Chap 1. Introduction to Software Architecture

1. Introduction
2. IEEE Recommended Practice for Architecture Modeling
3. Architecture Description Language: the UML
4. The Rational Unified Process (RUP)

1. Introduction

Preamble

*"Conventional wisdom has been to use terms like **'software architecture'**, 'software architectural design', or 'coarse-grained design' for the high-level structural subdivision of a system, and 'design' or 'detailed design' for more detailed planning… we denote the whole activity of constructing a software system as '**software design**' and the resulting artifacts as 'software architecture'."*

"Many developers nowadays prefer the term 'software architecture' to 'software design' for denoting all the artifacts that result from design activities."

*"In doing so, they want to express the fact that they do not just decompose the functionality of a system into a set of cooperating components, but rather that they **construct** a software architecture… They no longer agree that high-level design decisions can be made independently of lower-level decisions."*

From "Pattern-Oriented Software Architecture, A System of Patterns"
By F. Buschmann, R. Meunier, H. Rohnert, P. Sommerlad, M. Stal

Software Architecture as a Design Plan

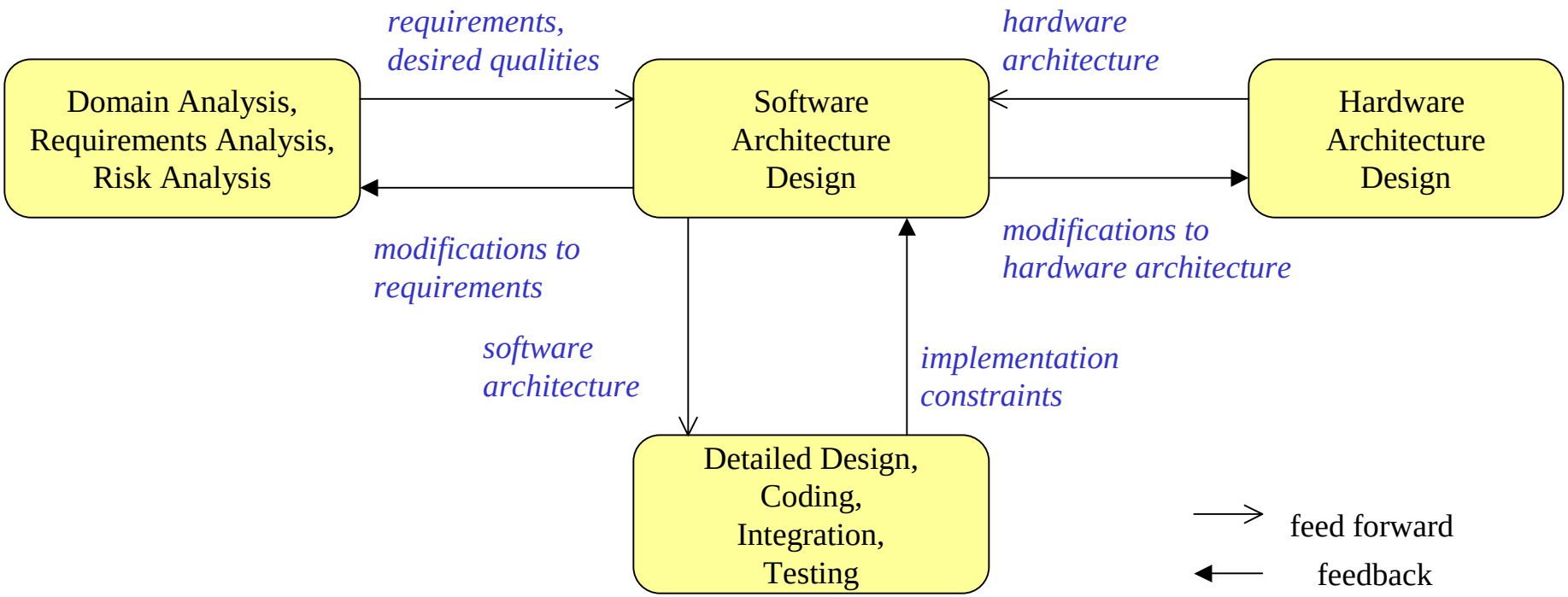
- Software architecture provides a ***design plan***, a blueprint of a system, an ***abstraction*** to help manage the complexity of a system, and also a communication medium between stakeholders.

- Critical factor for a product's success: good software architecture that is understood by the ***stakeholders*** and by the ***developers***.

- Structural plan that describes the elements of the system, how they fit together, and how they work together to fulfill the system's requirements.

  - Used to negotiate system requirements, and to set expectations with customers, marketing and management personnel.
  - Used as a blueprint during the development process
  - Guides the implementation tasks, including detailed design, coding, integration, and testing.

☞Comes after the domain analysis, requirements analysis, and risk analysis, and before detailed design, coding, integration and testing.



☞Key inputs to software architecture design:

- The requirements produced by the analysis tasks
- The hardware architecture (the software architect in turn provides requirements to the system architect, who configures the hardware architecture)

2. IEEE Recommended Practice

☞Unfortunately, software architecture is still an emerging discipline within software engineering; ***limitations***:

- lack of standardized ways to represent architecture
- lack of analysis methods to predict whether an architecture will result in an implementation that meets the requirements.

☞So far, the most advanced efforts towards the development of a standard have been made by the *IEEE Working Group on Software Architecture*, giving rise to the *IEEE Recommended Practice for Software Architecture Development*.

☞The *IEEE Recommended practice for Software Architecture Development:*

÷Define a conceptual framework for architecture development.

÷Goal: evolve into a standard

Conceptual Framework

-Every system has an inherent ***architecture***.

÷The concrete document that is associated with the architecture actually provides a specific description of the architecture, also referred to as an architectural description (AD).

-An ***architectural description*** consists of a collection of ***views***:

÷each view describes one or more concerns involved in the system.

-A ***viewpoint*** defines the modeling and analysis techniques and conventions used to create a view that describes the concerns addressed by the viewpoint.

÷Viewpoint definitions may be provided either as starting point of the AD or by reusing existing viewpoints also referred to as ***library viewpoints***.

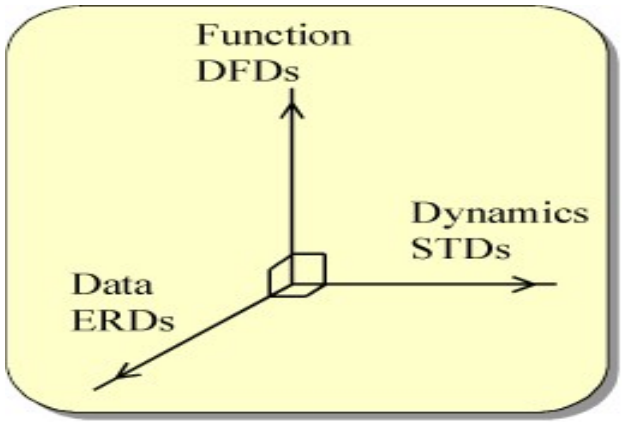
÷A view may be associated to exactly one viewpoint within the same AD, and consists of one or more ***architectural models***.

-Every ***stakeholder's*** concerns must be addressed by at least one viewpoint

÷Viewpoints may be overlapping, in which case potential inconsistencies must be analyzed and recorded.

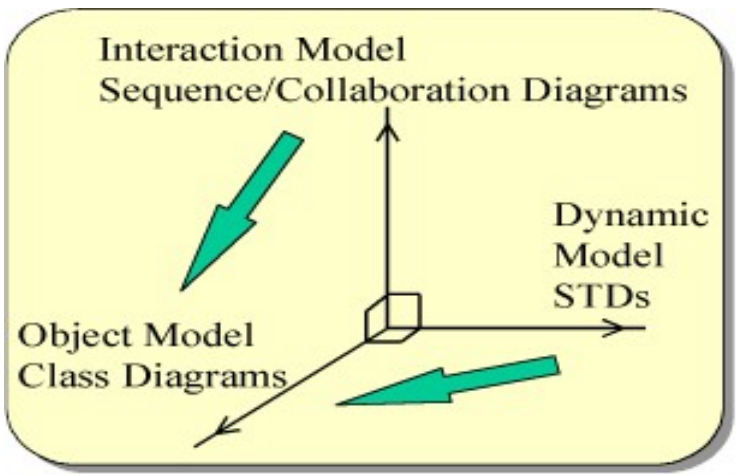
Examples:

÷*Viewpoints and Views in Structured Analysis (SA)*

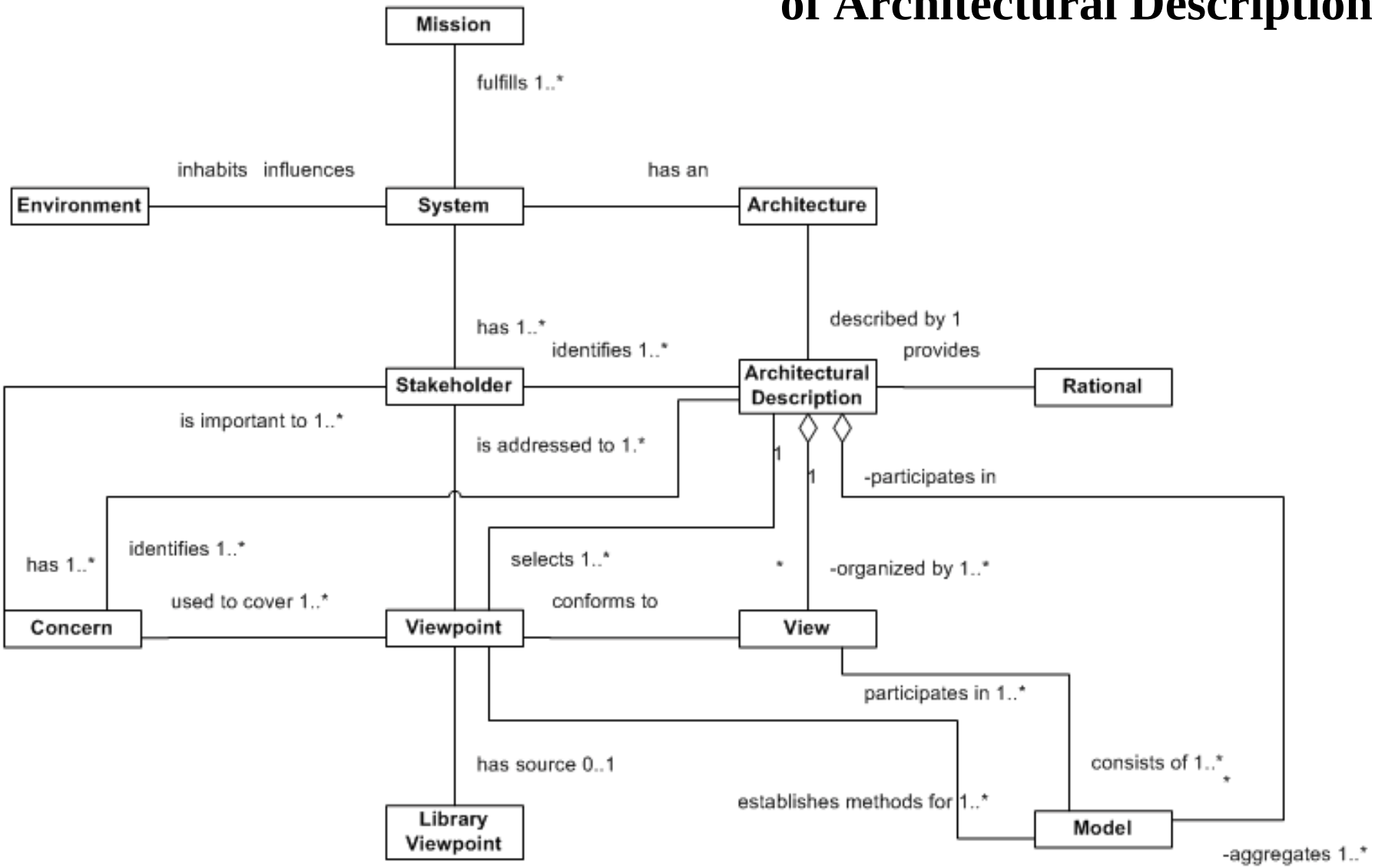


Note:
-DFD: Data Flow Diagram
-ERD: Entity-Relation Diagram
-STD: State Transition Diagram

÷*Viewpoints and Views in Object-Oriented Analysis (OOA)*



Conceptual Model of Architectural Description



Conformance

An architecture description that conforms to the IEEE guidelines encompasses at least ***six*** different kinds of information:

-***Architectural documentation***

÷provides reference and overview information about the AD: version number, issue date, issuing organization, summary, scope and context of the AD etc.

-***Identification of system stakeholders*** and their concerns.

-***Specification of the viewpoints*** selected to represent the AD and the motivation for the choice of these viewpoints.

-***Architectural views*** derived from the viewpoints. A view is associated to exactly one viewpoint, to which it must conform.

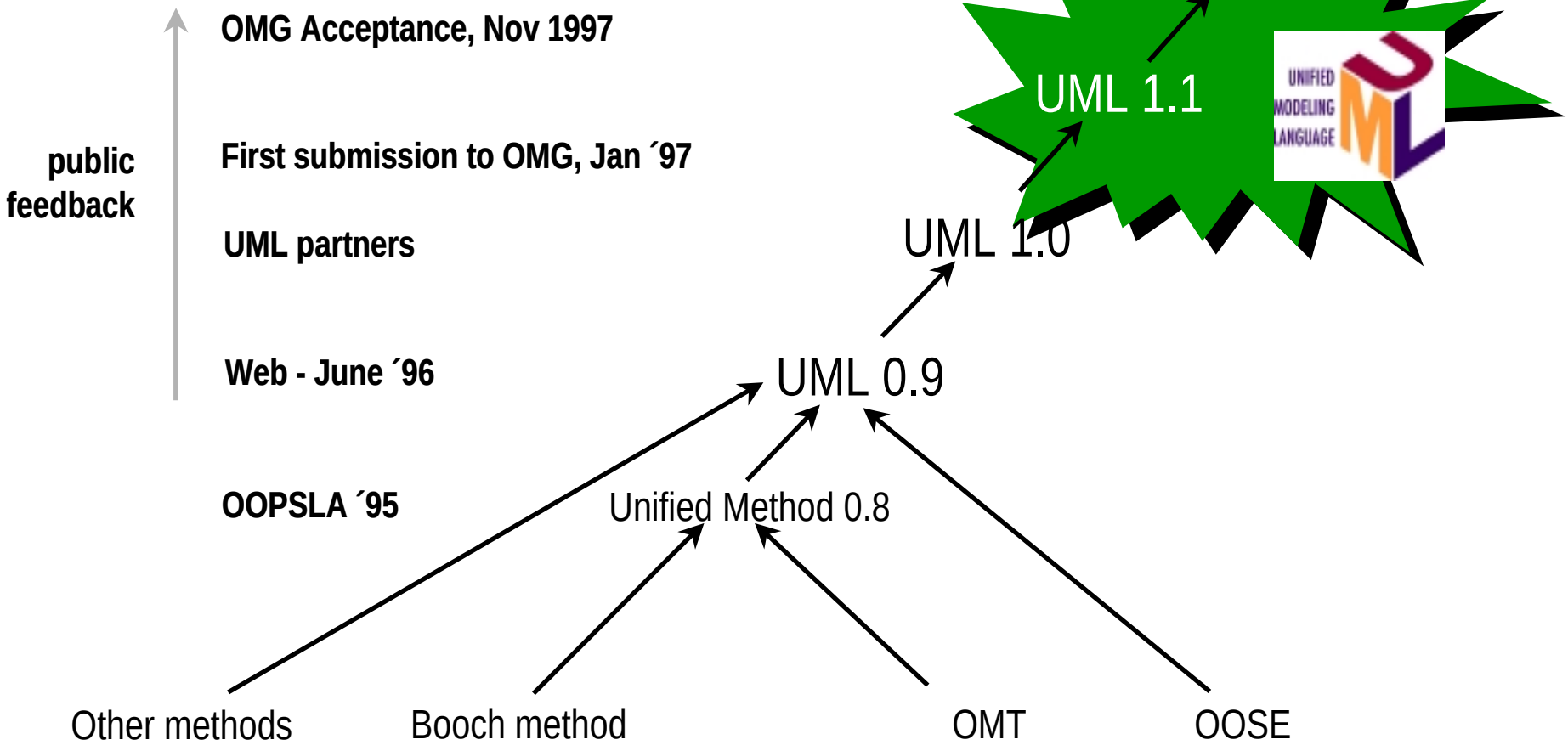
-***Potential inconsistencies*** among the views and the underlying models must be analyzed, recorded and if necessary resolved.

-***The rationale*** behind the architectural concepts selected.

3. Architect. Description Language: the UML

-**The UML** is a language for ***visualizing***, ***specifying***, ***constructing*** and ***documenting*** the artifacts of a software-intensive system.

-**Creating the UML**



Views, Models, and Diagrams

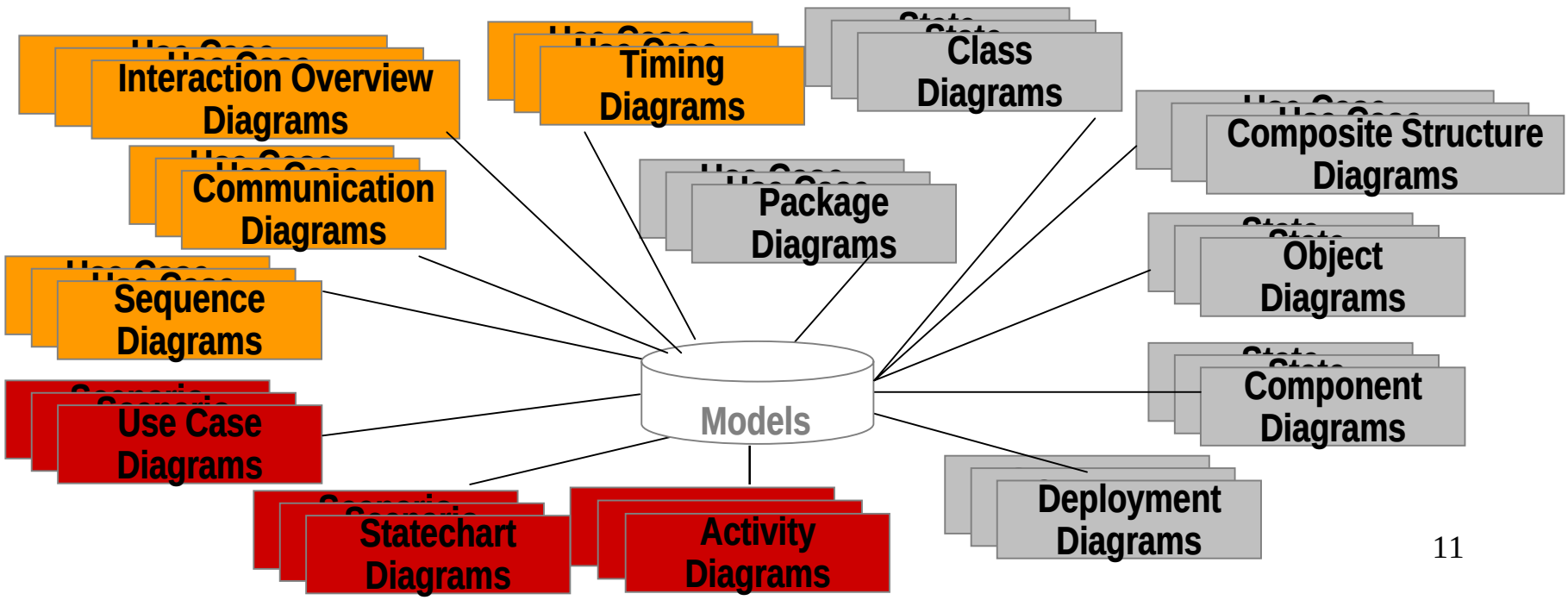
-A diagram is a model in a view; a view consists of one or more models

-A view is an instance of a viewpoint for a particular system:

- •presented from the aspect of particular stakeholders
- •provides a partial representation of the system
- •is semantically consistent with other views

-In the UML, there are ***thirteen standard diagrams***:

- •**Structure diagrams**: class, object, component, deployment, composite structure, package diagrams
- •**Behavior diagrams:** activity, state machine, use case, and interaction diagrams
  - **Interaction diagrams**: sequence, communication, interaction overview, and timing diagrams



4. The Rational Unified Process (RUP)

Process

-Software engineering process:

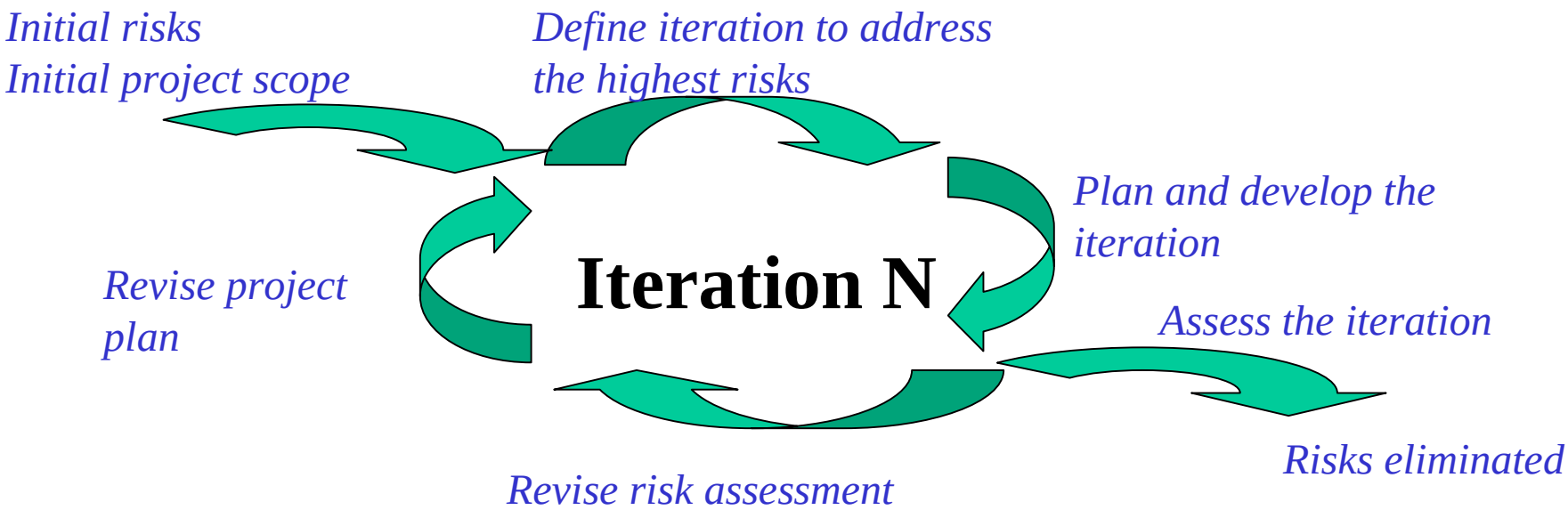
- A set of partially ordered steps intended to reach a goal, which is to build a software product or to enhance an existing one.

The Rational Unified Process

-Extensive set of guidelines supporting an iterative and incremental life cycle and focusing on requirements analysis and design.

- Development proceeds as a series of iterations that evolve into the final system.
- Each iteration consists of one or more of the following steps: requirements capture, analysis, design, implementation, and test.

- Risk-mitigating process: technical risks are assessed and prioritized early in the life cycle and are revised during each iteration.
- Releases are scheduled to ensure that the highest risks are tackled first.



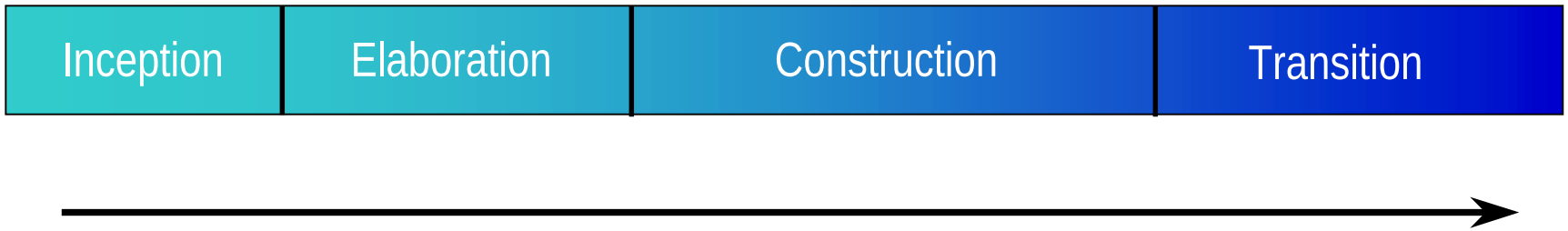
Phases of the Rational Unified Process

-Structured along two dimensions:

- •time division of the life cycle into phases and iterations
- •process components consisting of the production of a specific set of artifacts with well-defined activities

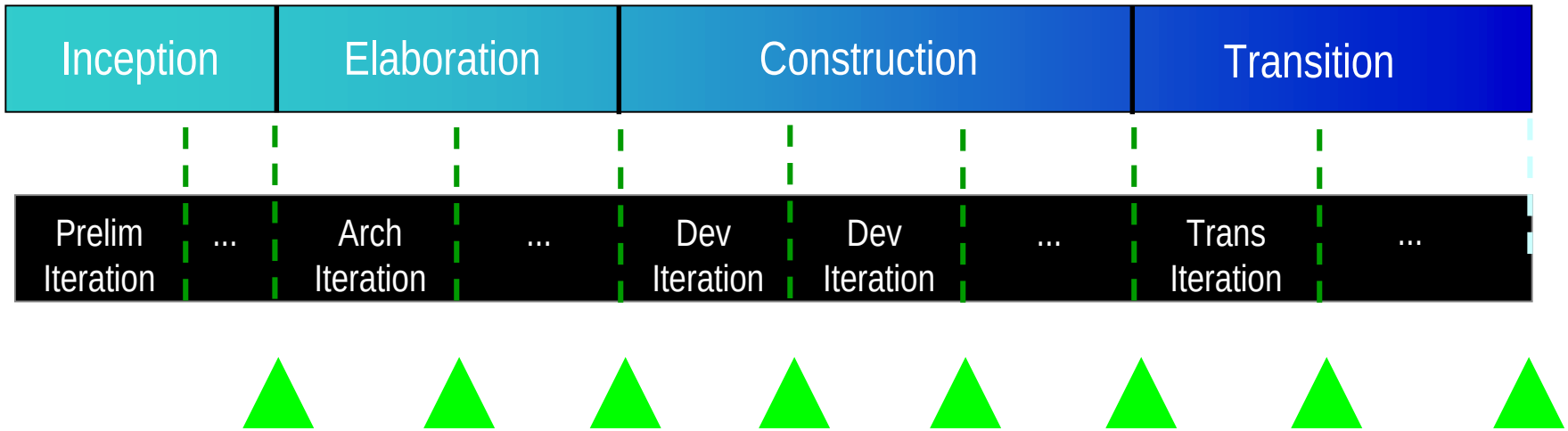
-Each activity of the process component dimension typically is applied to each phase of time-based dimension, but at a varying degree dependent upon the specific phase.

Lifecycle Phases (Time Dimension)



- *Inception* — Define the scope of the project and develop business case
- *Elaboration* — Plan project, specify features, and baseline the architecture
- *Construction* — Build the product
- ÷ *Transition* — Transition the product to its users

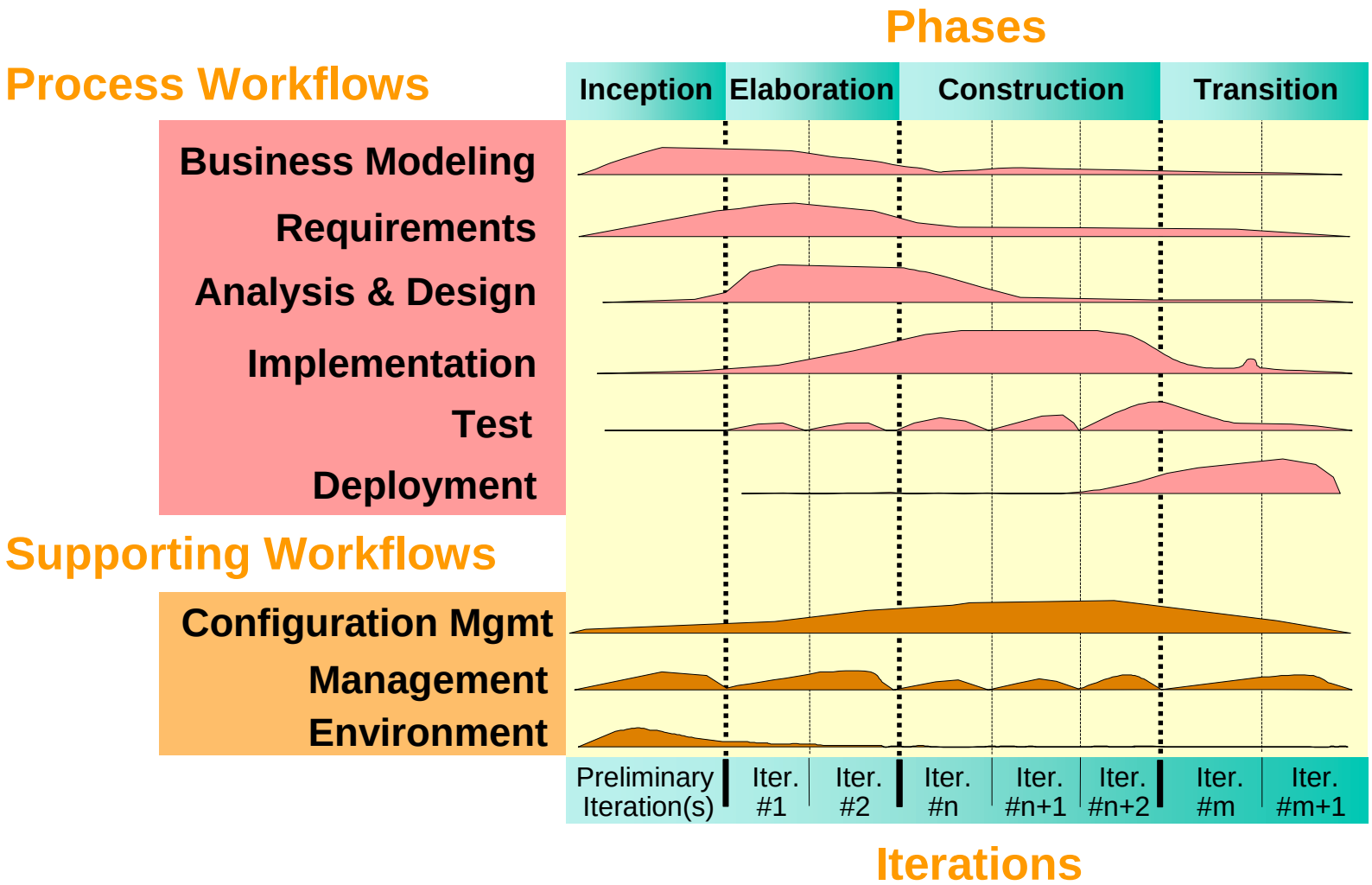
Phases and Iterations (Process Component Dimension)



☞The process component dimension includes:

- *Requirements capture*: a narration of **what** the system should do
- *Analysis and design*: a description of **how** the system will be realized in the implementation phase
- *Implementation*: the production of the code that will result in an executable system
- *Test*: the verification of the entire system

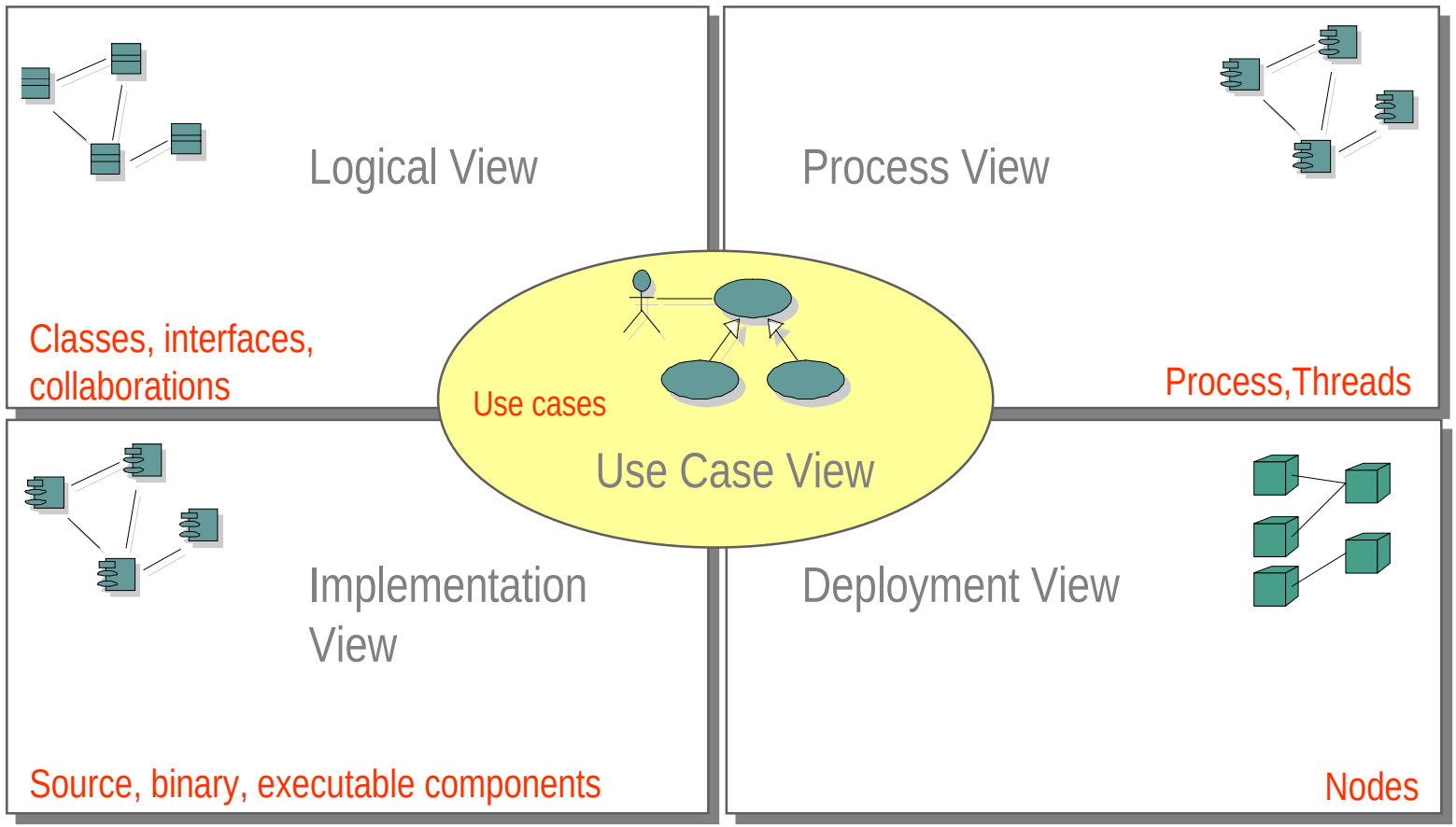
Unified Process Structure



Architecture Modeling

The "4+1" Views of Architecture

-RUP advocates the use of multiple perspectives to describe the various concerns.
RUP suggests a five views approach:



Organization
Package, subsystem

Dynamics
Interaction, State machine

-*Use case view*:

÷consists of a set of key use cases or scenarios, which guide the design of the architecture during the inception and elaboration phases and are used later to validate the other views.

-*Logical view*:

÷addresses the functional requirements of the system; provides an abstraction of the design model and defines main design subsystems and classes.

-*Process view*:

÷defines the system's concurrency and synchronization mechanisms at run-time (tasks, threads, processes etc.).

-*Deployment view*:

÷defines the hardware topology on which the system is executed.

-*Implementation view*:

÷defines the parts used to assemble and release the physical system (source code, data files, executables etc.).

Simple Monolithic App.

Use Case View
- Use case diagrams

Logical View
- Class diagrams
- Interaction diagrams

Process View
- None required

Implementation View
- None required

Deployment View
- None required

Complex Distributed App.

Use Case View
- Use case diagrams
- Activity diagrams

Logical View
- Class diagrams
- Interaction diagrams
- Statechart diagrams

Process View
- Class diagrams
- Interaction diagrams

Implementation View
- Component diagrams

Deployment View
- Deployment diagrams