

Object Oriented Frameworks

Prof. Dr. Dirk Riehle

Friedrich-Alexander University Erlangen-Nürnberg

ADAP C12

Licensed under [CC BY 4.0 International](https://creativecommons.org/licenses/by/4.0/)

Agenda

1. Components
2. Object oriented frameworks
3. Use-client interface
4. Inheritance interface
5. Meta-object protocol
6. Tiers vs. layers

1. Components

Components

- A component is some entity with a defined boundary; it should have
 - High internal cohesion
 - Low external coupling
- Components can be composed from smaller components
 - Atomic components may be files (code) or functions (runtime)
- There are two types of components
 - Code components (source code in directories, compiled binaries)
 - Runtime component (may or may not map on code components)
- Practically, you always take either about code or runtime components
 - Only modeling language designers may care about the more general term
 - Why? Because you are either designing a code architecture or runtime architecture

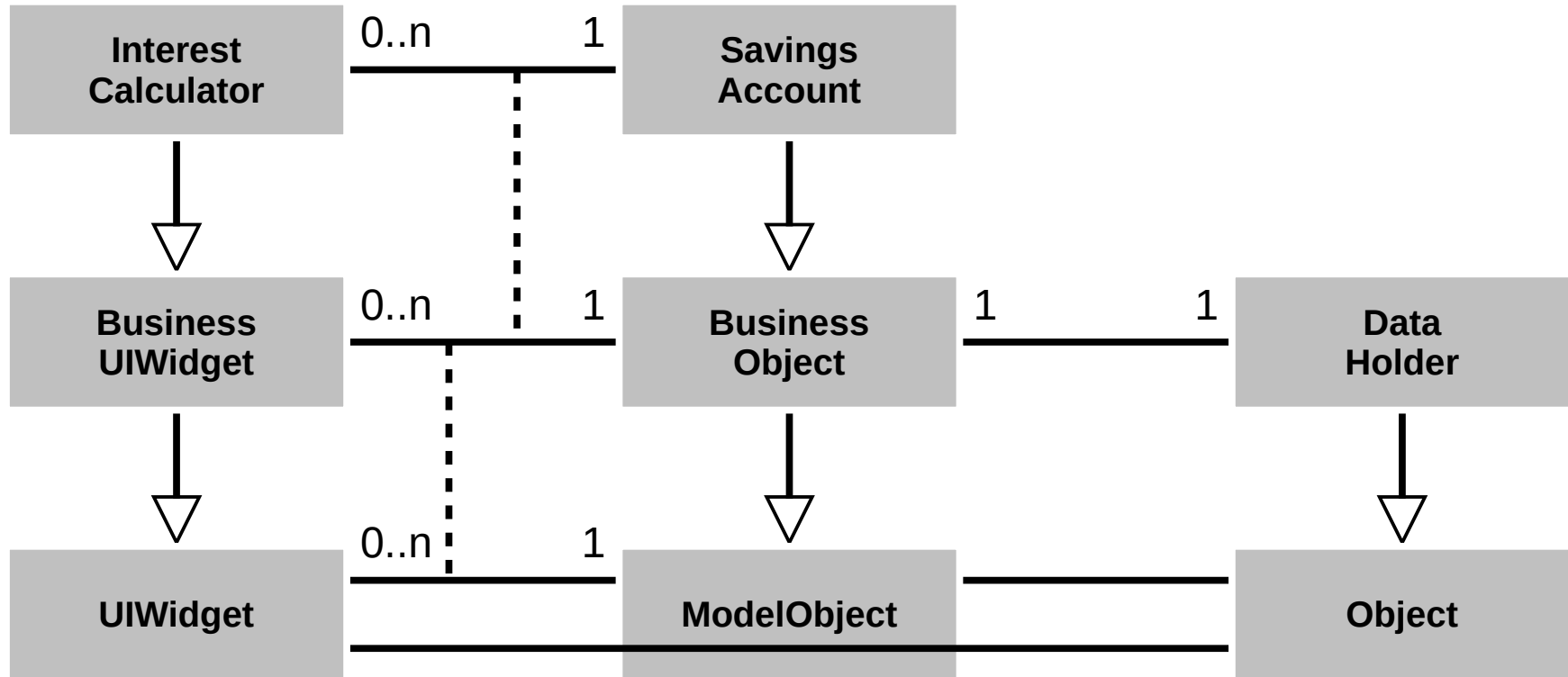
Code Components

- A set of source code files, compiled into a binary or related delivery format
 - With high cohesion and low coupling
- Example delivery formats for code components
 - Java: .class files, jar-files
 - C: .o files, shared libraries
 - Web servers: war files and more
- Source code is usually compiled into one binary, not reused as source code
 - Only (re-used) as the binary as part of a code component architecture
- Code components can be aggregated into larger code components
 - Used to be done mainly for binaries, not source code; is changing

Runtime Components

- One or more runtime entities (objects, data + functions) grouped into an entity
 - With high cohesion and low coupling
- The boundary around the entities often only exists only in an architect's mind
 - May be captured as part of a system model, but gets resolved at runtime
- The boundary around the entities can be made more explicit though
 - Closures
 - Threads or agents
 - Processes
 - Containers
- Runtime components can be composed into larger runtime components

Component Example



- **Libraries [1]**
- **Platforms**
- **Frameworks**

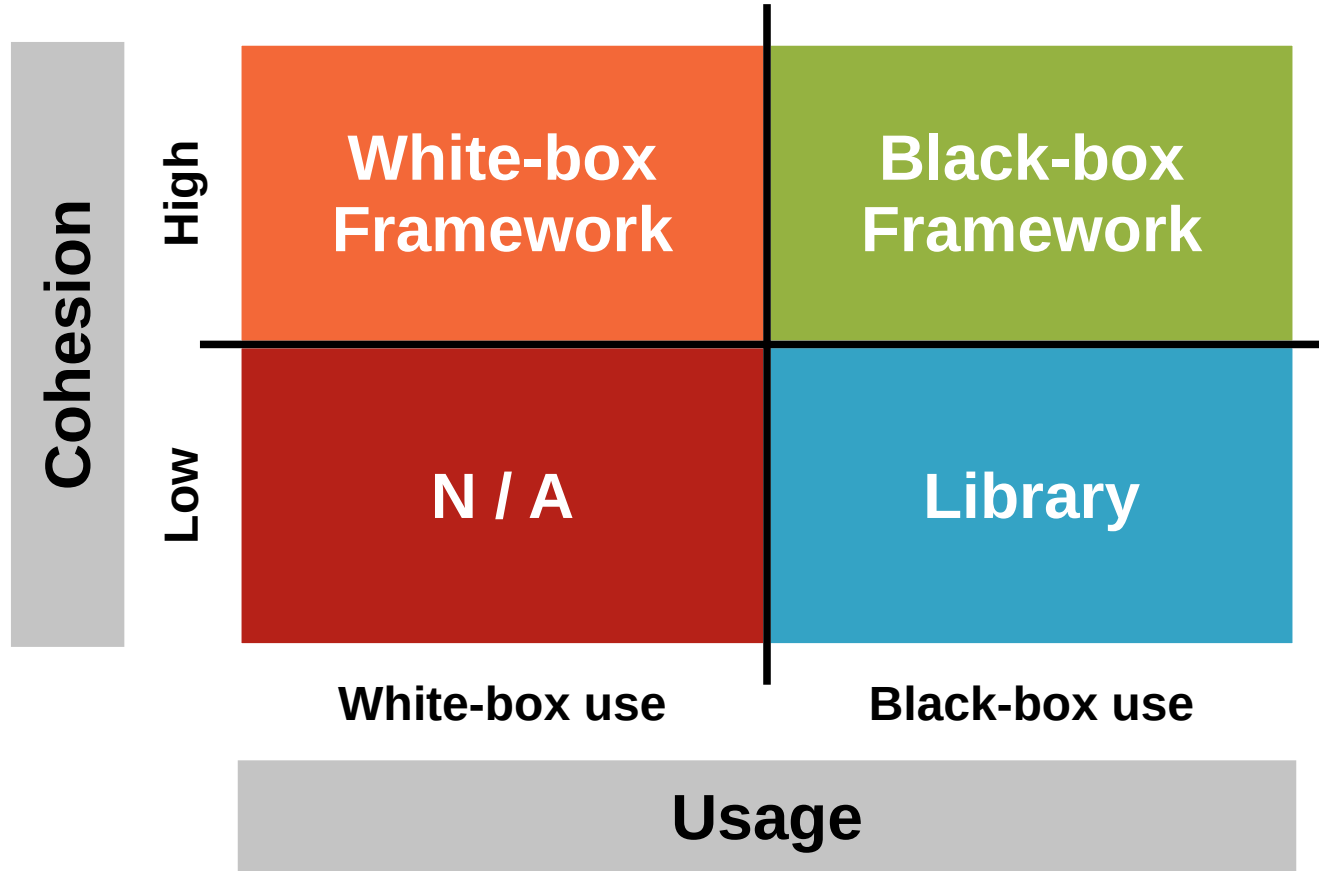
[1] A.k.a. toolkits

2. Object Oriented Frameworks

Object Oriented Framework

- Definition of object oriented framework
 - Is an abstract object oriented design that can be reused
 - Has default implementation classes that can be used
 - Typically covers one particular technical domain
- White-box framework
 - An object oriented framework mostly used by implementing subclasses
 - Requires user to understand internal workings of framework
 - Typically a framework in its early stages
- Black-box framework
 - An object oriented framework mostly used by composing instances
 - Easier to use but may be less flexible than white-box framework
 - Typically a framework in its mature stages

Frameworks vs. Libraries 1 / 2



Frameworks vs. Libraries 2 / 2

- Frameworks

- Provides abstract design
 - High cohesion of classes
 - Inheritance and delegation
 - Inheritance interface
 - More difficult to use than library
- Examples
 - Java Object framework
 - Wahlzeit domain model

- Libraries

- Provides no abstract design
 - Mostly loose class relationships
 - No or little use of inheritance
 - Only use-relationship
 - Easier to use than framework
- Examples
 - Java utility classes
 - Wahlzeit utility classes

- 1. Use-client interface**
- 2. Inheritance interface**
- 3. Meta-object protocol**

3. Use-Client Interface

Use-Client Interface

- The use-client interface is the traditional interface
 - Invoked using method calls by client objects on framework objects
- Best practices of defining use-client interfaces
 - An abstract object oriented design that reflects the domain
 - Using interfaces, abstract classes, and implementation classes
 - Using collaborations spelling out roles and their responsibilities
 - Using exceptions properly to document behavior in case of failure
 - With clear idea of types of objects, for example, value objects
 - With clear idea of patterns employed to structure the design

4. Inheritance Interfaces

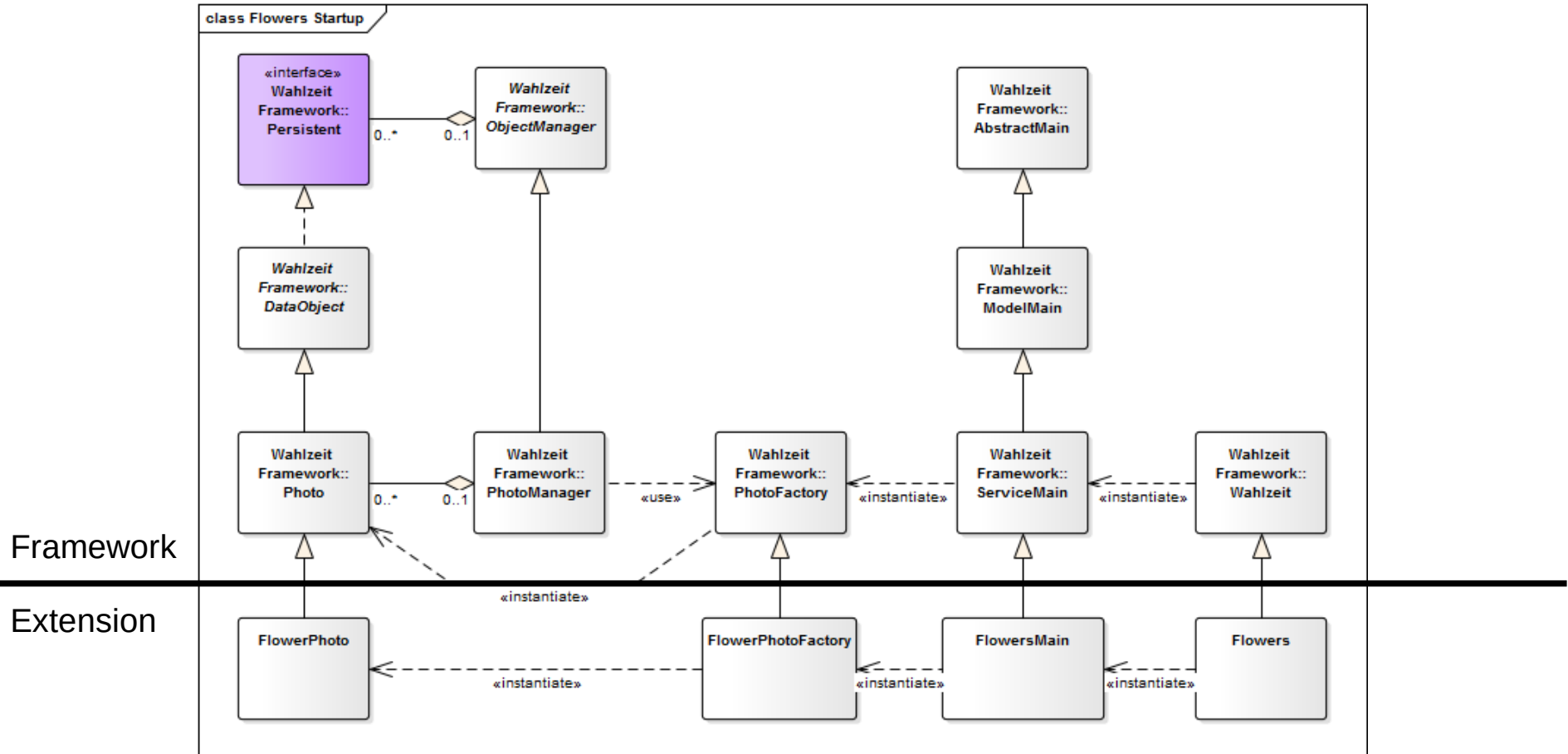
Inheritance Interface

- The inheritance interface uses polymorphism
 - Subclasses extend the design while conforming to it
 - Leads to inverted control-flow, a.k.a. “Hollywood principle”
- Best practices of defining inheritance interfaces
 - An abstract object oriented design that reflects the domain
 - Using the abstract superclass rule
 - Using the narrow inheritance interface principle
 - With clear idea of patterns employed to structure the interface, e.g.
 - Primitive and composed methods
 - Factory method, template, method, etc.
 -
 - Document extension points

Inheritance Interfaces of the Wahlzeit Framework

- Main (startup and shutdown protocol)
- Model (photo, user, and case handling)
- Handlers (user functions and workflows)
- Agents (threaded non-user functions)
- ...

Wahlzeit Framework with Flowers Extension



Main Inheritance Interface

```
public abstract class AbstractMain {
    protected void startUp(String rootDir) throws Exception { ... }
    protected void shutDown() throws Exception { ... }
    ...
}

public abstract class ModelMain extends AbstractMain {
    protected void startUp(String rootDir) throws Exception { ... }
    protected void shutDown() throws Exception { ... }
    ...
}

public class ServiceMain extends ModelMain {
    public void startUp(boolean inProduction, String rootDir) throws Exception { ... }
    public void shutDown() throws Exception { ... }
    ...
}

public abstract class ScriptMain extends ModelMain {
    public void run() { ... }
    ...
}
```

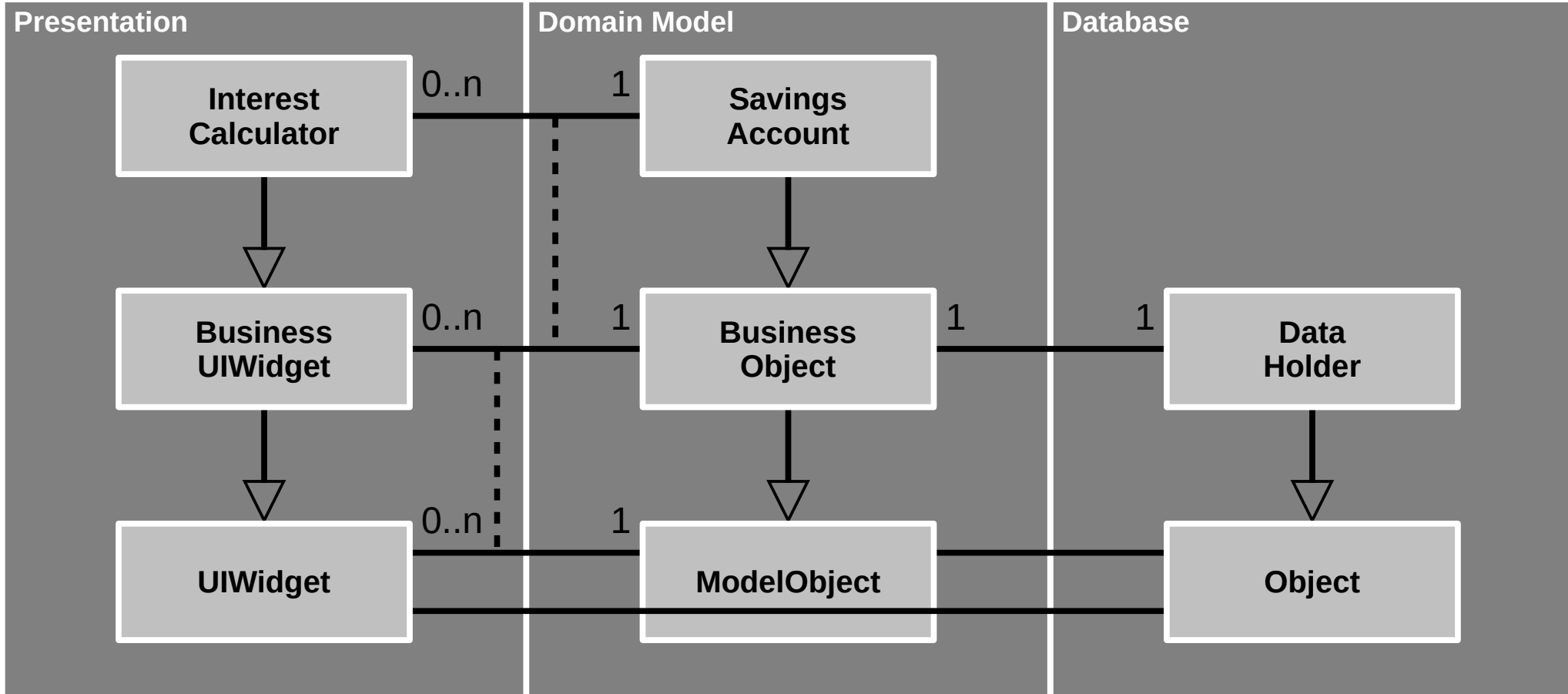
5. Meta-Object Protocol

Meta-Object Protocol

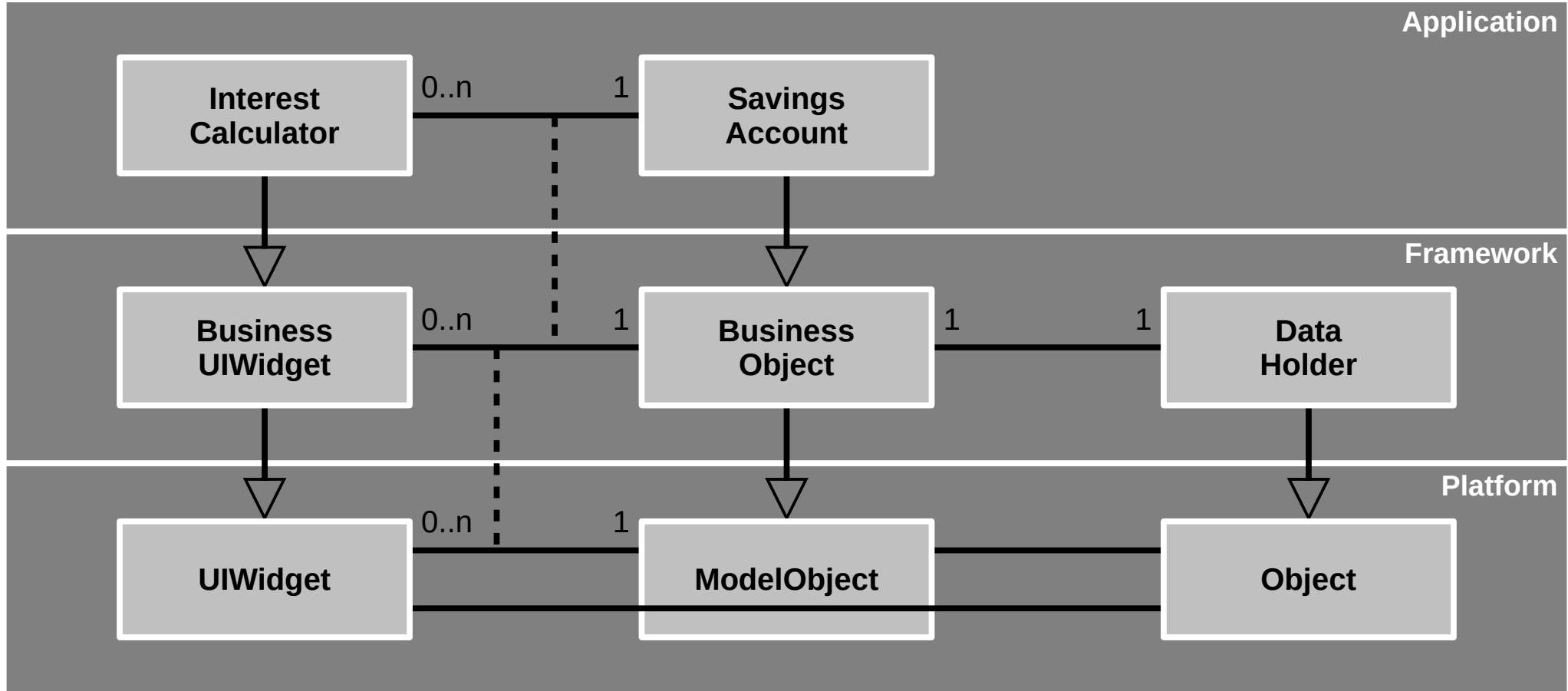
- Java annotations

6. Tiers vs. Layers

Tiers of Runtime Components



Layers of Code Components



Tiers vs. Layers (Riehle's Definition)

- Tiers and layers are both stacking mechanisms
 - Higher-level stack elements can only call / depend on lower-level elements
 - Explicit calls go from higher tier to lower element, never the other way
 - Control flow returns to higher element implicitly after a method call ends
 - Strict stacking allows only for dependencies on the next lower level
- Tiers are stacks of runtime components (object aggregations)
 - There can be multiple runtime components in one tier
 - Higher tiers use callbacks to receive control flow from lower tiers
 - Tiers are usually drawn left-to-right
- Layers are stacks of code components (class aggregations)
 - There can be multiple code components in one layer
 - Higher layers use inheritance to receive control flow from lower layers
 - Layers are usually drawn top-to-bottom
- Sadly, little industry agreement about these definitions

Review / Summary of Session

1. Components
2. Object oriented frameworks
3. Use-client interface
4. Inheritance interface
5. Meta-object protocol
6. Tiers vs. layers

Thank you! Questions?

dirk.riehle@fau.de – <https://oss.cs.fau.de>

dirk@riehle.org – <https://dirkriehle.com> – [@dirkriehle](#)

Legal Notices

- License
 - Licensed under the [CC BY 4.0 International](#) License
- Copyright
 - © 2012-2021 Dirk Riehle, some rights reserved