Applying MBSE to the Energy Sector

DIRK ZWEMER, MANAS BAJAJ & ROSE YNTEMA, INTERCAX LLC

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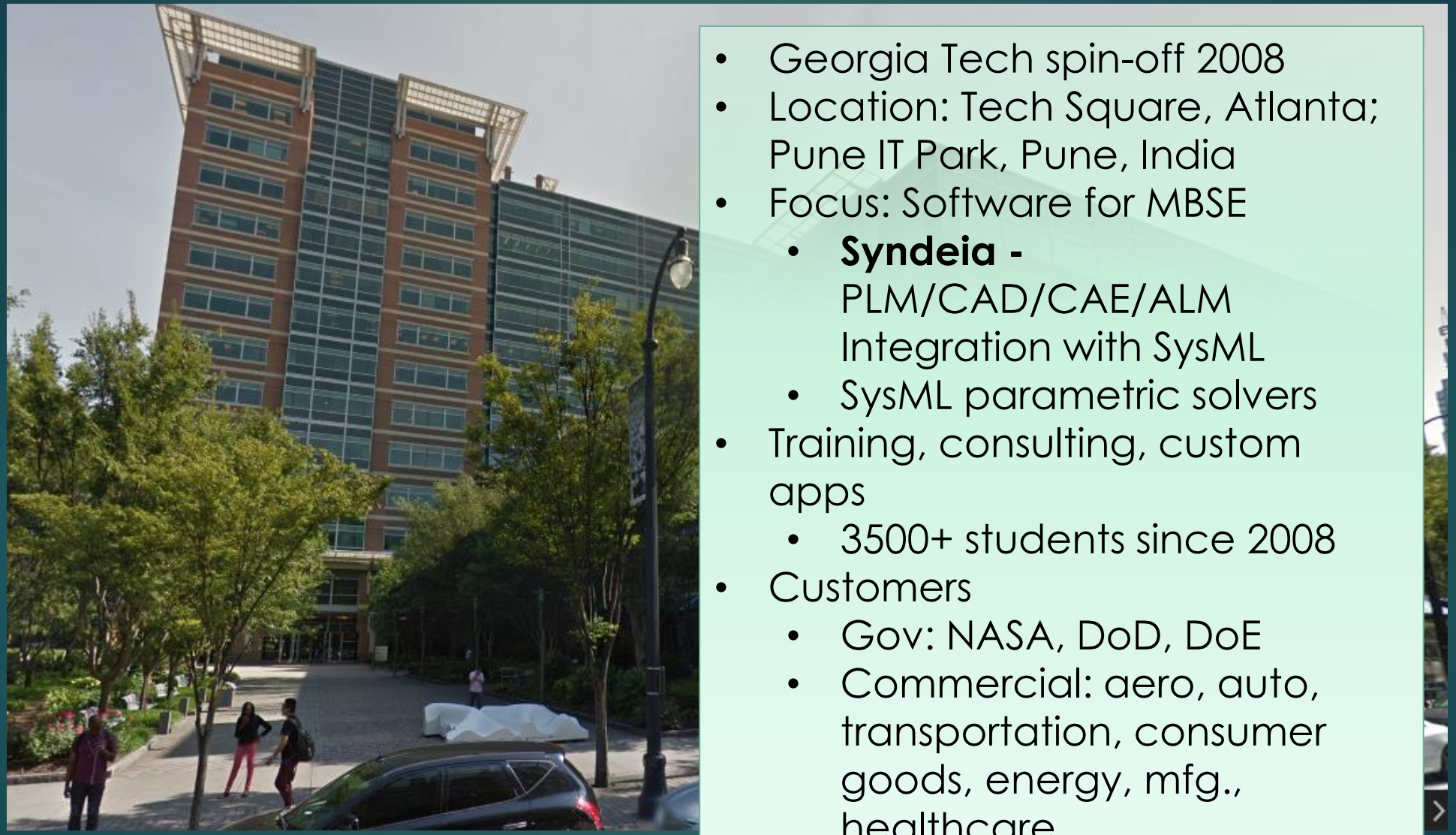
About Intercax



- Georgia Tech spin-off 2008
- Location: Tech Square, Atlanta; Pune IT Park, Pune, India
- Focus: Software for MBSE
  - **Syndeia -** PLM/CAD/CAE/ALM Integration with SysML
  - SysML parametric solvers
- Training, consulting, custom apps
  - 3500+ students since 2008
- Customers
  - Gov: NASA, DoD, DoE
  - Commercial: aero, auto, transportation, consumer goods, energy, mfg., healthcare

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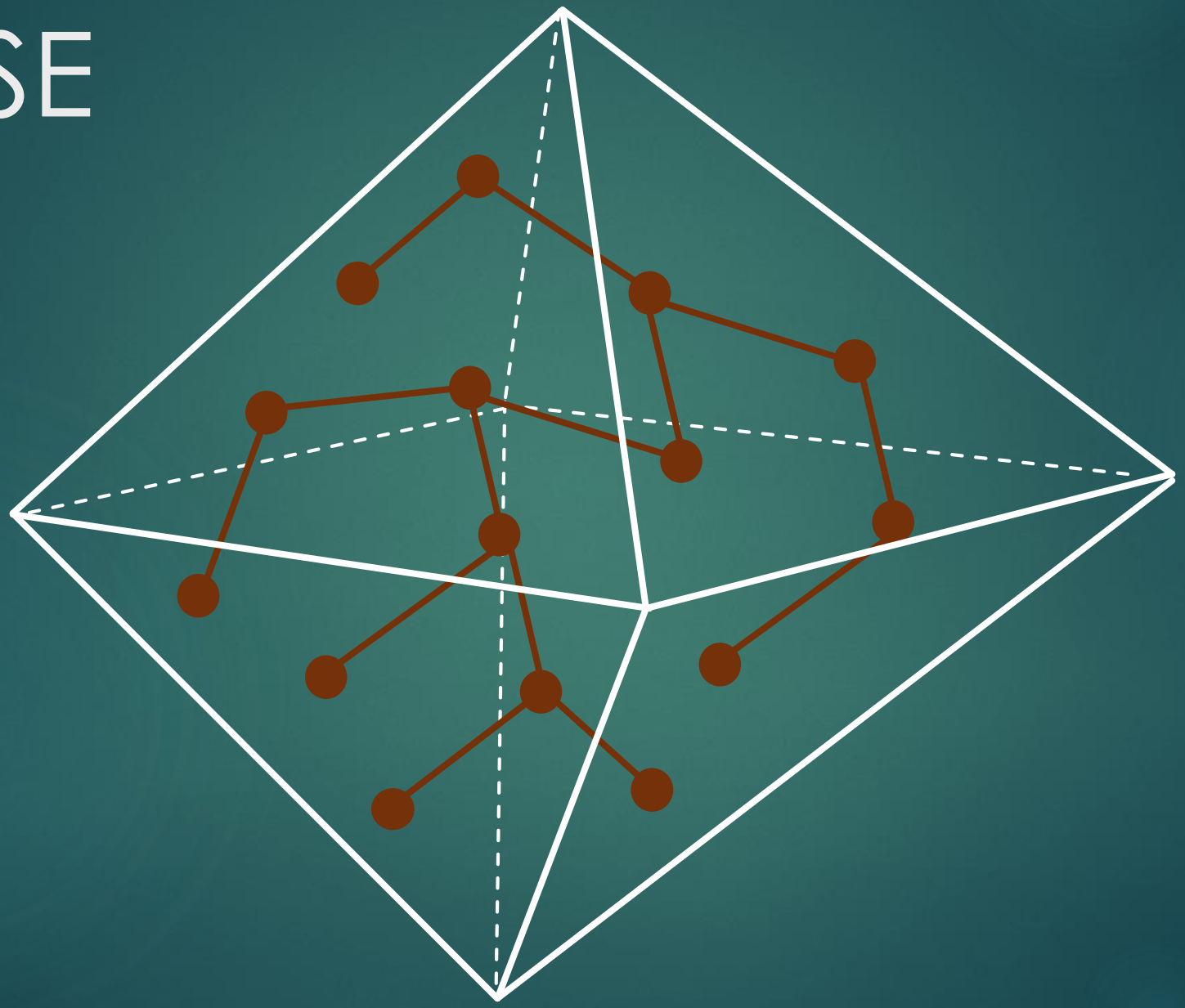
MBSE



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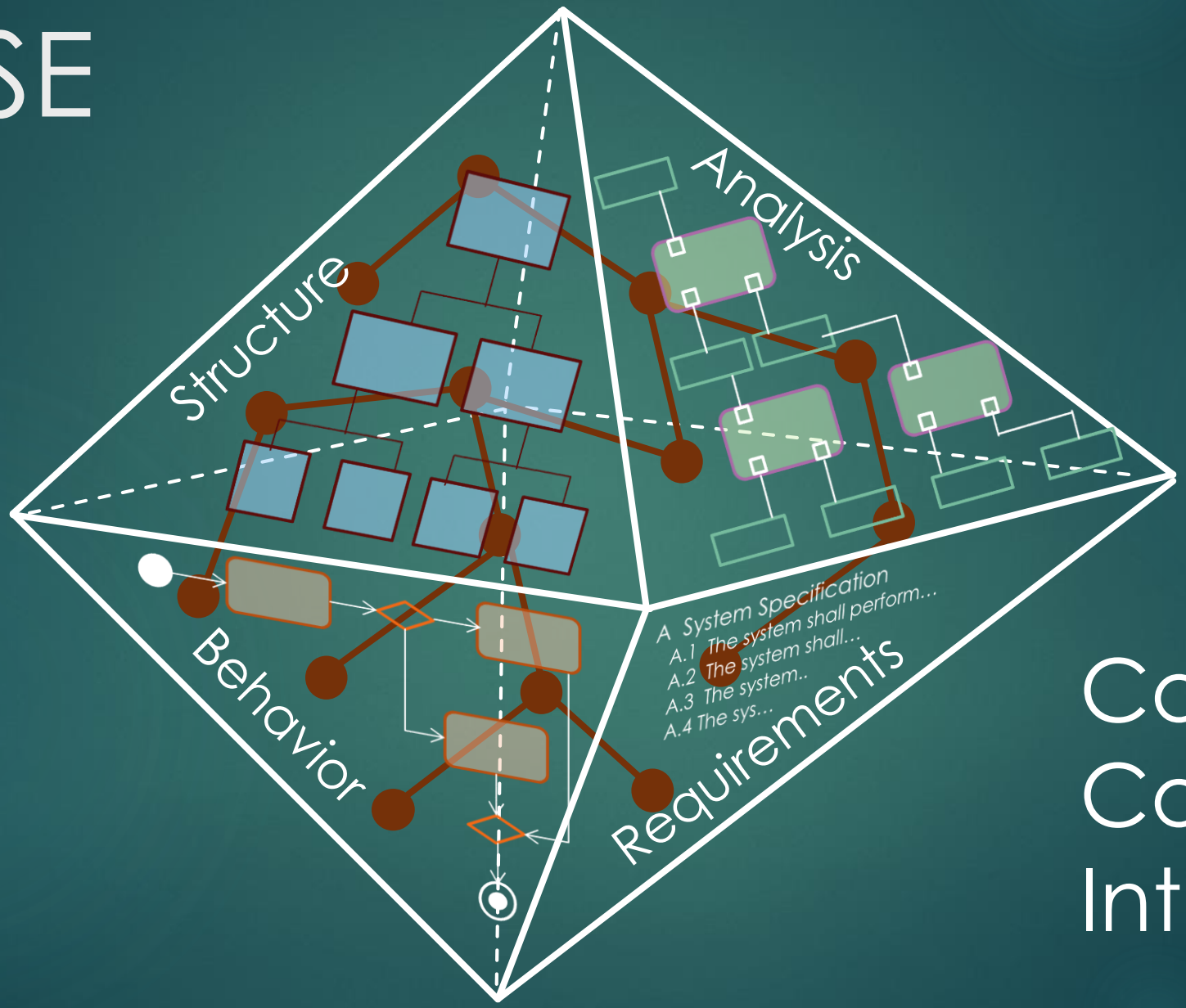
MBSE



Consistency
Coherence
Integrity

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The Engineering Software Universe

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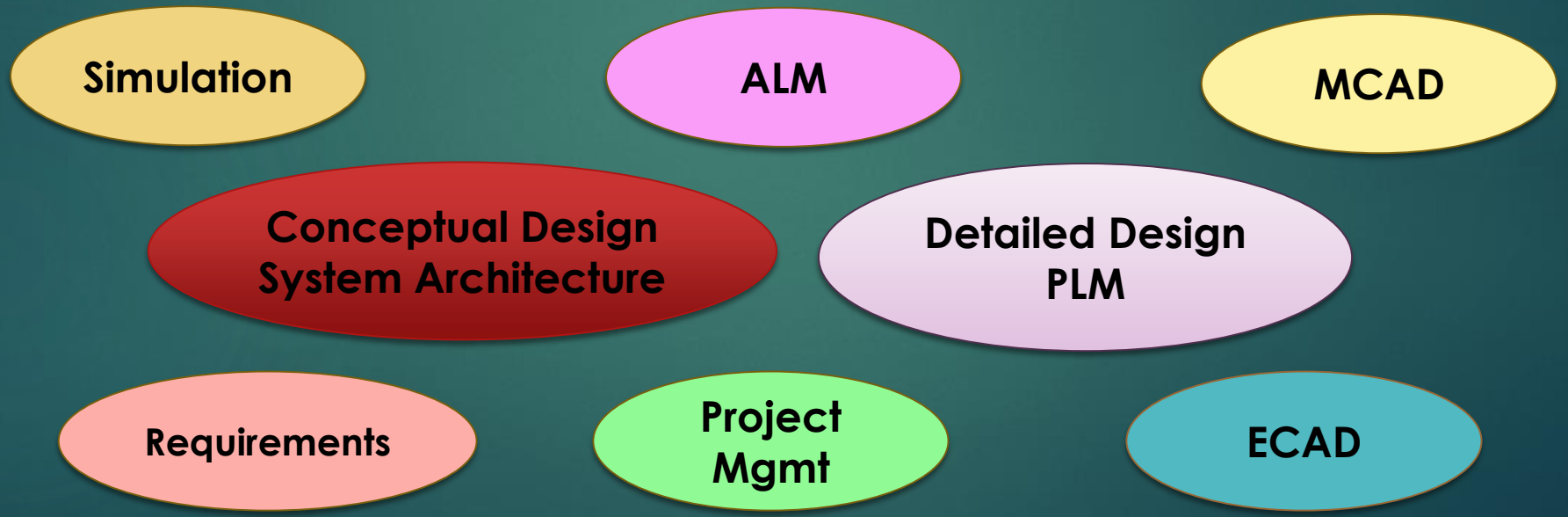
- Organizations deal with a diverse, multi-vendor engineering toolset.
- Organization create and store product/system data in a variety of tools, models and repositories: PLM, ALM, CAD, spreadsheets, SysML models…



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The Engineering Software Universe

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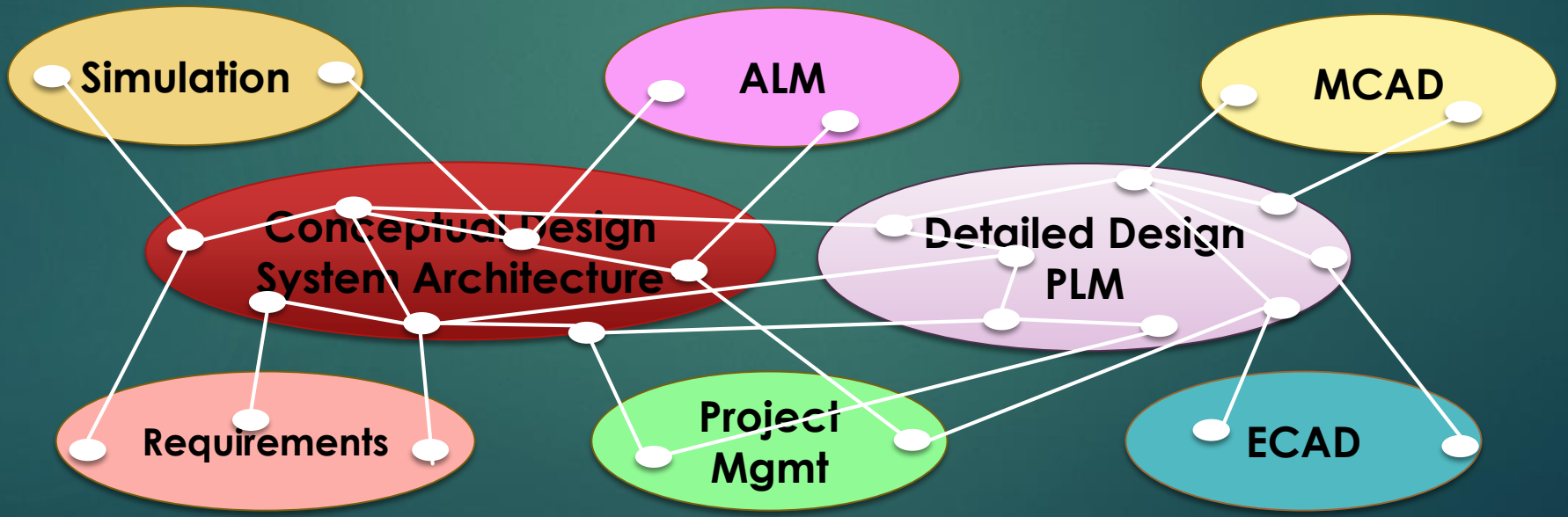
- The goal of MBE is to create a single, unified model (a Graph) extending over all the tools and data repositories.



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Why the Energy Sector Needs MBE

- Diversity of model types and tools
  - Multiple disciplines – electrical, mechanical, software, …
  - Multiple purposes – design, construction, operation
  - Multiple scales – individual user to national grid
  - Multiple stakeholders – financial, environmental, …
- Resilience, safety and security are critical
  - MBE should expose unexpected chains of causation
  - Predict emergent behaviors and vulnerabilities

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Building the Graph

- POPULATING THE SYSML MODEL FROM EXTERNAL TOOLS
- ADDING RELATIONSHIPS WITHIN THE SYSML MODEL
- POPULATING EXTERNAL TOOLS FROM THE SYSML MODEL

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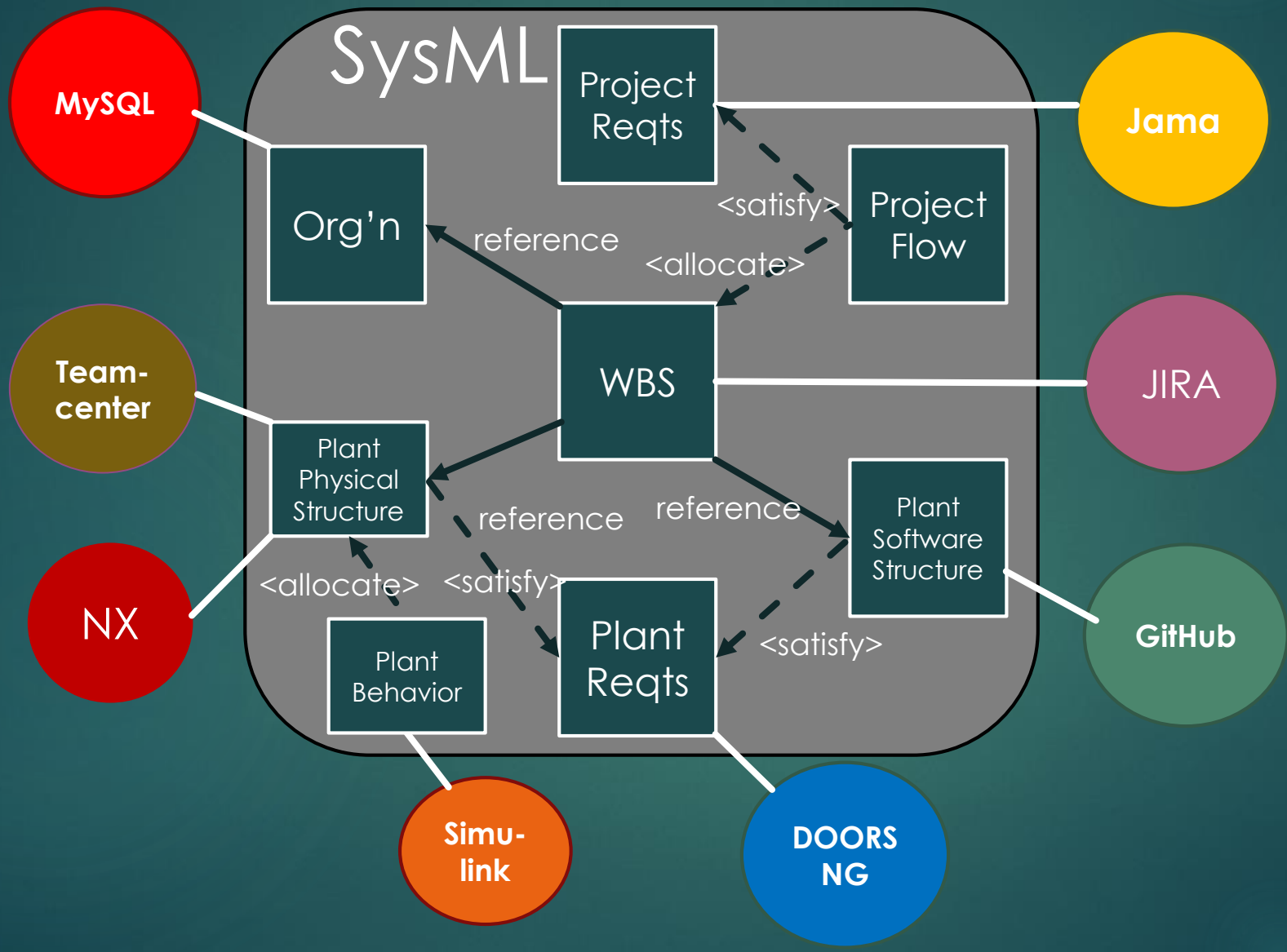
Total System Model



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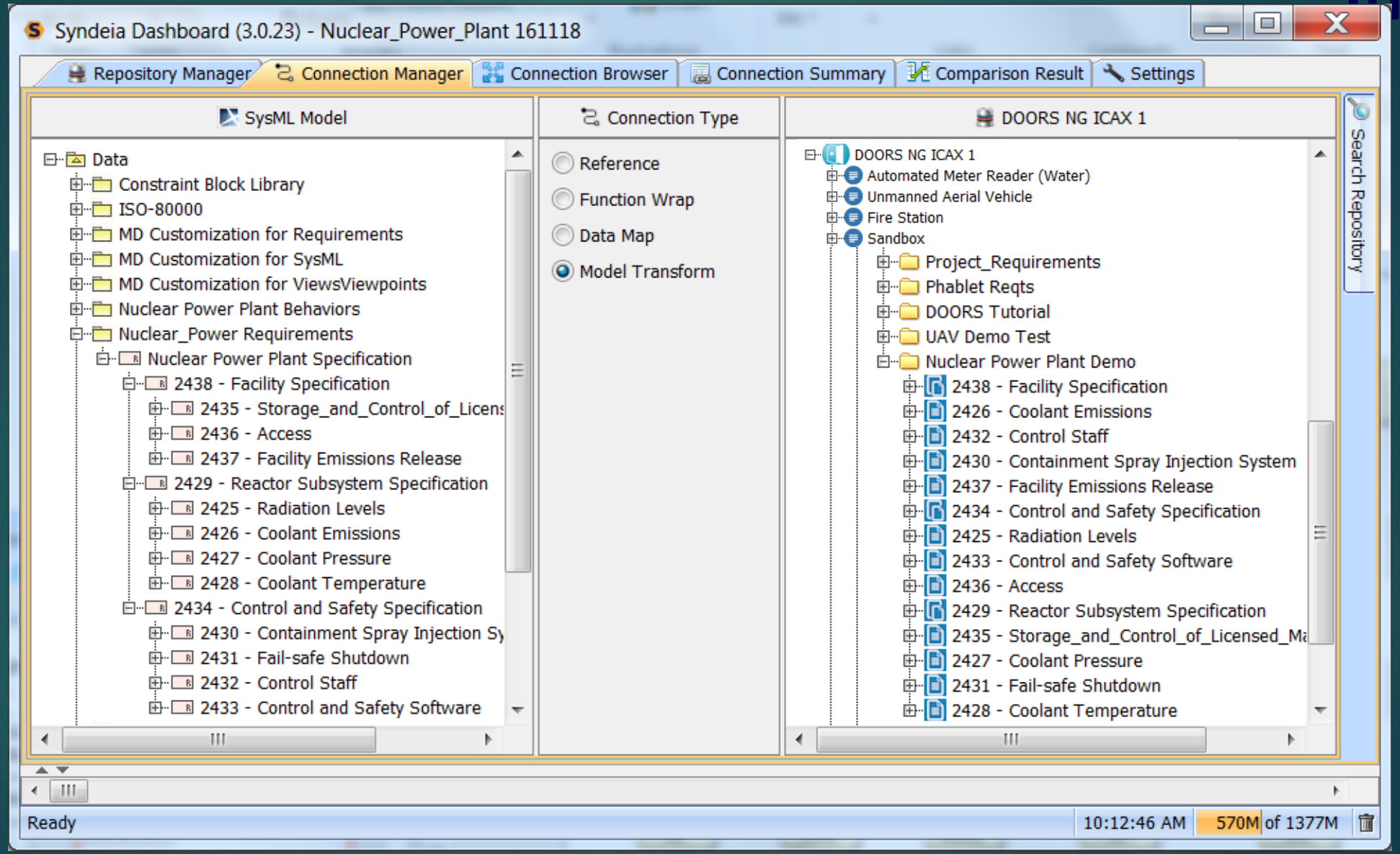
Importing Requirements into SysML



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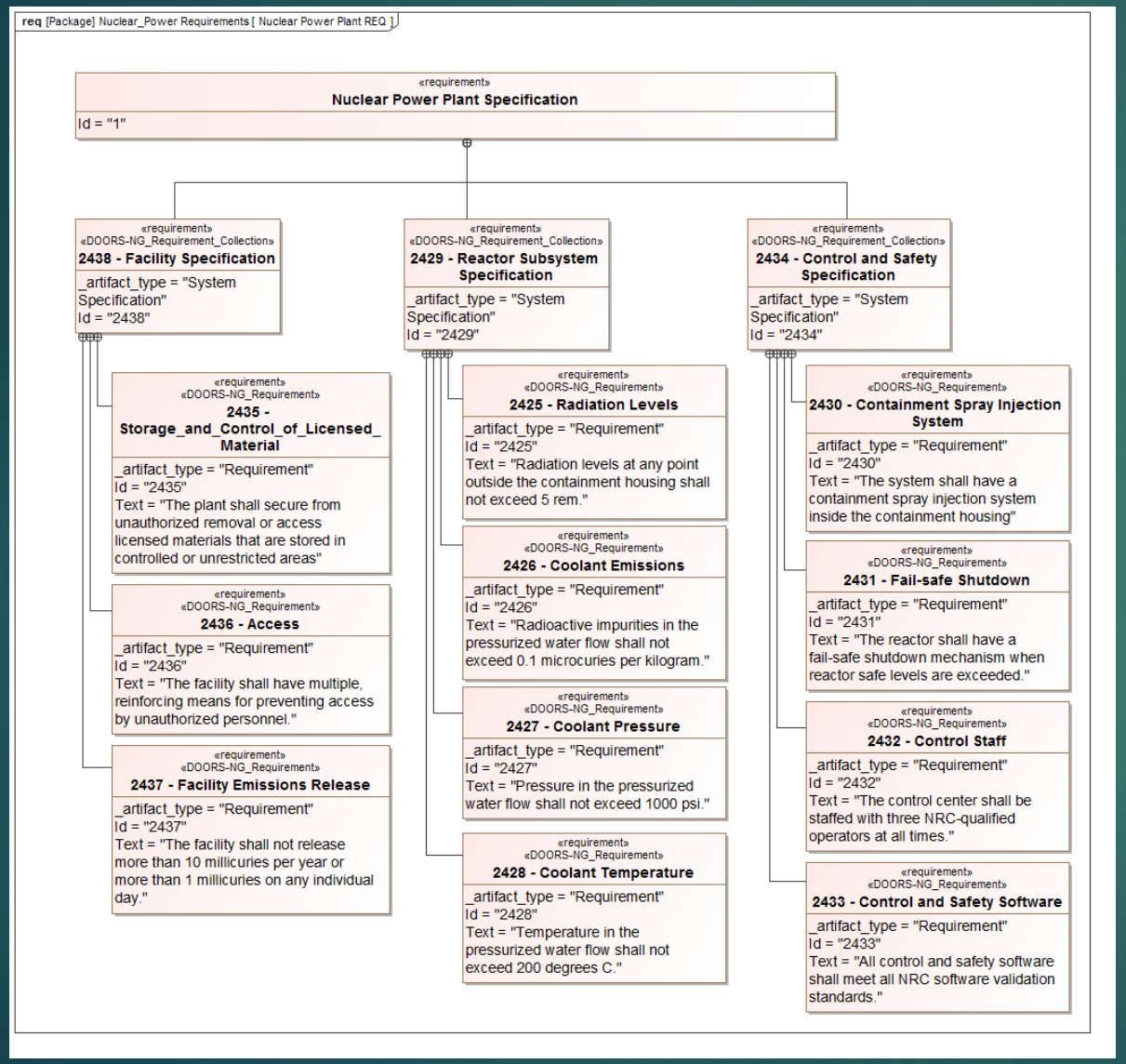
Importing Requirements into SysML



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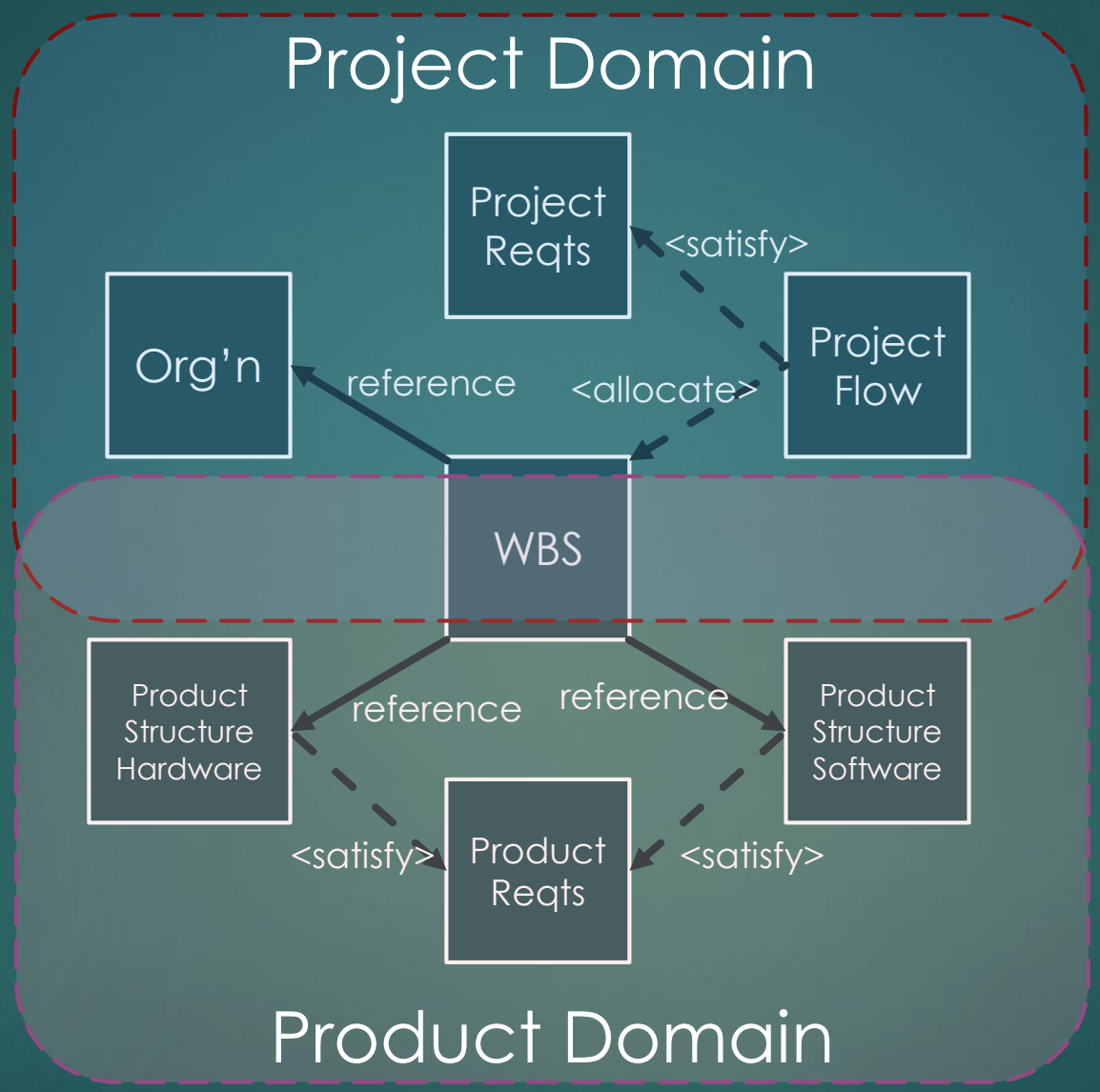
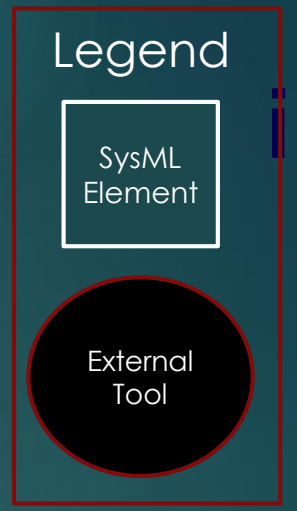
Building the SysML model





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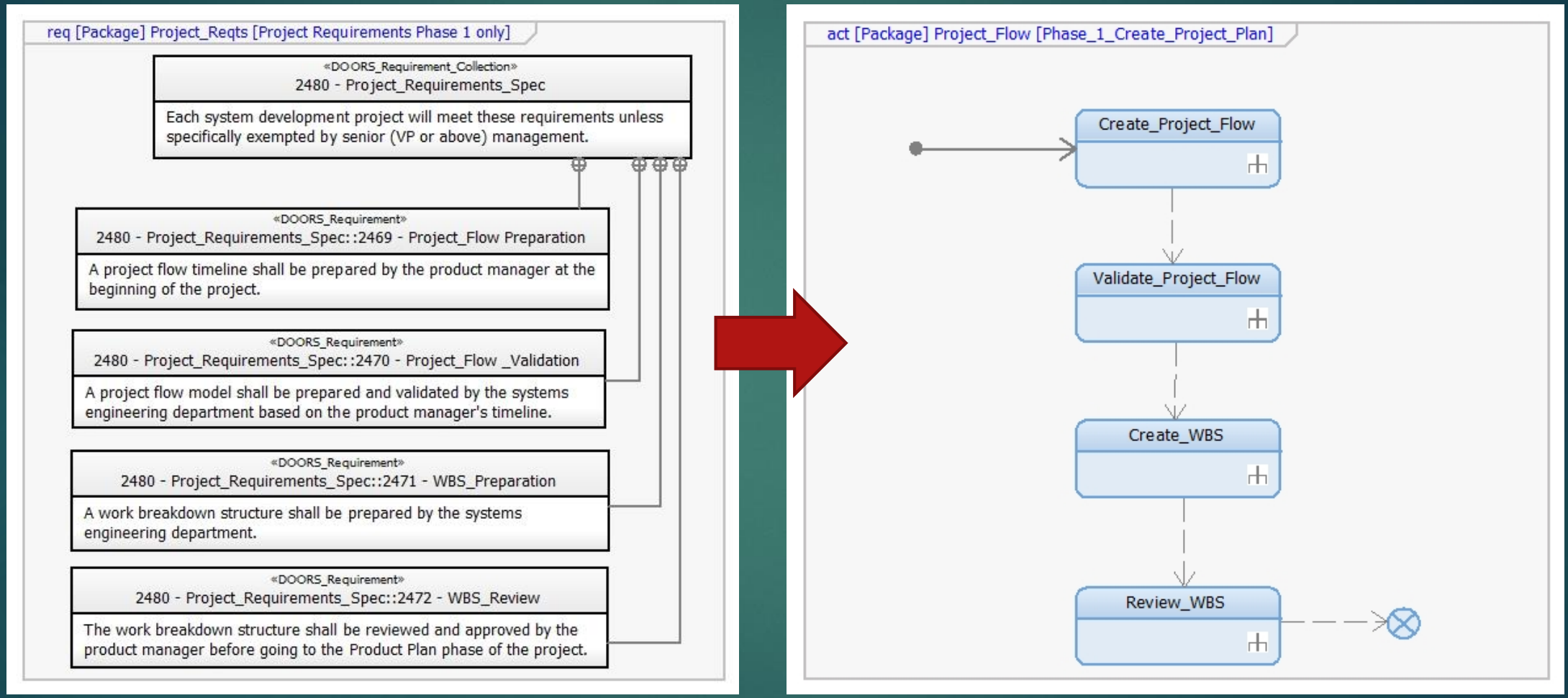
Project Requirements into Process Flows



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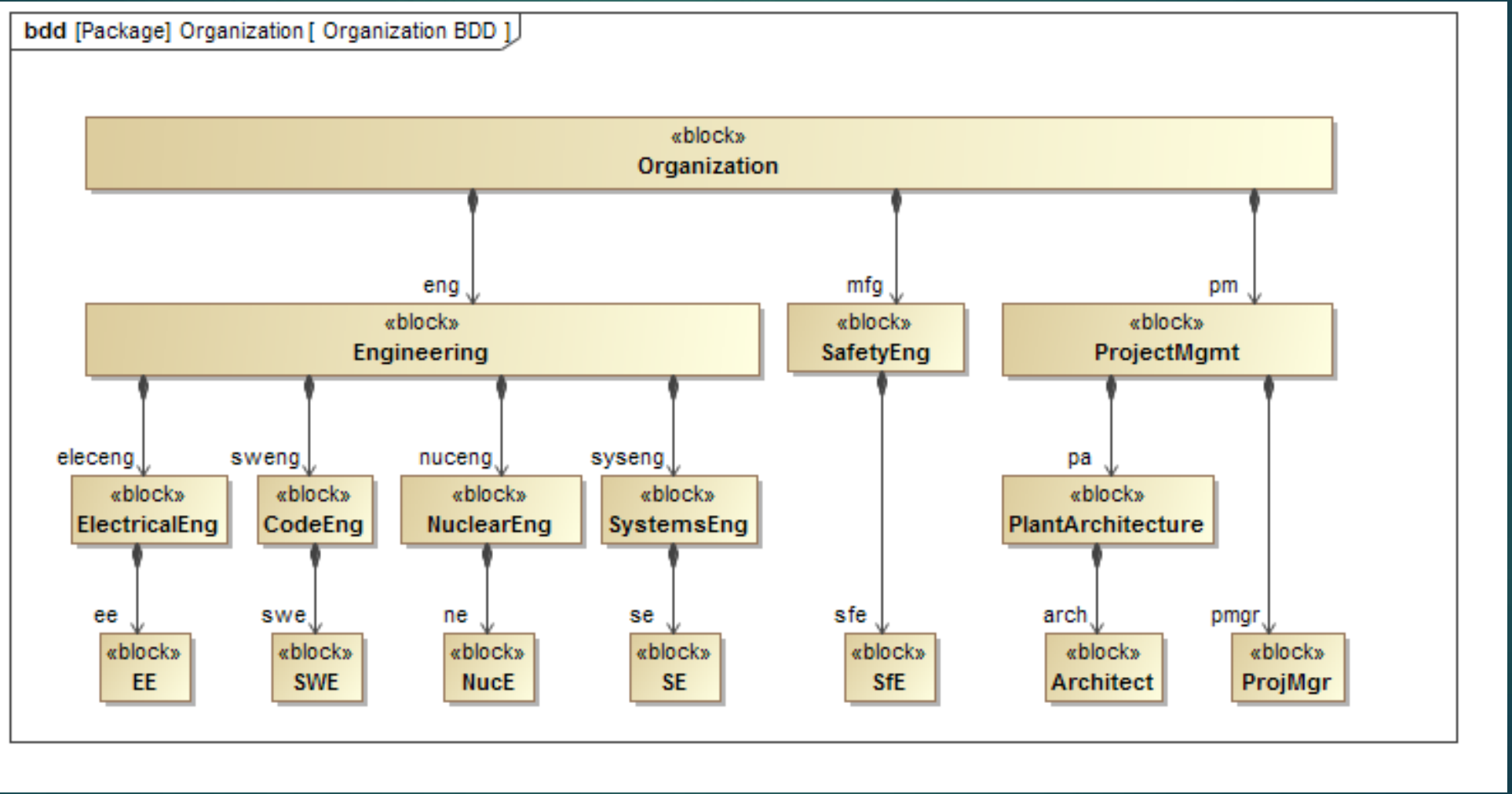
Modeling the Project Organization



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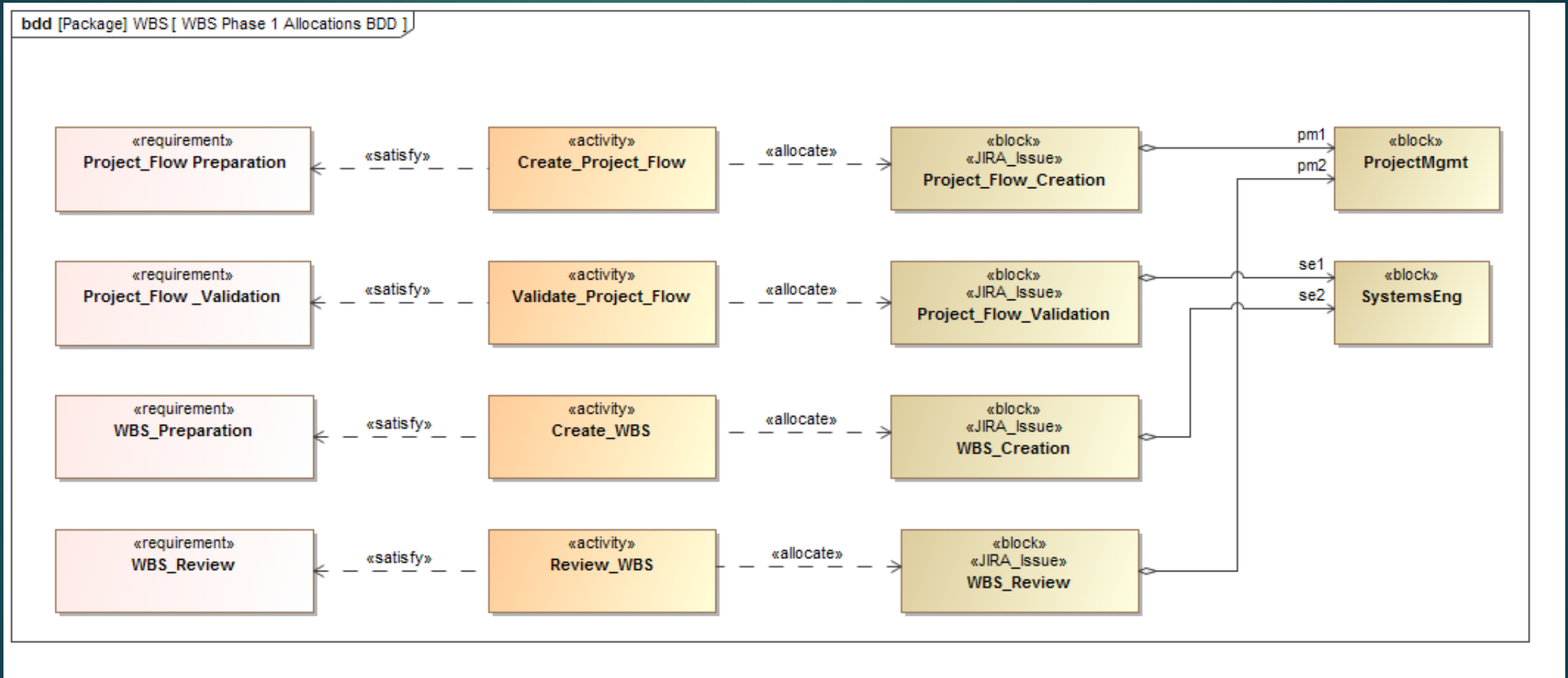
Linking Project Requirements, Processes, Tasks and Organization



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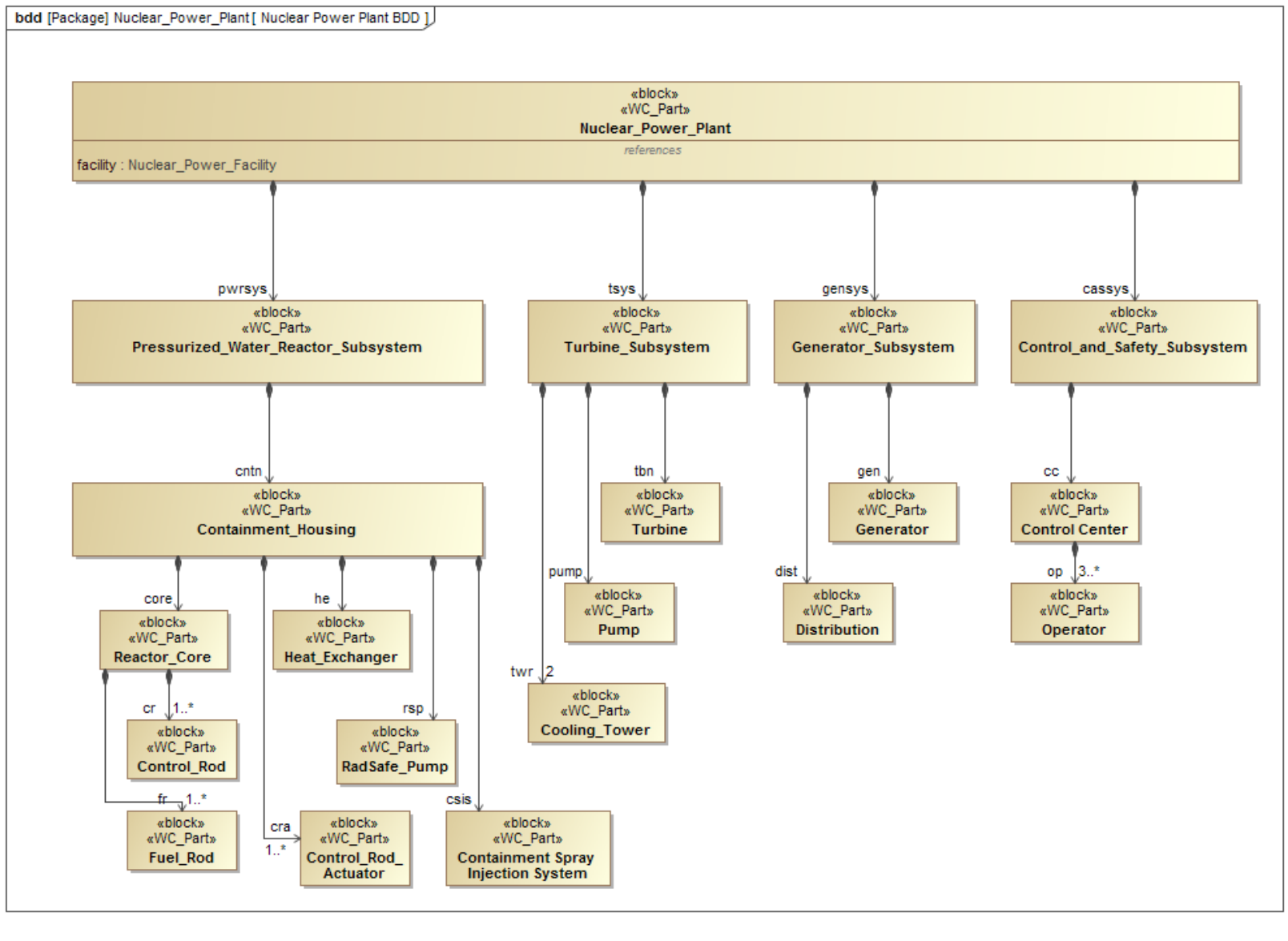
Modeling the Power Plant Structure



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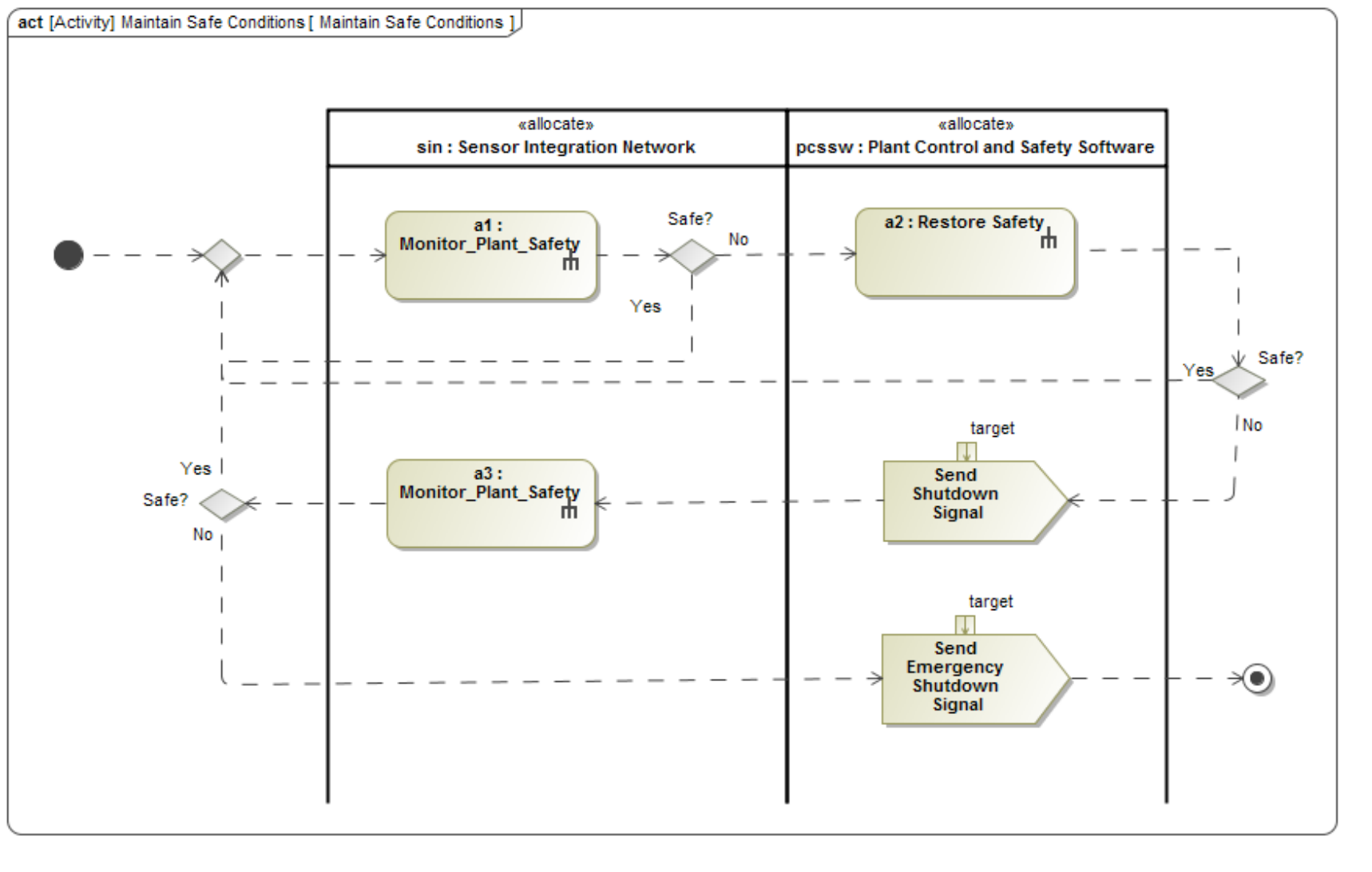
Modeling Power Plant Behavior



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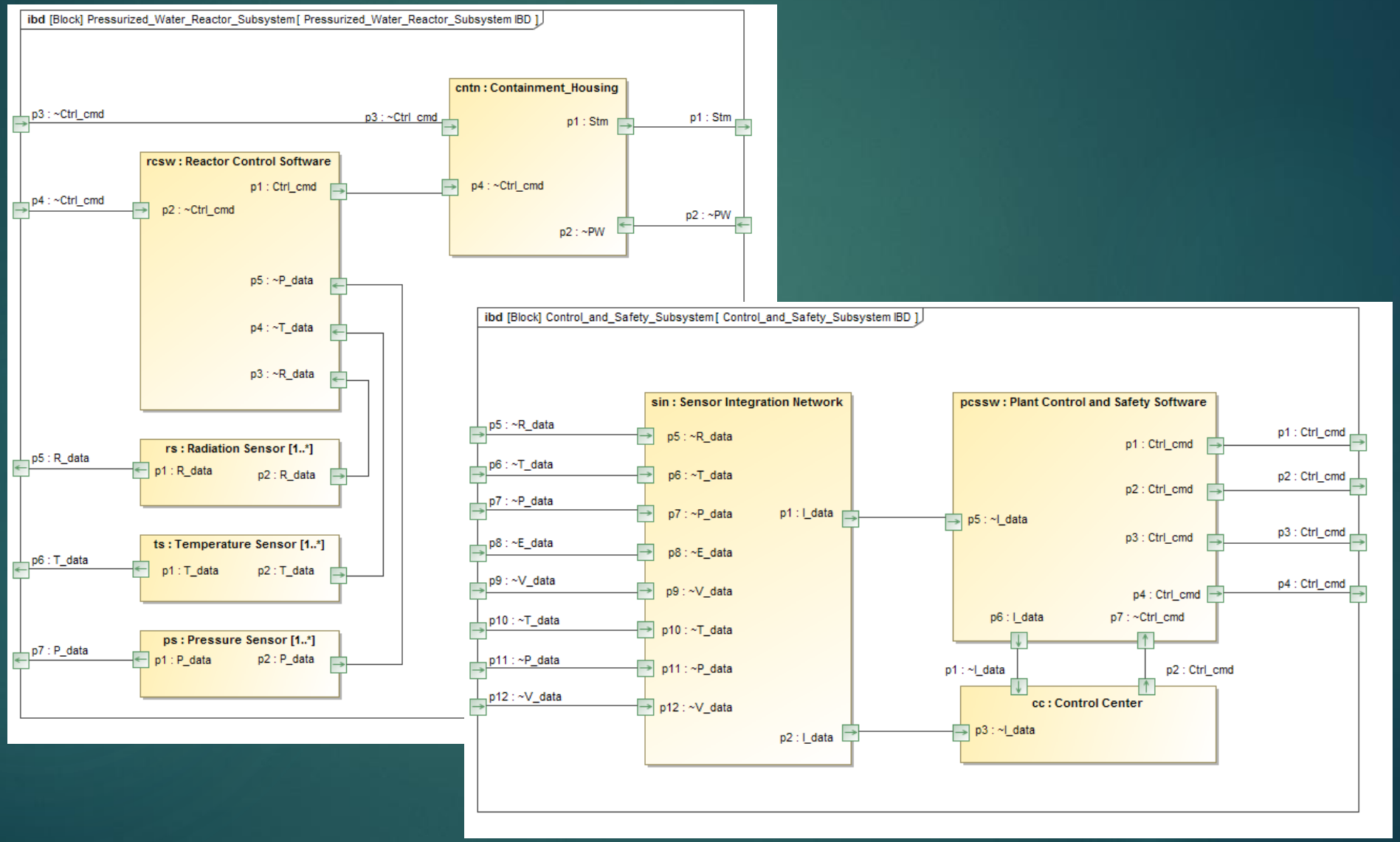
Modeling Power Plant Interfaces



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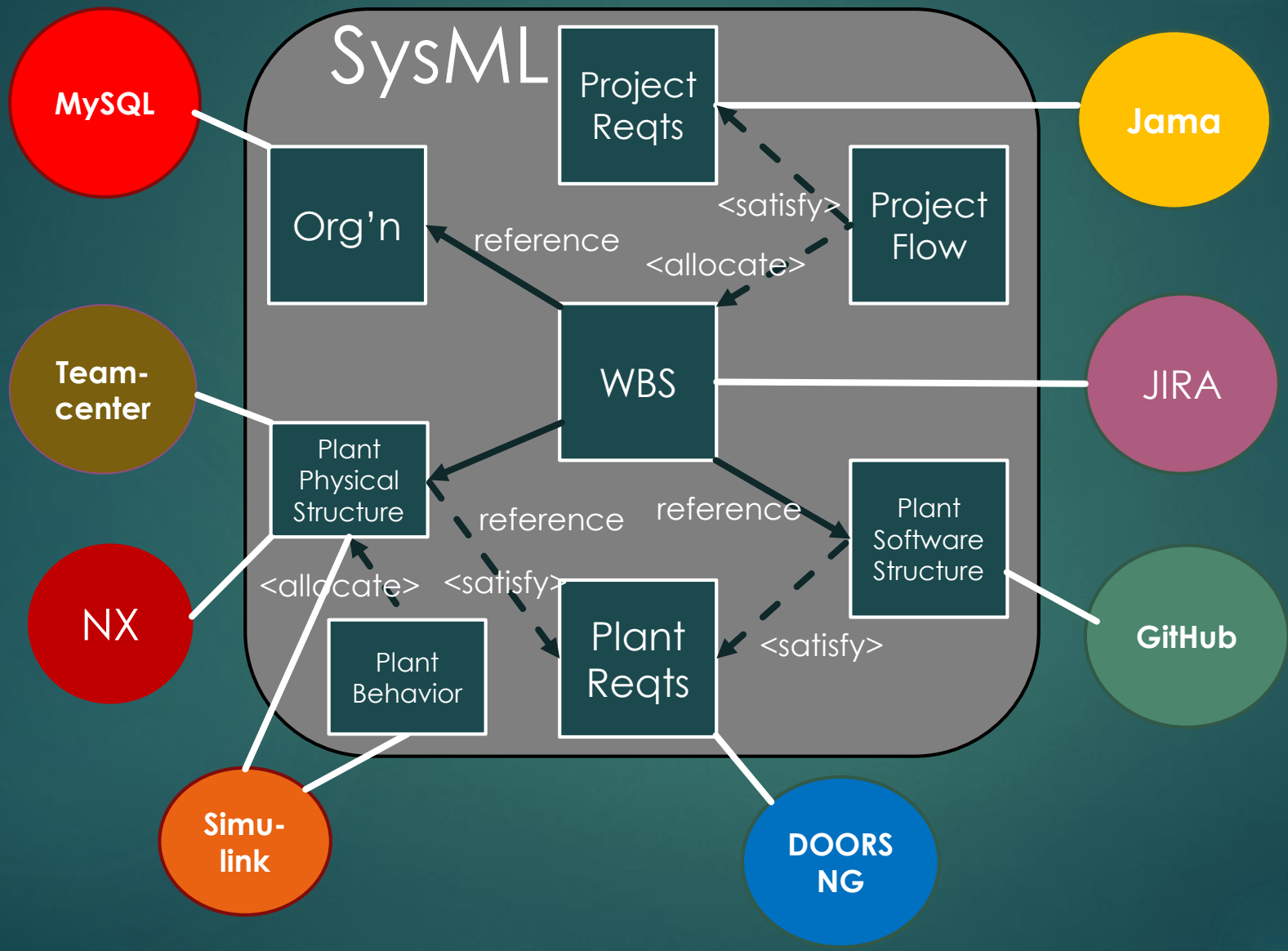
Total System Model



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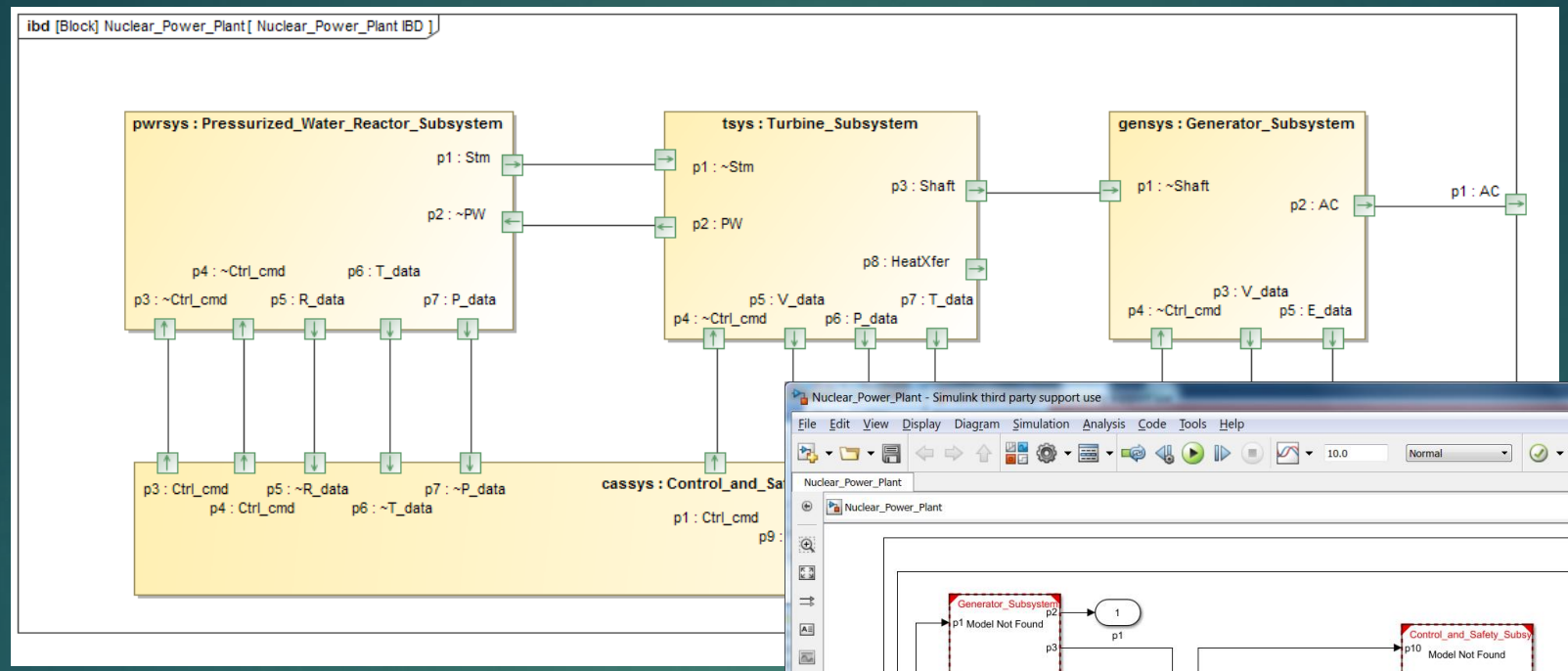
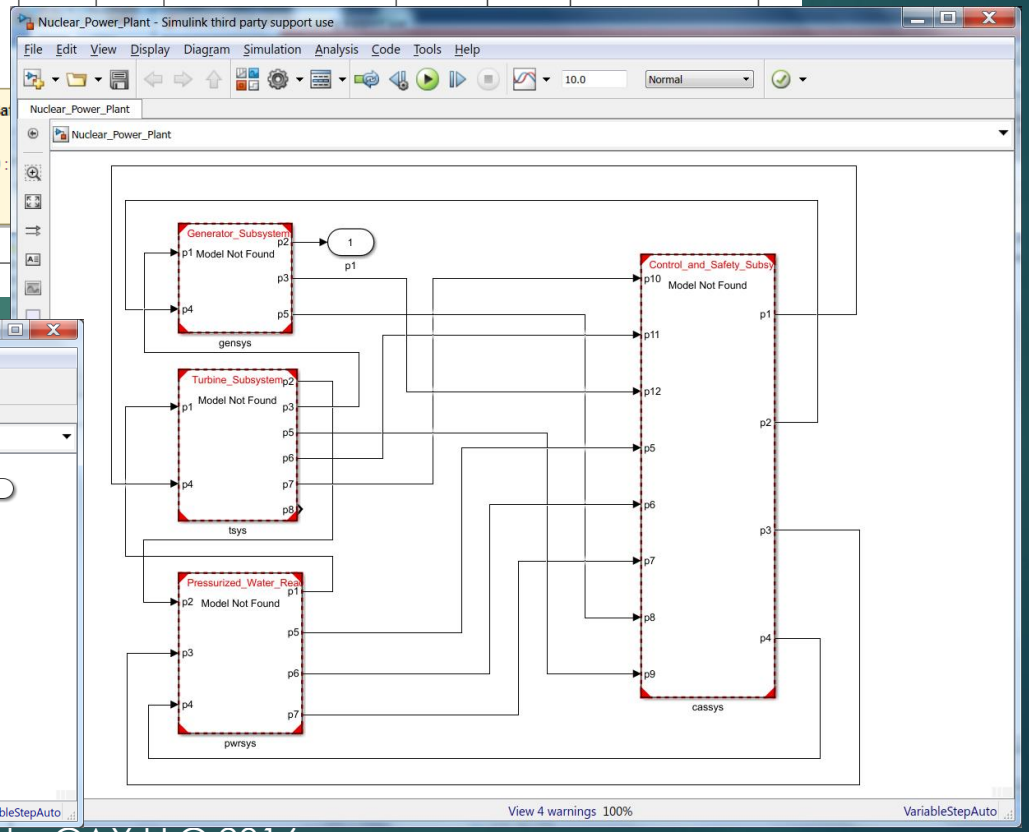
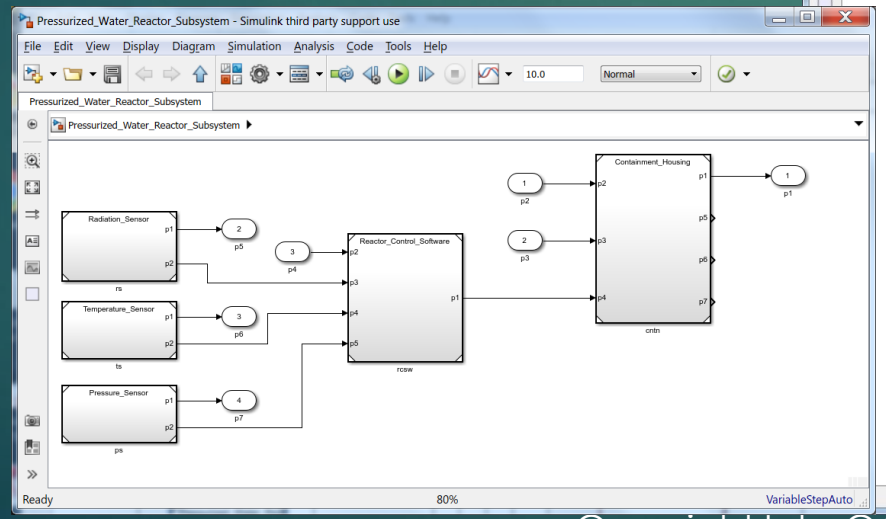
Linking Power Plant Architecture and Simulation







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Using the Graph

- ACCESSING EXTERNAL DATA THROUGH THE SYSML MODEL
- COMPARING AND SYNCHRONIZING BETWEEN SYSML AND EXTERNAL DATA

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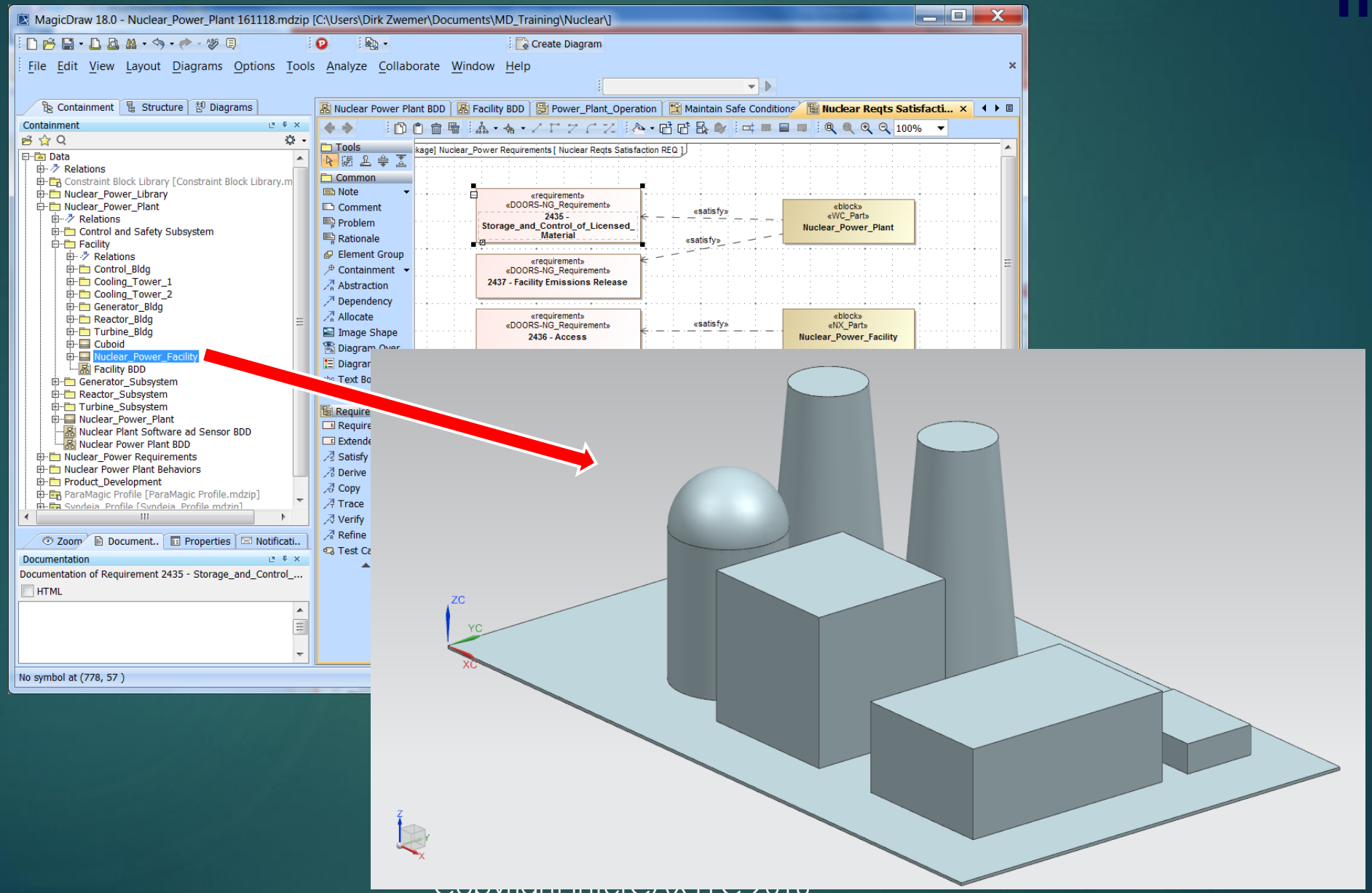
Accessing CAD Files through the SysML Model



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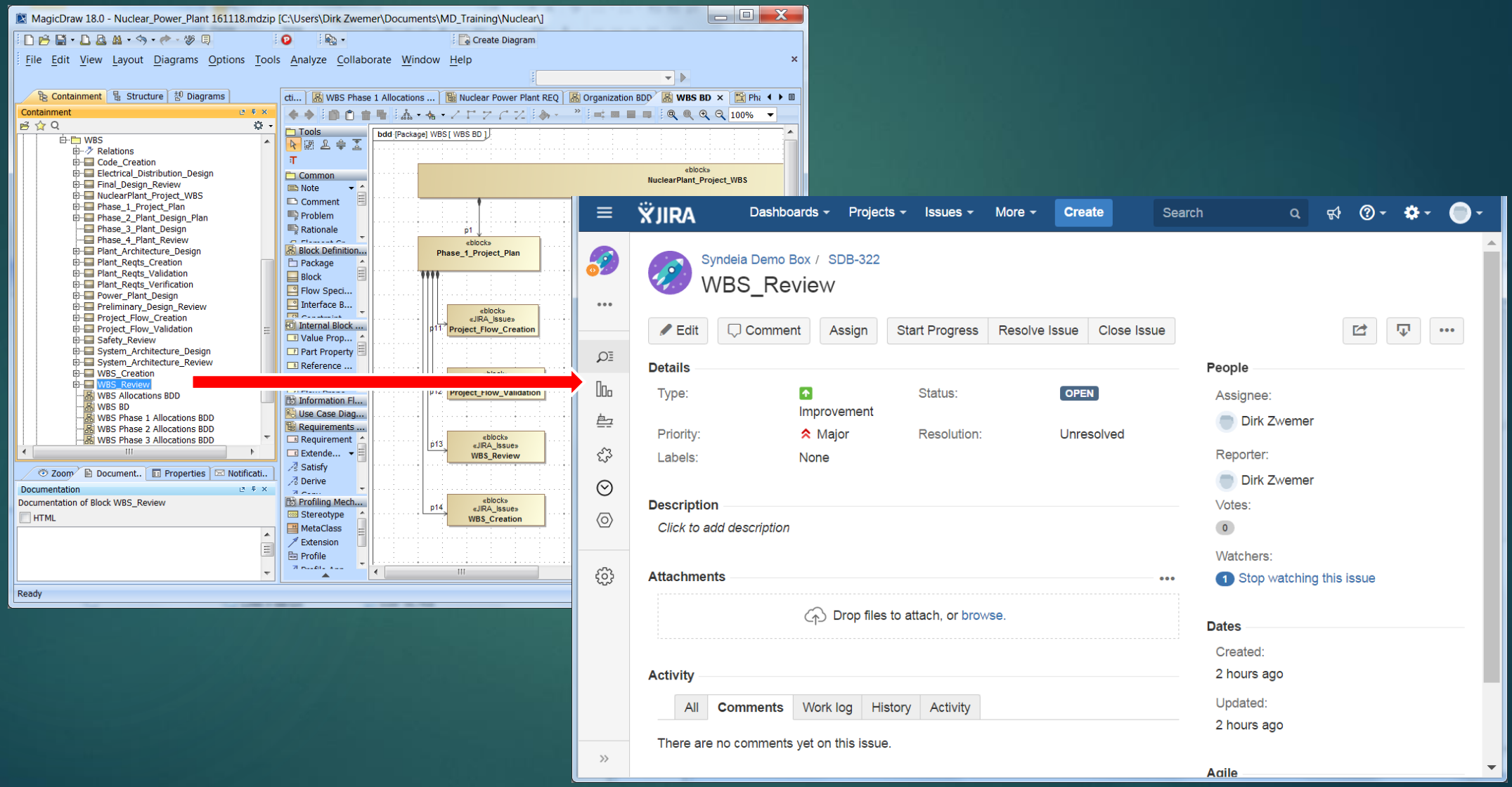
Accessing Project Management Issues



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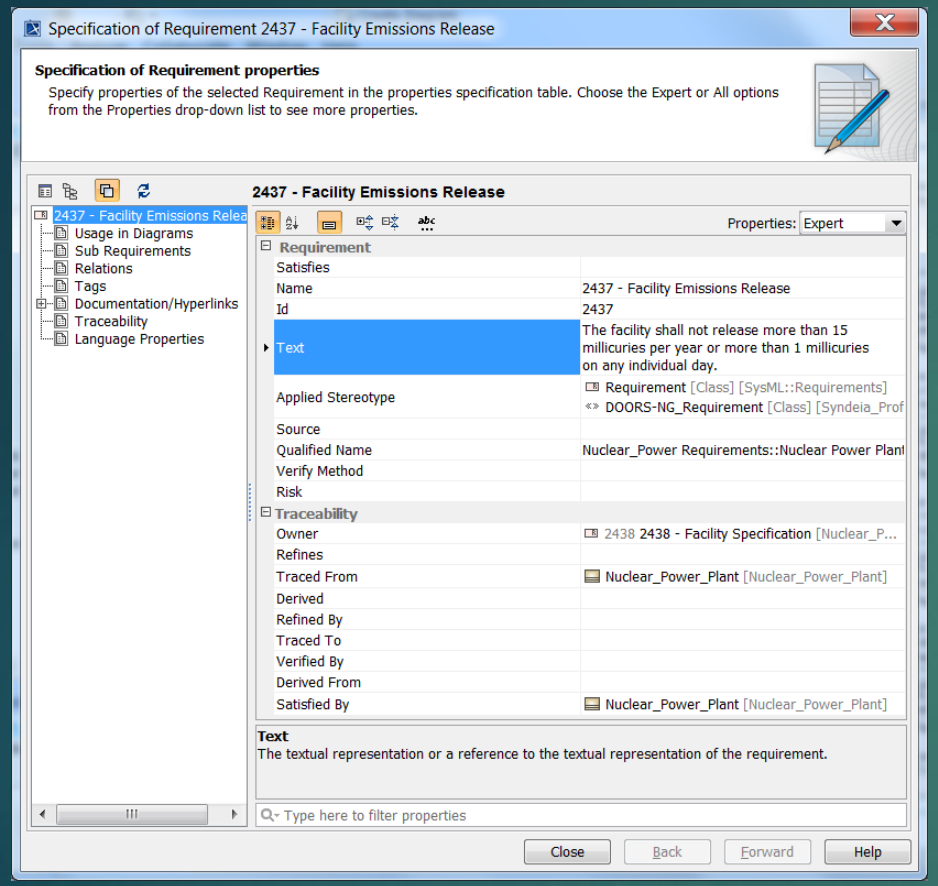
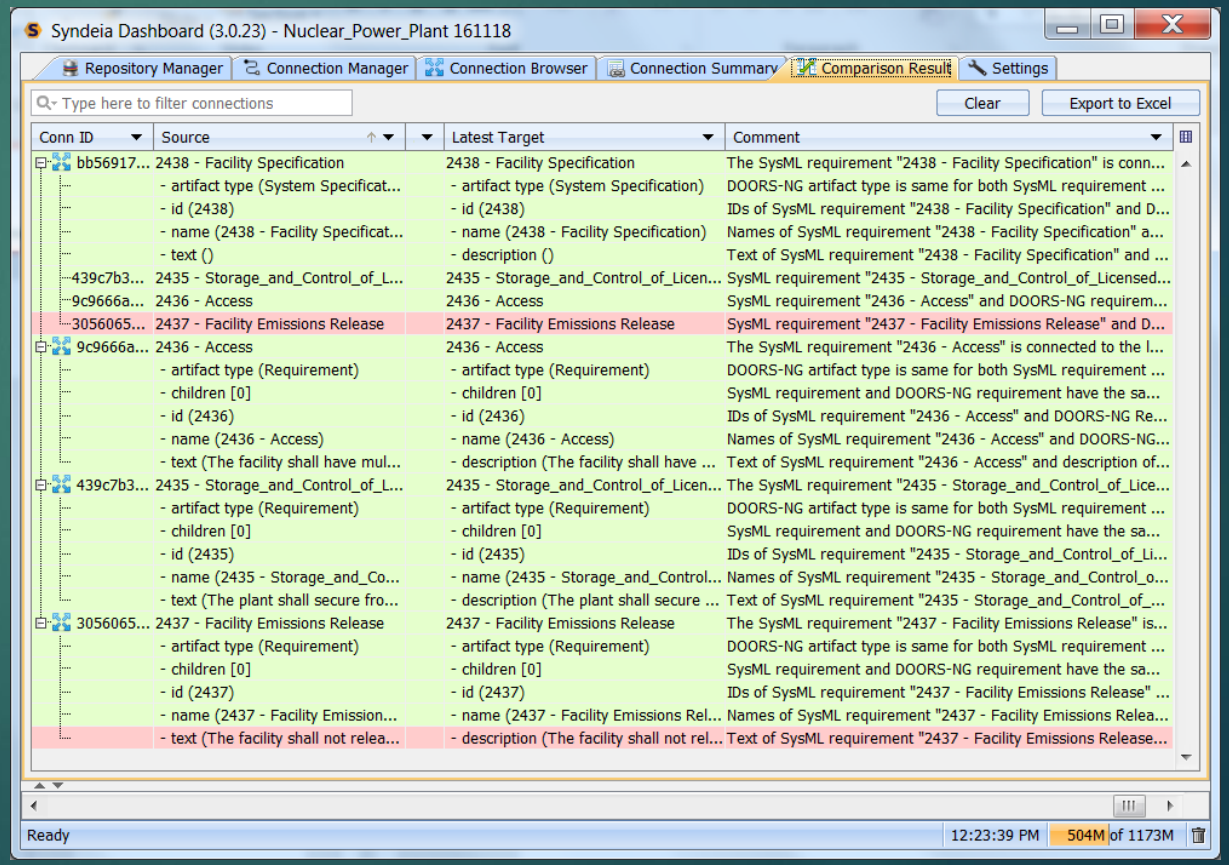
Comparing Linked Requirements in SysML and DOORS NG





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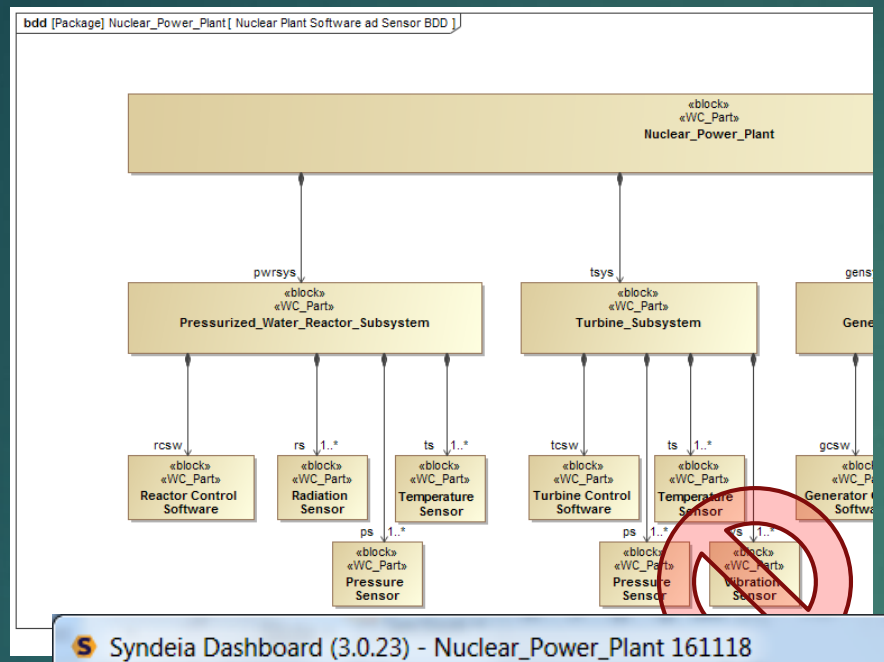
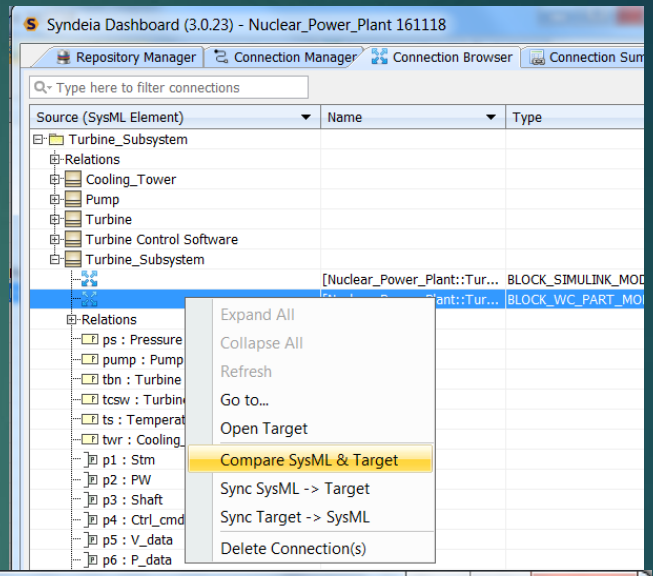
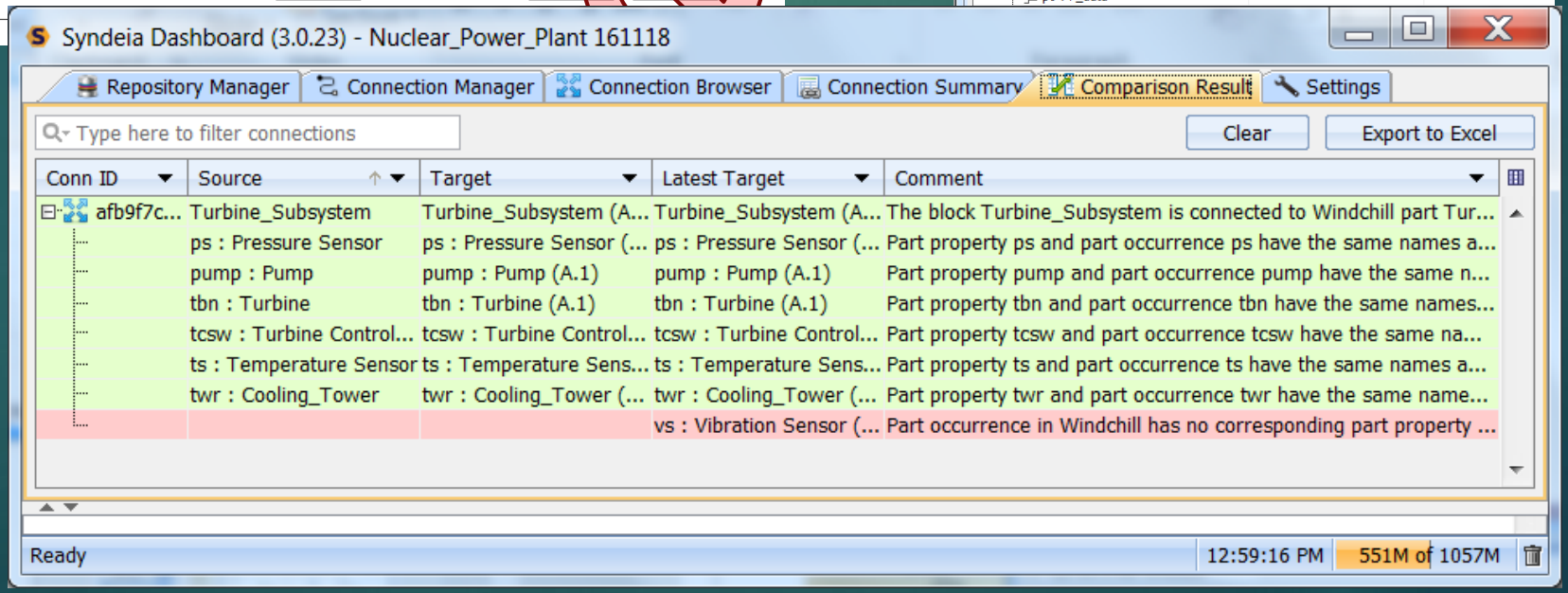
Comparing Structure in SysML and PLM







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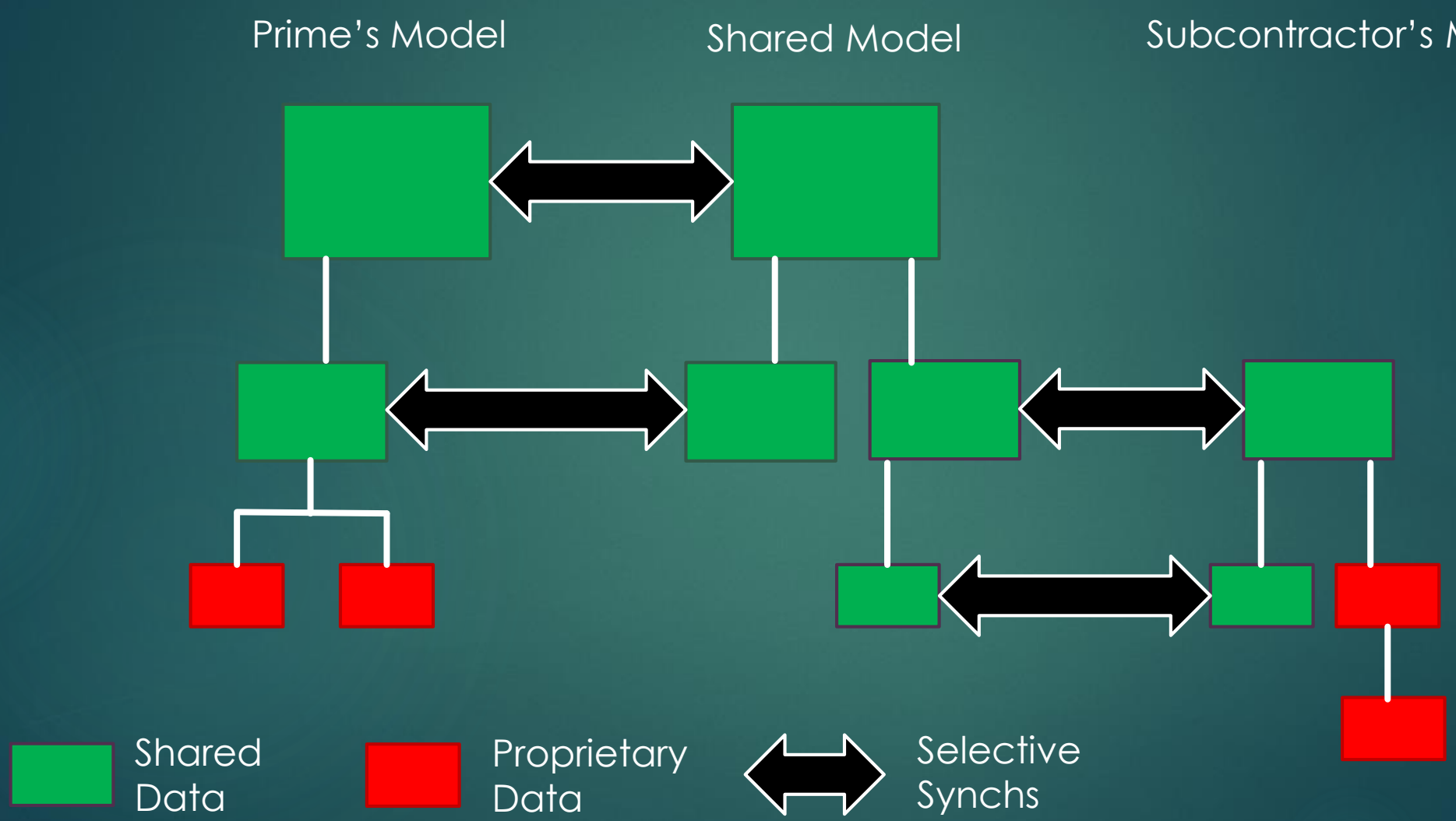
How can linked models protect proprietary data?



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Querying the Graph

- VISUALIZING THE INTERMODEL CONNECTIONS
- VISUALIZING EXTENDED CHAINS
- QUERYING THE GRAPH DATABASE (PROTOTYPE)

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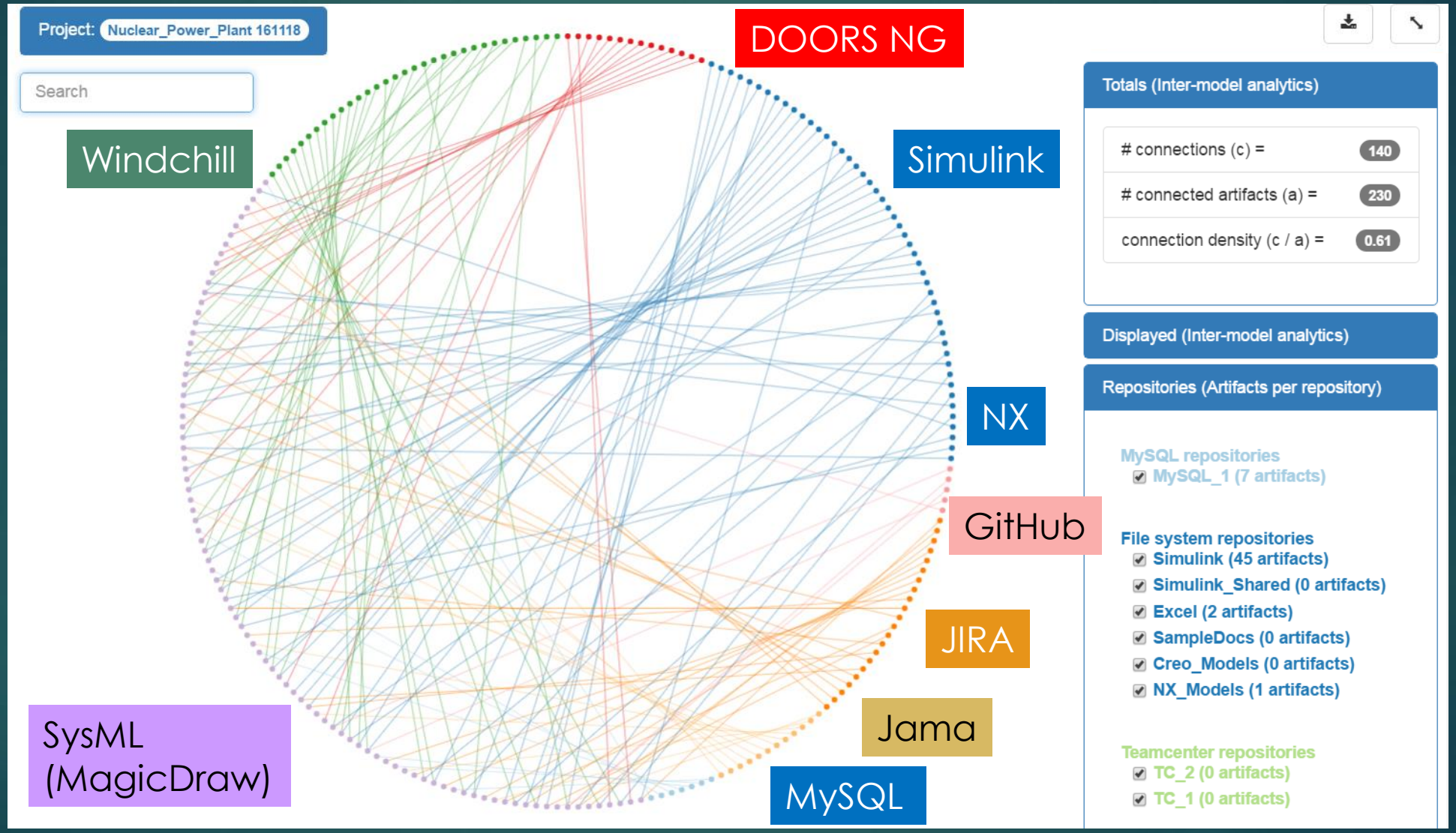
Global Visualization



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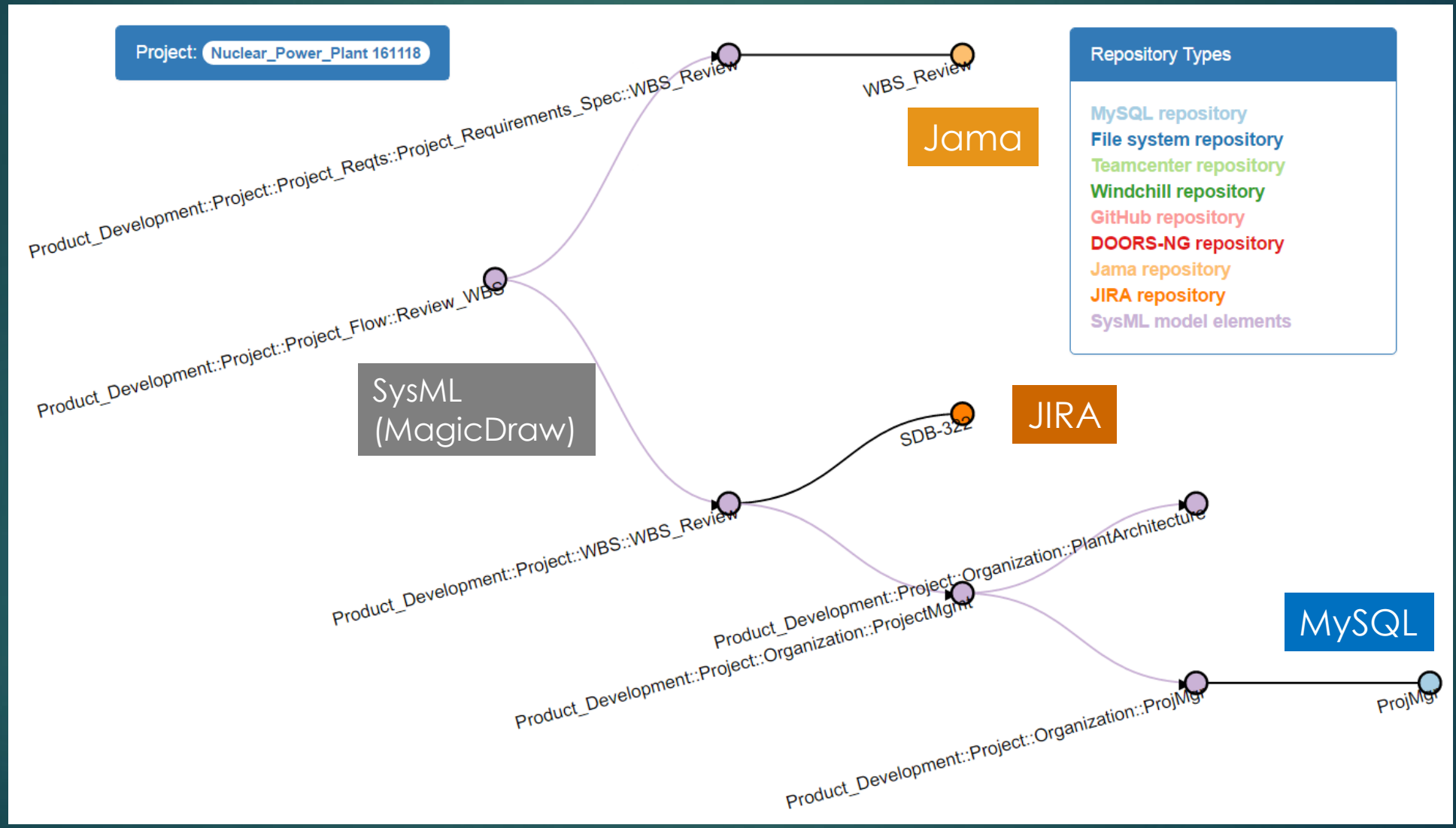
Directed Visualization



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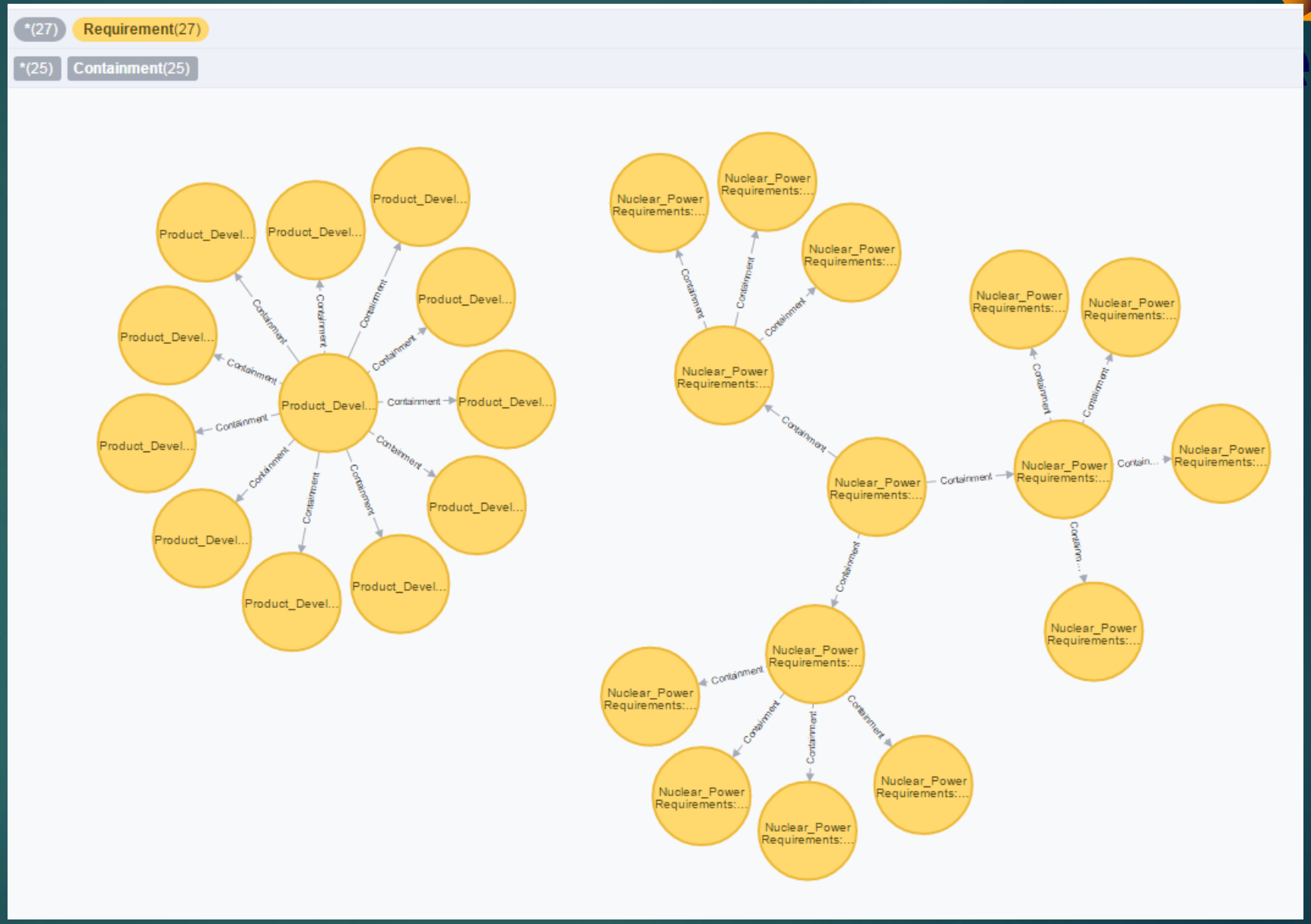
Query: Show me all the SysML requirements



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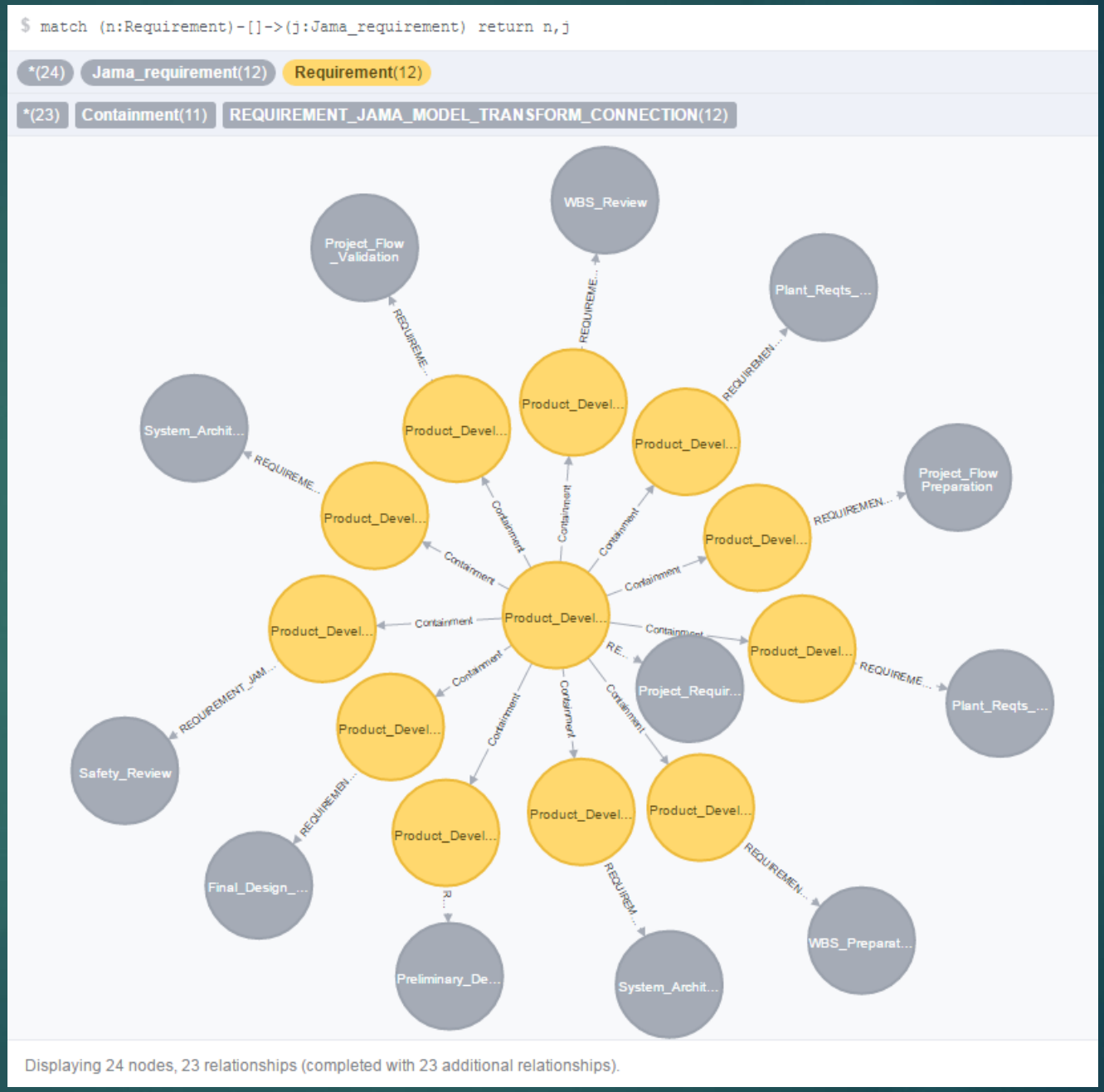
Query: Show me all the SysML requirements connected to Jama requirements



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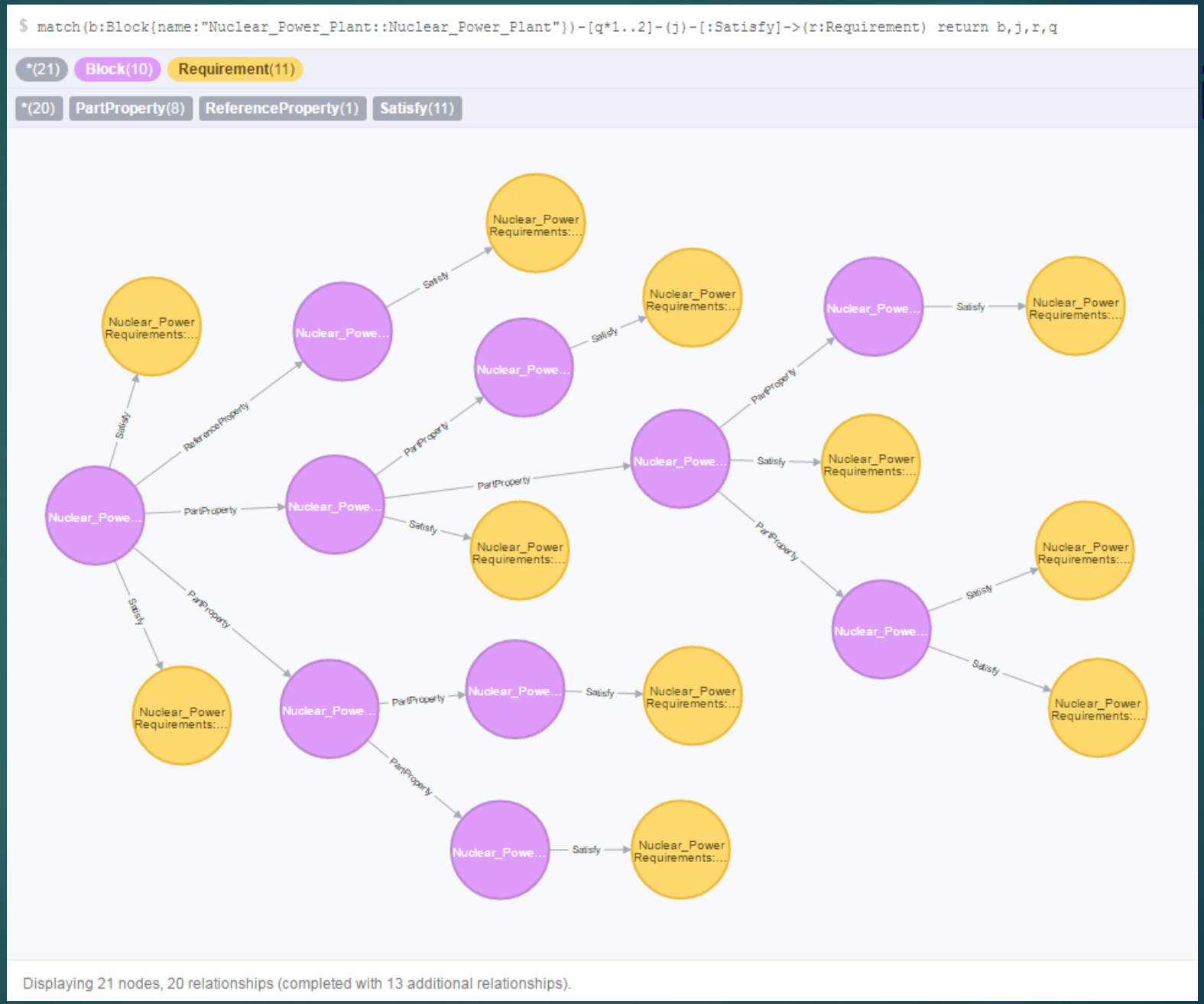
Query: Show me all the SysML requirements the Nuclear Power Plant block or its parts must satisfy directly



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Query: Show me all the SysML blocks affected by Fail-Safe Shutdown requirement

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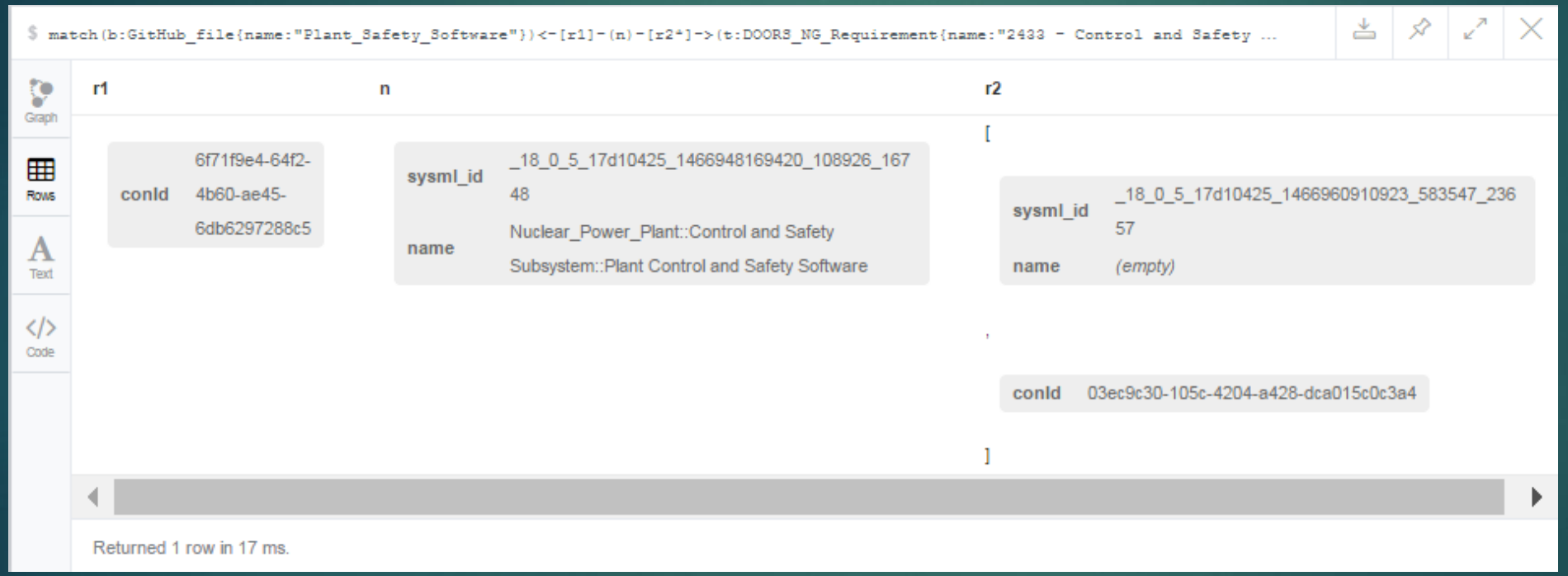
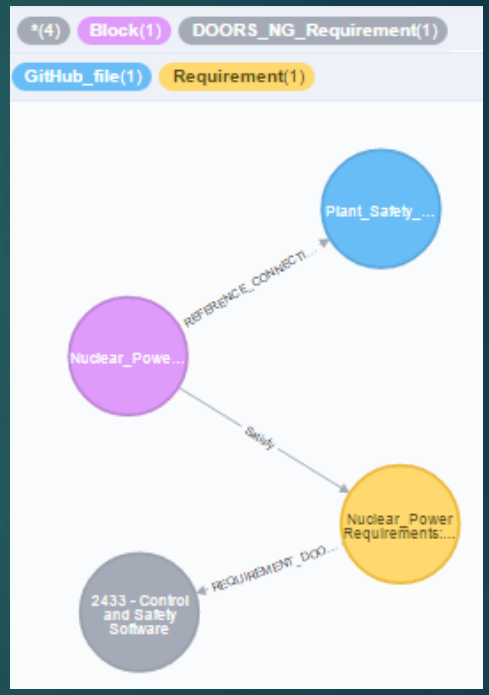
Query: Is GitHub file "Plant_Safety_Software" connected to DOORS requirement "2433 - Control and Safety Software"?





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Building a Bigger Graph

- USING YOUR MODEL IN A LARGER MODEL
- PERFORMING PARAMETRIC ANALYSES

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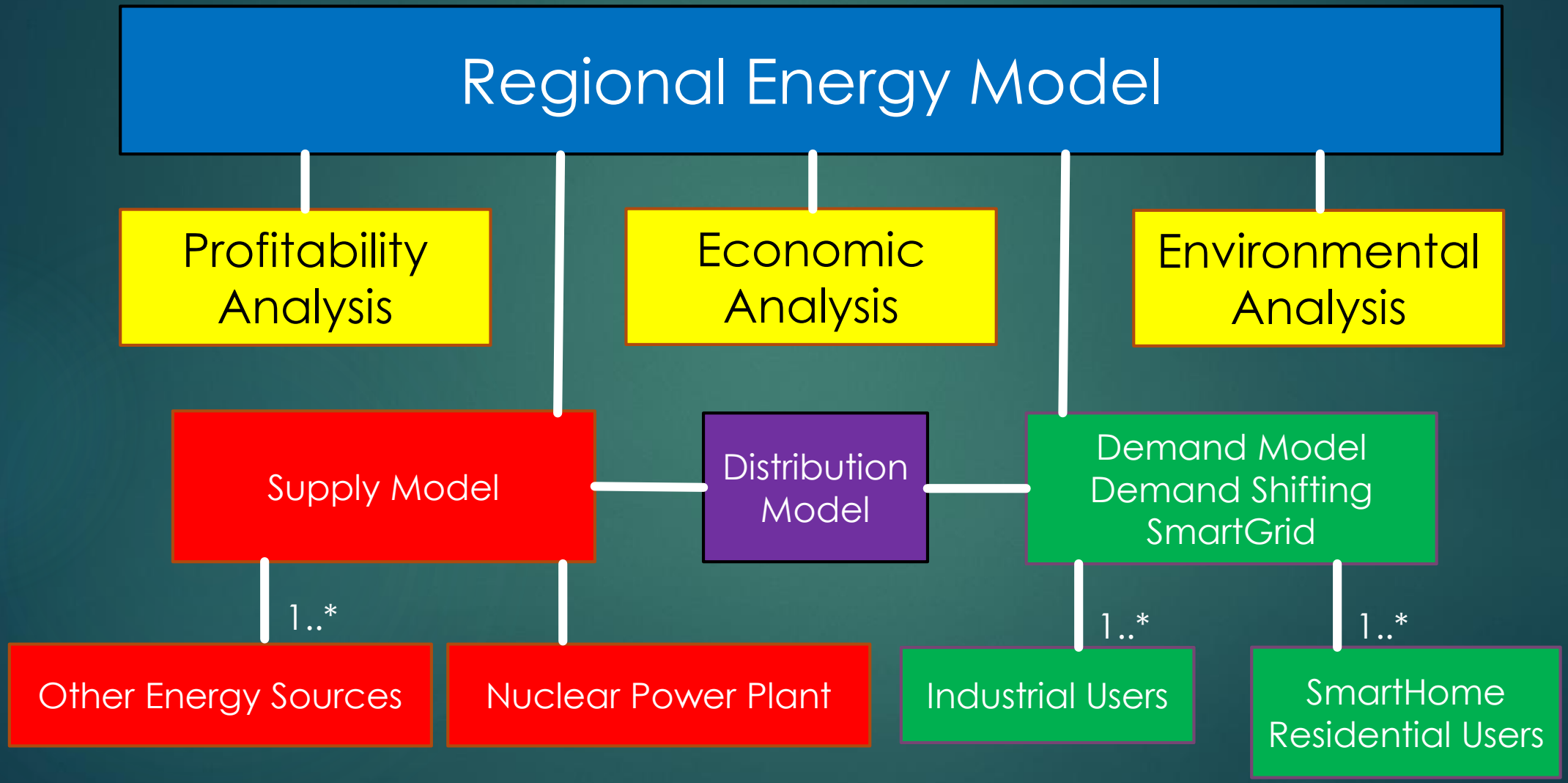
Energy System Model Integration



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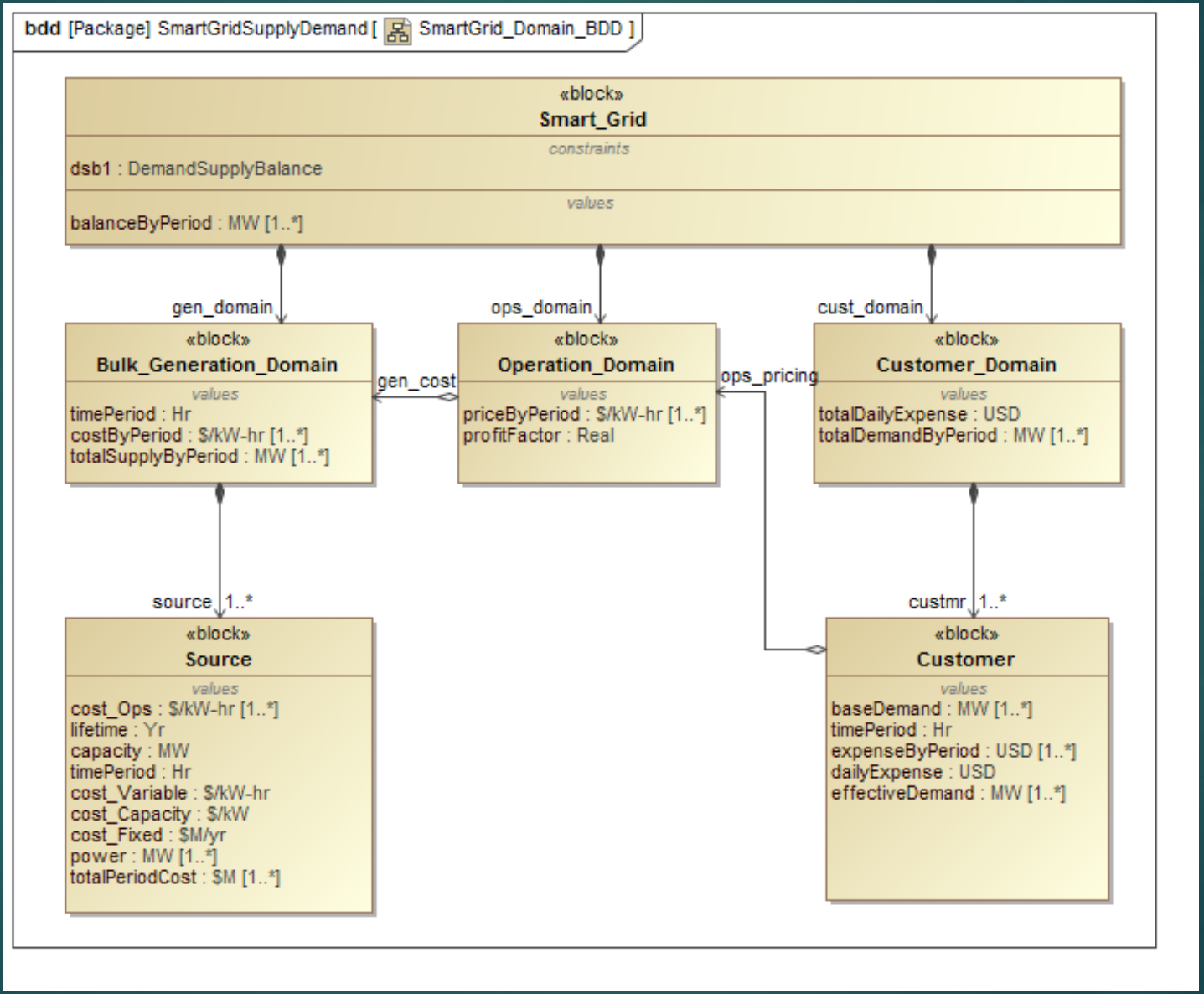
Smart Grid Model



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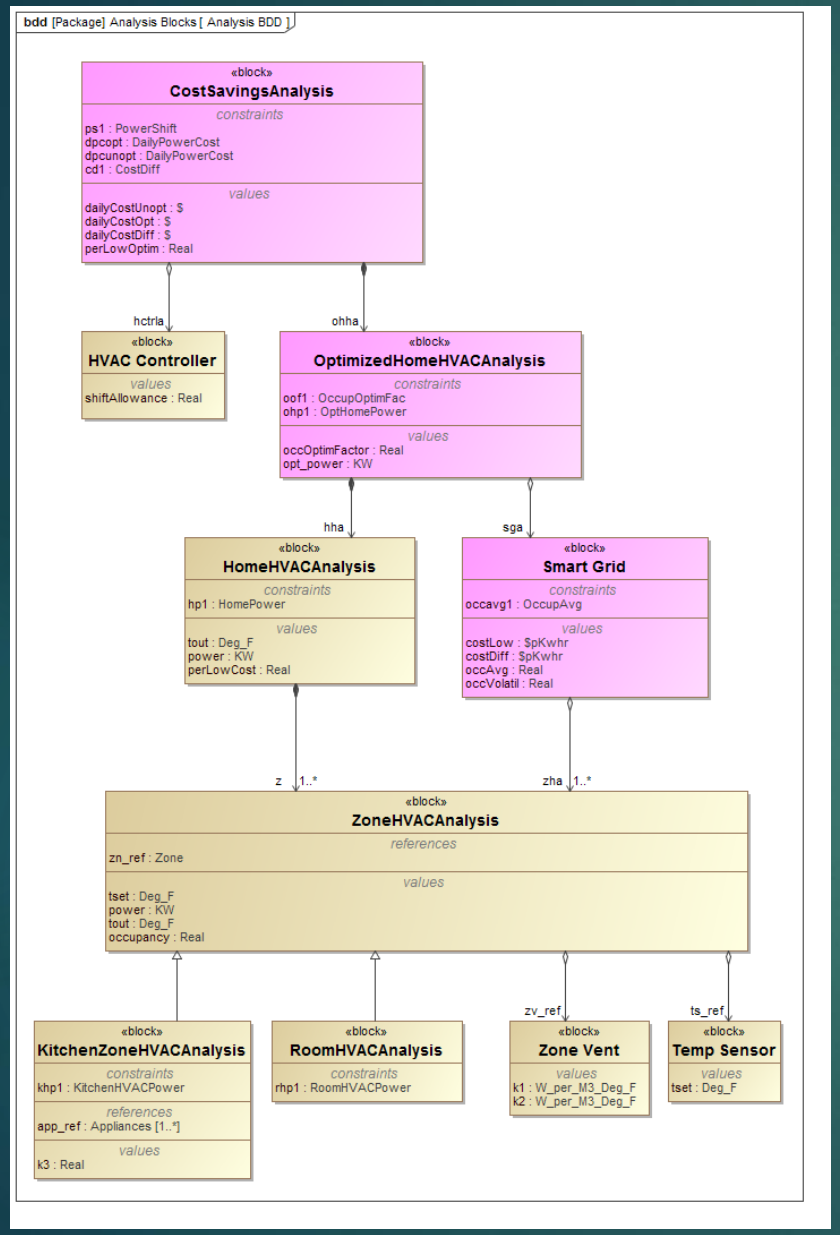
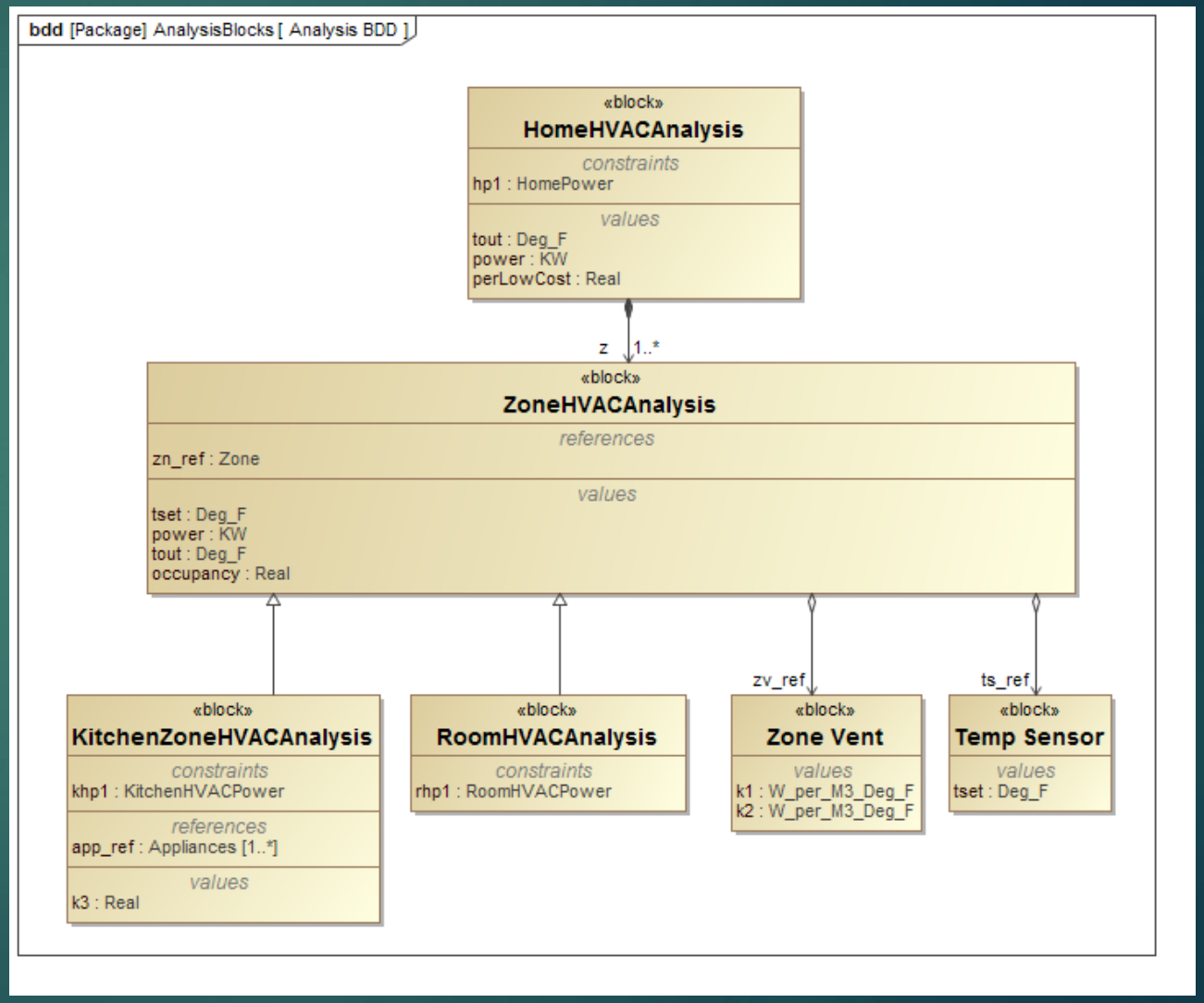
Smart Home Model





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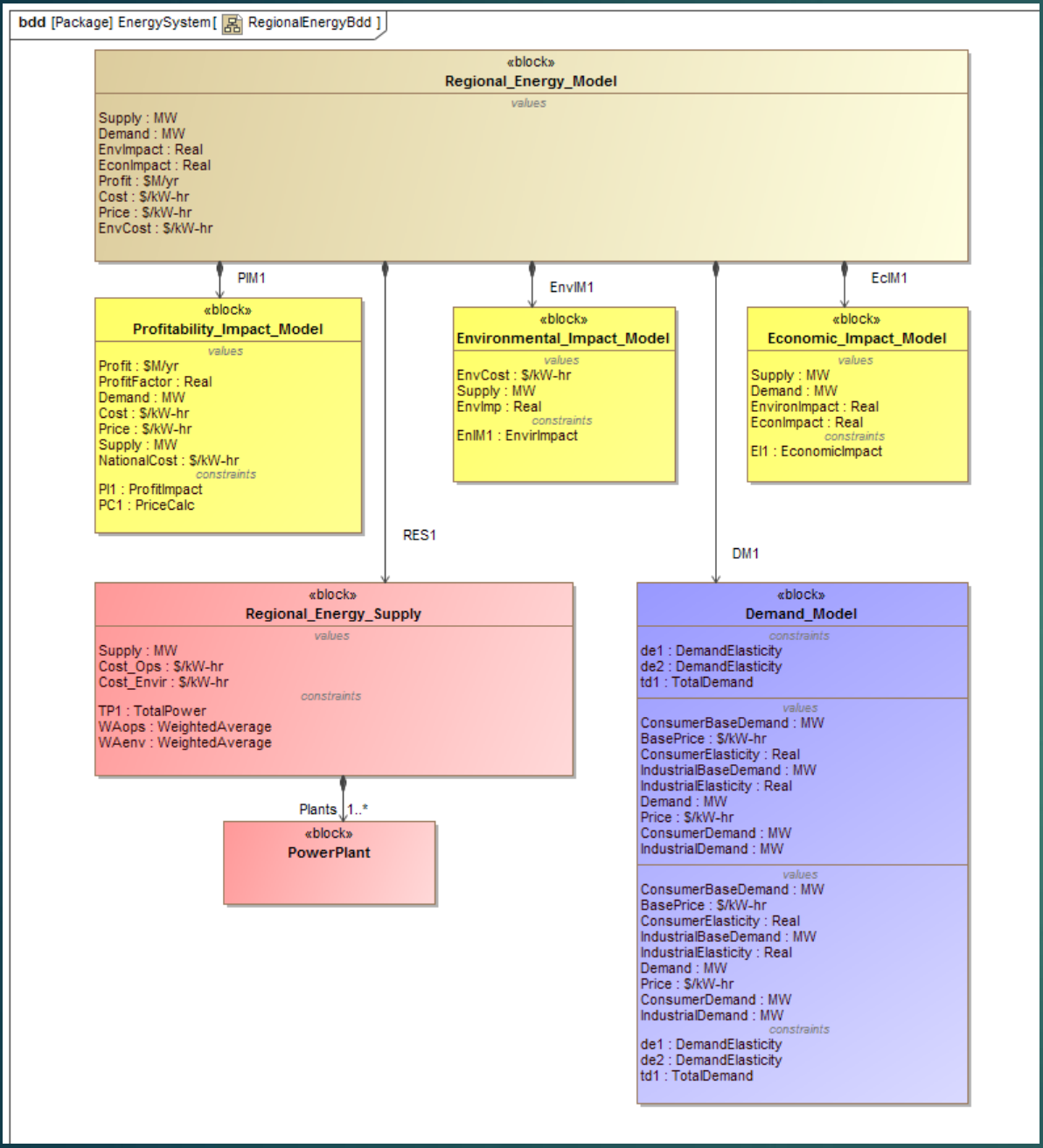
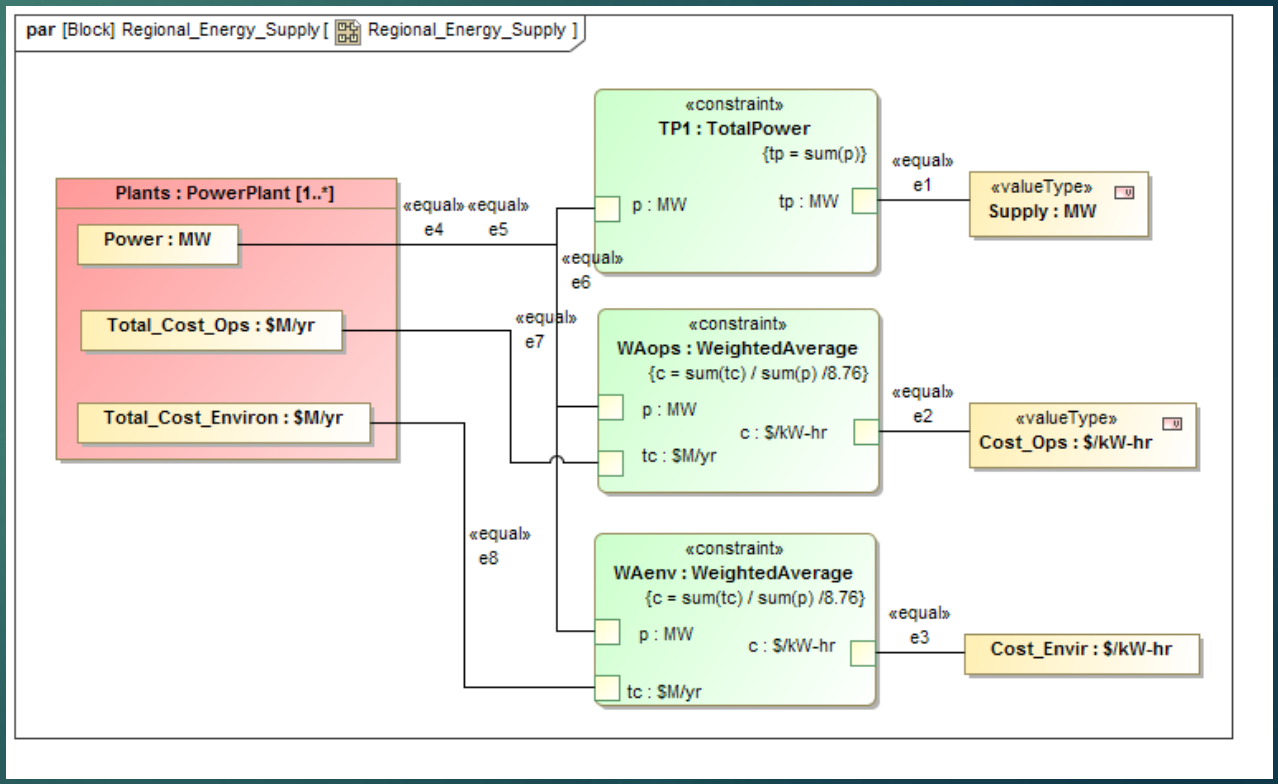
Energy System Analysis





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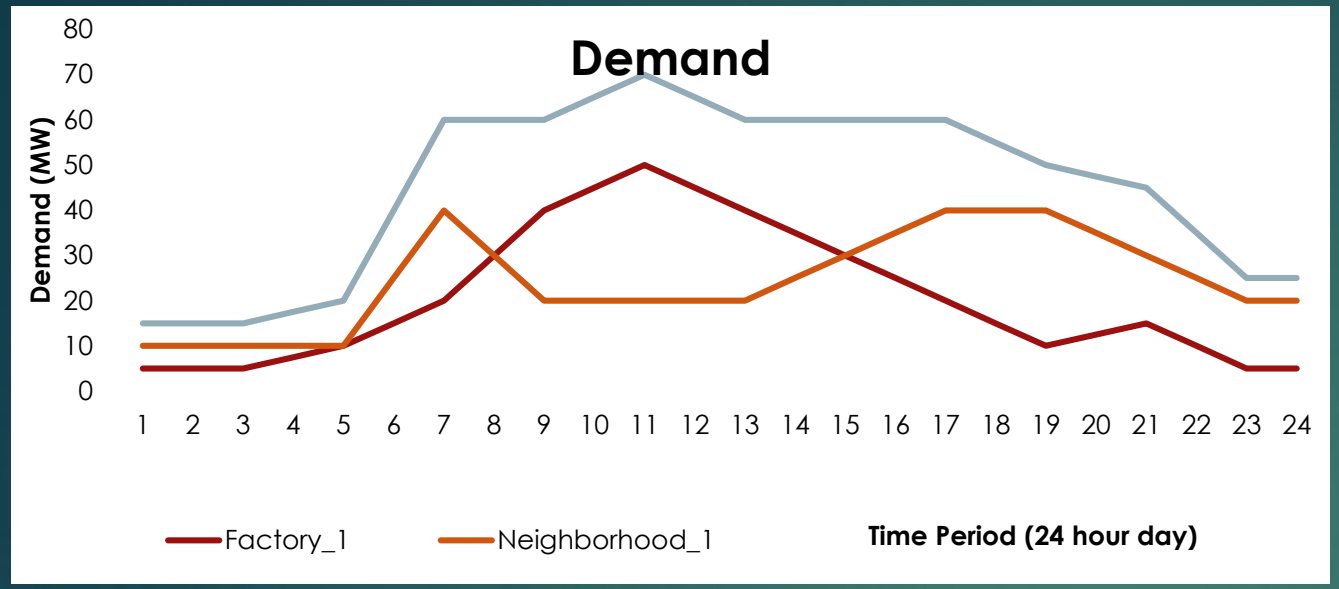
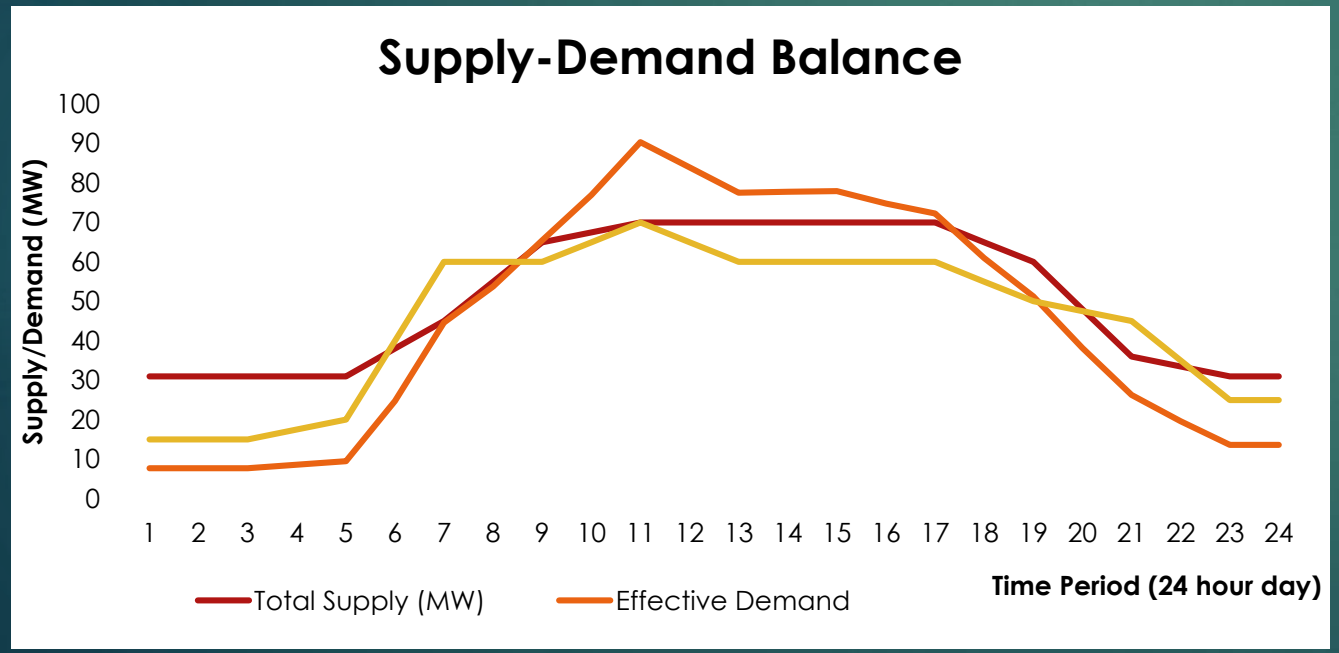
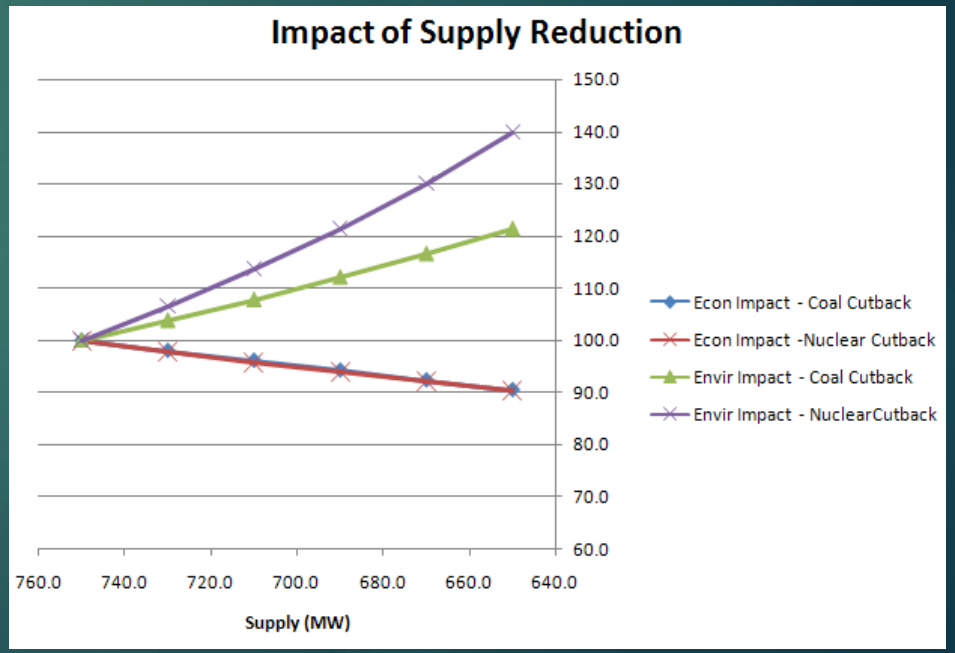
Energy System Analysis







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Why MBE Should Look Like Facebook

- It should tell you what's happened overnight
- It should be available 24/7 from multiple portals
- All your friends should be on it
- You can comment on your friend's stuff
- It should protect your private information
- It should make you aware of connections you didn't know existed

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Summary

- The goal of Model-Based Engineering is to create a single, unified model (a Graph) extending over all the tools and data repositories the energy industry uses.
- MBE is more about creating and exploring connections than making lists or building structures.

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Questions and Comments?

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