*A*vionics *S*ystems *H*osted on a distributed modular electronics *L*arge scale d*E*monstrator for multiple t*Y*pe of aircraft

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Configuration Management for IMA Components

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Preface

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Presentation Content

- *Introduction*
- *Meta-Model for IMA Configuration Data*
- *Platform Configuration Tool*
- *Transition between tools: Model2Model*
- *Summary and Outlook*
- *Contacts*

Introduction:
TUHH/FST Institution – Overview

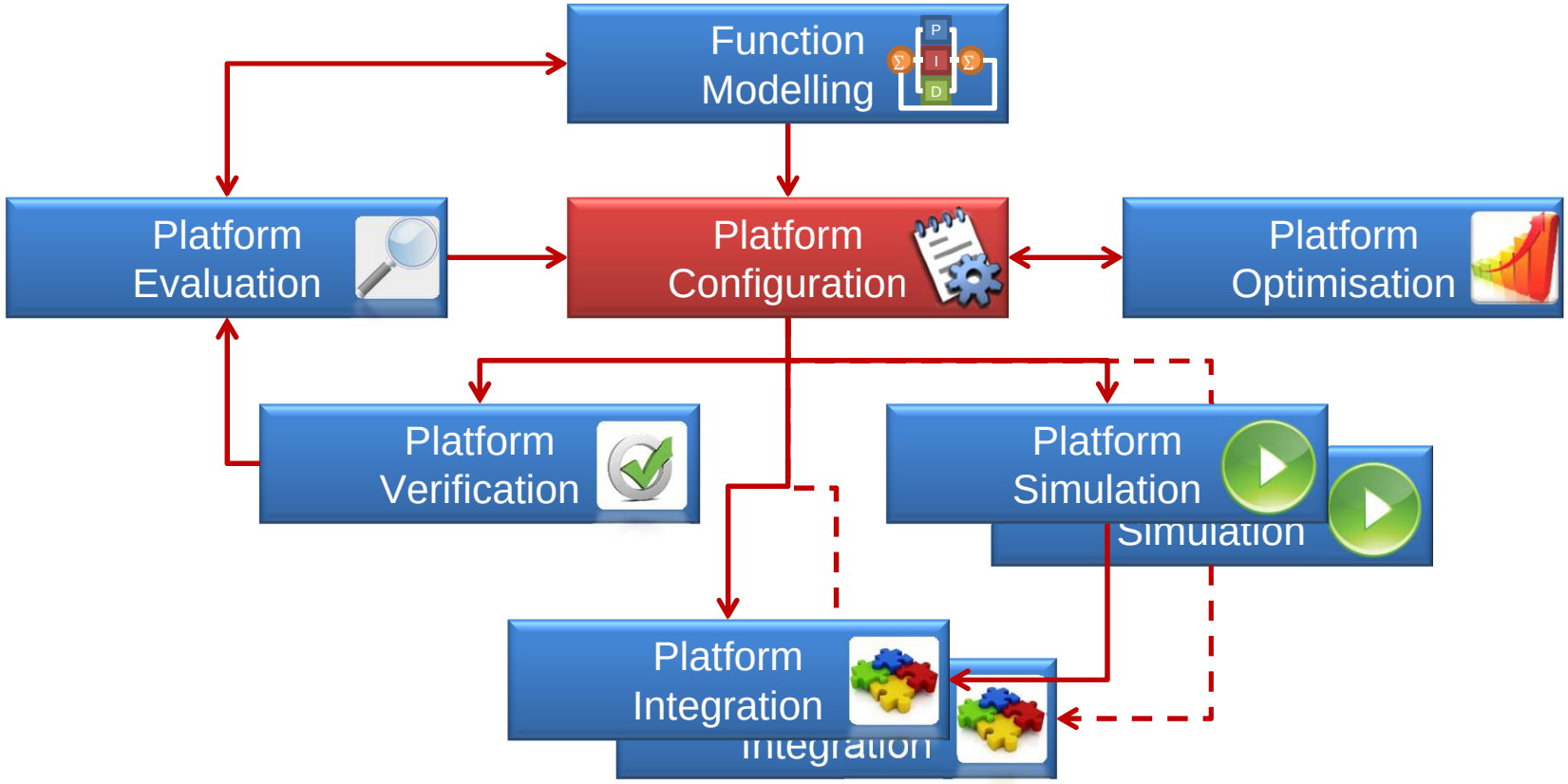
- Hamburg, University of Technology – Institute of Aircraft Systems Engineering
- Situated in Hamburg/Germany, next to Airbus (sharing the building)

- Head of department, secretary, 6 technicians, 25 research engineers
- Different research groups in areas like hydraulics, electrics, cooling, *avionics*

- Research facility for large test benches
- Technology demonstration for different aircraft systems in cooperation with industrial partners

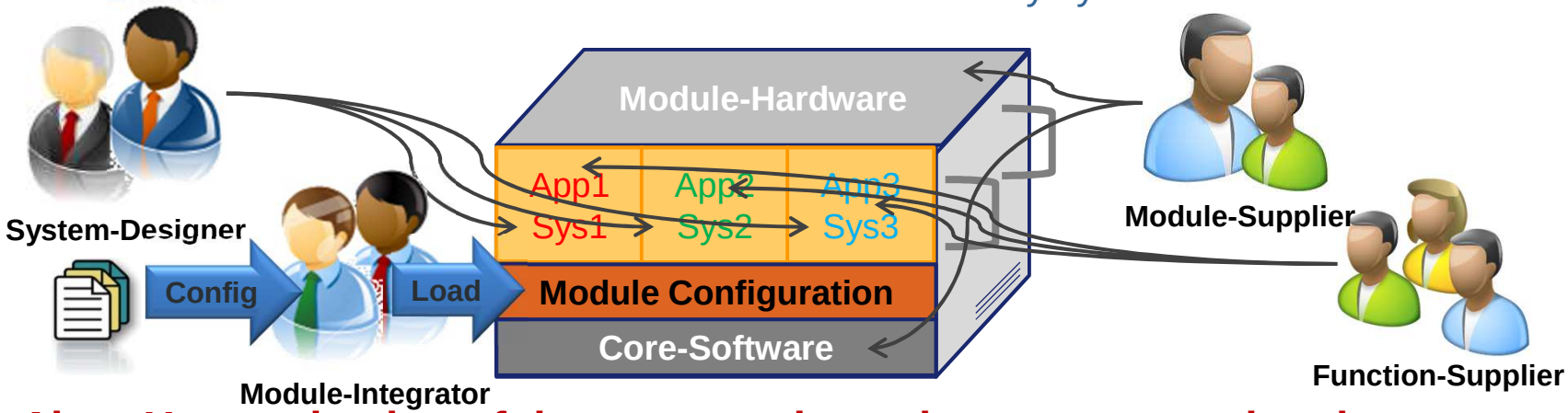
Introduction:
TUHH/FST @ ASHLEY

- Goal within ASHLEY:
  - Harmonise IMA development process with other tools "*seamless tool chain*"
  - Develop and enhance interfaces and tools for IMA2G
  - Support configuration process for demonstrator



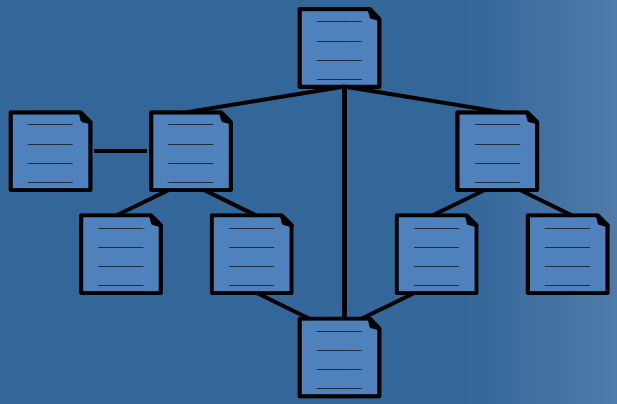
Introduction:
The IMA Configuration Management Process

- Challenges
  - Many thousands of configuration parameters need to be managed
  - Hard- and software development phase (new A/C programs):
    - ✓ Hard the define/specify exact resource needs of systems and their applications
      → Development process in iterations
    - ✓ What parameters exactly and how they need to be configured may not be known
      → Parallel development of hard- and software
- Integration phase:
  - Distributed process: Different actors specify different parts of the configuration
  - Different tool chains for different modules allocated by systems



→ Aim: Harmonisation of the process through computer assisted configuration engineering and validation for IMA modules

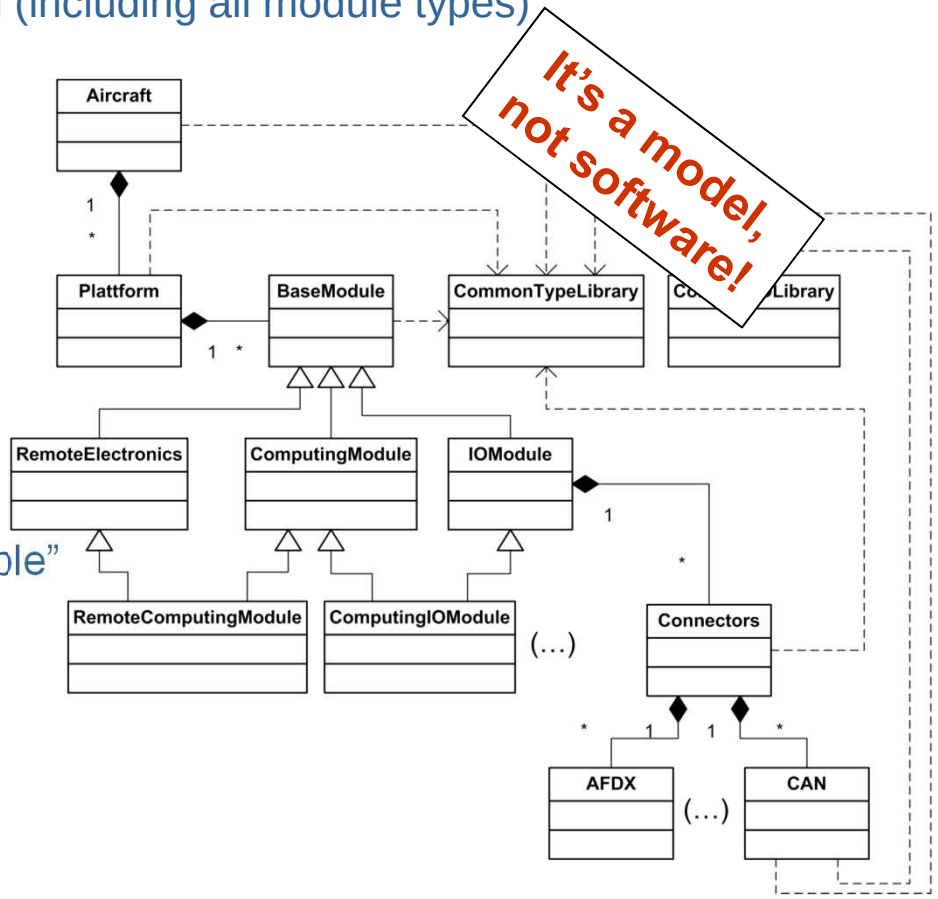
Meta-Model for IMA Configuration Data



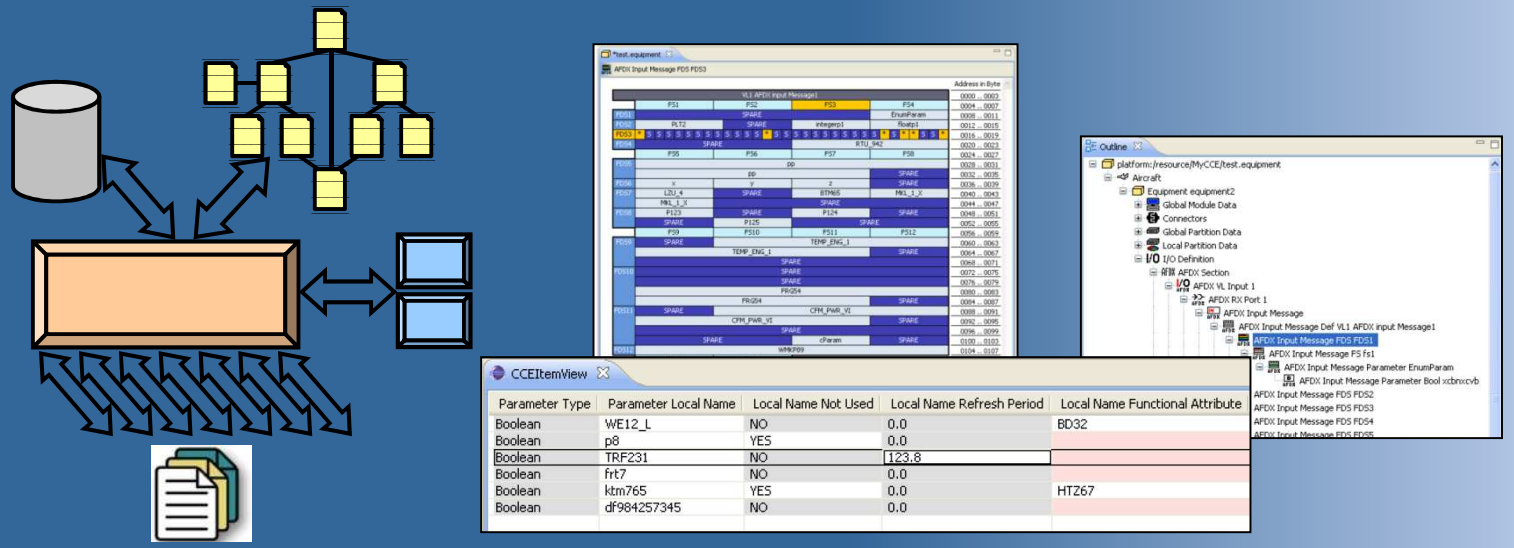
Meta-Model for IMA Configuration Data

- Requirements for the modelling domain
  - Include relevant configuration parameters for dedicated process steps
  - Encapsulate different parts of the configuration (actors)
  - Cover IMA configuration at aircraft level (including all module types)
  - Consider standards and commonalities
  - Module supplier independent
  - Extensible for future needs

- Realisation
  - There is no standard available (A653 part 1 is not sufficient)
  - Development of own Meta-Model
  - Object-oriented approach for a “pluggable” structure (→ configuration tree)
  - Make use of abstractions and libraries
  - Covers different module types and I/O parameters
  - A653 compatible



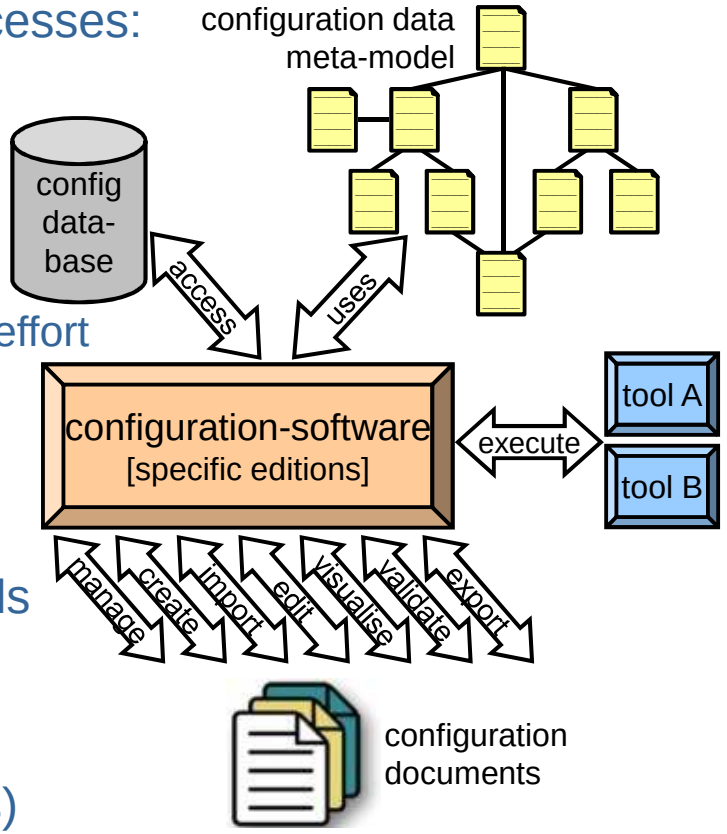
Platform Configuration Tool



Platform Configuration Tool

Rationale and areas of use

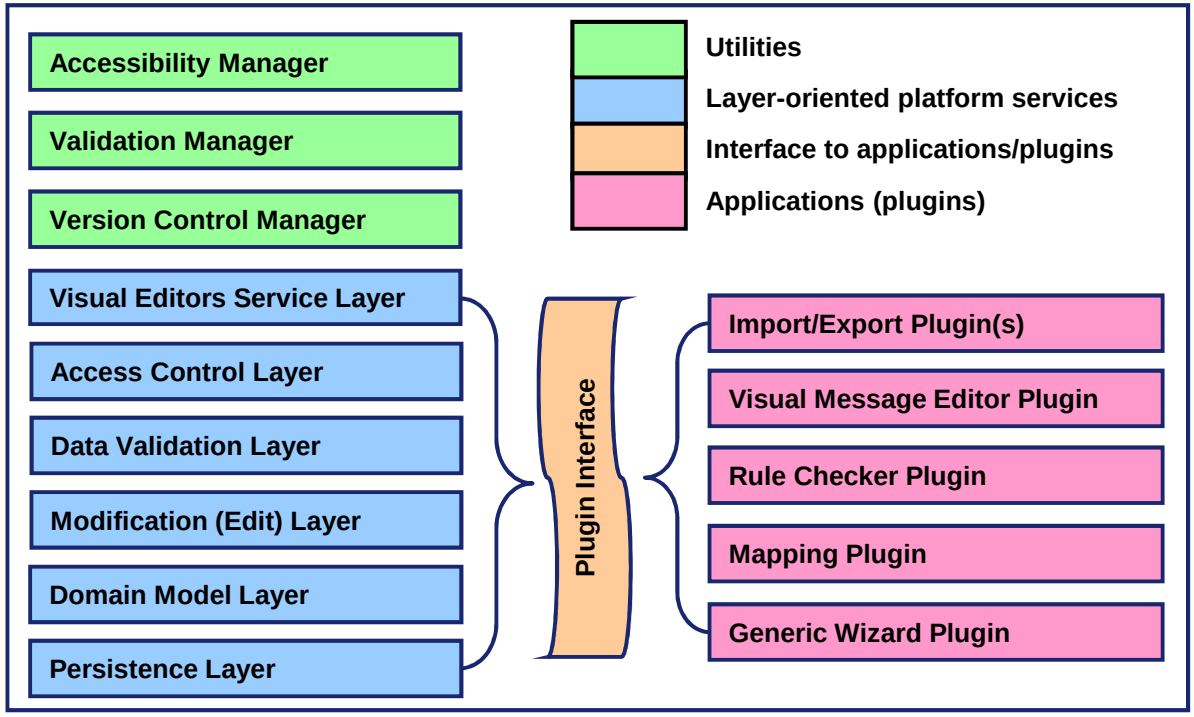
- Target nowadays mostly manual, error-prone processes:
  - Create/manage configuration data at aircraft level
  - Specification, resource negotiations
  - Creation of interface description documents (ICD)
  - Import/export from/into existing formats → re-use
  - Early configuration validation → reduce integration effort
  - Visualise complex relationships
- One integrated instead of many dedicated tools
- Integrate into configuration process with other tools
- Supports mainly Airframer activities
- Supports Function Supplier's processes (not tools)
- No replacement for (qualified) Module Supplier tools



Platform Configuration Tool

Implementation

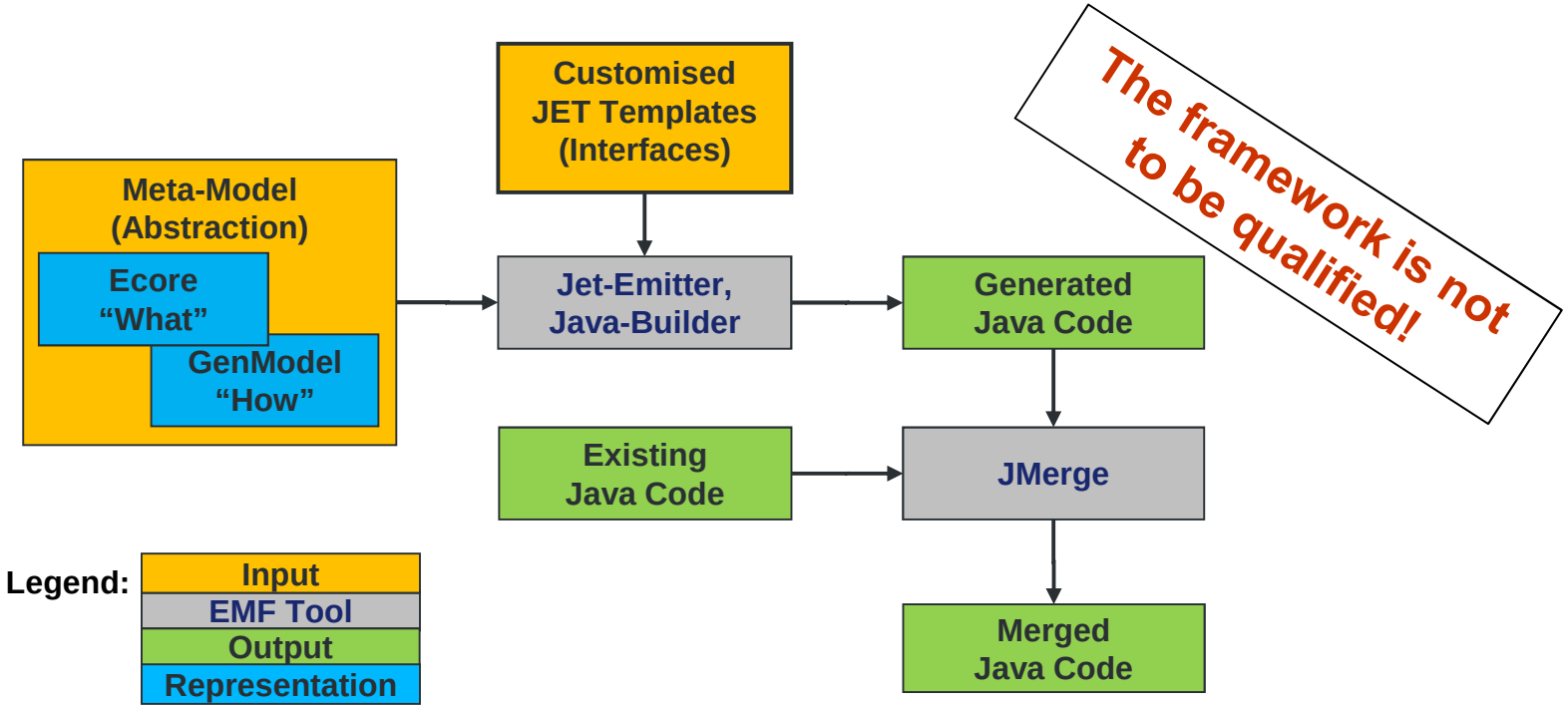
- "*Everything must be flexible.*": A programmers nightmare.
- Integrated software suite based on **plugins** and **extensions** following the **Eclipse** concept
- Heavy use of modern software frameworks
- Layer based architecture
- Interfaces, many of them!
- Functionality via Plugins



Platform Configuration Tool

“Morphable” Software through Code Generation

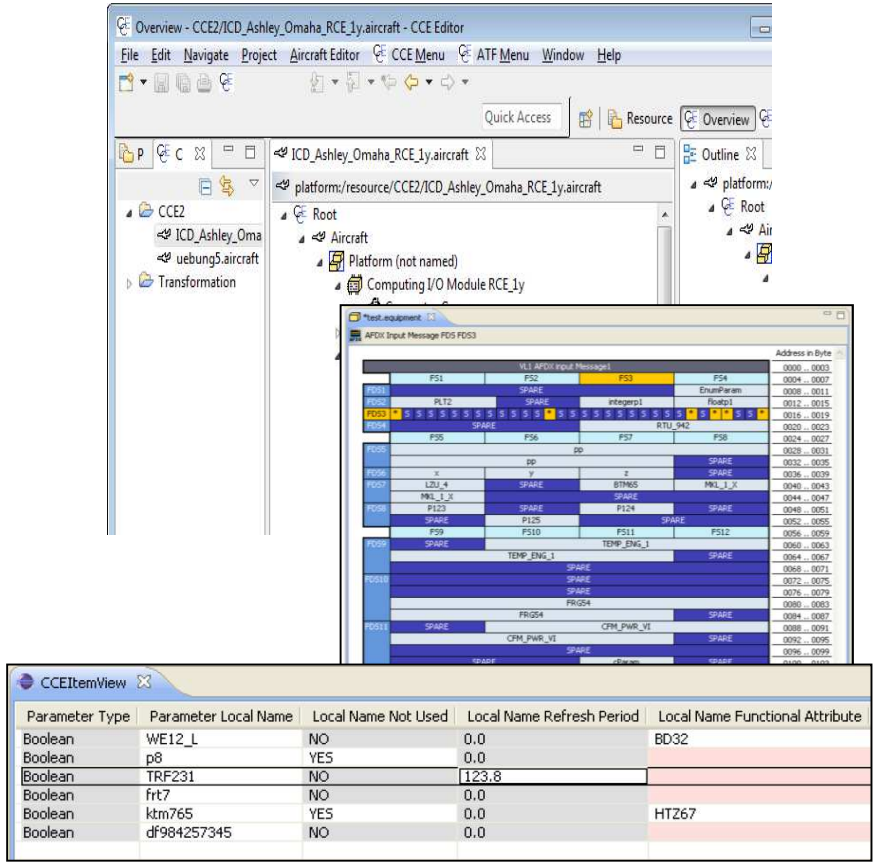
- Based on Eclipse Modelling Framework (EMF)
- Translates Meta-Model into software core (model-based S/W framework)
- Allows for fast adoption cycles
- Allows for code customisations (e.g. interfaces for plugins)
- Creates *all* lower layers of the presented architecture



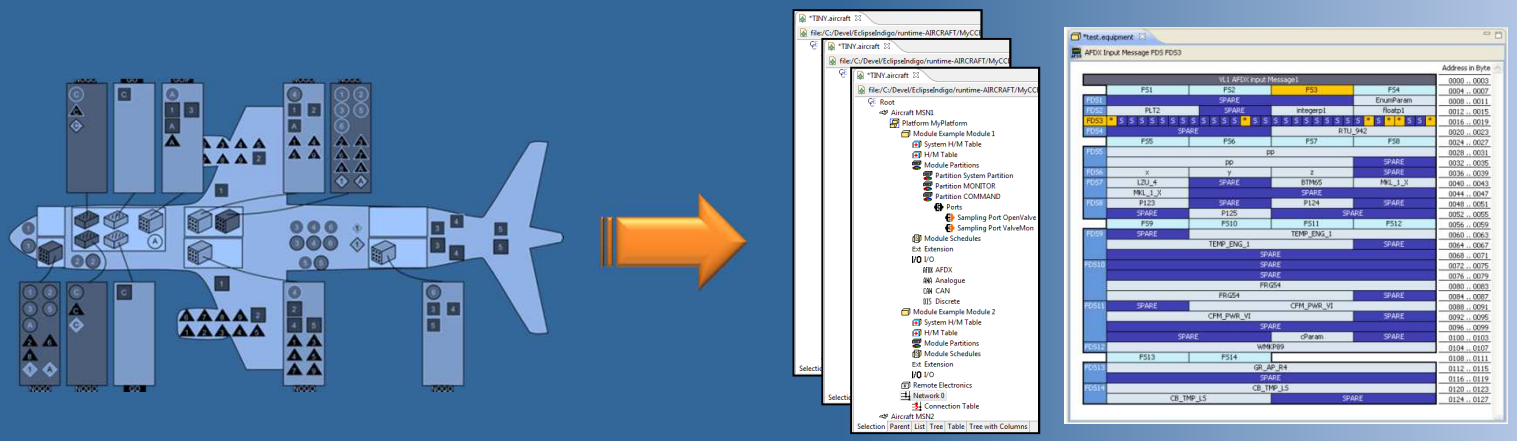
Platform Configuration Tool

Achievements

- Identified data flow and work flow for *enhanced* IMA process
- Developed generic meta-model for Platform Configuration Data for IMA modules used in demonstrator
- Achieved on-the-fly and user-triggered validation of Configuration Data for consistency
- Development of interface for all tools in the “ASHLEY Tool Framework”
- Achieved different visual representations



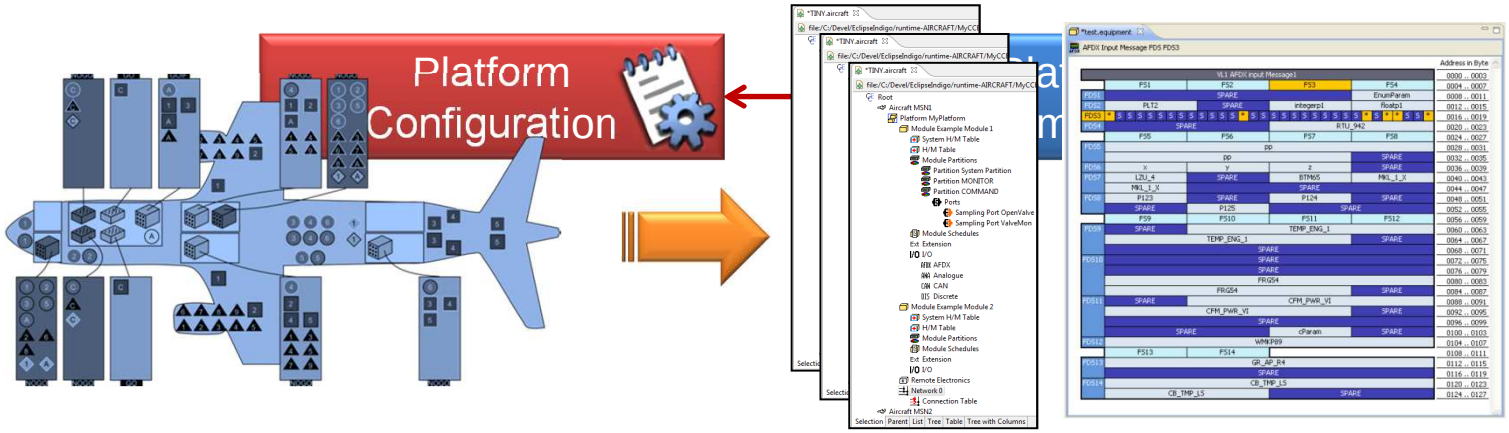
Transition between tools: Model2Model



Transition between tools: Model2Model

- Architecture Optimisation **results**
  - Generic module types
  - Abstract link types (data&power)
  - Simple routing (signal based)
  - Used very **early** in the process
- Configuration **needs**
  - Specific modules (CPM, RDC…)
  - Specific I/O channels (AFDX…)
  - Detailed routing/signal parameters
  - Used very **late** in the process

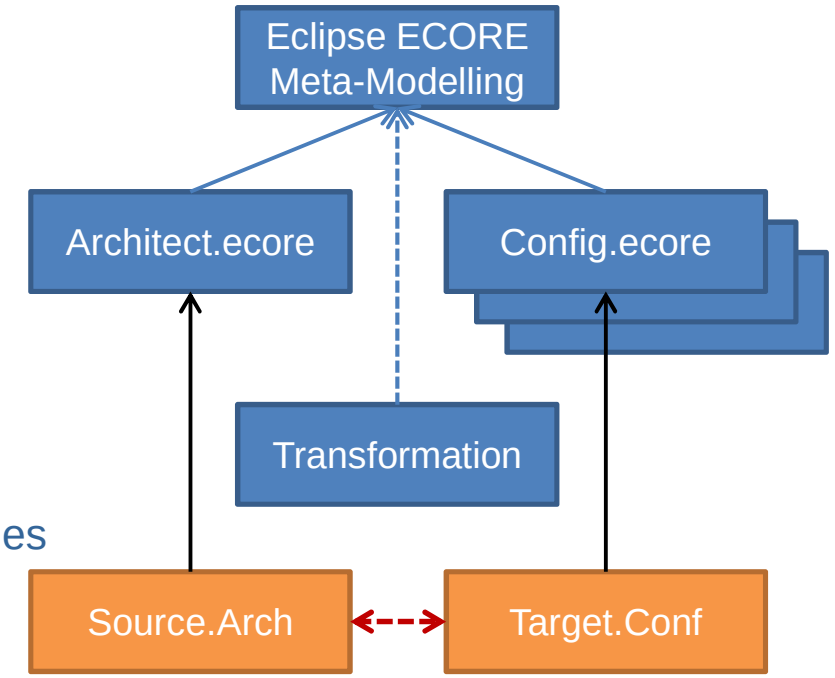
- **Auto-generate** IMA configuration stubs
- **Auto-retrieve** IMA architecture templates



- Methodology: **Model2Model transformation** between meta models
- Benefit: Error-free transition of information (re-use) between tools

Transition between tools: Model2Model

- Basis:
  - Both Frameworks are based on Eclipse
  - Both Frameworks share the same meta-modelling language (ECORE)
  - There exists a tooling that allows to define a transformation „script“ to transform parameters from one into another tool

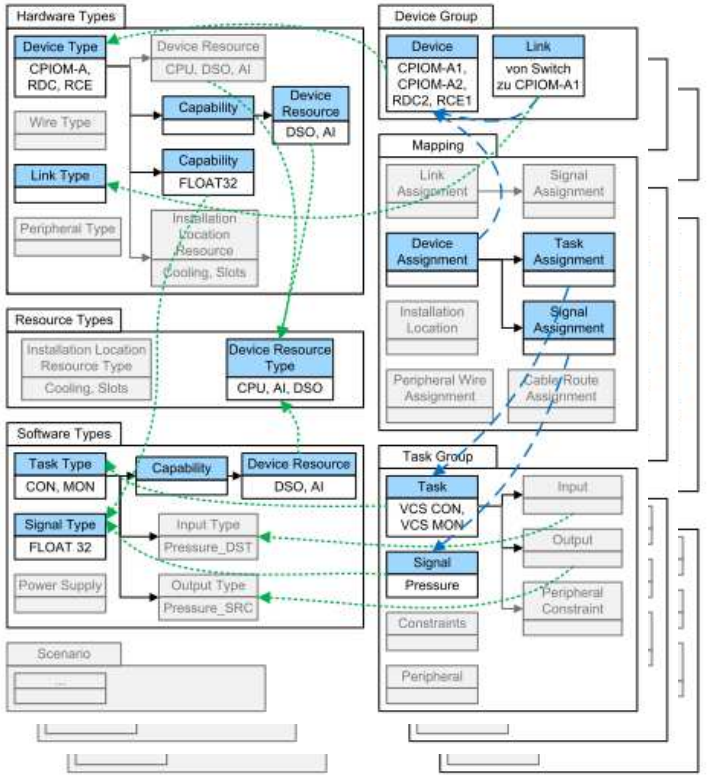


- Solution:
  - Different transformation technologies/languages
  - Some are file (XML) based, some are meta-model based

- Integration into Tools
  - Transformation script is code-generated and embedded as plugin into both tools
  - This results in the functionality

Transition between tools: Model2Model

- Result:
  - Investigated possible parameter transformations
  - Transform architecture → configuration stub
  - Transform configuration → architecture model
  - Developed sets of transformation scripts for both directions
  - Language with most benefits: “Query View Transformation operational” (QVTo)
  - By design, a 1:1 relation is not possible
    - ✓ Example for POT→PCT:
      In POT, device types are identified via string
      In PCT, devices are different classes
      → Solution: Naming rules
    - ✓ Example for PCT→POT
      No installation locations in PCT, but in POT (to compute cable length)
      → Data is missing after TraFo to POT
  - BUT: Better than starting from scratch!




```
//add default-child if TgtModule has no brotherObj
self.allSubobjectsOfType(SrcModule).oclAsType(SrcModule)->forEach(foundModule){
    var foundTargetModule := foundModule.resolveone(TgtModule);
    if (foundTargetModule <> null) then {
        if (foundTargetModule.brotherObj = null) then{
            foundTargetModule.childs += object TgtChildTypeA{
                name := "default";
            };
        } endif;
    } endif;
};
```

Any questions?

Conclusions

- Introduction of the configuration process
  - Complex, distributed process
  - Requires harmonisation to avoid iterations
- Introduction of Meta-Model and PCT
  - Supports several module types and actors
  - Modern software framework, based on plugins
- Transition between tools: Model2Model
  - Supports automatic, model-based transition of data between PCT and POT

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