



*Avionics Systems Hosted on a distributed modular electronics Large scale dEmonstrator for multiple tYpe of aircraft*

Presented by

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## Configuration Management for IMA Components

ASHLEY-WP73-TUHH-DISM-PRES-0483



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

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# 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



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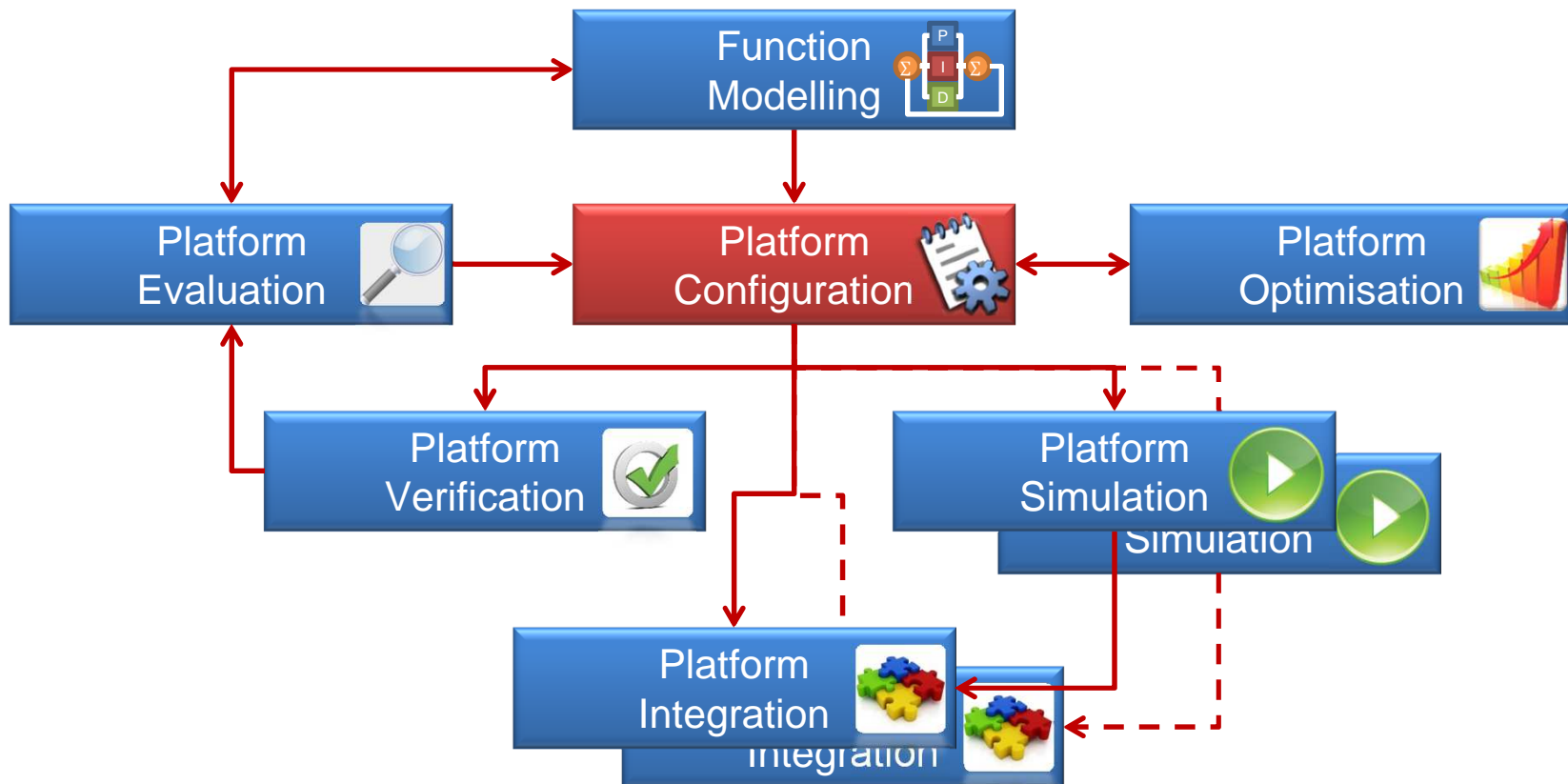
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# Introduction: TUHH/FST @ ASHLEY



## □ 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



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# Introduction: The IMA Configuration Management Process

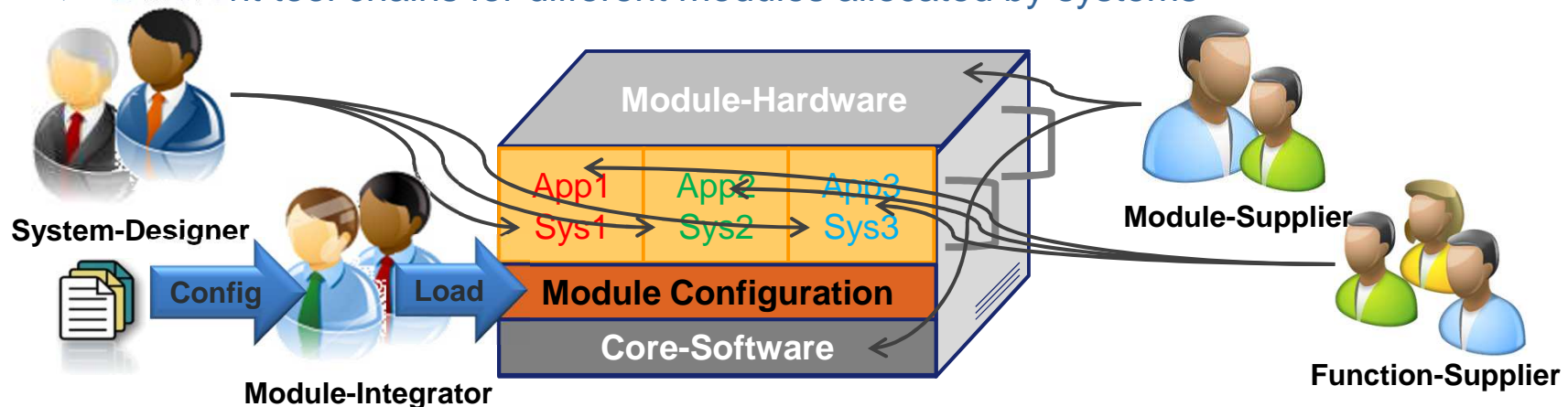


## ❑ Challenges

- 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



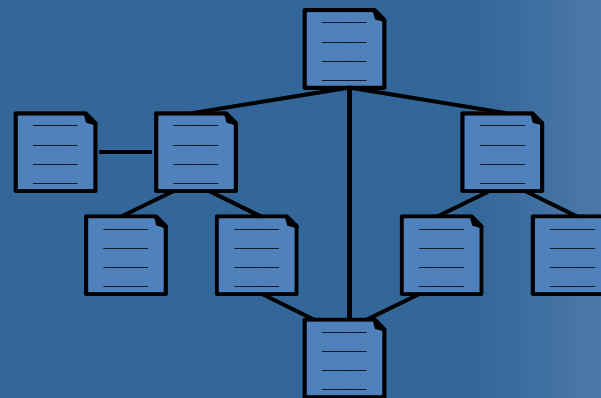
→ **Aim: Harmonisation of the process through computer assisted configuration engineering and validation for IMA modules**

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## Meta-Model for IMA Configuration Data



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# Meta-Model for IMA Configuration Data

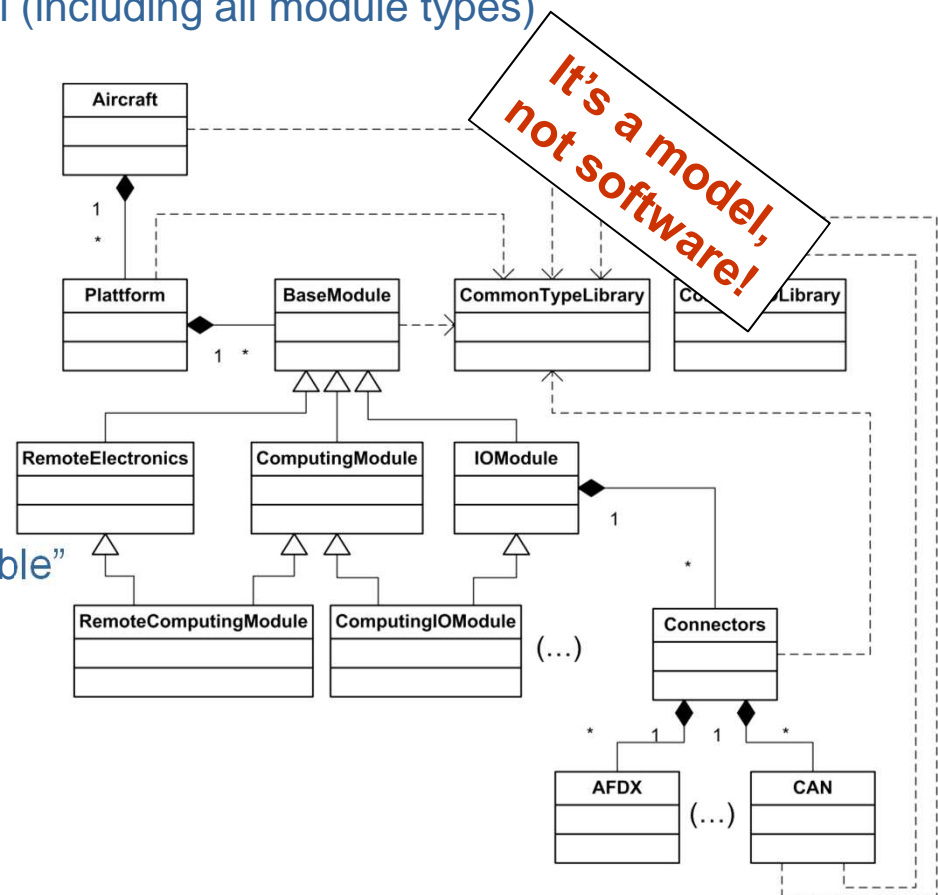


## □ Requirements for the modelling domain

- 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



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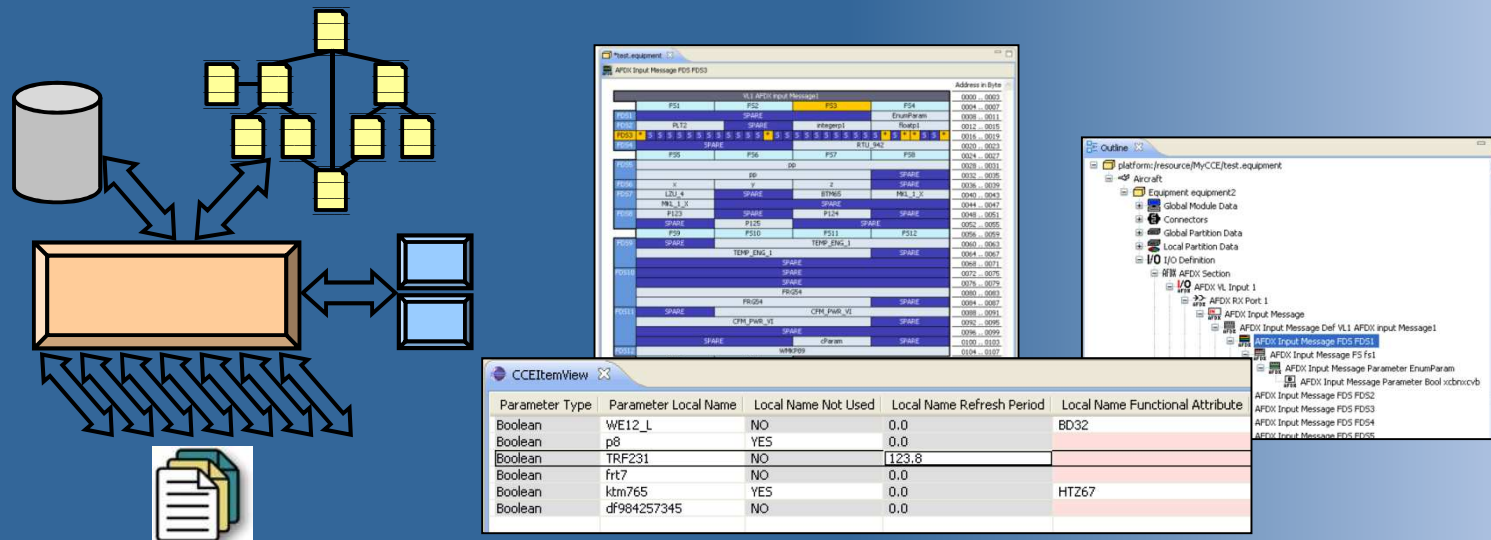
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# Platform Configuration Tool



The diagram illustrates the architecture of the Platform Configuration Tool. It features a central orange box representing the core configuration engine. To its left, a grey cylinder (database) and a tree structure of yellow boxes (hierarchical configuration) are connected to the central box. To its right, two blue boxes (output modules) are connected. Below the central box, multiple blue arrows point downwards to a document icon, representing the generation of configuration files. Three screenshots of the tool's interface are shown:

- AFDX Input Message FDS FDS3:** A table listing AFDX input messages with columns for Name, Type, Local Name, and Address in Byte.
- Outline:** A hierarchical tree view of the configuration structure, including sections like Equipment, Global Module Data, Connectors, and I/O Definition.
- CCItemView:** A table showing configuration items with columns for Parameter Type, Parameter Local Name, Local Name Not Used, Local Name Refresh Period, and Local Name Functional Attribute.

Parameter Type	Parameter Local Name	Local Name Not Used	Local Name Refresh Period	Local Name Functional Attribute
Boolean	WE12_L	NO	0.0	BD32
Boolean	p8	YES	0.0	
Boolean	TRF231	NO	123.8	
Boolean	frt7	NO	0.0	
Boolean	krm765	YES	0.0	HT267
Boolean	df984257345	NO	0.0	

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# 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

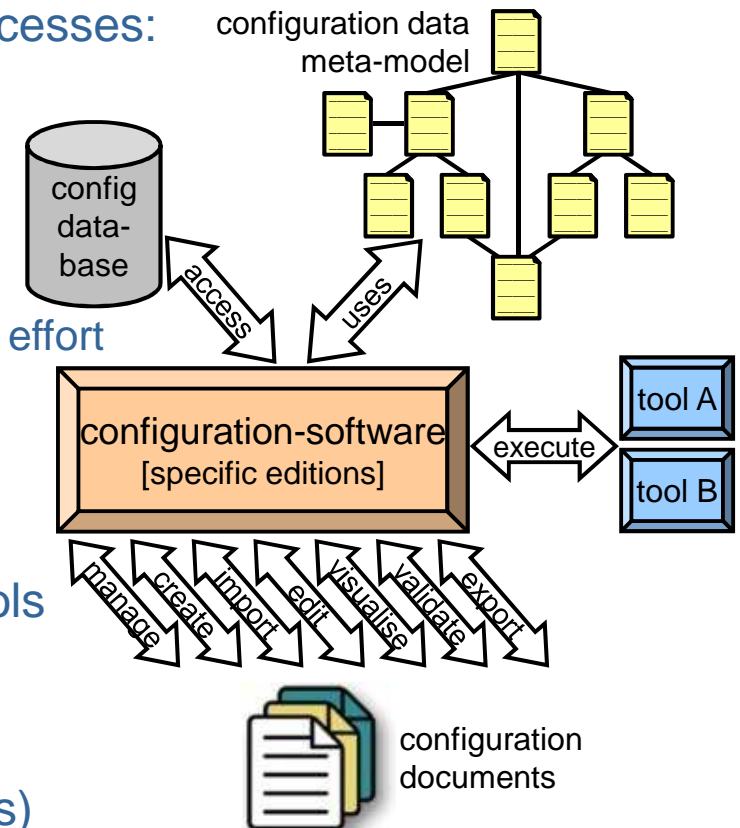
### ❑ One integrated instead of many dedicated tools

### ❑ 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



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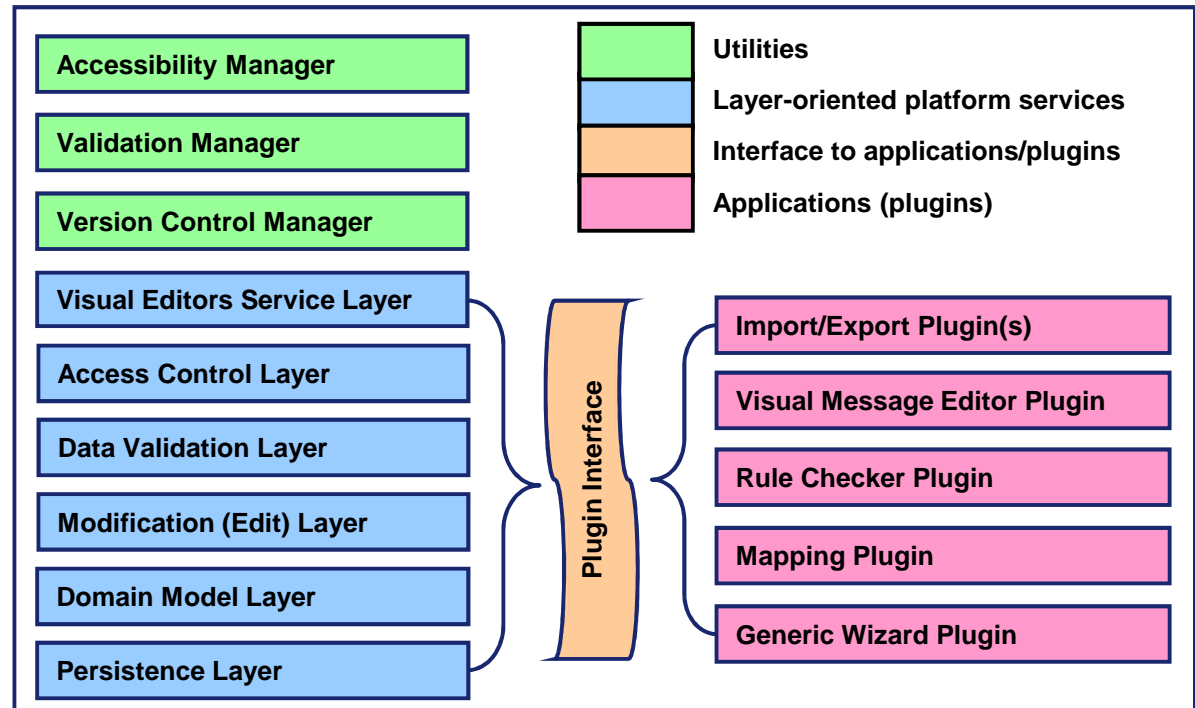
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# Platform Configuration Tool



## 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



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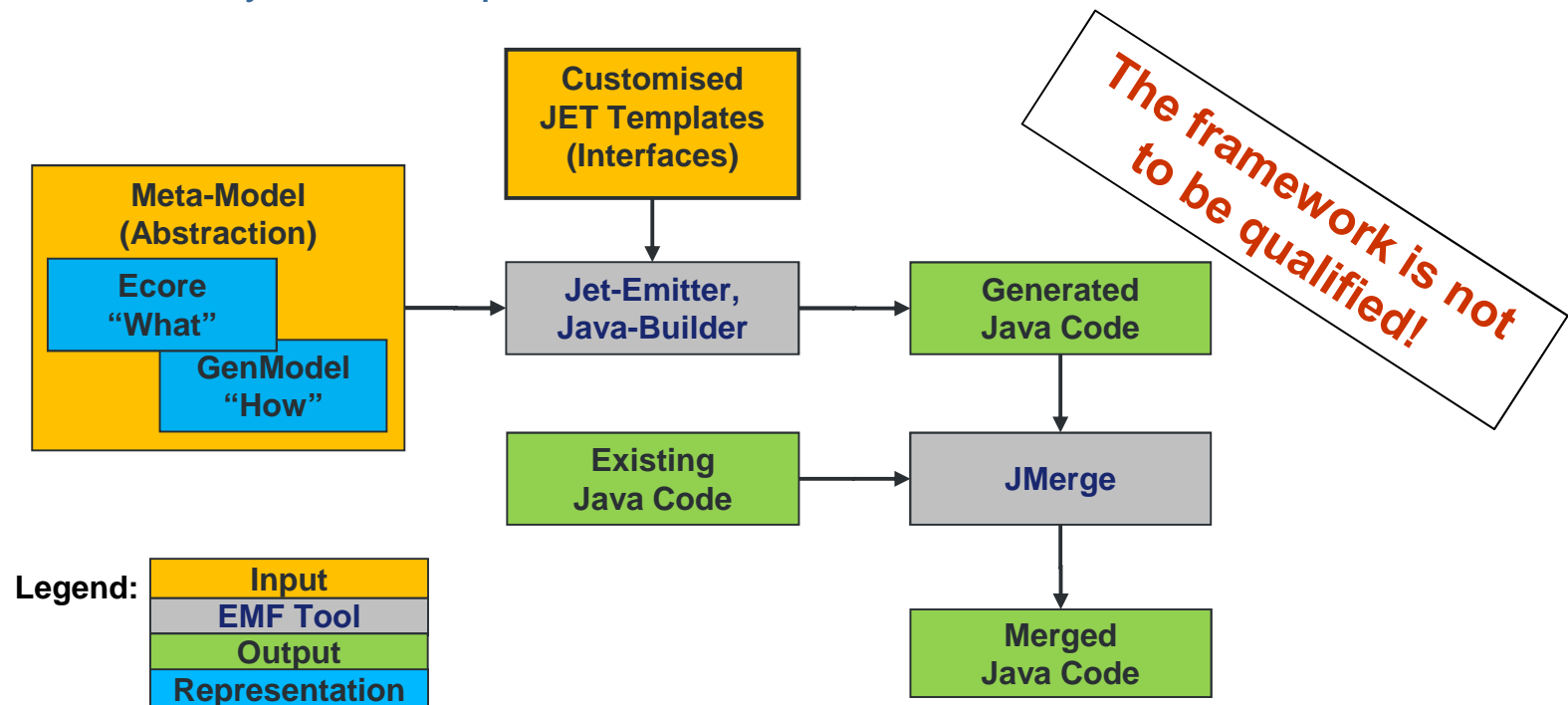
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# Platform Configuration Tool



## “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



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# 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

The screenshot displays the 'Overview - CCE2/ICD\_Ashley\_Omaha\_RCE\_1y.aircraft - CCE Editor' window. It features a menu bar (File, Edit, Navigate, Project, Aircraft Editor, CCE Menu, ATF Menu, Window, Help) and a toolbar. The main workspace is divided into several panes:

- Project Tree (Left):** Shows a hierarchy starting with 'platforms/resource/CCE2/ICD\_Ashley\_Omaha\_RCE\_1y.aircraft', containing 'CCE2', 'ICD\_Ashley\_Oma', 'uebung5.aircraft', and 'Transformation'.
- Outline (Right):** Shows a tree structure with 'platforms', 'Root', 'Aircraft', 'Platform (not named)', and 'Computing I/O Module RCE\_1y'.
- Data Table (Bottom Right):** A table titled 'AFDX Input Message FDS FDS3' with columns for 'Address in Byte' and data rows for parameters like F51, F52, F53, F54, etc.
- Parameter List (Bottom):** A table titled 'CCEItemView' with columns: 'Parameter Type', 'Parameter Local Name', 'Local Name Not Used', 'Local Name Refresh Period', and 'Local Name Functional Attribute'.

Parameter Type	Parameter Local Name	Local Name Not Used	Local Name Refresh Period	Local Name Functional Attribute
Boolean	WE12_L	NO	0.0	BD32
Boolean	p8	YES	0.0	
Boolean	TRF231	NO	123.8	
Boolean	frt7	NO	0.0	
Boolean	ktm765	YES	0.0	HTZ67
Boolean	df984257345	NO	0.0	

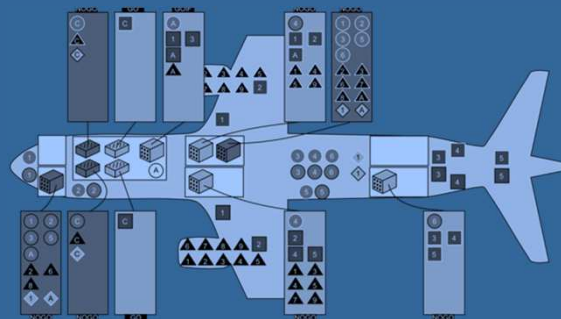
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# Transition between tools: Model2Model



The screenshots show the following interfaces:

- Left Screenshot:** A tree view of a system architecture, showing a hierarchy from 'Root' down to 'Aircraft MSGZ' and 'Connection Table'.
- Middle Screenshot:** A table with columns for 'Address in Byte' and 'Input Message', listing various system parameters and their addresses (e.g., P101, P102, P103).
- Right Screenshot:** A detailed view of a message table, showing columns for 'Address in Byte' and 'Input Message', with rows detailing specific message IDs and their corresponding parameters.

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# Transition between tools: Model2Model



## Architecture Optimisation results

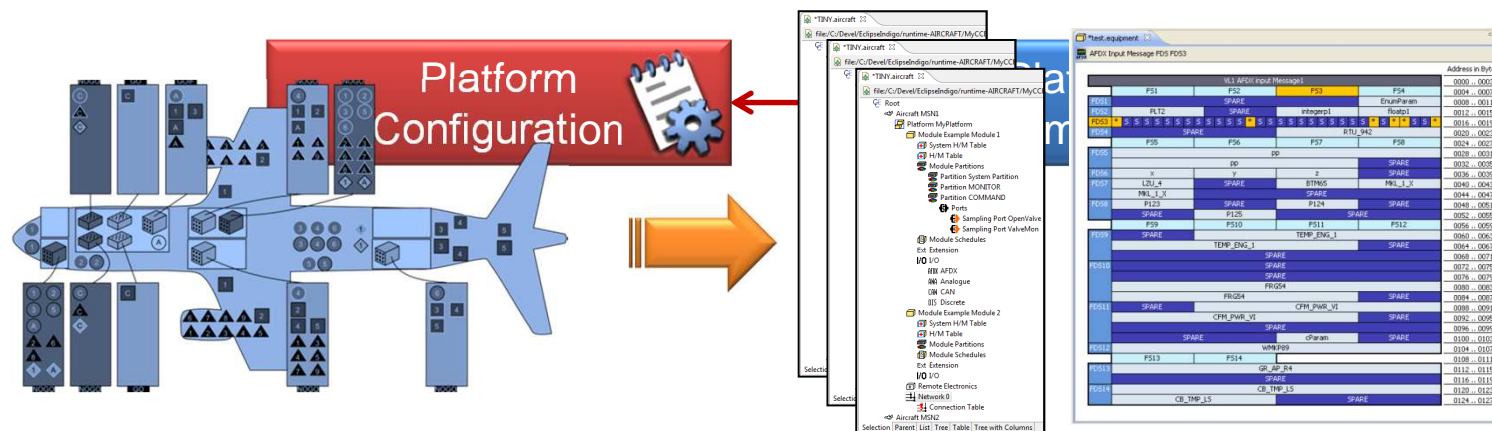
- Generic module types
- Abstract link types (data&power)
- Simple routing (signal based)
- Used very **early** in the process

## 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

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# Transition between tools: Model2Model



## □ Basis:

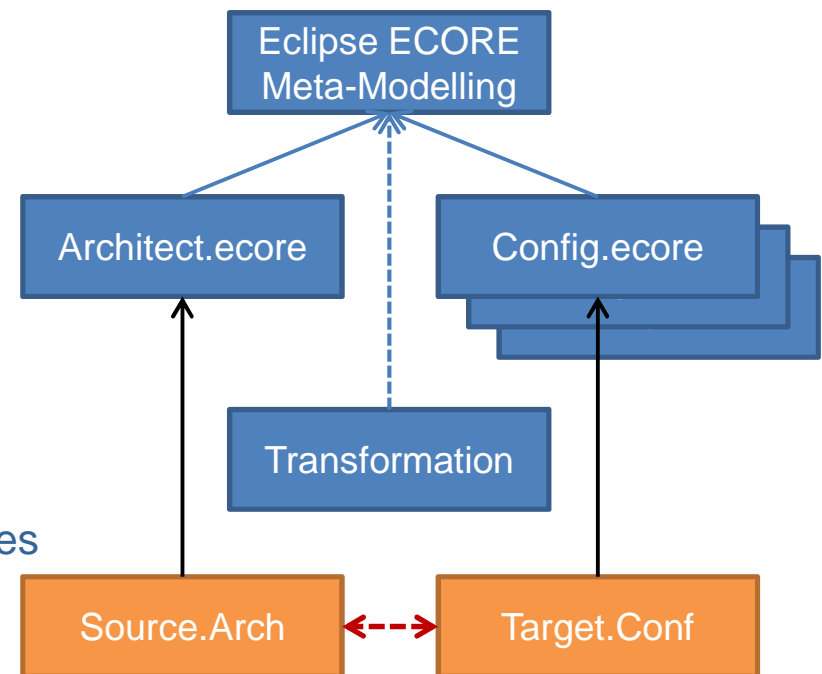
- Both Frameworks are based on Eclipse
- Both Frameworks share the same meta-modelling language (ECORE)
- There exists a tooling that allows to define a transformation „script“ to transform parameters from one into another tool

## □ 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



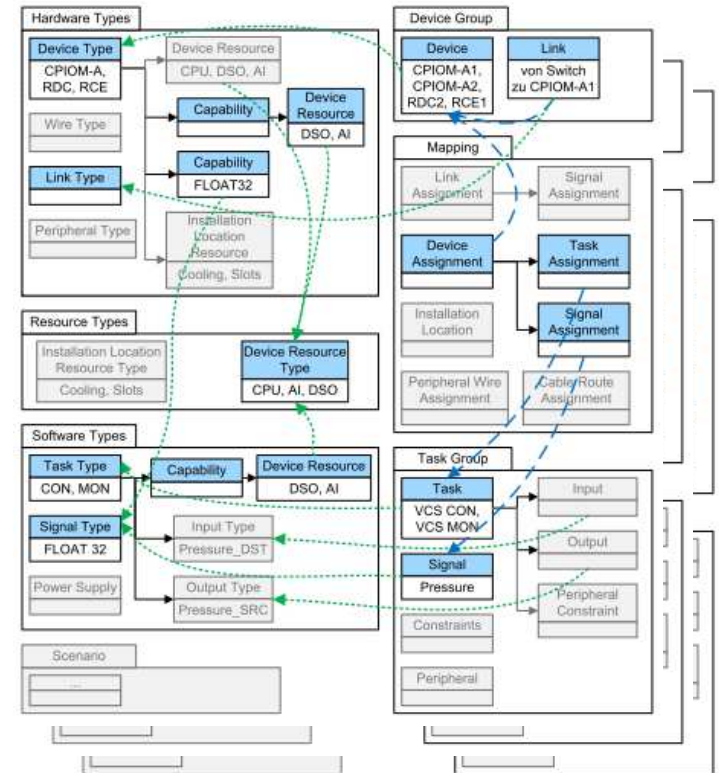


# Transition between tools: Model2Model



## □ 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;
};
    
```

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# 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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