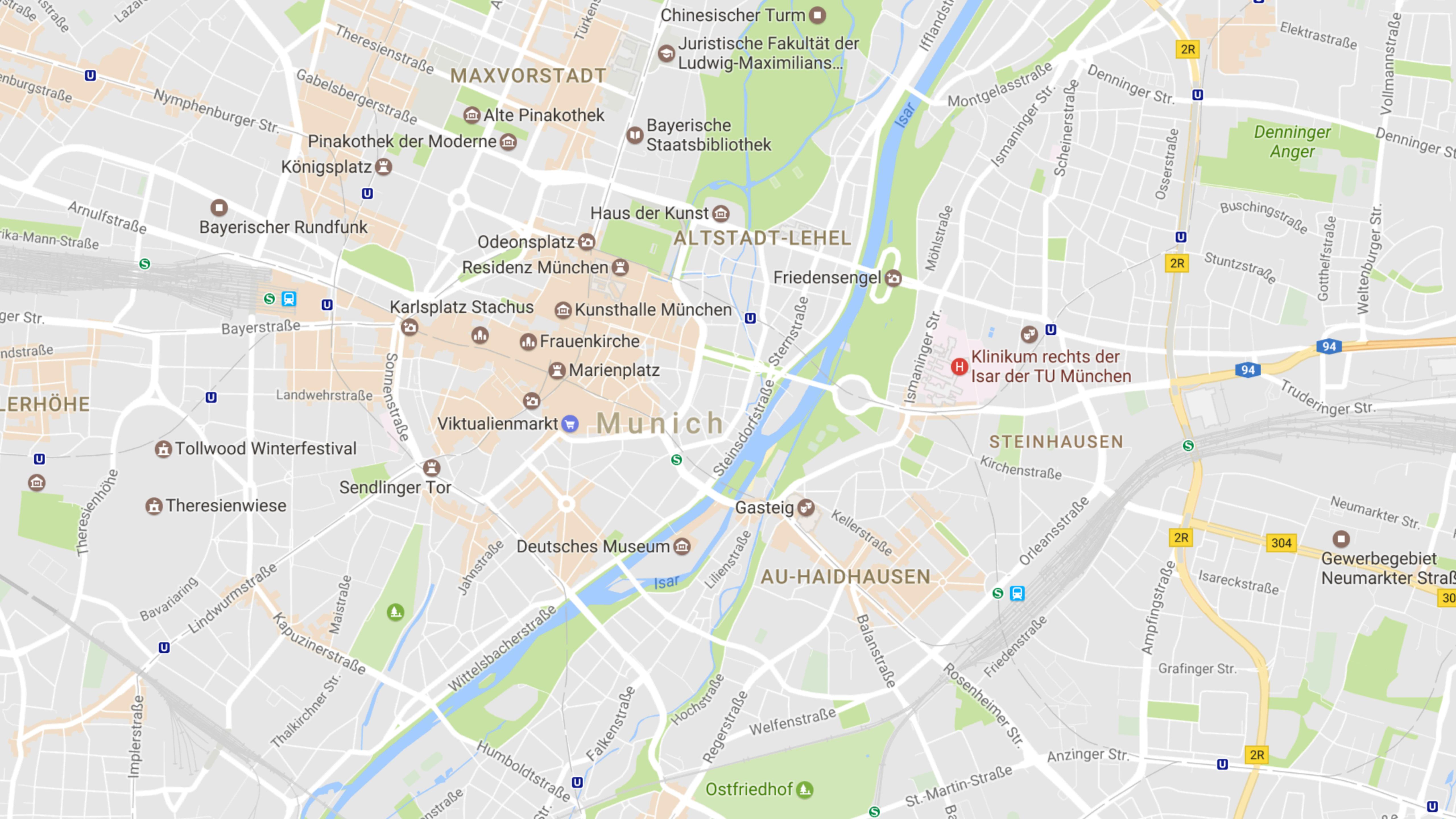
Model-code gap. Your architecture models and your source code will not show the same things. The difference between them is the *model-code gap*. Your architecture models include some abstract concepts, like components, that your programming language does not, but could. Beyond that, architecture models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

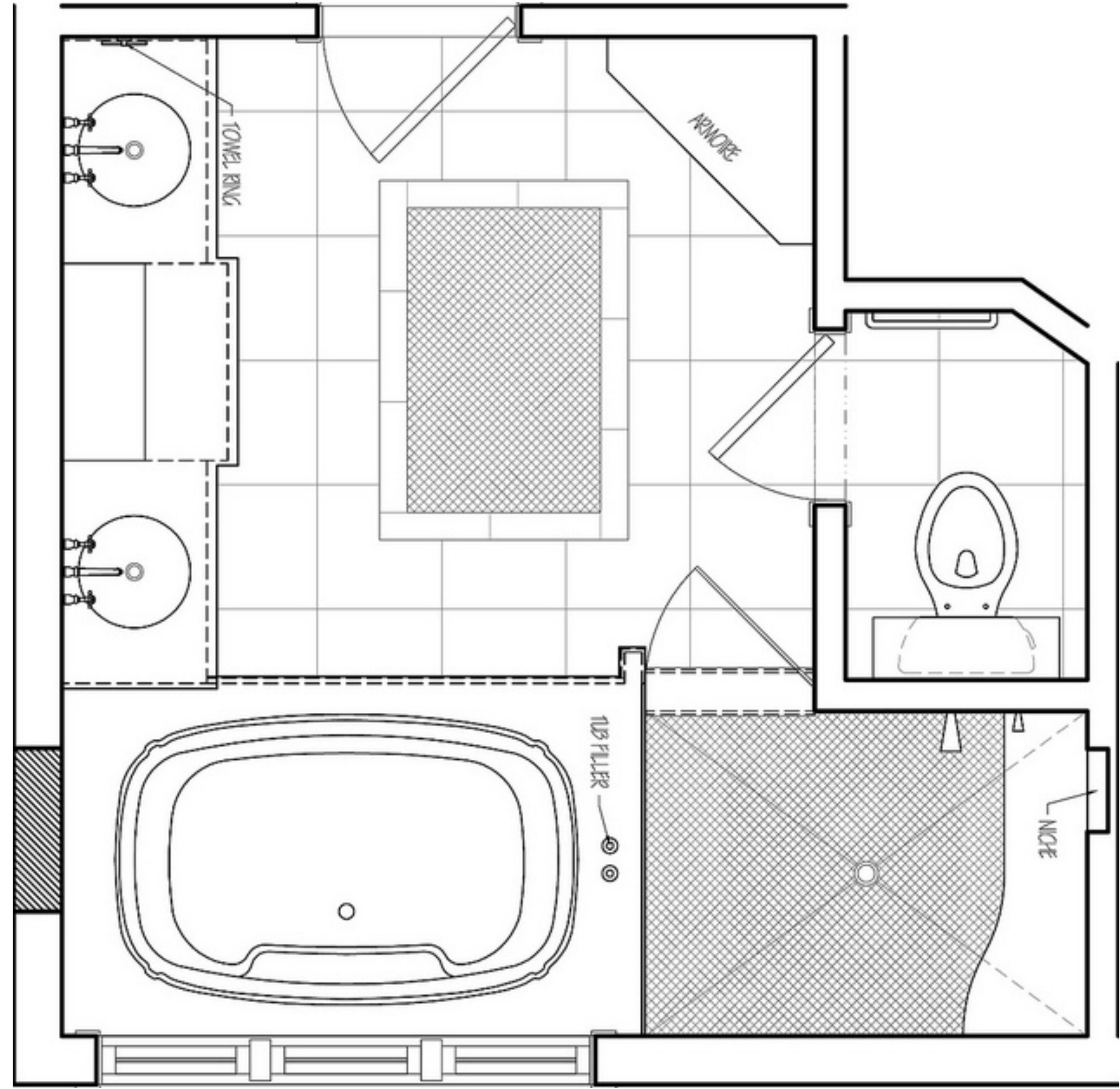
Consequently, the relationship between the architecture model and source code is complicated. It is mostly a refinement relationship, where the extensional elements in the architecture model are refined into extensional elements in source code. This is shown in Figure 10.3. However, intensional elements 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”

We lack a common vocabulary
to describe software architecture





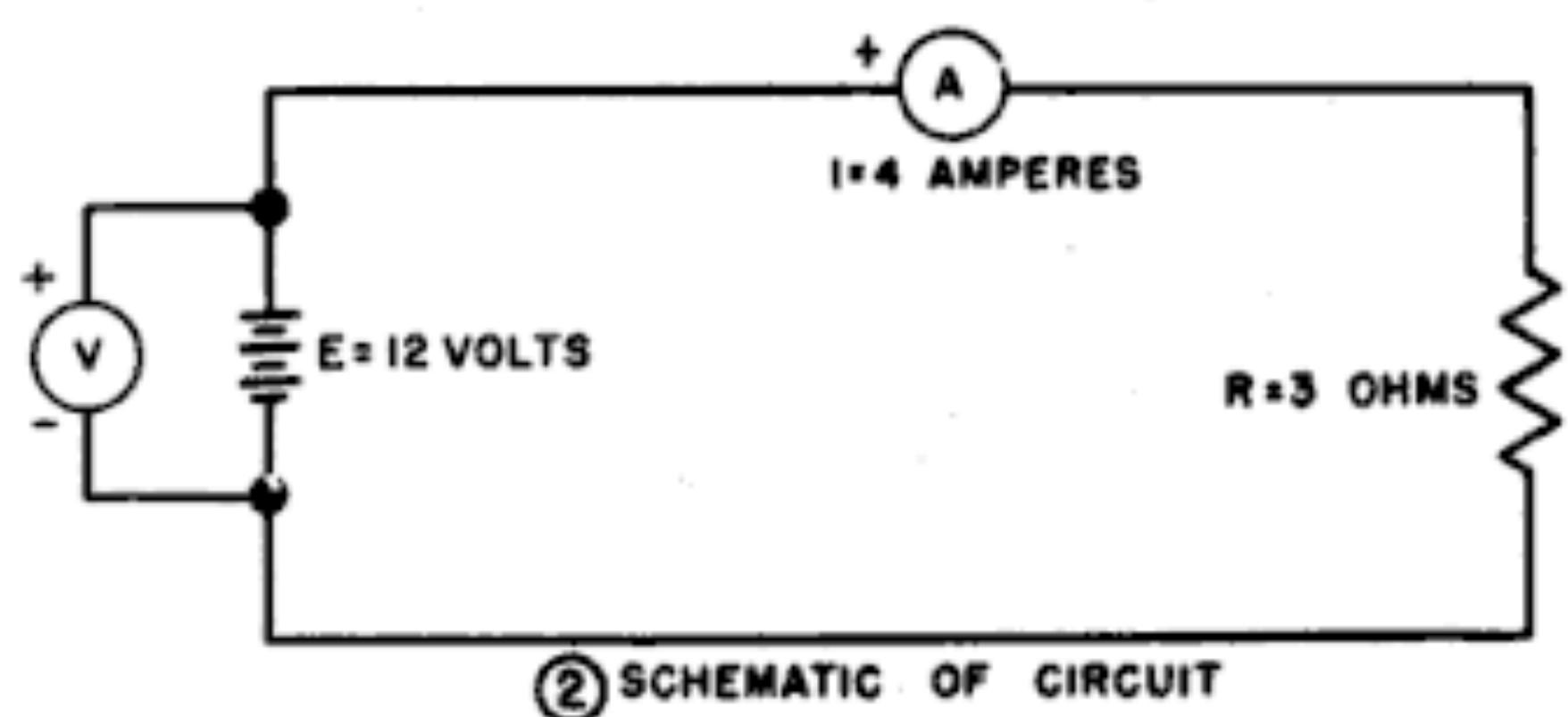
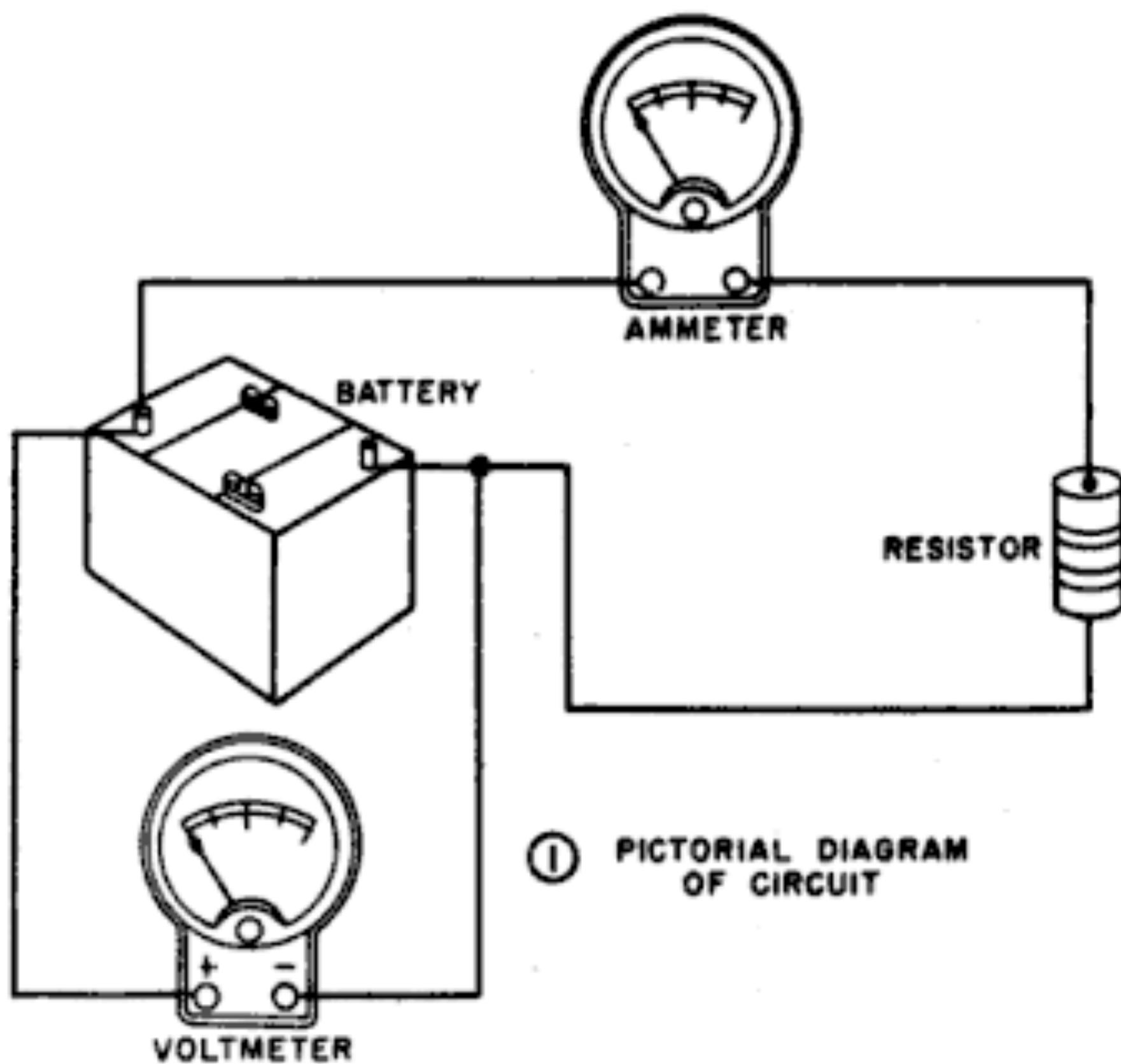
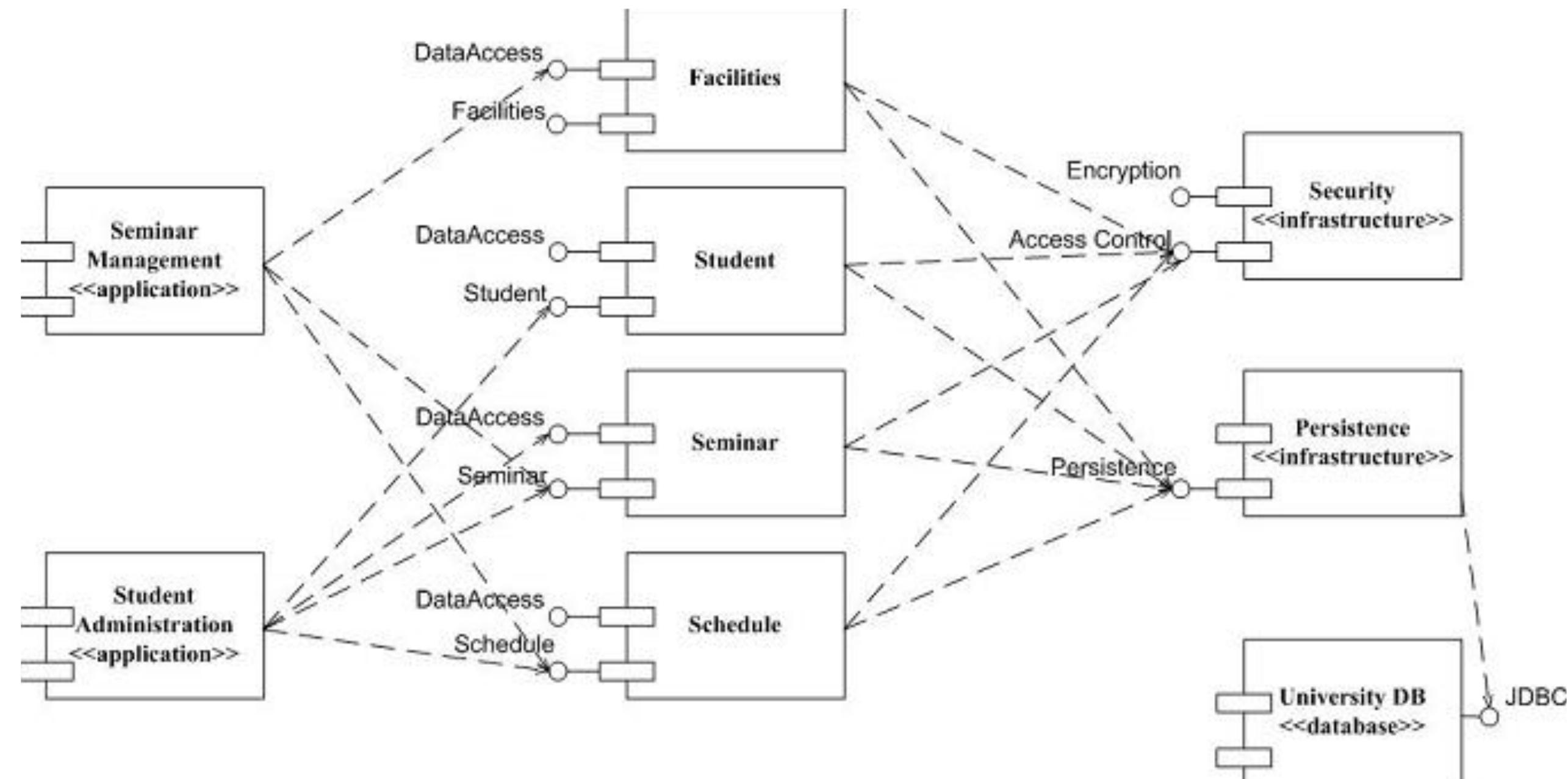
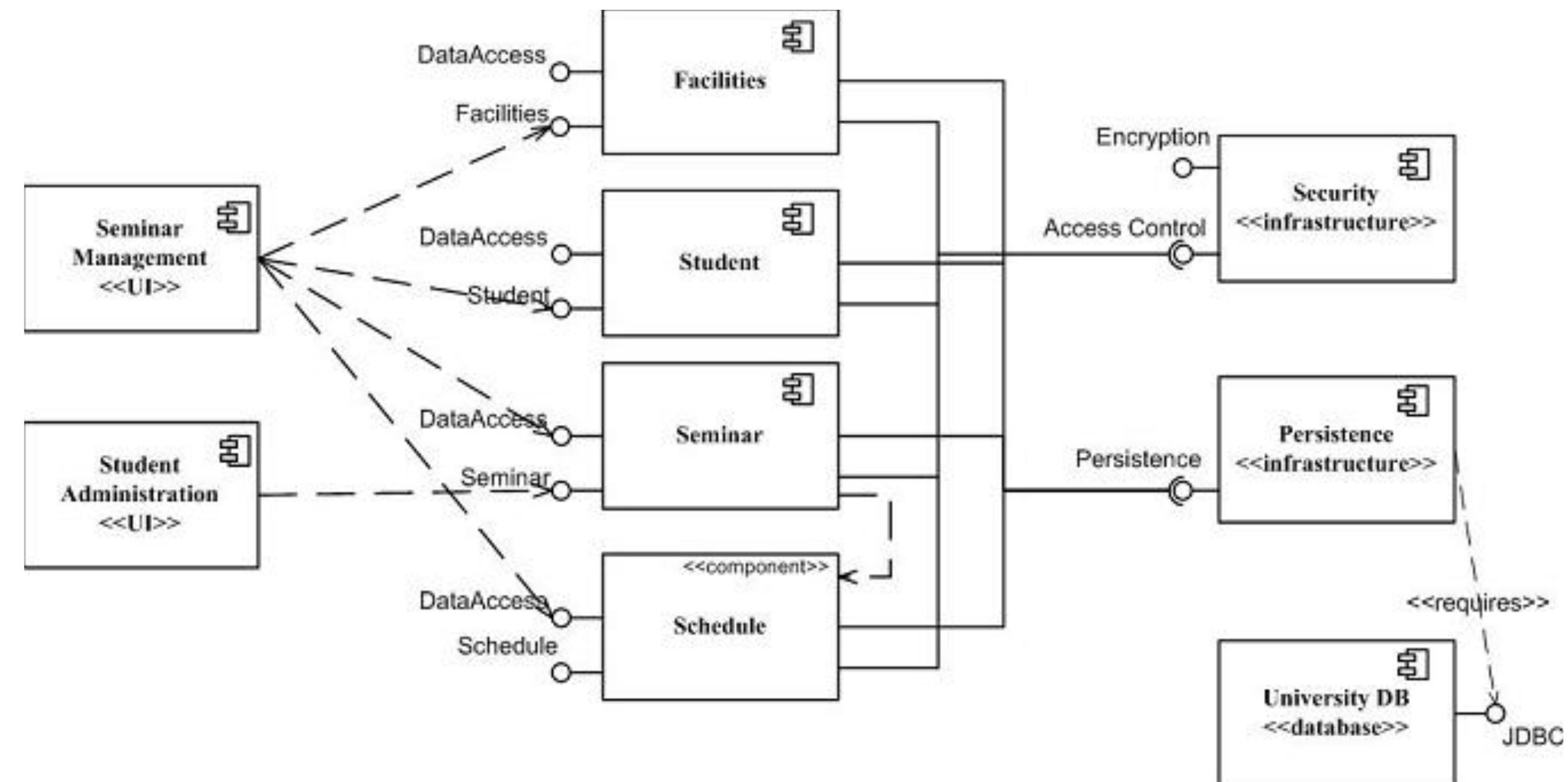
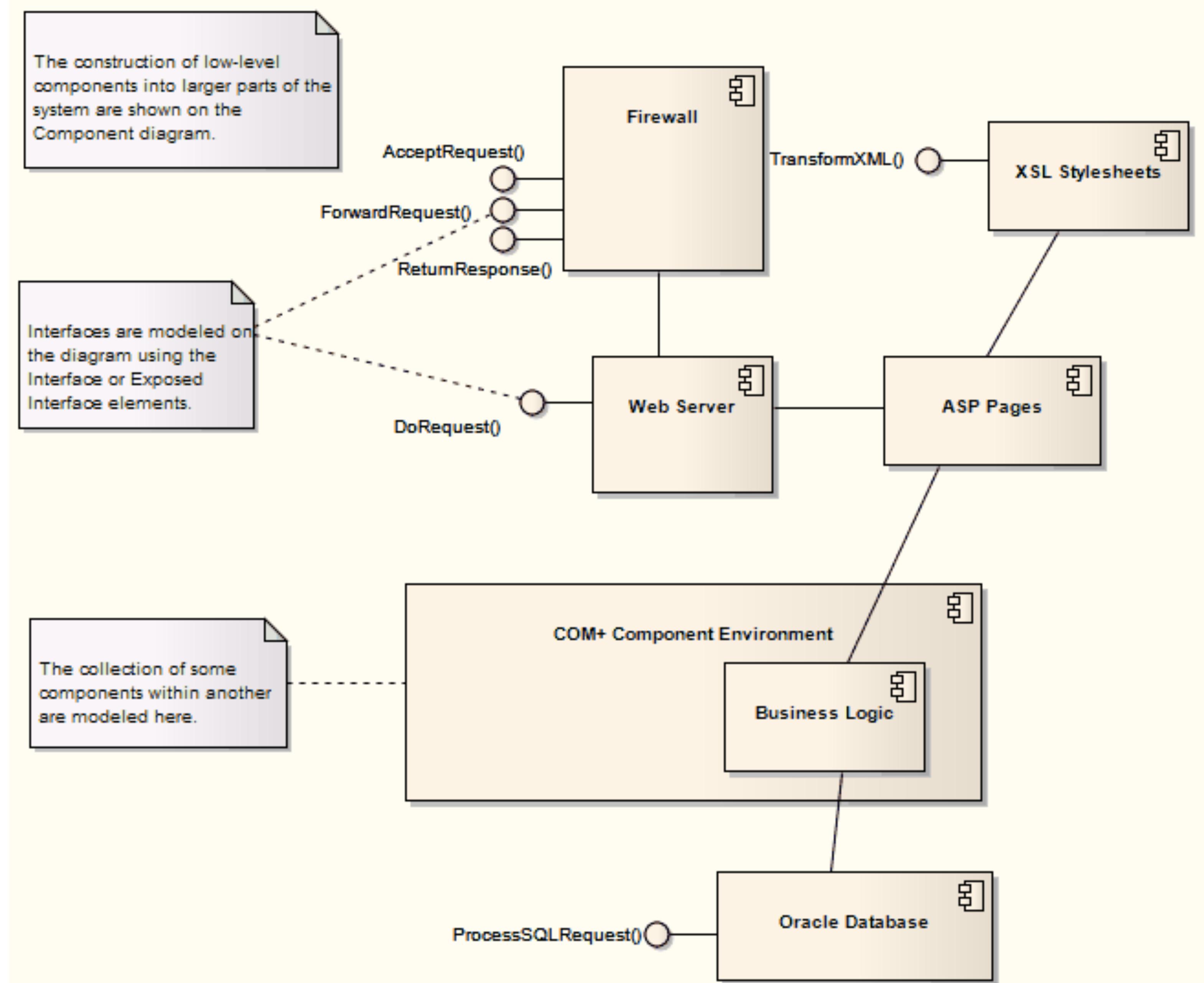


Figure 48. Diagram of a basic circuit.





Software System

Web
Application

Logging
Component



Relational
Database

¹ component

noun | com·po·nent | \kəm-'pō-nənt, 'käm-, käm-'\

Simple Definition of COMPONENT

Popularity: Top 30% of words

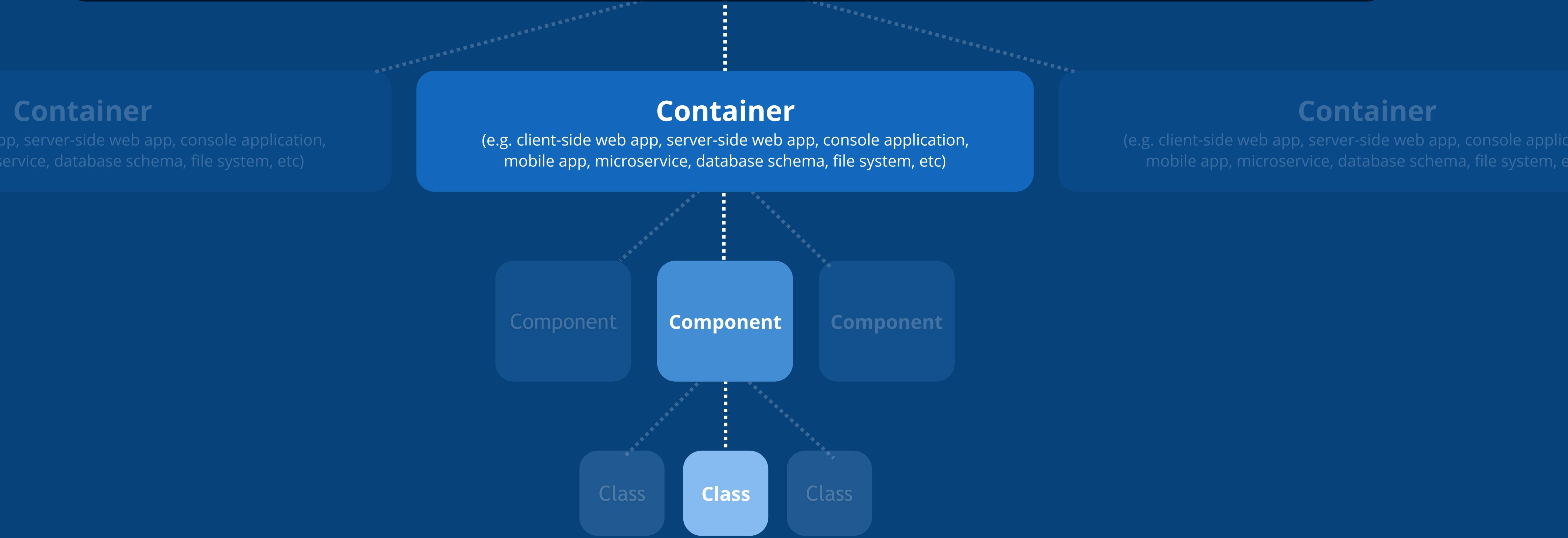
: one of the parts of something (such as a system or mixture) : an important piece of something

Source: Merriam-Webster's Learner's Dictionary

Ubiquitous
language

A common set of abstractions
is more important
than a common notation

Software System



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 **classes** (or **code**).

C4

1. System Context

The system plus users and system dependencies.

2. Containers

The overall shape of the architecture and technology choices.

3. Components

Logical components and their interactions within a container.

4. Classes (or Code)

Component implementation details.

Overview first

Zoom & filter

Details on demand

News Events Talks Content Tweets Code People Tribes Jobs

Find me people who know about... or Search...

Most active people Most active business tribes Most active community tribes

News

- C5 Alliance plans Microsoft events in Channel Islands**

Channel Island cloud provider, C5 Alliance are organising two breakfast events in both Jersey and Guernsey. The events will be held at 'The Technology for Regulatory Compliance'. The breakfast briefings are due to include demonstrations of the latest Microsoft technologies and how they can be used. The briefings will cover Microsoft CRM process driven forms, SharePoint Workflow & Collaboration and SQL Server Data Warehousing technology. C5 Alliance, who work with a number of clients, both financial and...

Posted Today
- Jersey residents set to have choice in fibre broadband**

Sure customers will soon be able to access Jersey's fibre network following the reaching of an agreement between Sure and JT. JT finalises the commercial arrangements for access to the network. The agreement means that JT has gone some way in fulfilling the second condition of the funding that was set out in the States of Jersey's funding arrangements for the network, as agreed by the Treasury Minister, Senator Philip Coumou. "This is excellent news for our broadband customers who have been extremely patient..."

Posted Yesterday
- Logicalls Group taking over Jersey cloud provider**

Logicalls Group, the international IT solutions and managed services provider, has announced the acquisition of Jersey iConnect Limited, a privately owned Jersey company and provider of desktop and multi-hosted infrastructure and managed services (MIS) market within the Channel Islands. Through their data facility on the island, Logicalls now offer services to the local business and professional services sectors. Their main offering is a hosted desktop solution, using primarily...

Posted 18 Oct 2013

More...

Local events

2014 2013 2012

- Ivan Nikkhoo - Growth Funding**

The third set of Tech Tribes talks are ready to rock your world! After a very successful July event we are excited to bring you another great talk for our October talks. We have a great line up of speakers and we take great pleasure in inviting you to attend...

Postponed to 2014
- Tech Tribes Talks**

The Internet of Everything and Gigabit Jersey

The Internet of Everything. Currently, there are an estimated 10 to 15 billion "things" connected to the Internet and this is predicted to grow to 50 billion by 2020. How will this change the way our infrastructure will be used next opportunity...

Postponed to 2014
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Postponed to 2014

2014 2013 2012

Talks by local speakers

2014 2013 2012

- Ted talk**

With the business plan and objectives recently launched for Digital Jersey, our Session Six with Ted Ridgway Watt, will explore some of the key challenges and opportunities that small businesses are currently focused on in order to provide competitive advantage and also give provide interesting examples of how the speakers simple solutions, can change everything.

Digital Jersey Conference 2013 Presentation | 17 Oct 2013
- Agile software architecture sketches and NoUML**

Agility is about moving fast and this requires good communication. A common language is essential in order for teams to push in the same direction, but it's surprising that many agile teams struggle to effectively communicate the architecture of the software they are building. As an industry we do have the Unified Modelling Language (UML), yet most people seem to prefer simple UML-like sketches instead. The problem is that such diagrams rarely make any sense, usually need a narrative to accompany...

Digital Jersey 2013 Workshop | 11 Oct 2013
- Software architecture and the balance with agility**

The agile and software craftsmanship movements are helping to push up the quality of the software systems we produce. Together they are helping us to deliver better software faster, while still maintaining the quality of business while carefully managing time and budgetary constraints. But there's still more we can do. In this event, the impact of software architecture can help prevent many of the problems that projects face, particularly if the team seems to be more chaotic than they are self-organising. Success...

Digital Jersey 2013 Workshop | 10 Oct 2013

Blog posts, etc

2014 2013 2012

- C5 Alliance plans Microsoft events in Channel Islands**

Channel Island cloud provider, C5 Alliance are organising two breakfast events in both Jersey and Guernsey. The events will be held at 'The Technology for Regulatory Compliance'. The breakfast briefings are due to include demonstrations of the latest Microsoft technologies and how they can be used. The briefings will cover Microsoft CRM process driven forms, SharePoint Workflow & Collaboration and SQL Server Data Warehousing technology. C5 Alliance, who work with a number of clients, both financial and...

Posted Today at 16:50
- Increase Your Pinterest Power : Pin Using Viratag**

Three weeks in to the Pinterest experiment, and it didn't take long for me to realize I had bitten off a quite a big task. Fitting in 50 pins between other work, meetings and the day-to-day was going to be a challenge, but I did my best to make it work. Thankfully I had the app Viratag to help me manage the workflow. Viratag allows you to keep all your pins in one place, and it makes it easy to collect up a lot of content when you have the time and release it slowly so you don't flood your followers...

Posted Yesterday at 16:02
- Back to the future: Is this déjà vu? CMI Presentation**

Property 24-7 were recently invited to present at the Jersey CMI Annual event in St Helier, Jersey. Chris Clark, Managing Director was set the subject matter of 'Back to the Future' and the CMI were very happy with his presentation upon McGregor's K.Y Management theories plus an updated version of the principles of management. The rest world economies are demonstrating more local companies are innovating and distributing tasks and enabling the workforce rather than traditional...

Posted Yesterday at 15:48
- Jersey residents set to have choice in fibre broadband**

Sure customers will soon be able to access Jersey's fibre network following the reaching of an agreement between Sure and JT. JT finalises the commercial arrangements for access to the network. The agreement means that JT has gone some way in fulfilling the second condition of the funding that was set out in the States of Jersey's funding arrangements for the network, as agreed by the Treasury Minister, Senator Philip Coumou. "This is excellent news for our broadband customers who have been extremely patient..."

Posted Yesterday at 08:00

More...

Tweets

2014 2013 2012

- And by tomorrow, nearly all of the work on my house I tweeted about will be done (lets be honest, I love it when a plan comes together)**

And by tomorrow, nearly all of the work on my house I tweeted about will be done (lets be honest, I love it when a plan comes together)

I posted Today at 16:00
- Do you like gin, design and conserving elephants? Just so happened there is something that looks like all 3 here. May I present @dineanddrunk**

Do you like gin, design and conserving elephants? Just so happened there is something that looks like all 3 here. May I present @dineanddrunk

I posted Today at 15:50
- @JerseyITGuy this is what's returned when my search term happens there is something that looks like all 3 here. May I present @dineanddrunk**

@JerseyITGuy this is what's returned when my search term happens there is something that looks like all 3 here. May I present @dineanddrunk

I posted Today at 15:48
- @jonathanbp send me that black photo please**

@jonathanbp send me that black photo please

I posted Today at 15:48
- When reading non-technical reporting about nuclear power try substituting the phrase 'The Devil' for 'Radiation'...**

When reading non-technical reporting about nuclear power try substituting the phrase 'The Devil' for 'Radiation'...

I posted Today at 15:02
- EE achievable...jersey has Fukushima and Chernobyl fear has caused more health problems than radiation: http://jx.co/hzQJ89CH (via @pikler)**

EE achievable...jersey has Fukushima and Chernobyl fear has caused more health problems than radiation: http://jx.co/hzQJ89CH (via @pikler)

I posted Today at 14:47
- @knight How long before USA invades???**

@knight How long before USA invades???

I posted Today at 14:43
- Reform - abstract shapes playground tool thing... em yeah http://carpediem400.com/reform/index.html**

Reform - abstract shapes playground tool thing... em yeah http://carpediem400.com/reform/index.html

I posted Today at 14:40
- RT @drcrb: I'm hoping the new Mac Pro also comes in a gold color. Gotta have everything matching, ya know.**

RT @drcrb: I'm hoping the new Mac Pro also comes in a gold color. Gotta have everything matching, ya know.

I posted Today at 14:40
- @ewarpig @BootstrapJersey Me or just send up lasers? ;)**

@ewarpig @BootstrapJersey Me or just send up lasers? ;)

I posted Today at 14:40

More...

techtribes.je is the only way to keep up to date with the IT, tech and digital sector in Jersey and Guernsey, Channel Islands

[Twitter](#) [YouTube](#) [Sign in with Twitter](#)

About techtribes.je (build 347)

techtribes.je

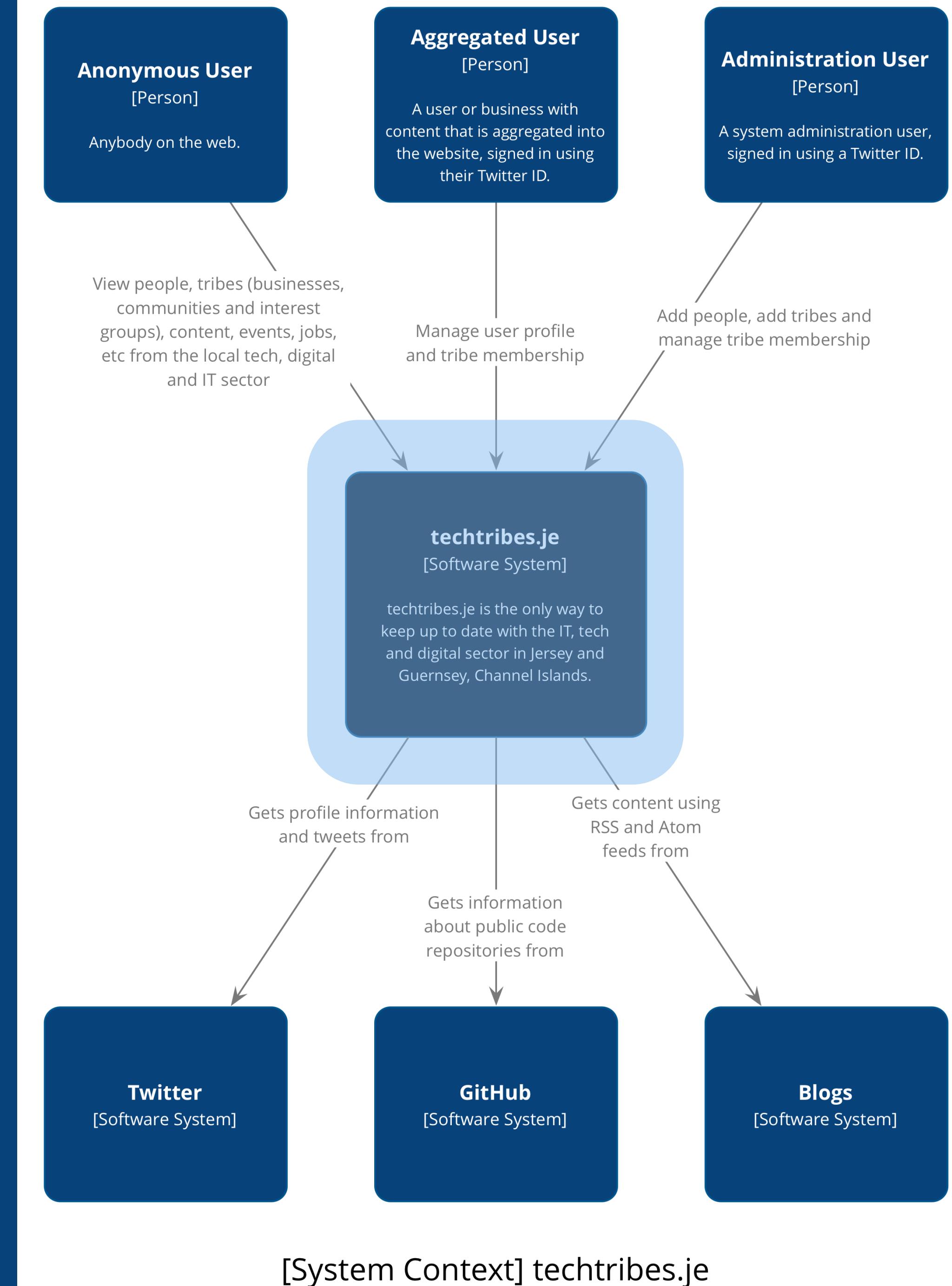
A simple content aggregator for the local tech and digital industry

1. System Context diagram

2. Container diagram

3. Component diagram

4. Class diagram

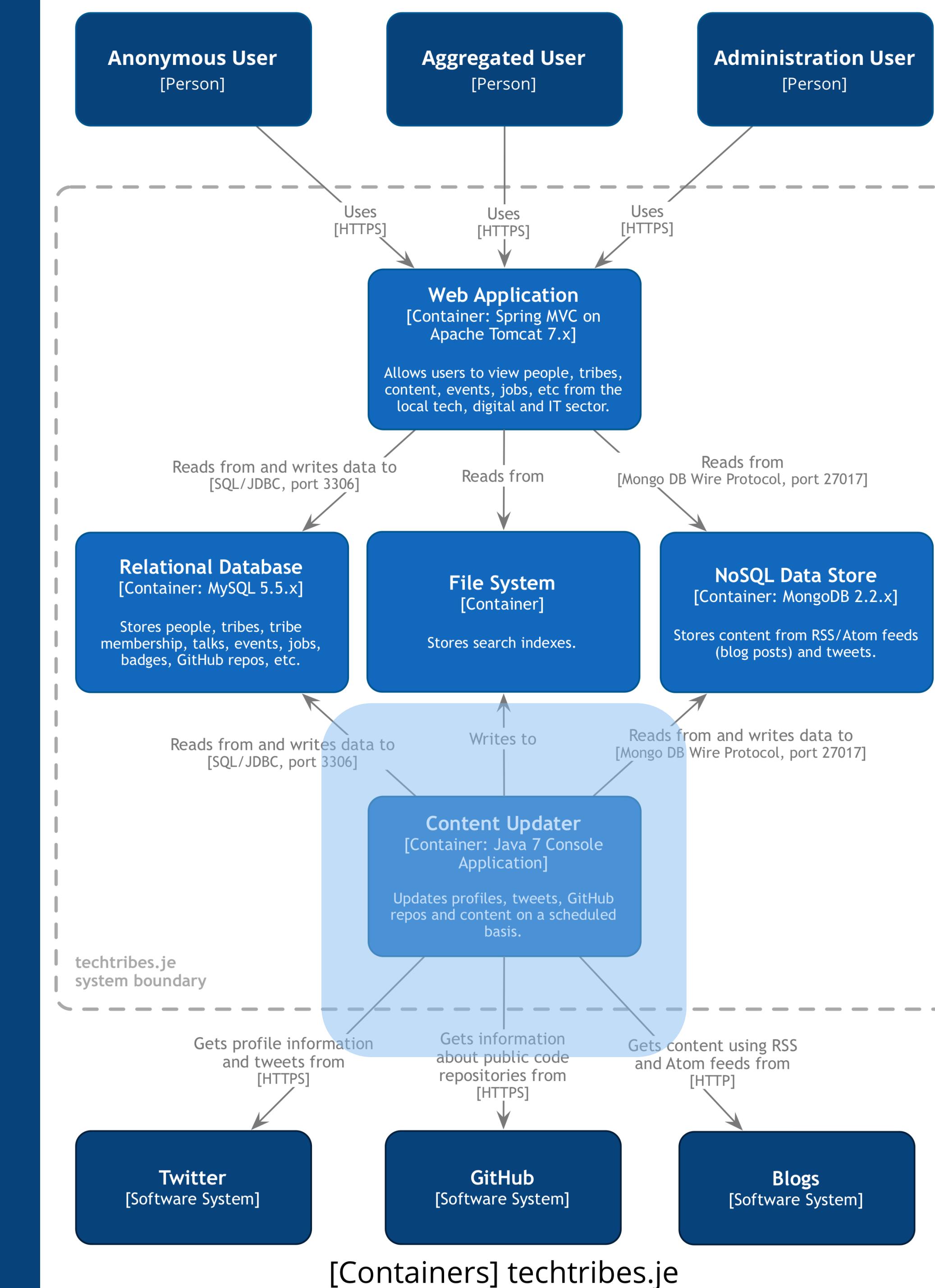


1. System Context diagram

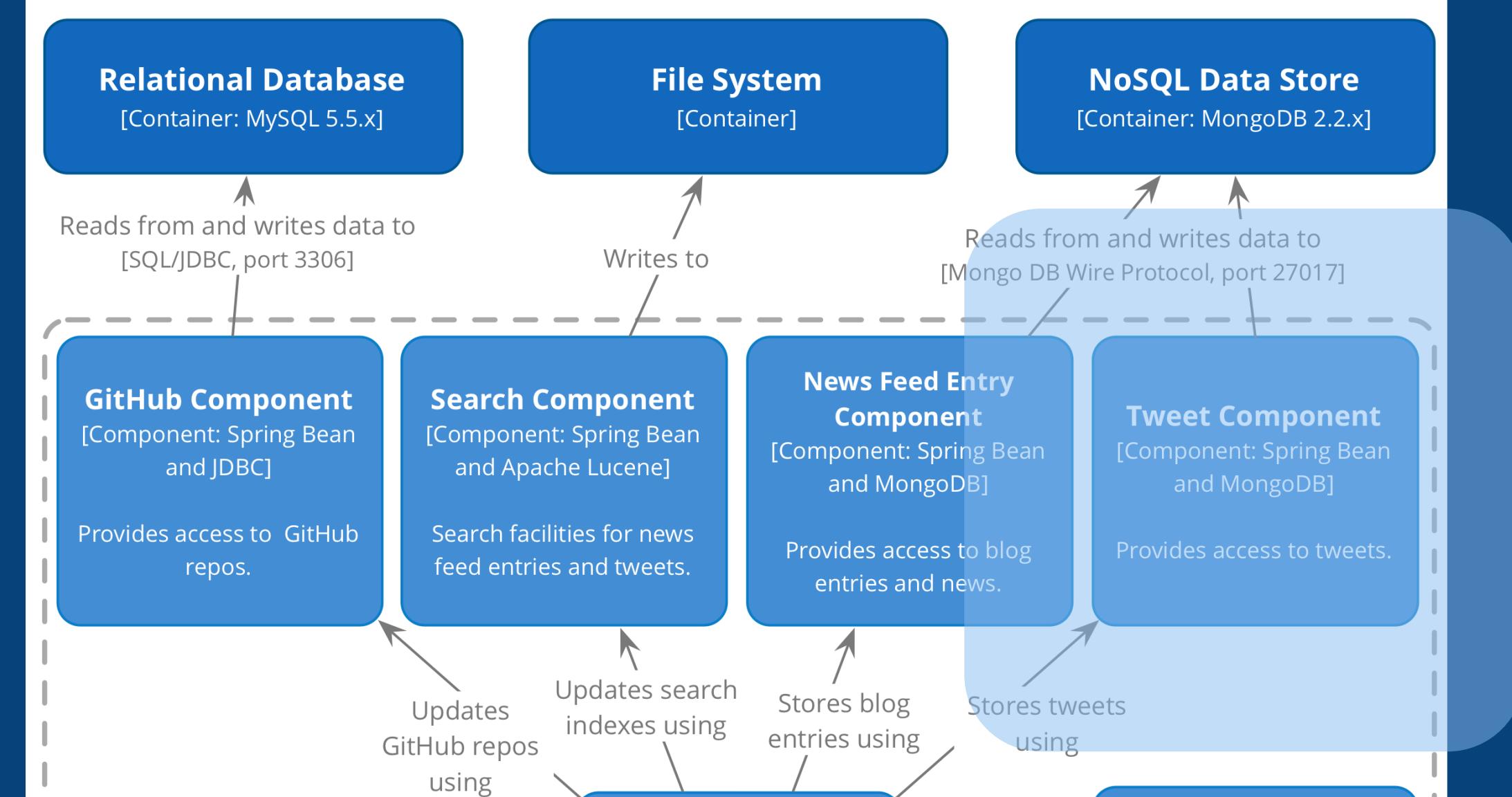
2. Container diagram

3. Component diagram

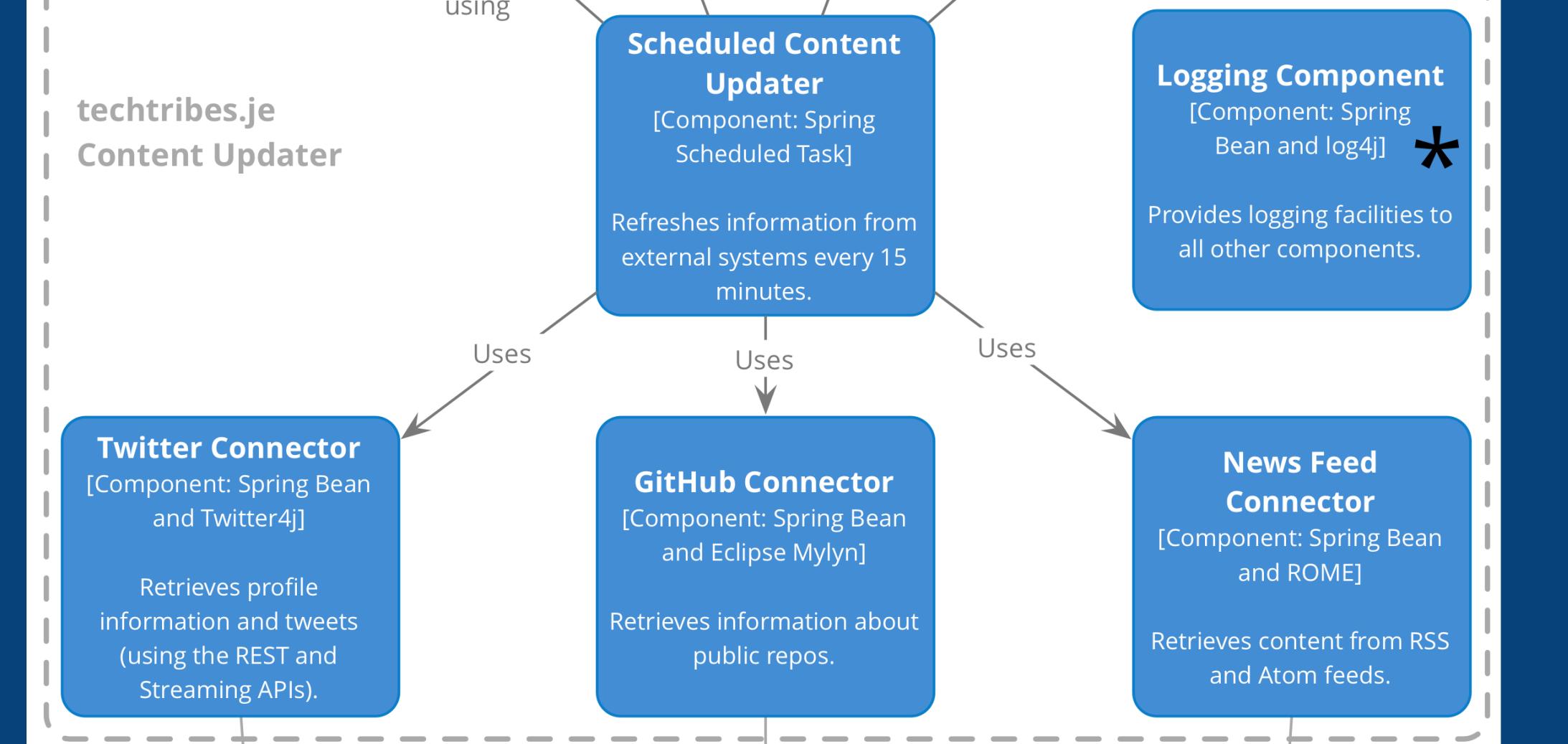
4. Class diagram



1. System Context diagram



2. Container diagram



3. Component diagram



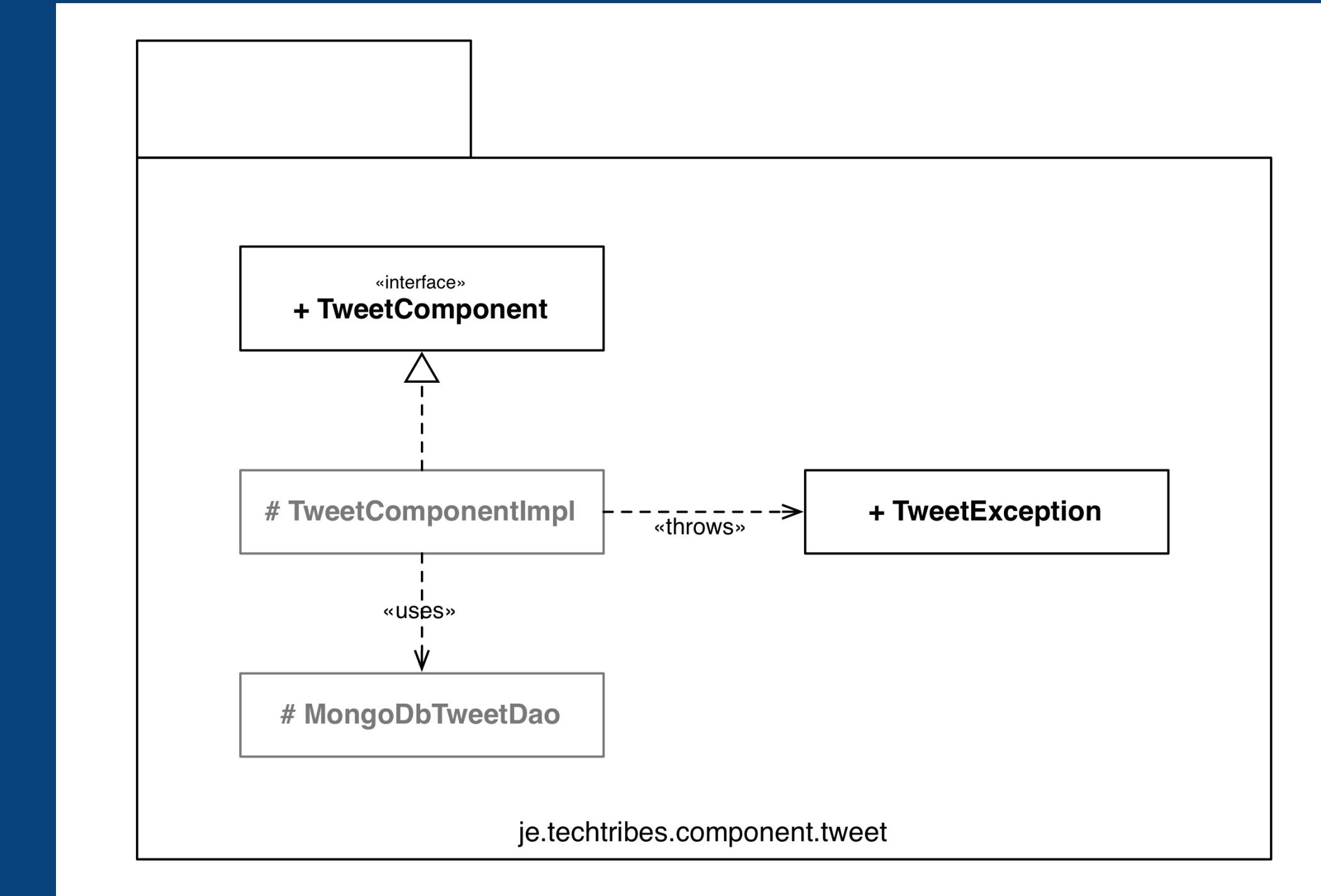
* Used by all components

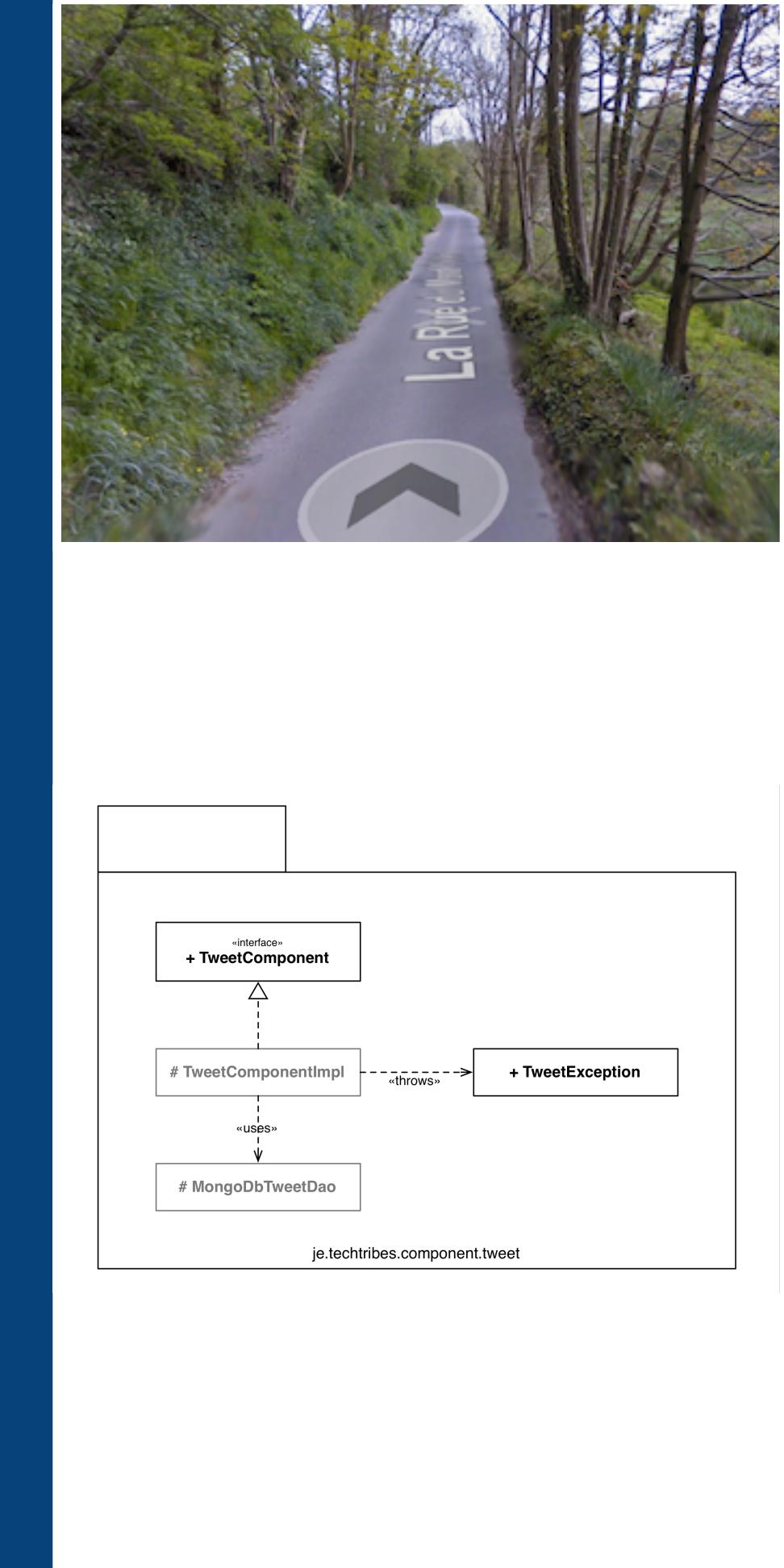
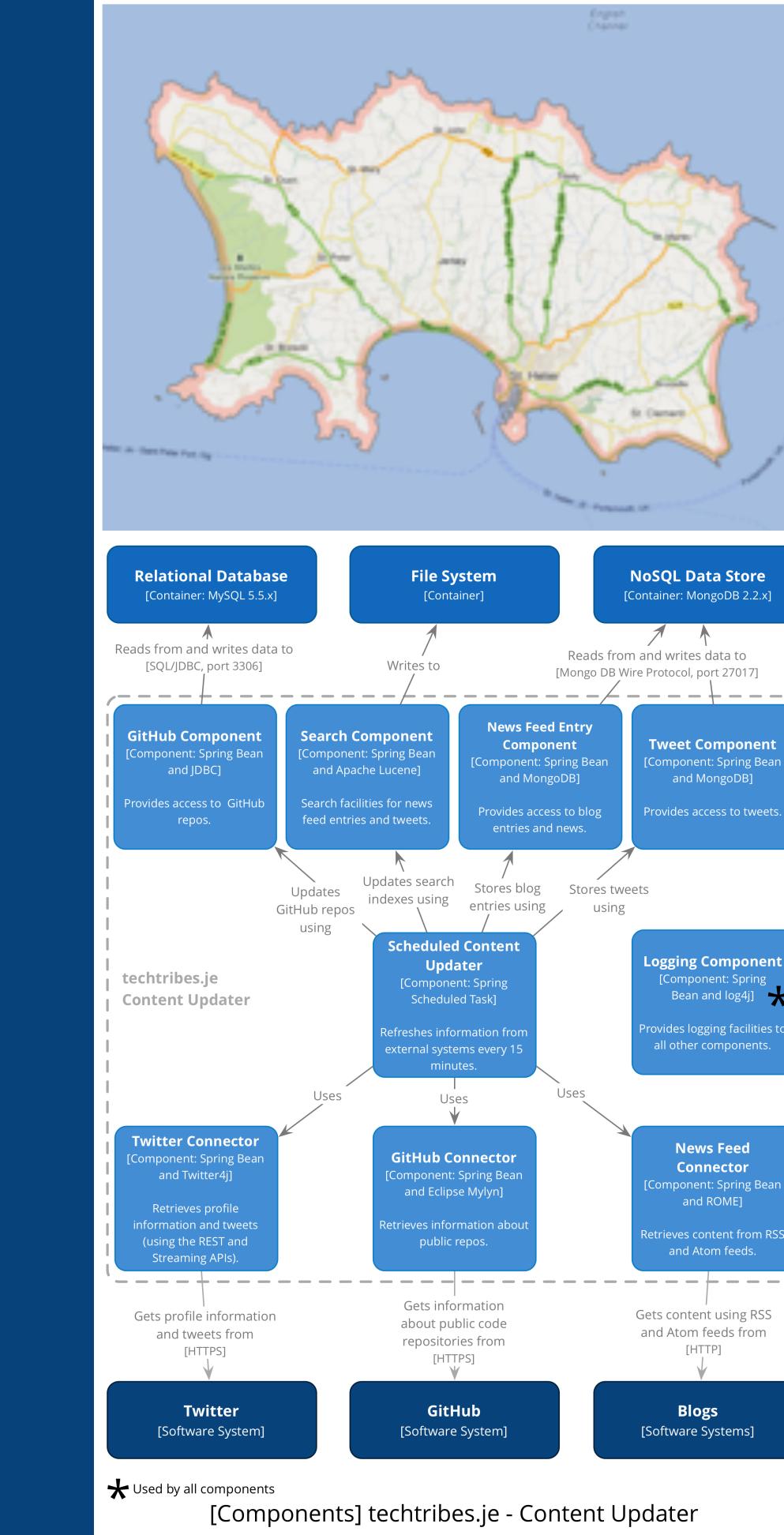
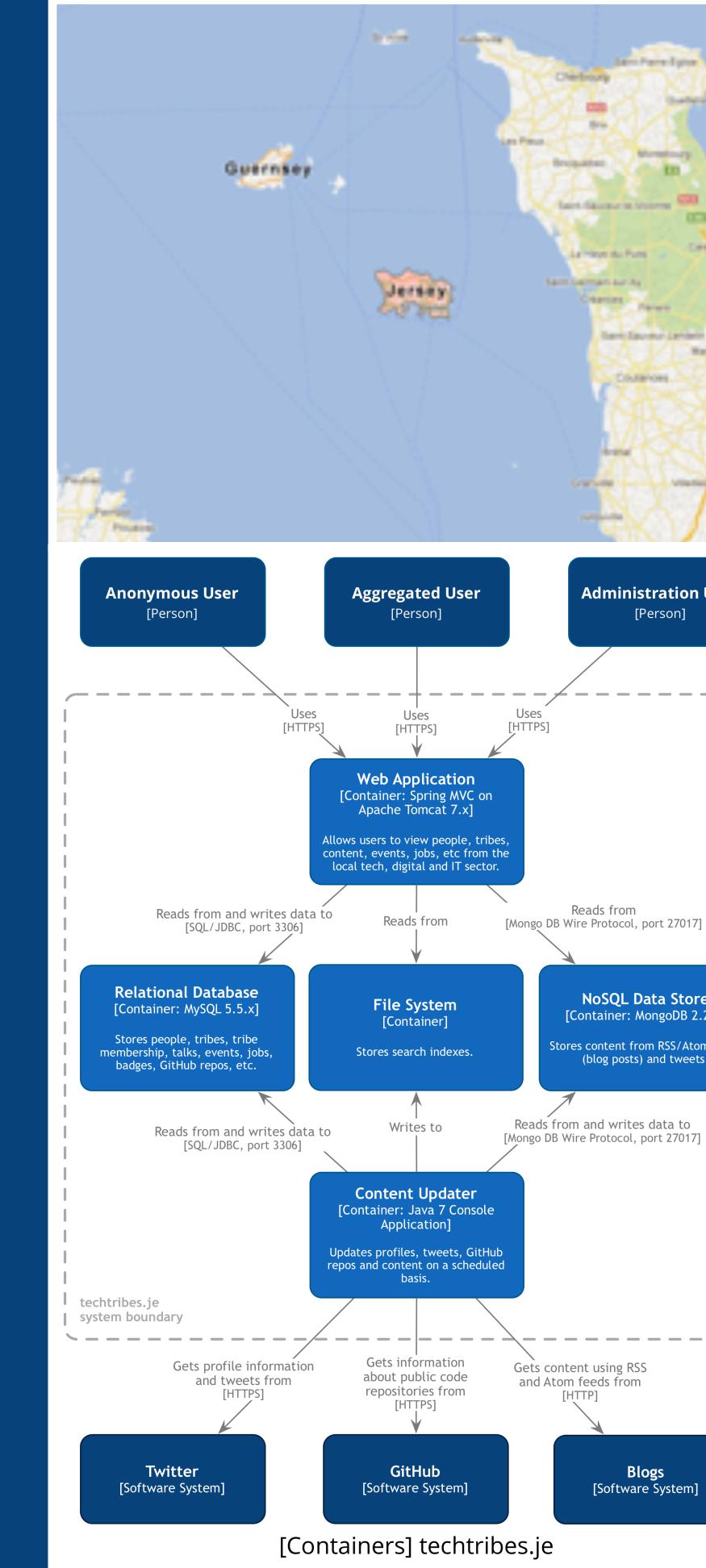
1. System Context diagram

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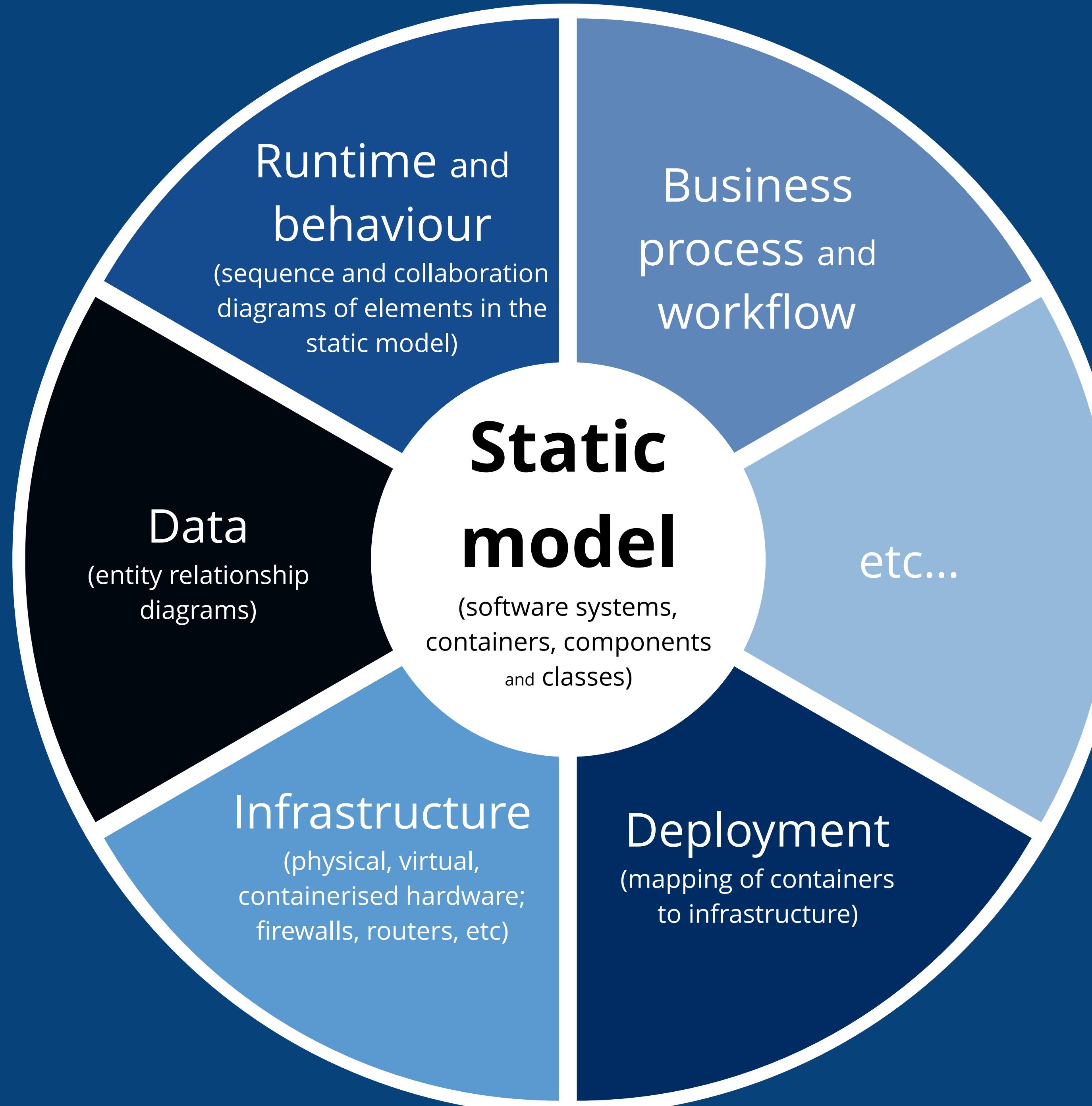
4. Class diagram





Diagrams are maps

that help software developers navigate a large and/or complex codebase



A model of the
static structure
forms the basis
for other views

What tools do you
recommend?

► 1. System Context



► 2. Containers



► 2. Containers (withou..



► 3. Components (Cont..)



► 4. Classes (TweetCo...)



Anonymous User

[Person]

Anybody on the web?

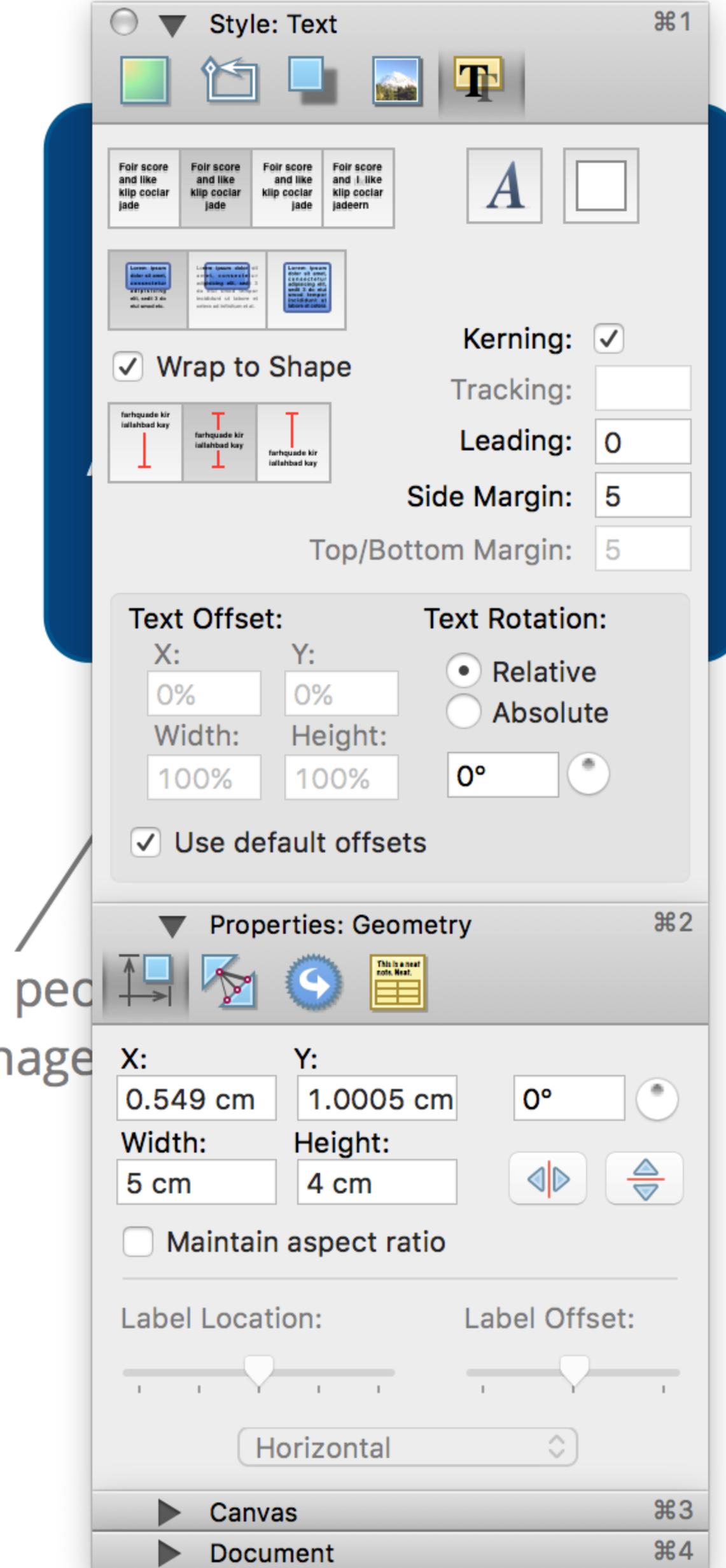
Aggregated User [Person]

A user or business with content that is aggregated into the website, signed in using their Twitter ID.

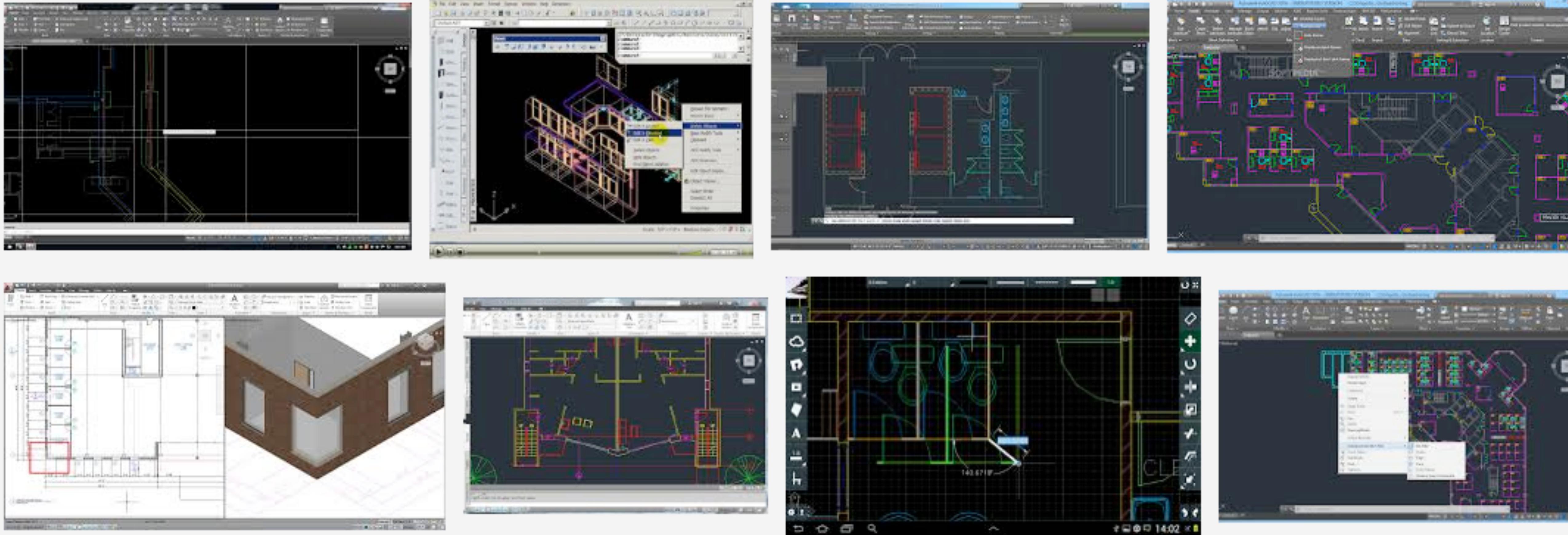
View people, tribes (businesses, communities and interest groups), content, events, jobs, etc from the local tech, digital and IT sector

Manage user profile and tribe membership

Add people
manage



techtribes.jp



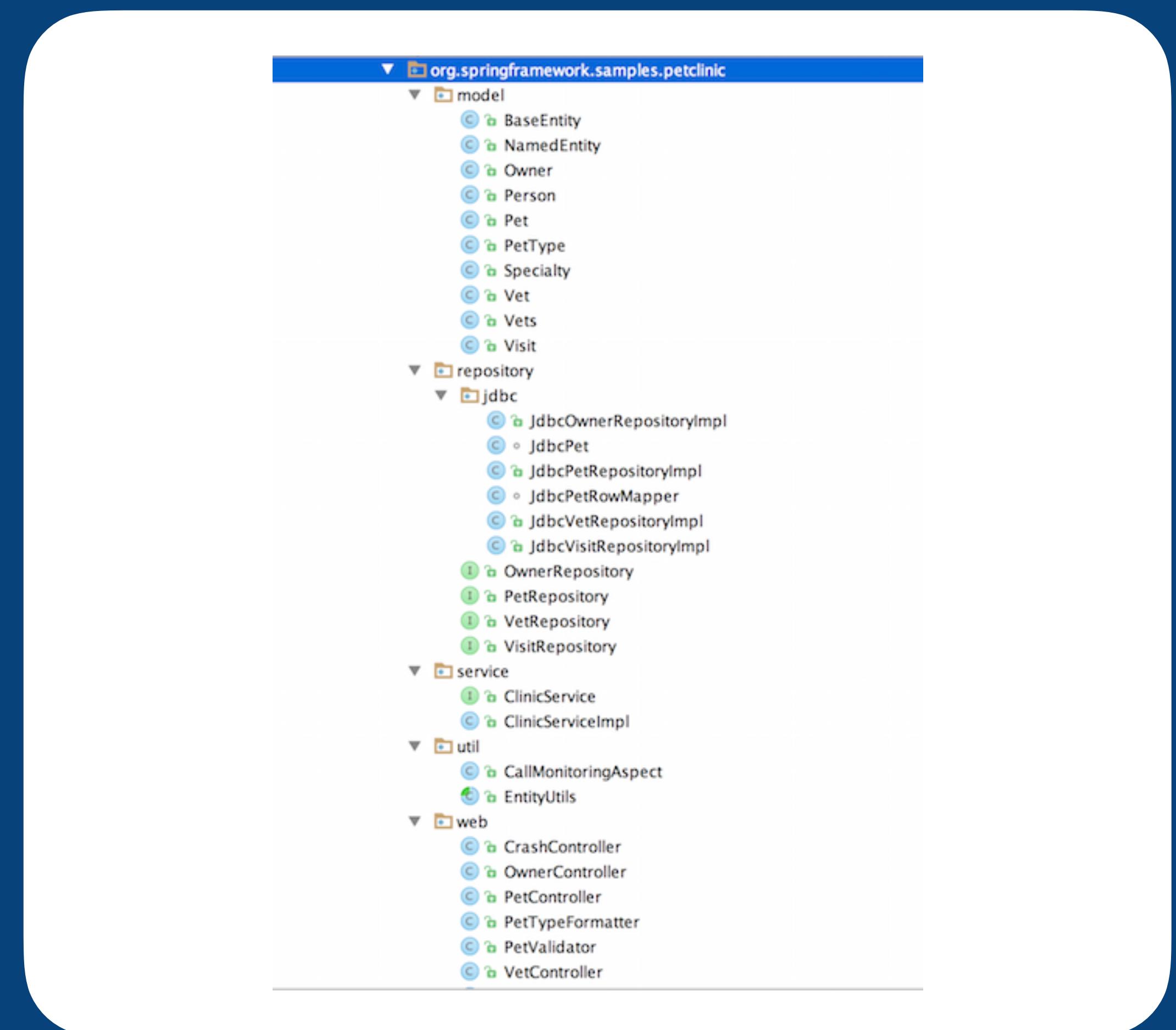
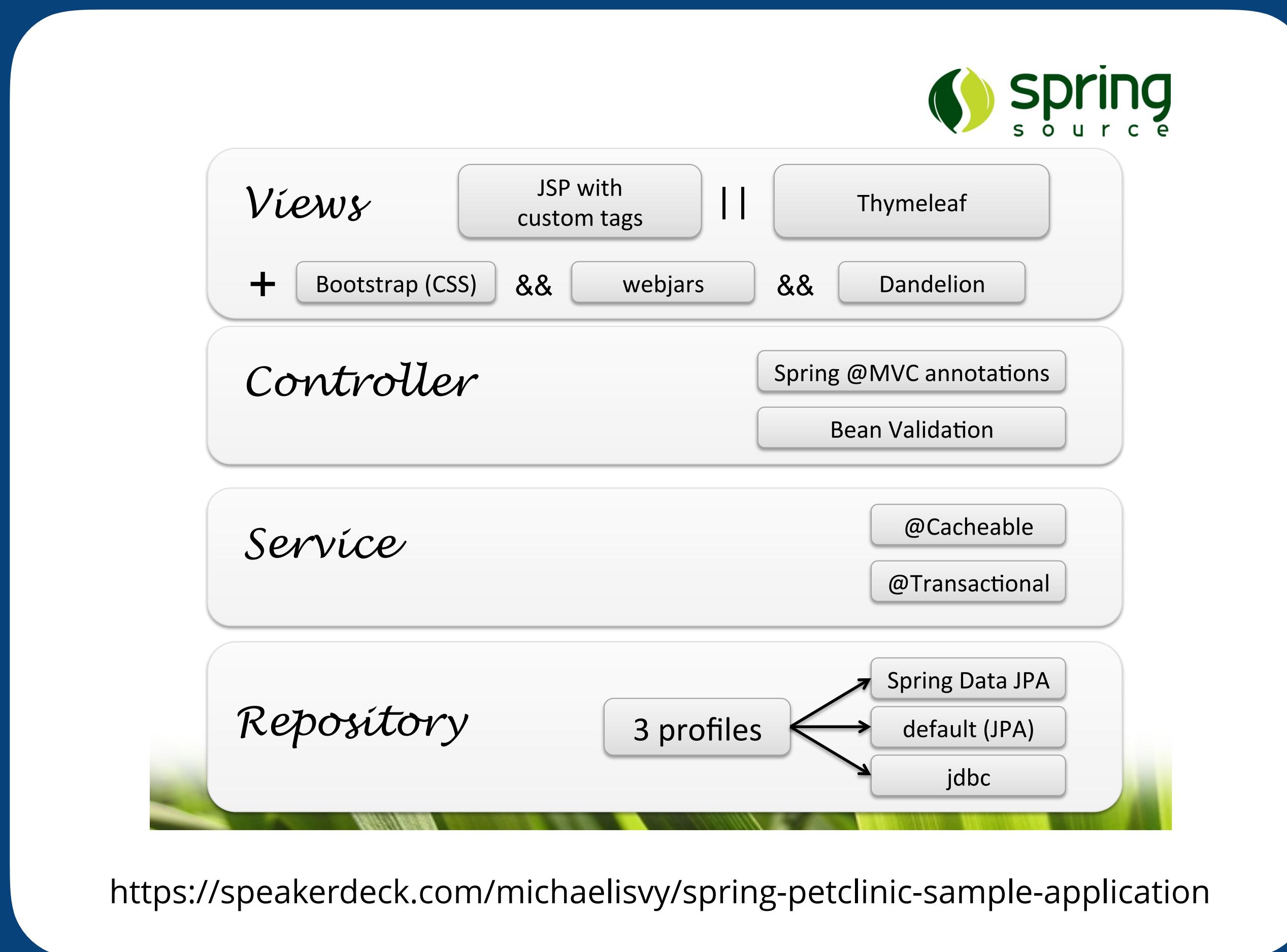
Do structural engineers and building architects
use general purpose drawing tools?

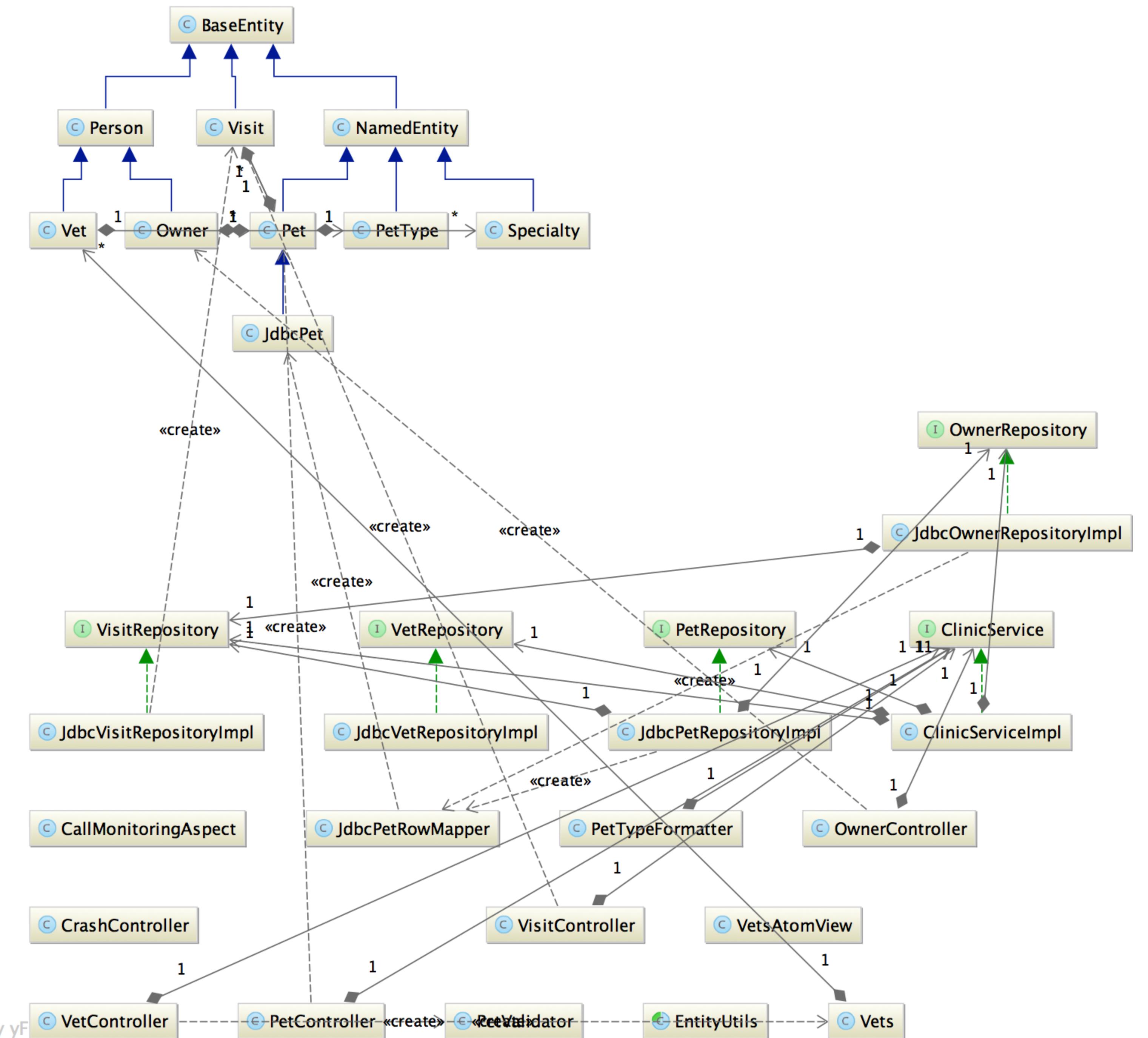
Reverse-engineer code to diagrams?

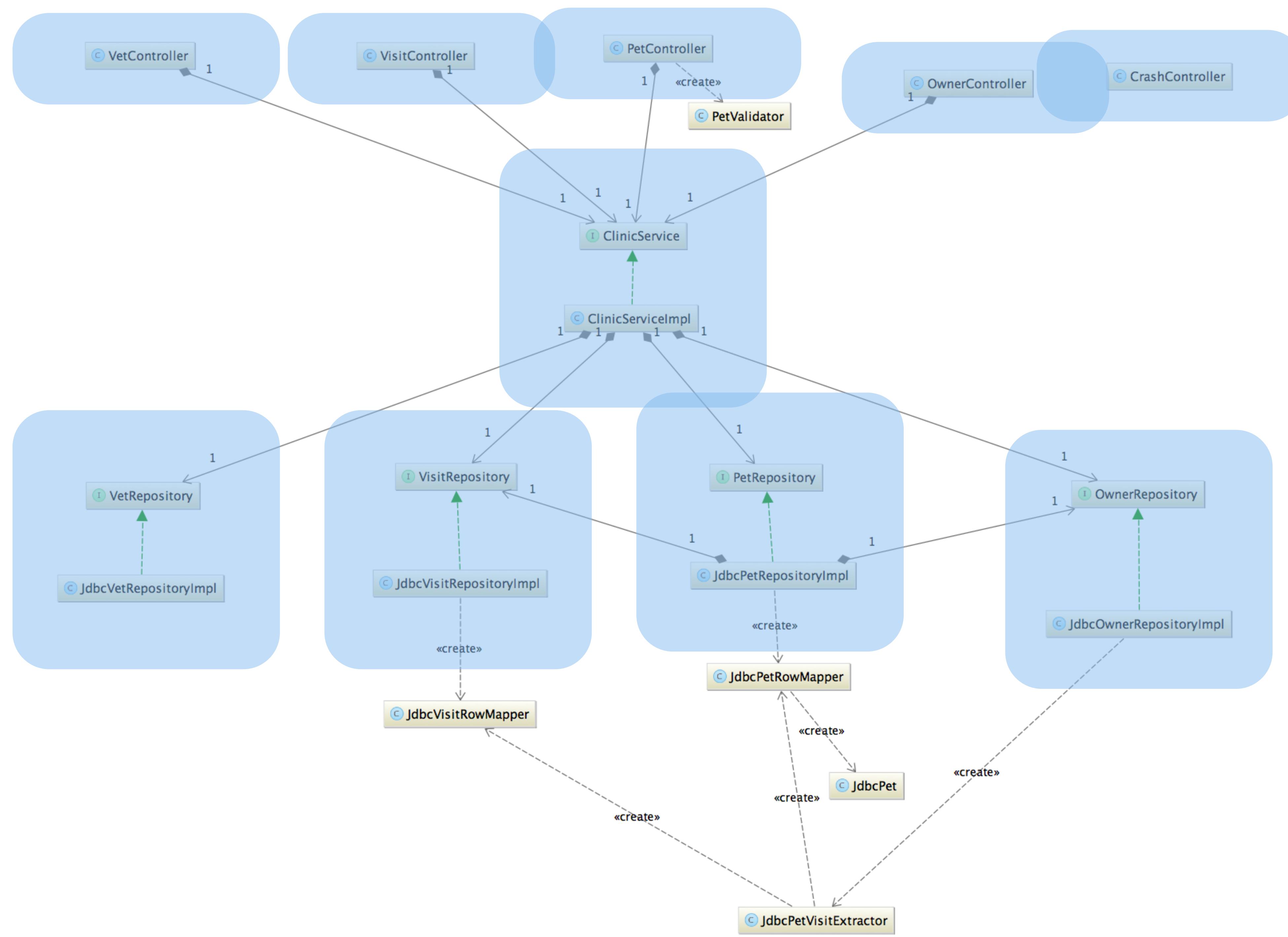
Spring PetClinic

A sample application that illustrates how to build Java web applications using the Spring MVC framework

<https://github.com/spring-projects/spring-petclinic/>







Most tools see code,
not components

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

Gail C. Murphy and David Notkin

Dept. of Computer Science & Engineering
University of Washington
Box 352350
Seattle WA, USA 98195-2350
{gmurphy, notkin}@cs.washington.edu

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.

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Kevin Sullivan

Dept. of Computer Science
University of Virginia
Charlottesville VA, USA 22903
sullivan@cs.virginia.edu

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.

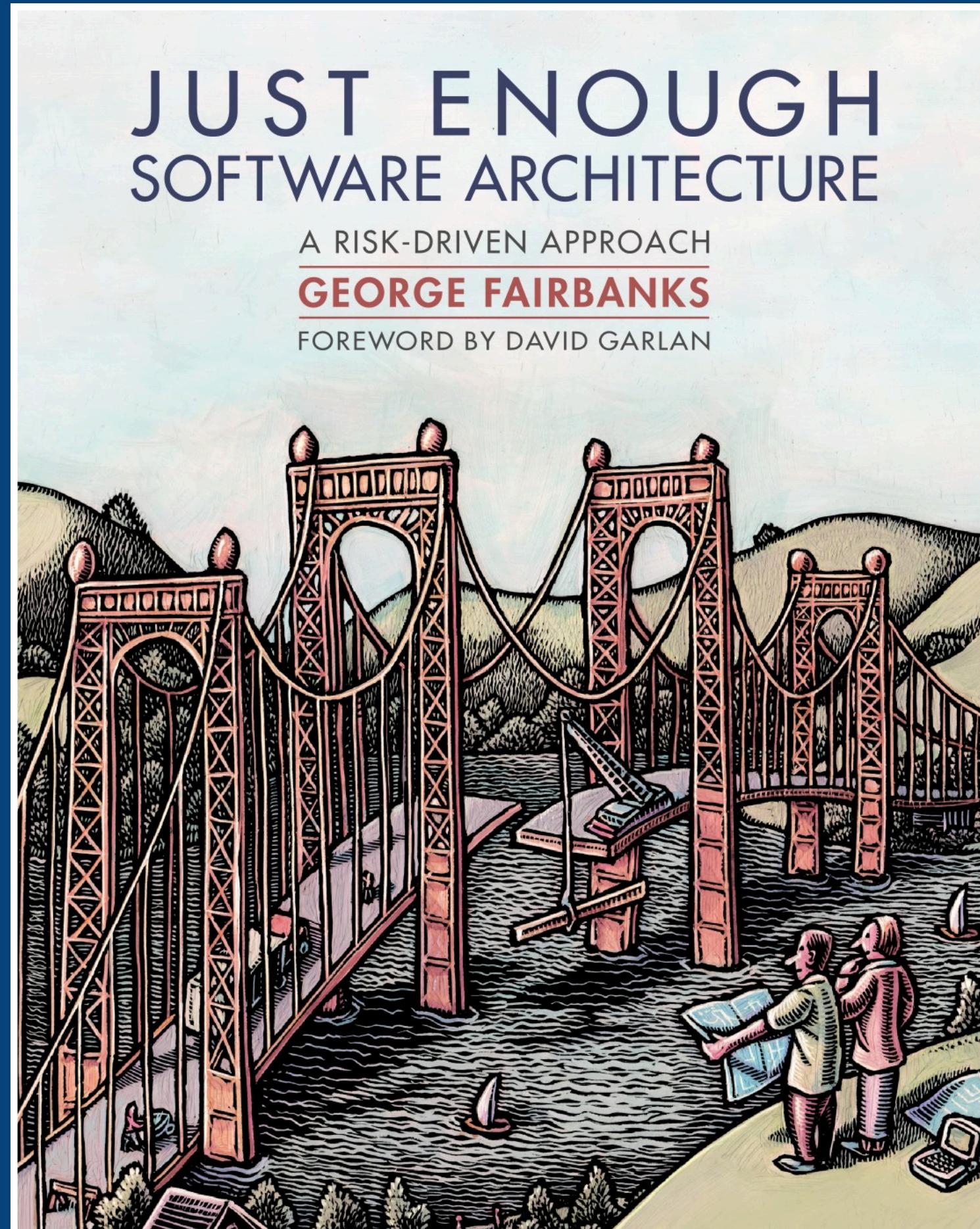
¹The old English spelling differentiates our use of "reflexion" from the field of reflective computing [Smi84].

1 Introduction

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Information about
software architecture
doesn't exist in 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.

“architecturally-evident coding style”

Examples of architecturally-evident coding styles

Annotations/attributes (@Component, [Component], etc)

Naming conventions (*Controller, *Service, etc)

Namespacing/packaging (com.mycompany.system.components.*)

Maven & Gradle modules, OSGi & Java 9 modules

JavaScript module patterns, ECMAScript 6 modules,
microservices, etc

Executable architecture description language

Structurizr for Java and .NET



```
public static void main(String[] args) throws Exception {  
    Workspace workspace = new Workspace(  
        "Spring PetClinic",  
        "This is a C4 representation of the Spring PetClinic sample app  
        (https://github.com/spring-projects/spring-petclinic/)");  
  
    Model model = workspace.getModel();  
  
}  
}
```

```
// software systems and people
SoftwareSystem springPetClinic = model.addSoftwareSystem(
    "Spring PetClinic",
    "Allows employees to view and manage information regarding the
    veterinarians, the clients, and their pets.");
```



```
Person clinicEmployee = model.addPerson(
    "Clinic Employee", "An employee of the clinic");
```



```
clinicEmployee.uses(springPetClinic, "Uses");
```

```
// containers

Container webApplication = springPetClinic.addContainer(
    "Web Application",
    "Allows employees to view and manage information regarding the
     veterinarians, the clients, and their pets.",
    "Apache Tomcat 7.x");

Container relationalDatabase = springPetClinic.addContainer(
    "Relational Database",
    "Stores information regarding the veterinarians, the clients,
     and their pets.", "HSQLDB");

clinicEmployee.uses(webApplication,
    "Uses", "HTTP");

webApplication.uses(relationalDatabase,
    "Reads from and writes to", "JDBC, port 9001");
```

```
// components
ComponentFinder componentFinder = new ComponentFinder(
    webApplication,
    "org.springframework.samples.petclinic",
    new SpringComponentFinderStrategy(
        new ReferencedTypesSupportingTypesStrategy()
    ),
    new SourceCodeComponentFinderStrategy(
        new File(sourceRoot, "/src/main/java/"), 150));
componentFinder.findComponents();
```

```
// connect components with other model elements  
webApplication.getComponents().stream()  
    .filter(c -> c.getTechnology().equals(SpringComponentFinderStrategy.SPRING_MVC_CONTROLLER))  
    .foreach(c -> clinicEmployee.uses(c, "Uses", "HTTP"));  
  
webApplication.getComponents().stream()  
    .filter(c -> c.getTechnology().equals(SpringComponentFinderStrategy.SPRING_REPOSITORY))  
    .foreach(c -> c.uses(relationalDatabase, "Reads from and writes to", "JDBC"));
```

```
// system context, container and component views
ViewSet viewSet = workspace.getViews();

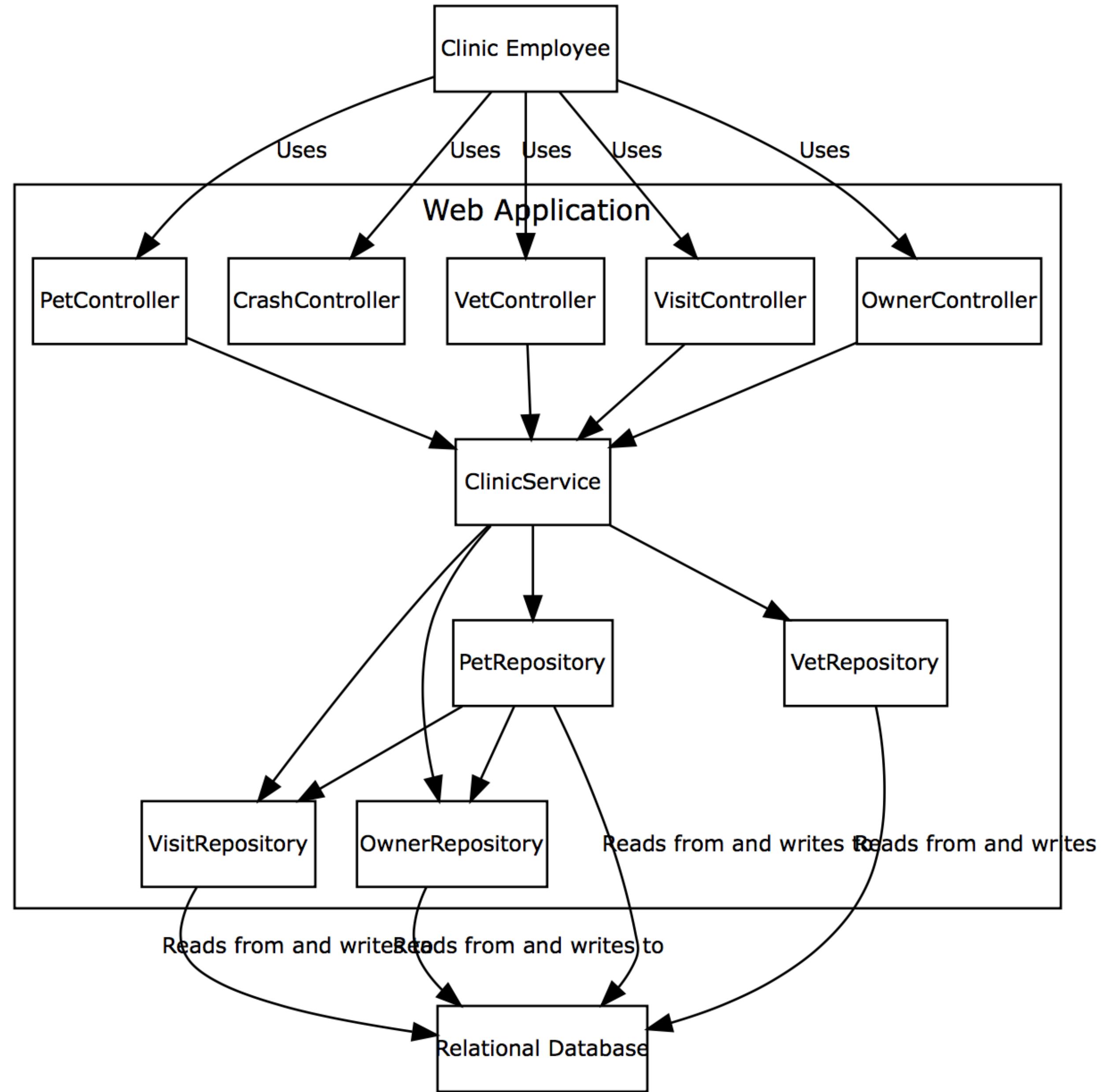
SystemContextView contextView = viewSet.createContextView(
    springPetClinic, "context", "Context view for Spring PetClinic");
contextView.addAllSoftwareSystems();
contextView.addAllPeople();

ContainerView containerView = viewSet.createContainerView(
    springPetClinic, "containers", "Container view for Spring PetClinic");
containerView.addAllPeople();
containerView.addAllSoftwareSystems();
containerView.addAllContainers();

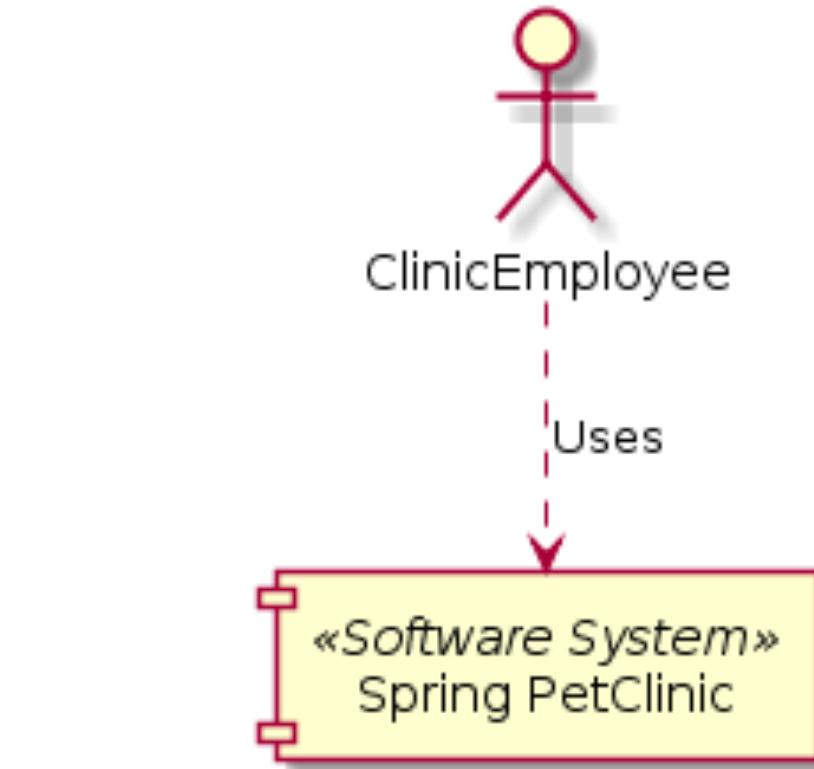
ComponentView componentView = viewSet.createComponentView(
    webApplication, "components", "Component view for the Spring PetClinic webapp.");
componentView.addAllComponents();
componentView.addAllPeople();
componentView.add(relationalDatabase);
```

You can create
many visualisations
from a single model

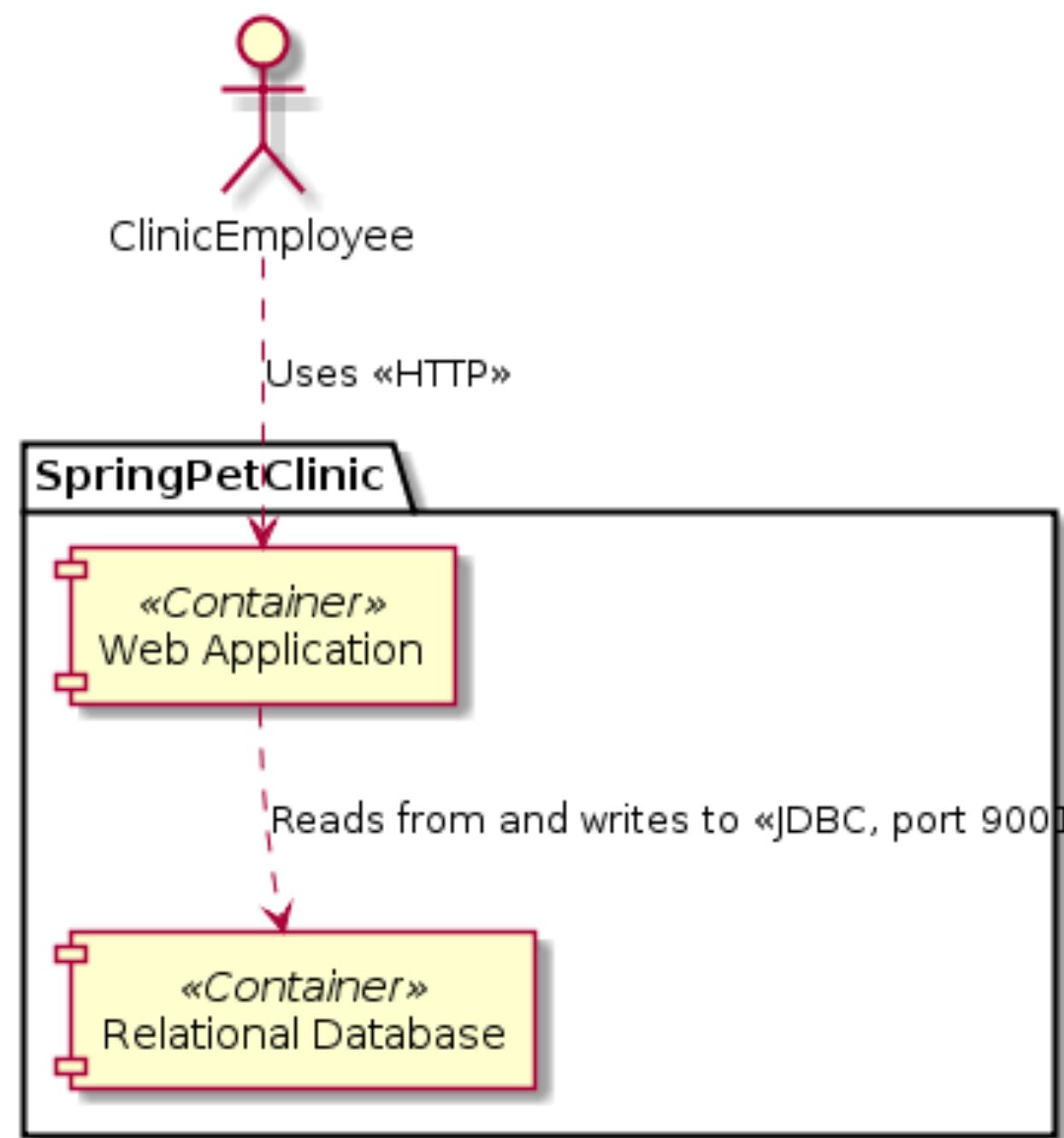
Spring PetClinic - Web Application - Components



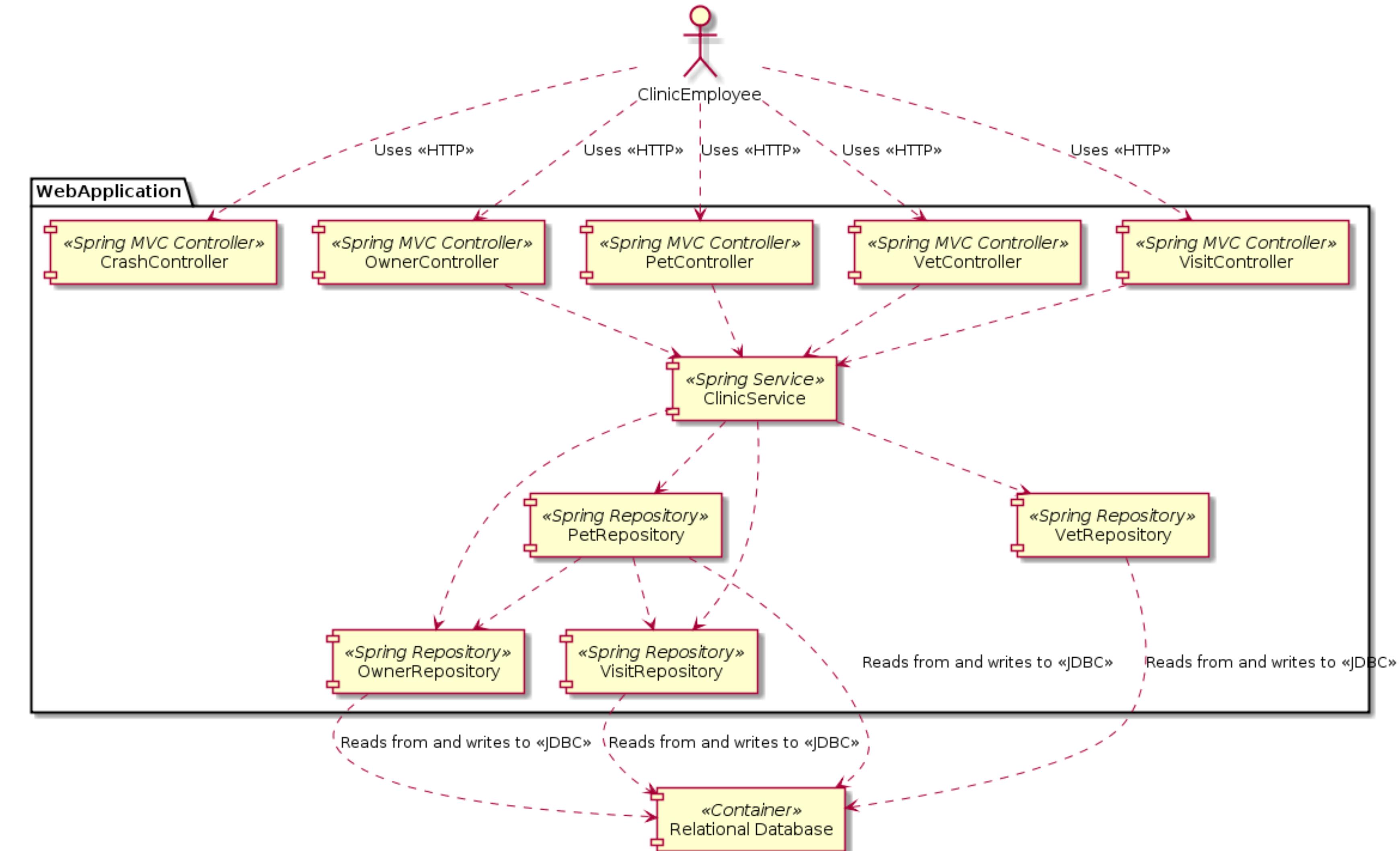
Spring PetClinic - System Context



Spring PetClinic - Containers



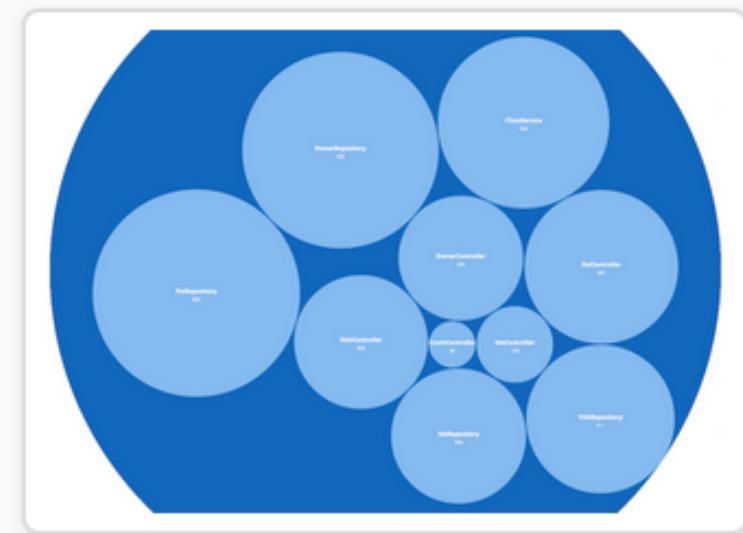
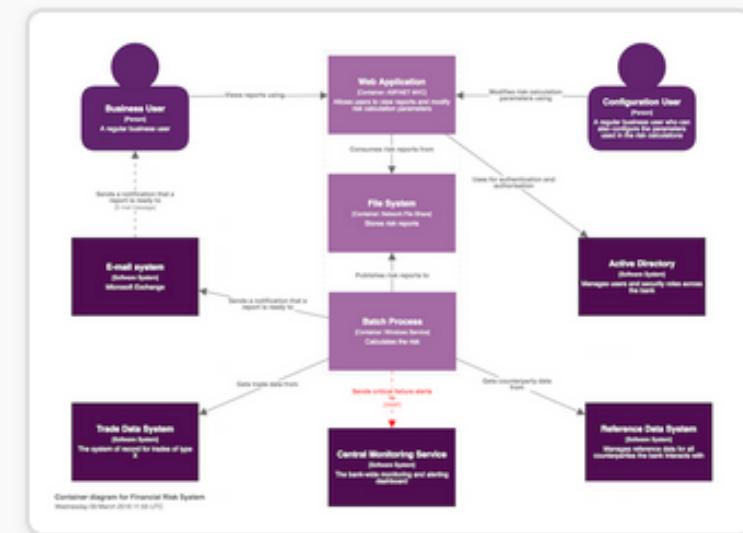
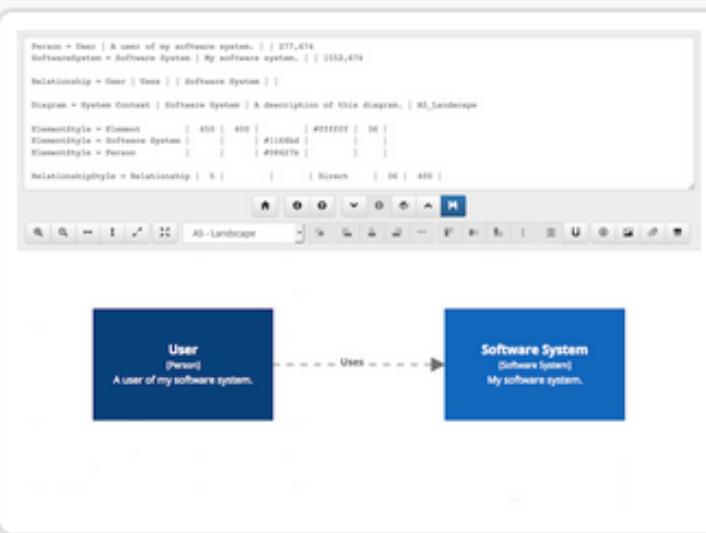
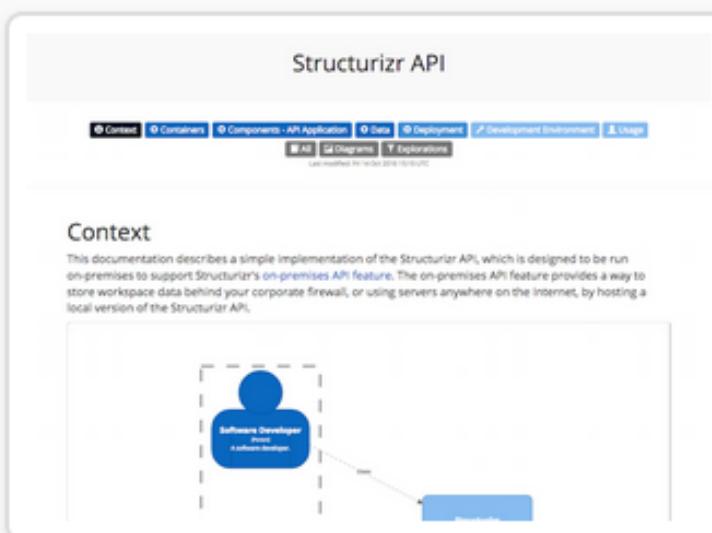
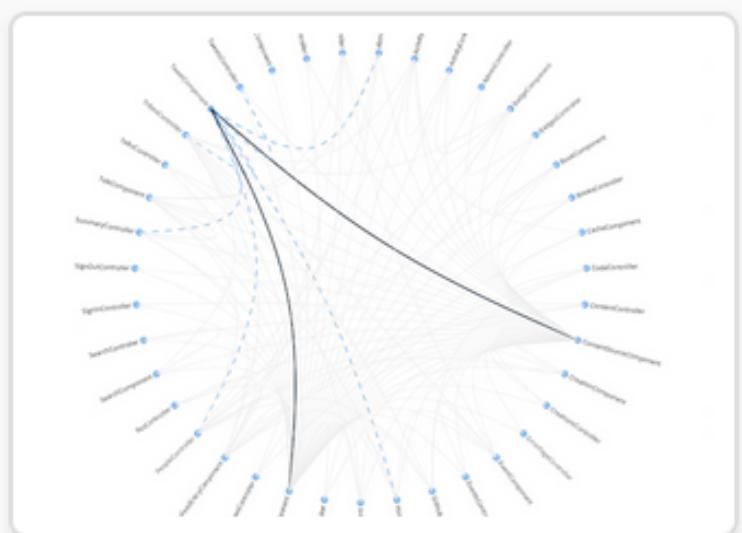
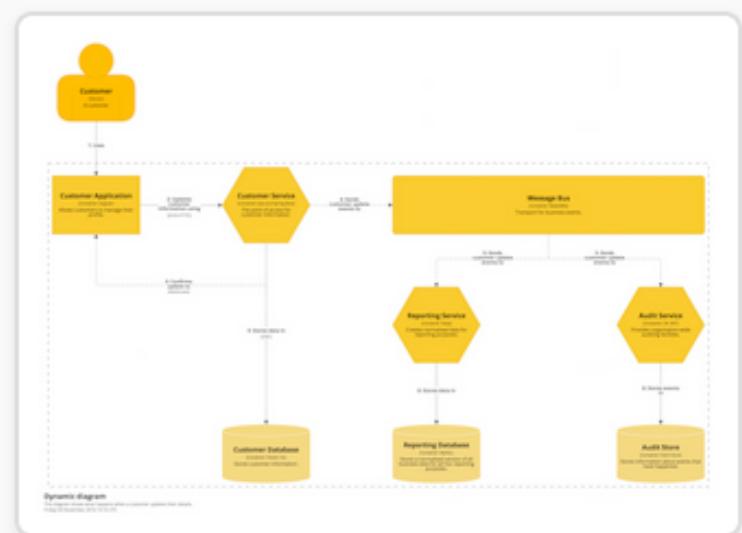
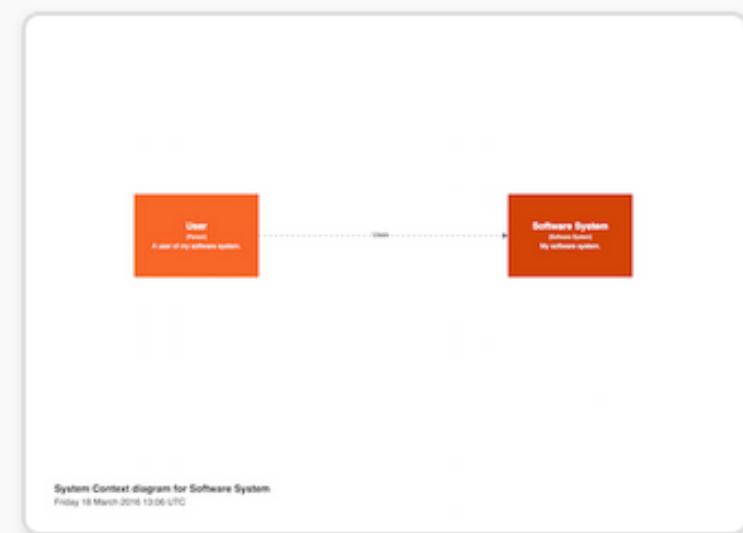
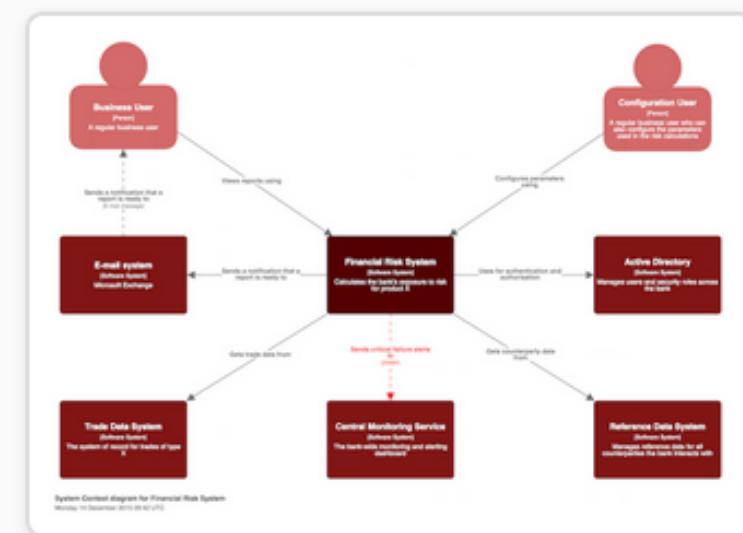
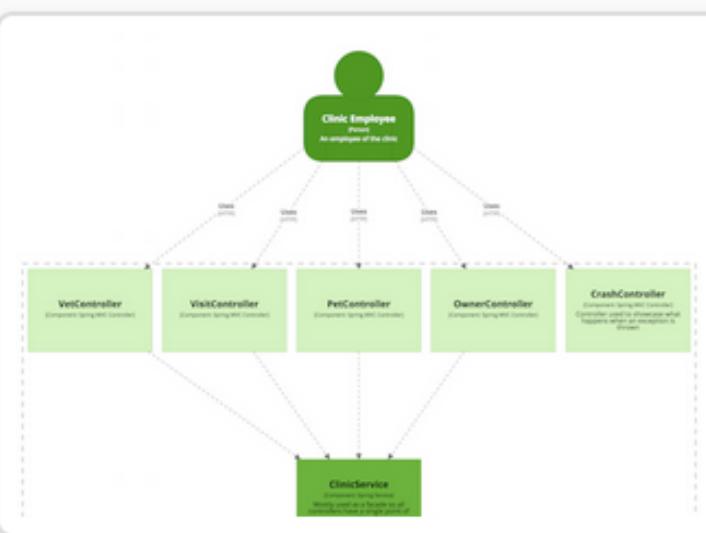
Spring PetClinic - Web Application - Components





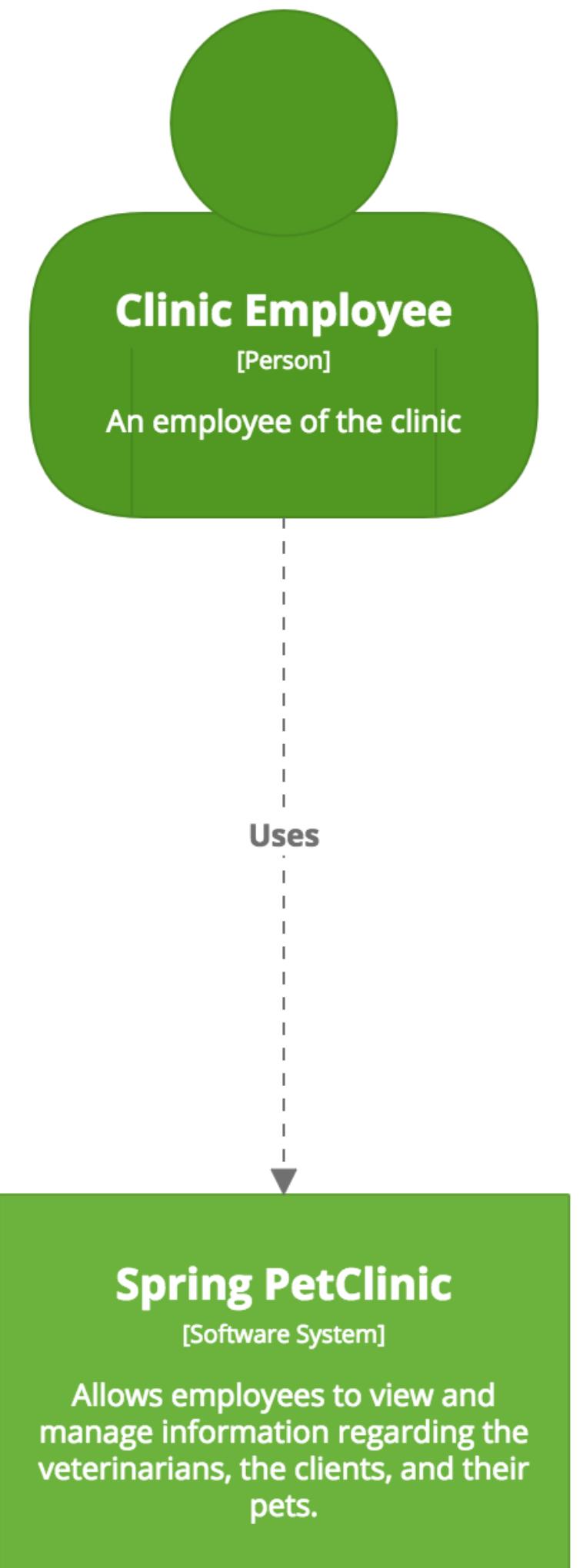
Structurizr

Visualise, document and explore your software architecture



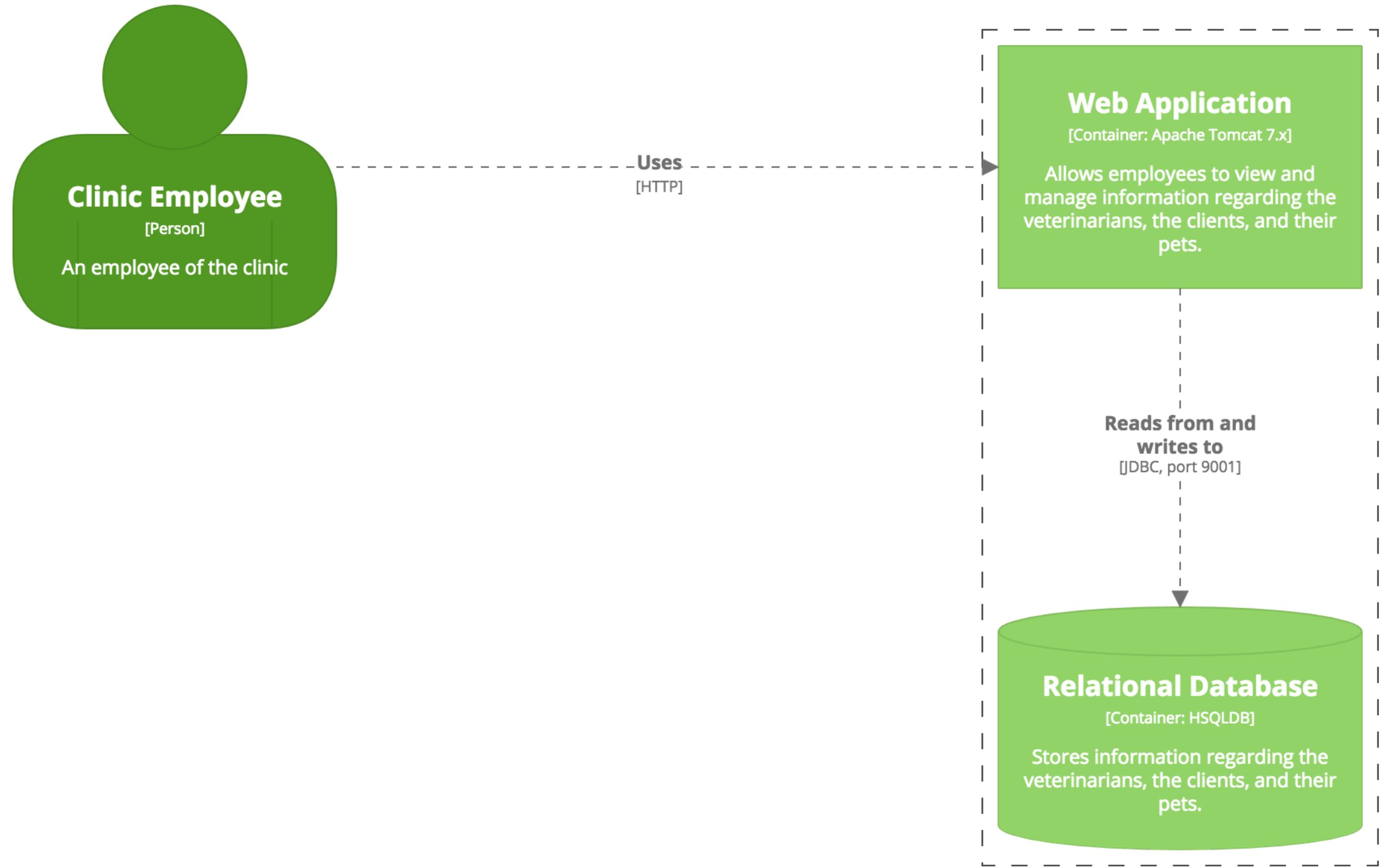
```
// upload the software architecture model to structurizr.com
StructurizrClient client = new StructurizrClient("key", "secret");
client.mergeWorkspace(1234, workspace);

{
  "id" : 0,
  "name" : "Spring PetClinic",
  "description" : "This is a C4 representation of the Spring PetClinic sample app (https://github.com/spring-projects/spring-petclinic/)",
  "model" : {
    "people" : [ {
      "tags" : "Element,Person",
      "id" : "2",
      "name" : "Clinic Employee",
      "description" : "An employee of the clinic",
      "relationships" : [ {
        "tags" : "Relationship,Synchronous",
        "id" : "3",
        "sourceId" : "2",
        "destinationId" : "1",
        "description" : "Uses",
        "interactionStyle" : "Synchronous"
      }, {
        "tags" : "Relationship,Synchronous",
        "id" : "6",
        "sourceId" : "2",
        "destinationId" : "4",
        "description" : "Uses",
        "technology" : "HTTP",
        "interactionStyle" : "Synchronous"
      }, {
        "tags" : "Relationship,Synchronous",
        "id" : "28",
        "sourceId" : "2",
        "destinationId" : "8",
        "description" : "Uses",
        "technology" : "HTTP",
        "interactionStyle" : "Synchronous"
      }
    }
  }
}
```



System Context diagram for Spring PetClinic

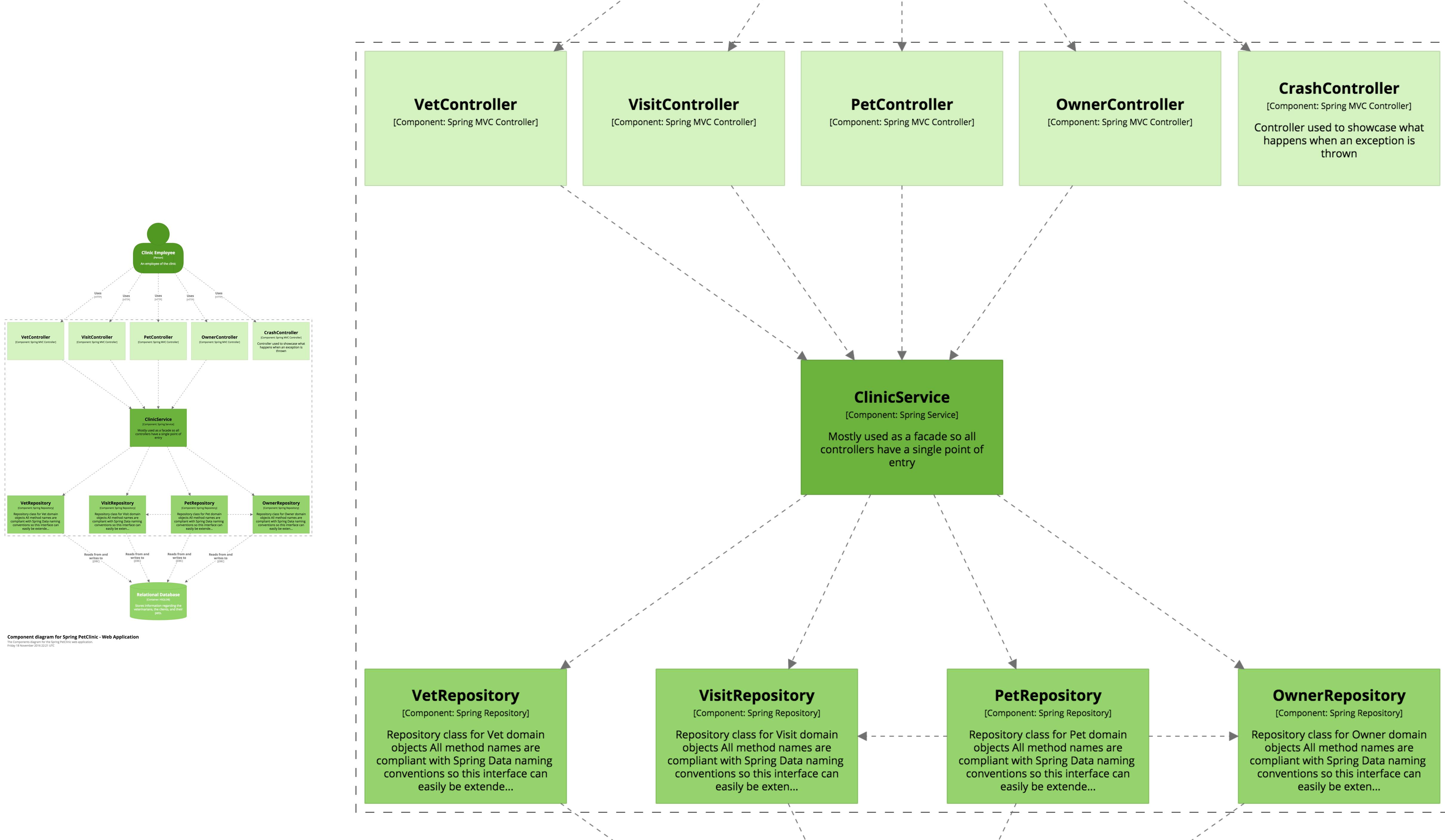
The System Context diagram for the Spring PetClinic system.
Friday 18 November 2016 22:21 UTC



Container diagram for Spring PetClinic

The Containers diagram for the Spring PetClinic system.

Friday 18 November 2016 22:21 UTC

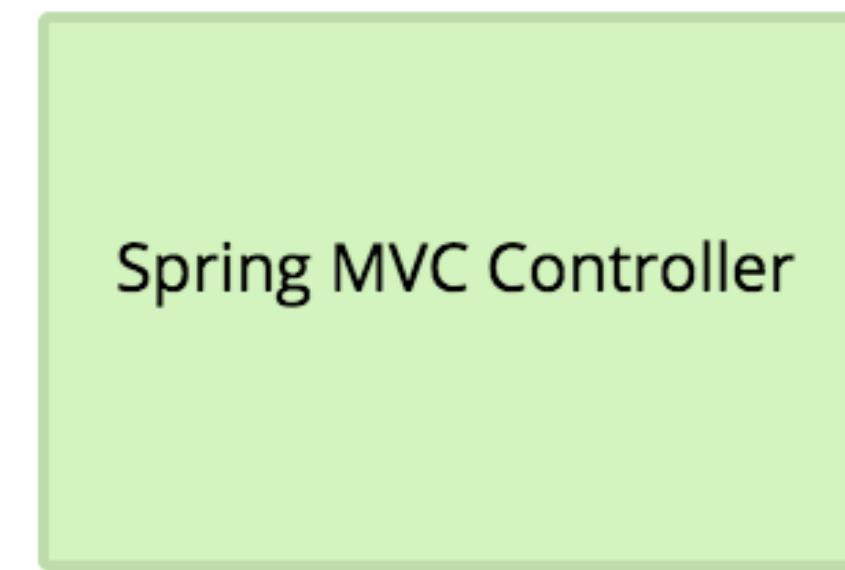


i Diagram key

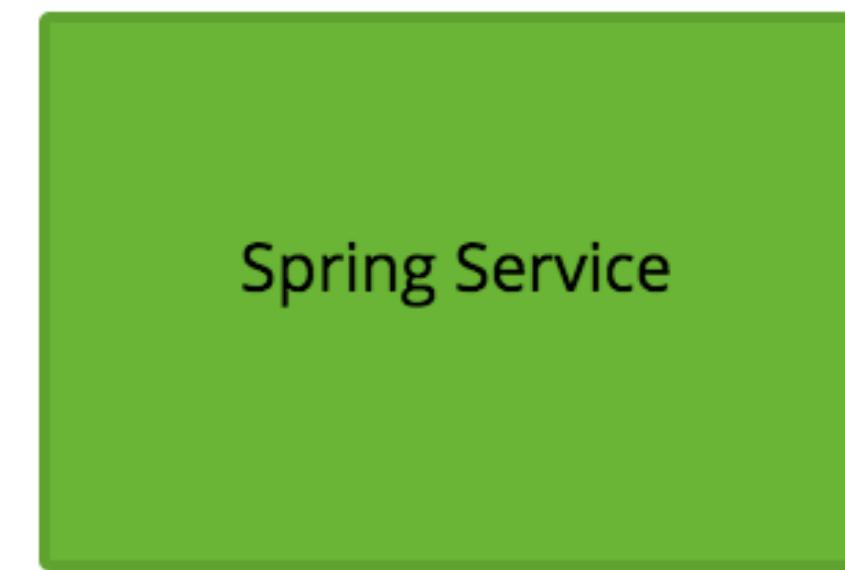
Here are the styles that have been used on this diagram.



Web Application
[Container]



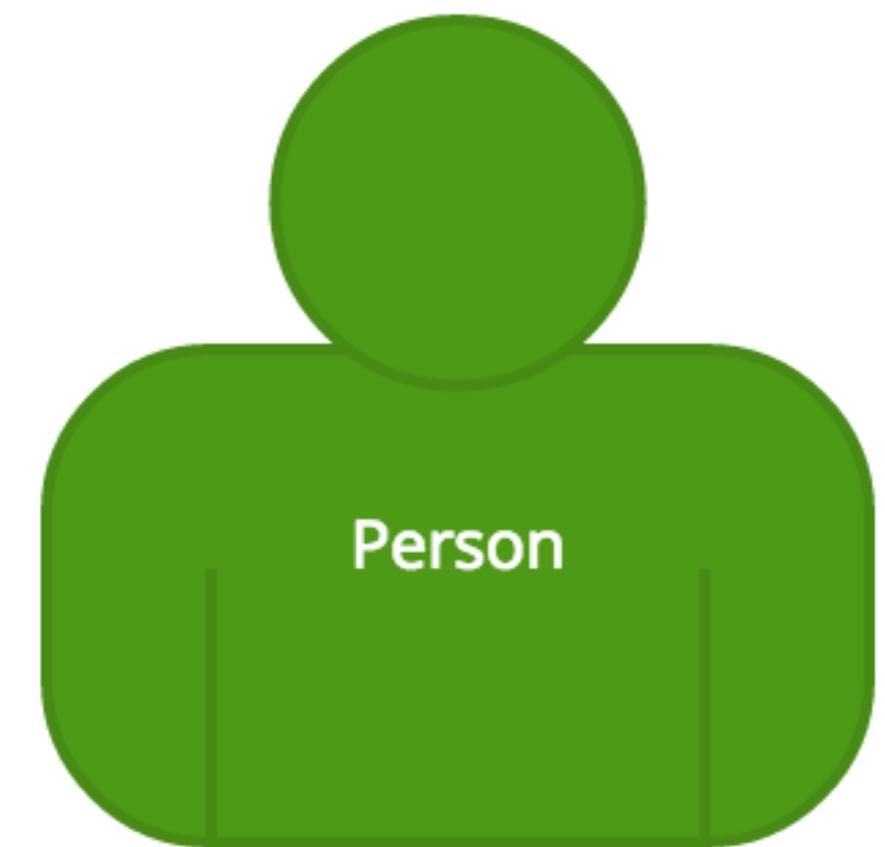
Spring MVC Controller



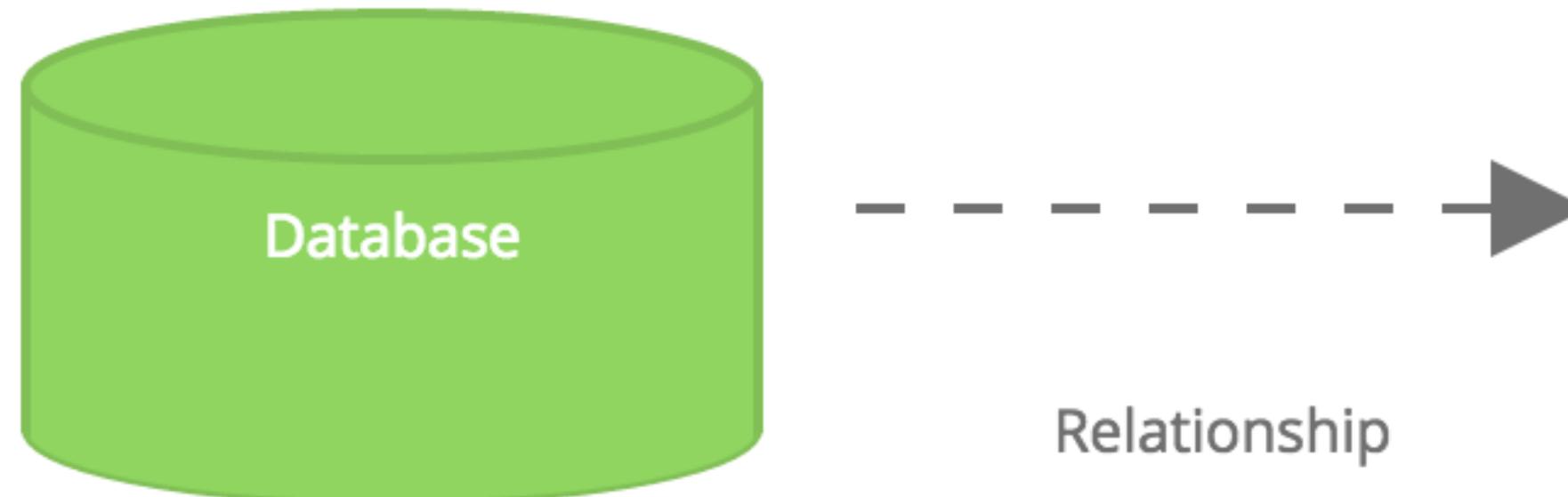
Spring Service



Spring Repository



Person

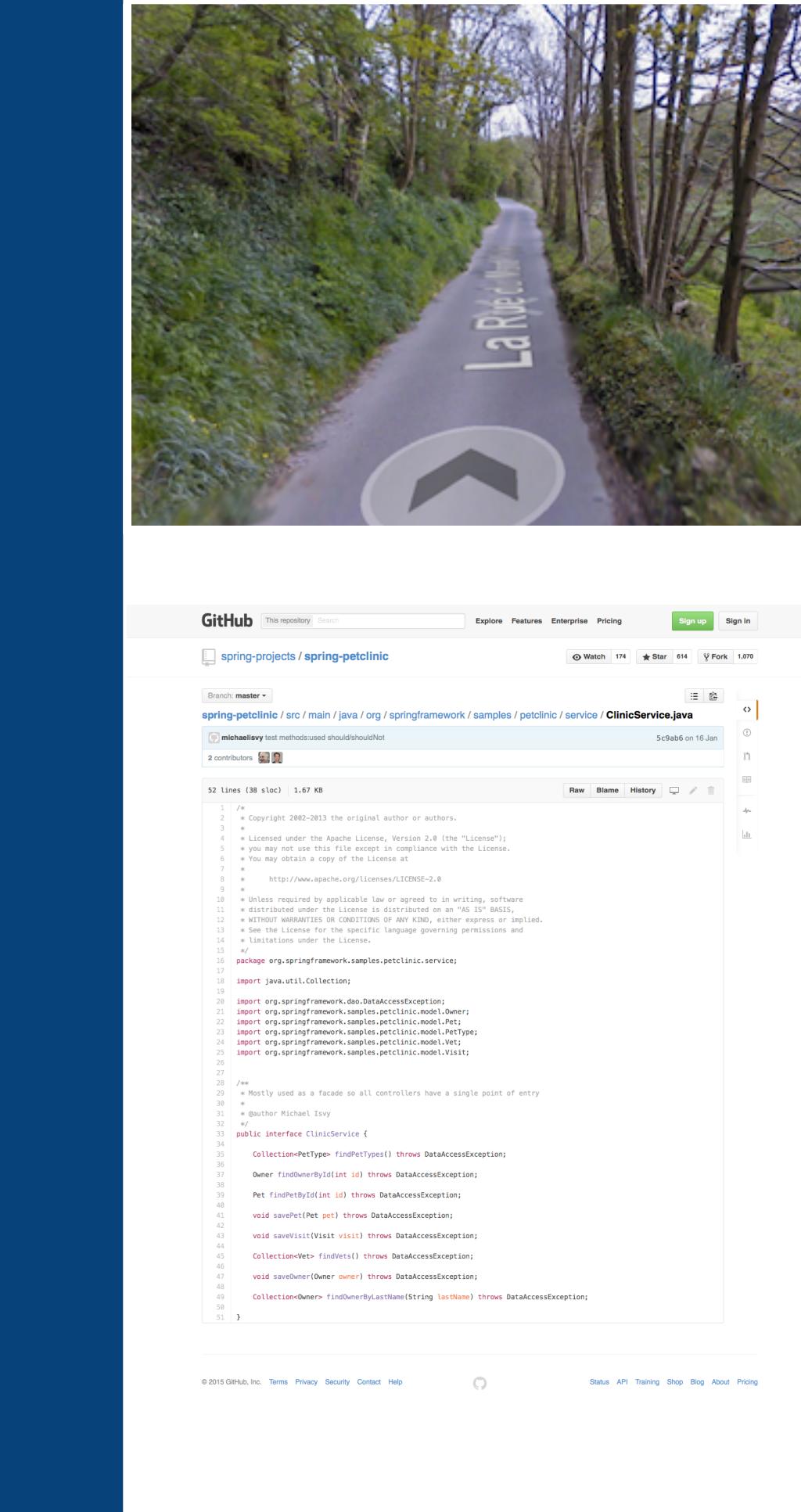
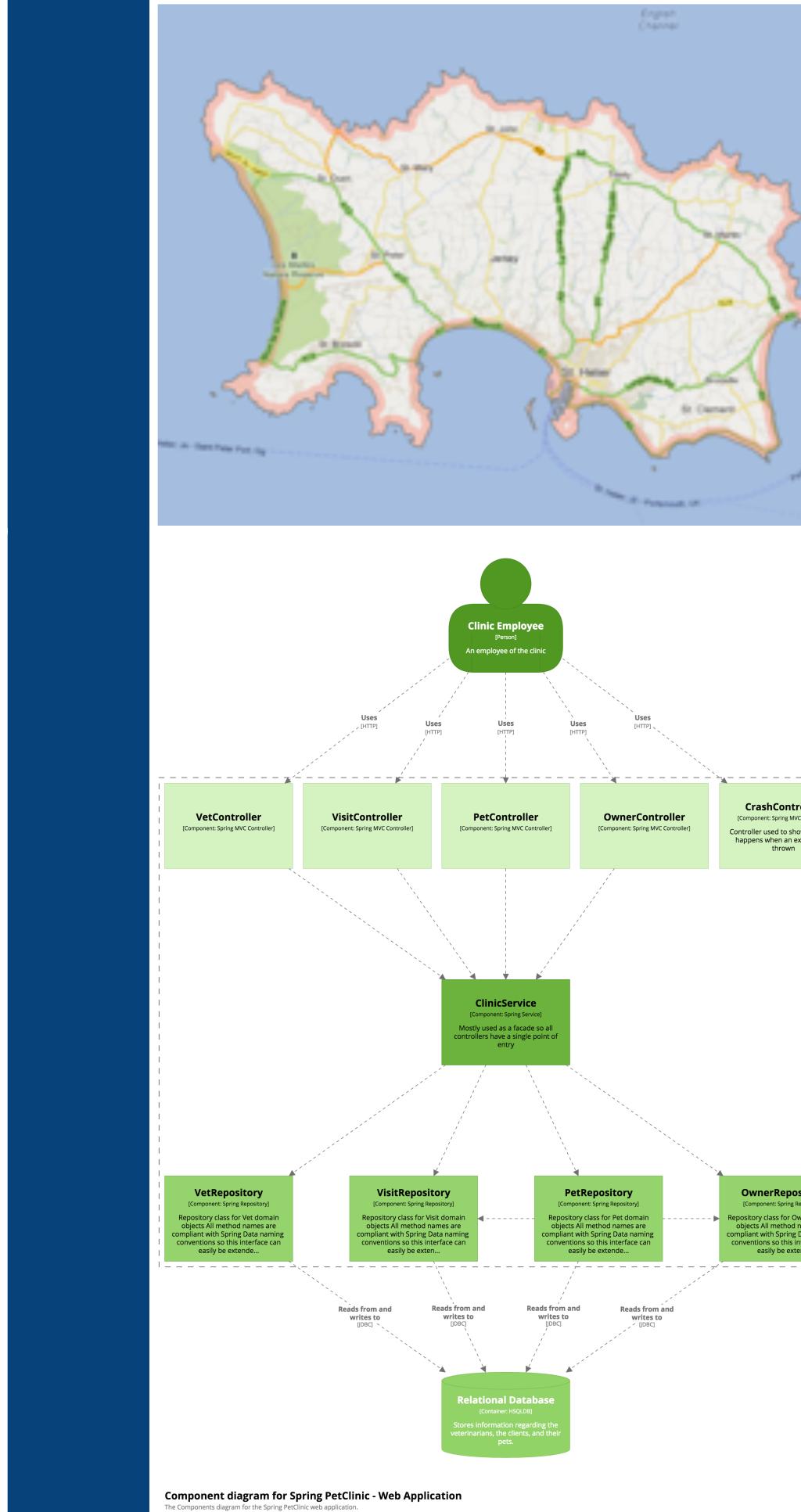
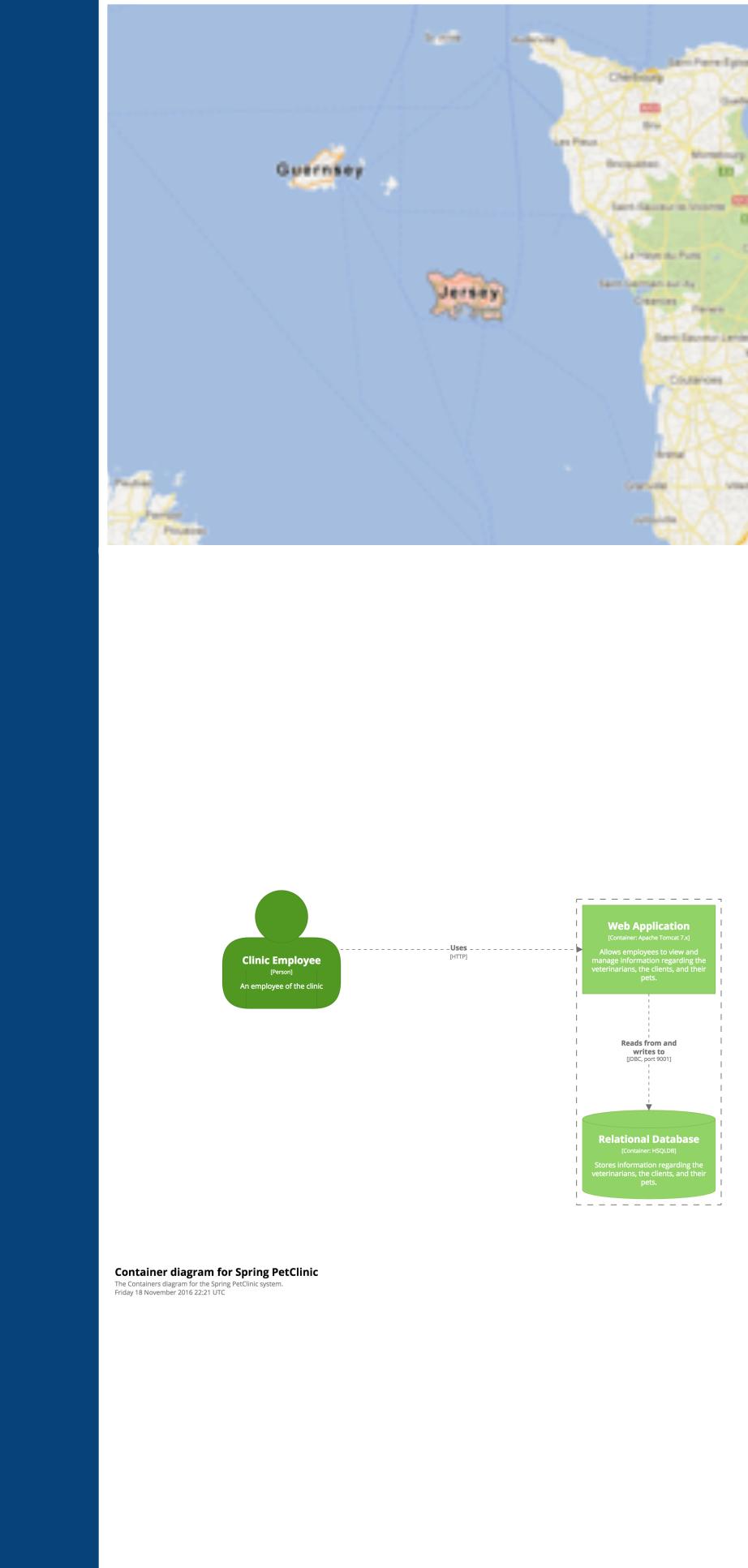
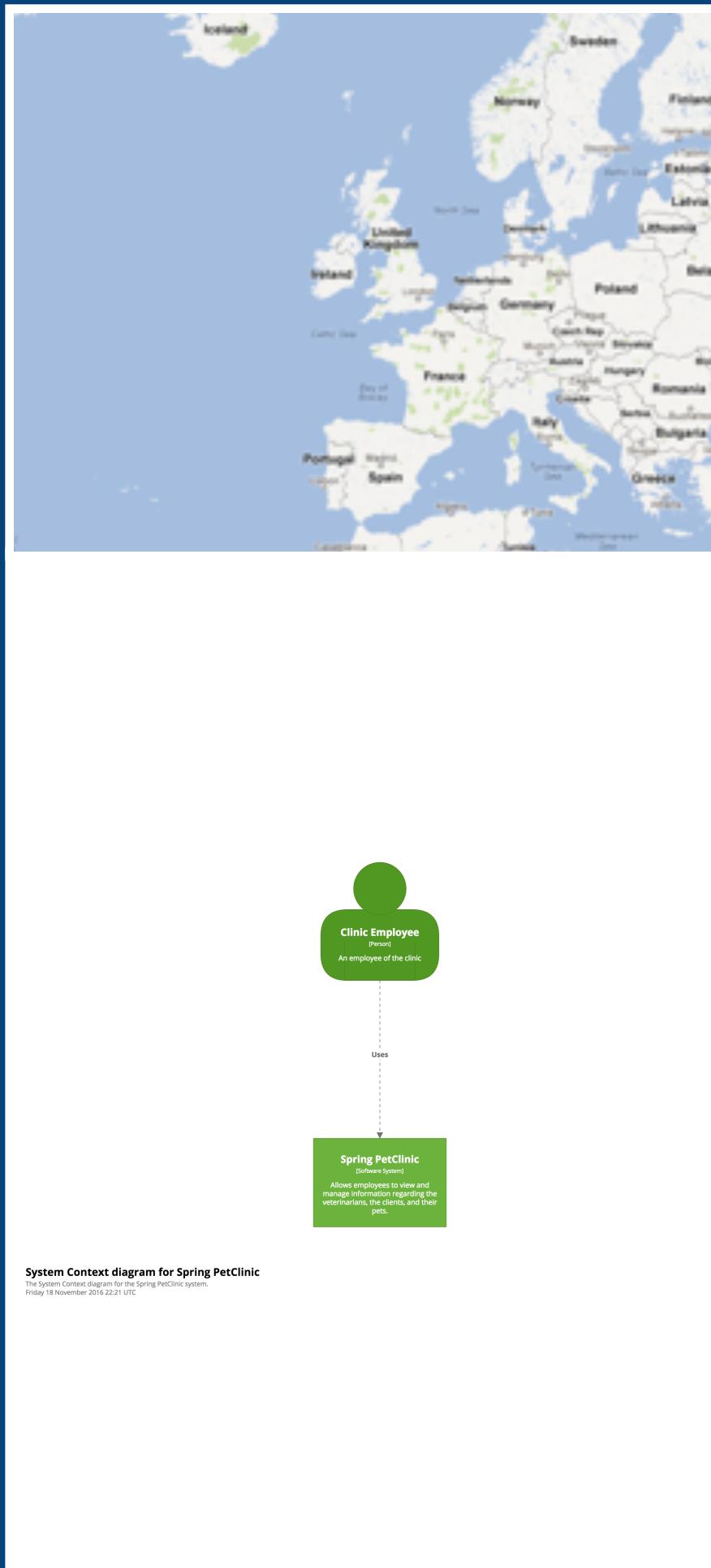


Database



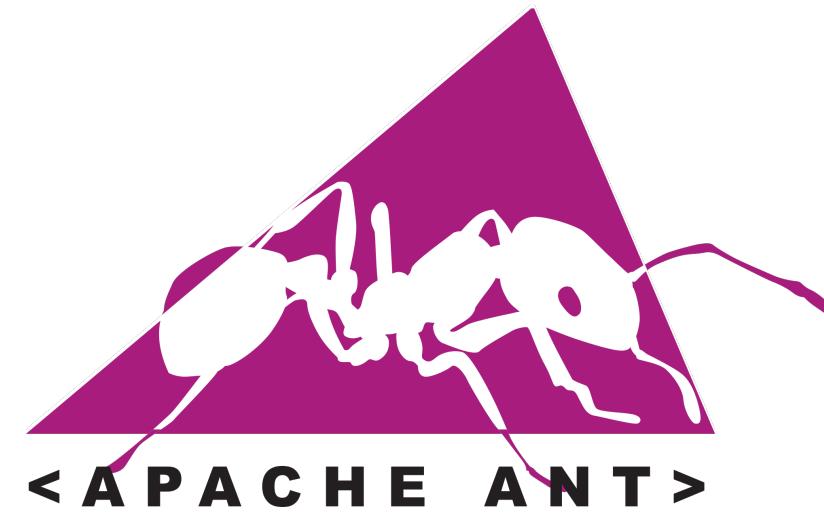
Relationship

Close



Diagrams are maps

 TeamCity



 gradle

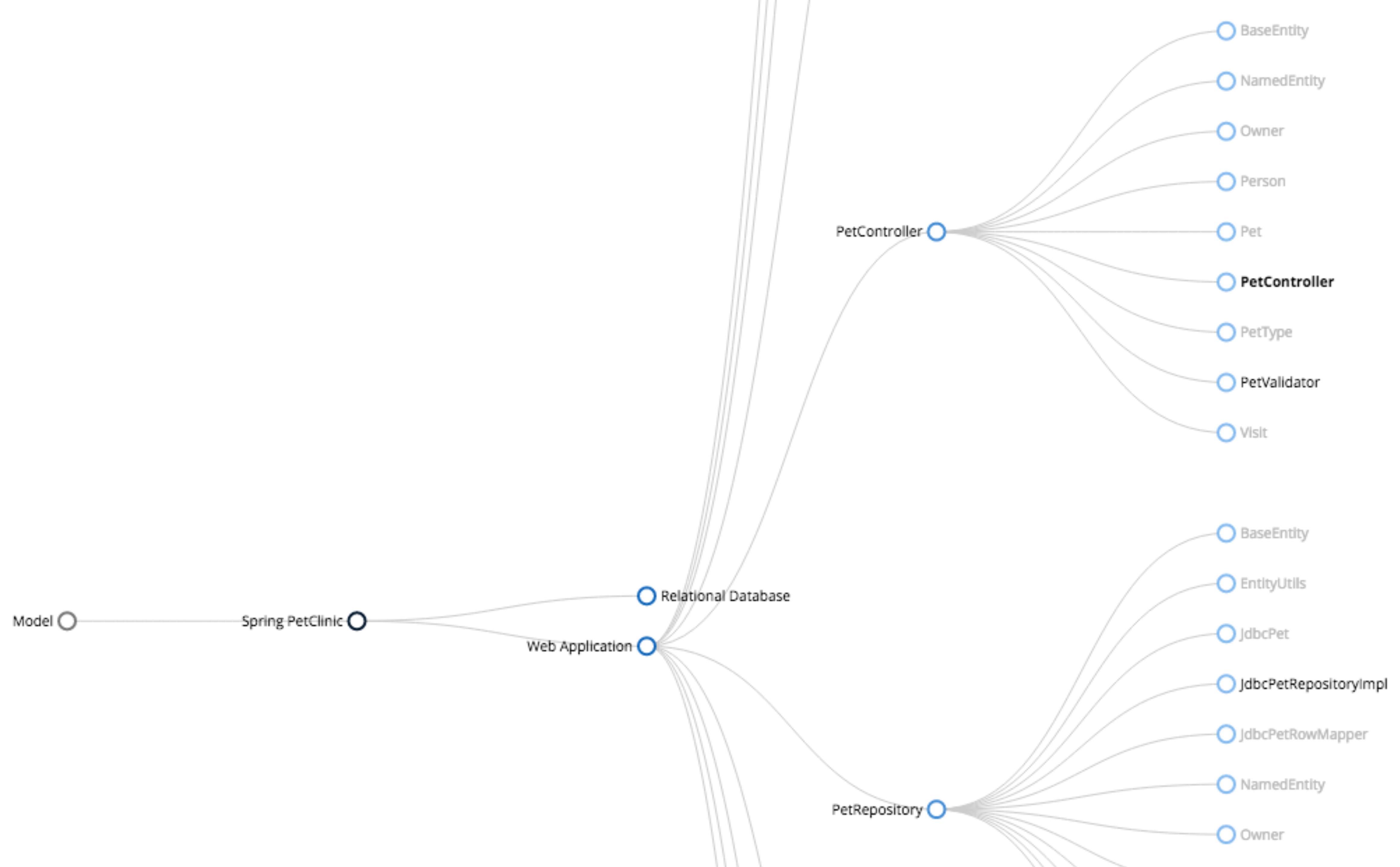
maven

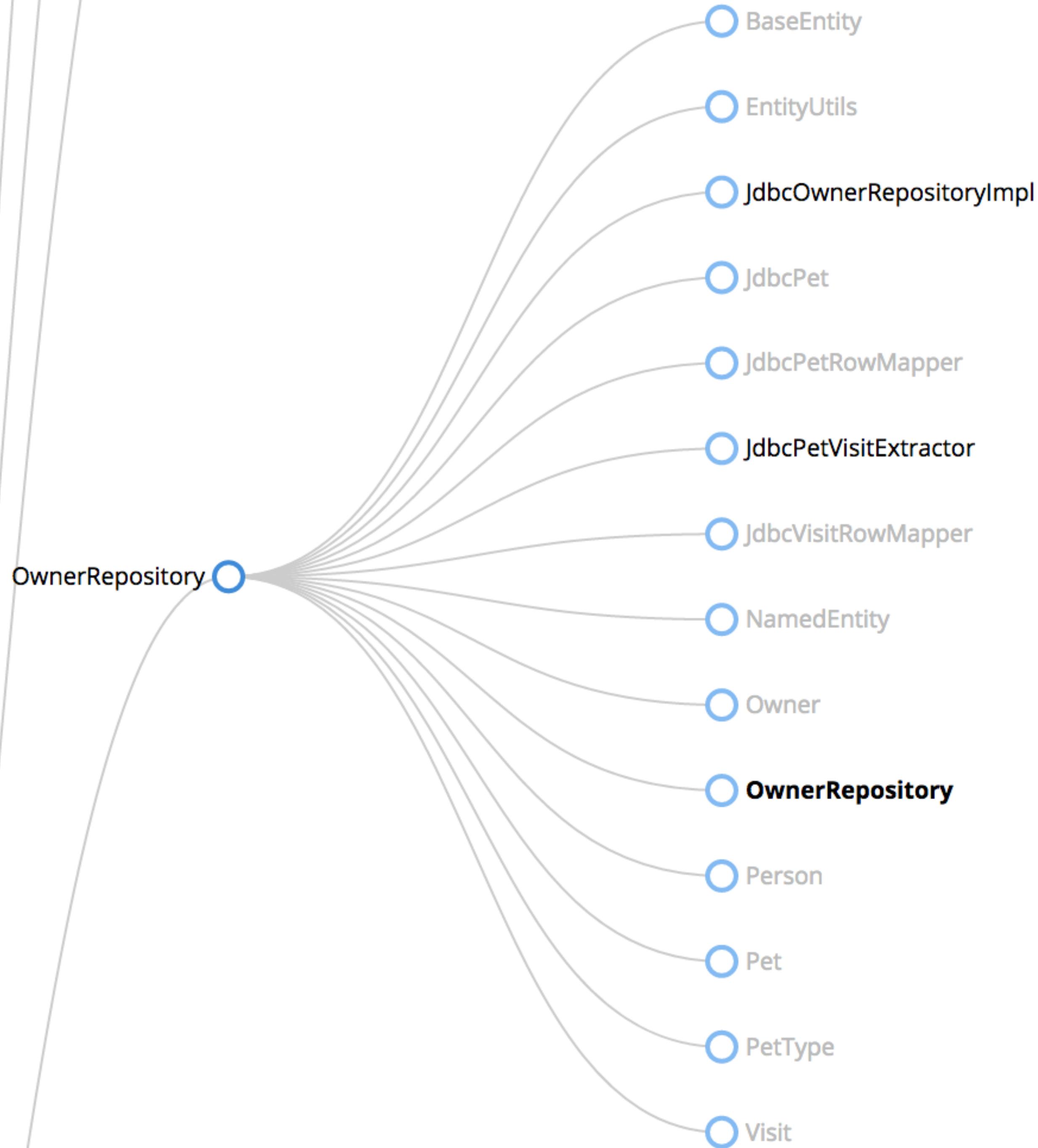


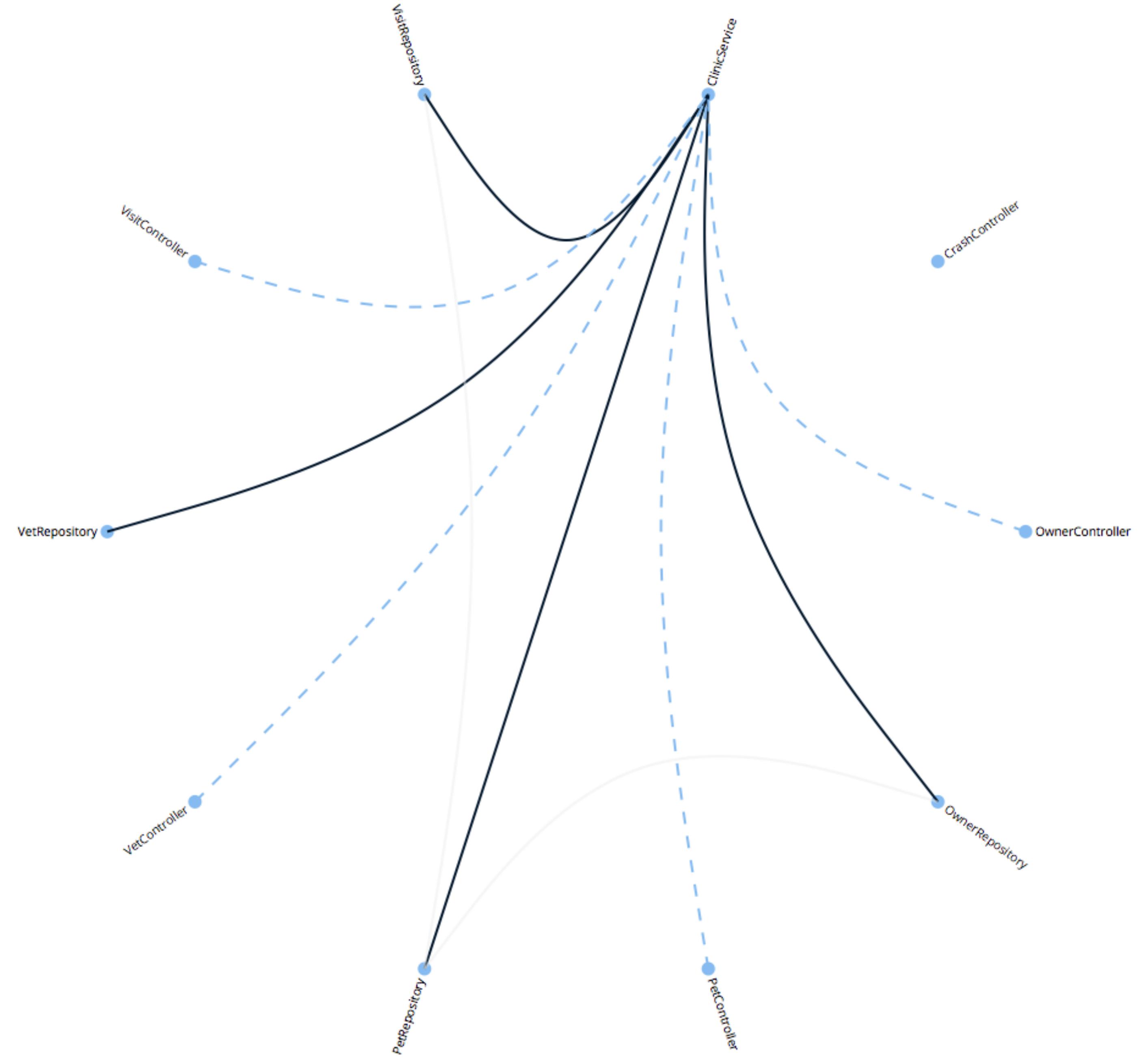
Jenkins

Integration with your
build process keeps
models up to date

Once you have a model
of your software system,
you can **explore** it







VisitRepository
[Component: 789]

OwnerRepository
[Component: 1096]

VisitController
[Component: 765]

PetController
[Component: 856]

CrashController
[Component: 80]

VetRepository
[Component: 486]

VetController
[Component: 744]

ClinicService
[Component: 780]

OwnerRepository
[Code: 64]

Owner
[Code: 153]

Visit
[Code: 123]

JdbcPet
[Code: 48]

BaseEntity
[Code: 47]

NamedEntity
[Code: 48]

PetType
[Code: 29]

JdbcPetRowMapper
[Code: 43]

EntityUtils
[Code: 54]

JdbcVisitRowMapper
[Code: 42]

Person
[Code: 56]

JdbcPetVisitExtractor
[Code: 54]

Summary

The 1990's called and
they want their tools back!

It's 2017 and we shouldn't be using a general purpose
diagramming tool for software architecture

Abstractions first,
notation second

Ensure that your team has a ubiquitous
language to describe software architecture

Thank you!

simon.brown@codingthearchitecture.com

@simonbrown