Hardware-Software Allocation Specification of IMA Systems For Early Simulation

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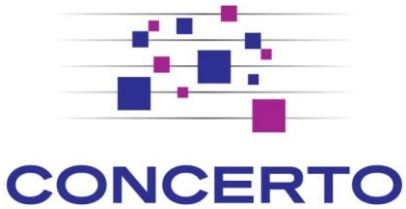
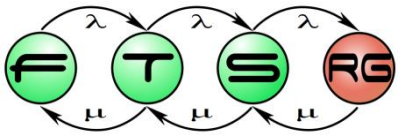
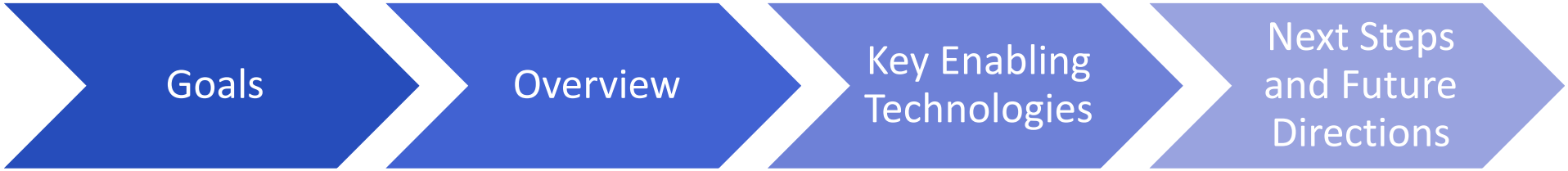
Embraer

DASC 2014





Overview of the Talk



- Other Contributors
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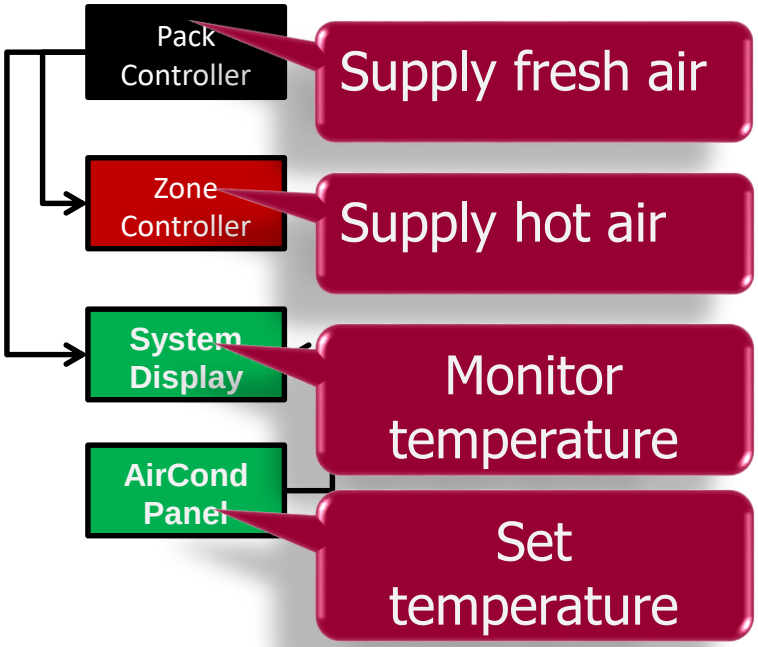
  - István Ráth
  - Zoltán Ujhelyi
  - Ákos Menyhért
  - Lincoln de Oliveira Campos Nascimento

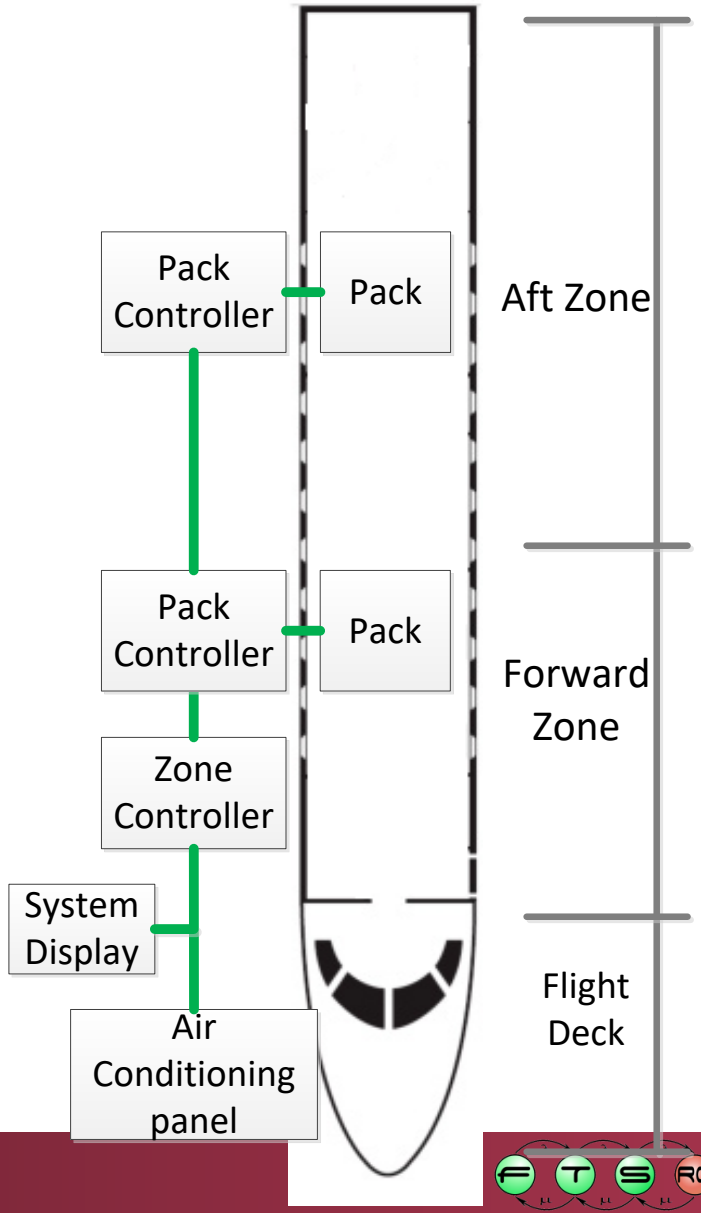
Goals to achieve

On what abstraction level are we working

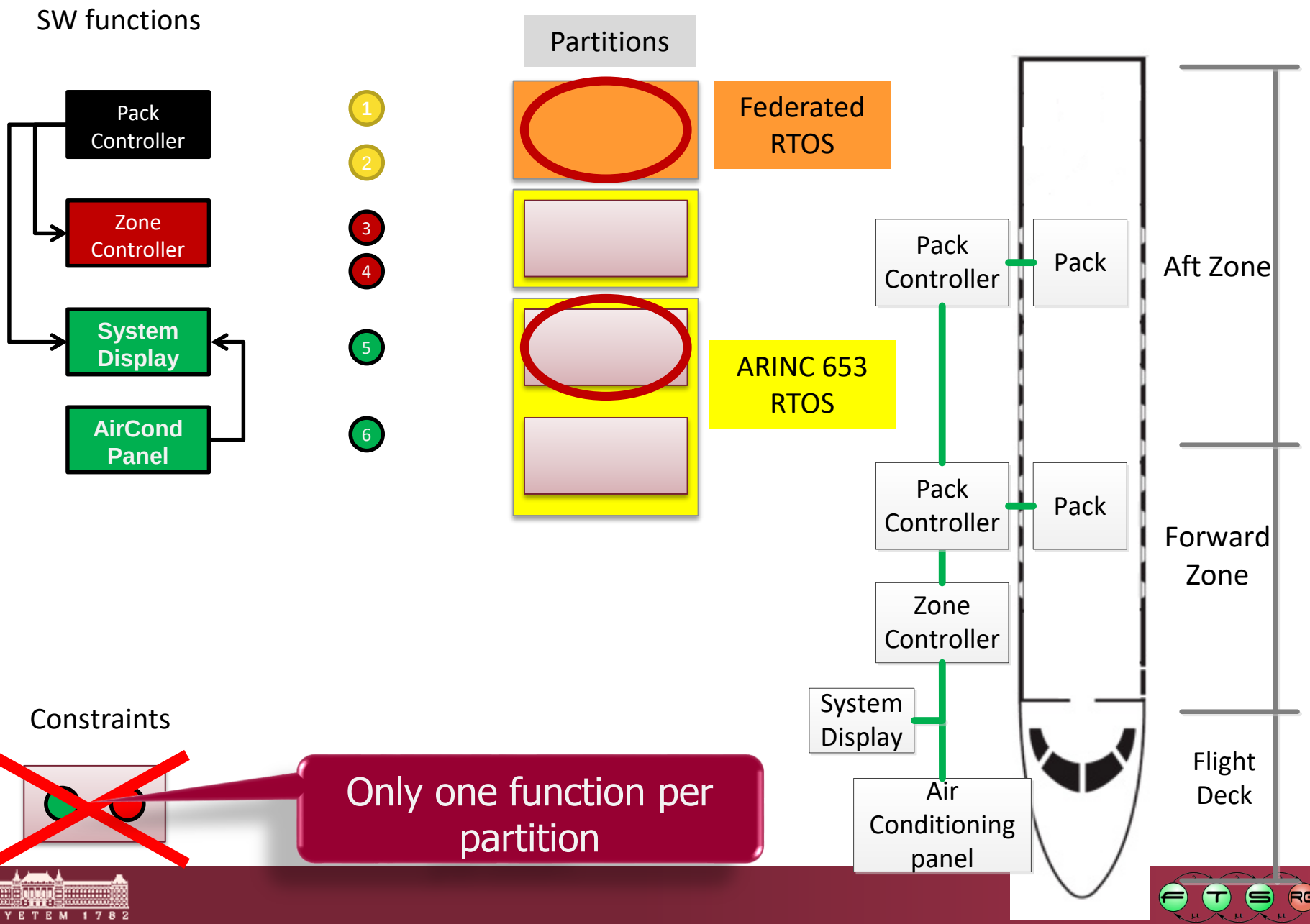
HW-SW allocation

SW functions





Functions to partition allocation – User-Driven



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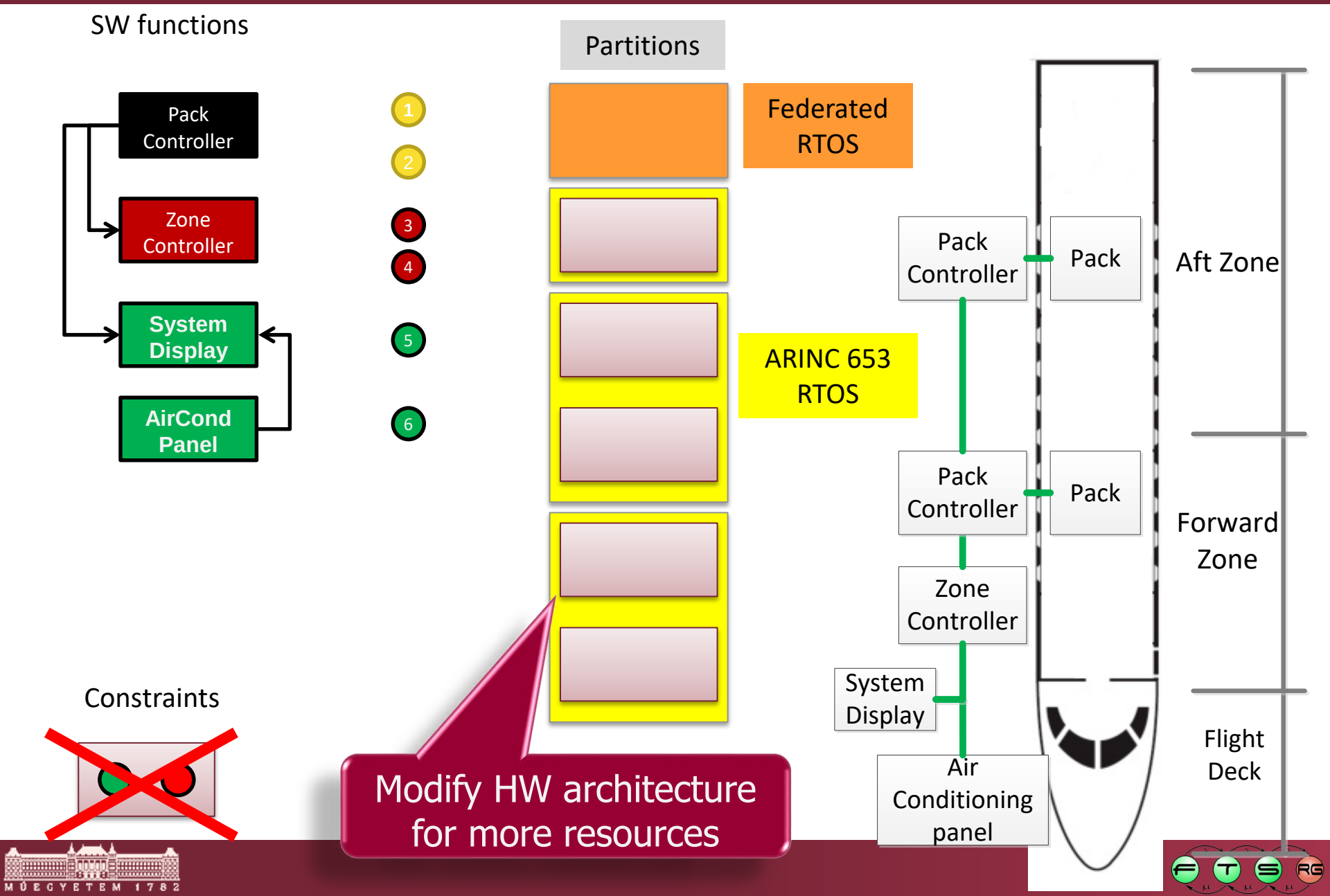
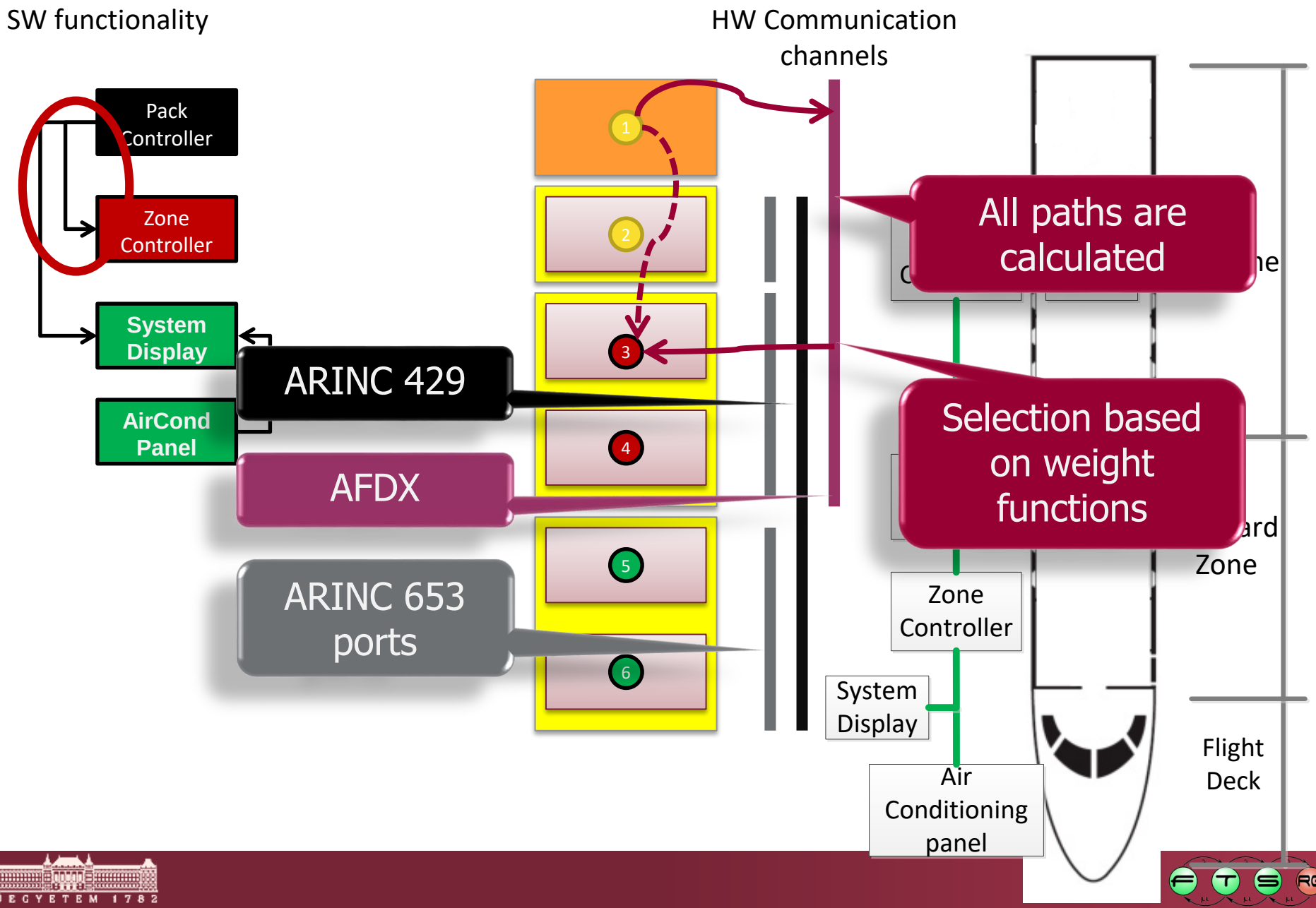


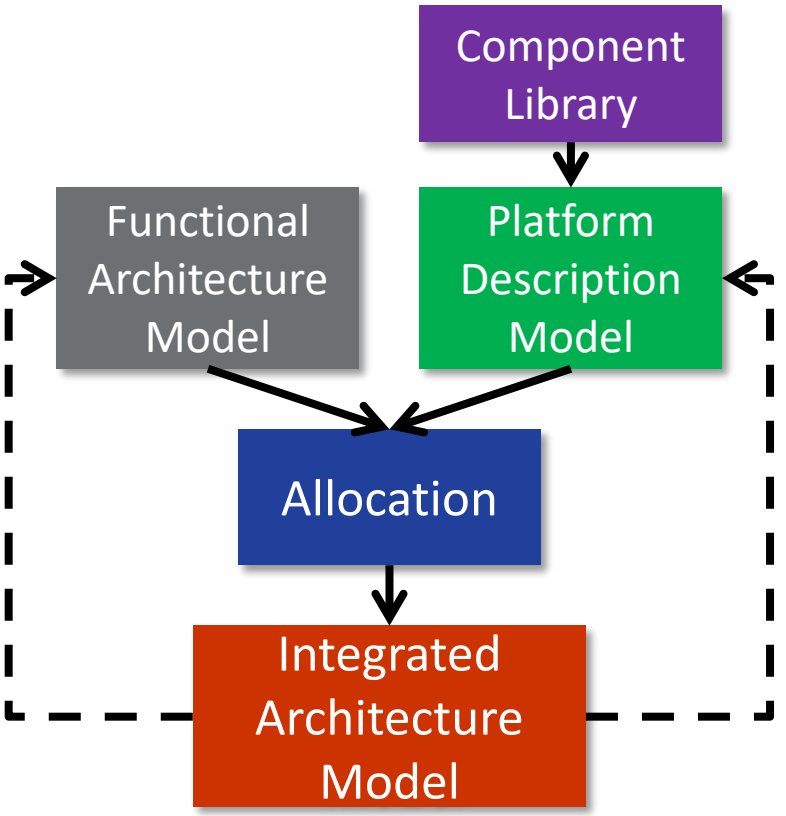
Allocating communication channels – Semi-automated



Overview:
TRANS-IMA Project

Overview of the TRANS-IMA project

- A tool to allocate system functionalities to different HW platforms using model-driven development techniques
  - **Early validation**:
    Find design flaws as early as possible
    - Directly on model level
    - Simulating the IAM in Simulink
  - **Model Transformation**: Generate
    - Communication paths
    - Integrated Architecture Model
  - **Traceability**:
    Complex traceability links as models
  - **Integrated Development Environme**
    Eclipse based
  - **Tool Integration**:
    MATLAB Simulink – Eclipse



"Study and development of Model Transformation (MT) methods applied to the design of Integrated Modular Avionics Systems"
➔ Knowledge + Techn. Readiness

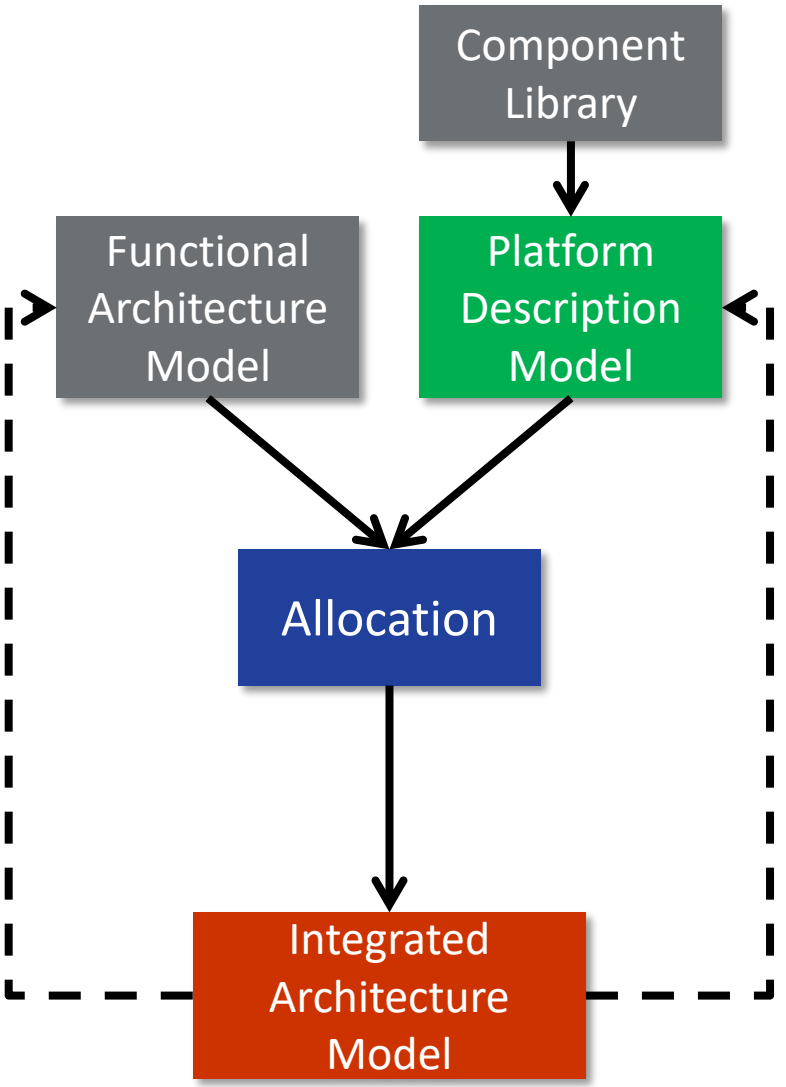
Design of HW-SW allocation

Inputs: (Simulink)
- Functional Architecture Model (FAM)
- Simple Component Library (Simulink library)
- Automated import

Tooling: (Eclipse)
- Platform Descr. Model (PDM) Editor
- Extensibility by plug-in infrastructure

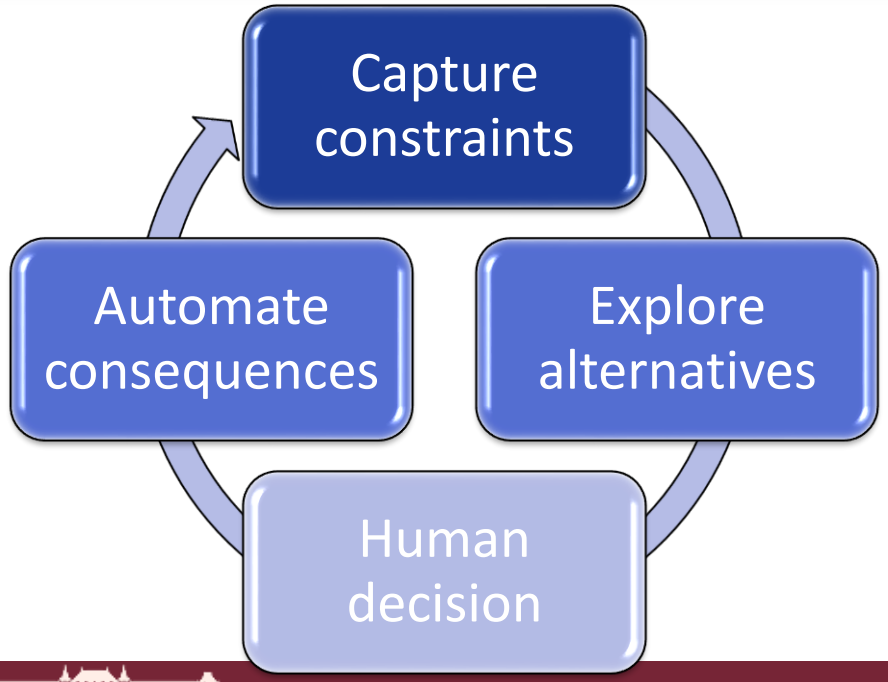
Allocation:
- Reuses existing Simulink models
- Generates required simulation elements
- Batch model transformation

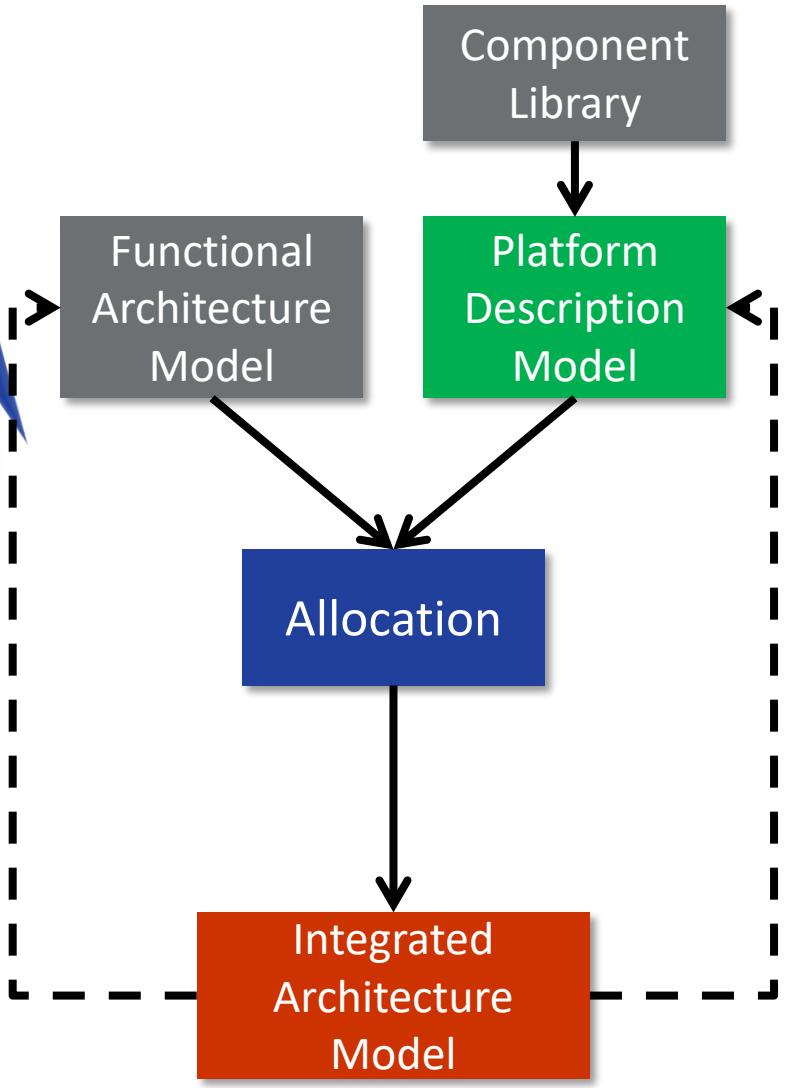
Output:
- Integrated HW/SW model
  - ready for simulation in Matlab
- End-to-end traceability links

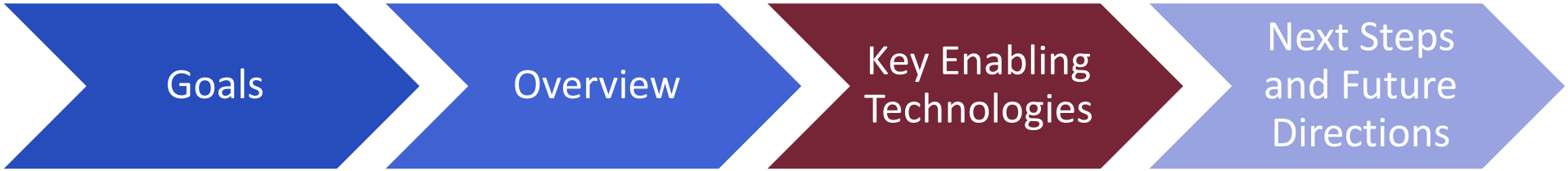


Model Driven Development of HW-SW allocation

Allocation steps:
- Designer-guided manual steps
- Automated steps:
  - Communication channels calculation
  - Integrated Architecture Model
- Continuous validation of design rules







Key Enabling Technologies: Eclipse based approach

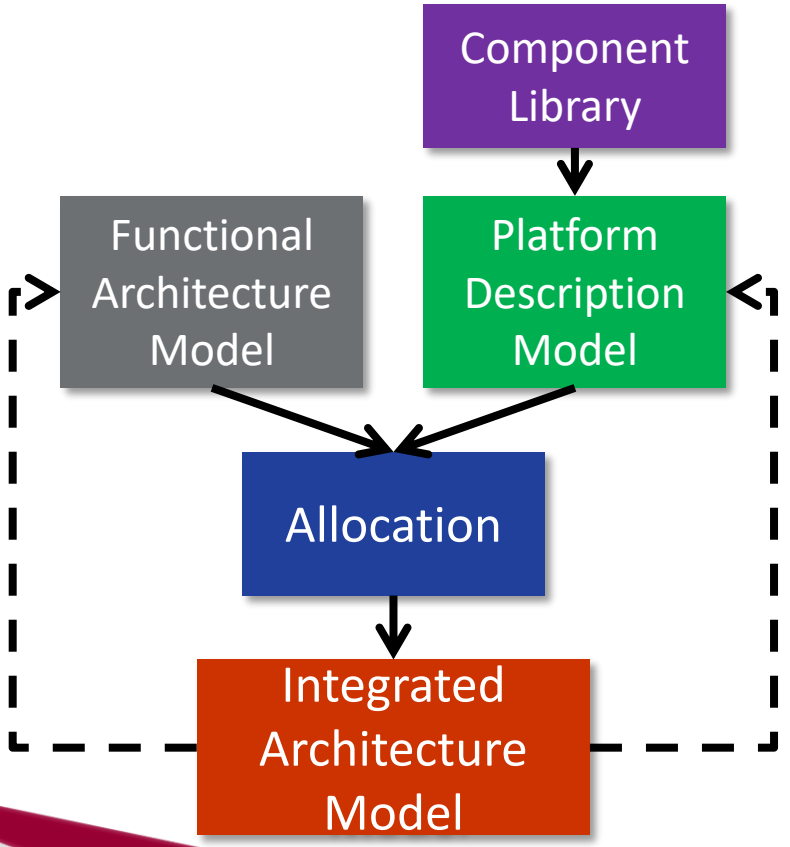
Overview: MDD Infrastructure

Model Driven Development =
Languages, Models and Transformations

Modeling Languages (EMF)	Model Queries (EMF-IncQuery)	Model Transformations (VIATRA)

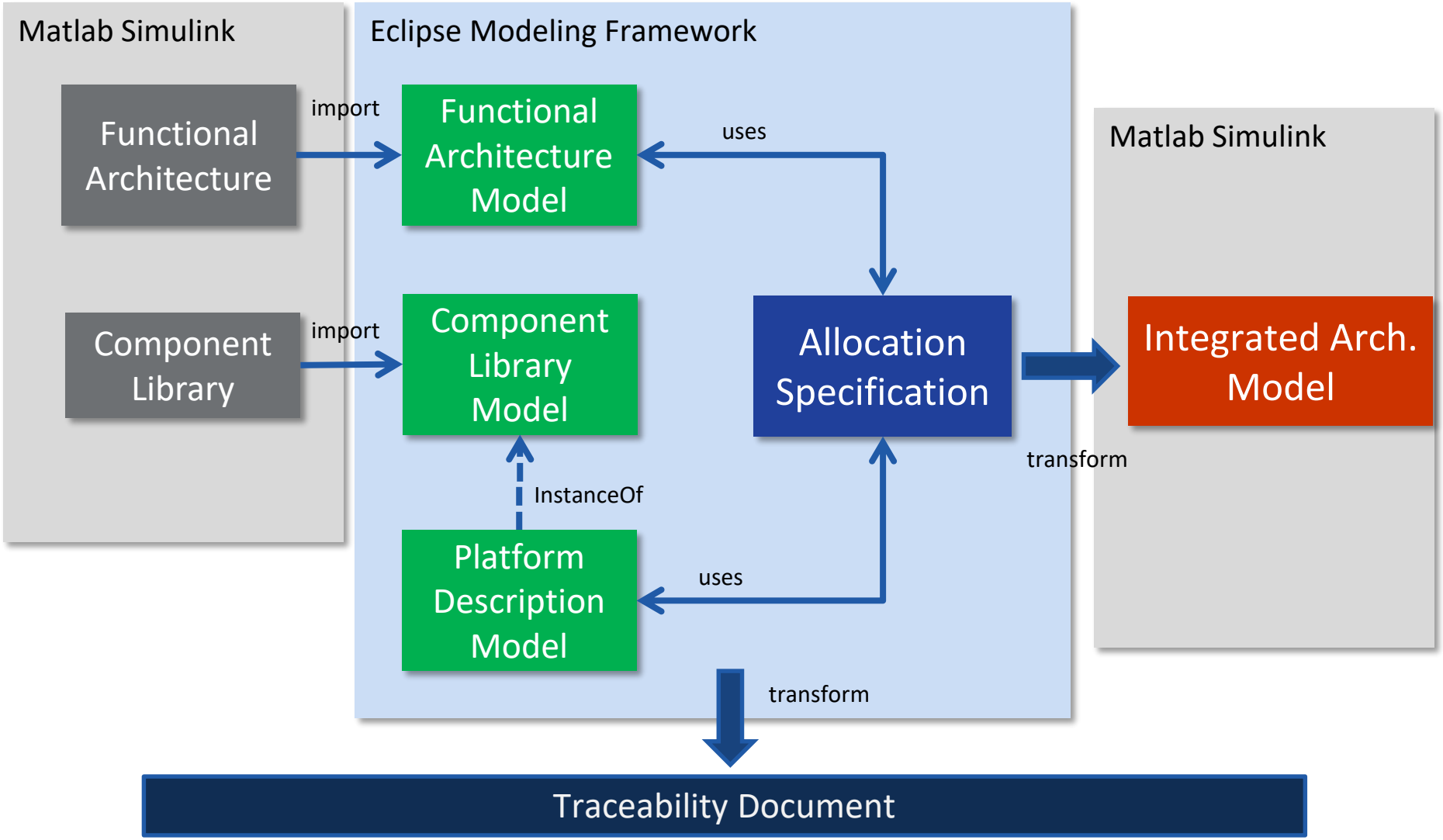
MDD Infrastructure: Eclipse Modeling Framework

- A tool to allocate system functionalities to IMA platforms using model-driven development techniques
  - **Early validation**:
    Find design flaws as early as possible
  - **Model Transformation**: Generate
    - Communication channels
    - Integrated Architecture Model
  - **Traceability**:
    Complex traceability links as models
  - **Open source technologies**: Evaluation of Eclipse framework
  - **Tool Integration**:
    MATLAB Simulink – Eclipse

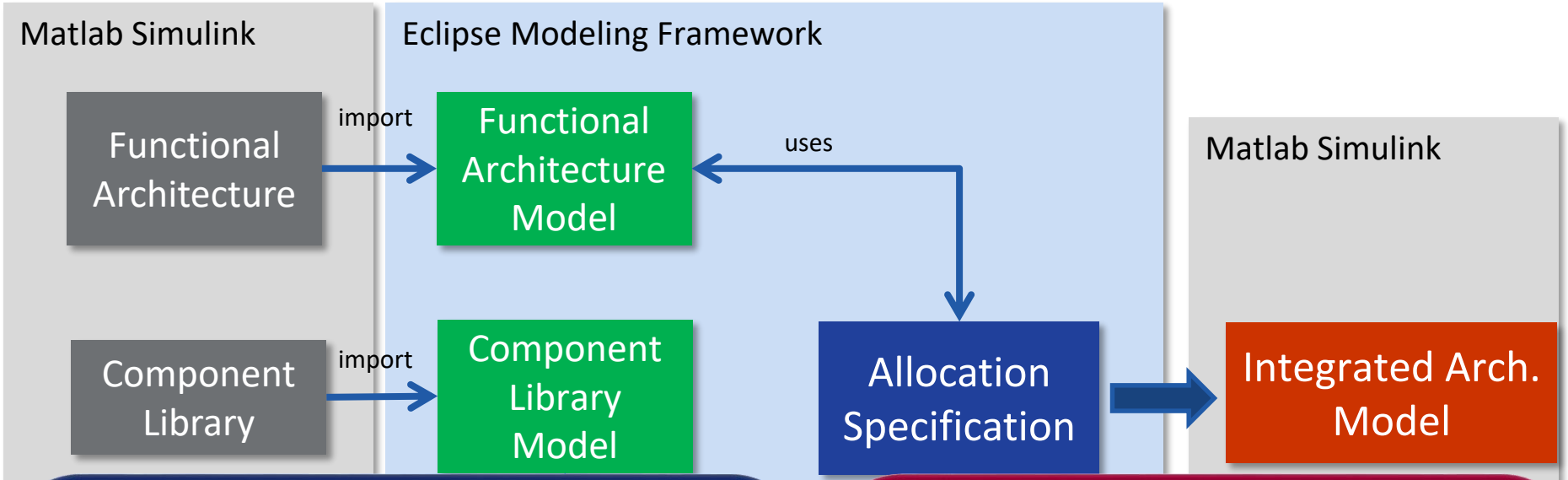


Eclipse Modeling Framework (EMF):
- open source platform
- model representation & dev.tools
- for domain-specific langauges

Eclipse Modeling Framework



Eclipse Modeling Framework



Technical Advantages of EMF:

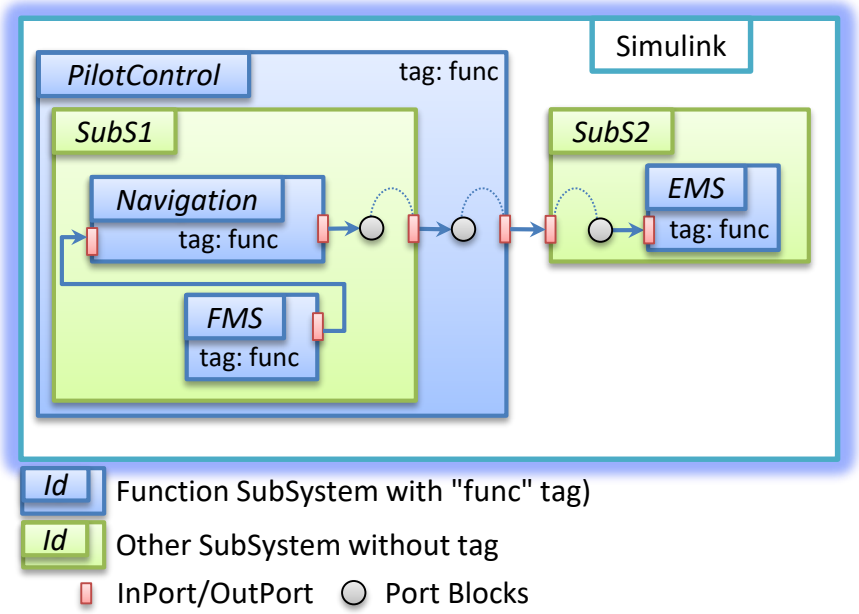
- Open source modeling standard for (Eclipse based) modeling tools
- Design metamodel ➔auto-generate interface, implementation, editor…
- Examples: UML, AADL, SysML, BPMN, AUTOSAR

Value for Users:

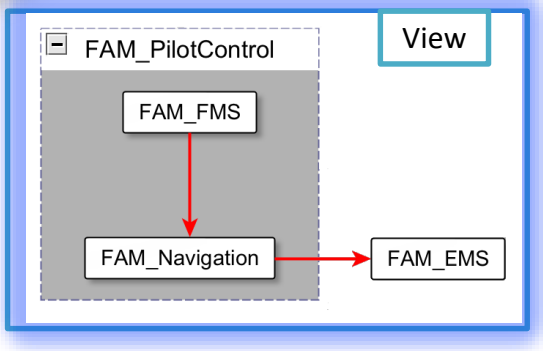
- Helps avoid vendor lock-in
- Knowledge based tool integration
- Future integration with open standard simulation techniques (Modelica)

Customizable views for EMF model

Goal: Hide irrelevant information from detailed models



View:
- Defined by queries
- Navigable as a model
- Maintained Incrementally + Immediately



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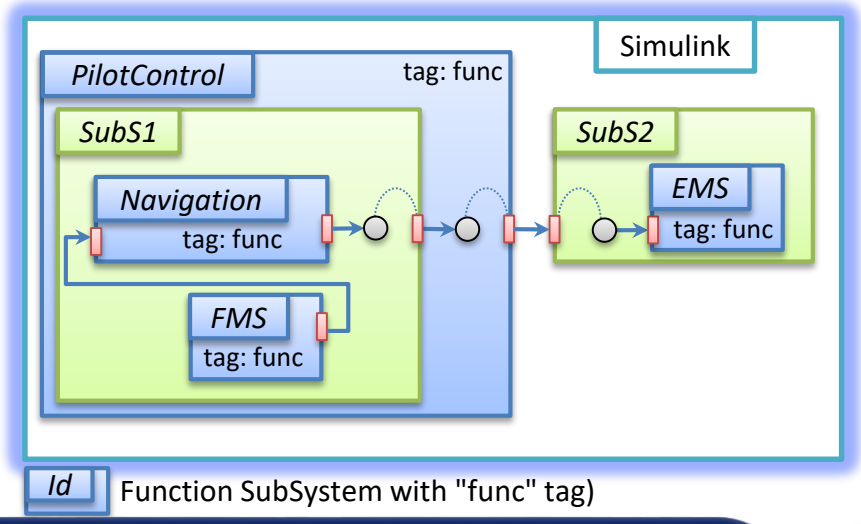

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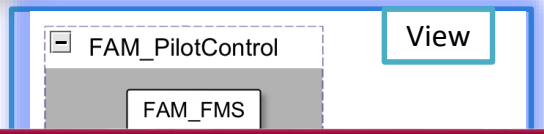

EMF-IncQuery Viewers:
- Capture visualization rules as model queries
- Incremental update of rules over large models
- Layouting based on industry leader yWorks libraries

Value for Users:
- Custom views extendable by domain experts
- Reusable visualization module
- Integration to EMF-based tools (UML, SysML, AADL, TOPCASED)

MDD Infrastructure: Model Queries

- A tool to allocate system functionalities to IMA platforms using model-driven development techniques
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  - **Model Transformation**: Generate
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    - Integrated Architecture Model
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  - **Open source technologies**: Evaluation of Eclipse framework
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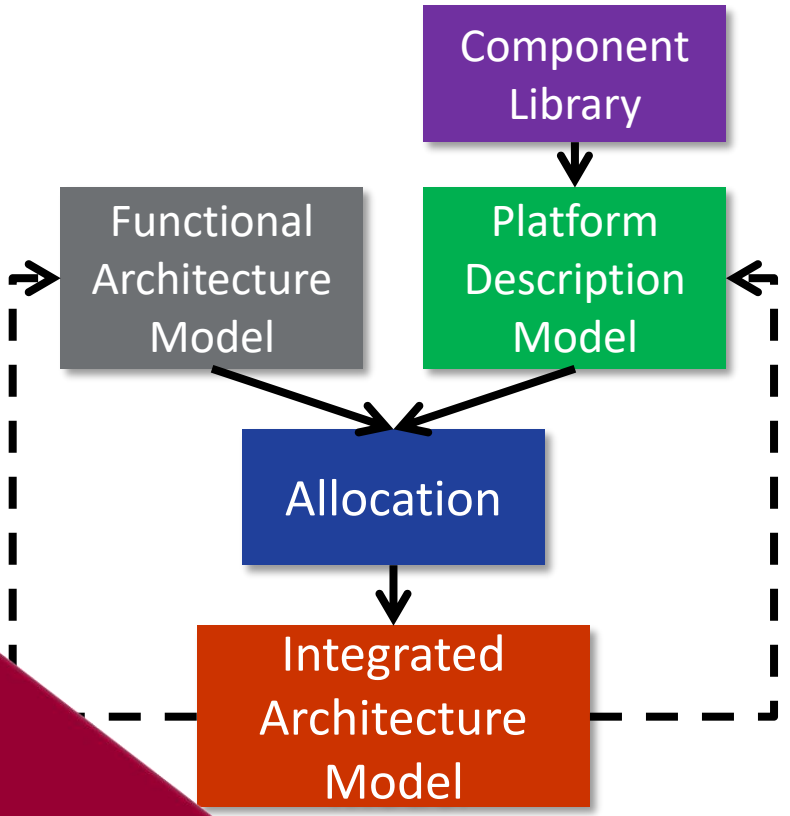
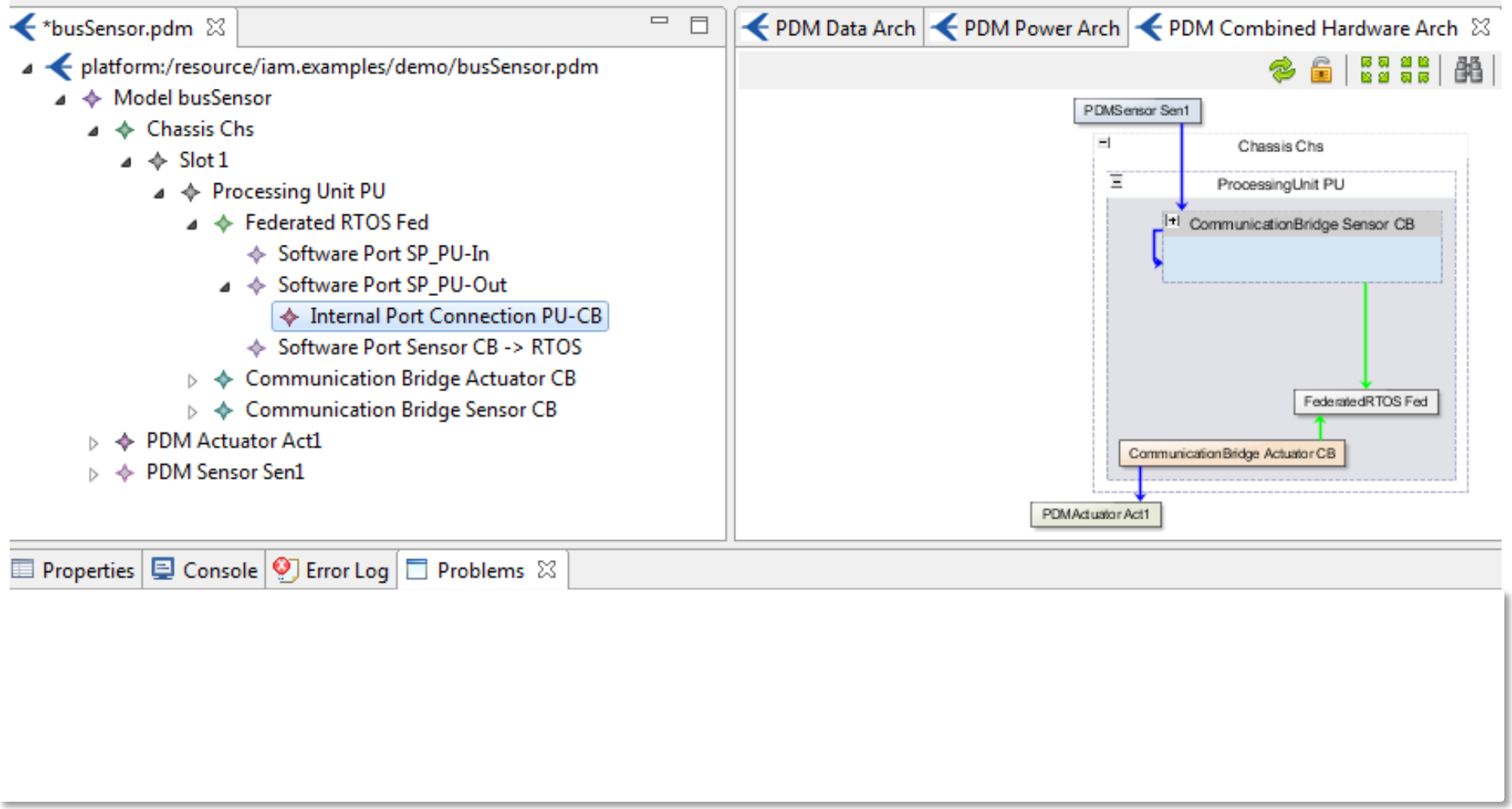


EMF-IncQuery (open source)
- model queries for design constraints
- incremental eval. over EMF models
- violations immediately reported
- supports dynamic model synchronization

Early validation of design rules/constraints

Input-to-Input port connection design rule



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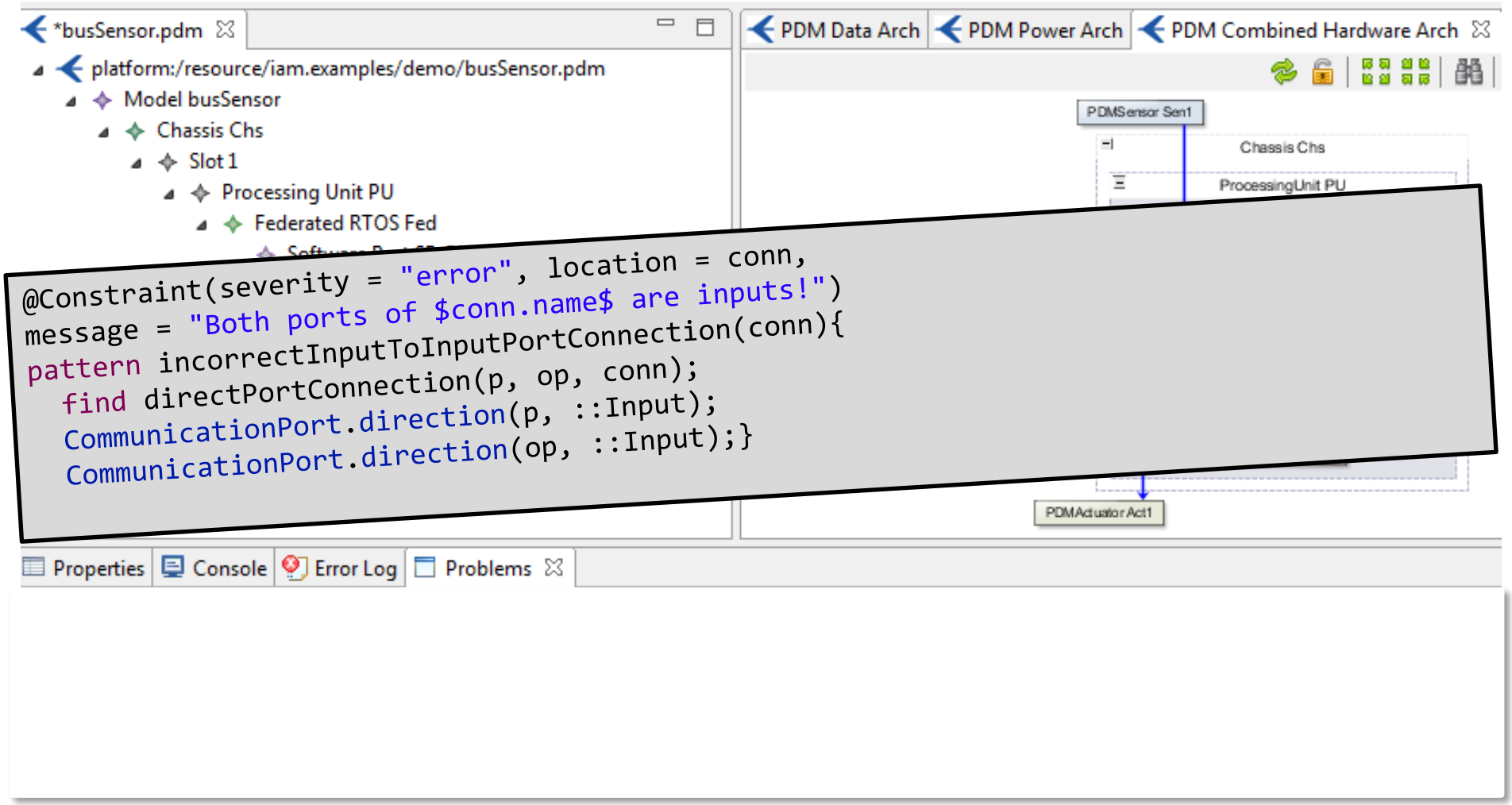

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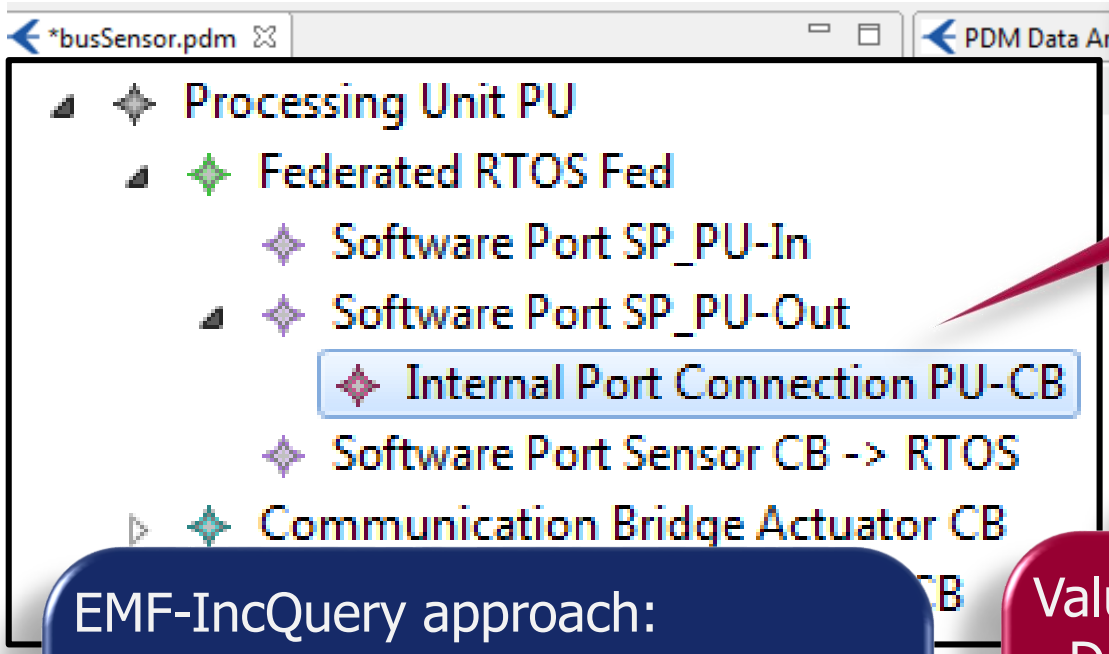
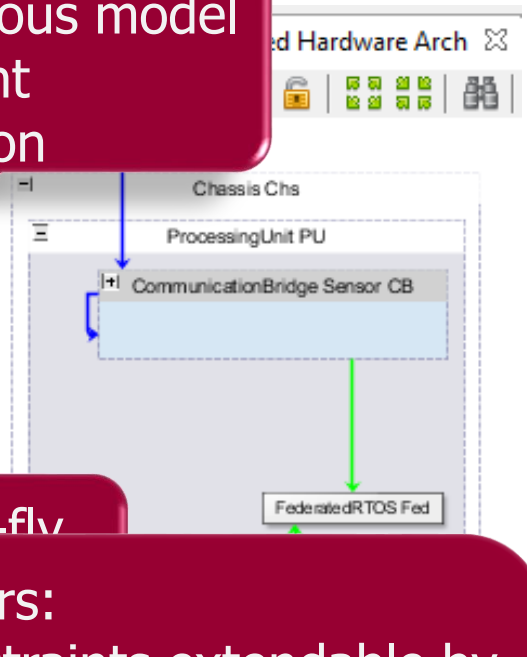




Erroneous model element selection

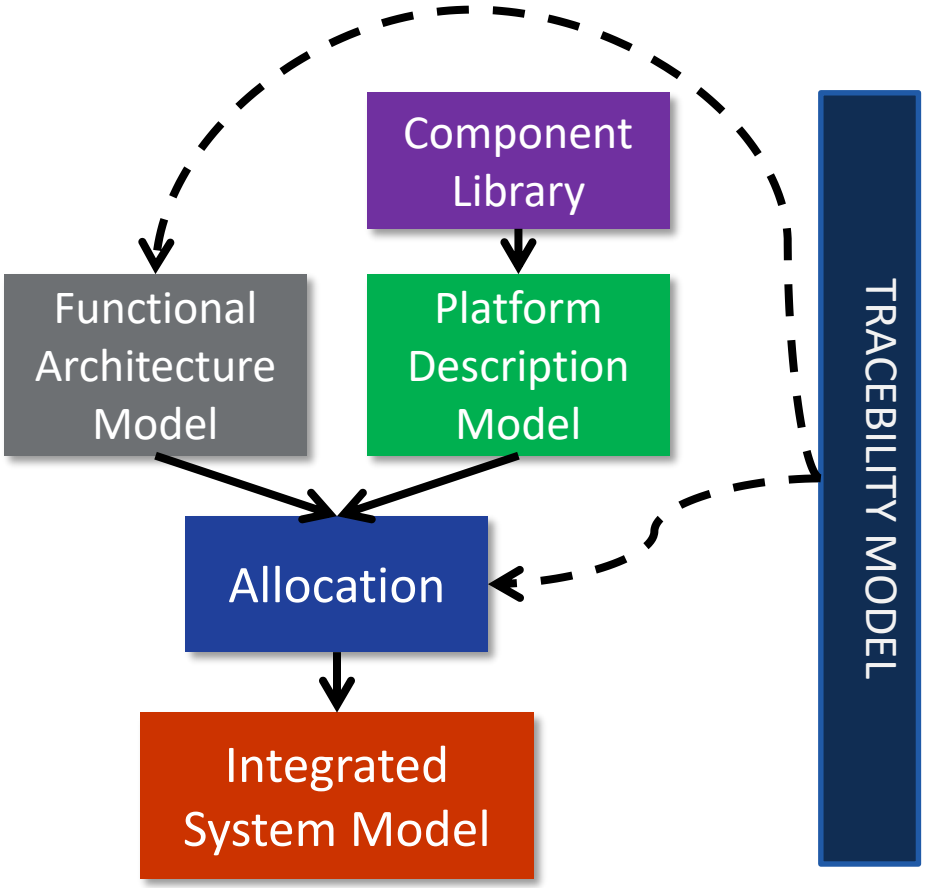
On-the-fly Problems view

EMF-IncQuery approach:
- Capture design constraints as model queries
- Incremental re-validation of constraints over large models (>100k)
- Immediate error reporting

Value for Users:
- Design constraints extendable by domain experts
- Definition of structural constraints
- Reusable validation library
- Integration to EMF-based tools (UML, SysML, AADL, TOPCASED)

Traceability based on queries

- Model-based Traceability
  - Complex M-N traceability
  - Traceability models
    - Automated generation
    - Automated maintenance
      → both based on query technology
  - Auto-generate traceability document/matrix (AIR 6110)
  - OSLC based integration



MDD Infrastructure: Model Transformations

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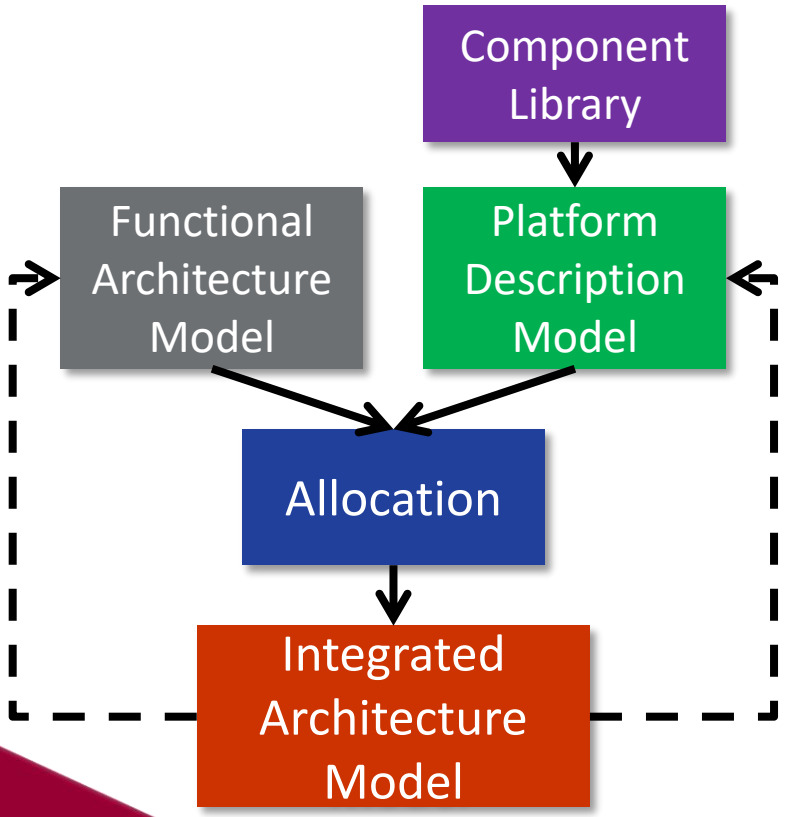
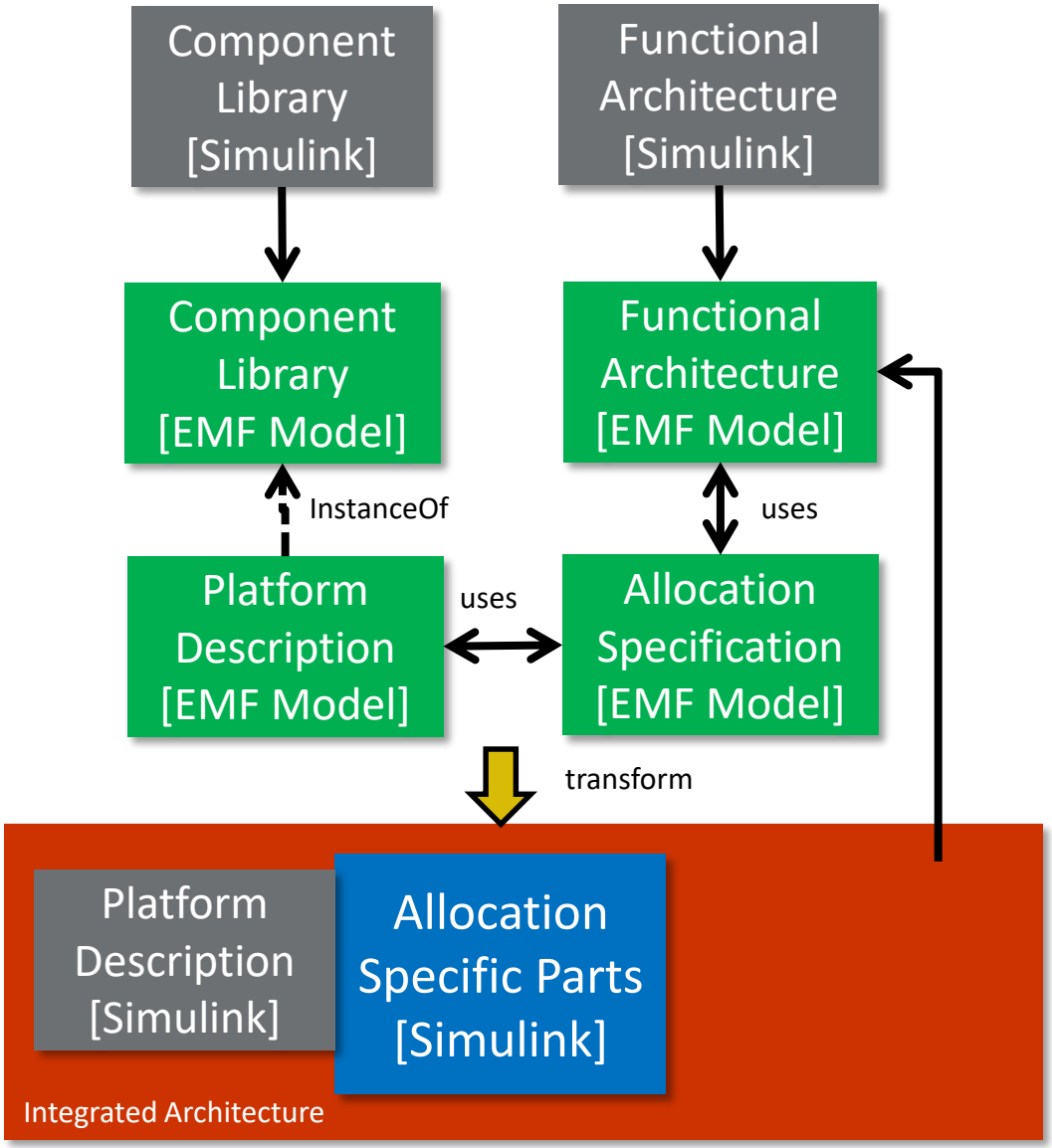
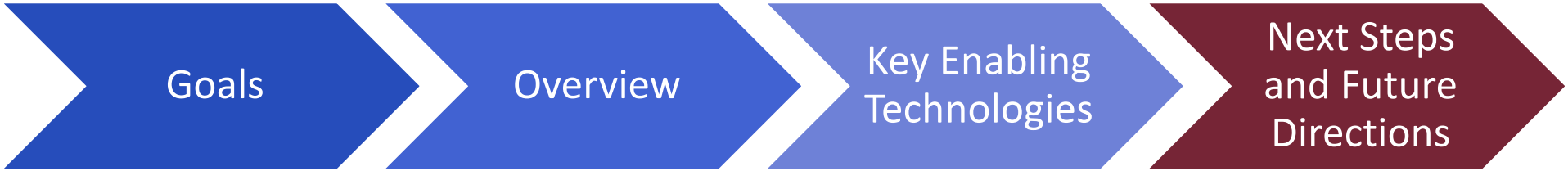


Role of Model Transformations:
- rule based generate&merge
- automated synthesis of traceability links

Role of model transformations: Synthesis

- Complex MT:
  - „Merge and extend”
  - Output Simulink model:
    - Use FAM and PDM as is
    - Generate allocation parts
  - Smooth integration with Simulink
    - Reuse available models
    - Bus handling
- Used open source technologies
  - Xtend
  - EMF-IncQuery + Viatra



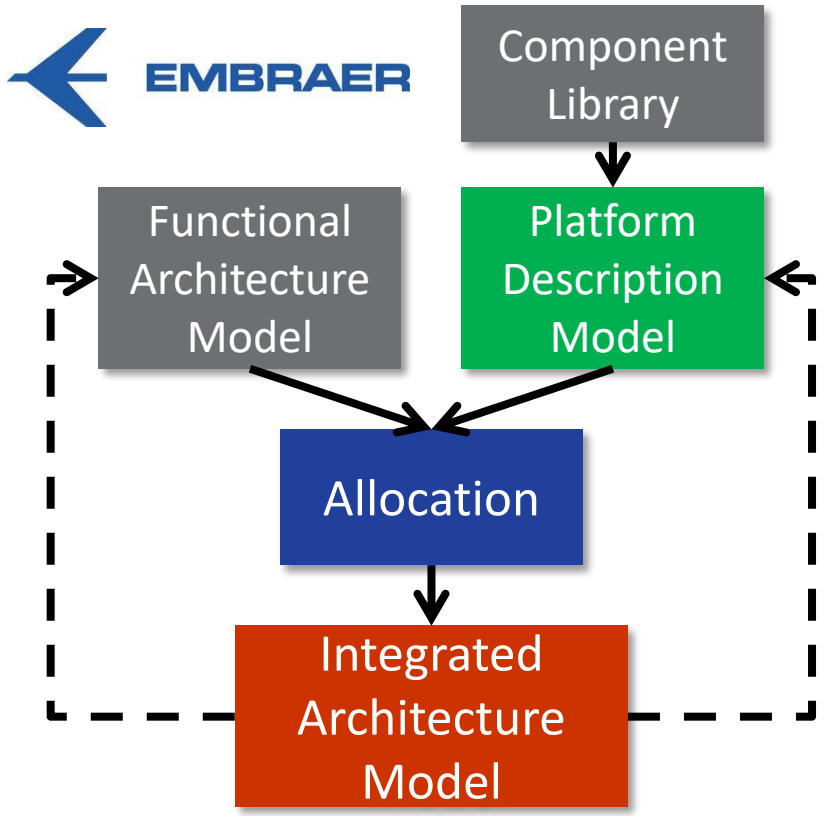


Next Steps and Future Directions

Summary and Future Directions

- A tool to allocate system functionalities to IMA platforms using model-driven development techniques

- Future directions
  - **Semi-automated allocation**
  - **Polarsys** initiative
    - Long term support for open source technologies
    - EMF-Simulink bridge
  - Standalone **OSLC** based traceability framework



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