Digital Engineering Framework as enabler for System-Software Co-Engineering

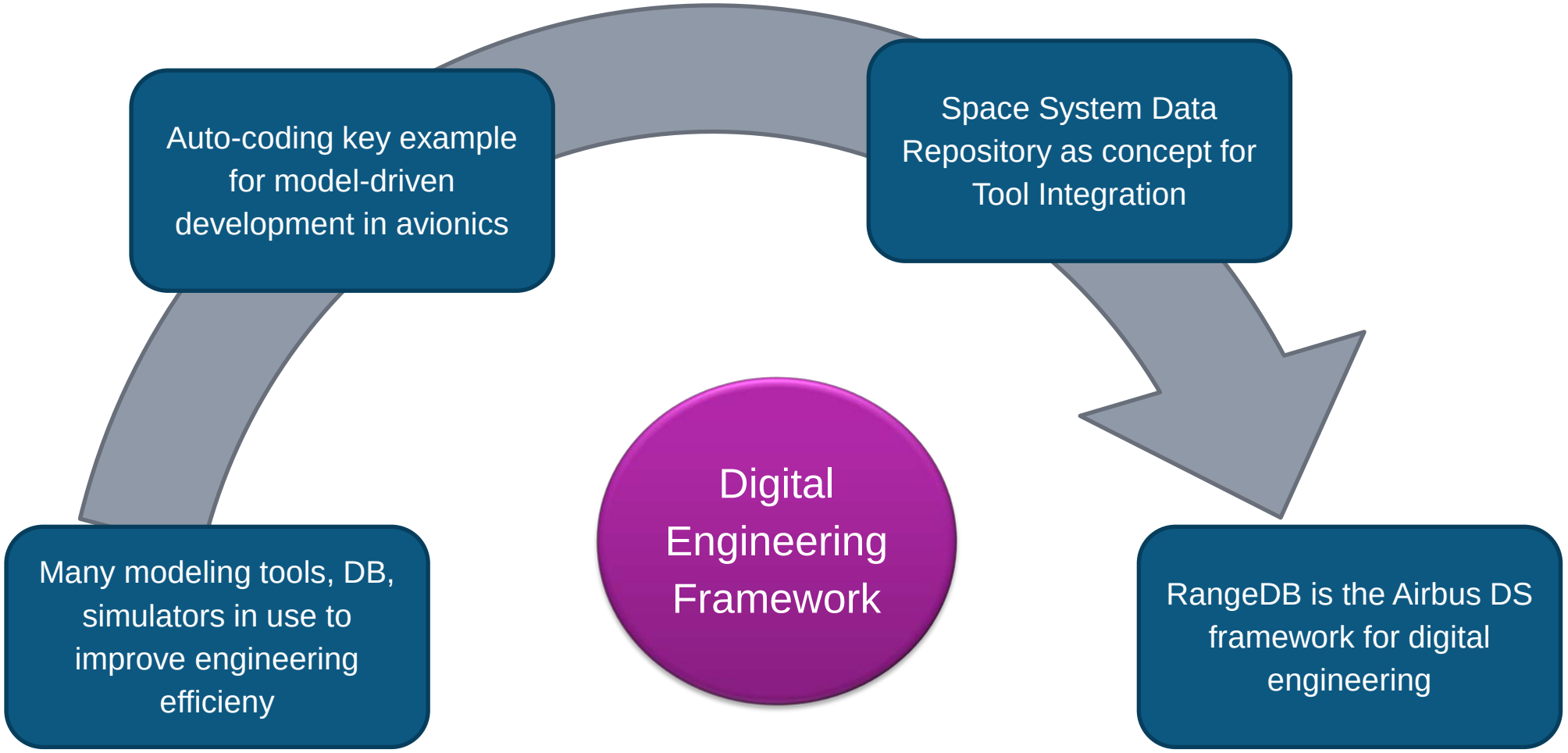
RangeDB to evolve scope of SRDB towards “integrated avionics“

Harald Eisenmann, David Lesens, David Gendre

28th October 2014

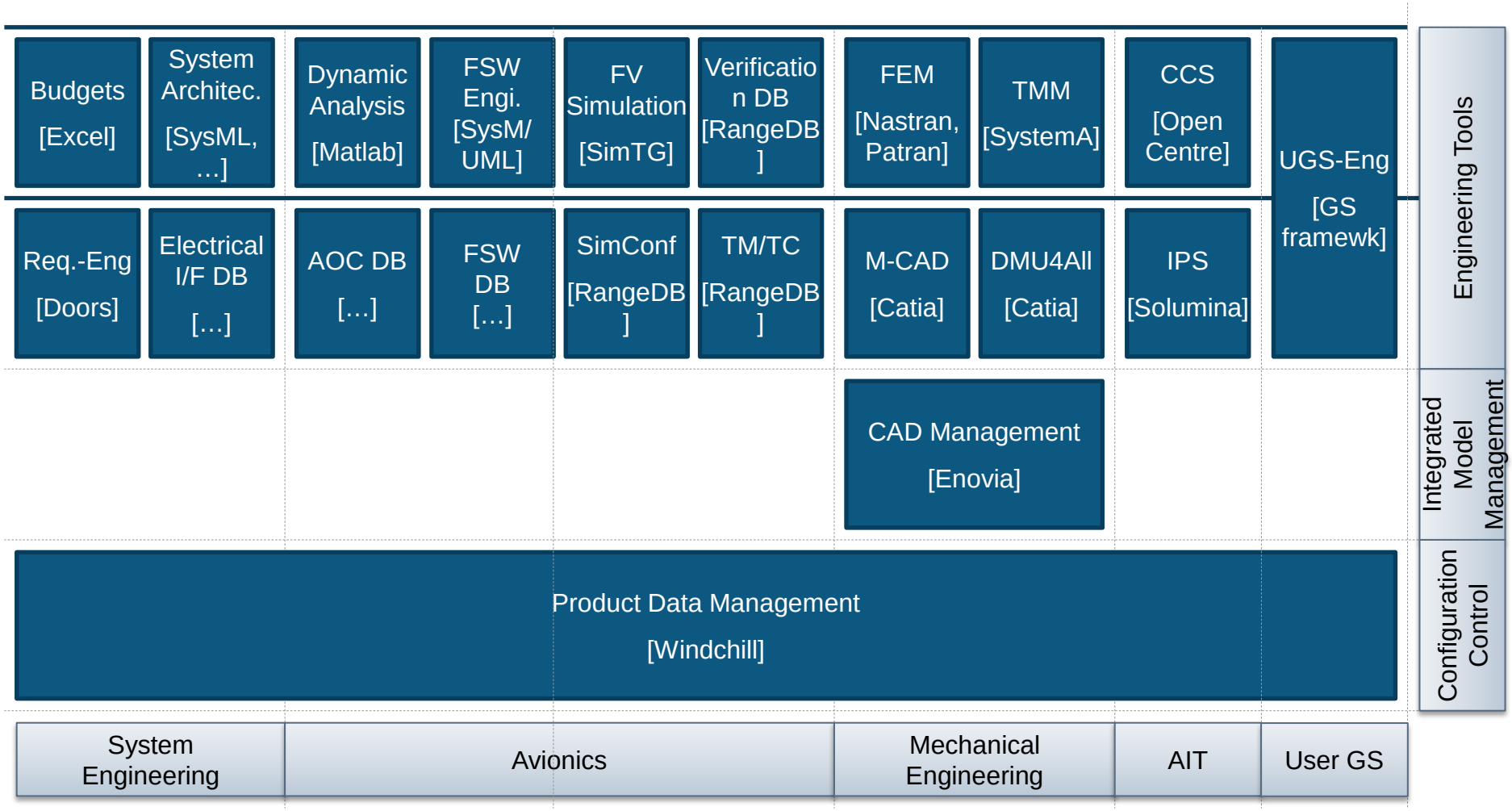
AIRBUS DEFENCE & SPACE

Overview

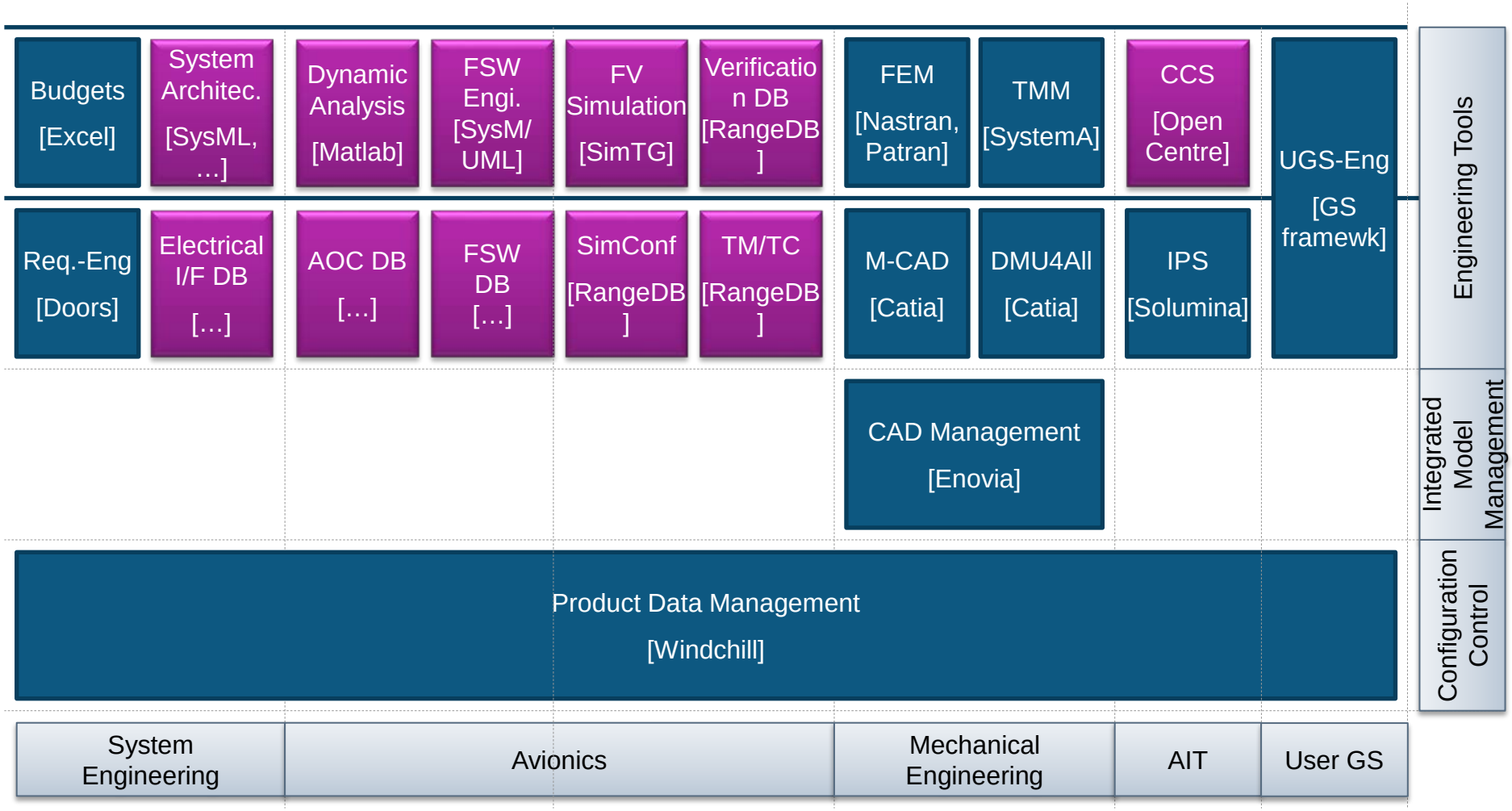


AIRBUS DEFENCE & SPACE

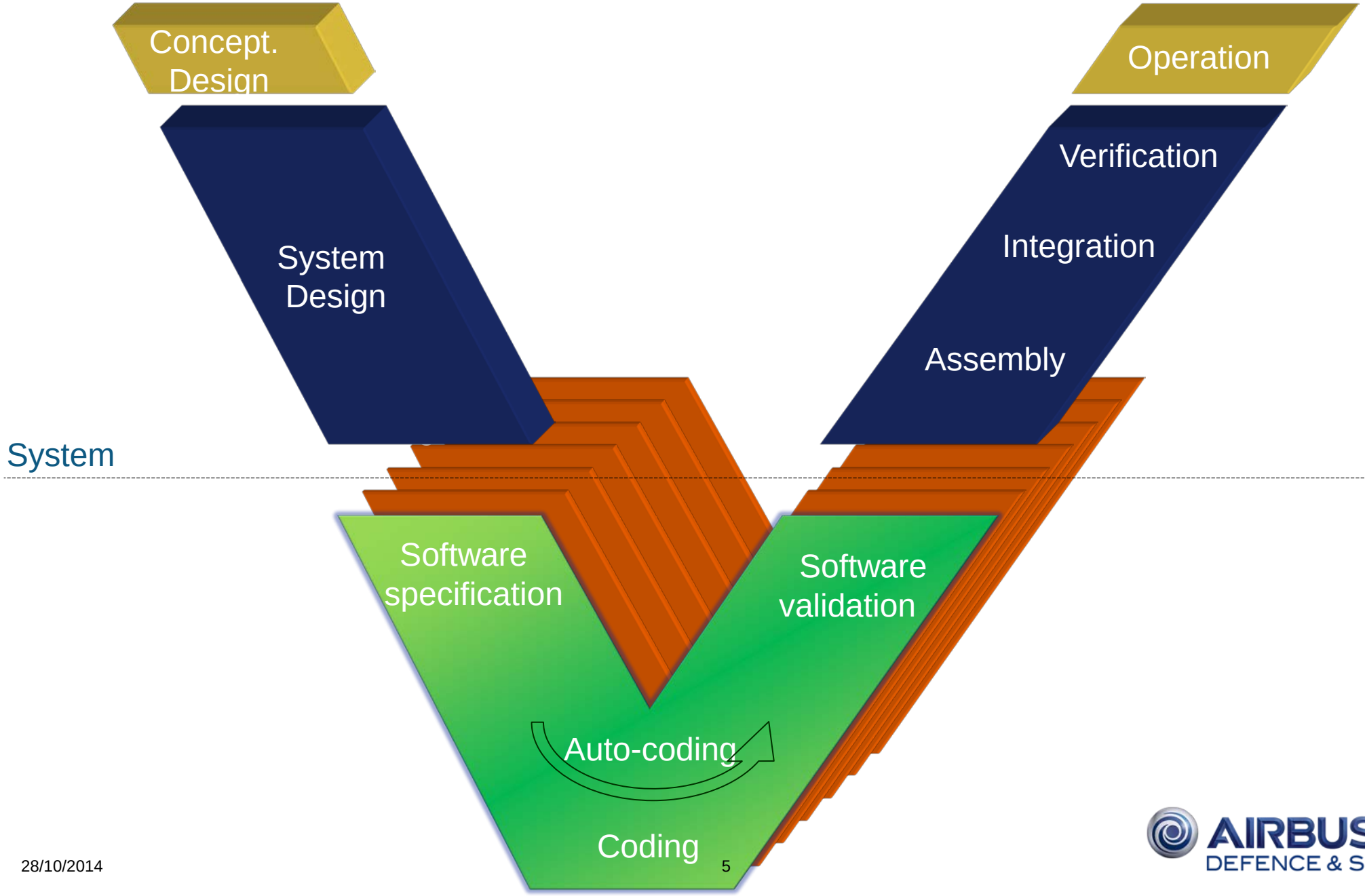
Digital Engineering comprises the application of modeling tools, DB, and simulators for the increased efficiency of engineering process



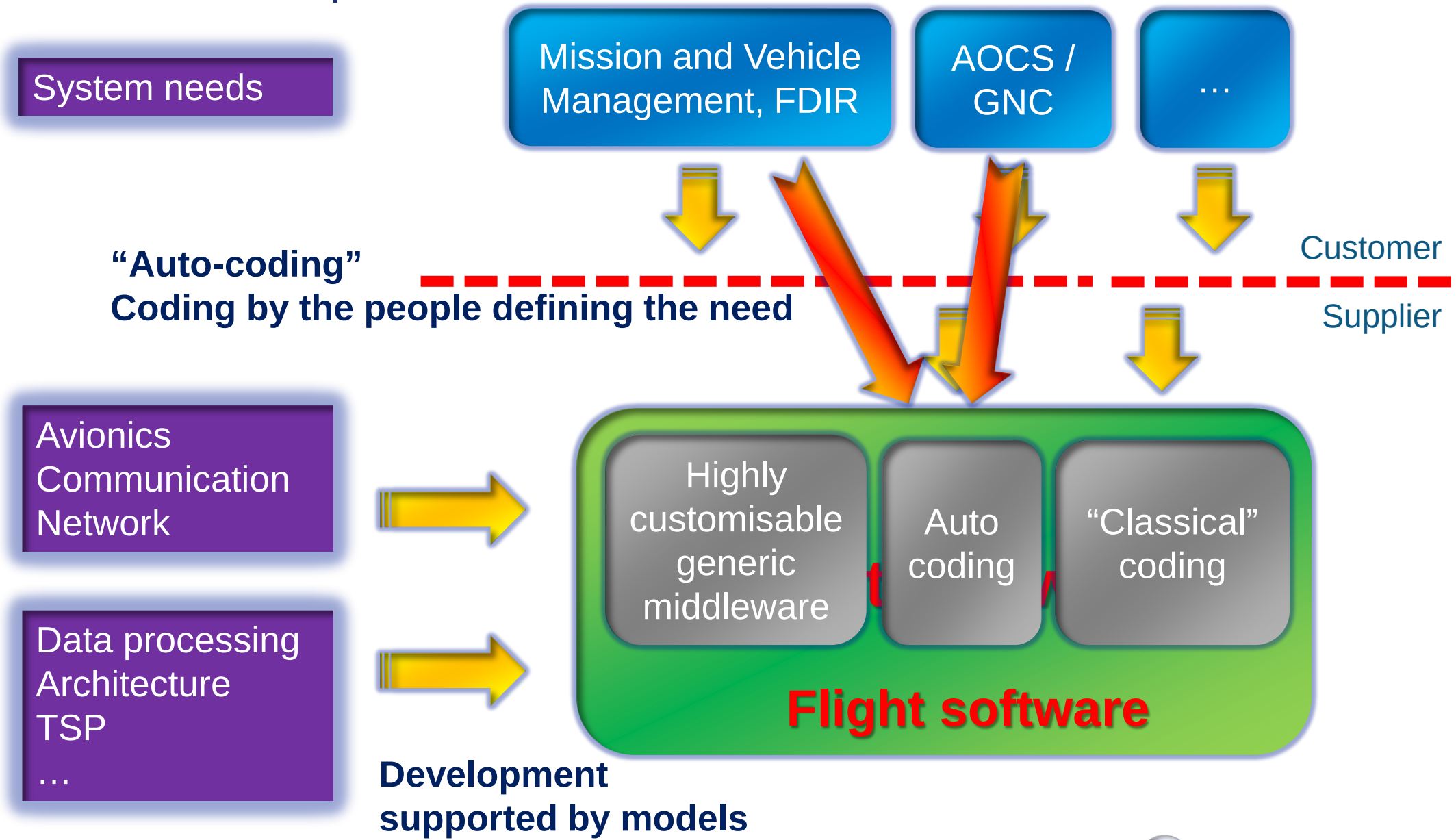
Also in avionics considerable progress has been made in the utilization of modeling techniques



Example of mature MBE approach with auto-coding

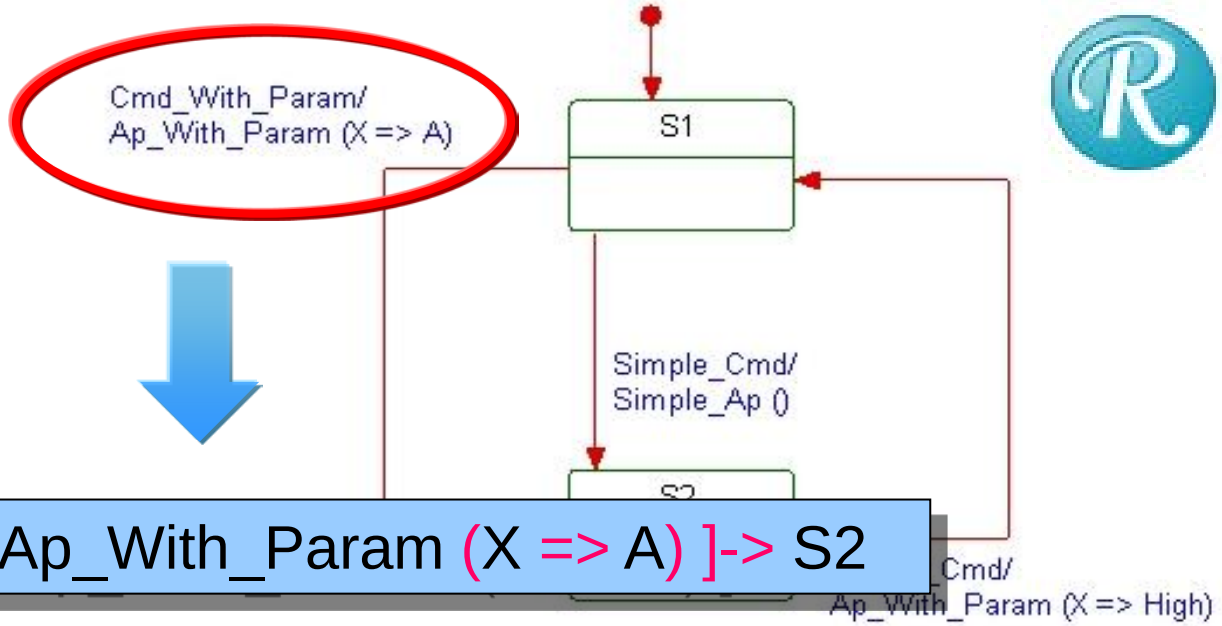


Software development



AIRBUS DEFENCE & SPACE

Auto-coding of SysML Finite State Machines



Intermediate textual language

```
S1 -[ Cmd_With_Param (A) / Ap_With_Param (X => A) ]-> S2
```

Ada 2012

```
S1 =>
  (Cmd_With_Param => FSM_FUMs.T_FUM_Transition'
     (Is_Valid            => True,
      Target_FUM_State_Id => S2,
      FUM_AP_Command_Call => FSM_FUMs.T_FUM_AP_Command_Call'
       (Number_Of_Parameters => 1,
        Command_Id           => Ap_With_Param,
        Parameter_Table      => FSM_FUMs.FUM_AP_Command_Calls.T_Command_Actual_Parameter_Table'
         (1 => FSM_FUMs.Reference (1)))))
```

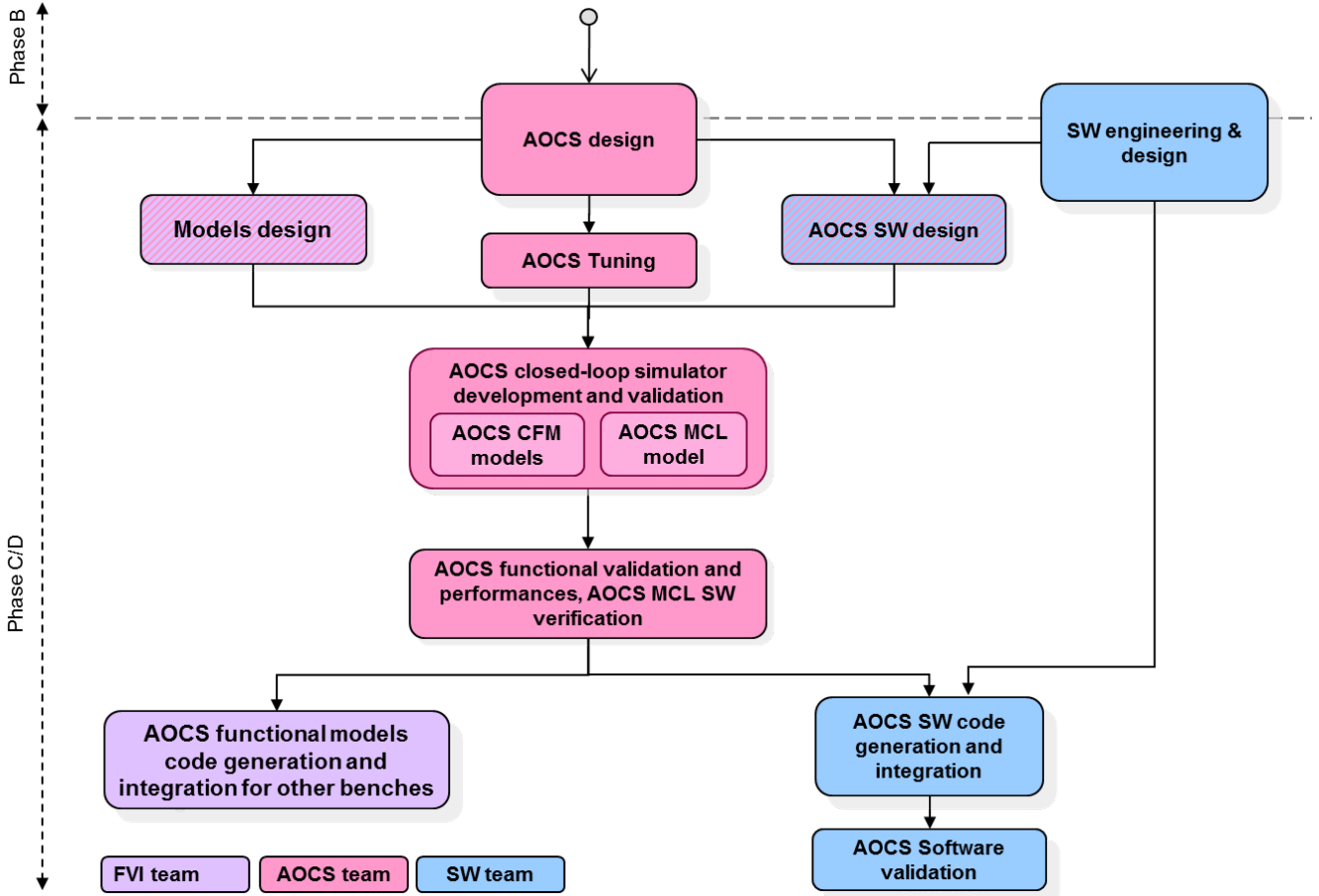

DEFENCE & SPACE

Auto-coding of GNC with Ada and of AOCS with automatic code generation from Matlab/Simulink

AOCS Modes & Control Law autocoding

- AOCS SW code and verification activities largely automated.
- Schedule reduction expected on development and modifications
- Quality improvement expected because no more translation from AOCS to SW team
- Strengthened reuse approach at functional level

AOCS automatic code generation process

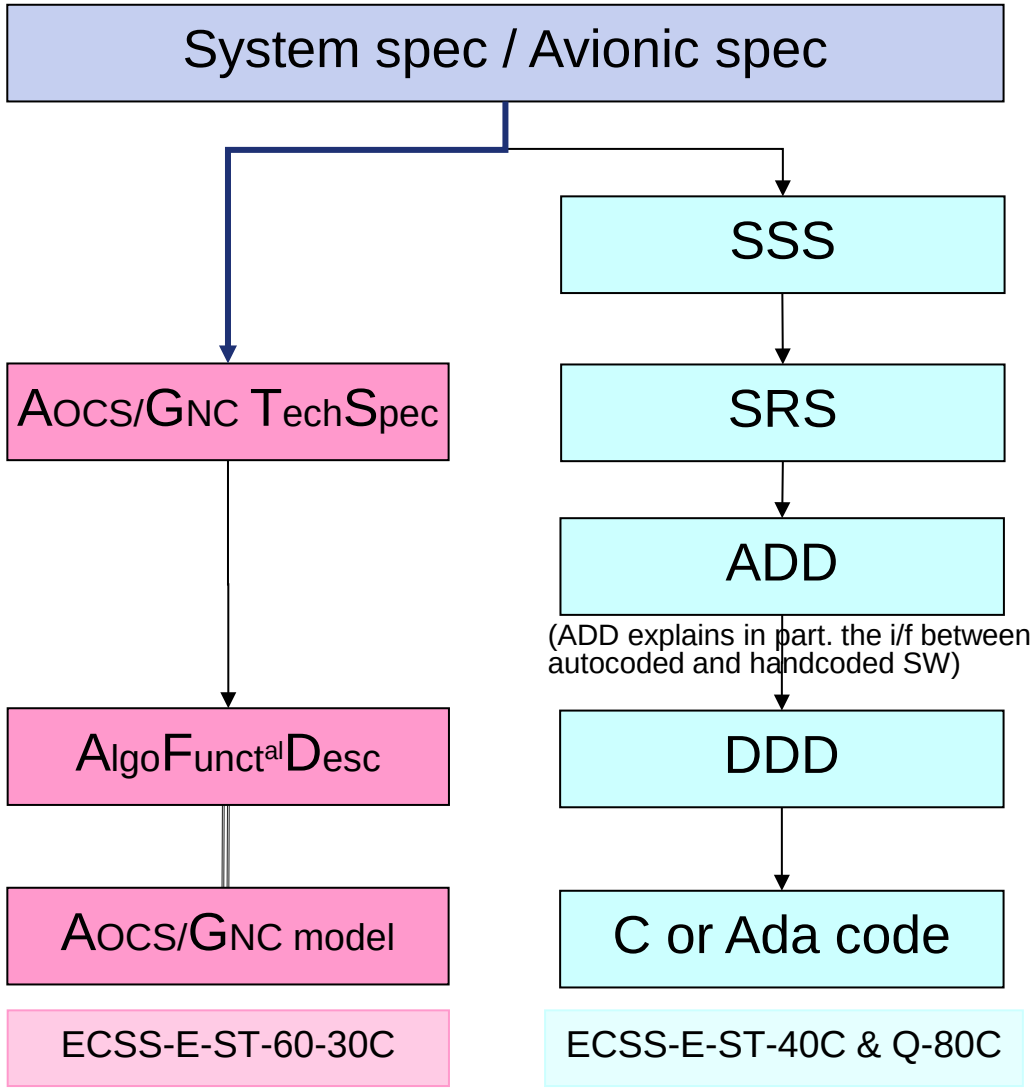


Auto-coding brings AOCS / GNC software engineering closer to System

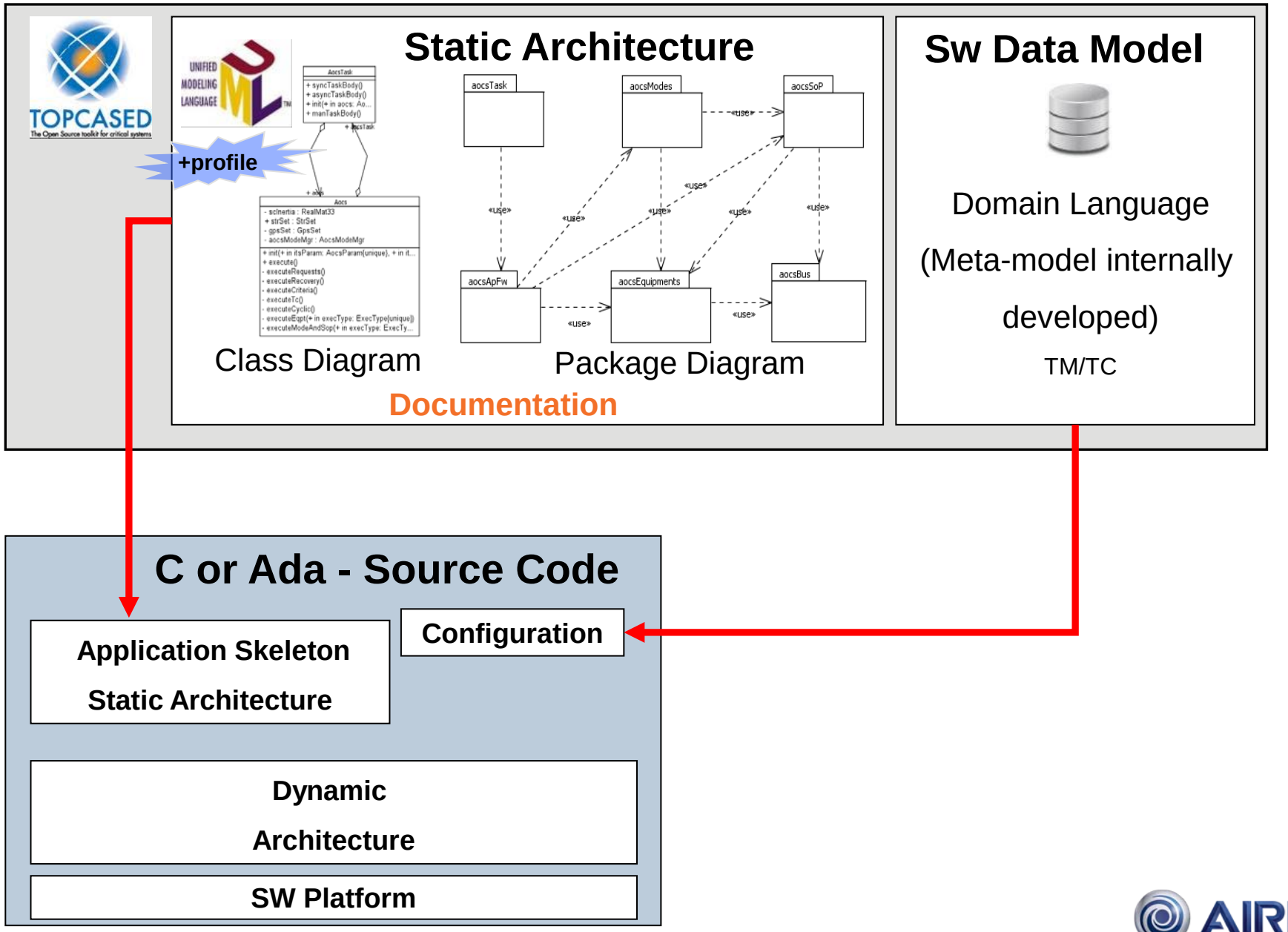
Autocoding brings naturally AOCS / GNC functional design closer to system design

- One specification step brought upward
- Model-based System Engineering enabled, with continuity towards AOCS / GNC design
- Strengthened continuity between phase B and phase CD modelling activities

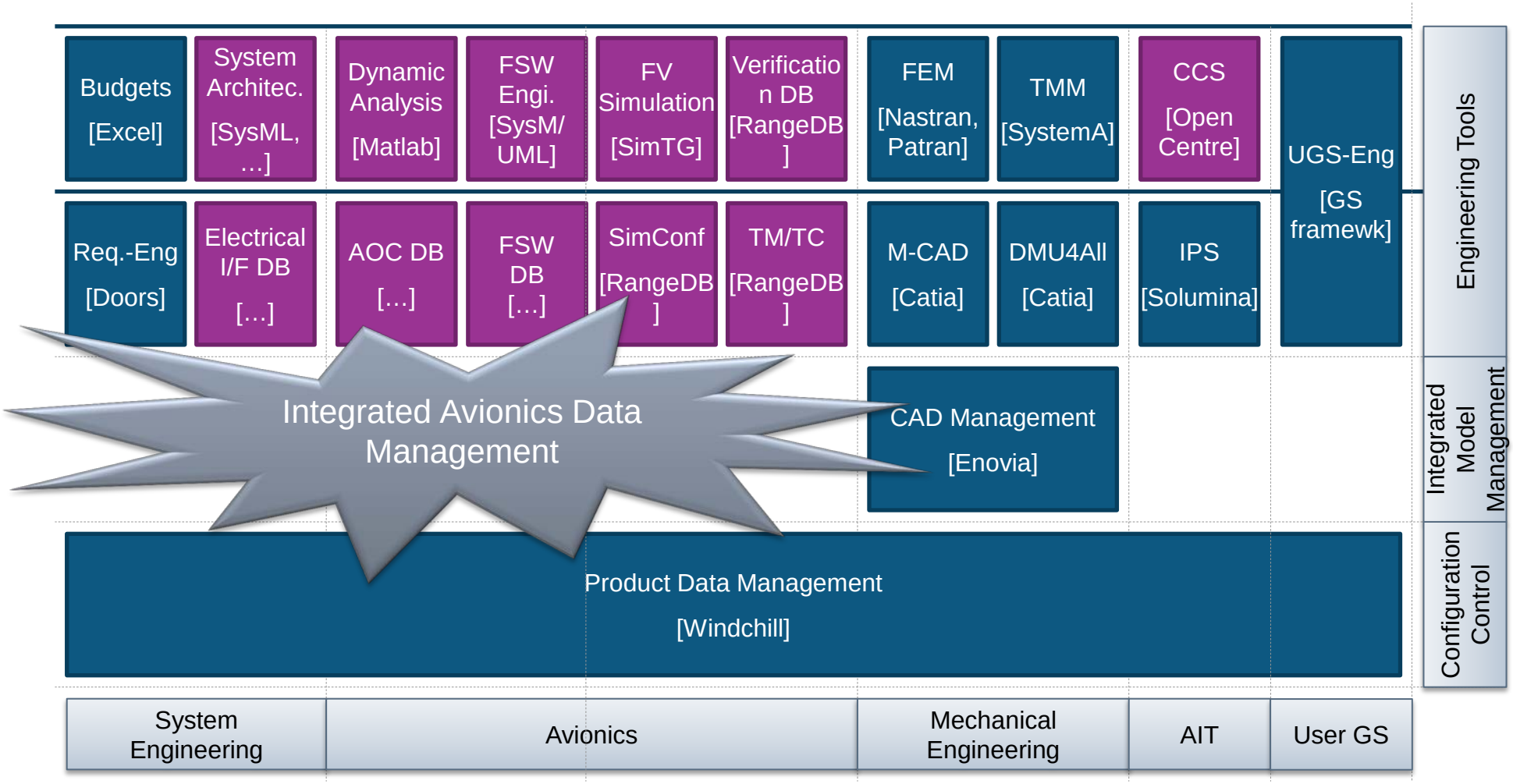
Overall compliance to SW ECSS (-E-ST-40C and -Q-ST-80C, but also -E-ST-60-30C)



Software Engineering: Static Architecture in UML

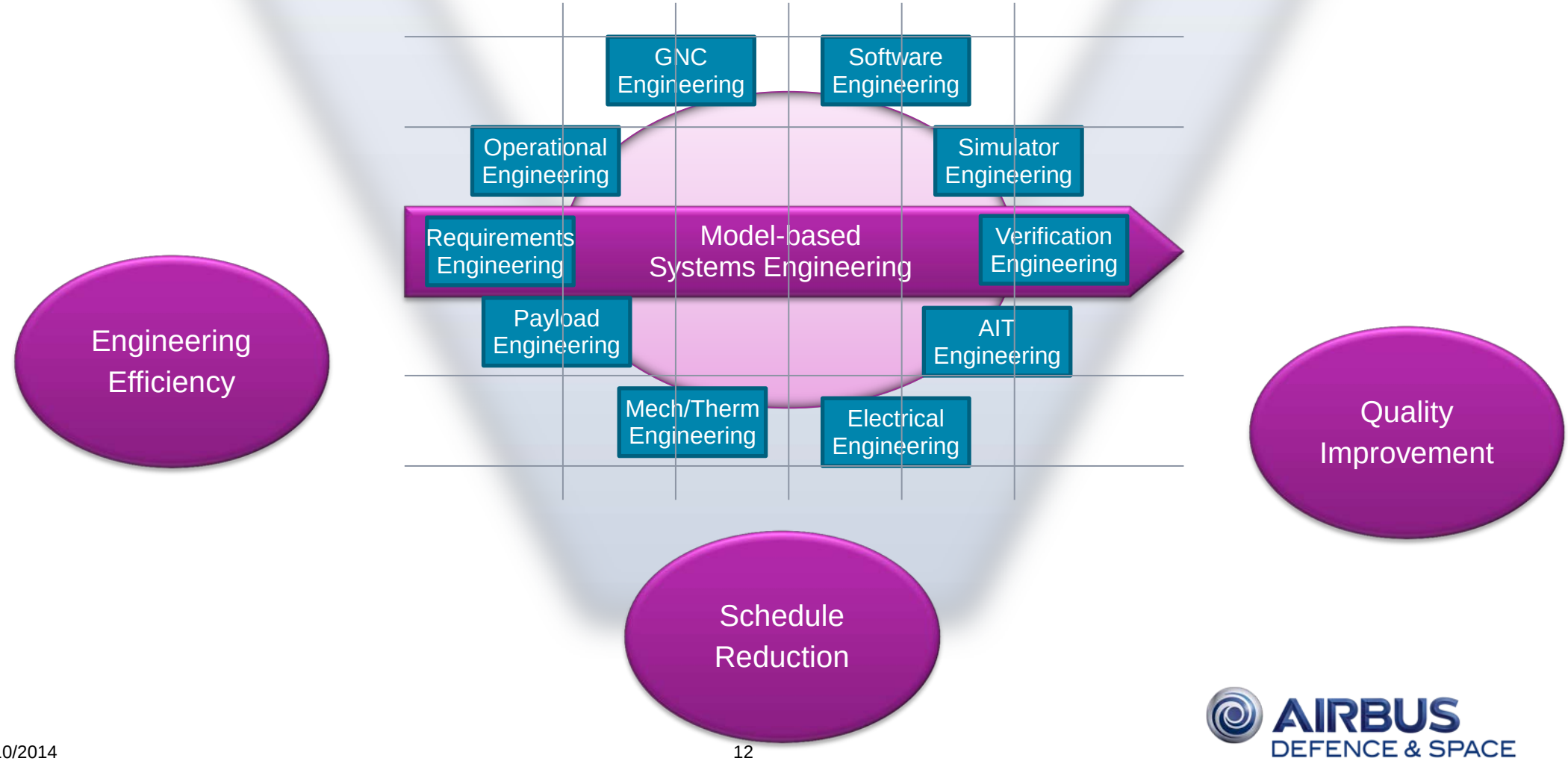


The various database and tools in use, also put much more emphasis on semantic consistent data sharing and exchange



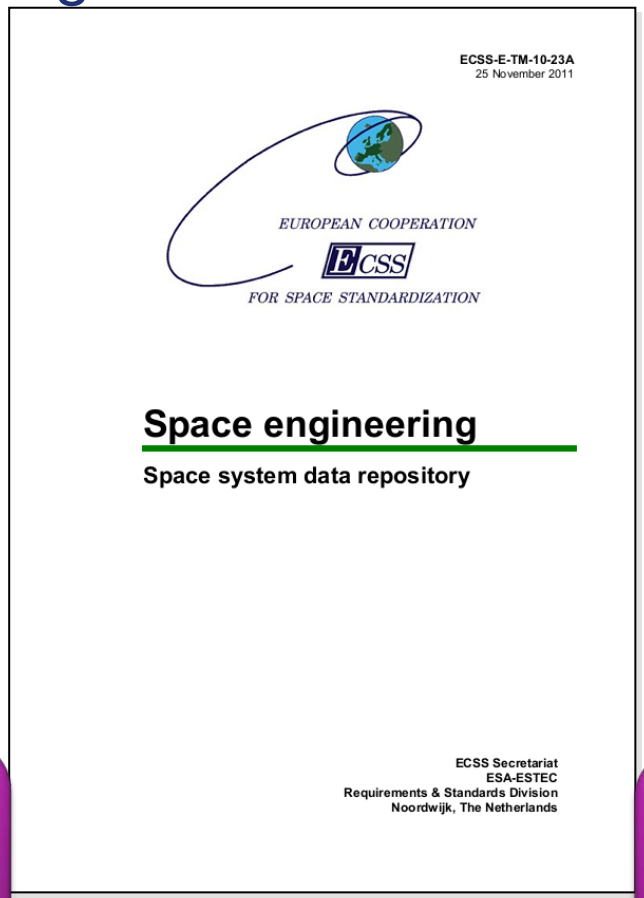
AIRBUS DEFENCE & SPACE

The integration of discipline data (including) avionics delivers an essential part of MBSE and Digital Engineering



AIRBUS DEFENCE & SPACE

ECSS-E-TM-10-23 introduced 2 concepts in order to manage complexity of “Engineering Database” to facilitate MBSE for Space

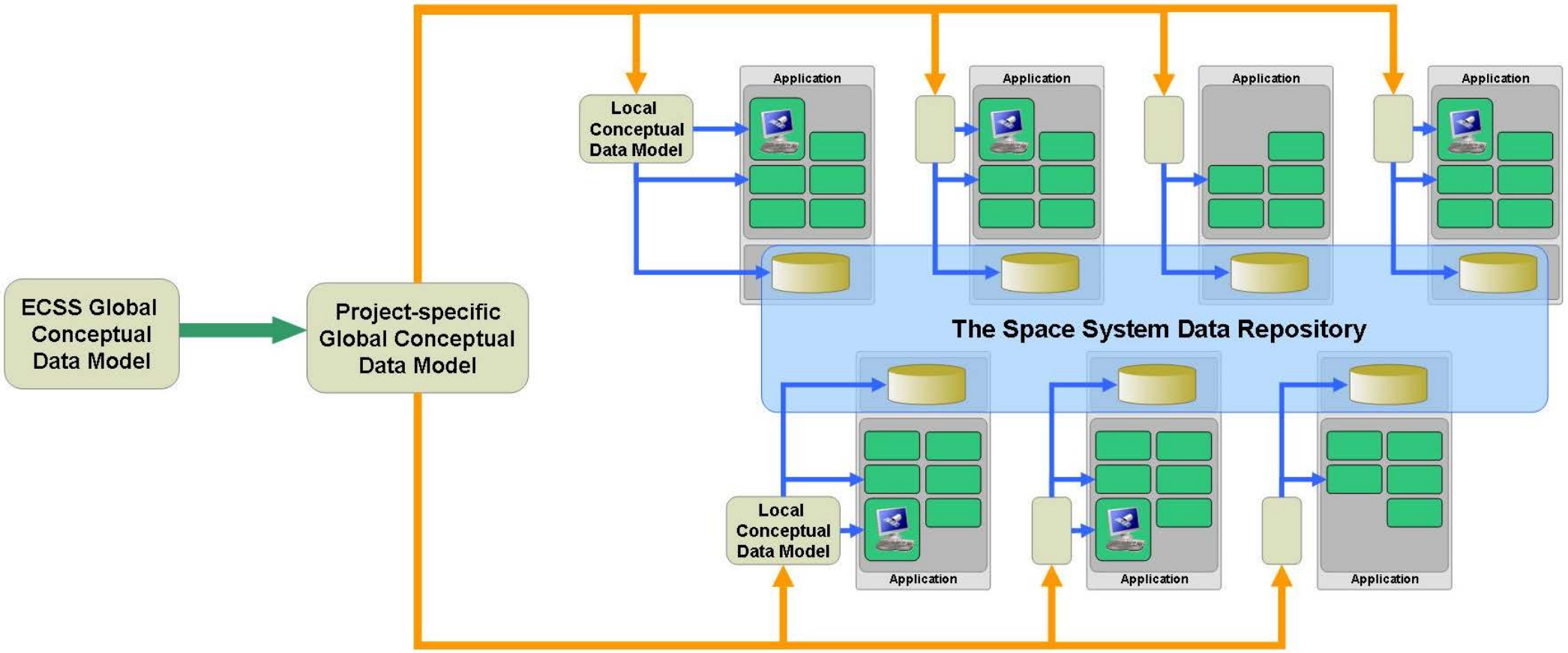


Space System Data Repository – for managing federated Databases

Conceptual Data Model driven by space project needs

AIRBUS DEFENCE & SPACE

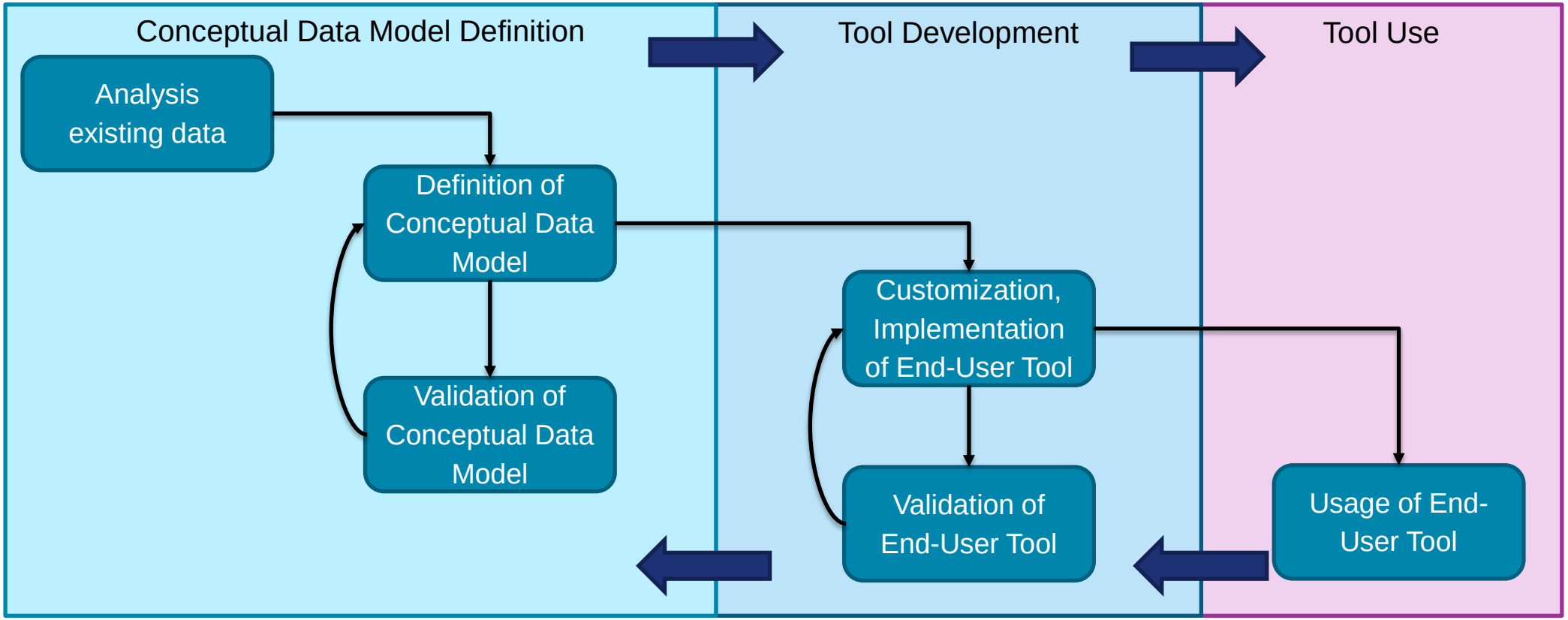
Space system repository for managing the federation of databases, i.e. the sharing of data across different databases

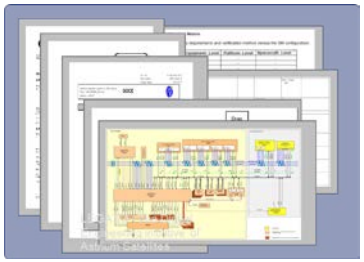


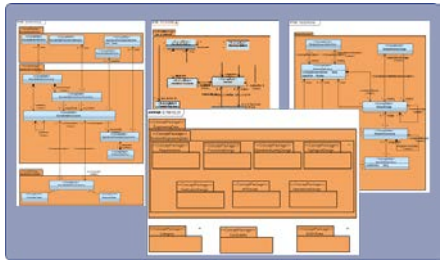
The vision as expressed in ECSS E-TM 10-23

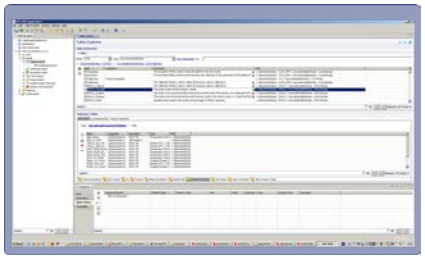
AIRBUS DEFENCE & SPACE

Conceptual data modeling is a key activity in order to bridge business needs into tool realization (customization or development)

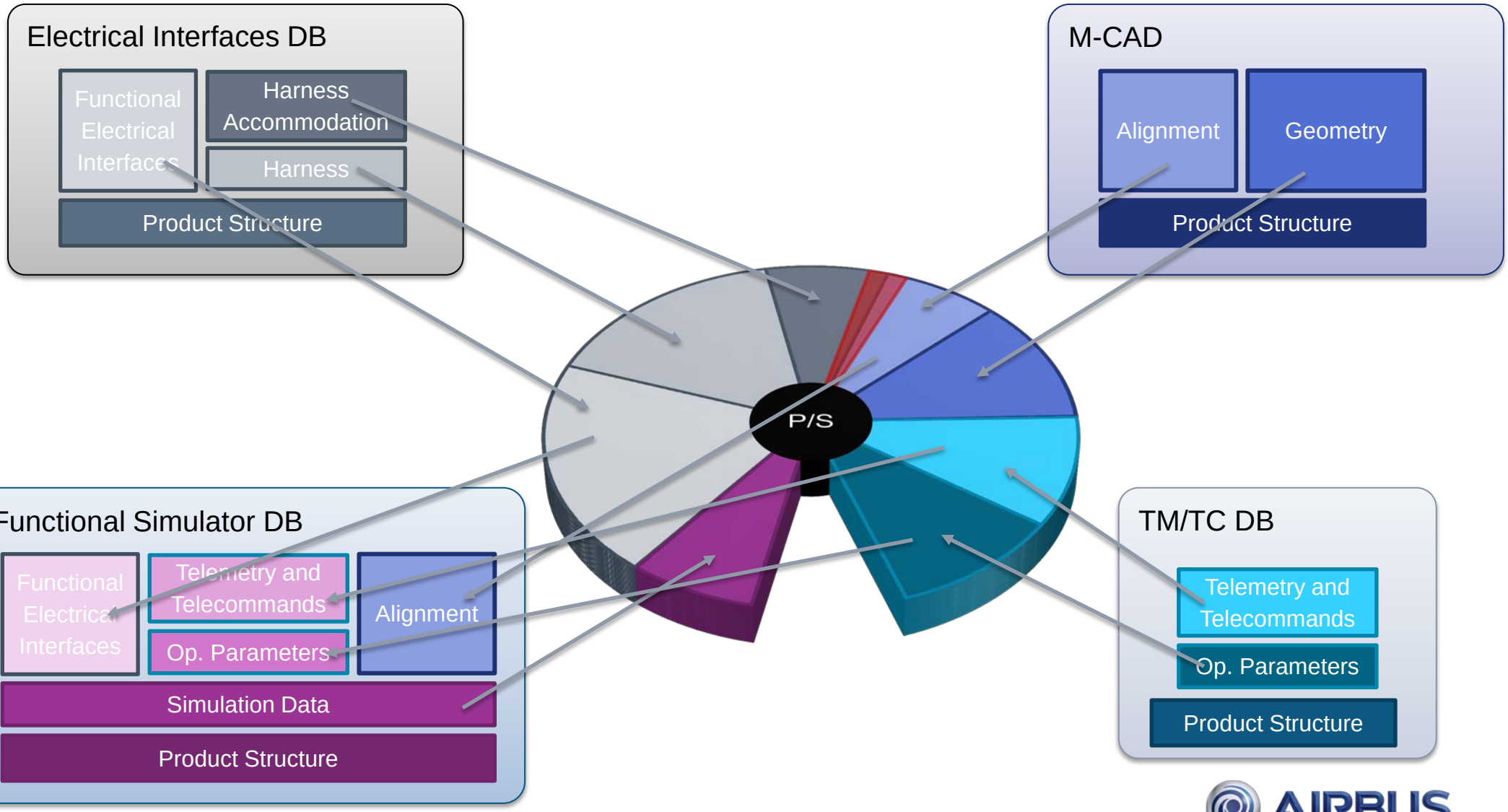








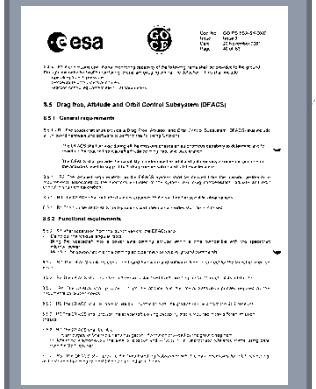
Shared Product Structure required enabling the sharing, alignment and common management of system level relevant data



AIRBUS DEFENCE & SPACE

ESA TRP “Virtual Spacecraft Design” to demonstrate a solution for an integrated data management realizing ideas of E-TM-10-23

Requirements



Operational Modes

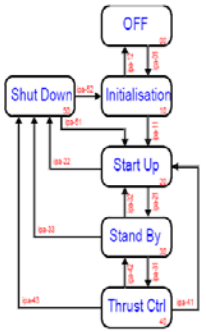
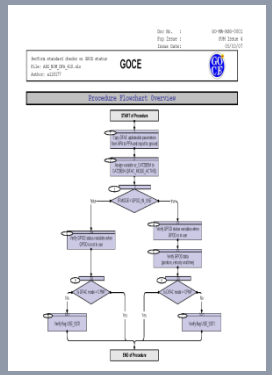
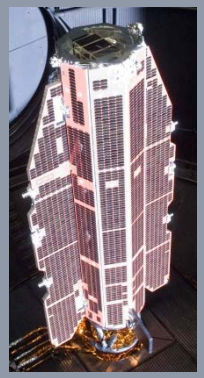


Figure 4-10: IPA Operational Modes and Transitions

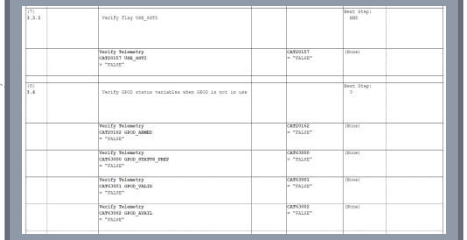
Operational Proc



Configuration



Integration Procedure



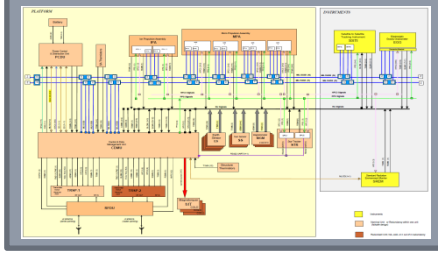
Verification Matrix

7.1.1 Platform SM Verification Matrix

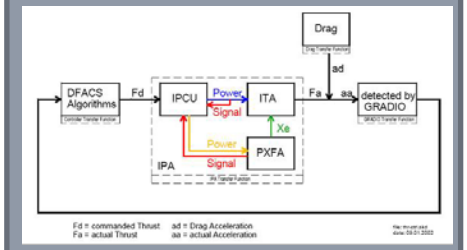
The following table summarises the key requirements and verification method versus the SM configuration:

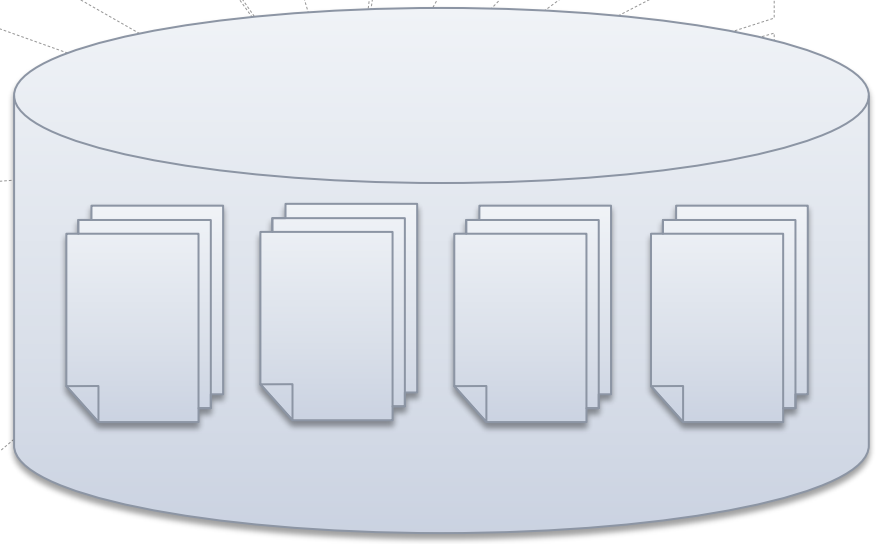
Requirement Category	Equipment- Level	Platform- Level	Spacecraft- Level
Function	-	-	-
Performance	-	-	-
Leakage	-	-	-
Alignment	-	T	T
Thermo Elastic Stability	-	A	T
Interfaces	T, I	T, I	-
Physical Properties (mass, CoG)	T 1)	-	T
Quasi Static Load	-	-	T
Vibration	-	-	T
Acoustic	-	-	T
Separation Shock	-	-	T
Thermal Verification (TV/TB Test)	-	-	-
EMC- R & C	-	-	-
ESD	-	-	-
Magn. Moment	-	-	-
Radiation environment	-	-	-
Oxygen	-	-	-

Electrical Interfaces

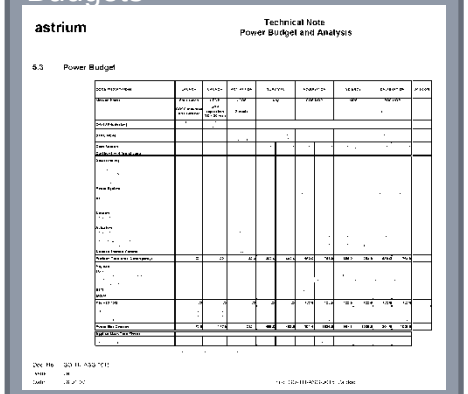


Functional Architecture



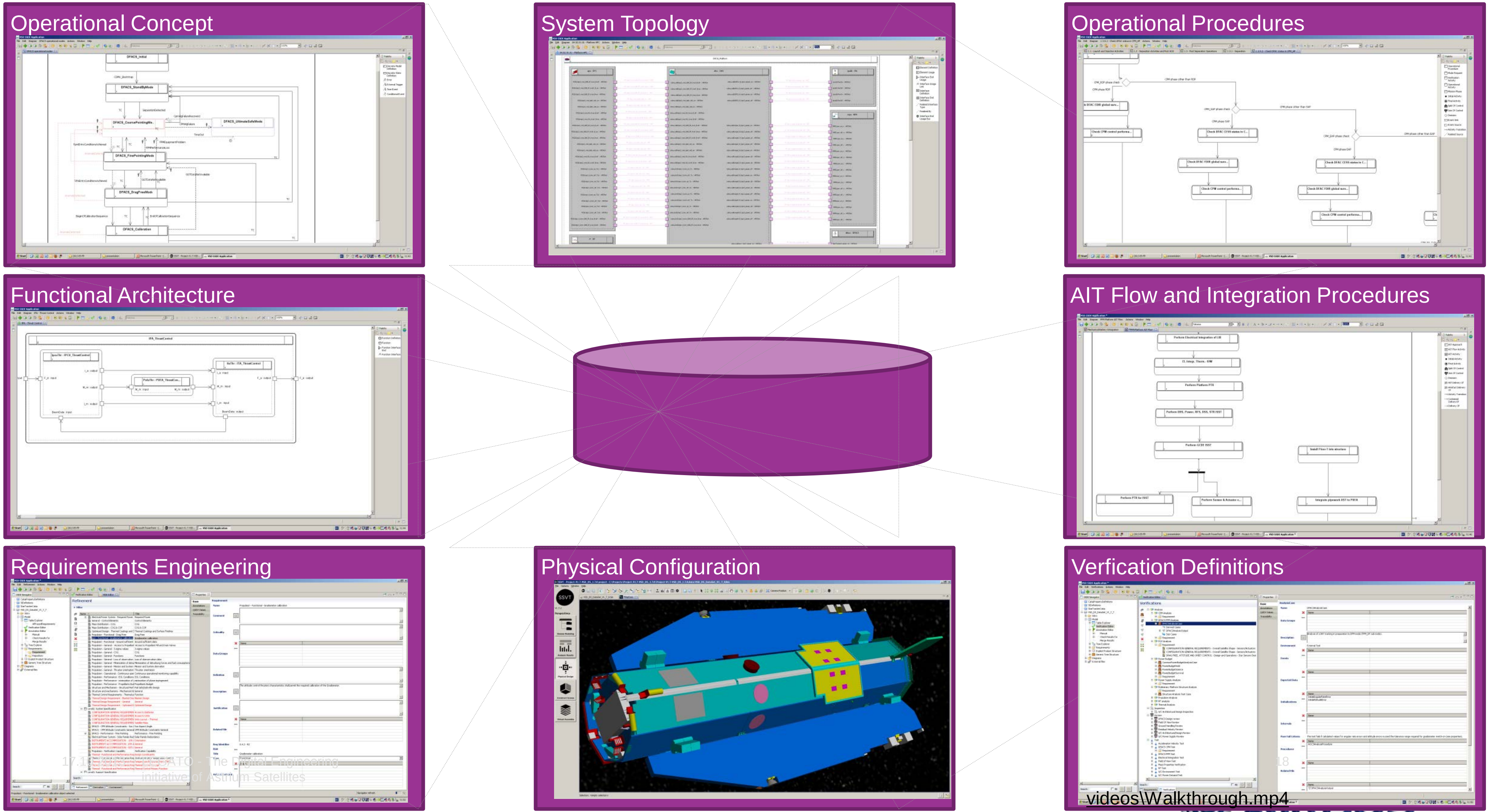


Budgets



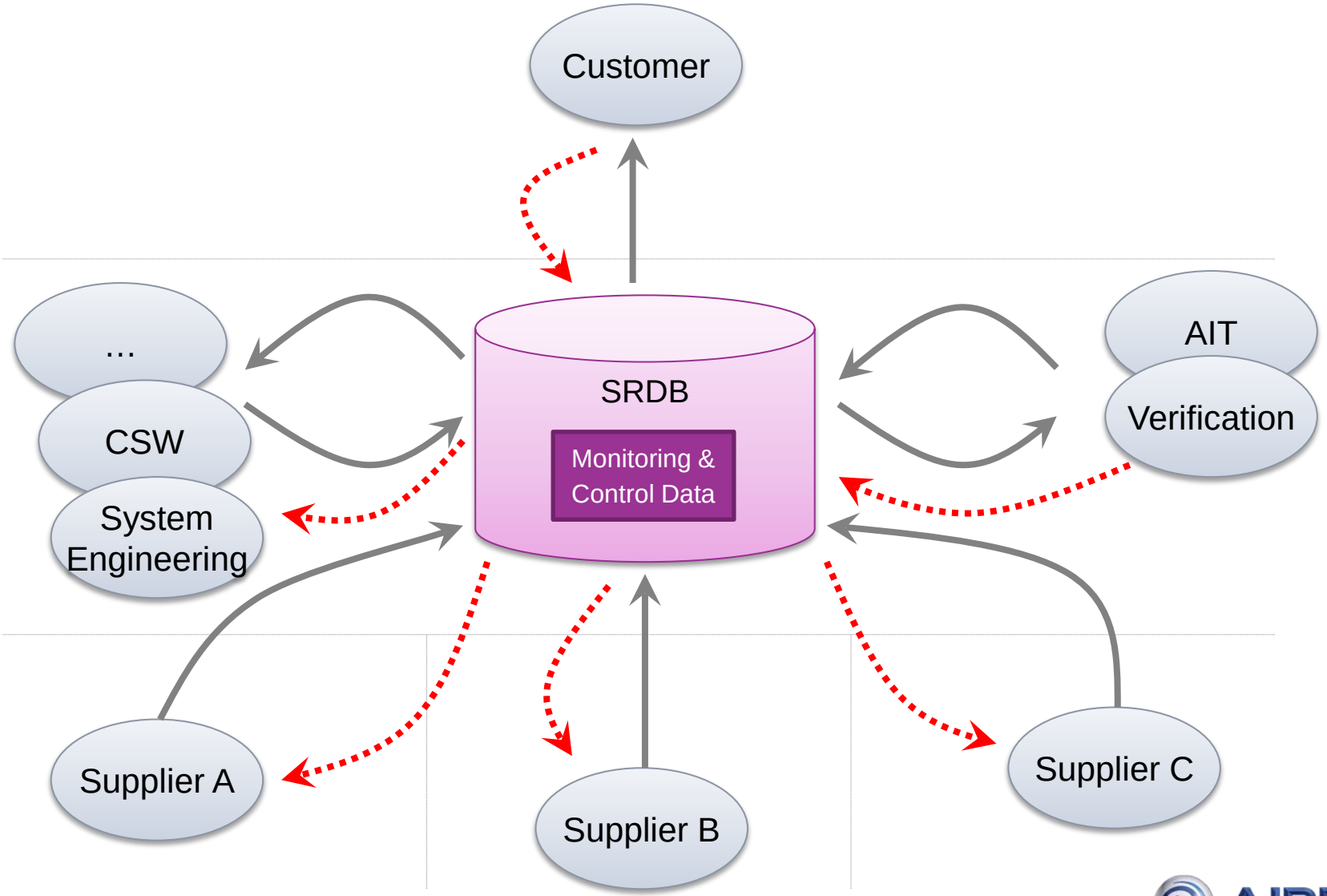
AIRBUS DEFENCE & SPACE

“Virtual Spacecraft Design” demonstrated that the realization of Space System Data Repository of ECSS-E-TM-10-23 is possible



videos\Walkthrough.mp4

A classic SRDB is an information hub, right in the centre of a heavy-weight concurrent engineering process in late phases



RangeDB: Development of a new product allowing the configuration of a SRDB with evolved scope – constraints and expectations

Ability to be "extend" scope (managed data)

cost reduction for maintenance

State of the art model-management

Evolved SRDB (→ Avionics DB)

Classic SRDB

Adopting concepts of E-TM-10-23 "System Data Repository"

Overall process efficiency to exchange data "digitally"

Demanding FV process many concurrent activities

Powerful System Simulators requiring complex data

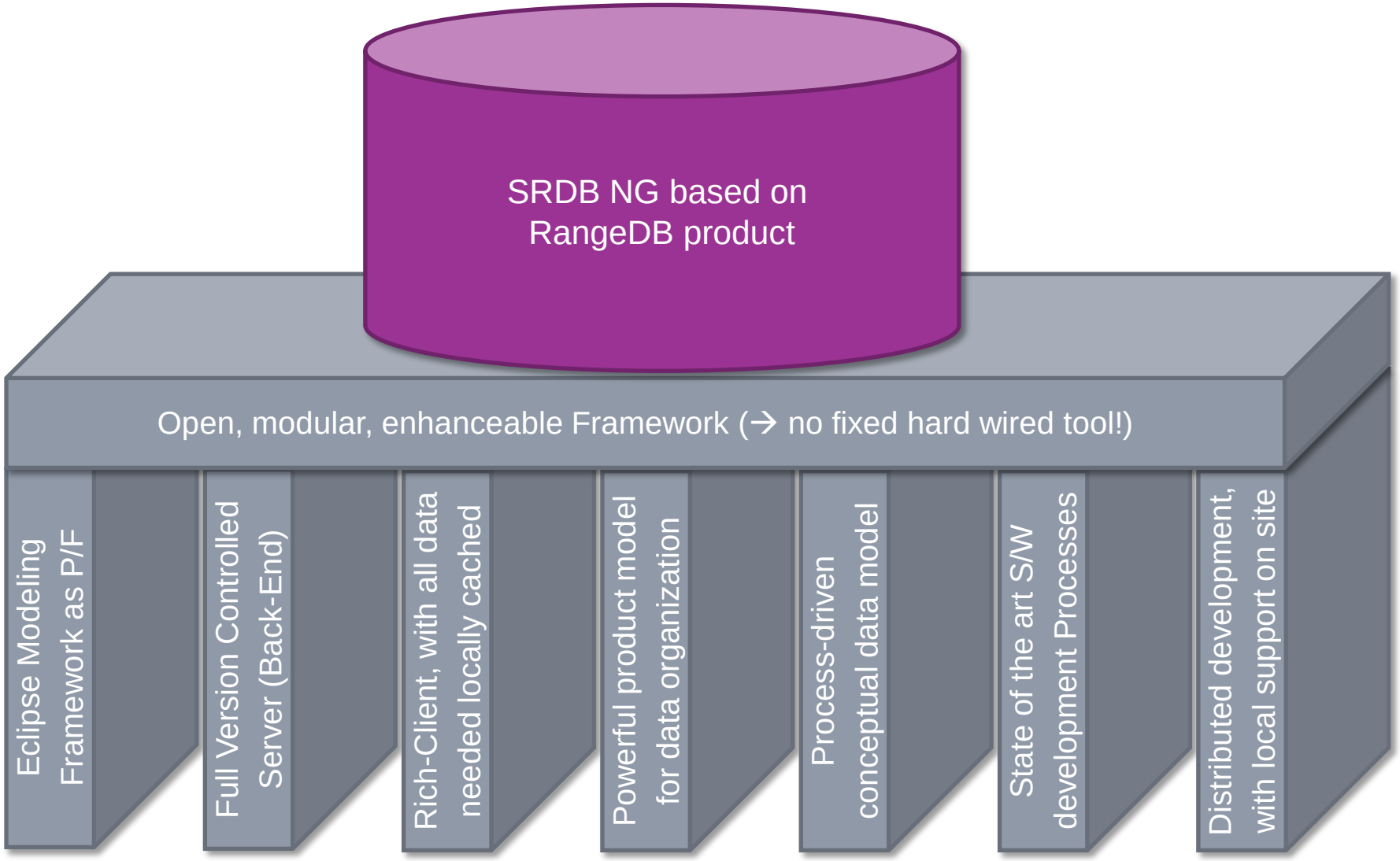
Increasing Scope of SRDB towards "all avionics data"

EGS-CC developments, and related CDM introduced

Technology obsolescence

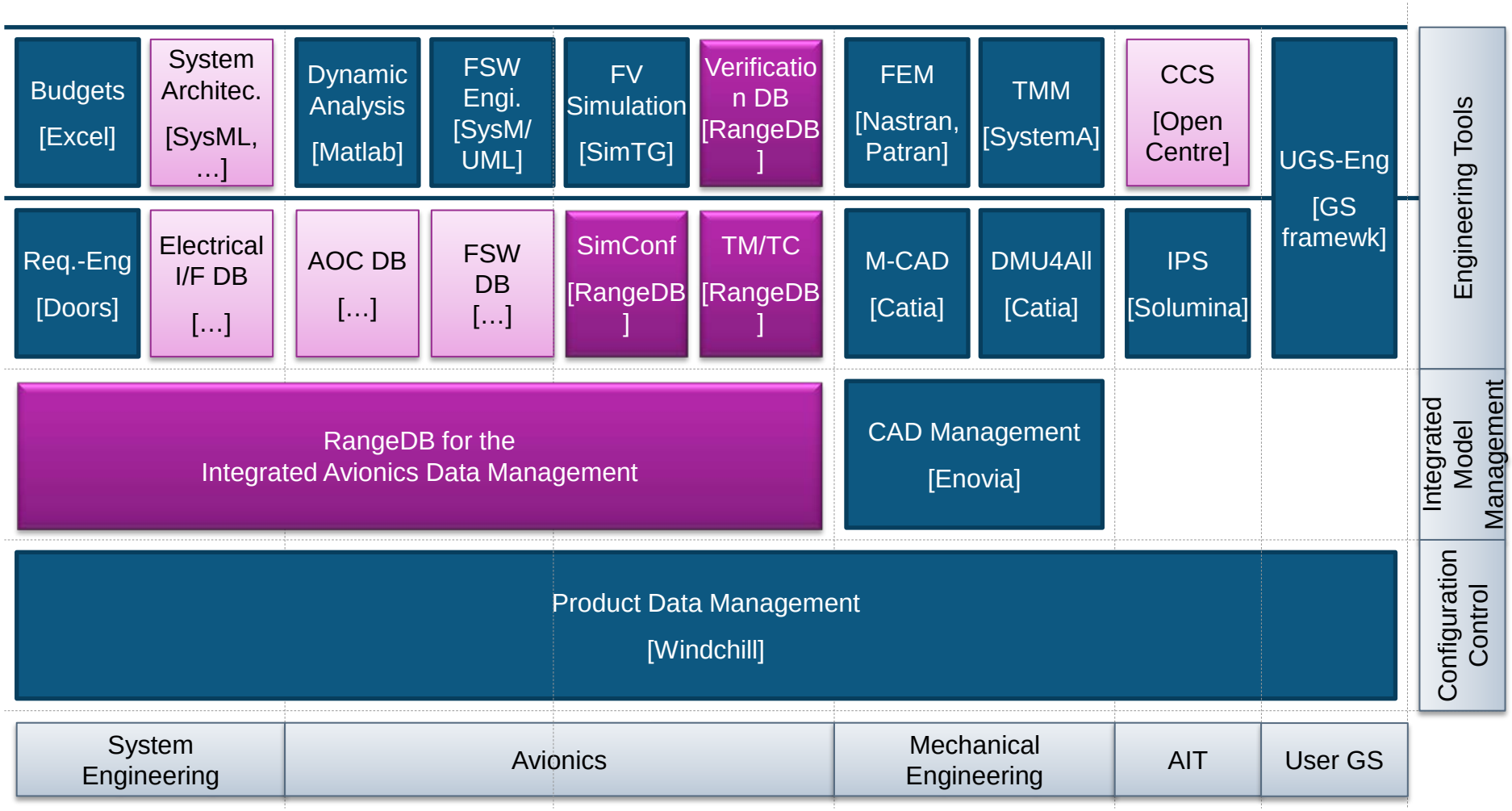
AIRBUS DEFENCE & SPACE

The following technological concepts are forming the pillars, the RangeDB product is relying on to meet the expressed expectations



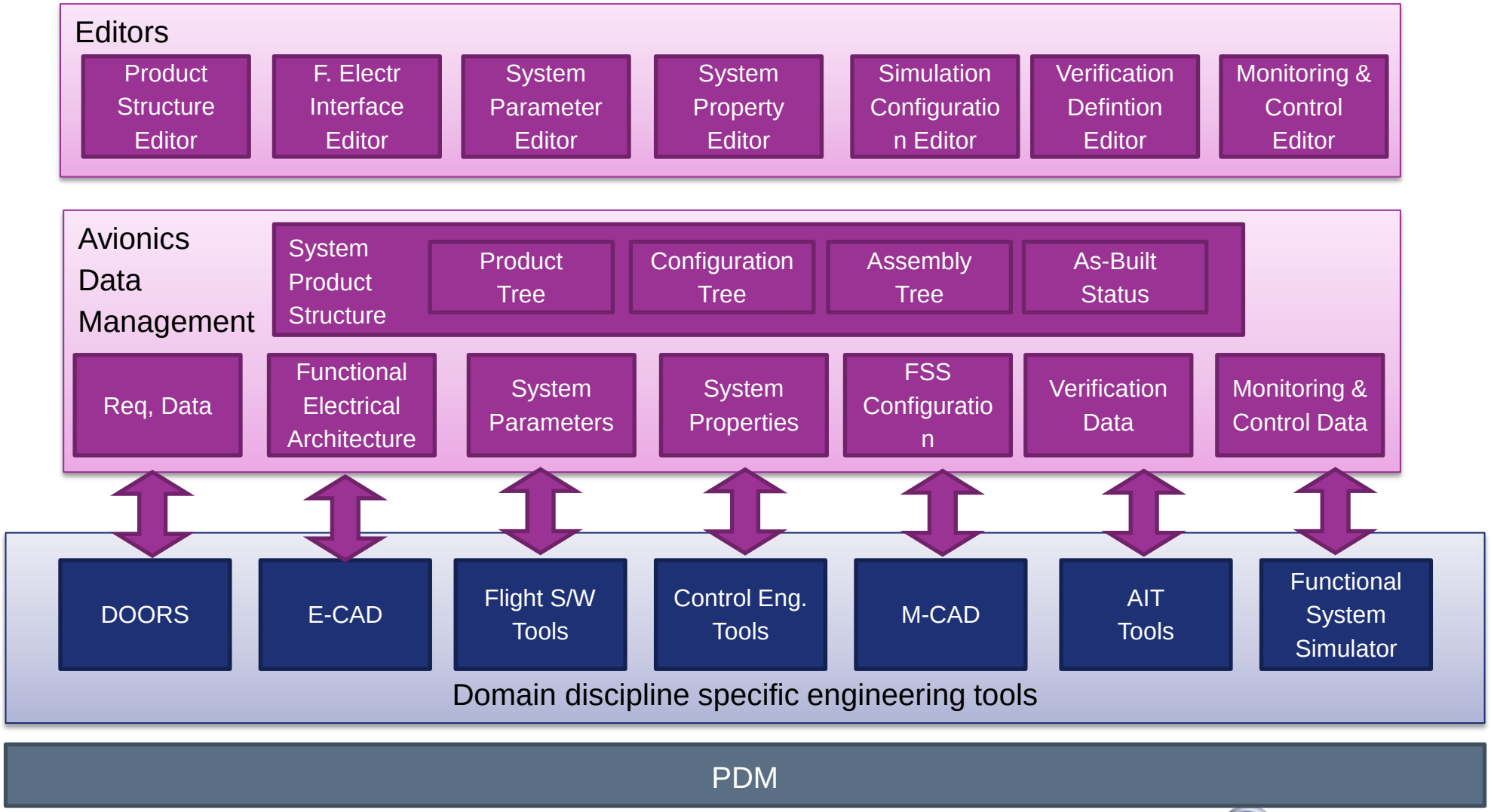
AIRBUS DEFENCE & SPACE

RangeDB forms the underlying framework allowing managing “all avionics” related data in a coherent way along ECSS-TM-10-23



AIRBUS DEFENCE & SPACE

Architectural view of the RangeDB with external interfaces, internally managed data, and view for inspecting / changing data



AIRBUS DEFENCE & SPACE

Conclusion

In the past decade significant progress has been made to improve discipline processes with models / DB

The “Digital Engineering” Integration Framework is a key element for proper interoperability
- COTS (e.g. Matlab/Simulink) can be integrated “as they are”
- Development and improved sharing of data management functions is possible
- Technologies are now mature (strongly relying on Open Source mainstream technologies) and used to deploy the Framework

In general an harmonization effort on space system data repository might play a major role in managing the transition towards integrated model-based engineering (→ MBSE)
- Providing a vision for the future overall collaboration framework through an overall roadmap
- Standardization to be done on ECSS should take into account international efforts like OMG, ISO, …
- The Open Source approach is to be considered in the context of the Space Community needs and business models

AIRBUS DEFENCE & SPACE