BASILES
on its way up to a wide-spread Simulation Service

Bernard DELATTE
Frédéric MANON
CNES DCT/SB/VS

summary

- The creation of the Simulation Service in 2004
  - The Situation
  - The main Findings
- Objectives of the Simulation Service in 2004
- BASILES
- New Context, New Needs
- The Process
- To conclude

The Situation and the main Findings

- **The Situation:**

- **CNES absent of Satellite AIV ->**
  - **Gap between Studies and System Validation,**
  - **No reuse of Models,**
  - **No demand nor culture of Models exchange.**
- **The CNES Role: System Responsible**
- **The key-position of Satellite Simulators in CNES**

- **The main Findings:**

- **A Project-based Organisation**
- **Partitioned Architects Platforms**
- **Partitioned Developments**

The CNES Role: System Responsible

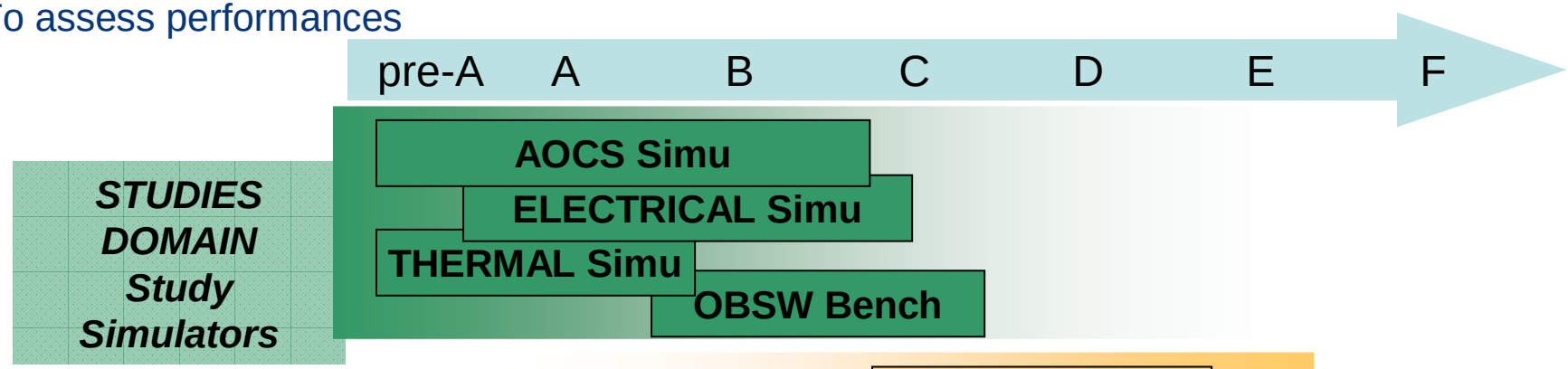
- CNES is responsible for the system validation,
  and for the associated means.
- CNES is independent from industrials for its study and validation means (SINUS, PRESTO, BVSS, home-made tools).
- CNES dispose of a large legacy, qualified and operational.
- CNES possess a know-how recognised by partners.
- CNES has developed simulations means well suited to dimension missions adequately, and qualify systems.

- Thanks to the simulation, CNES dispose of excellent means to maintain and develop his knowledge.

The key-position of Satellite Simulators in CNES

Functional Chains Studies

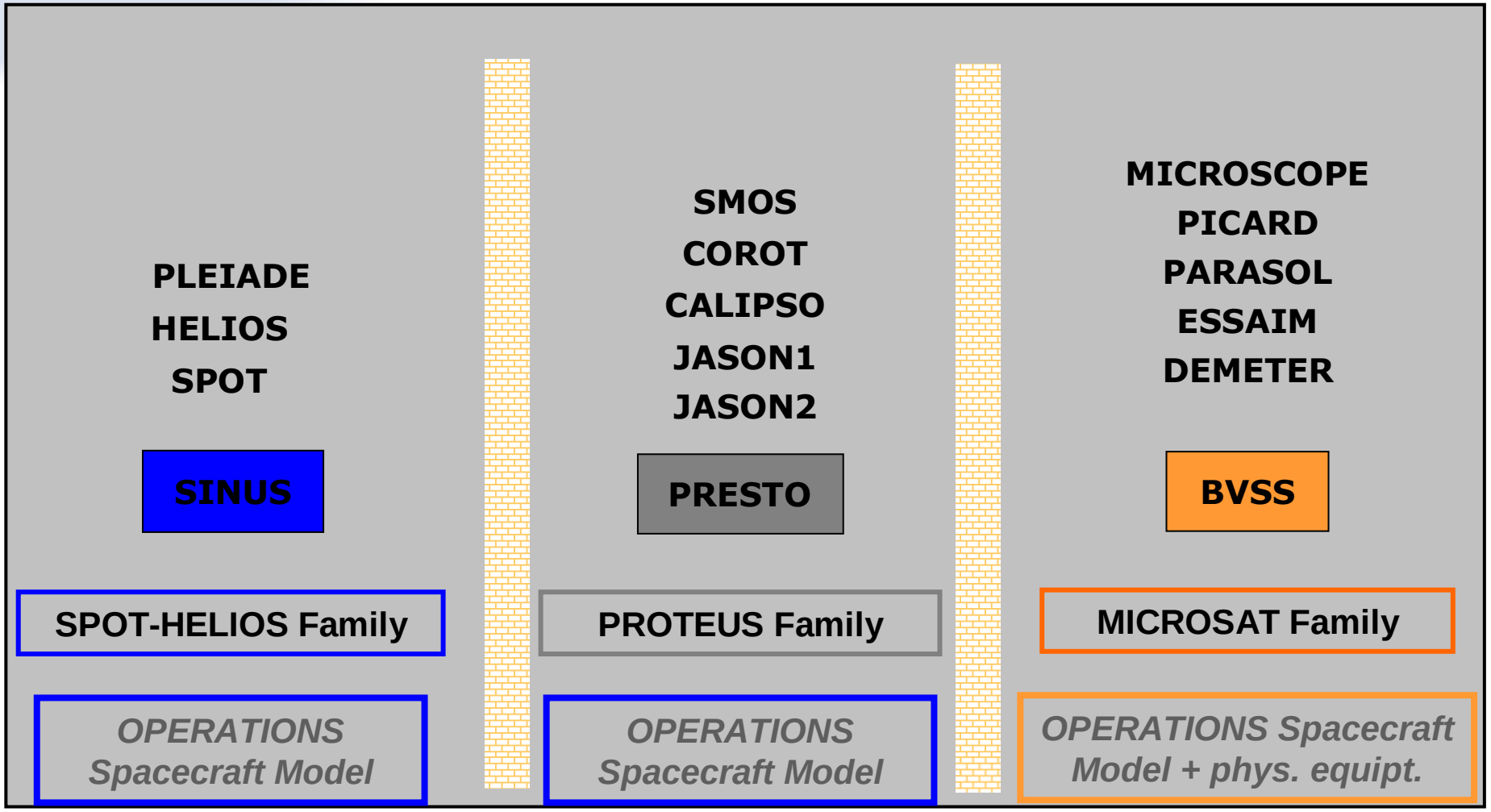
- To dimension equipments
- To design Algorithms and solutions
- To assess performances



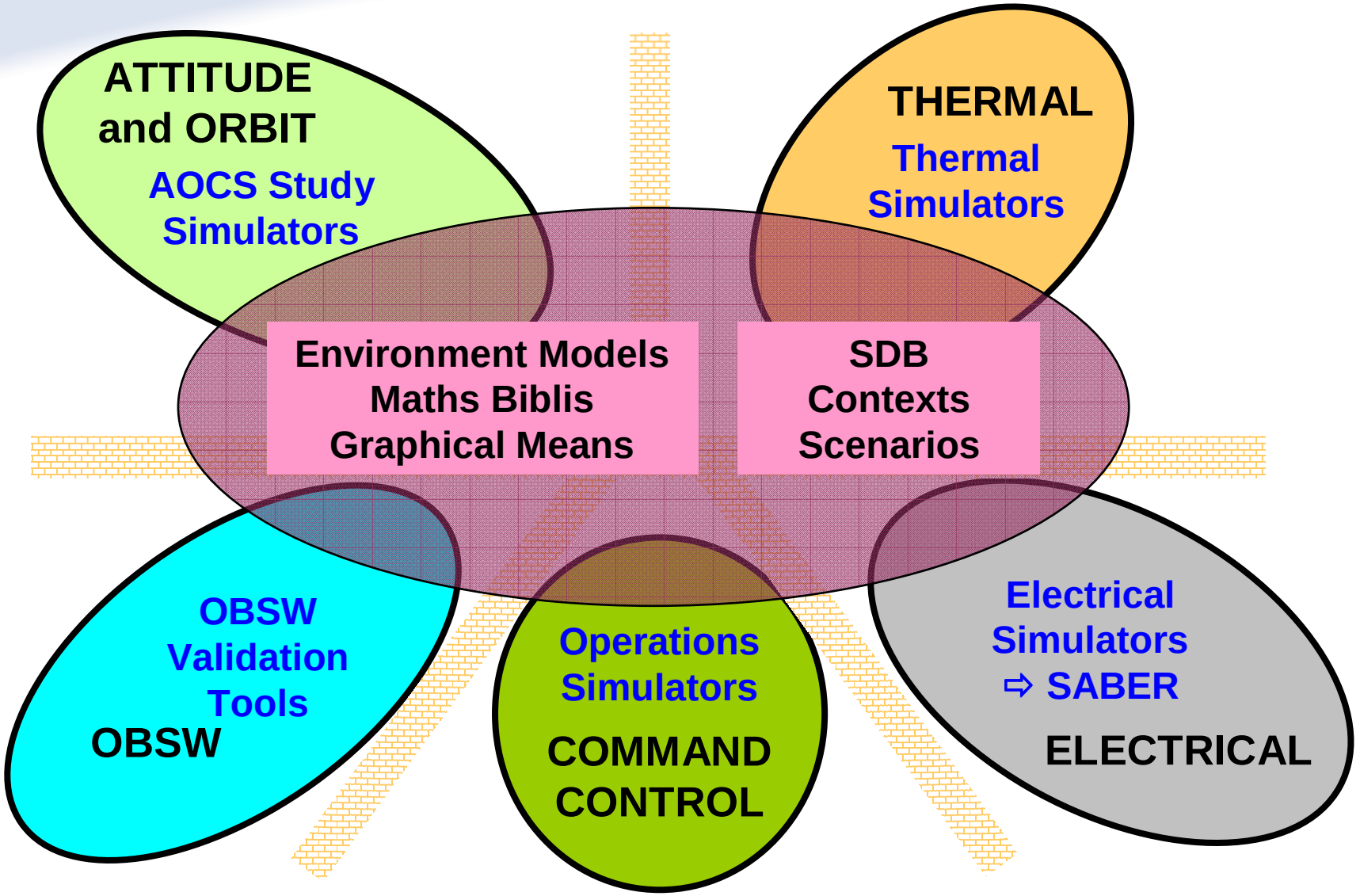
System Validation

- To qualify functional chains
- To technically and operationally qualify ground and space segments
- To assess the system against the mission requirements
- To train operations teams.

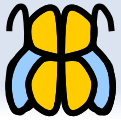
A Project-based Organisation



Partitioned Architects Platforms



Partitioned Developments



A / B /C Phases	D/ E/F Phases

Studies

Validation & Operations

ANALYSIS & DESIGN Spacecraft Model

OPERATIONS Spacecraft Model

OPERATIONS Spacecraft Model + phys. eqpt.

AOCS Simulator
- Equipments Models
- OBSW Functions Models

ELECTRICAL Simulator

THERMAL Simulator

SINUS | **PRESTO** | **BVSS**

Operation Simulator
- Equipments Models
  - Functional IF
  - Electrical IF
- Middleware
- Drivers
- OBC (Emulator or Real)
- OBSW (binary)

Objectives of the Simulation Service in 2004

- Concerned Domain: Satellites Simulation
- Goal: to propose a process and means to ease and harmonise the Satellites Simulators development
- Directed towards developers, integrators and users
- Mutualise System Simulation means inherited from the different Families (SINUS, PRESTO, BVSS)
  - Share Models (environment, equipments…)
  - Build a common Infrastructure
  - Favour models reuse trough out the life of projects

BASILES

- **BASILES Factory shall be used to:**
  - Design, develop and maintain Study, Validation and Operations Simulators,
  - Provide means to integrate Simulation needs of all teams,
  - Un-partition teams, means, phases of the lifecycle of a project

- **Aims are:**
  - To Reduce development costs of all these Simulators,
  - To improve the synergy between teams,
  - To improve the quality and representativeness of Operations Simulators

- **BASILES is:**
  - A development Factory for all Simulators,
  - An Environment to run Simulations,
  - Tools to observe Simulations and exploit theirs results

The Simulation Integration: from Studies to System Tests

- Based on the existing Infrastructure (Tests Driver, Kernel…)
- To get an Infrastructure and Models to accompany the engineering activities of a Project from the Studies in the CDF (PASO), up to the Electrical, Thermal, Command-Control, OBSW Studies
  - AOCS Guidance Profiles -> Thermal and Electrical teams
- Enhancing the Interoperability with dedicated Simulation means
  - Connection with SABER (Specific Electrical Simulation)
  - SIMULINK Wrapper

New Context, New Needs

- **Distributed Simulation**
  - Cooperation between Simulators
  - Validation of Formation Flying systems
- **SMP**
  - Sharing models with industrial partners
- **Exploitation of new host computers architectures**
  - Multi-core, multi-thread
- **Hybridising**
  - Need to synchronise the numerical simulator with the HITL
- **System Database**
  - Need to consider the Data lifecycle
- **Parallelised development activities (OBSW, OBC, STR…)**
  - Modularity shall be improved
  - Agility of means to develop

The Process (1/3)

- **HLA:**
  - **API developed upon CERTI from ONERA**
  - **Design of a methodology to connect 2 Simulators in a few days, and to distribute an existing Simulator in a few hours**
  - **Experienced on the PRISMA Project**
  - **SMOS: cooperation of 2 existing Simulators: PF (PRESTO, CNES, SPACEBEL) and PL (MIRASIM, ESA, SCISYS)**
    - Shall result in architectural guidelines
- **SMP:**
  - **« Industrial Validation of SMP » study involving ASTRIUM, THALES, SPACEBEL, ELLIDISS**
  - **BASILES Kernel adaptation to offer SMP services by the end of 2008**

The Process (2/3)

Separability:

- R&T Study for defining separability criteria by IRIT
- Analysis and Application by SPACEBEL
- Results applied to DORIS on PLEIADE,
- Used within BASILES

Distributed Kernel:

- R&T: exploitation of multi-thread, parallel processors, equipments with real time constrains (ex. Star Tracker)

OBSW:

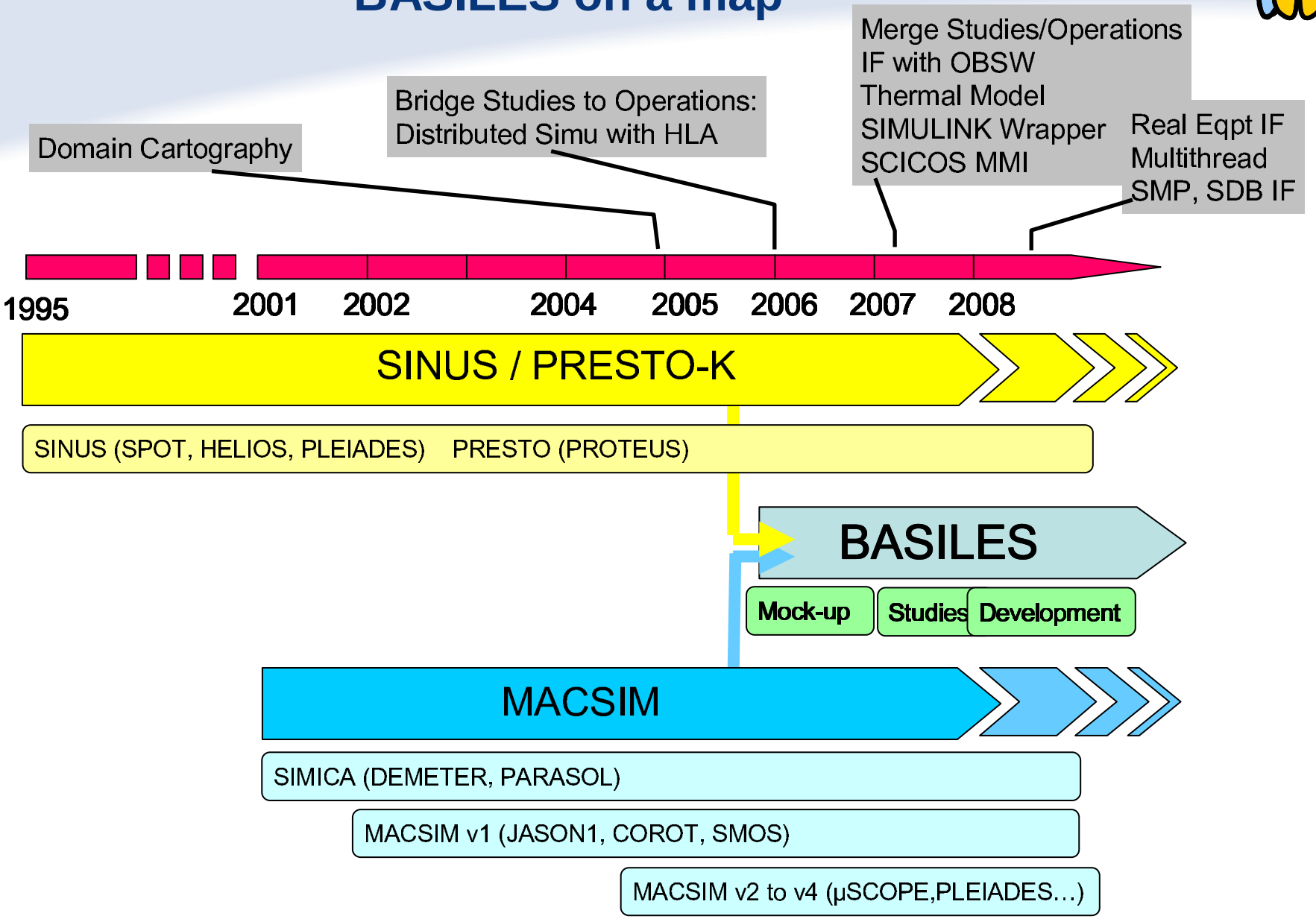
- standard IF between PF Simulation and OBSW
- Functional OBSW: by-pass of communication layers between OBSW functions (Commands, Data) and equipments Models

The Process (3/3)

- **Link with the SDB**
  - **Experiments of bindings with System Data: (configurable gateway between the SDB and the Simulator internal Data);**

    Standards: XTCE, XIF
  - **On-Going Work with the « System Data Factory »**
- **New OBC: LEON**
  - **Next step to support ISIS**
- **HITL:**
  - **Trying to decouple from Hardware constraints**
  - **Study of the hybrid collaboration between a Numerical Simulator and a real Equipment (application on SMOS via a 1553 bus card)**

BASILES on a map

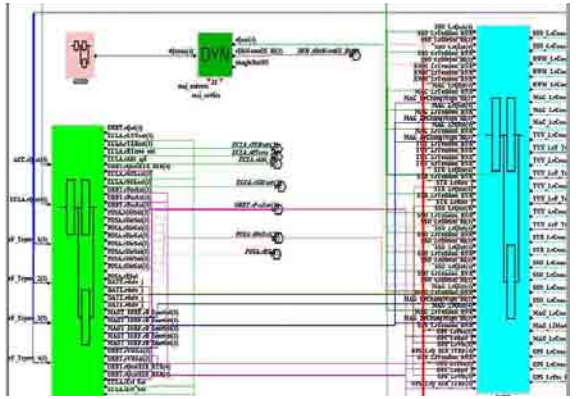


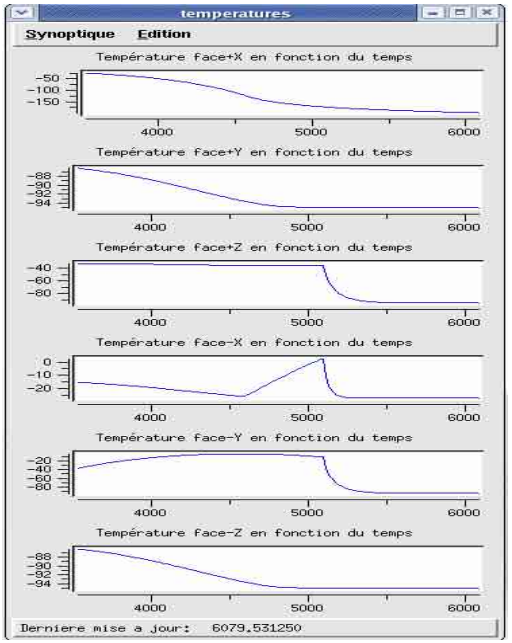
Testing Support

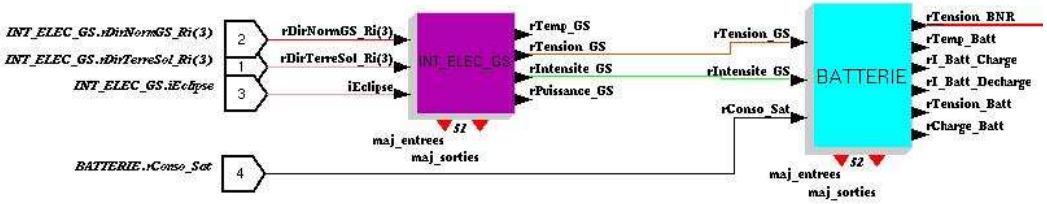
- **Common MMI**
  - Simulator management more easy,
  - Learning curve shortened
- **Results Visualisation : CELESTIA**
  - Starting from a freeware, extension to take real-time into account
  - Cooperation CNES – ESA – SPACEBEL
- **Prototyping Solutions on SIMBOL-X**
  - System of 2 Satellites
  - Several Industrials implied
  - CNES is responsible of the Validation of the Whole System

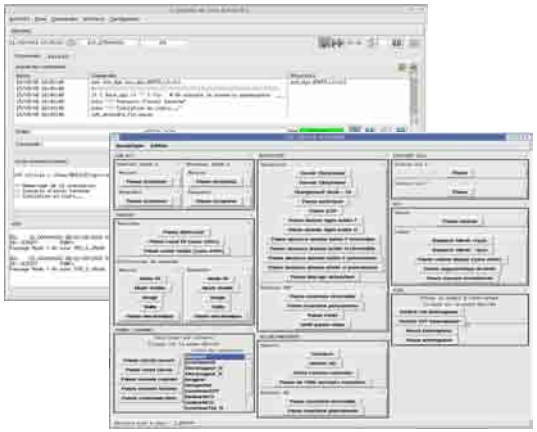
BASILES: real stuff

- **MMI:**
  - **Models: creation, code generation, connection, grouping (blocks), visualisation**
  - **Simulation management**
  - **Exploitation of the Resu**

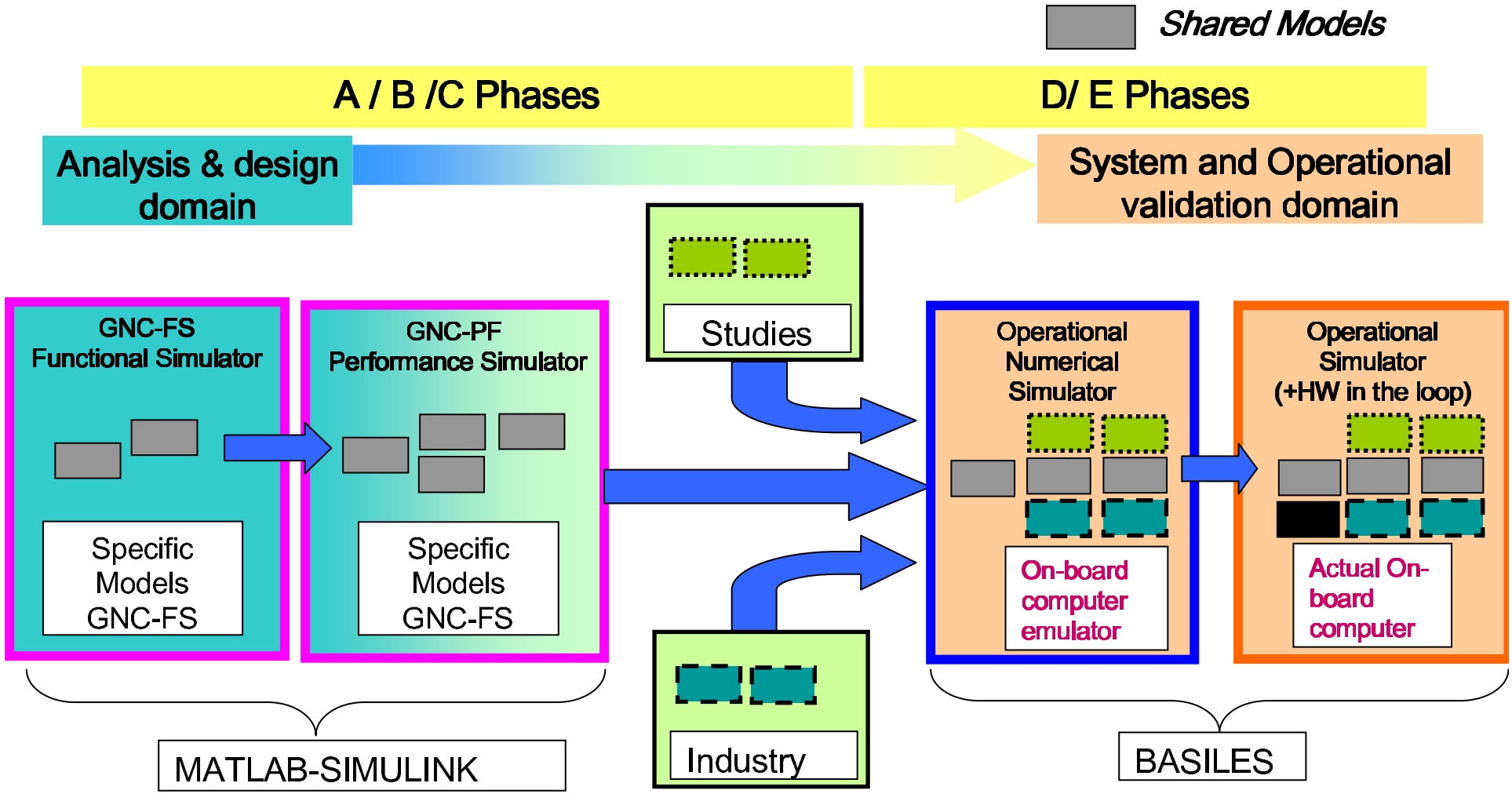








BASILES Reuse Process on SIMBOL-X



Trying to conclude

- A step-by-step Action centred on the Engineering of Space Systems
- An on-going Project
- Real stuff already operational
- A foreseen success with the deployment on upcoming Projects:
  - SIMBOL-X
  - ISIS (Initiative for Space Innovative Systems)