Presented by

Gert Döhmen
Airbus Deutschland GmbH

Embedded System Development for Distributed Networked Computing Platforms

Content

1. The SPEEDS Project
2. Distributed Networked Computing Platform
3. Using SPEEDS for IMA Development

The SPEEDS Project

SPEculative and Exploratory Design in System‘s Engineering

SPEEDS is funded by the European Commission

under Contract IST-033471

AIRBUS

SPEEDS technological contribution

- “Fool-proof" representations of Systems [HRC: Heterogeneous Rich Components].
- Formal technical analyses to verify compatibility, consistency, of Systems [ADT; Analysis Design Techniques].
- Process Control/Monitoring Techniques to evaluate the progress, maturity, of Systems Projects. [SDS; Speculative Design and Seamless Access; Process Adviser].
- Integrated development with transparent access to information and transfer of data between tools [Speeds Bus].

„Heterogeneous Rich Components“ – Objectives

- To provide a characterization of components of electronic components
  - supporting all phases, levels, and viewpoints of electronic system design
  - Allowing complete re-use (across multiple platforms, across multiple organizations, and/or as part of design libraries)
  - Allowing characterization of allowed/assumed environments of component (for all viewpoints)
  - Basis for (de-facto) standardization, compatible with Autosar Component Model

- As basis for tool-independent meta-model for capturing and validating function networks
  - Supporting semantic based integration of industry standard System & SW design tools (UML, Matlab-Simulink/Stateflow, ASCET, …)
  - Supporting view-point specific and cross viewpoint requirement capturing, modeling, analysis and design

AIRBUS

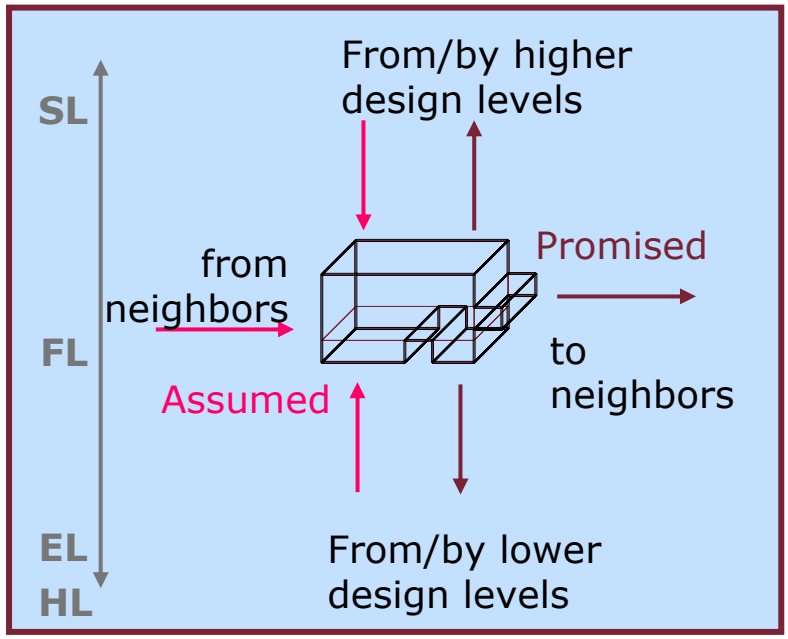
Heterogeneous Rich Component – HRC

Follows Design by Contract Paradigm :

- Assumptions
  - **reflect current degree of knowledge of anticipated design context**
  - **Determine boundary conditions on actual design context for each view-point under which component is promising its services**
  - **are decorated with confidence levels**
  - **horizontal and vertical**
- Promises
  - **Are guaranteed if component is used in assumed design context**
  - **horizontal and vertical**

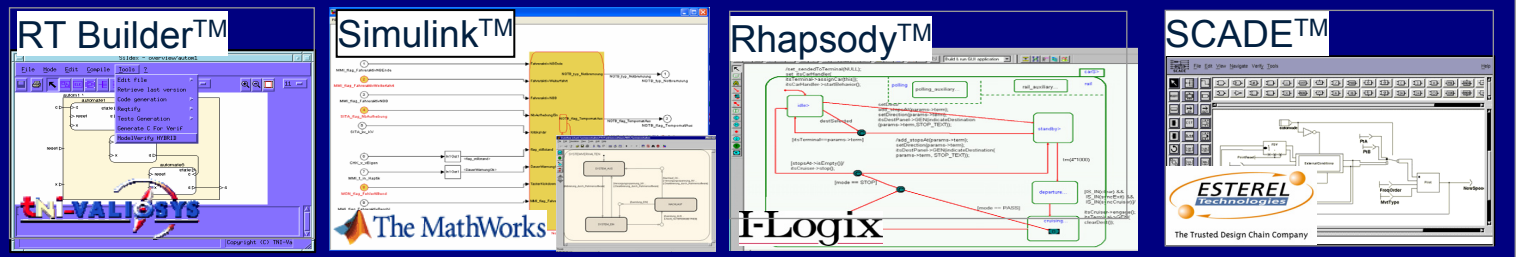
Is organized per viewpoint :

- **Behavior, Coordination, Safety, Real-Time, ….**
- **But allow specification of cross viewpoint dependencies**

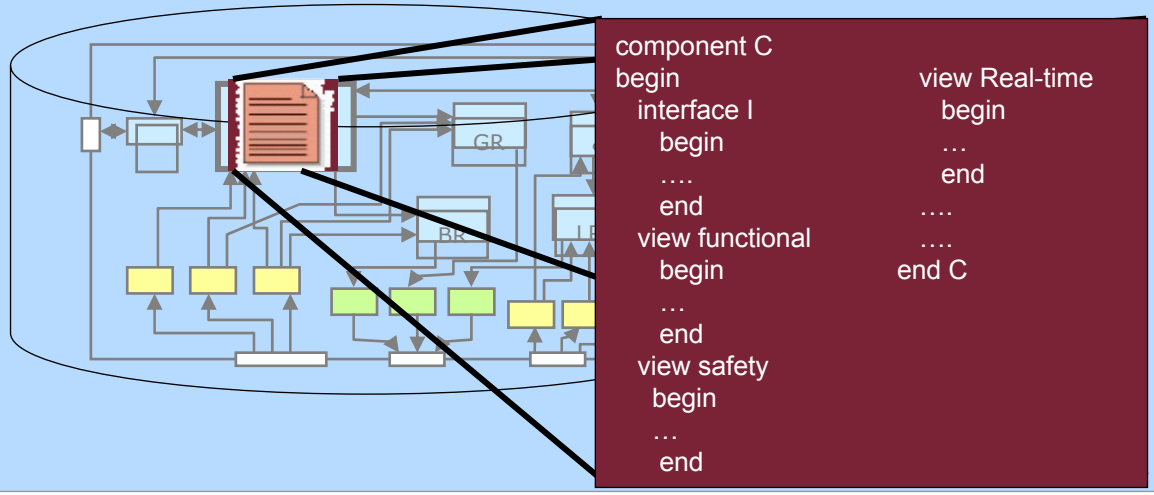


SPEEDS Design Entities

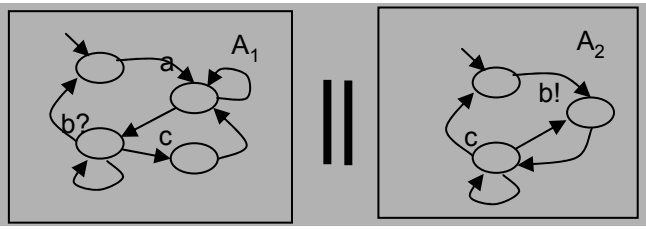
User's View: COTS modeling tools



Speeds Metamodel



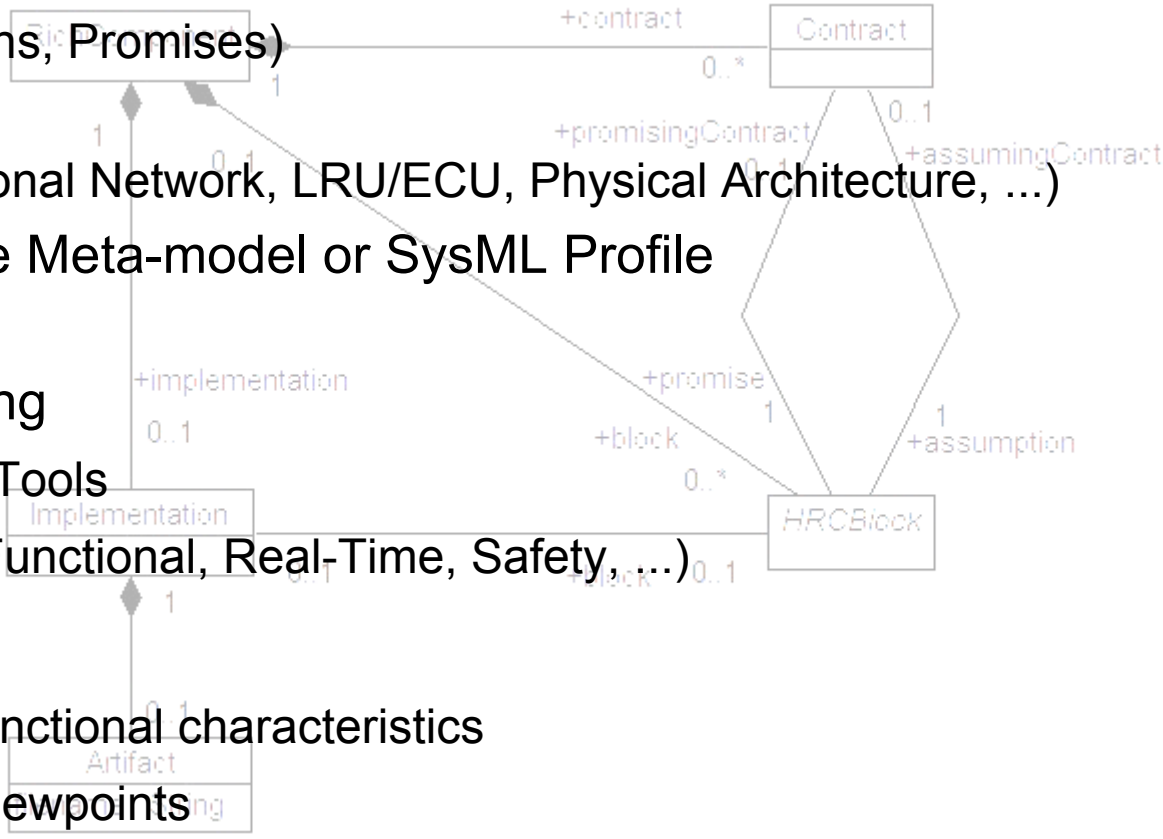
Speeds Semantic Foundation



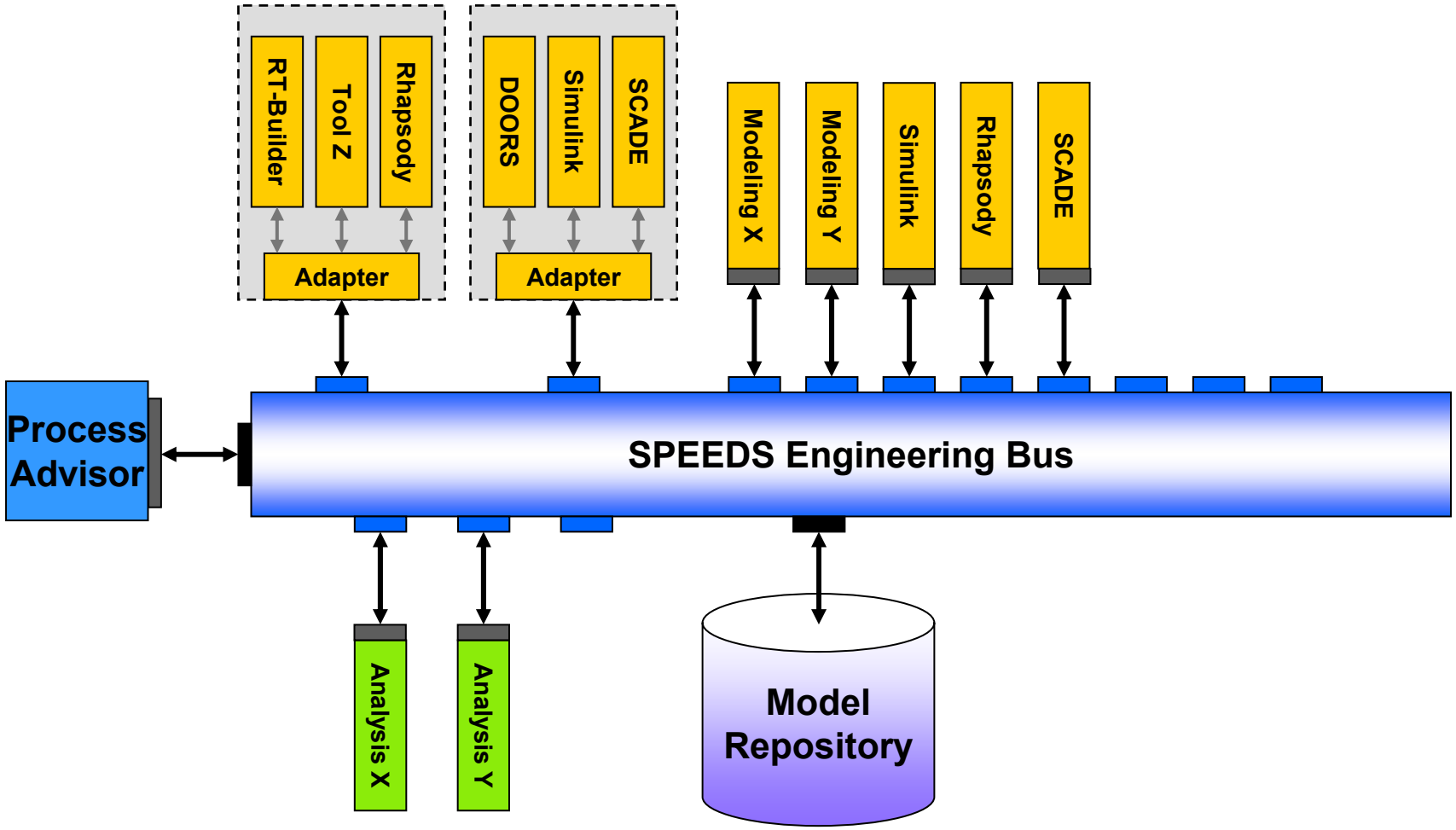
for all viewpoints v:
$\cap$ L(A(OutI.v.pr_j)) $\subseteq$
$\cap$ L(A(InI.v.$assm_i$))

HRC Meta-model

- Based on SysML
- Added Features
  - Contracts (Assumptions, Promises)
  - Various Viewpoints
  - Linking layers (Functional Network, LRU/ECU, Physical Architecture, ...)
- Available as Standalone Meta-model or SysML Profile
- Heterogeneous Modelling
  - Integration of Design Tools
  - Multiple Viewpoints (Functional, Real-Time, Safety, ...)
- Analysis
  - Functional and non-functional characteristics
  - Interaction between viewpoints
- Design Space Exploration



SPEEDS Engineering Bus



Distributed Networked Computing Platform

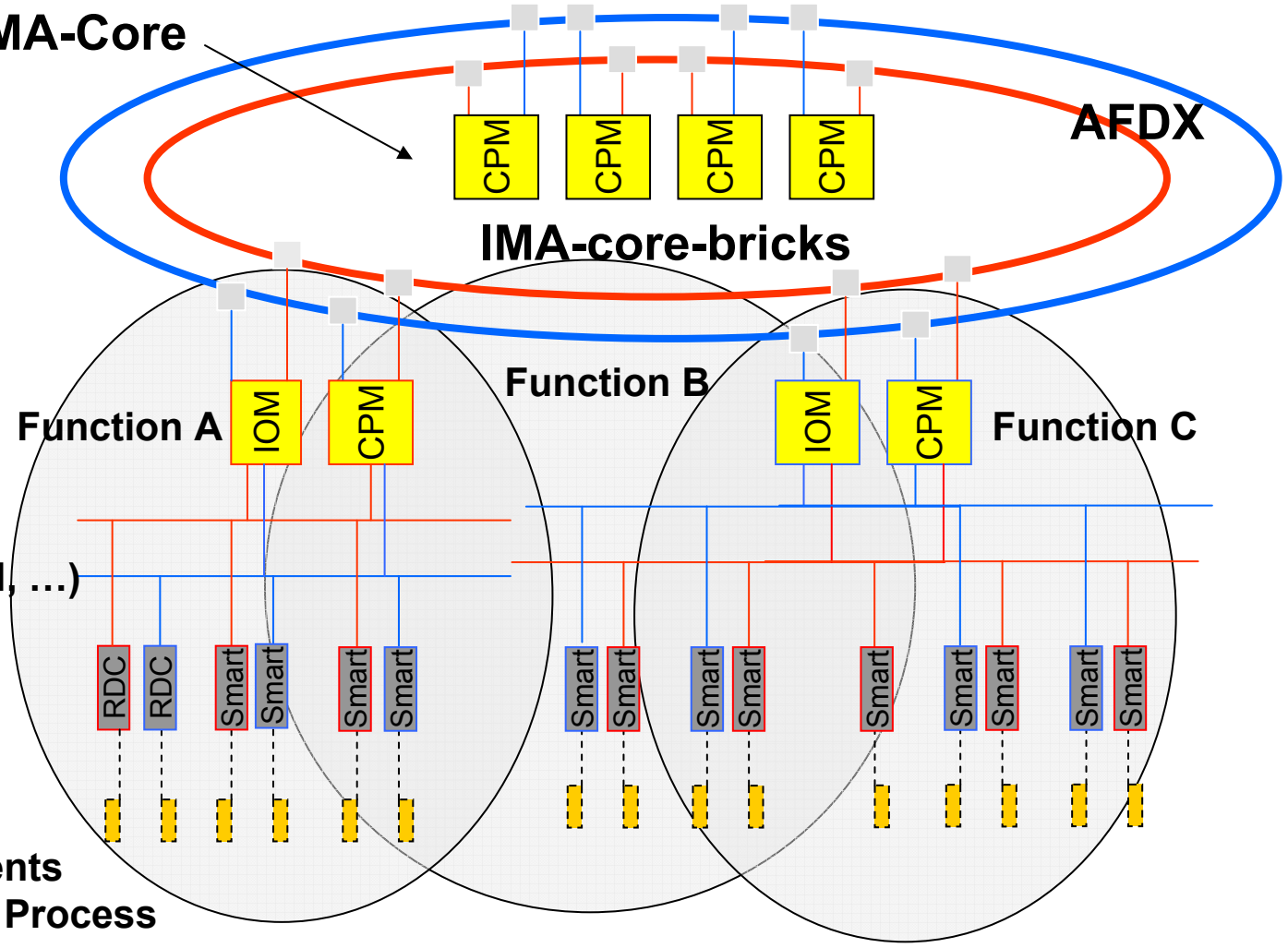
AIRBUS

Distributed Networked Computing Platform

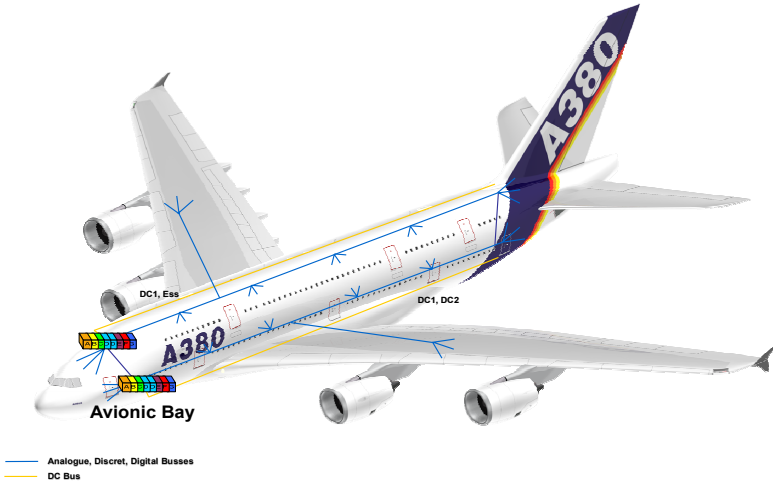
Global Functions:
Consolidation,
BITE, Diagnostic

Field-Bus:
TT-Bus, A429, CAN, …)

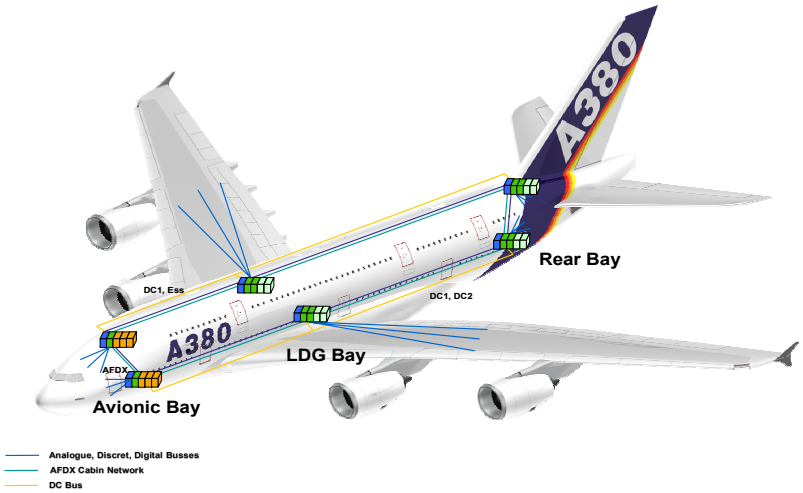
Common:
- **HW Components**
- **Development Process**
- **Tools**



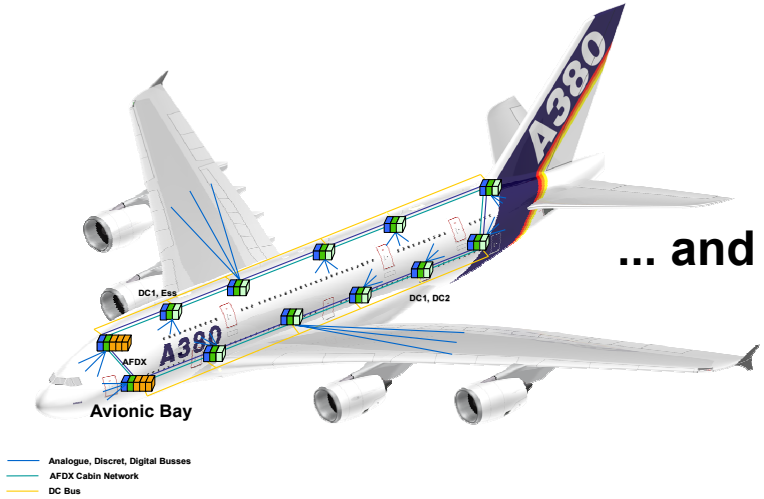
Different IMA Topologies



Fully integrated and centralized CPIOMs



CPM centralized – IOM/ RDC distributed

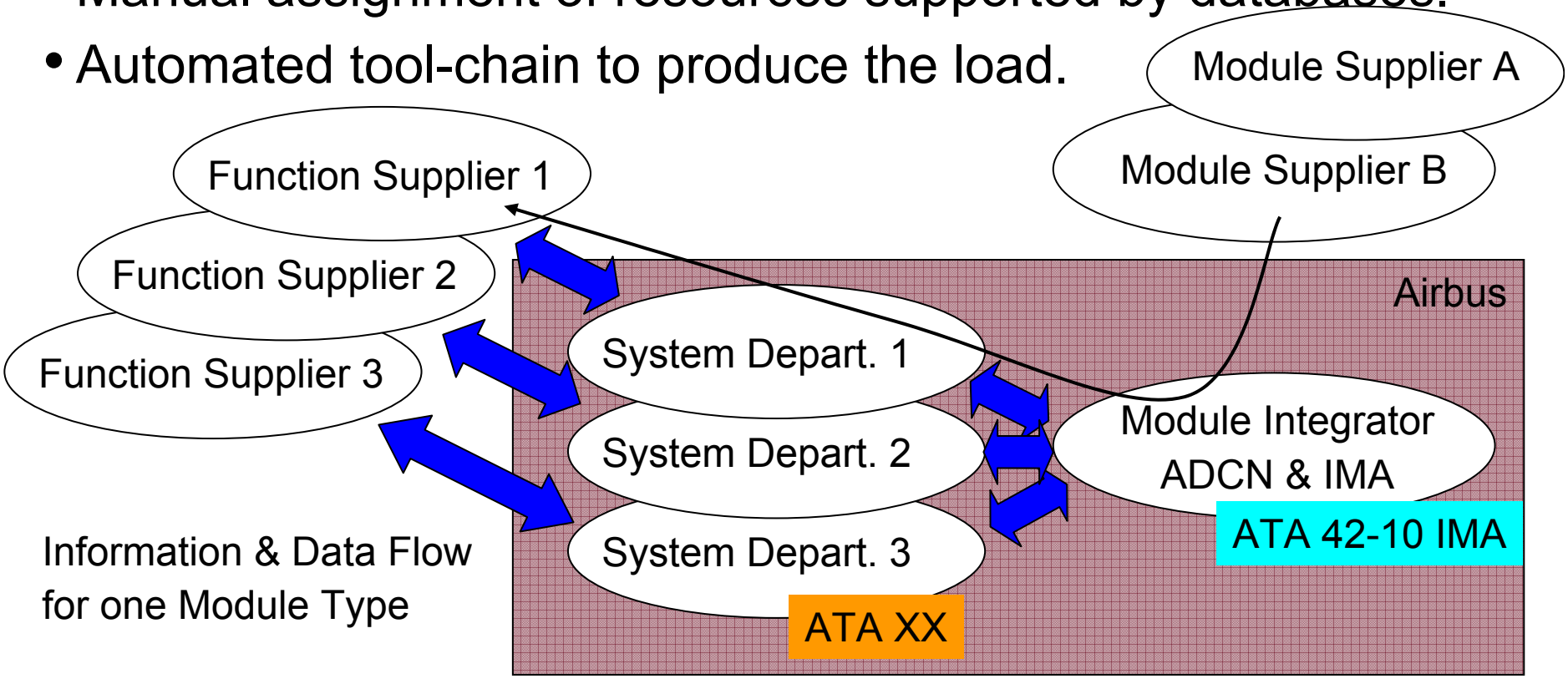


... and the right Function to Resource Allocation ?

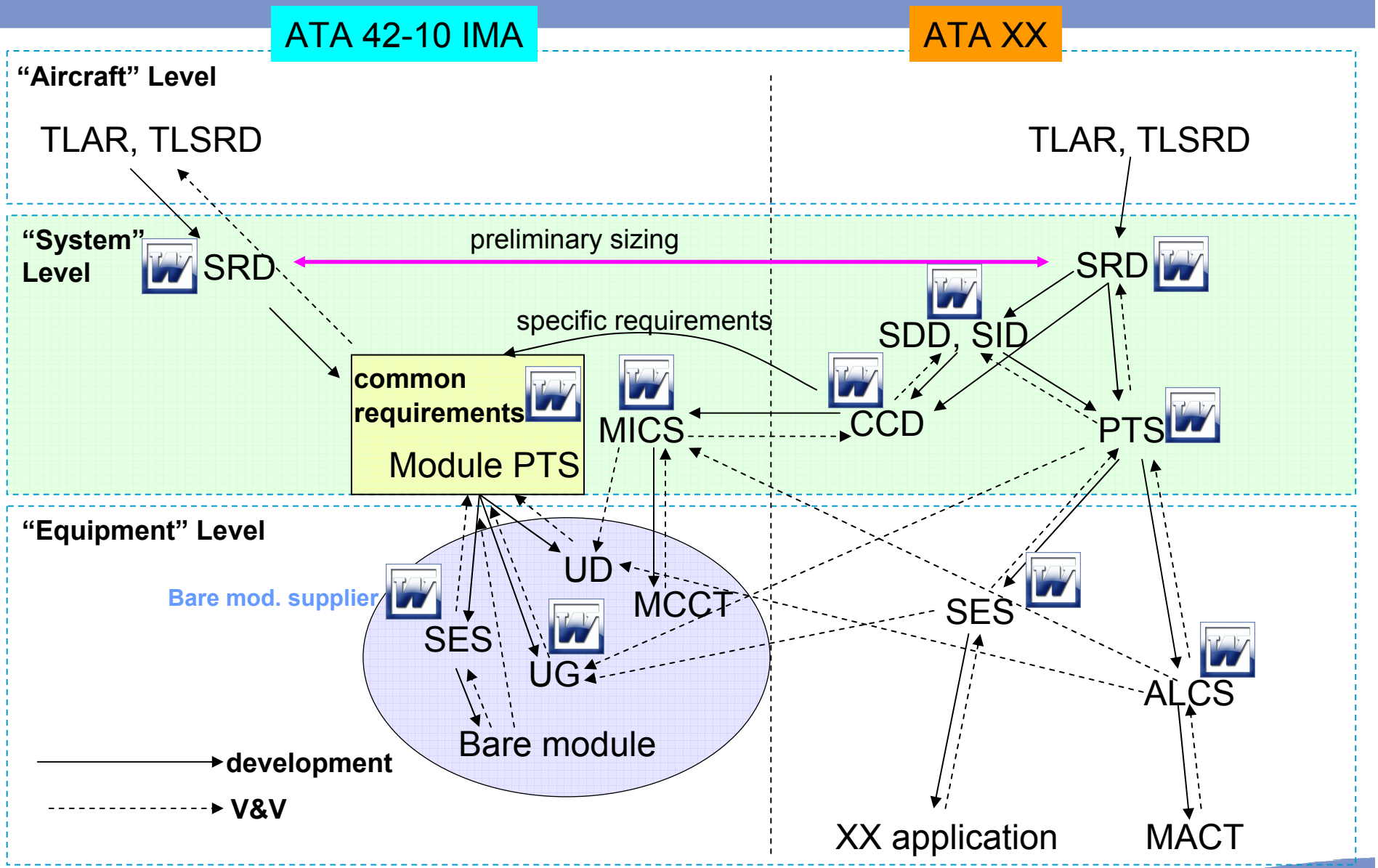
CPM centralized – IOMs/ RDCs per section

A380 IMA – Development Process Aspects

- Classification of Configuration Parameter (Module, Global, Local).
- Hardware/OS specific configuration parameter.
- Manual assignment of resources supported by databases.
- Automated tool-chain to produce the load.



Specification architecture & validation



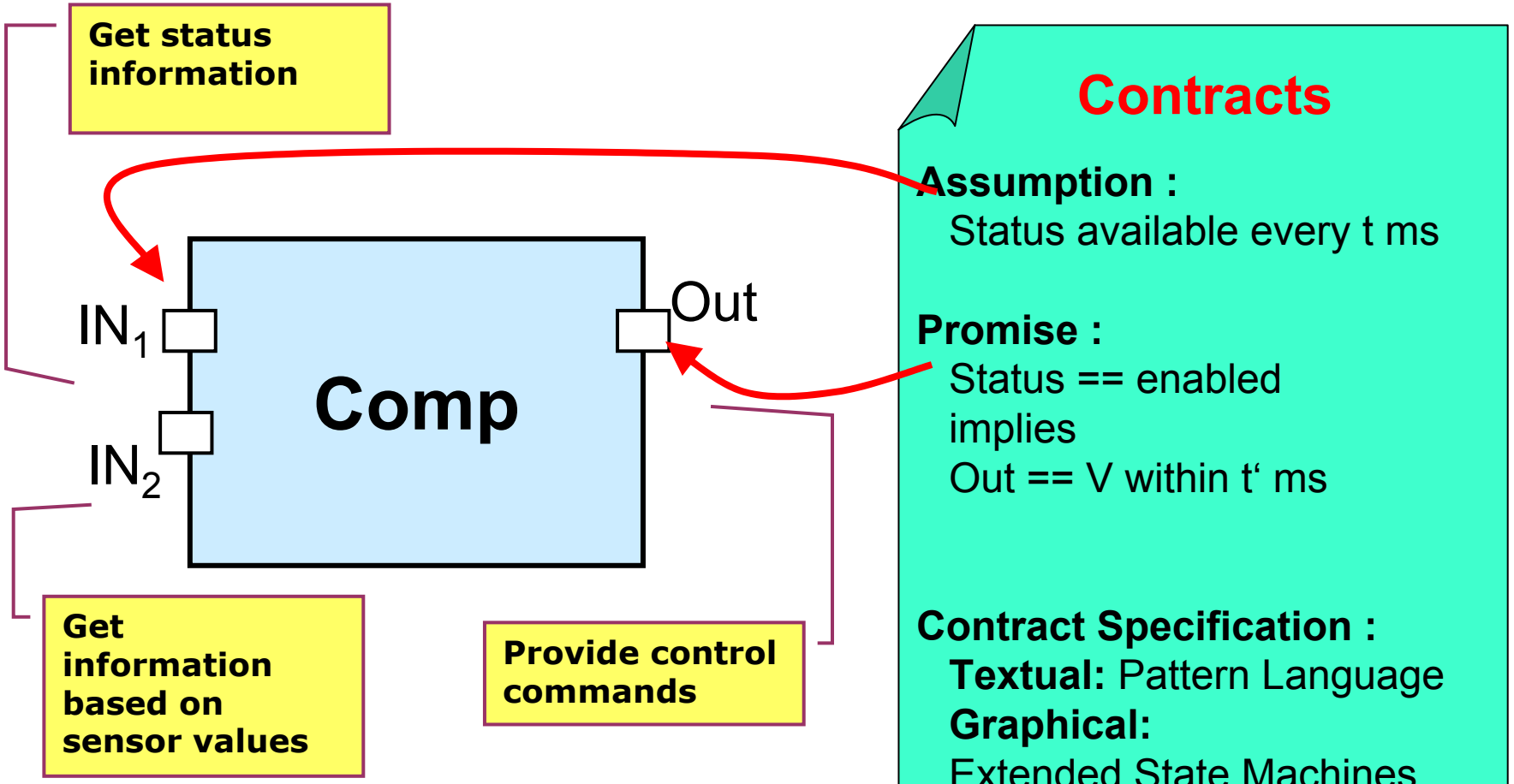
Using SPEEDS for IMA development

AIRBUS

Needed Improvements of Development Process

- Ubiquitous seamless model-based design access
  - hiding heterogeneity and semantic diversity of representations and methods, and
  - providing a design-centric access to all design activities.
- During all design phases, process steps must be guided by an estimation how far overall requirements (e.g. safety, costs) are fulfilled. This “speculative” design can be based on HRC analysis methods.
- High flexibility and robustness with respect to late changes and overlapping design activities.
- More guidance and tool support is required for systematic and structured:
  - system requirements analysis
  - system concept evaluation
  - system design & system equipment specification

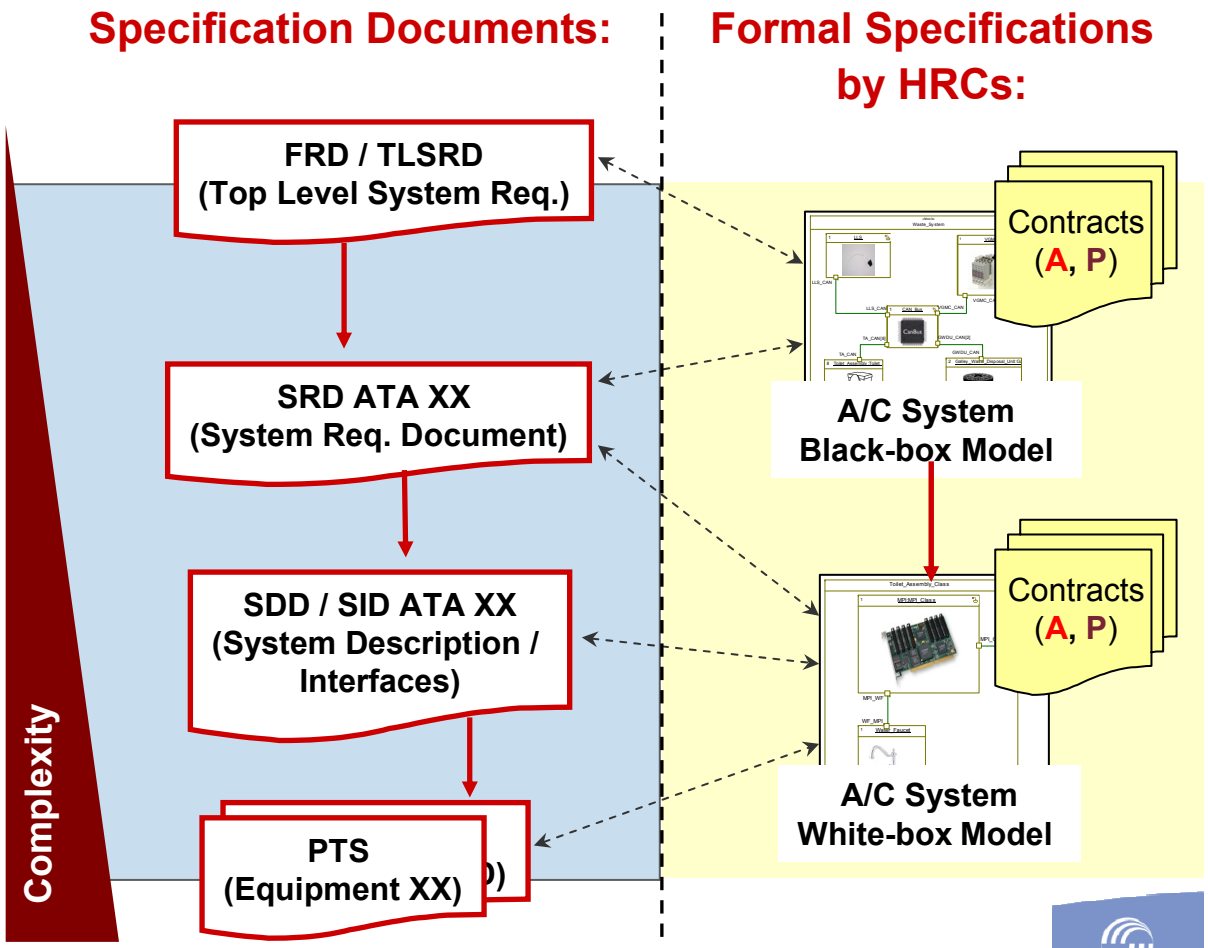
Rich Component Models – RCM – with Contracts



RCM-based Process for a Single Function

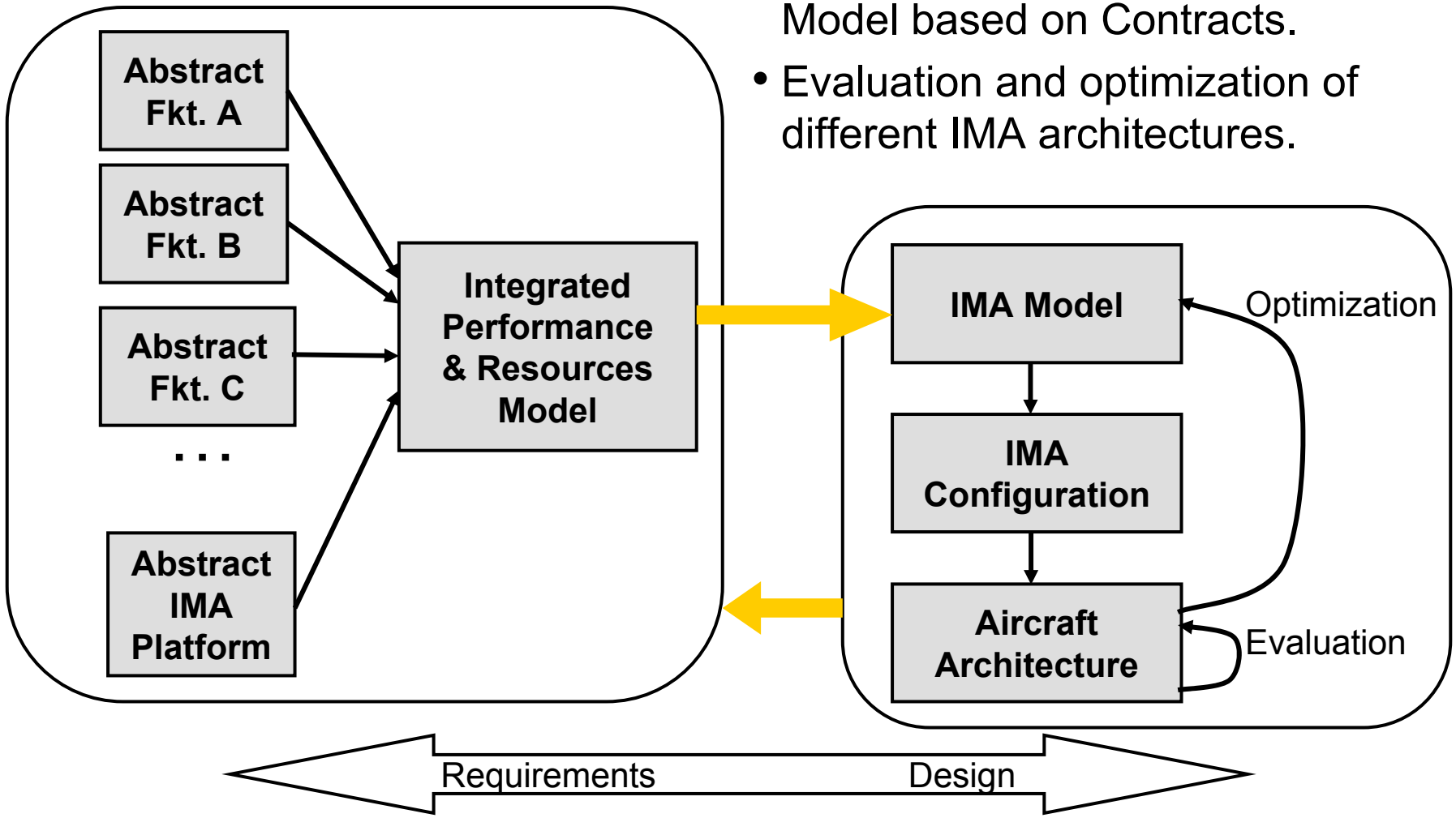
Formalized Communication btw. OEM and Supplier:

- ✓Concept and Definition Phases (new System policy)
- ✓Functional System Definition
- ✓Non-functional aspects
- ✓Use of design assumptions

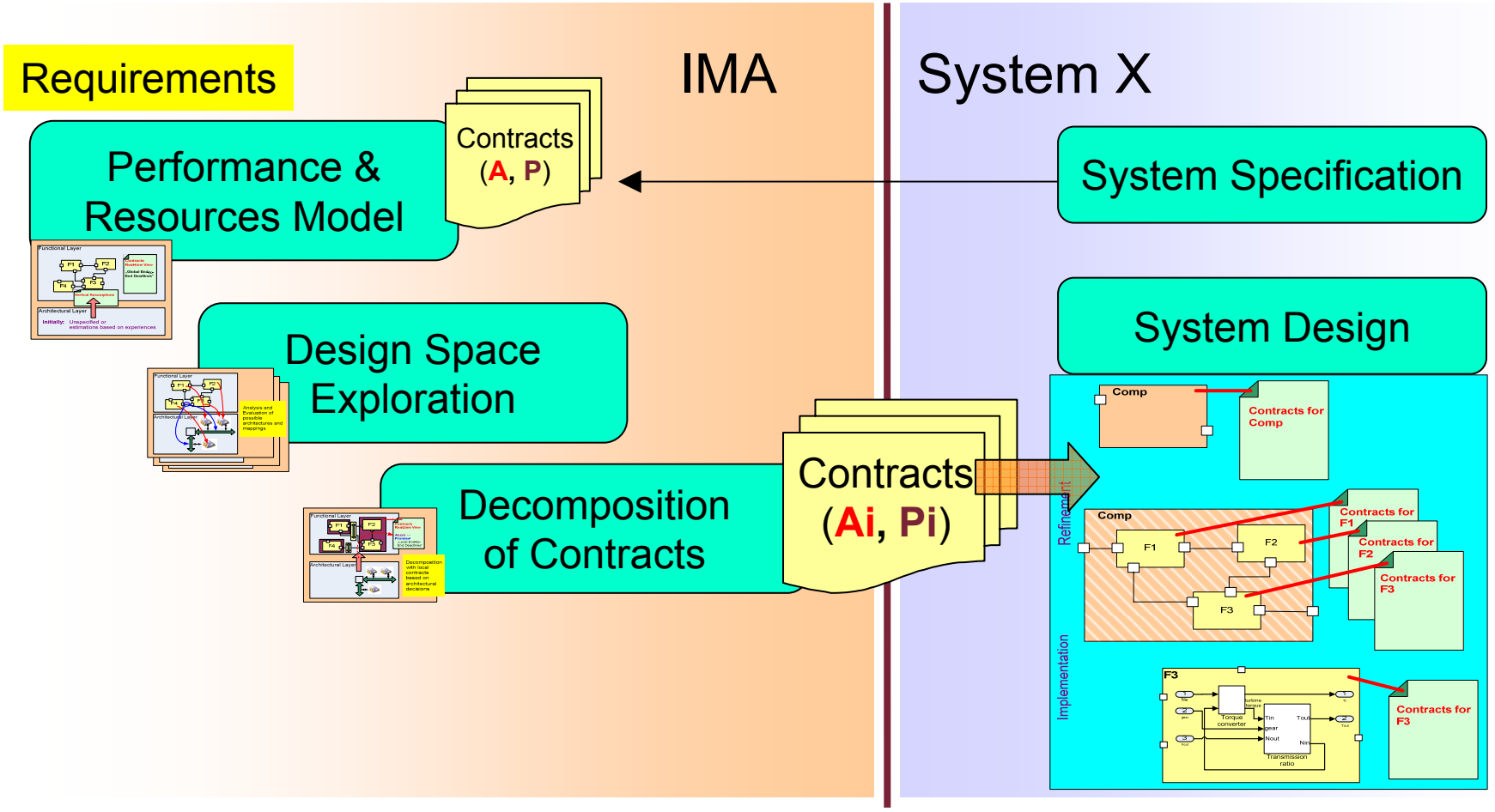


Alignment of IMA and System Specifications

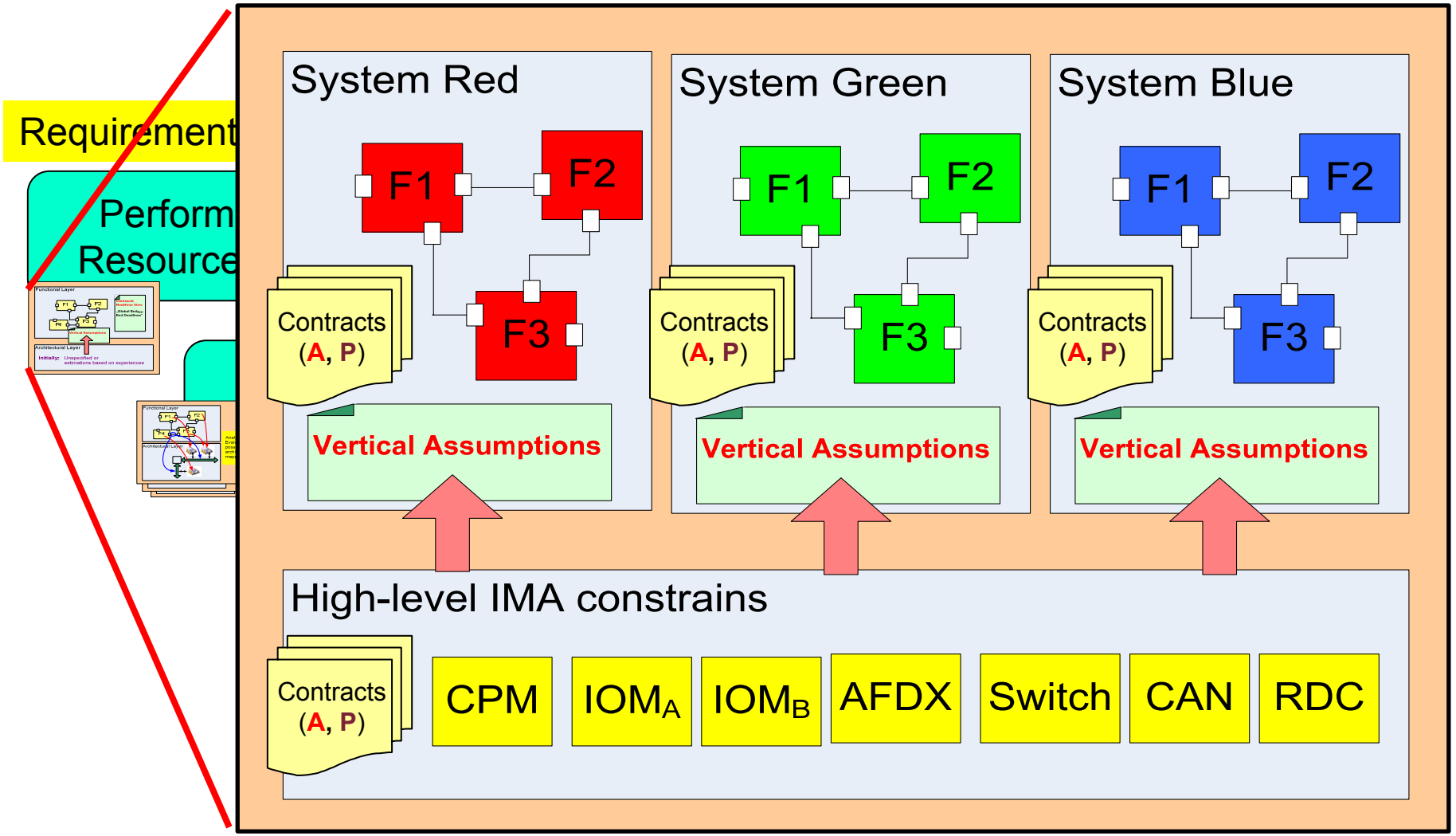
- Integrated Performance & Resources Model based on Contracts.
- Evaluation and optimization of different IMA architectures.



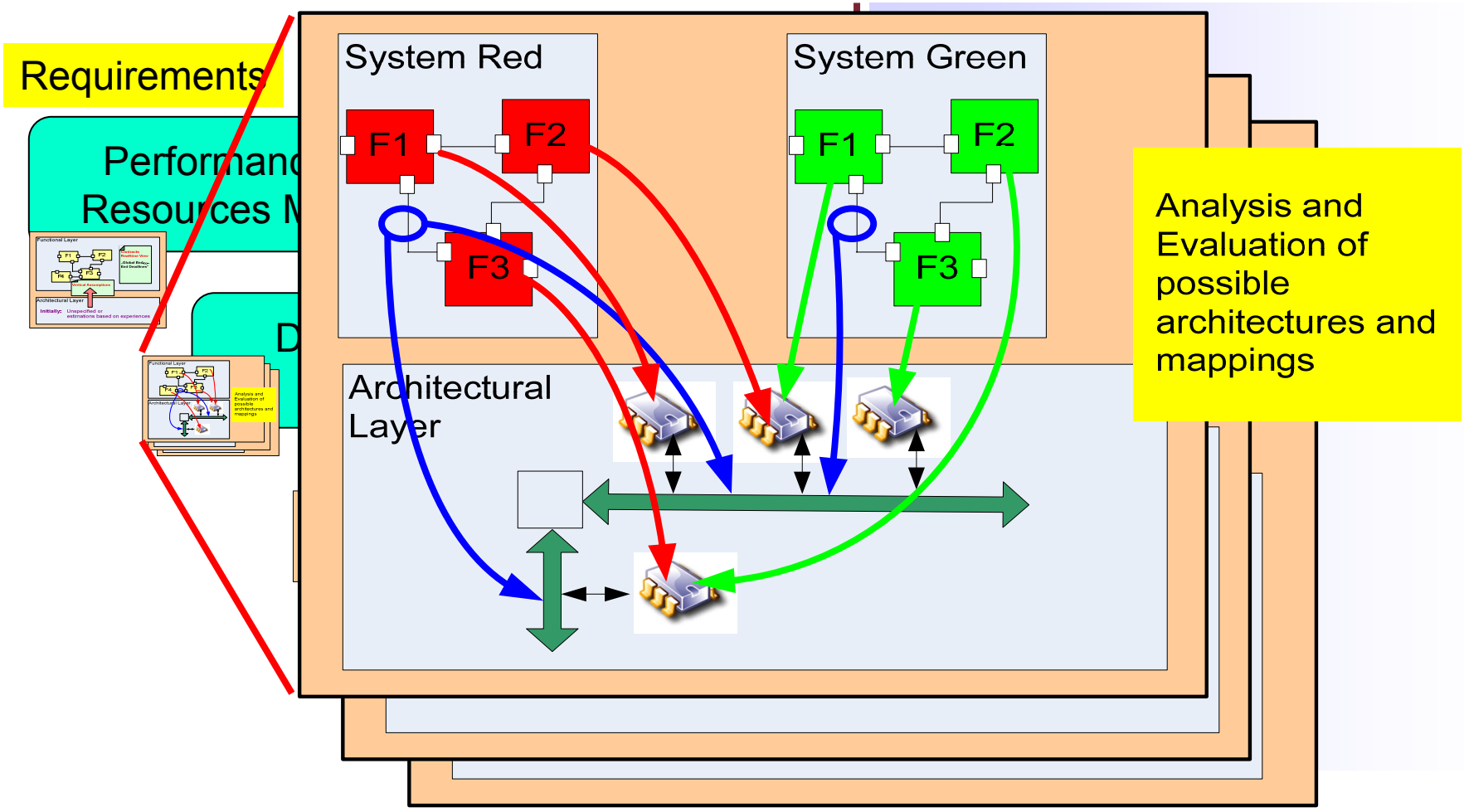
RCM for IMA development – Overview



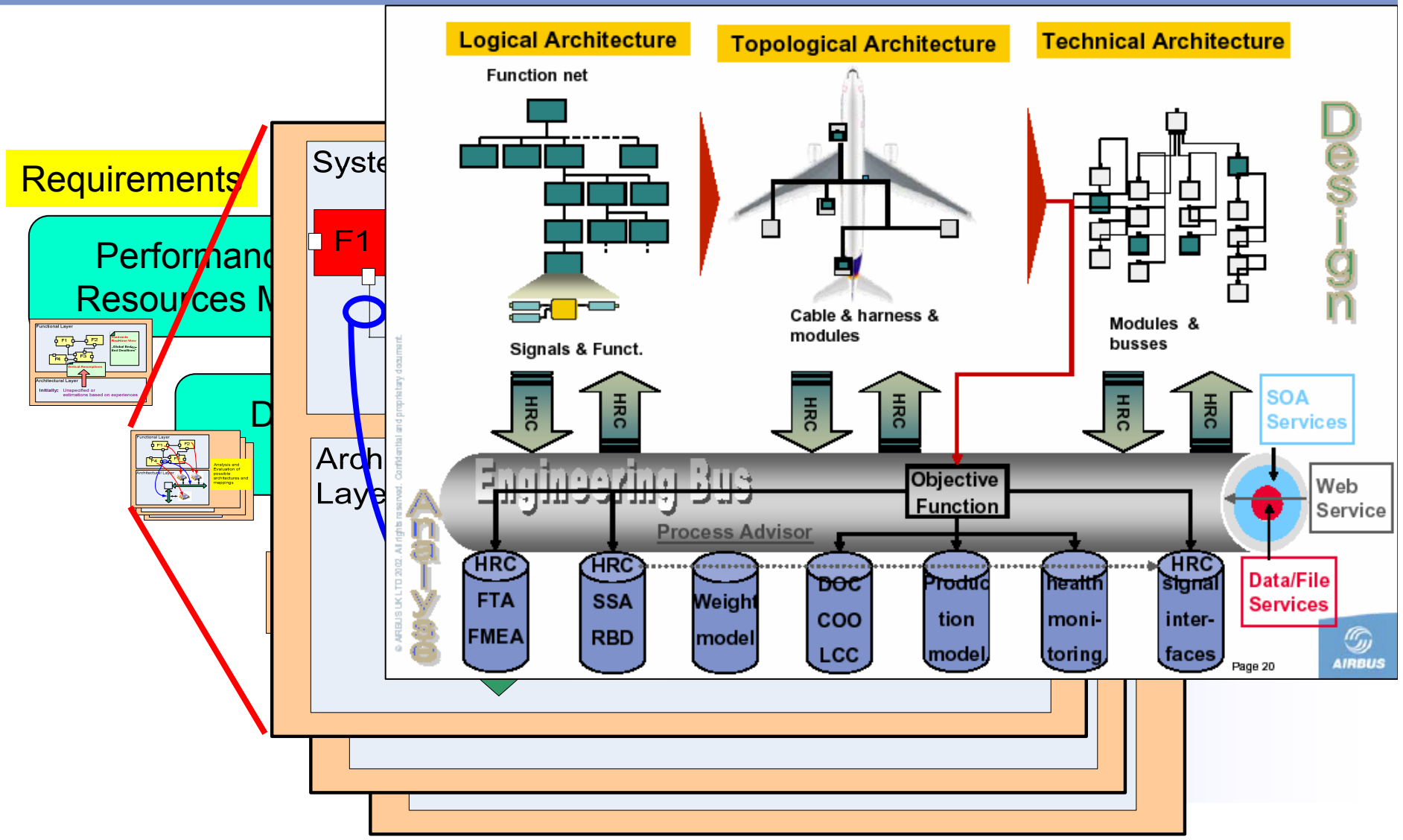
RCM for IMA development – Requirements Model



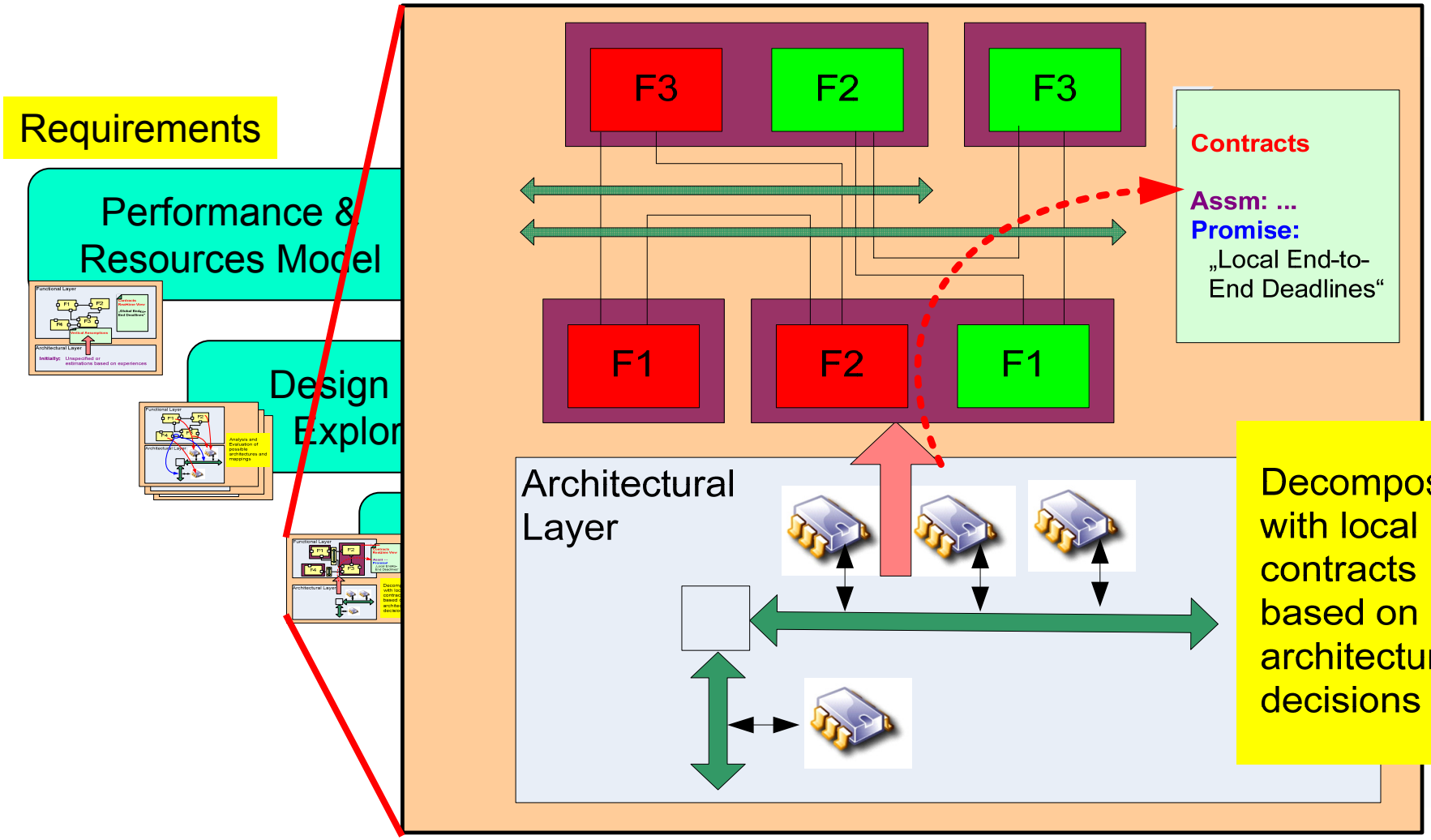
RCM for IMA development – Architecture Analysis



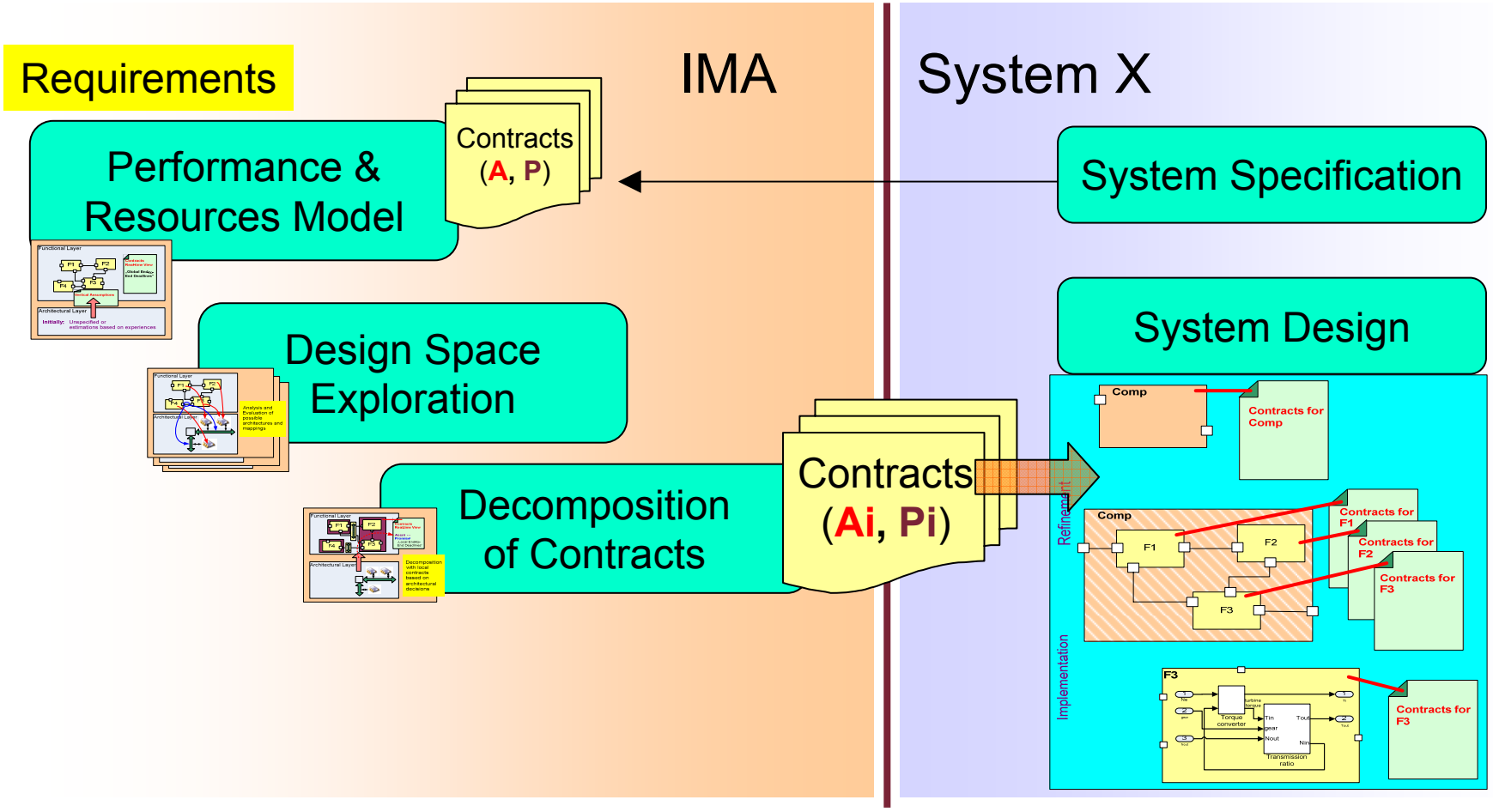
RCM for IMA develop. – Architecture Optimization



RCM for IMA develop. – Contract Decomposition



RCM for IMA development – Overview



System Design on IMA – looking ahead

SPEEDS Methodology supports:

- **Formal system specifications including non-functional aspects.**
- **Early identification of errors in the specification due to formal analysis.**
- **Multi-System Integration in early phases based on contracts.**
- **Increased transparency of system functionality during implementation at the supplier.**