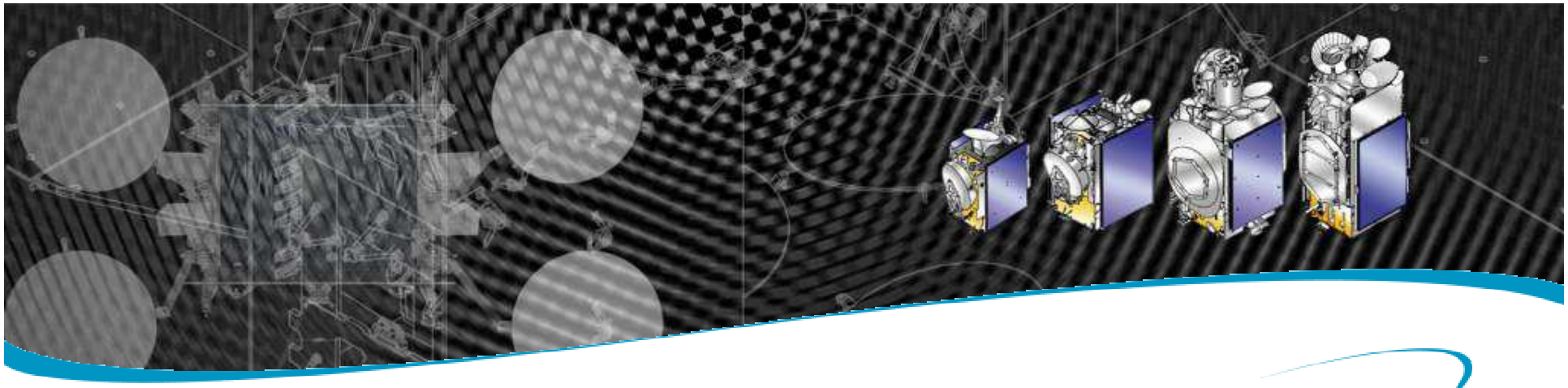

ThalesAlenia Space
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Model-Based Avionics Verification & Validation

ESA Workshop on Avionics Data, Control and Software Systems (ADCSS)
ESTEC, Noordwijk, The Netherlands,
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H. Bratulic, F. Maingam
presented by Jean-Luc Petit (Head of Data Handling TL section)
THALES ALENIA SPACE Cannes

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Main topics

- **What Model-types are involved in the avionics verification and validation process ?**
- **What is the impact on validation plans induced by introduction of models ? Traceability of different models and their relationship throughout the verification process ?**
- **Which system properties (data) are required for models, all along the avionics V&V process ?**
- **How are the models validated with respect to their domain of applicability, and maintained throughout the avionics lifecycle?**

Model-types (1/3)

Several perimeters / levels are involved in Avionics Validation :

- Functional Chains (ADCS, EPS, DHS, Thermal)
  - FC performance assessment
  - Equipment unit characterization & qualification
  - FC performance and robustness verification
- On Board SoftWare Verification & Validation
  - OBSW verification
  - HW/SW integration
    - Focus on Processor module & mains interfaces (TM/TC, I/O, mass memories, buses, …) of the On Board Computer
  - OBSW performance and robustness verification
- Avionics Verification & Validation
  - Functional Chains & global system test
  - Tests performed with both “real” equipment units and simulated models
    ➔ Avionics Test Bench (ATB).

Model-types (2/3)

Model-type used vs perimeter :

- At Functional Chain level :
  - HW Engineering Models (EM) : Equipment characterization → calibration of simulated model
    - For example StarTracker (proton sensitivity), Sun Sensor on 3axis table, OBC running Test Application SW…
  - Equipment simulation Functional Models
    - Function modelling
    - Model must be representative of the equipment performances
  - Environment models
    - Physical behaviour of the spatial environment
  - Dynamic model
    - Physical behaviour of S/C

- At OBSW V&V level :
  - HW Engineering Models (EM or BB) to support HW/SW integration
  - OBC simulation operational model
    - High representativeness of OBC behaviour, timing, mapping & addressing is required
    - Need of processor emulator (at instructions level)

Model-types (3/3)

Model-type used vs perimeter :

- At Avionics V&V level :
  - HW Engineering Models (EM)
    - Essentially complex units (OBC, StarTracker, GPS, Gyro, PCDU, RIU/PLIU, …)
  - Unit models (for all avionics equipment units having I/F with OBC) :
    - Operational Models (Cmd/Ctrl)
    - System Interface Model (I/O interfaces)
    - Functional Models (Operational mains functions)
  - Environment models
    - Physical behaviour of the spatial environment
  - Dynamic model
    - Multiple Bodies link with poly-articulate links

Impact on validation plans (1/2)

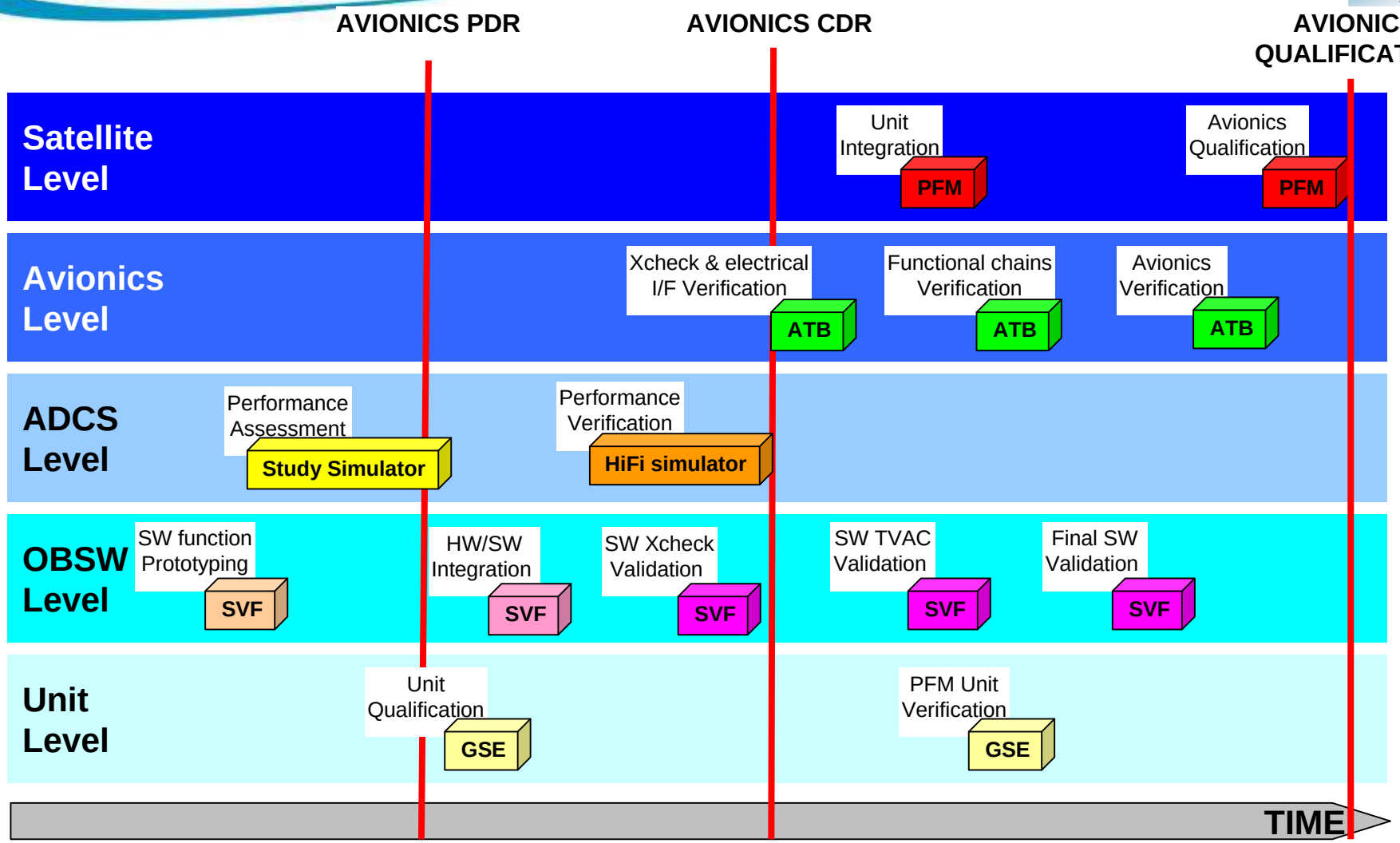
The benefits of the introduction of models :

- Verifying system feasibility and performance,
- Allowing design trades during system design,
- Early demonstration and testing before hardware is available,
- Avoidance / optimization of building hardware prototypes / models,
- System Verification and Training.

These benefits allow :

- To spread V&V activities on an incremental development approach,
- To parallelize V&V activities, getting rid of the need of HW models.
  - Planning optimization
  - Cost optimization
- To increase the efficiency of the V&V activities, using means best fitted to the test objectives.

Impact on validation plans (2/2)



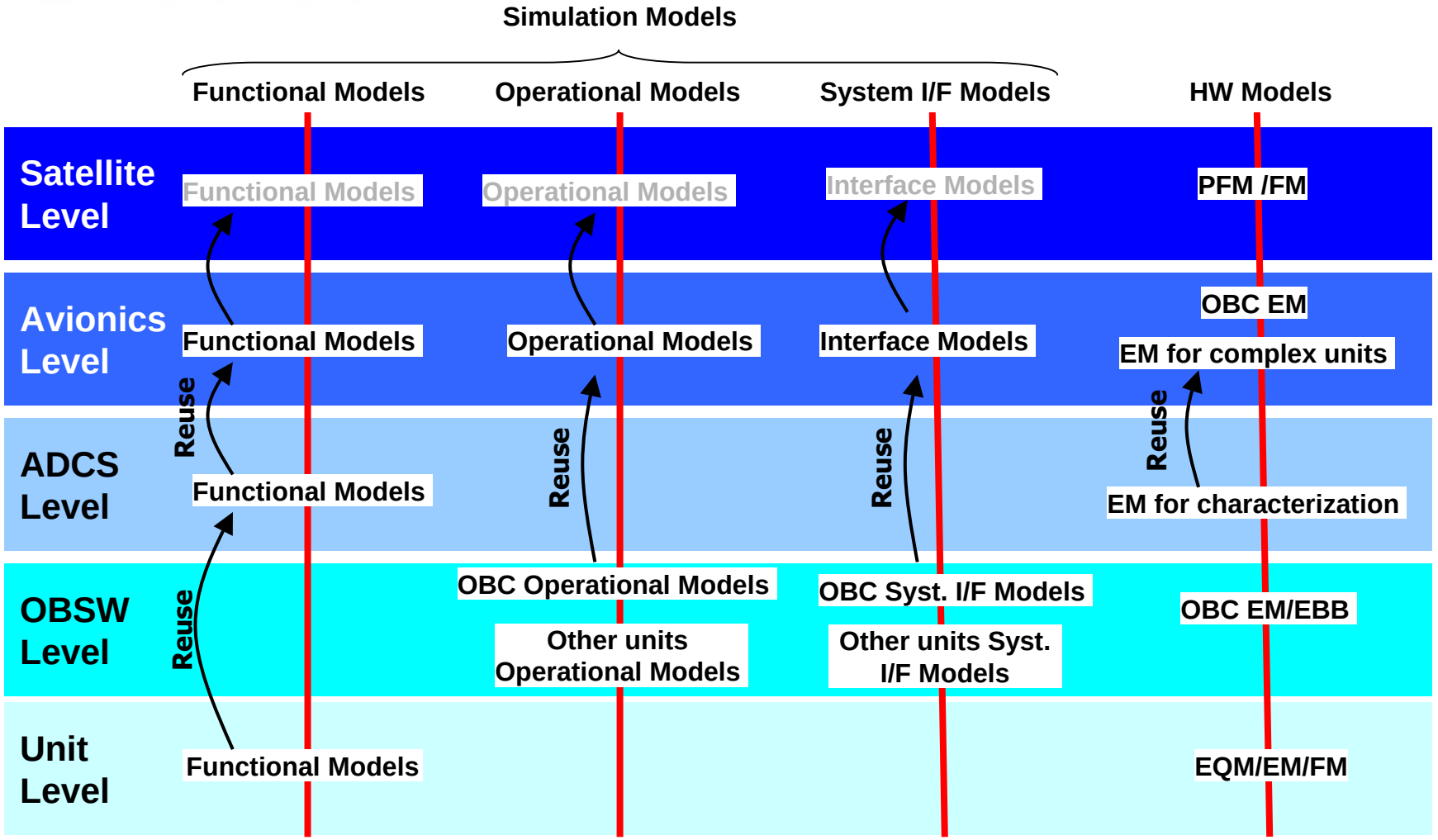
Traceability of different models (1/2)

Models code & simulators are configured

- **Their limitations are listed**
- **Their traceability is ensured**
  - **Evolutions**
  - **Corrections**

Industrialisation of the simulator assembly insure the simulator composition vs model versions

Traceability of different models (2/2)



System properties (data) required

Model level :

- Functional Models :
  - Physical data (Mass, Center of Mass, inertia, Position, Orientation, …)
  - Performance features (Bias, Noise, Delay, …)
  - Specific data (star catalog, calibration data, …)
- Operational Models :
  - Equipment : User Manual, State Machine, TM/TC, Transfer functions, …
  - OBC : memory mapping,
- System Interface Models
  - Interface features : Bus Address, data rate, Electrical ICD…

Simulator level :

- S/C Harness (Pin allocation)
  - To integrate the simulator assembly
- Model instances
  - For example nominal and redundant unit
- Model scheduling table
  - Define order and frequency for scheduling

How are the models validated ?

Two cases are considered :

1. **Models provided by equipment manufacturer :**
   - Validation of simulation model is performed by the provider
2. **Models developed by Prime :**
   - SW model verification / validation against SRS/RB documents
     - Functional Unit tests
     - Integration / validation tests
   - X-Validation against results obtained on real unit
     - OBC : Calibration of the OBC simulation model is performed in parallel of the OBSW development (HDSW development and HW/SW integration).
     - Other complex unit : Reference results are obtained during
       - ATB integration/validation
       - Equipment characterization tests
       - X-Check and Avionics tests
     - Dynamics & Environment : Reference results from previously validated simulators (by agency)