The ISO/IEC/IEEE 42010:2011 standard

System and Software engineering - Architecture Description

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17 settembre 2018

Introduction

Introduction

Generals

- The IEEE 42010 standard is an international standard for architecture description of *systems* and *software*
- It addresses the creation, analysis and sustainment of architectures through the use of *architecture description*
- It is an evolution of the IEEE 1471:2000 standard. The main concepts are generalized, each one with a specific, non-ambiguous name, to address a huge variety of systems

Introduction

What does the standard do?

The standard establish and specifies the following concepts:

- A conceptual model of the architecture description
- The required contents of an architecture description
- Architecture viewpoints, frameworks and description languages are introduced and the contents of these are specified
- It also provides motivation and background for *key concepts* and *terminology* of the standard

The ISO/IEC/IEEE 42010:2011 standard consists of several parts, each one addressing diffe-
rent issues about the definition of a system and the description of its architecture.

These parts define a standard set of terms used to define architecture descriptions, guidelines for the metamodel that has to be done and a set of "best practices" for the description and the requirement definition of the system.

We will focus on the first two parts of the standard, which are of uttermost interest for our job.

Conceptual Model

- The *conceptual model* of architecture descriptions (also called "metamodel") define the set of terms, their definitions and the relations among them. These are then used in expressing the requirements of the system

Architecture Description

- The standard formally defines *architecture descriptions* and specifies the requirements the architecture descriptions have to meet in order to satisfy the standard. However, it does not define what *form* has to be used to provide the description (i.e. it can be a document, a repository, a wiki...)

Architecture Viewpoints

- At the core of the standard there is the idea of *architecture viewpoints*. A viewpoint is a way of looking at the architecture of a system. Viewpoints are strongly related with the level of detail required to model a certain view (e.g. cyber-physical, informative, service level)

Architecture Frameworks and ADLs

- The last section of the standard specifies *best practices* for *architecture frameworks*.
  The focus is on the specification of the best practices for documenting the architecture of a system. As we know, documentation has to be used for the *whole* lifetime of a system (starting from its design to its implementation).
  The principles used with architecture frameworks can be used in a similar manner with ADLs (Architecture Description Languages)

Conformance to ISO/IEC/IEEE 42010:2011

In the previous section we had an overview of the standard, what is its focus and what are main parts it consists of.

In this section we will have a deeper look at the definition of the conceptual model and some of the requirements an architecture has to meet in order to conform to the standard, that is: an explanation of what is an *Architecture Description* along with the requirements it has to meet and what is the role of the conceptual model.

If there is enough time we will also have a brief look at architecture viewpoints and why they are so important for the standard.

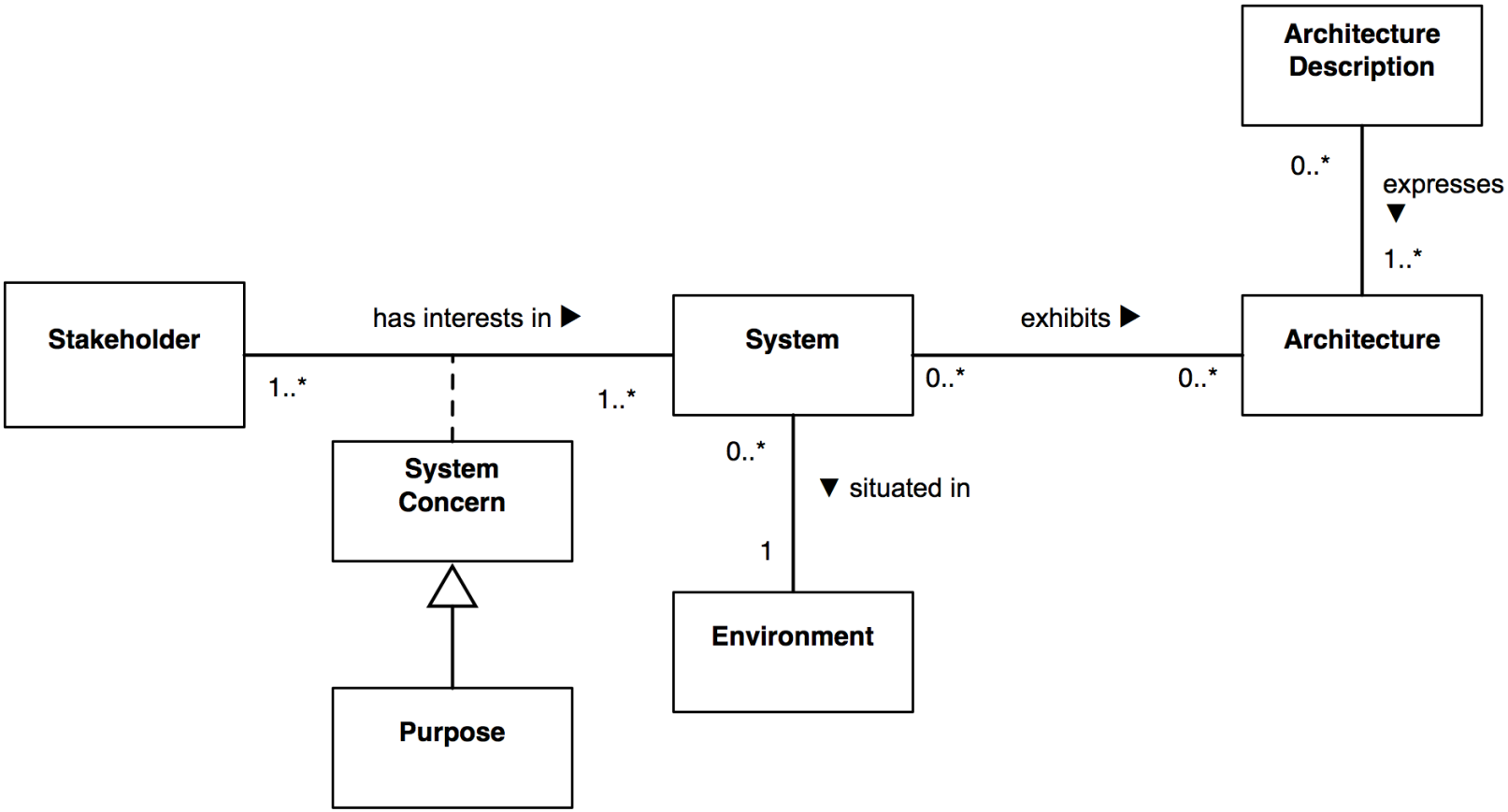
Conceptual Model

- The standard itself is based upon a conceptual model of the terms and concepts pertaining to *Architecture Description*
- This metamodel guides the system (or software) designer in the process of creating an Architecture Description
- It is divided in different section, each addressing different problems and/or perspectives of the architecture
  1. Context
  2. Core of Architecture Description
  3. AD Elements and Correspondences
  4. Architecture Decisions and Rationale
  5. Architecture Frameworks and ADLs

Conceptual Model Overview

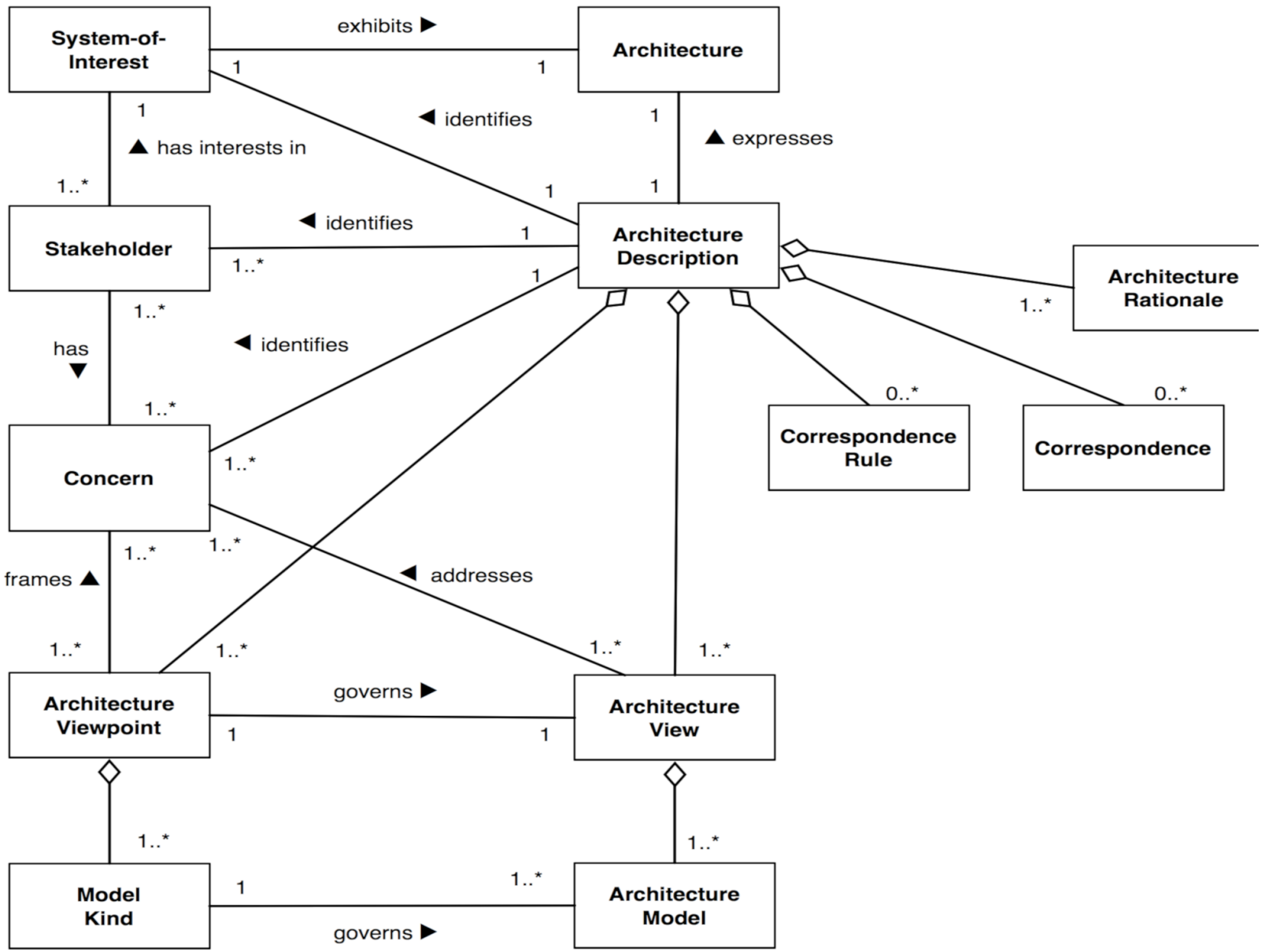
- The "Context" diagram captures terms and concepts of systems and their architectures. These are used as a *Context* for understanding Architecture Description
- The standard is organized around terms and concepts introduced in the Architecture Description diagram. This diagram depicts the contents of an AD and the relations among those items to produce an *Architecture Description* to express an *Architecture* for the *System of Interest*
- ADs are comprised of *AD elements*. *Corrispondences* and *Corrispondence Rules* capture and express relathionships between these elements
- *Architecture Decisions* and *Rationales* are used to keep a trace of architecture decisions made during the design of the architecture (such as conventions, technologies involved, design decisions)
- *Architecture Frameworks* and *ADLs* can be easily specified by building on the concepts of *Architecture Description*

CONTEXT


Architecture Description
0..*
expresses
1..*
Stakeholder
has interests in
1..*
1..*
System
exhibits
0..*
0..*
Architecture
System Concern
0..*
situated in
1
Environment
Purpose

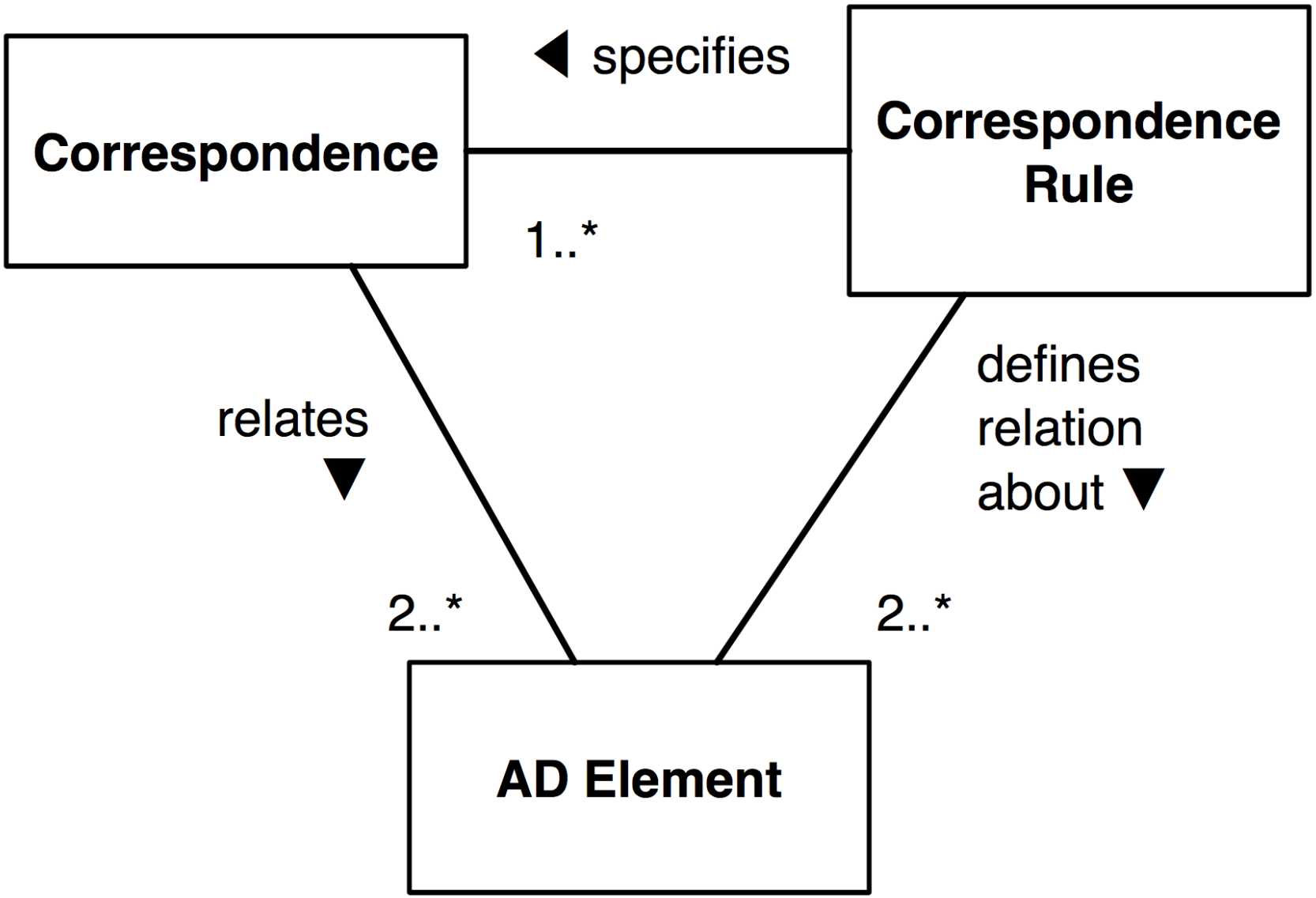
- The diagram assumes that a system exists, it is situated in an *Environment* that could include other systems.
- The standard does not make any assumption on the kind of the system. This means it can be either a system, a SoS, Physical system (man-made or natural)...
- Stakeholders have interests in a System. These interests are called *Concerns*. A system's *Purpose* is a Concern that is common to (possibly) all the Stakeholders.
- A system inhabits its *Environment*. The system influences the Environment and vice versa. The Environment of a system determines all the influences upon the system. These influences are categorized as Concerns.
- In the standard, the *architecture* of a system has a formal definition, that is: "fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution".
- An *Architecture Description* is an artifact that expresses the system's architecture.

ARCHITECTURE DESCRIPTION


System-of-Interest
exhibits
Architecture
identifies
has interests in
expresses
Stakeholder
identifies
Architecture Description
Architecture Rationale
has
identifies
Concern
Correspondence Rule
Correspondence
frames
addresses
Architecture Viewpoint
governs
Architecture View
Model Kind
governs
Architecture Model

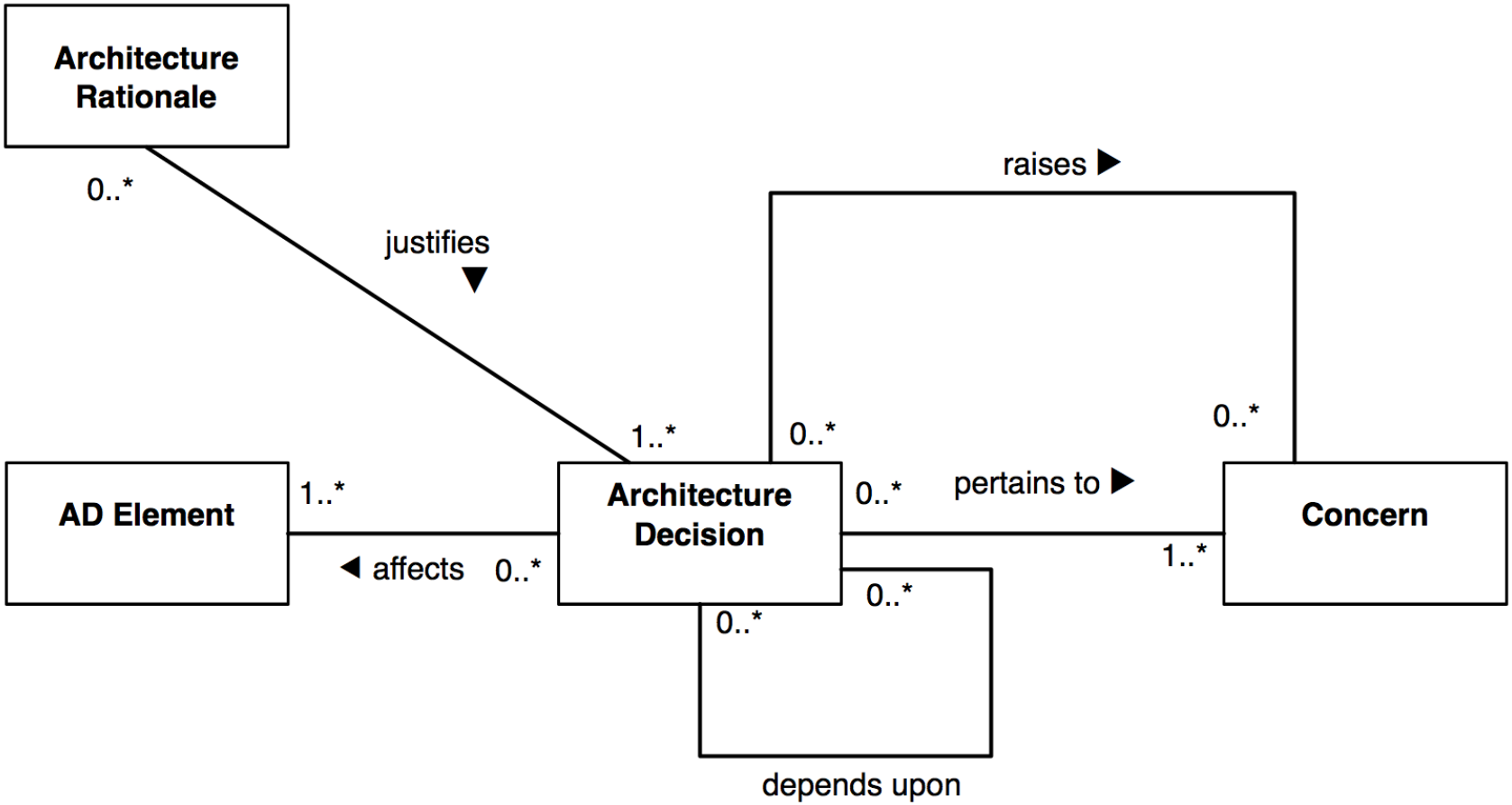
- An *Architecture Description* is used to express the Architecture of some System of Interest. The AD describes one possible Architecture for the System of Interest whose requirements are specified by the standard.
- *Stakeholders* are individuals, groups or organizations holding Concerns for the System (e.g. client, owner, consumer, designer...)
- A *Concern* is **any interest** in the system (i.e. system purpose, functionality, structure, behaviour, *safety*...)
- An *Architecture Viewpoint* is a set of conventions for constructing, using and analyzing **one** type of Architecture View and it includes Model kinds, notations, modeling methods and analytic techniques to frame a *specific set of Concerns*. Examples of Viewpoints are: operational, technical, logical, information...
- An *Architecture View* in an AD expresses the Architecture of the System from the perspective of the Stakeholders to address specific Concerns and it consists of one or more Architecture Models
- *Architecture Models* are constructed in accordance with the conventions established in their Model Kind. Models provide means for sharing details among different views
- A *Model Kind* defines the conventions for **one** type of Architecture Model

ARCHITECTURE DESCRIPTION ELEMENTS AND CORRESPONDENCES


Correspondence
specifies
Correspondence Rule
1..*
relates
defines relation about
2..*
2..*
AD Element

- Any item in an AD is considered an *AD Element*. Stakeholders, Concerns, Viewpoints etc. are all AD Elements, as well as constructs introduced by Viewpoints or Model Kinds
- *Correspondences* express relations between AD Elements. They can also describe relations between two different ADs
- *Correspondence Rules* are used to govern Correspondences

ARCHITECTURE DECISIONS AND RATIONALE


Architecture Rationale
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justifies
raises
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0..*
AD Element
1..*
Architecture Decision
0..*
pertains to
Concern
affects
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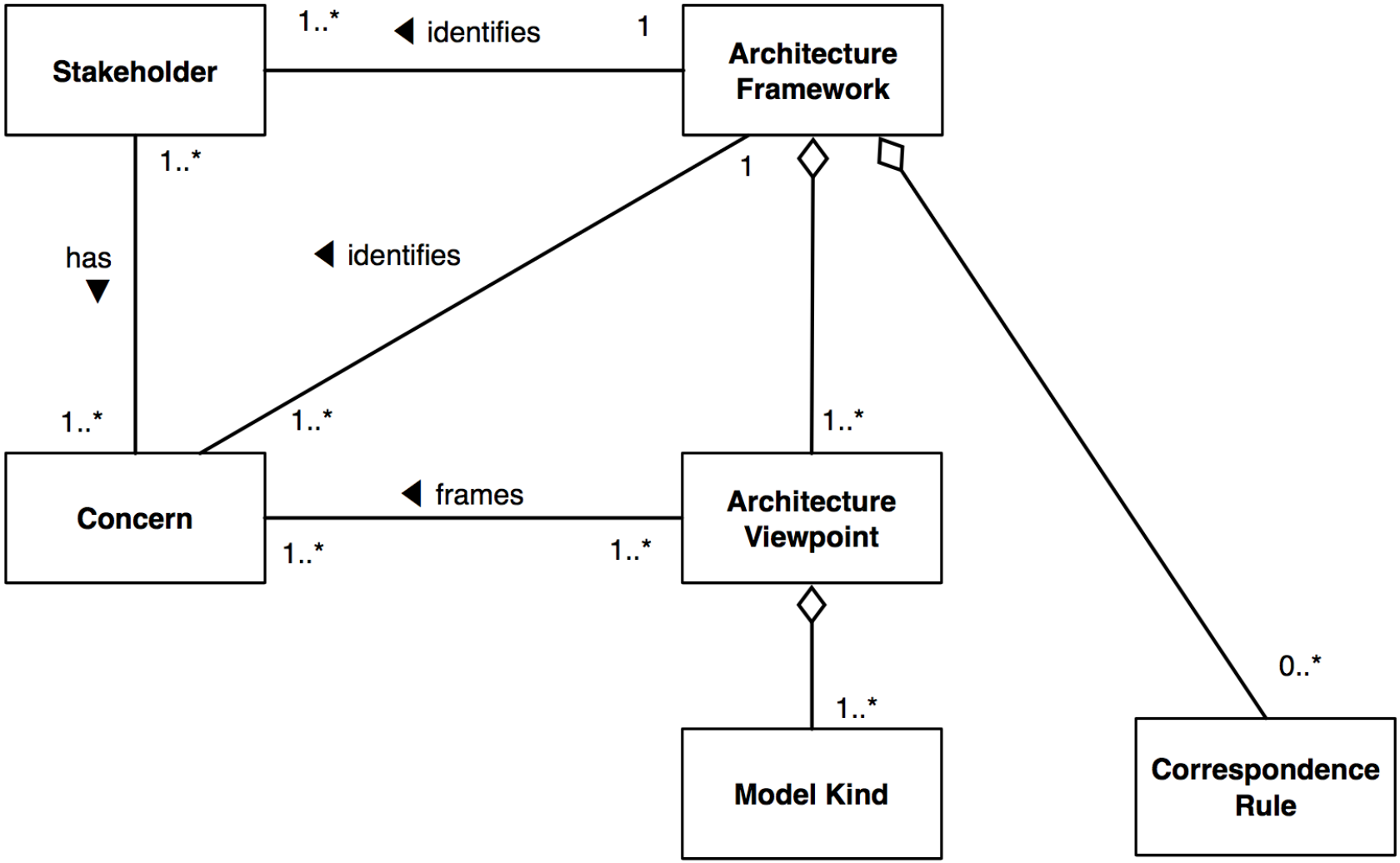
depends upon

- *Architecture Decisions* affects AD Elements and pertains to one or more Concerns. Architecture Decisions could raise new Concerns.

- *Architecture Rationale* is used to record explanation, justification or reasoning about Architecture Decisions and/or architectural alternatives not chosen

ARCHITECTURE FRAMEWORKS AND ADLs


Stakeholder
1..*
identifies
1
Architecture Framework
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has
identifies
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Concern
frames
Architecture Viewpoint
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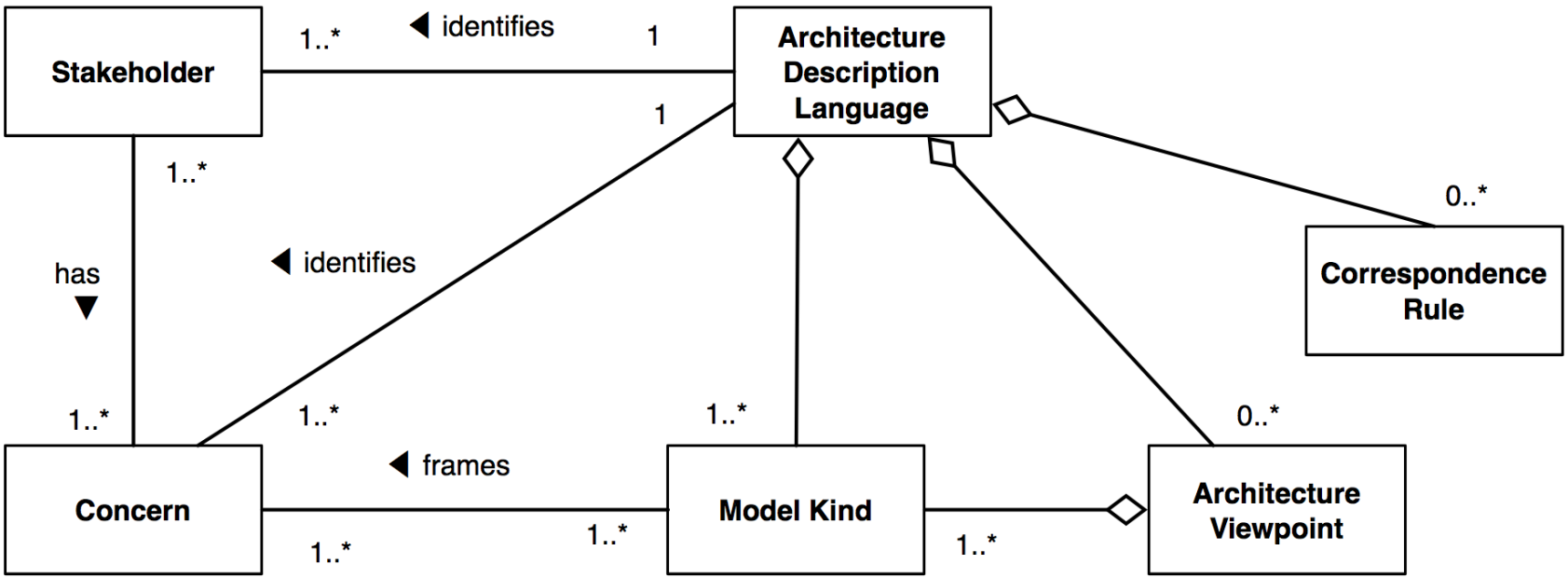
Model Kind
Correspondence Rule


Stakeholder
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identifies
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Architecture Description Language
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has
identifies
Correspondence Rule
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0..*
frames
Concern
Model Kind
Architecture Viewpoint
1..*
1..*
1..*

ARCHITECTURE DESCRIPTION AND VIEWPOINTS

At this point, we had an overview of the standard, along with its main concepts and
the established Conceptual Model used to guide us in the creation of the System.

Even if it is not in the scope of this presentation, it's useful to have a quick look at how the standard defines *Architecture Descriptions* and *Architecture Viewpoints* that are at the core of it.

In this section we will see the process for preparing an AD and how the Architecture Viewpoints are determined.

Architecture Description

- An Architecture Description identifies the System-of-interest and expresses its Architecture
- The central part of the standard describes the best practices for creating an AD
- It is a list of 24 requirements ("shalls")
- An AD *conforms* to the Standard if it satisfies all the requirements
- The Standard does not make any assumption on what kind of System we are going to describe, nor the *form* of the description
- The Standard gives Templates in order to facilitate the process of creation of the AD

Taken together, the list of requirements expressed by the Standard gives us a process for creating the AD:

Architecture Description Process

1. Identification of the relevant Stakeholders and record them in the AD
2. Identification of the Architecture Concerns of each Stakeholder:
   - Purposes of the System
   - Suitability of the Architecture for achieving System's purposes
   - Feasibility of constructing the System
   - Potential risks and impacts of the System to its Stakeholders, throughout the whole life-cycle
   - Maintainability and Evolvability of the System
3. Choose one (or more) Architecture Viewpoints for expressing the Architecture such that *each* Concern is *framed* by at least one Viewpoint
4. Record those Viewpoints in the AD and provide a *Rationale* for each choice of Viewpoint

Architecture Description Process

5. Document each Viewpoint with a *Viewpoint Definition*. Each Viewpoint Definition links the Stakeholders and Concerns to the kinds of notation and model to be used
6. Create Architecture Views of the System, for each chosen Viewpoint, following the conventions of its Viewpoint. Views must include:
   - One, or more, models
   - Identifying informations
7. Document correspondences between Views and Model Elements, guarantee consistency across views, record inconsistencies
8. Record the AD Rationales for architecture decisions and *give evidence of the consideration of multiple architectures*

We understand that ADs are characterized by the differents Viewpoints we can choose to describe it.

But how are Viewpoints determined? The Standard gives us a guideline for this too:

Determining Viewpoints

An Architecture Viewpoint is determined by:

- One or more concerns
- Stakeholders interested in those concerns (which constitute a potential audience for views resulting from this viewpoint)
- One or more Model Kinds
- For each Model Kind, the conventions, such as: languages, notations, modelling and analytical techniques...

- The ISO/IEC/IEEE 42010:2011 standard sets its focus on documenting an Architecture
- It is also useful to address **every** aspect of interest in the System to be made
- The standard does not make any assumption on what kind of System we are about to document, keeping its definition the most general it can, allowing to describe any kind of system (either physical or cyber)
- In this way we are able to observe every aspect of the System we have to study, to maintain a trace of design choices and it helps us to address every element that could have an impact on it

THANKS FOR YOUR ATTENTION

References

- http://www.iso-architecture.org/ieee-1471/getting-started.html
- http://www.iso-architecture.org/ieee-1471/cm/
- http://www.iso-architecture.org/ieee-1471/ads/
- https://en.wikipedia.org/wiki/ISO/IEC_42010