Change Management of UML-Based Systems Engineering Artefacts

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Agenda

- UML® artefacts for SE, OMG SysML™
- Engineering Change Management
- A Standard Approach to Change Management for SysML
  - ISO AP233

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UML artefacts for SE, OMG SysML

The “U” means “Unified”

- In the beginning, there were several software engineering diagramming techniques
  - largely pretty pictures for human consumption
- Unified Modeling Language (UML®)
  - is their merger/standardization in the Object Management Group (OMG™)
  - includes numerous diagrams
  - includes rigorous underlying model of the information contained on those diagrams
  - is extensible, can tailor UML to create new languages called UML Profiles

UML in Systems Engineering

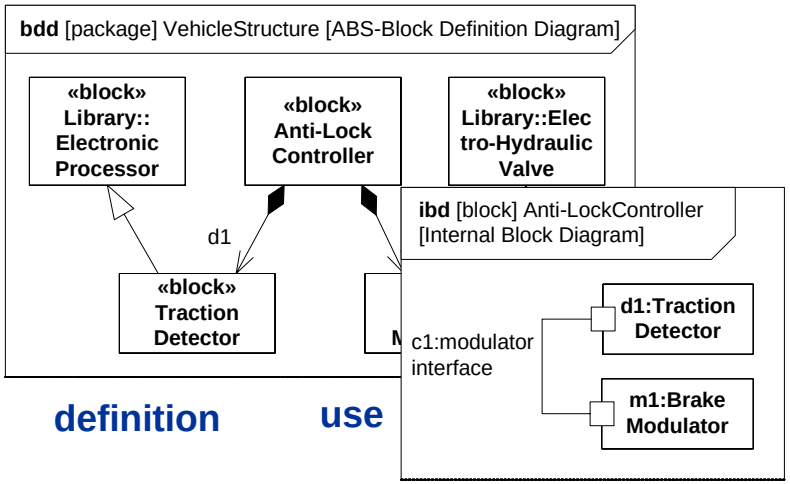
- Some UML diagrams are useful outside the software engineering community
  - E.g. State machines to simulate systems behavior
- Organizations created methodologies for using UML in Systems Engineering
- SE community desired more commonality and so the OMG Systems Modeling Language (SysML) standard was born
  - Same thing happened for Systems Architecture and thus the OMG Unified Profile for DODAF/MODAF (UPDM) was born

What is SysML?

- SysML is really two things
  - A set of graphical notations for modeling systems
  - A formal specification of the information content the icons on the diagrams represent
    - a subset UML language model with SE extensions

- SysML was developed in collaboration between INCOSE, OMG and ISO
  - SysML is a key step towards the Model Based Systems Engineering vision

Structure



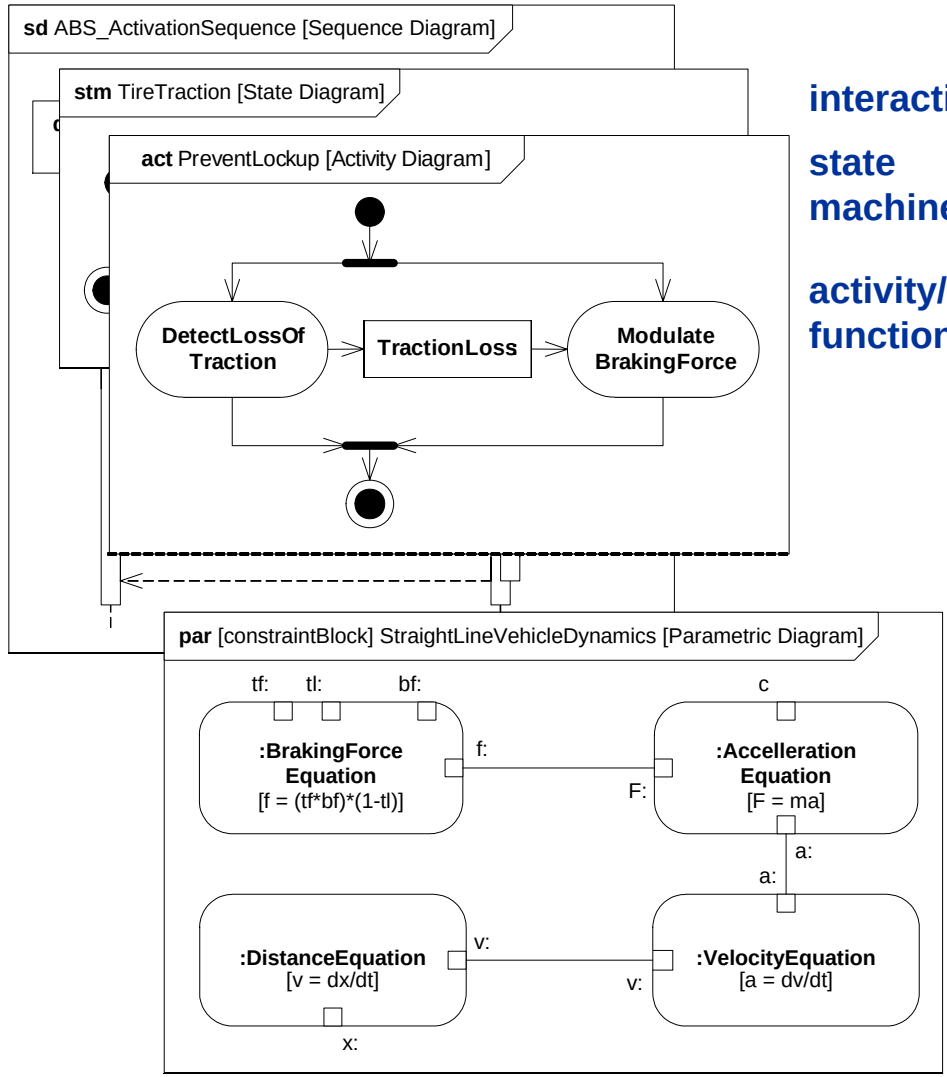
definition use

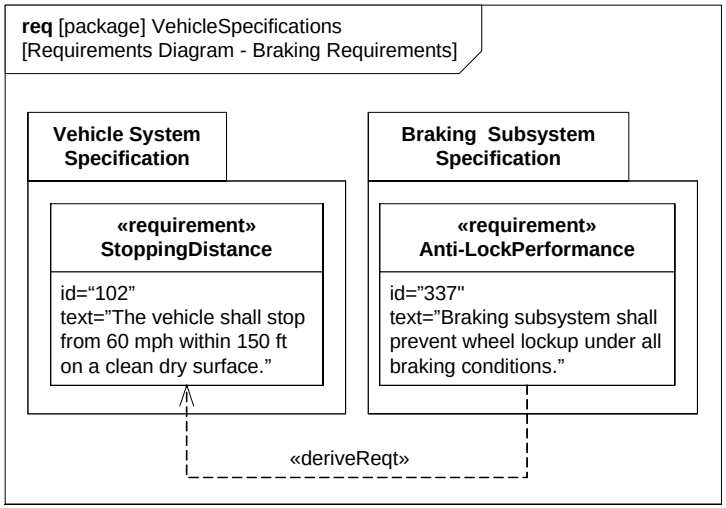
Behavior

interaction

state machine

activity/ function





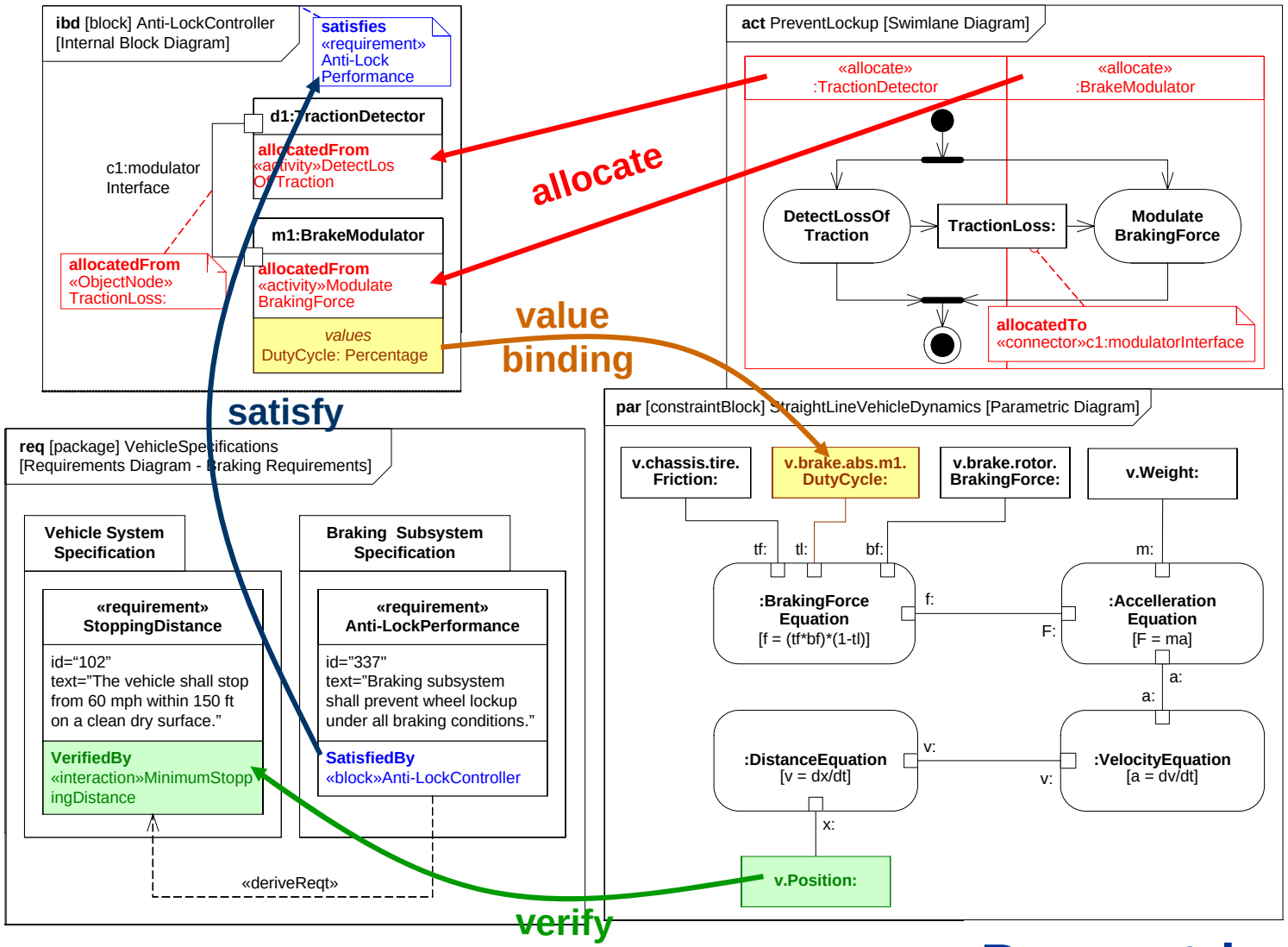
Requirements

Parametrics

Cross-cutting relationships

Structure

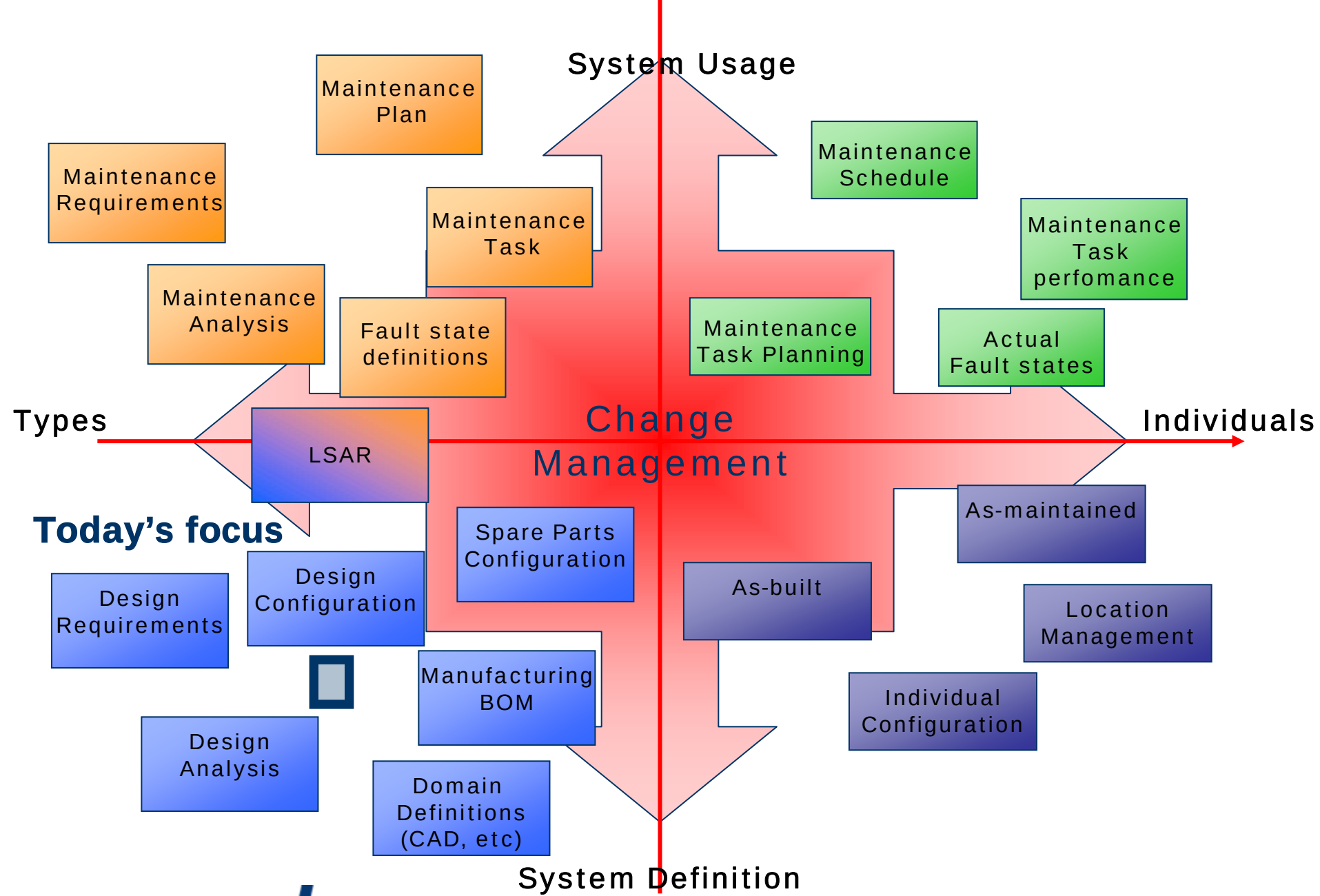
Behavior



Requirements

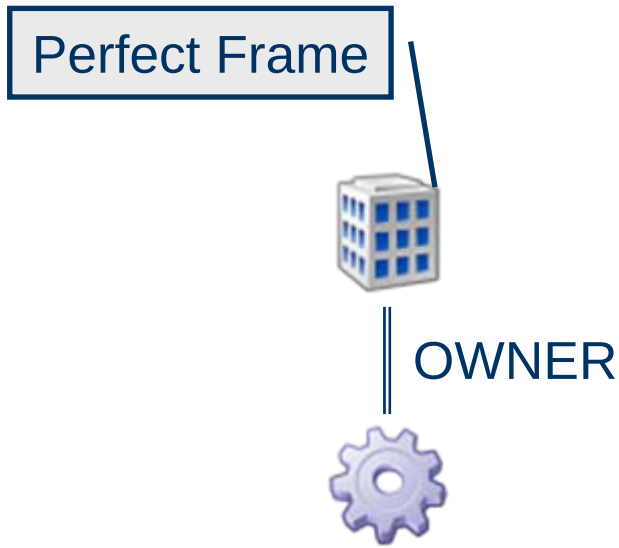
Parametrics

Engineering Change Management

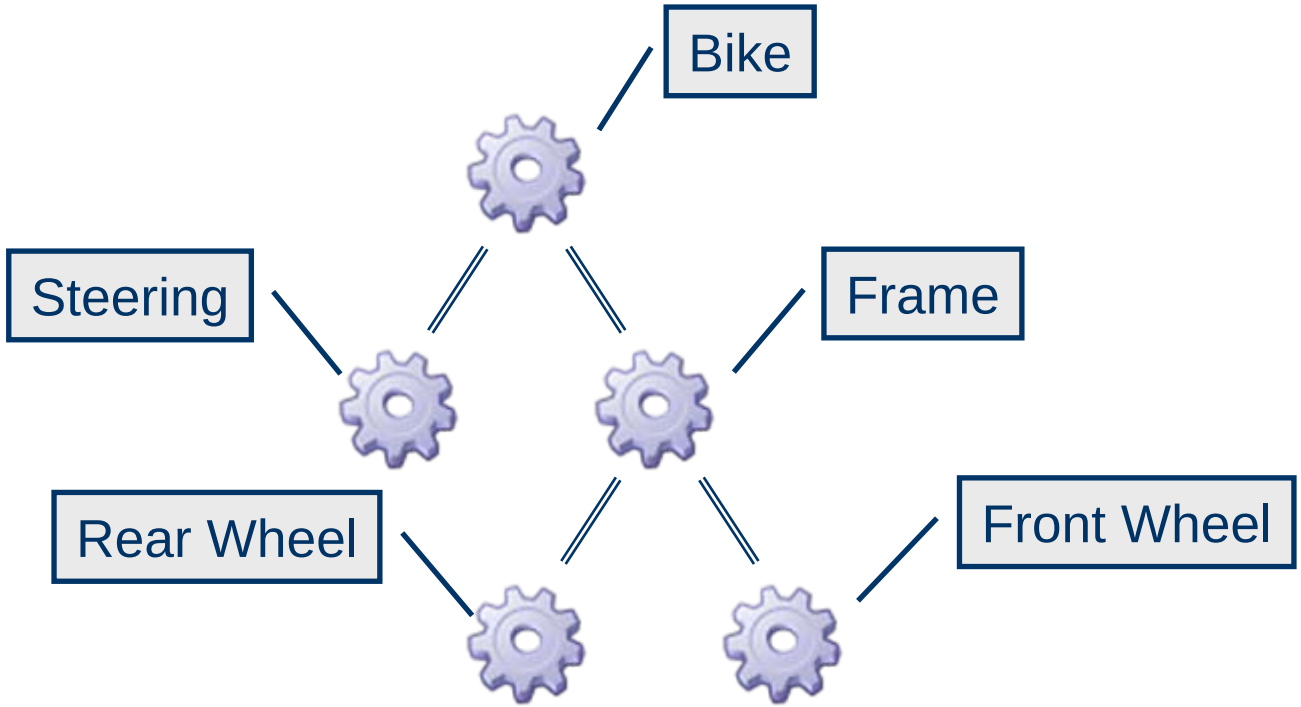


Item

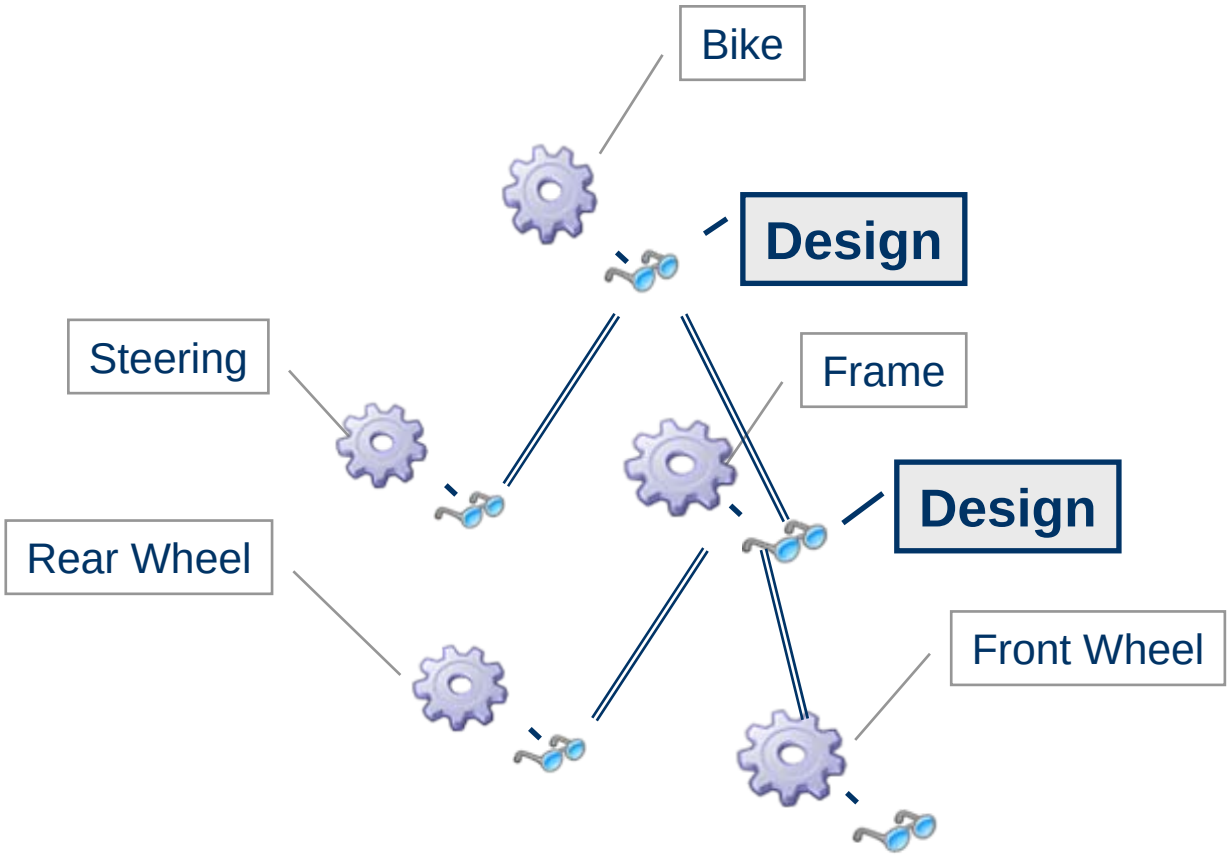
Item - Owner



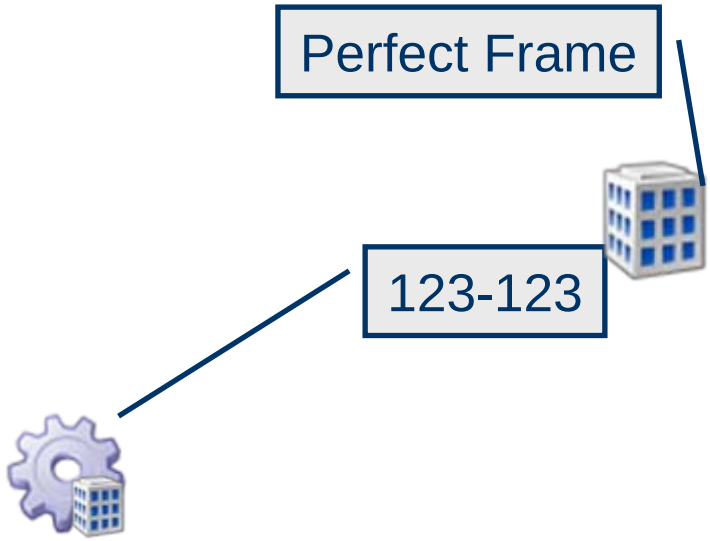
Structure - Basic



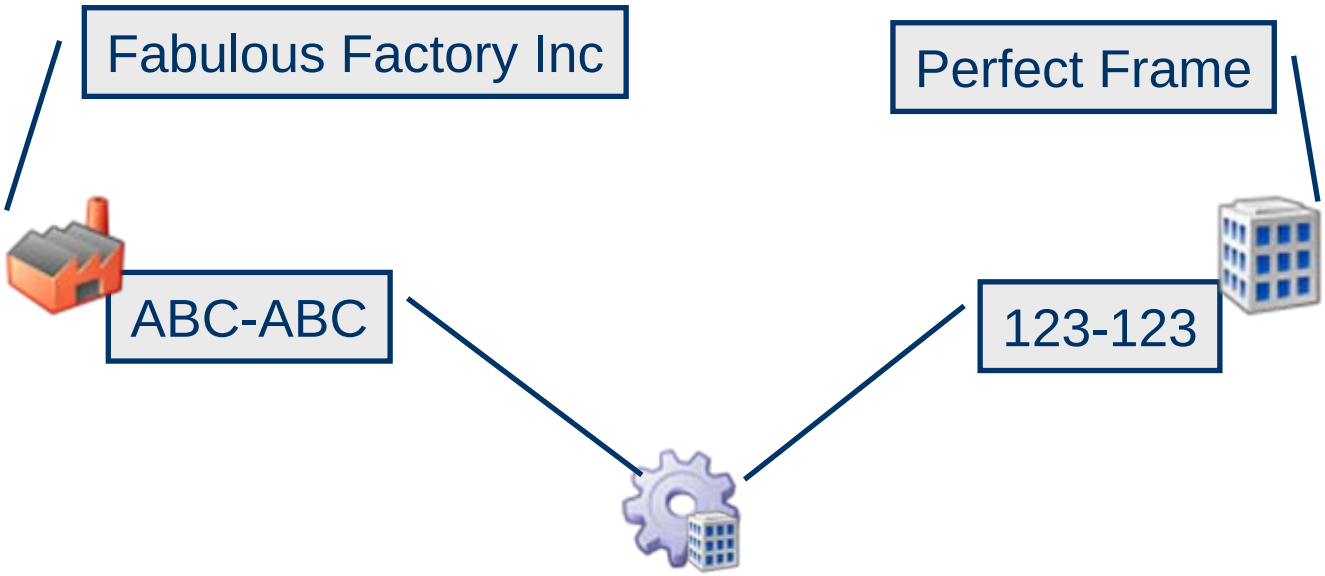
Structure – View Based



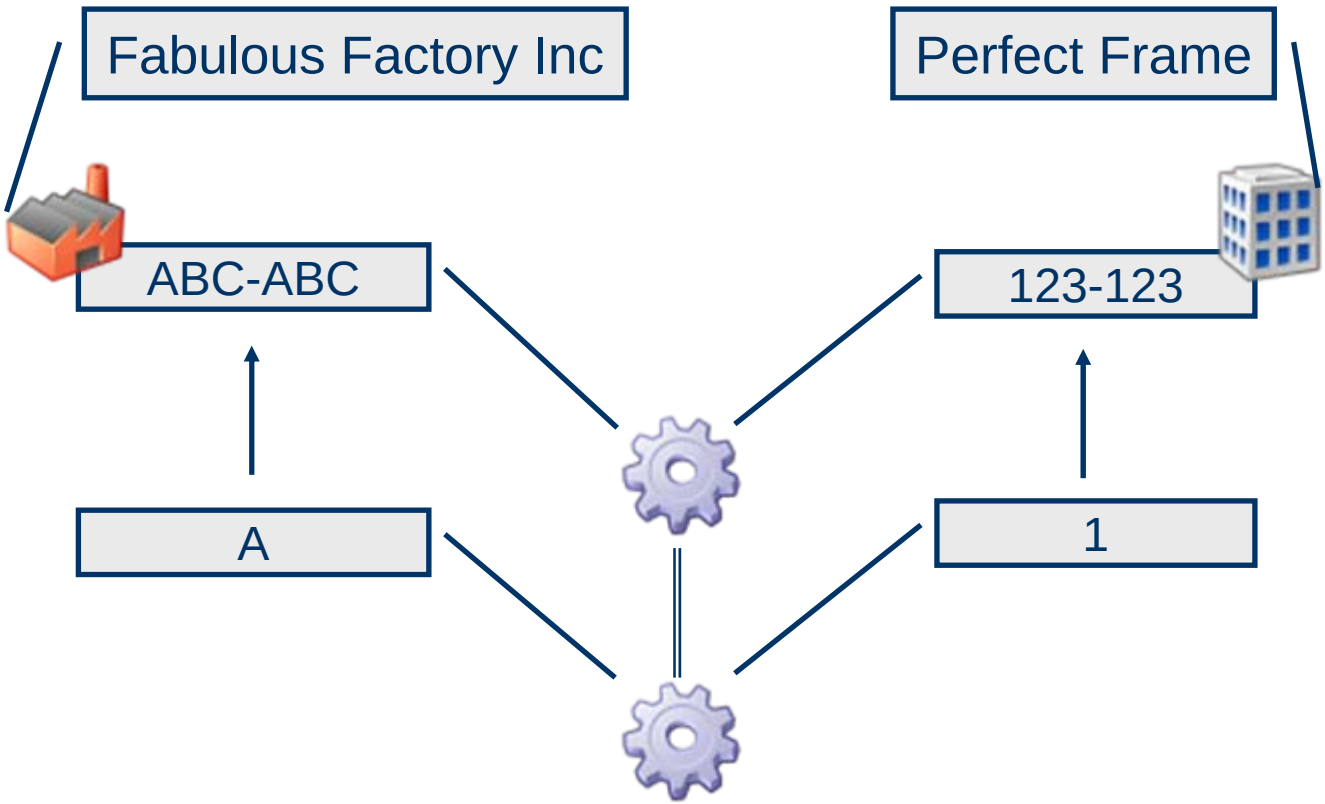
Item - ID



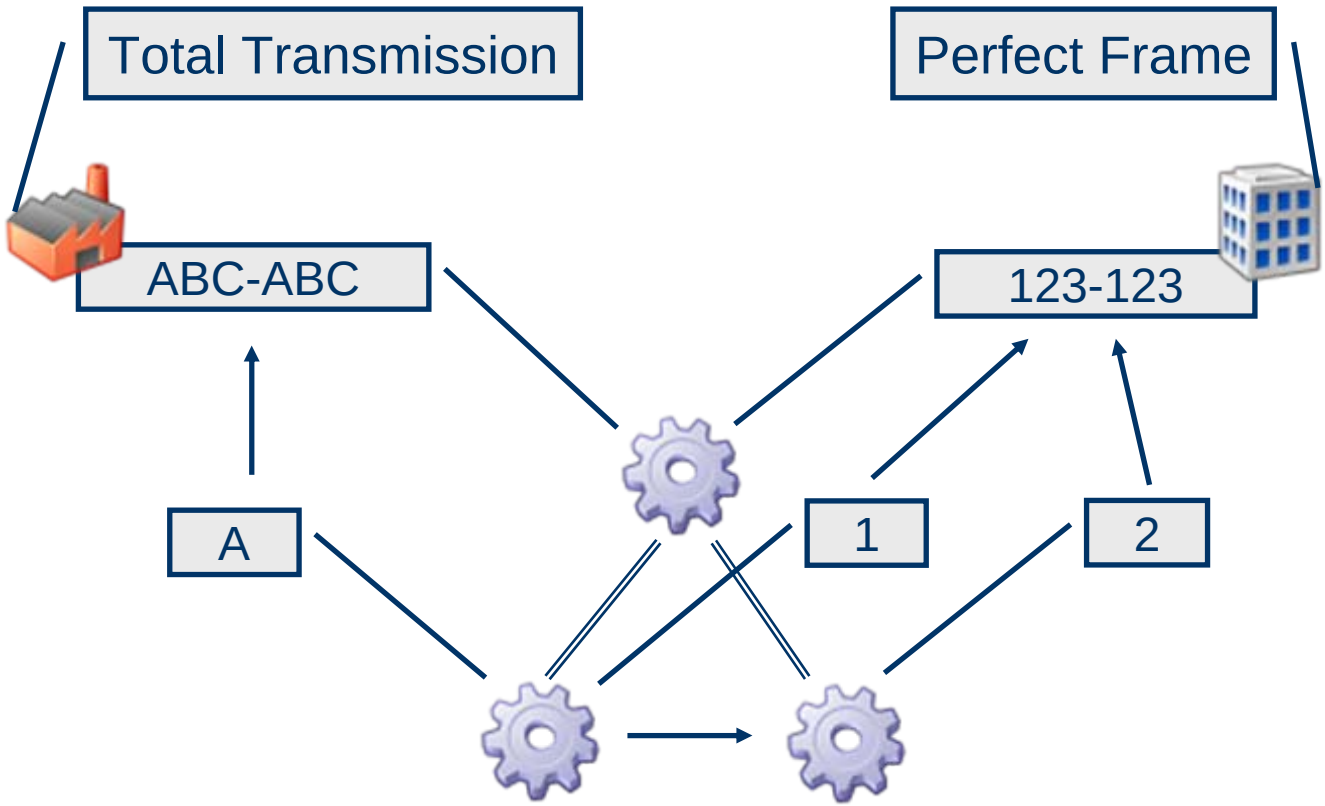
Item – Multiple ID



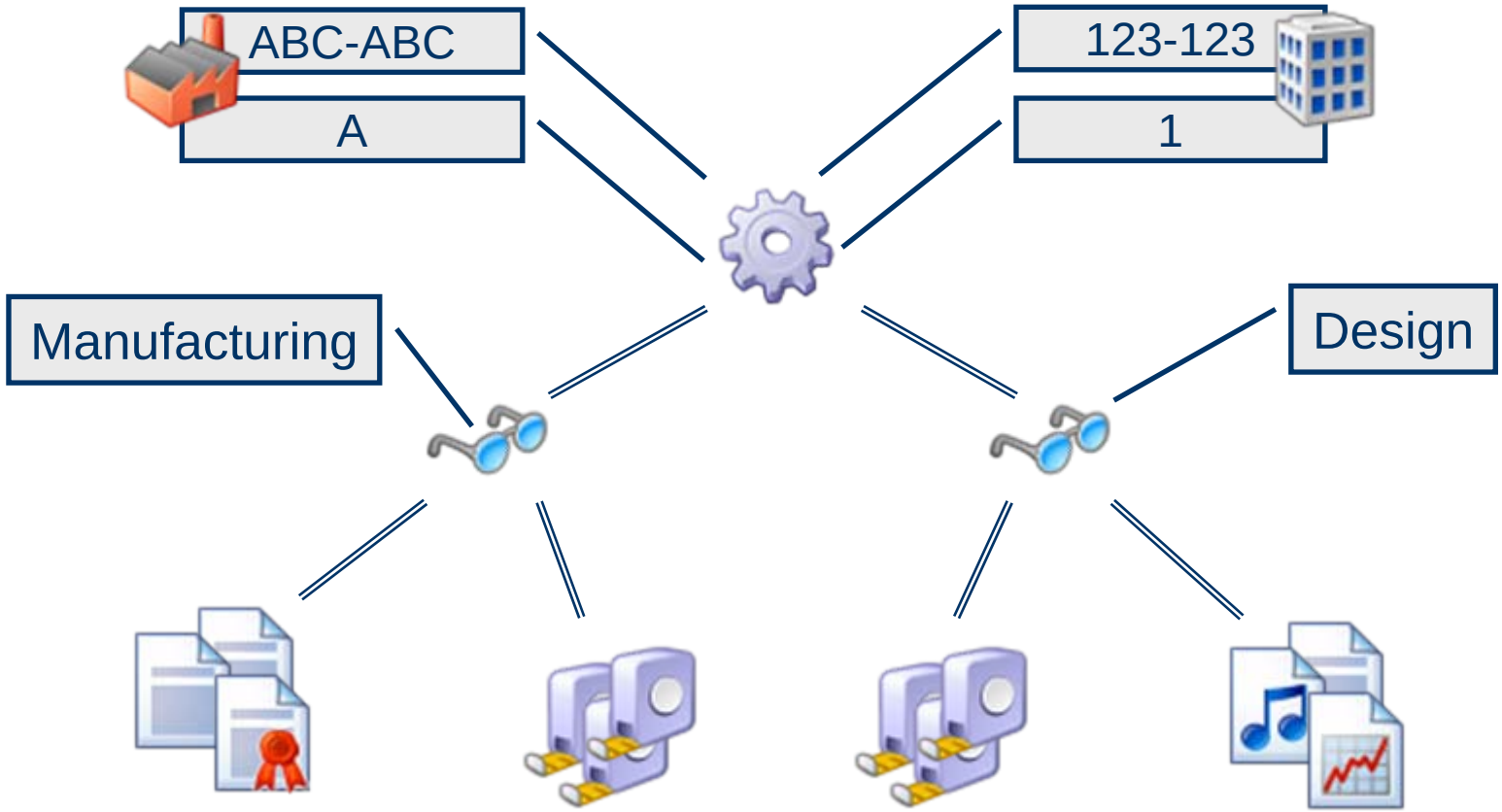
Item - Version



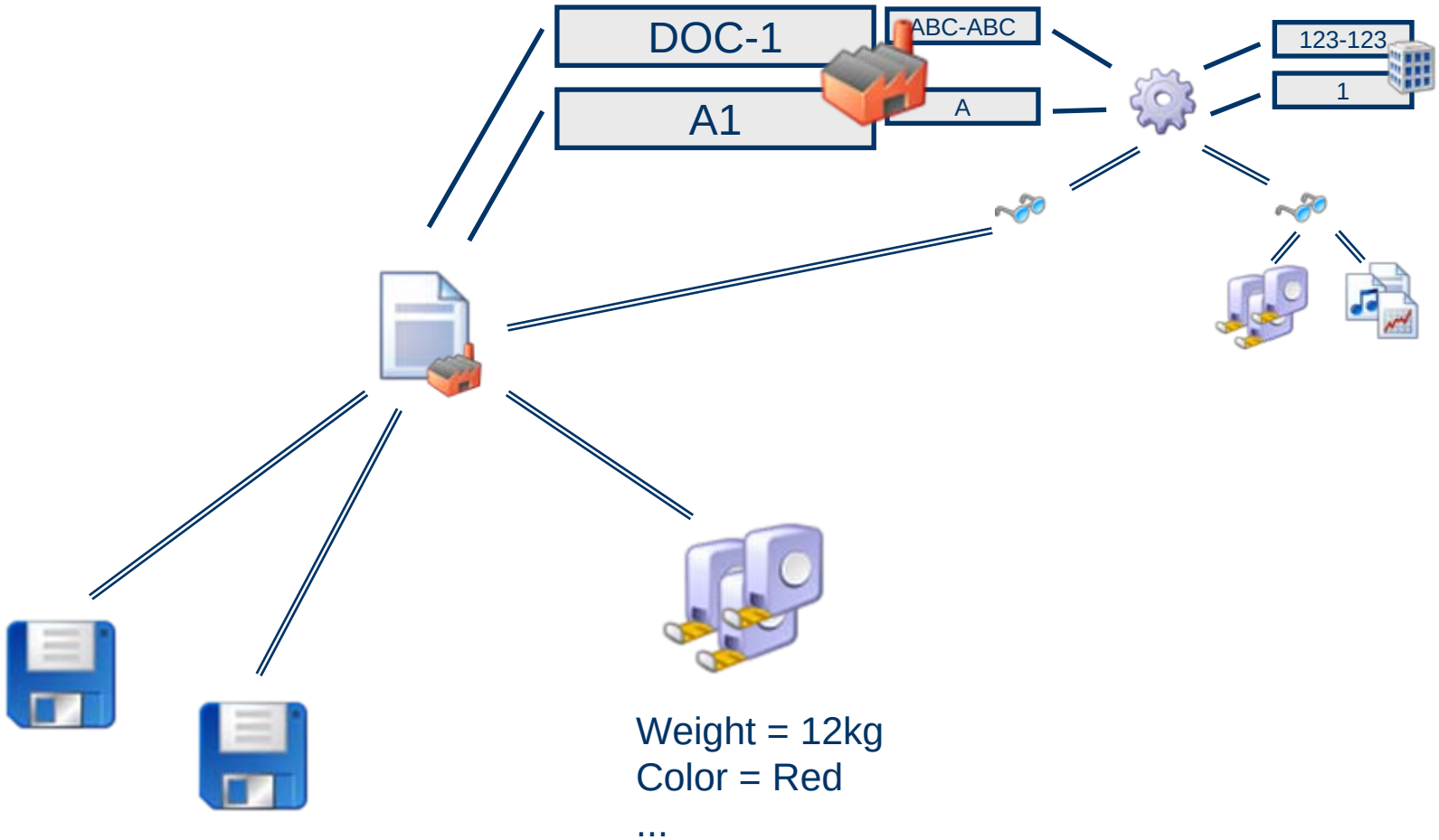
Item - Version 2



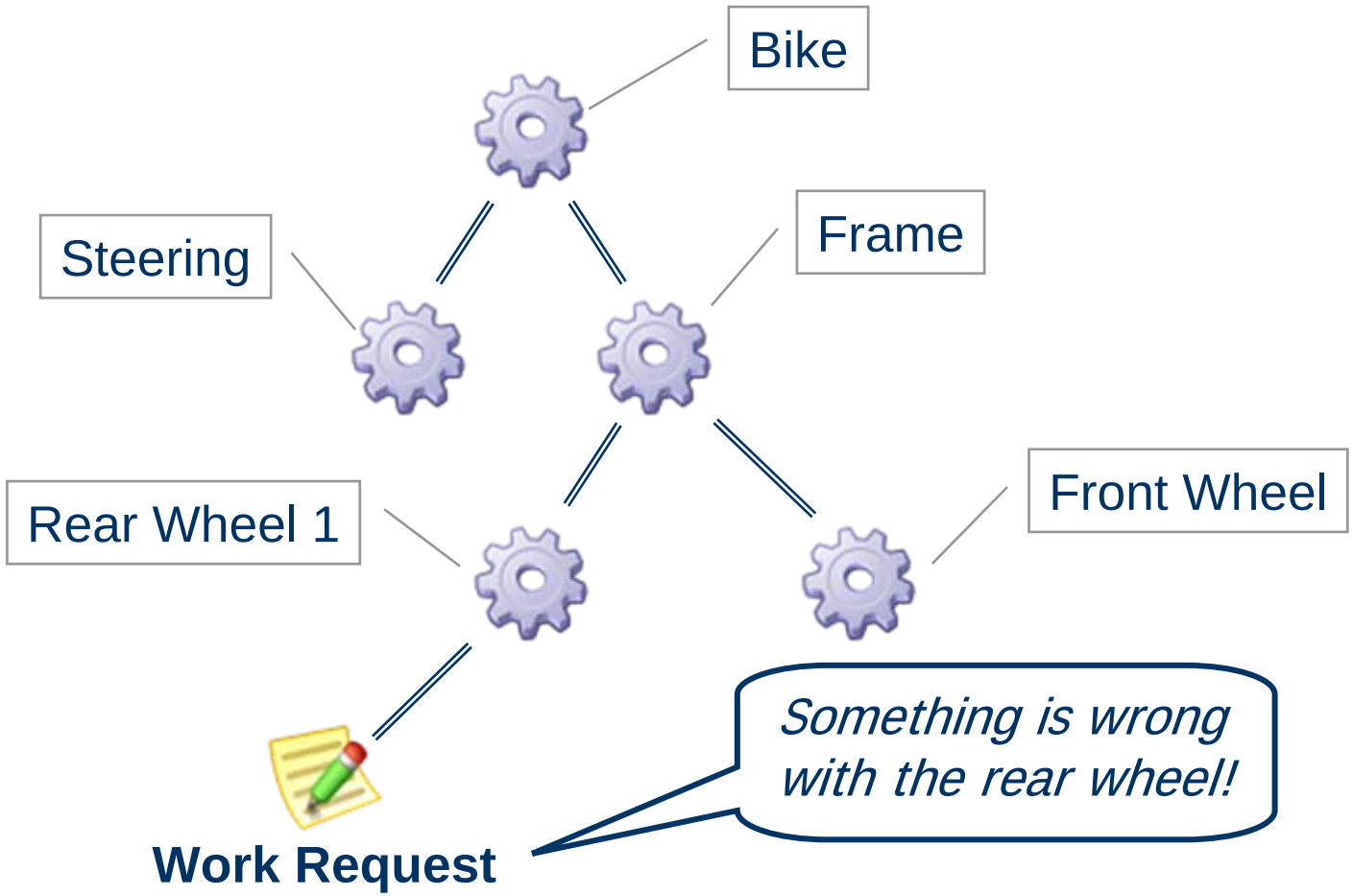
Item - Views



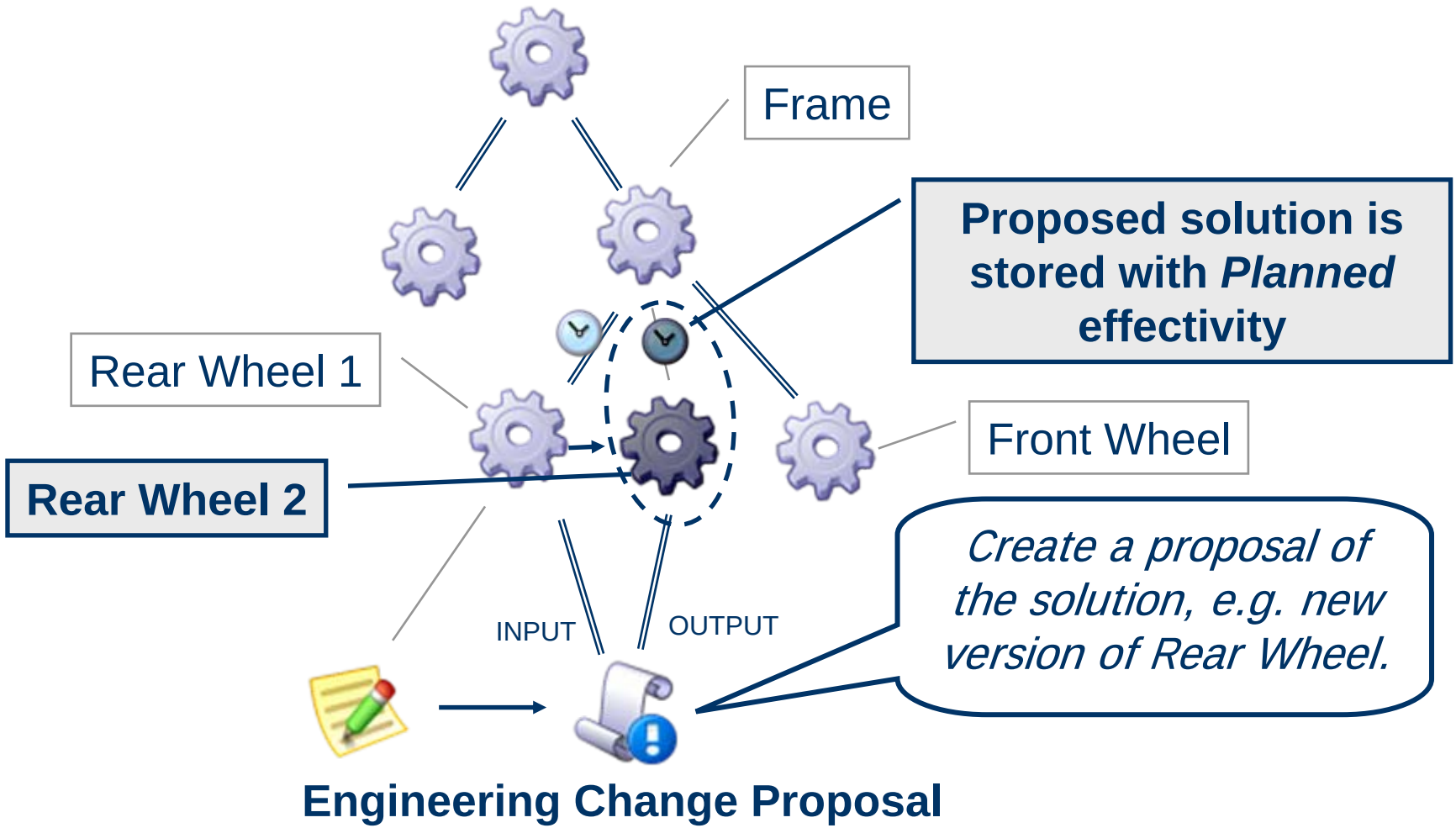
Document



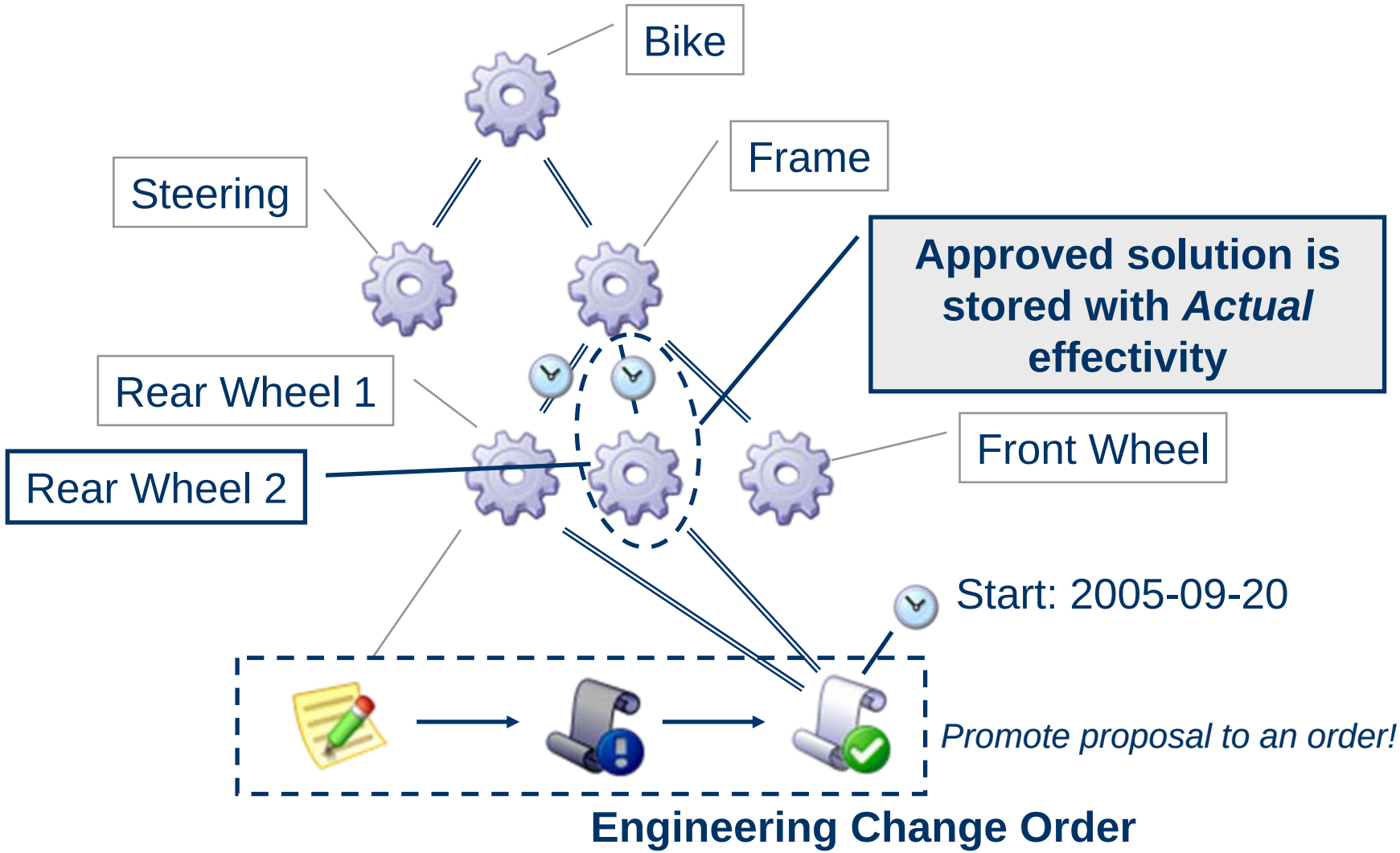
Change Management - Design



Change Management - Design

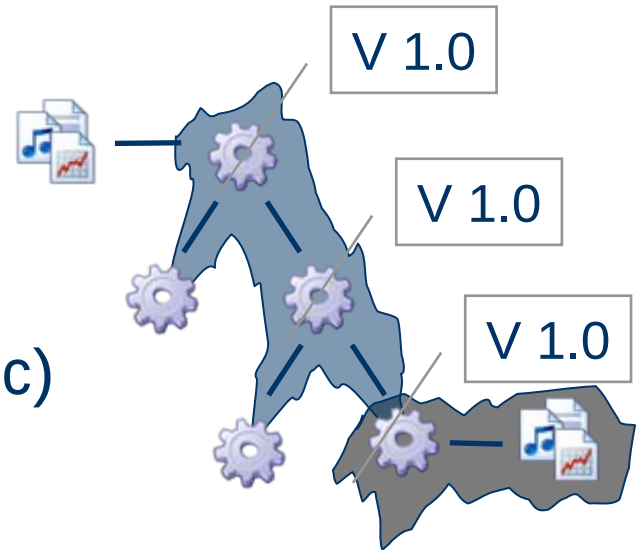


Change Management - Design



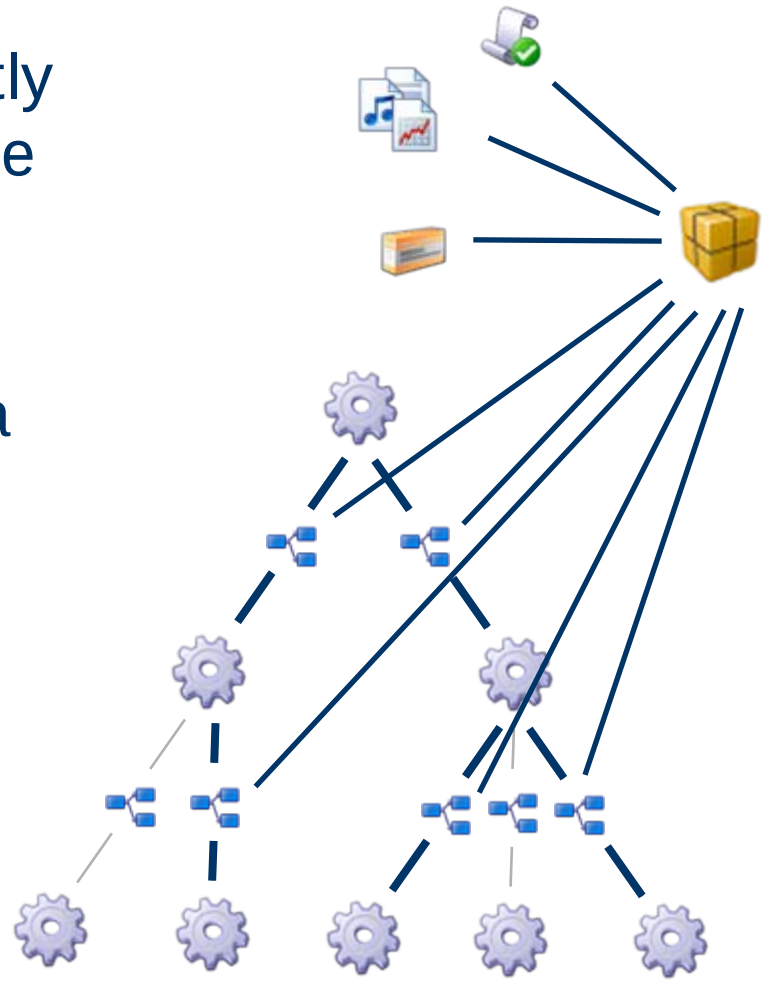
Freezing

- Freezing is divided into two parts
  - Freezing Structure
  - Freezing Definitions (prop, doc)
- Freezing can be done on individual views



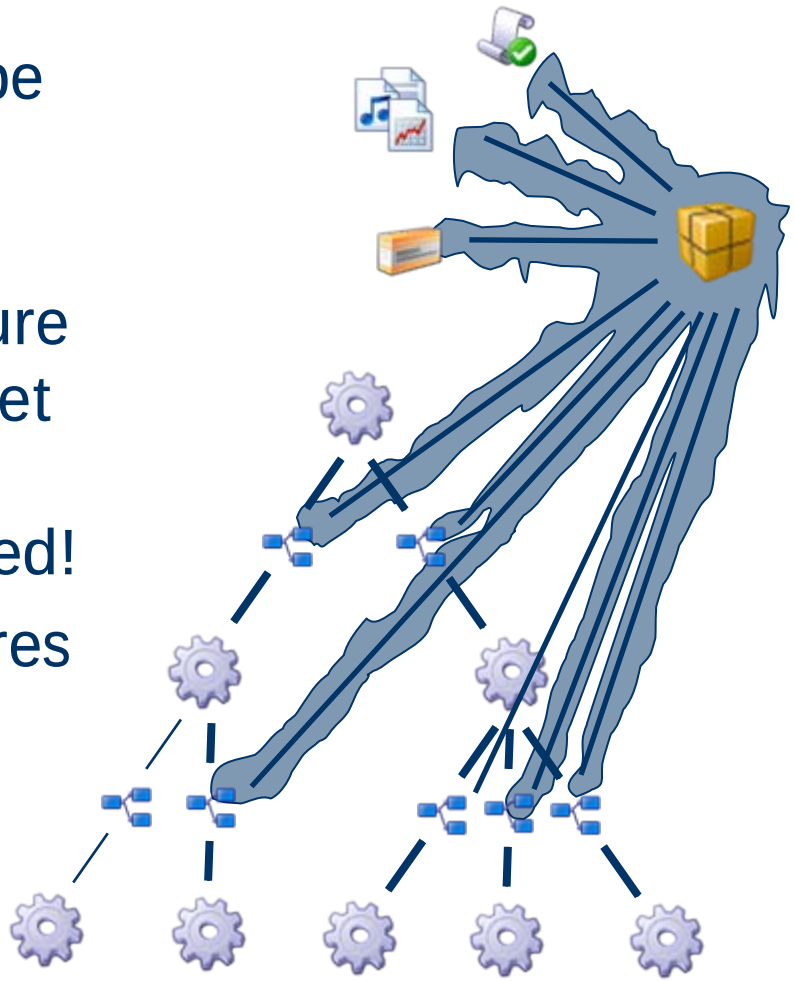
Baselining

- The baseline object can explicitly point out the complete structure contained in a baseline 
- Except baselining a structure, a baseline can contain all other business objects



Freezing a Baseline

- The content of a baseline can be edited but the history of it is always kept
- Baselines can be frozen to ensure that the specified information set can be re-called at all times. A frozen baseline can not be edited!
- Enables work on ‘open’ structures

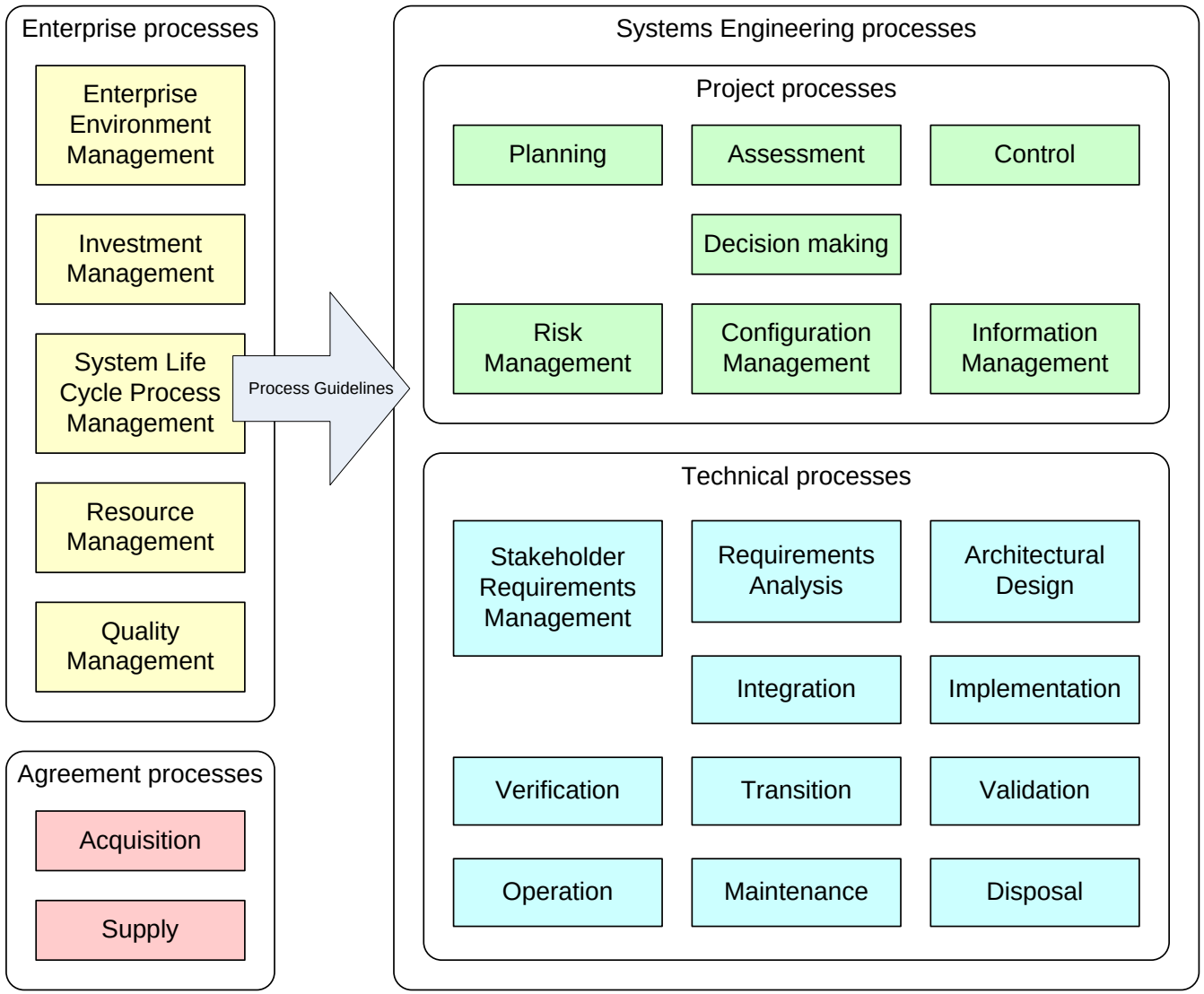


A Standard Approach to Change Management for SysML

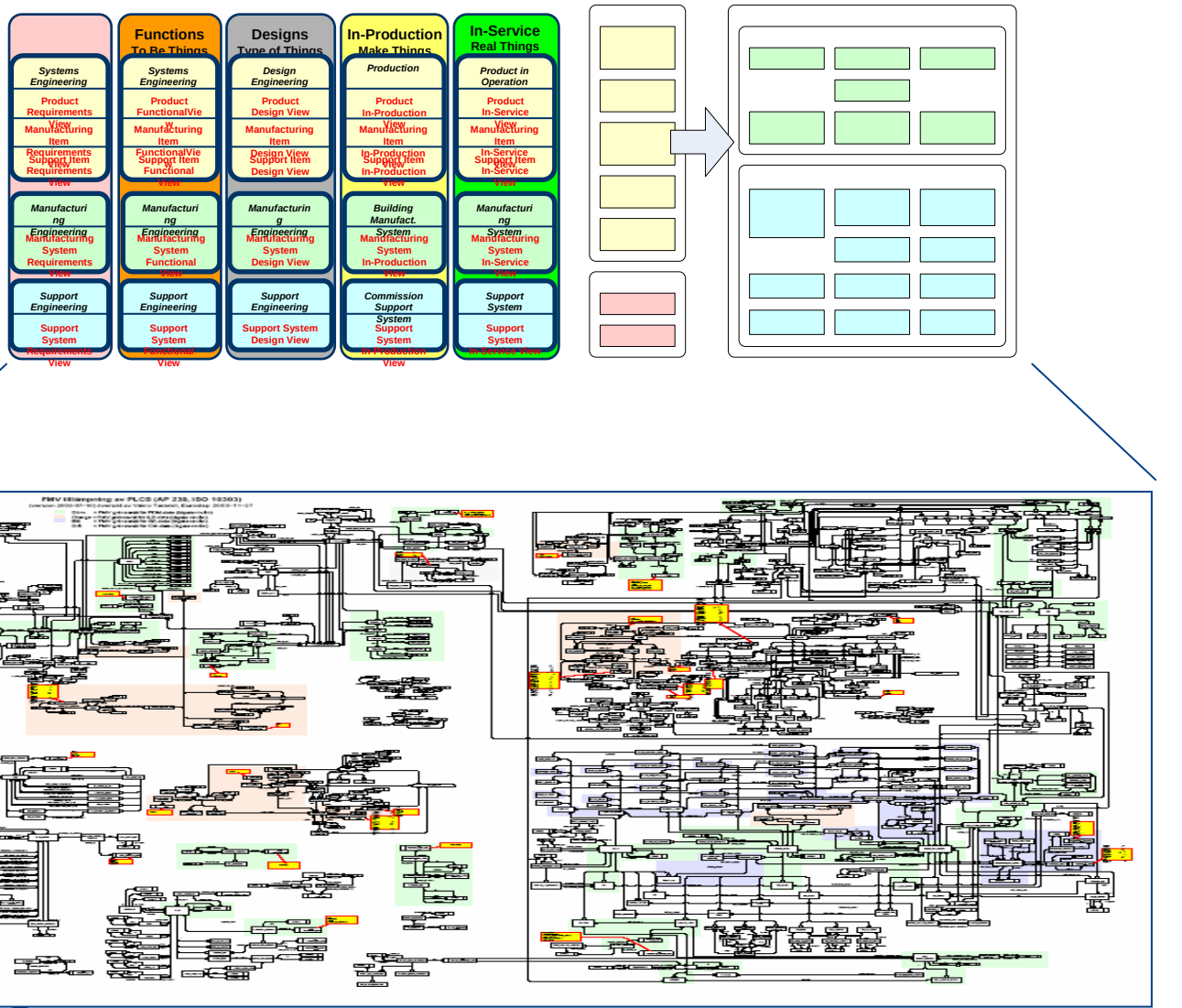
Extended Lifecycle Scope

Requirements Need Things	Functions To Be Things	Designs Type of Things	In-Production Make Things	In-Service Real Things
Systems Engineering	*Systems Engineering*	*Design Engineering*	*Production*	*Product in Operation*
Product RequirementsView	Product FunctionalView	Product Design View	Product In-Production View	Product In-Service View
Manufacturing Item Requirements View	Manufacturing Item FunctionalView	Manufacturing Item Design View	Manufacturing Item In-Production View	Manufacturing Item In-Service View
Support Item Requirements View	Support Item Functional View	Support Item Design View	Support Item In-Production View	Support Item In-Service View
Manufacturing Engineering	*Manufacturing Engineering*	*Manufacturing Engineering*	*Building Manufact. System*	*Manufacturing System*
Manufacturing System Requirements View	Manufacturing System Functional View	Manufacturing System Design View	Manufacturing System In-Production View	Manufacturing System In-Service View
Support Engineering	*Support Engineering*	*Support Engineering*	*Commission Support System*	*Support System*
Support System Requirements View	Support System Functional View	Support System Design View	Support System In-Production View	Support System In-Service View

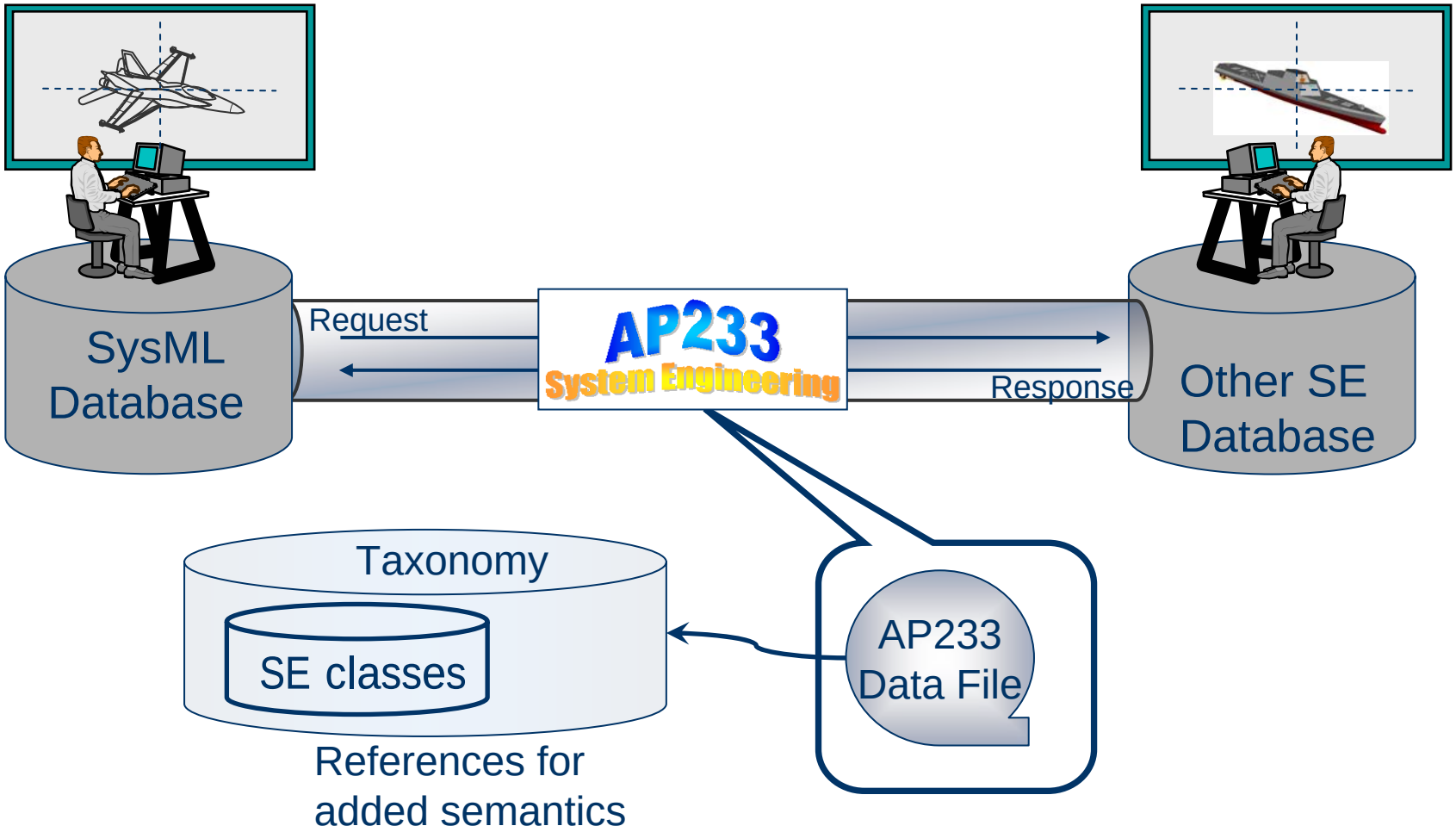
Full Process View



Integrated Information View



AP233 is a neutral SE information model



SysML-AP233 Alignment

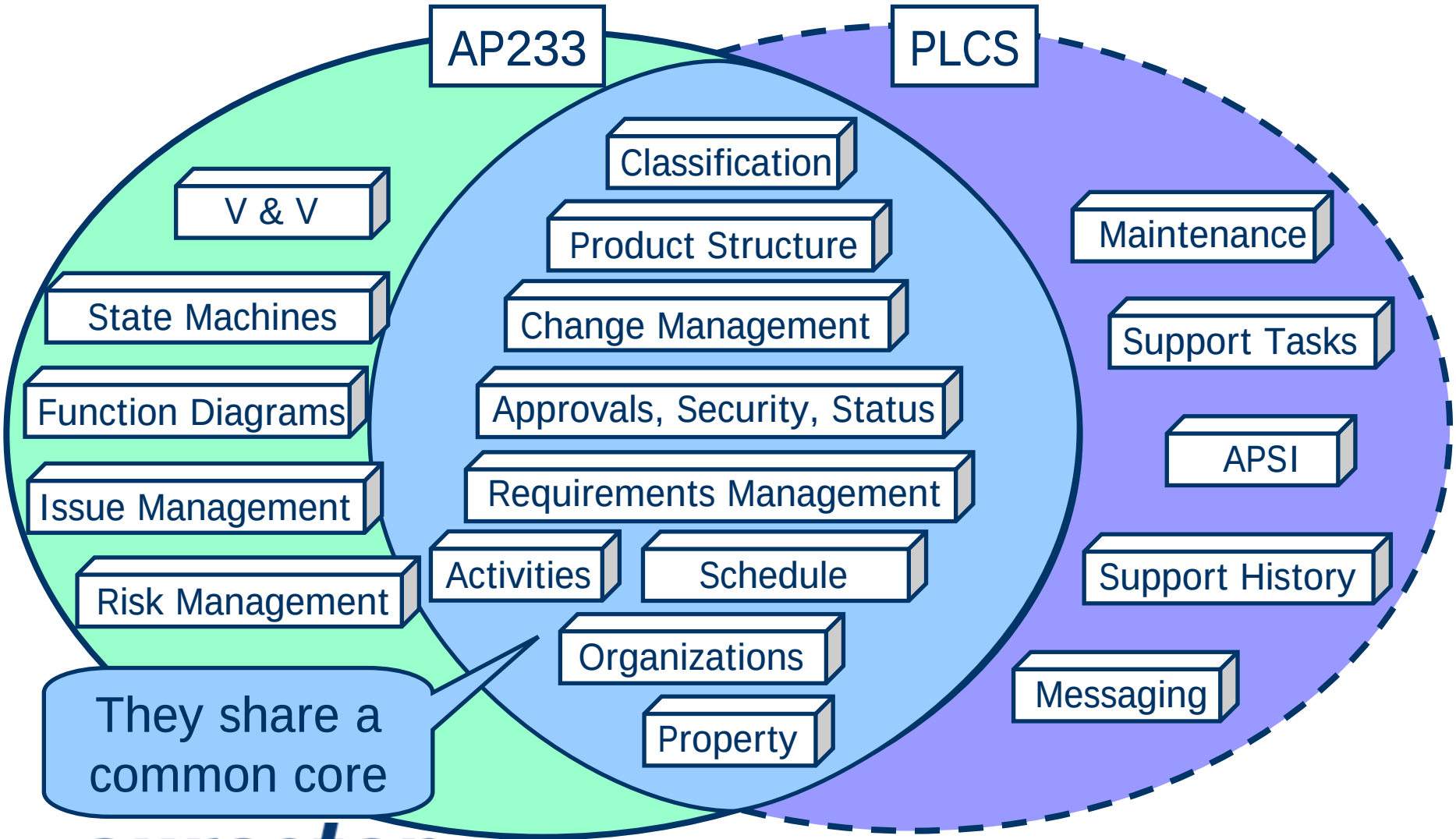
- INCOSE drove much AP233 and SysML standardization
  - OMG for SysML
  - ISO TC184 SC4 Industrial Data for AP233
- AP233 and SysML teams worked together to align them
- Aims include
  - Align SysML and AP233 models
  - Provide meta-model mapping
  - Provisions for an independent public domain SysML/AP233 API
  - Set-up of data-exchange test-bed

SE Tool Plug-fest

- The SE Tool Interoperability Plug-Fest
  - SysML, AP233 and CADM testing capability from NIST and DoD's Systems and Software Engineering office

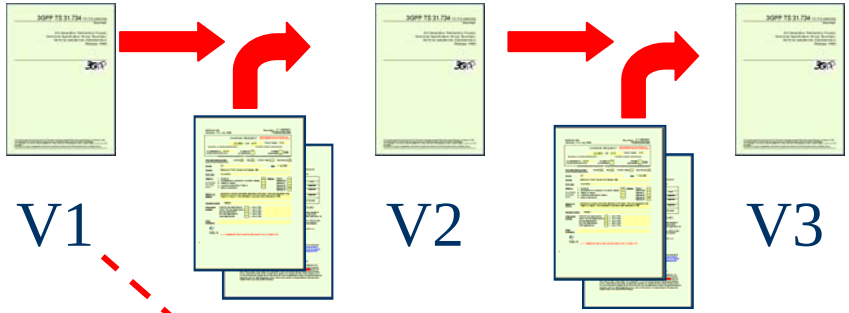
- Aims to support testing of SysML XMI and AP233 XML files
  - Just getting started
  - http://syseng.nist.gov/se-interop/plugfest/

AP233-PLCS Alignment

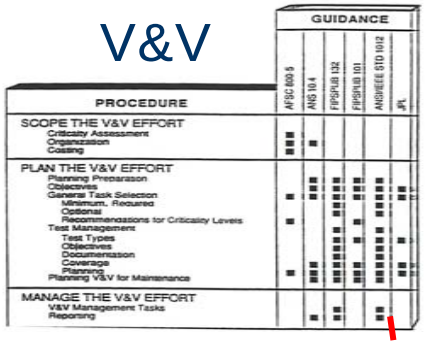


AP233

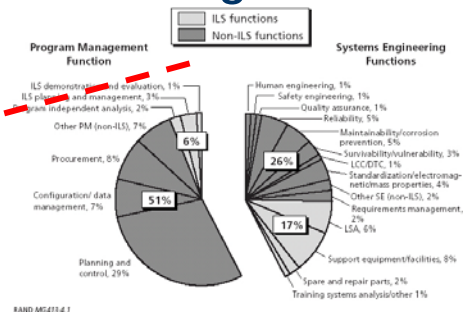
Engineering Change Control



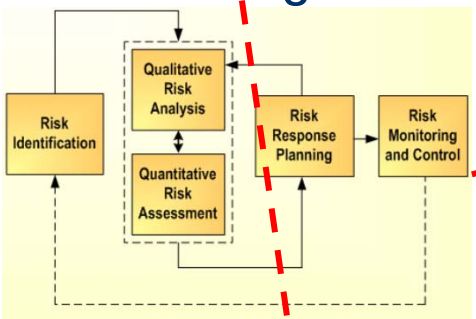
V&V



Program Management

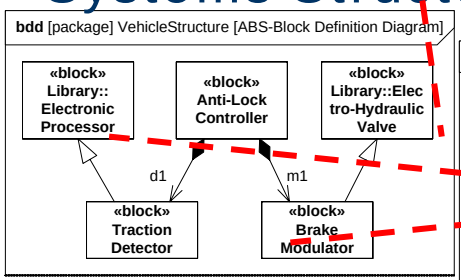


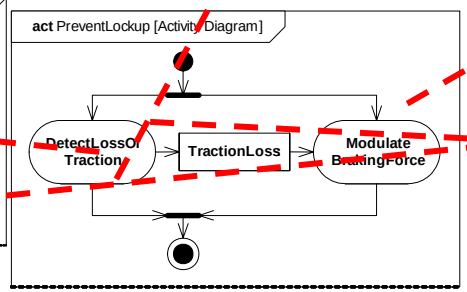
Risk Management



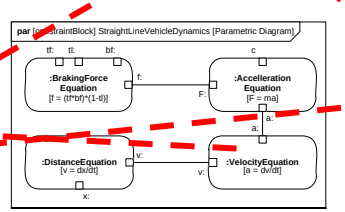
SysML

Systems Structure/Behavior

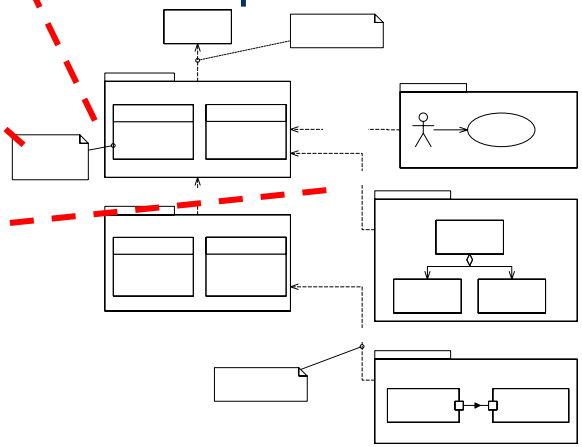




Parametrics



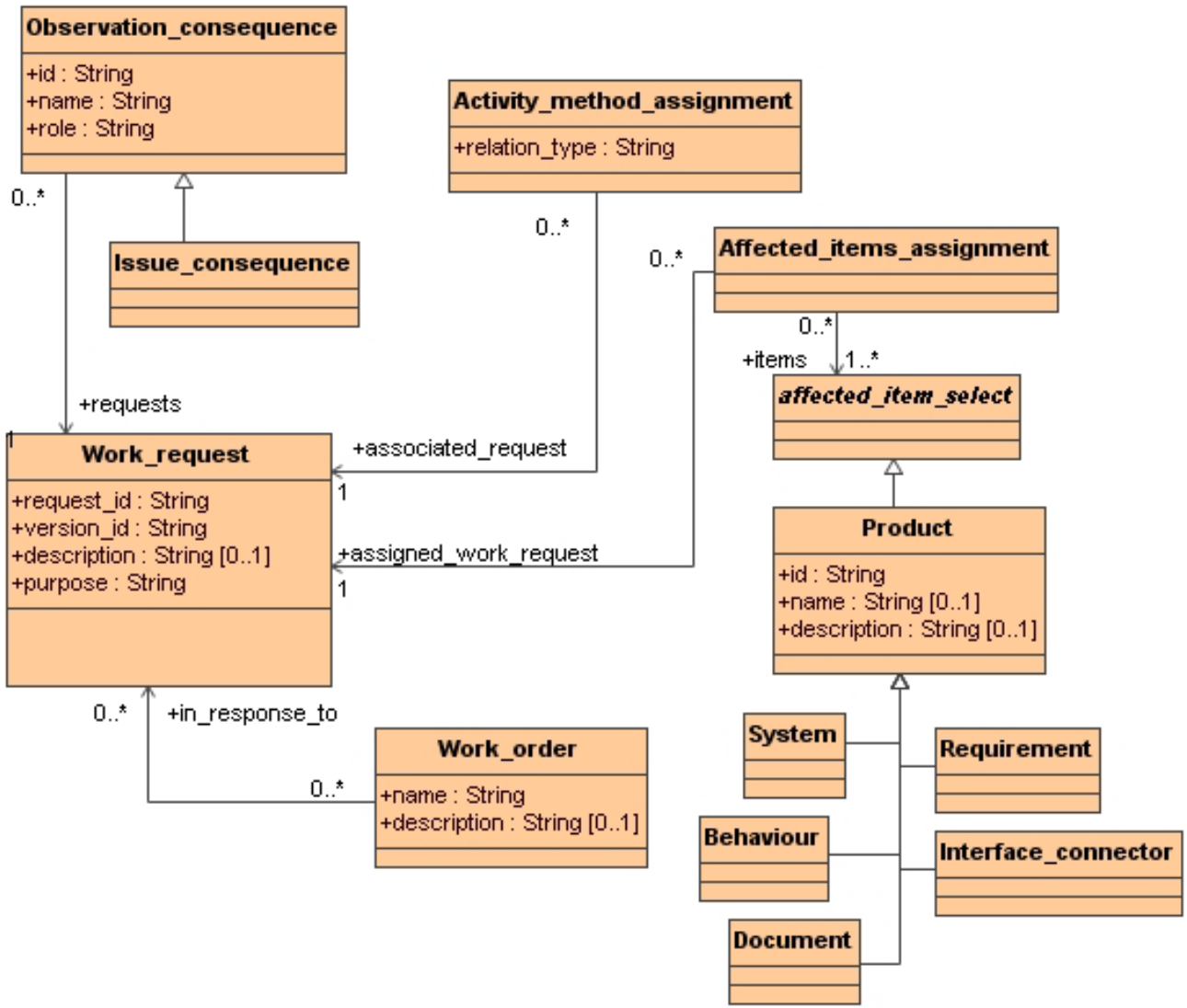
Requirements



CM Items in AP233

- In AP233, the CM Item concept is represented as “Product” or any of its subclasses
- Specify SysML concepts that map to AP233 CM items
- Implement SysML/AP233 software
  - Convert the internal SysML data into A233 data maintaining reference to SysML data file itself
    - AP233 allows reference to any type of data file

AP233 Change Management Schema

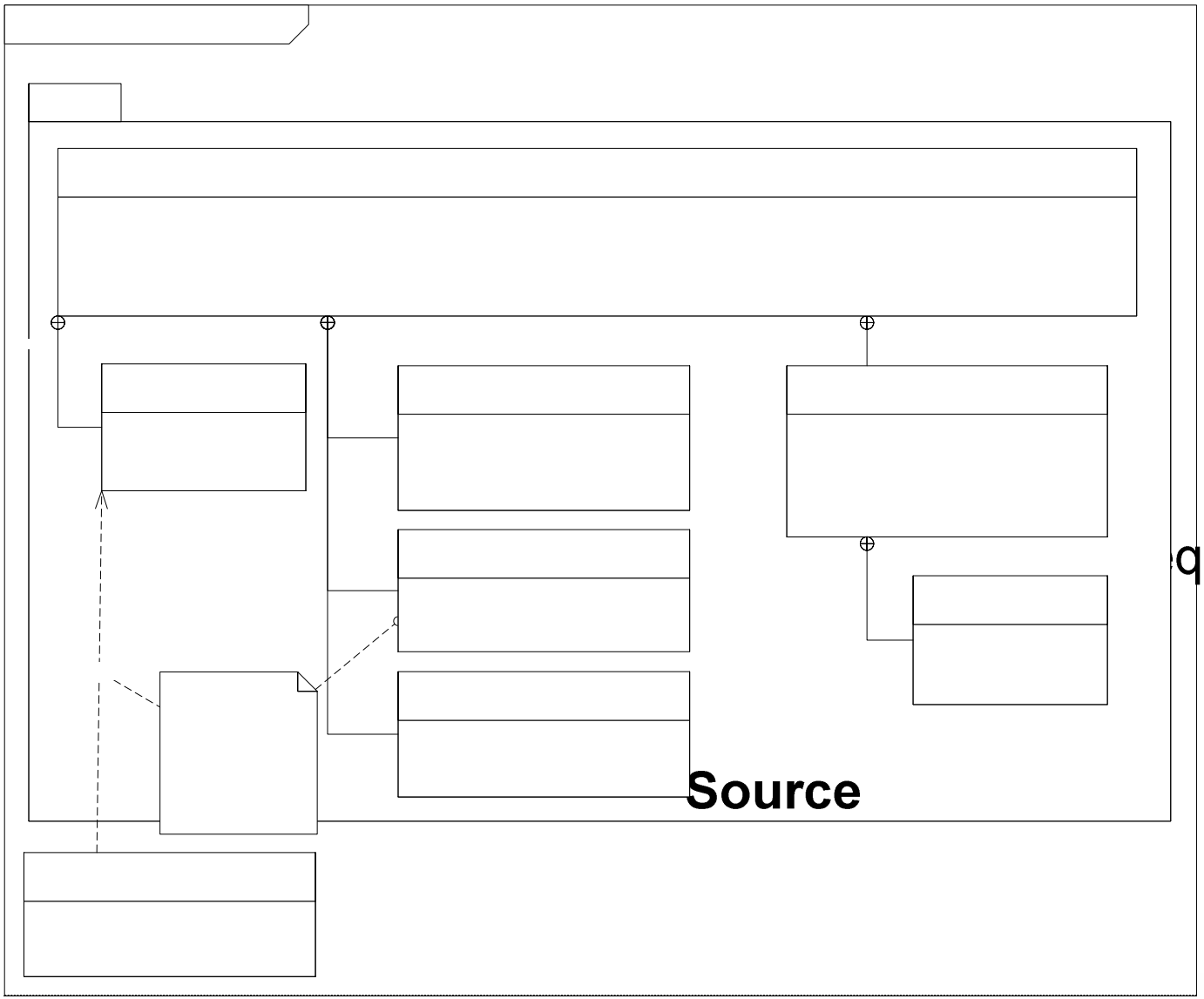


Use Change Management Tool

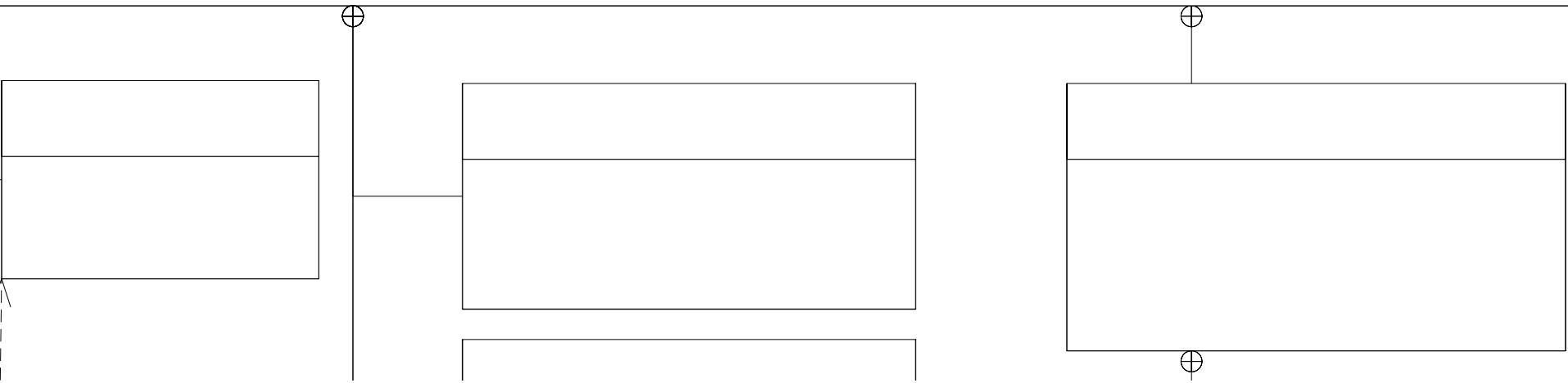
- In a tool that implements Engineering Change Management
  - Import AP233 data into Item, Item Version, etc.
  - Check-in the SysML data file itself
  - Create link between SysML data file and related Item

- Use CM Tool to manage Work Requests, Change Proposal and Change Order as describe earlier

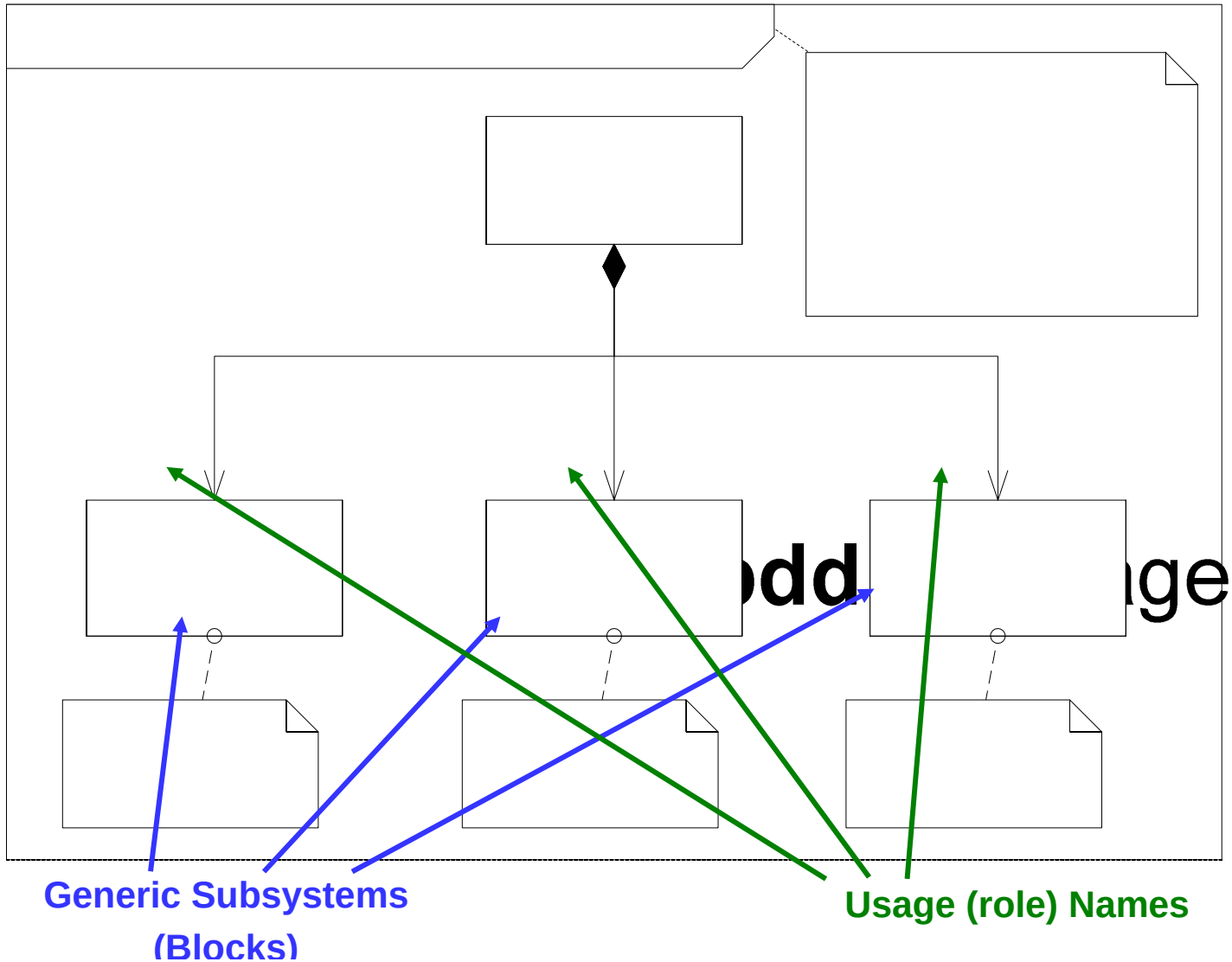
Example Requirements Diagram



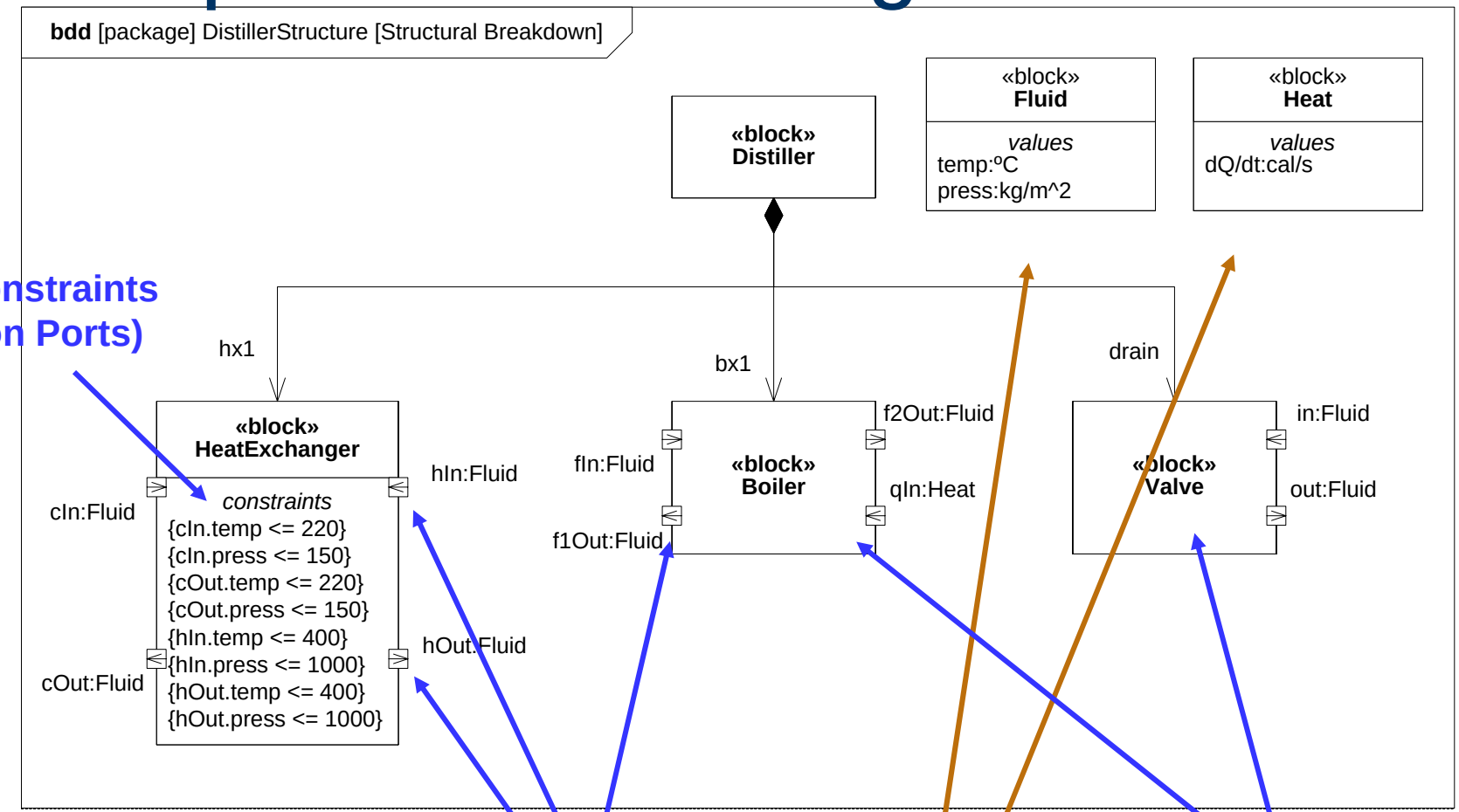
Zooming in on the Requirements



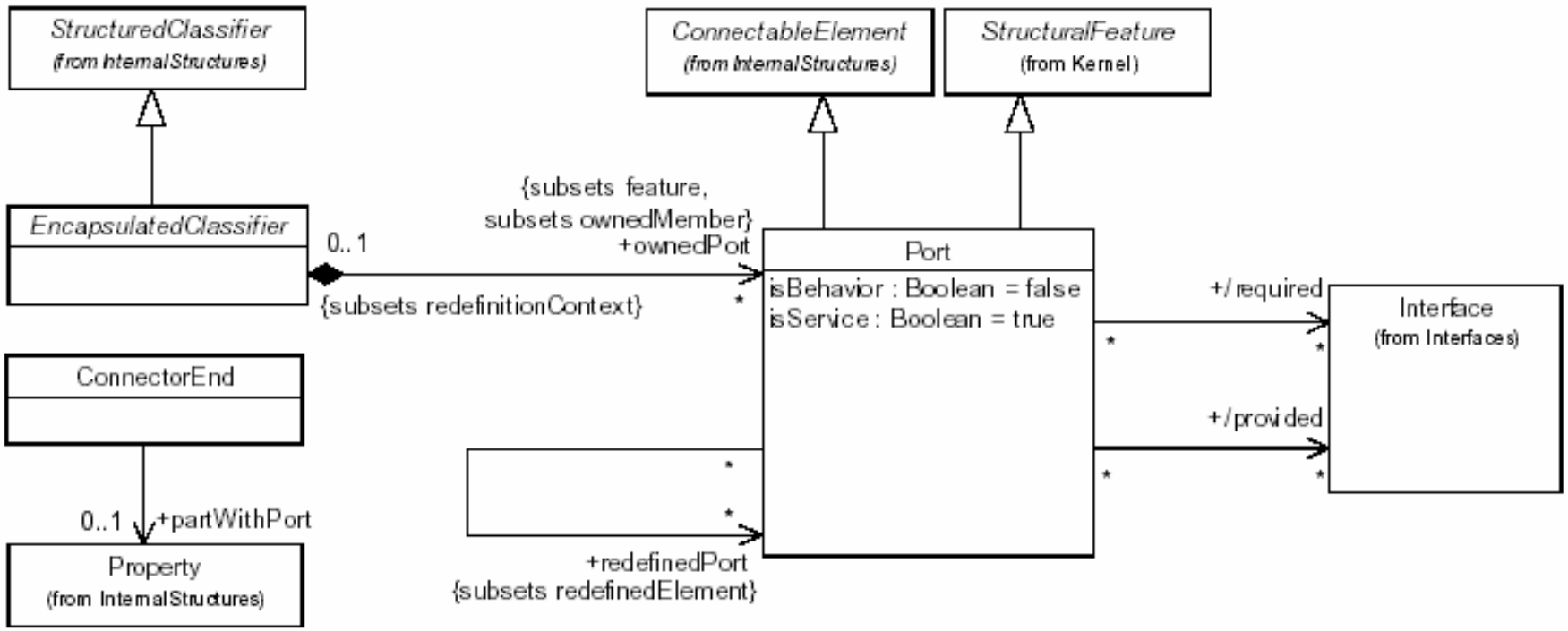
Example Block Definition Diagram



Example Heat Exchanger Flow Ports



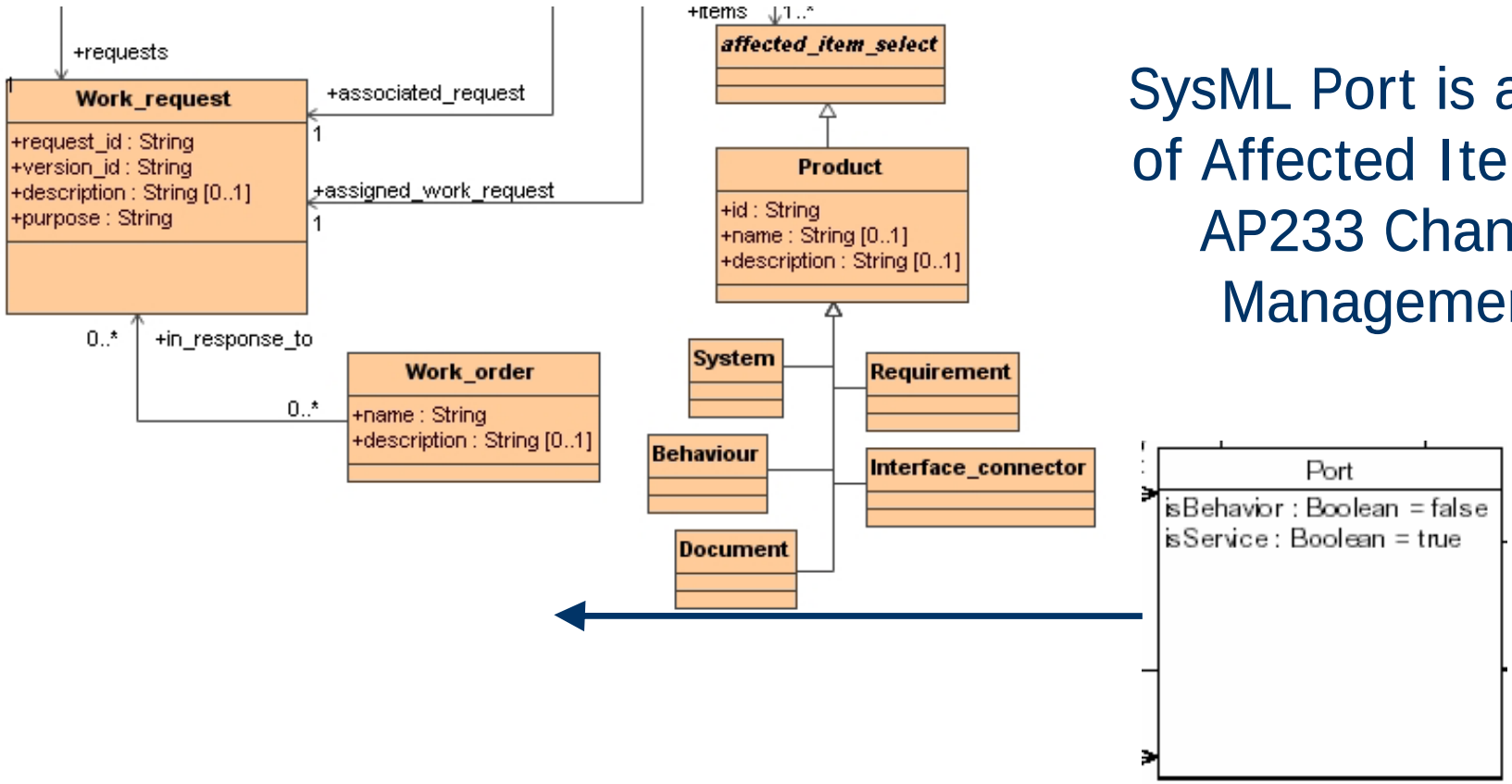
SysML Underlying Schema for Port



Initial SysML Map to AP233 CM Item

SysML Views	AP233 View
SysML Model	AP233 Document
SysML Package	AP233 System
SysML Block	AP233 System
SysML Requirement	AP233 Requirement
SysML State Machine	AP233 State Based Behaviour
SysML Ports	AP233 Interface Connector
SysML Use Case	AP233 Function Based Behaviour
SysML Problem	AP233 Work Request

Conceptually merge AP233/SysML



SysML Port is a kind of Affected Item for AP233 Change Management

Future integration approach

- ISO AP233 is modeled using the ISO EXPRESS information modeling language
- ISO EXPRESS being submitted to OMG for standardization, called MEXICO project
- Enables OMG Model Driven Architecture technologies to be applied to AP233 CM of SysML
  - Tight, direct, standardized AP233/SysML alignment

Issues for future work

- Working with multiple versions in SysML tools
- More work required on other SysML diagrams (e.g. Parametrics)
- Links between Items on diagrams and the SysML diagrams on which they appear in CM tools
- Feedback into SysML tools from CM tools

Conclusions

- ISO AP233 enables Engineering Change Management of significant aspects of SysML and other UML-based models
  - Brings more rigour to SE processes
- However, there's still plenty of work to be done
- Proof-of-concept development underway using our Share-A-space product as collaboration and change management tool for MagicDraw SysML tool

AP233 References

- DODAF/AP233 project site
  - http://www.exff.org/ap233
- AP233 standards team site
  - http://www.ap233.org
- Eurostep
  - http://ap233.eurostep.com (kickoff Nov 07)
  - http://www.eurostep.com
  - http://www.share-a-space.com