GSAW 2006

Harmonizing Ground Segment CSOS (Complex System of Systems) in Europe

"As difficult as a Tyrannosaurus-Rex turning vegetarian“

N. Peccia, ESA

OUTLINE

- The Foundations
  - **Technology Strategy**
  - **European Space Technology R&D**
  - **Harmonization Cycle**
- The process of harmonizing Ground Software Systems
  - **Roadmap**
- Phases
- Conclusions

Objective of European Space Technology R&D

- **Ensure**
  - Effective technological preparation for future European Space Programmes
  - Worldwide leadership in selected areas
  - Decisive support to the worldwide competitiveness of European industries
- **Objectives**
  - Strengthening the foundation **(independent and affordable access to space + industrial capability to design, manufacture, and operate satellite systems and the associated ground infrastructure)**
  - Enhancing scientific knowledge
  - Reaping the benefits for market and society

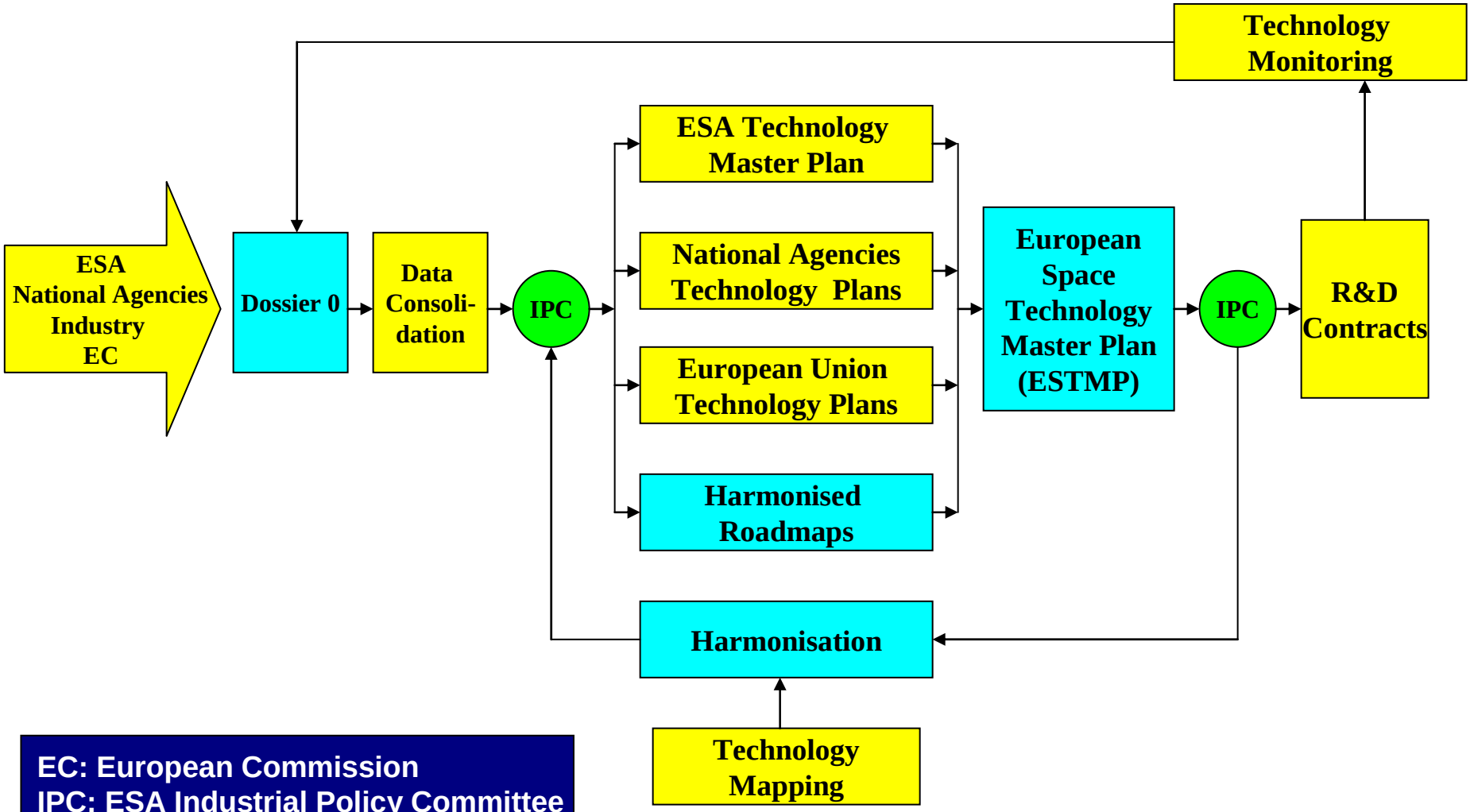
Reaffirmation by ESA Council

- **Mandate from ESA Ministerial Resolution in Edinburgh, on November 2001,**
  - Pursue the programmatic coordination and harmonization of technology Programmes and prepare the European Space Technology Master Plan (ESTMP) as a further step to the 2001 developed ESA Technology Master Plan

Roadmap

- **ESA as overall coordinator**
  - Step 1 – Dossier 0
    - Defines a Technology Tree
    - Technology Domains (26)
      - Technology Domain 9 = Ground Software Systems
  - Step 2
    - Mapping of European developments and competence
    - Harmonization of technology activities
  - Step 3 - ESTMP
    - Production of a coherent European Space Technology Master Plan (ESTMP)

Overall Technology Strategy Flow Chart



Harmonisation Cycle

ESA Technical Dossier

Background and Technology Overview
Future Mission & market Needs
World wide Technology trend
European Status of Current technology
Competitiveness and Benchmarking
European Strategic Interest
Proposed Future Development

Overview from National Agencies

On-going activities at National Level
Future National Mission & Needs
Strategic Interest
Proposed future developments

EUROSPACE (on behalf of european industries) Industry Perspectives

European Industry Mapping
Current Technology status
Strategic Interest
Proposed future developments

MAPPING MEETING

To gain a common understanding of the current situation for the Selected technology
Participants: ESA, National Delegations, EC, Eurospace (e.g. European Industry)

ESA Technical Dossier Update (to include information from maping meeting)

ESA Roadmap Proposal

Detailed medium / long term strategy
Expected added value
Proposed development approach
Schedule and Cost
Risk Analysis

CONCLUSIONS

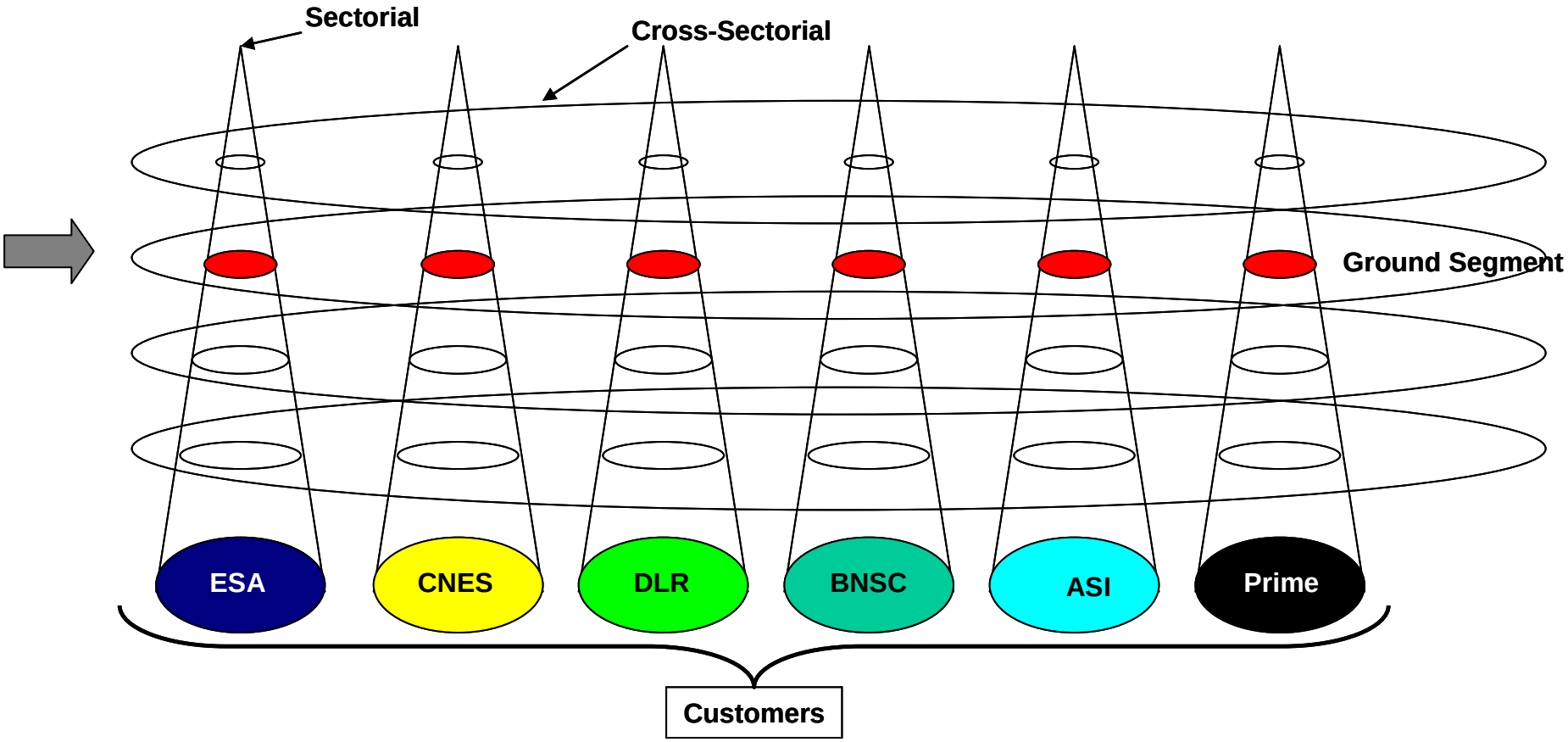
ROADMAP MEETING

Agreement on who is doing what, for when and on which budget
Participants: ESA, National Delegations, EC, No industry

Technology Domain 9

GROUND SOFTWARE SYSTEMS

Strategy Landscape



We focus on Cross-sectorial strategy for Ground Segment

Strategy Landscape

Cross Support Interoperability
at Ground Segment Components
(high level of granularity)

European Harmonisation Interoperability
at Ground Segment Subsystem
(medium level of granularity)

Software Re-usability
at Software Middleware Components
(low level of granularity)

International

Via CCSDS / ECSS / OMG standards

European

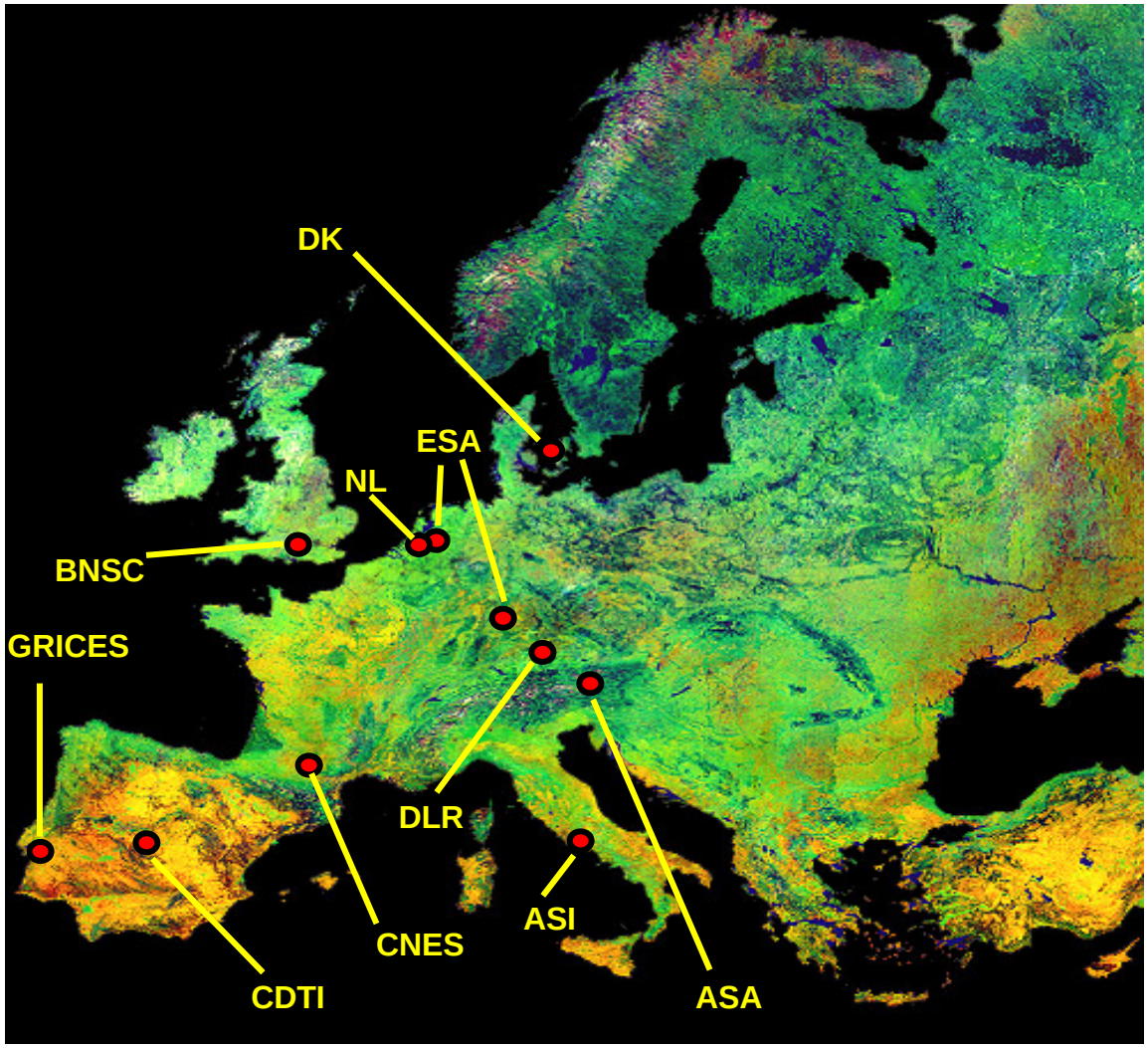
Via ECSS standards

Plug & Play Subsystem Components

Organization

Plug & Play Middleware Components

Participants



+

EUROSPACE

- **EADS Astrium Toulouse**
- **EADS ST Germany**
- **Alcatel Alenia**
- **Laben Italy**
- **LogicaCMG UK**

Ground System SW Mapping Meeting

Non European Products presence is increasing	Buy European
Remarkable Diversity of product	Harmonise
Lack of Reusable Infrastructure	For any class of Orbits / mission Single / family / Constellation
Lack of Full IPR with Organizations	Free license to European Industry
Products not covering the whole Ground Segment	Broadening the Product Line
Budget constraints	Mission culture, not a cost culture

Ground System SW Mapping Meeting

- **Large diversity of products and customers / programmes in Europe**
- ***Competition from non- European suppliers of MCS (Mission Control System) / EGSE (Electrical Ground Support Equipment) COTS will increase***
- **Harmonization around European products supported**
- **Standardization of product functions and external interfaces needed**
- **Commonality between MCS and EGSE is of interest for institutional programmes and low-cost national programmes**
- **COTS Ground Software products in Europe will satisfy industry's need to have well-know, mastered products that can be used to build robust low-cost solutions**

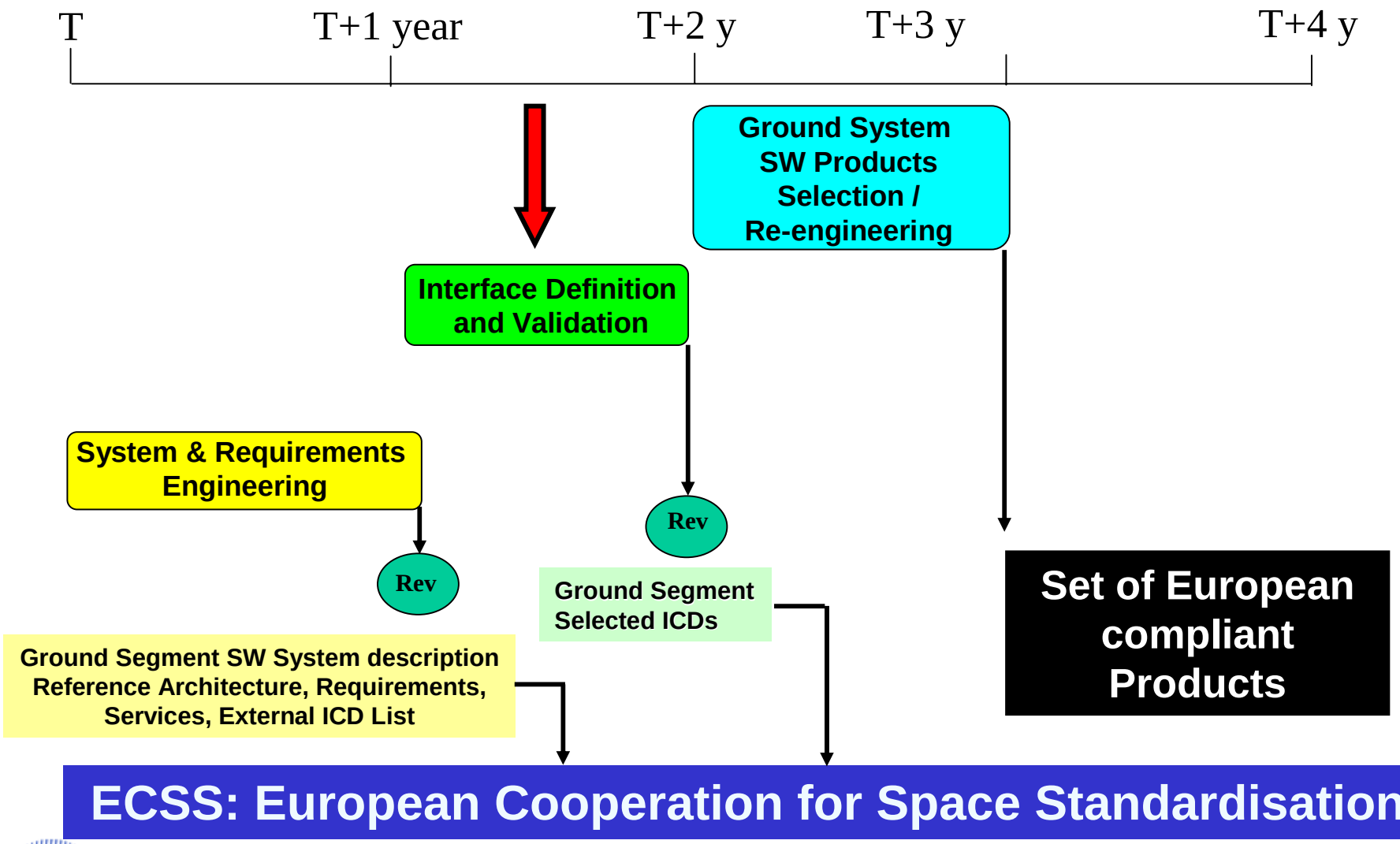
Ground System SW Mapping Meeting

- The harmonization activity could be focused through ECSS (European Cooperation for Space Standardization) and harmonization could help to speed up this standardization
- European products already exist in many of the domains (e.g. MCS, simulators, flight dynamics), however without standard external interfaces
- Conclusion:
  - focus on interoperability of products, by specifying set of products with defined functionality and standardized interfaces

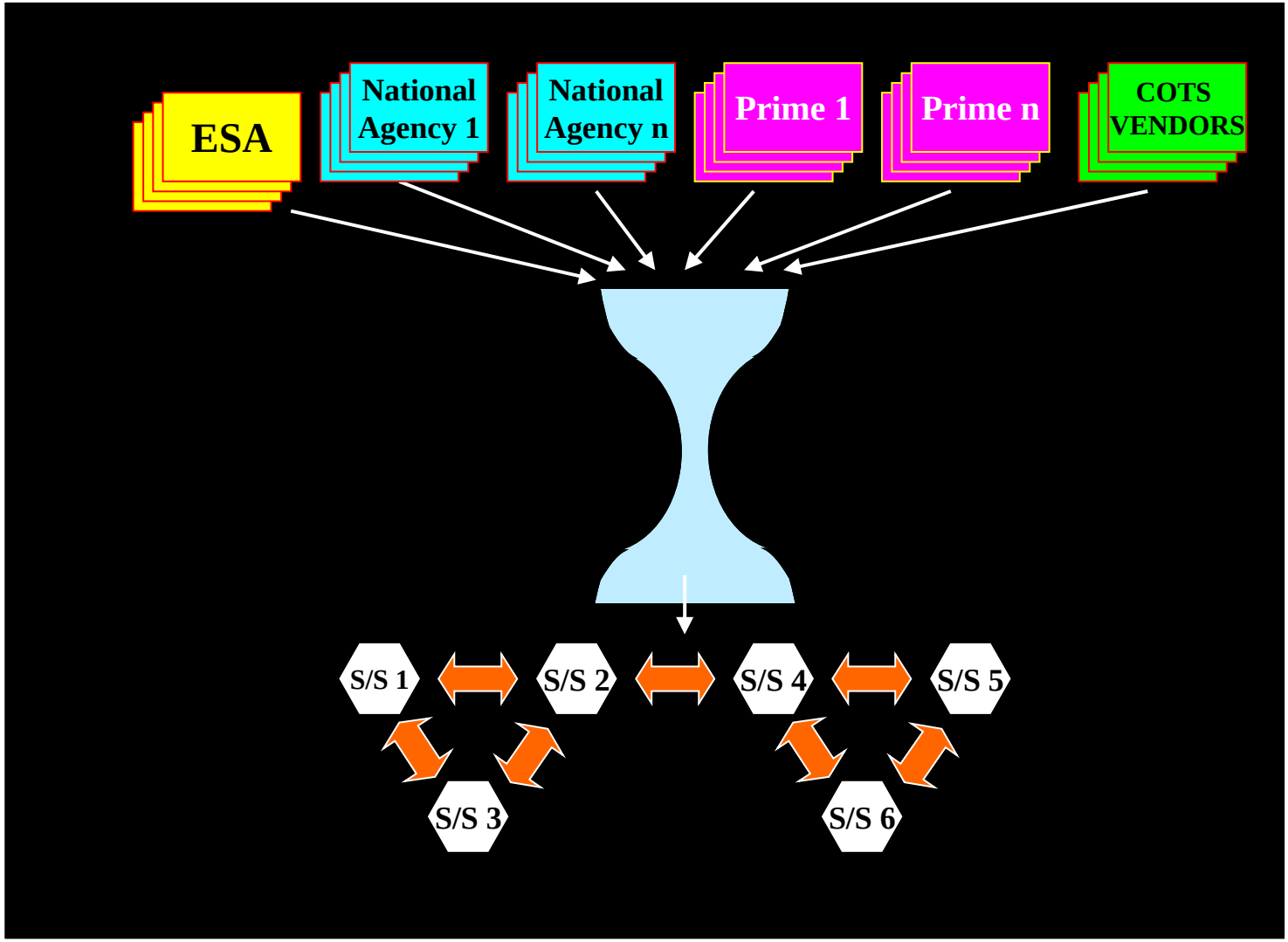
Ground System SW Roadmap Meeting

- **Medium/long Term Strategy: Objective and Market**
  - **Objective**
    - Availability of set of European ground software products
      - Covering all major technical domains
      - With an adequate number of commercially competitive products
  - **Target Markets**
    - European Institutional programmes
    - Commercial markets

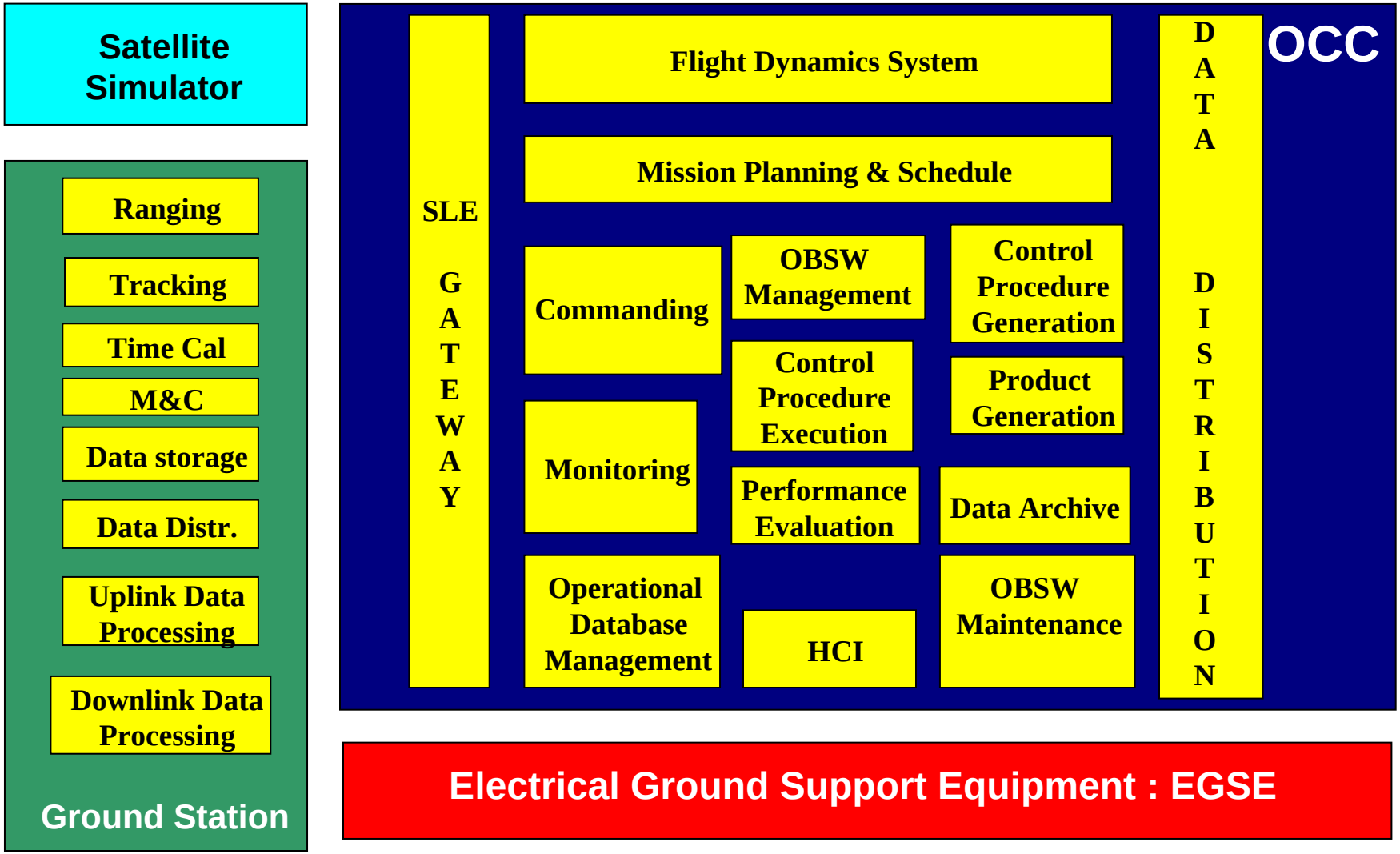
Agreed Roadmap



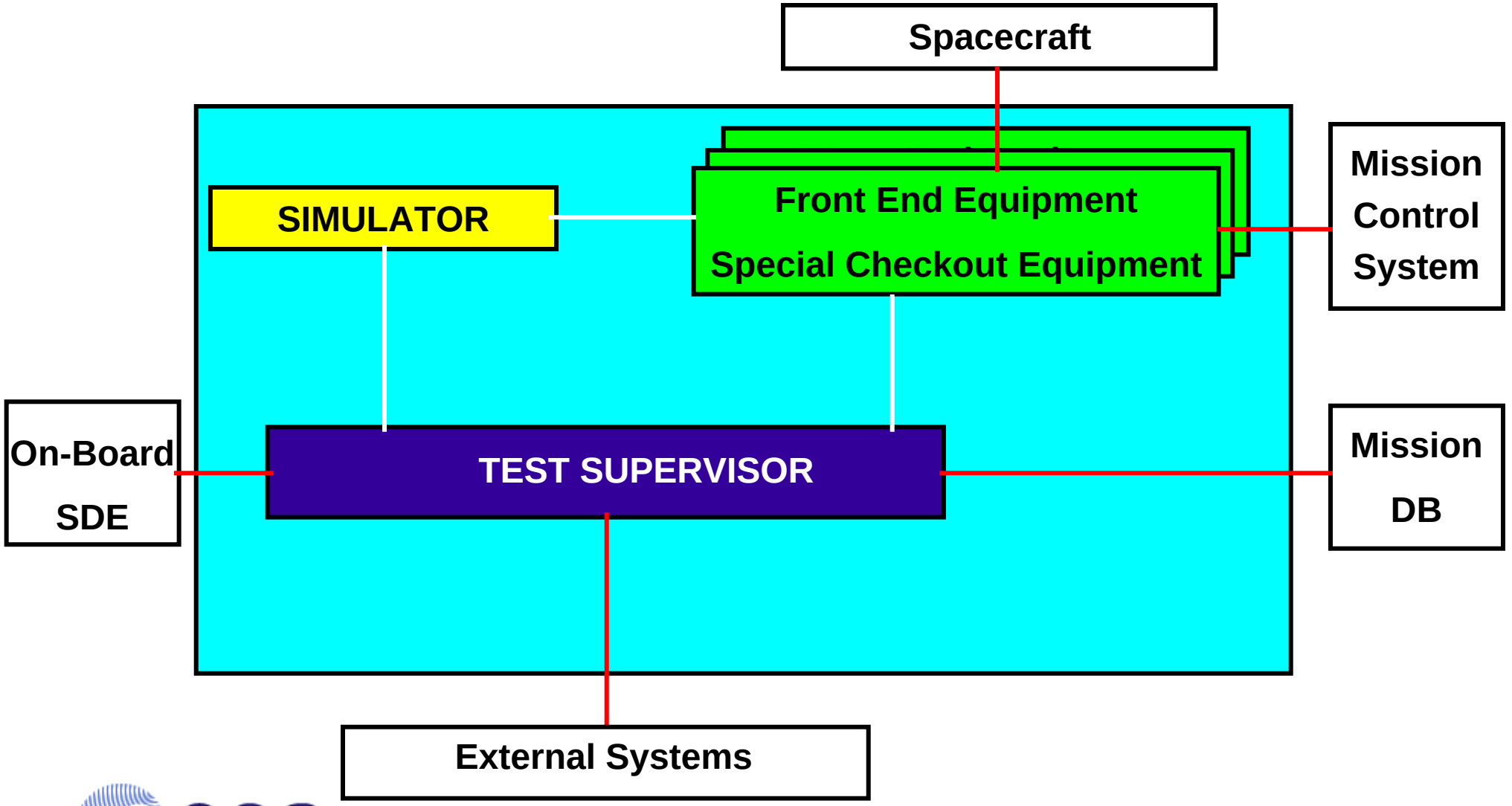
Agreed Roadmap



Ground System SW : The ECSS-70 View



Ground System SW : The EGSE View



The Principles of Harmonization

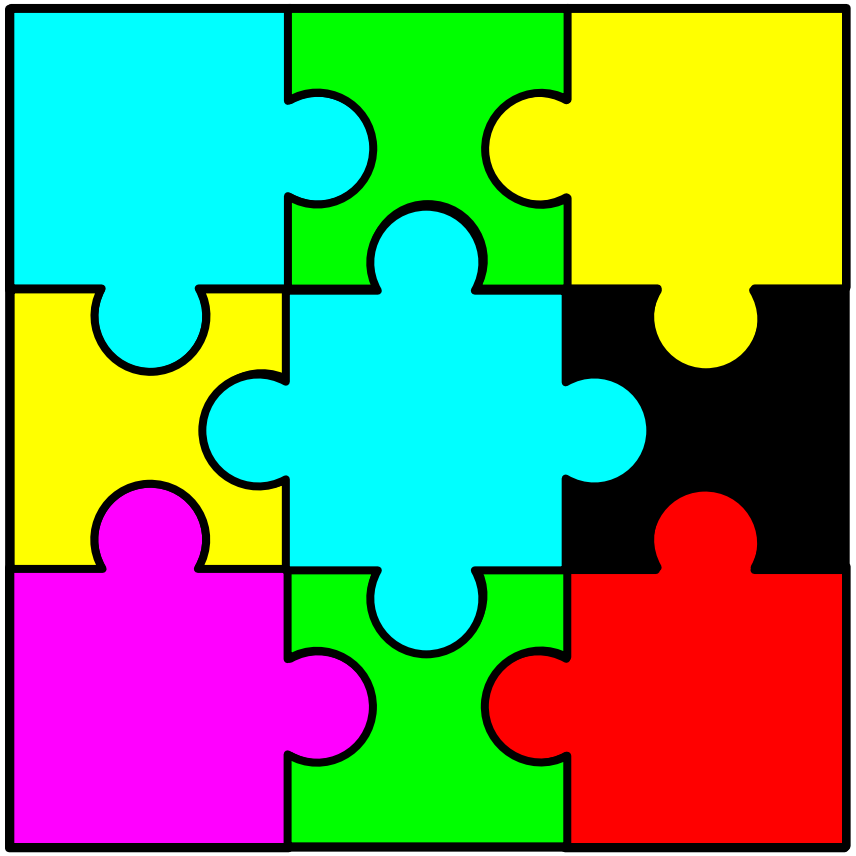
French Space Agency

CNES

German Space Agency

DLR

ESA



EADS

COTS Vendor 1

COTS Vendor 2

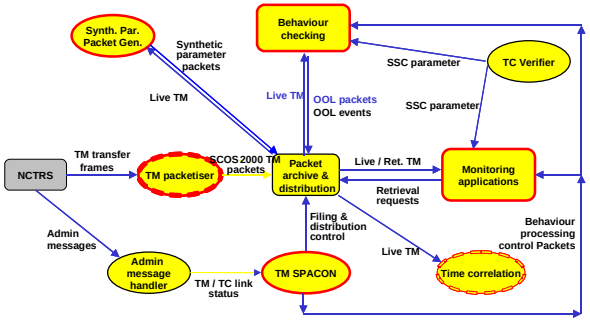
THE PROCESS

Different Possibilities

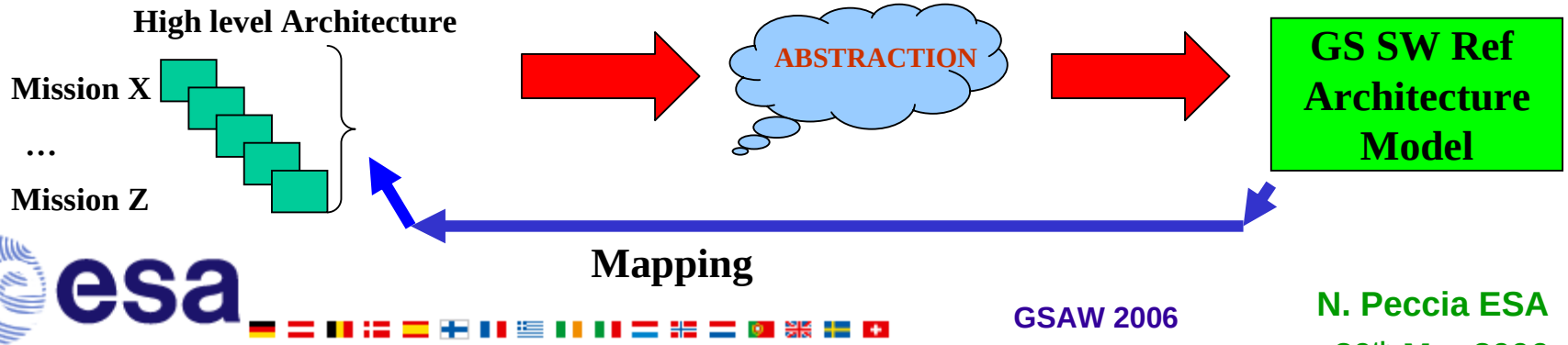
- **Definition of priorities on ECSS level 1 functionality**
  - We can not address everything in one go
- **Definition of level of granularity wished for "Architecture Reference Model"**

Monitoring

OR

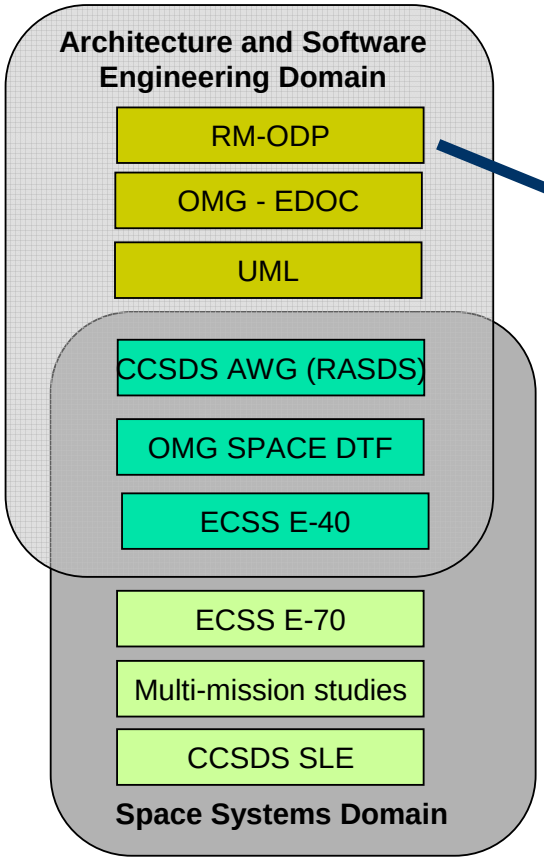


- **Collection of information from different sources**
  - High Level Architecture, High Level requirements, Services, Mapping to ECSS-E70
    - ATV, Columbus, MTP, MSG, Launchers, Champ, Terrasar, Rosetta, Integral, Galileo, Eutelsat, Hispasat



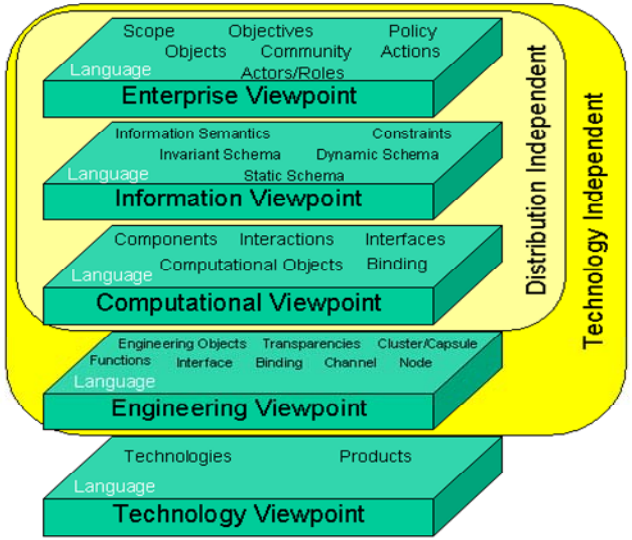
Architecture and Terminology assessment

- Assess different standards aiming to reach an enhanced terminology



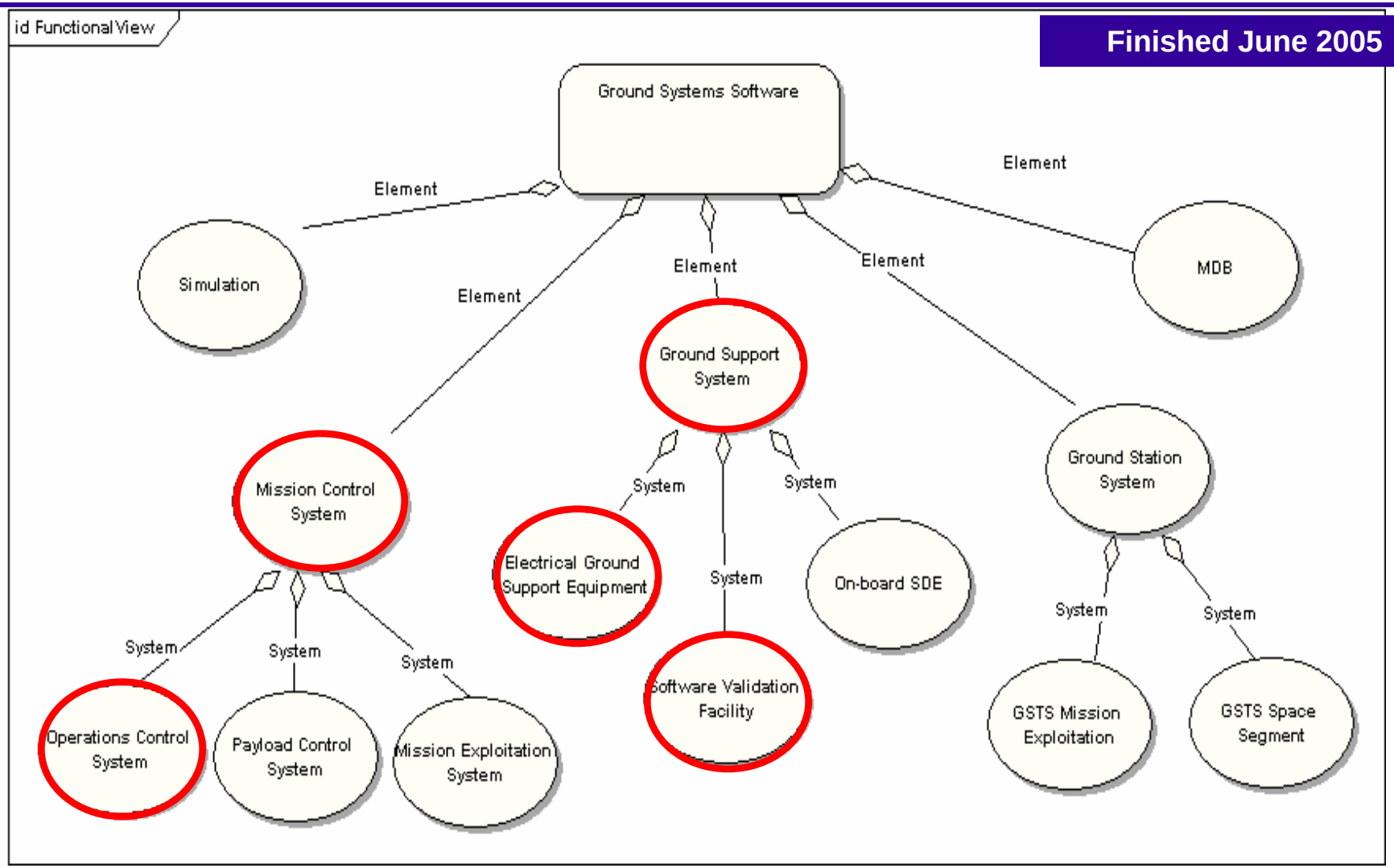
- RM-ODP - Reference Model for Open Distributed Processing is a ISO standard for modelling distributed open systems architectures.

Five standard independent viewpoints



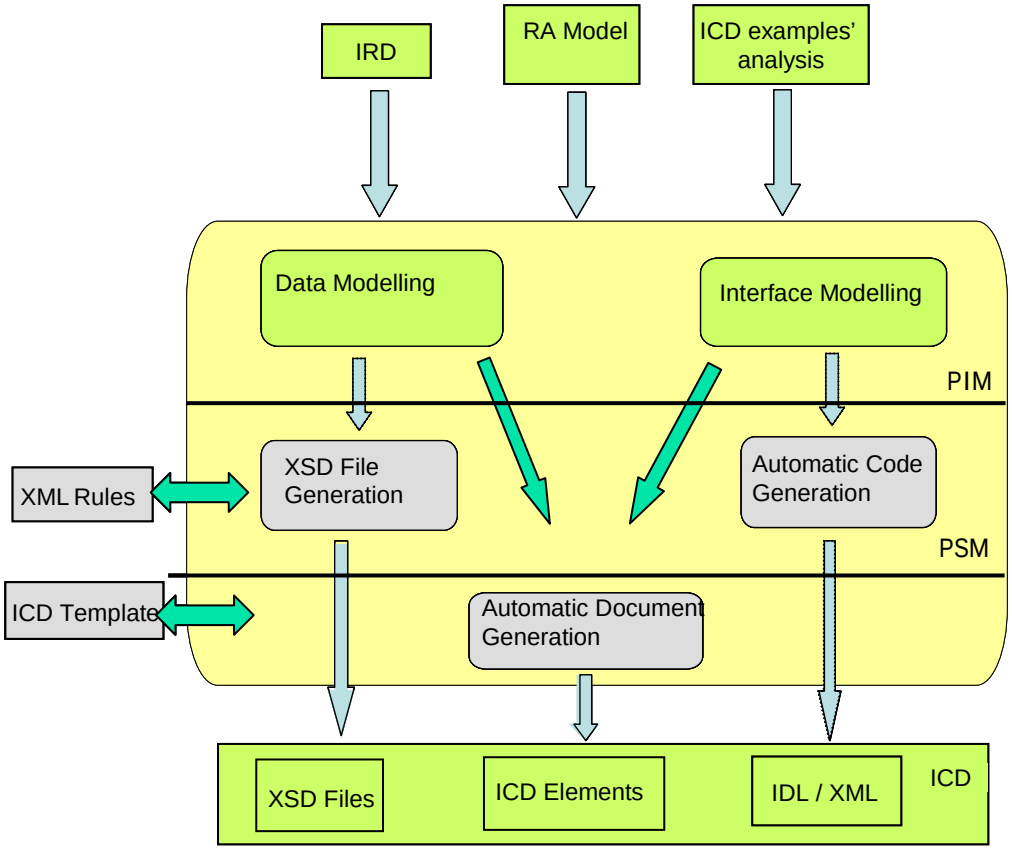
- ECSS E-70 is the baseline
- Scope: all ground segment software, including MCS, Ground Stations, EGSE, SVF FDS, MPS

Phase 1: Reference Architecture



Phase 2 - Interface Specification Methodology

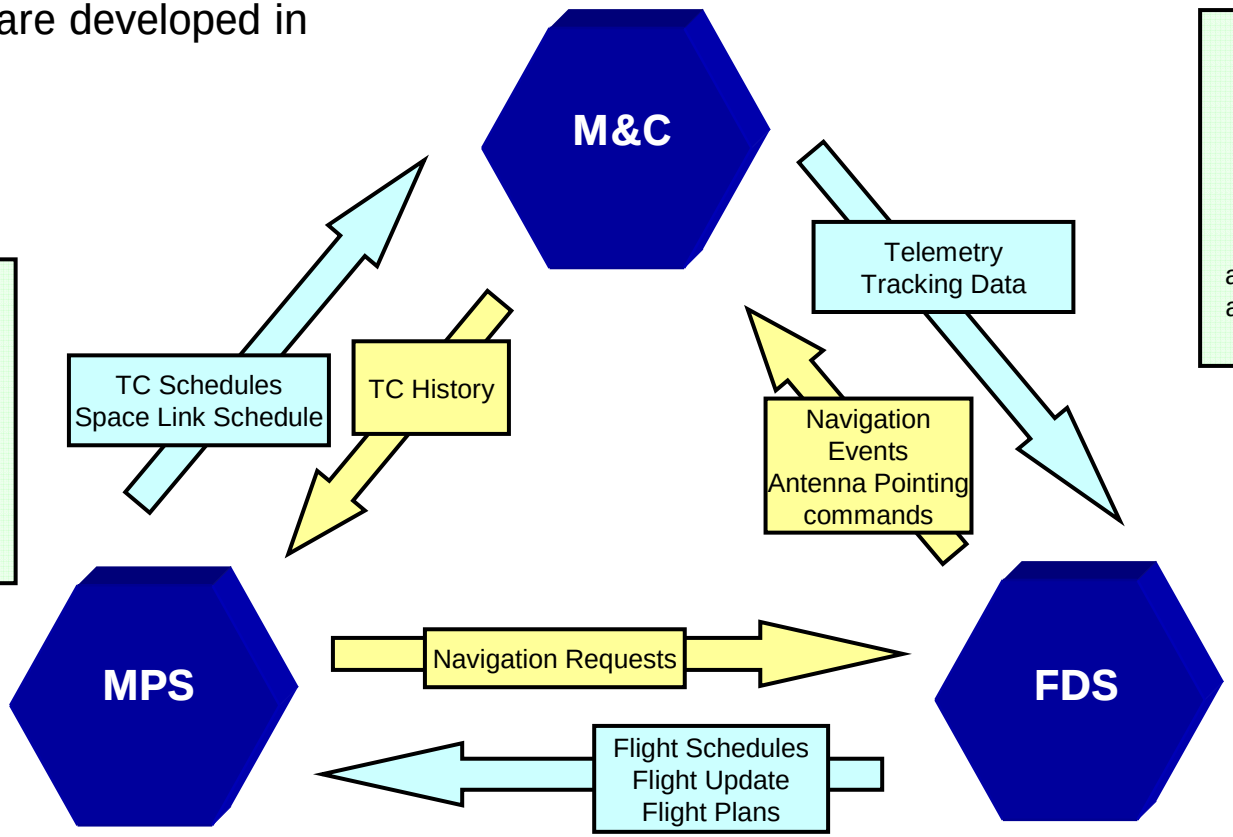
- The methodology for the interfaces specification is technology independent
- Uses the MDA architectural paradigm to model the interface and generate a specification to a specific target platform/technology:
  - **Platform Independent Model (PIM)** is modeled based in the Reference Architecture from phase 1
  - **Platform specific model (PSM)** is generated from PIM
  - Foresees the usage of transformation mappings to XML schemas and IDL
- Produces ICDs using the build-in features of the modeling tool
  - automatic document generation taking as reference the ICD templates



MODELLING TOOL: EA Enterprise Architect

Phase 2 - Interface Requirements (MPS-M&C-FDS)

The three Ground Control interface requirements are developed in coordination

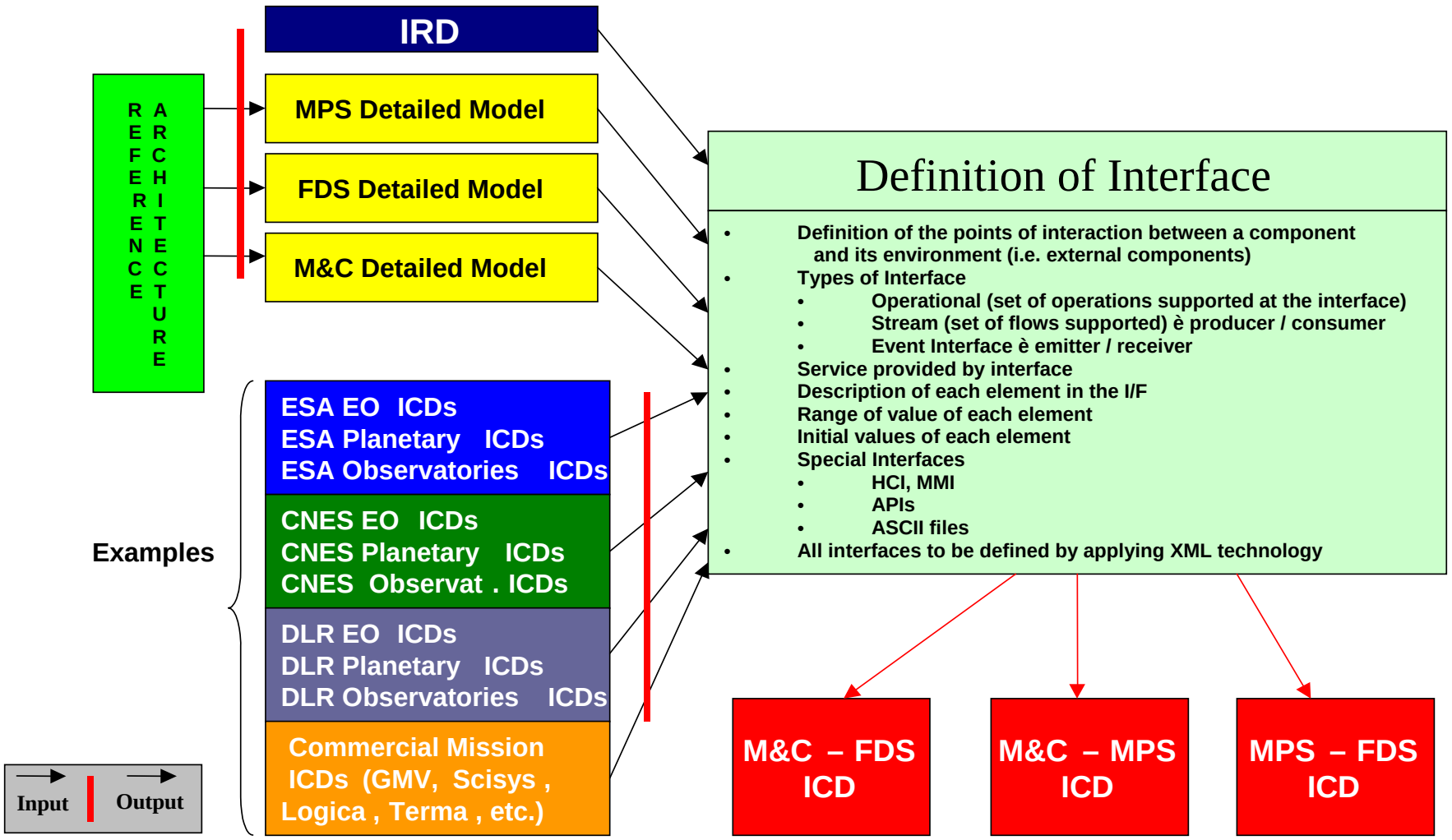


MPS-M&C
Allows MPS to send operational schedules for execution on the M&C or elsewhere. M&C provides feedback to MPS on the success or failure of scheduled activities.

FDS-M&C-
allows flight dynamics to monitor and exert control over the spacecraft flight. Additionally it allows M&C to use and distribute FDS data.

FDS-MPS - FDS receives navigation change requests from MPS and then calculates maneuvering schedule needed to perform them. This schedules are then supplied to MPS.

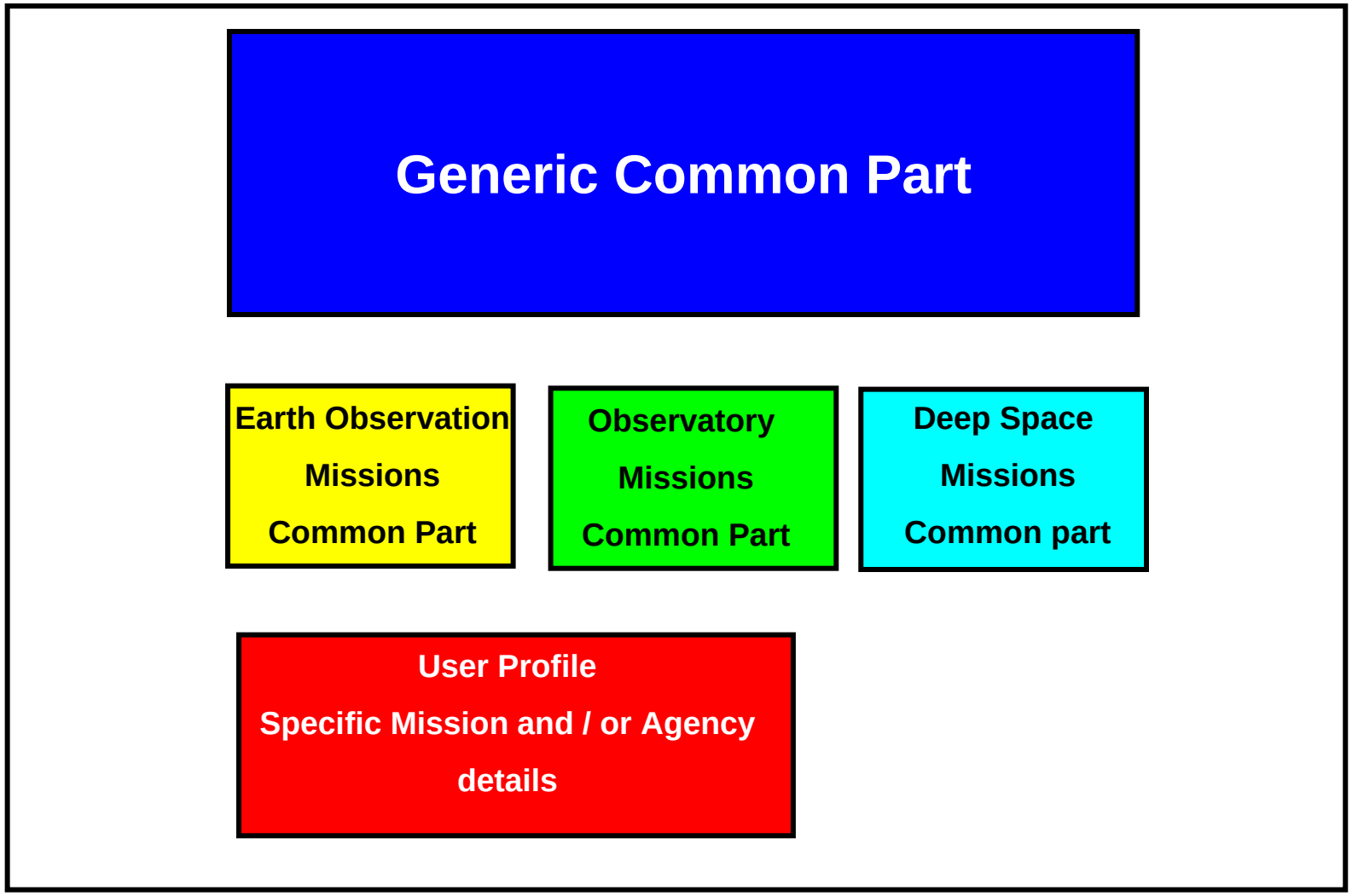
Phase 2 - ICD Process



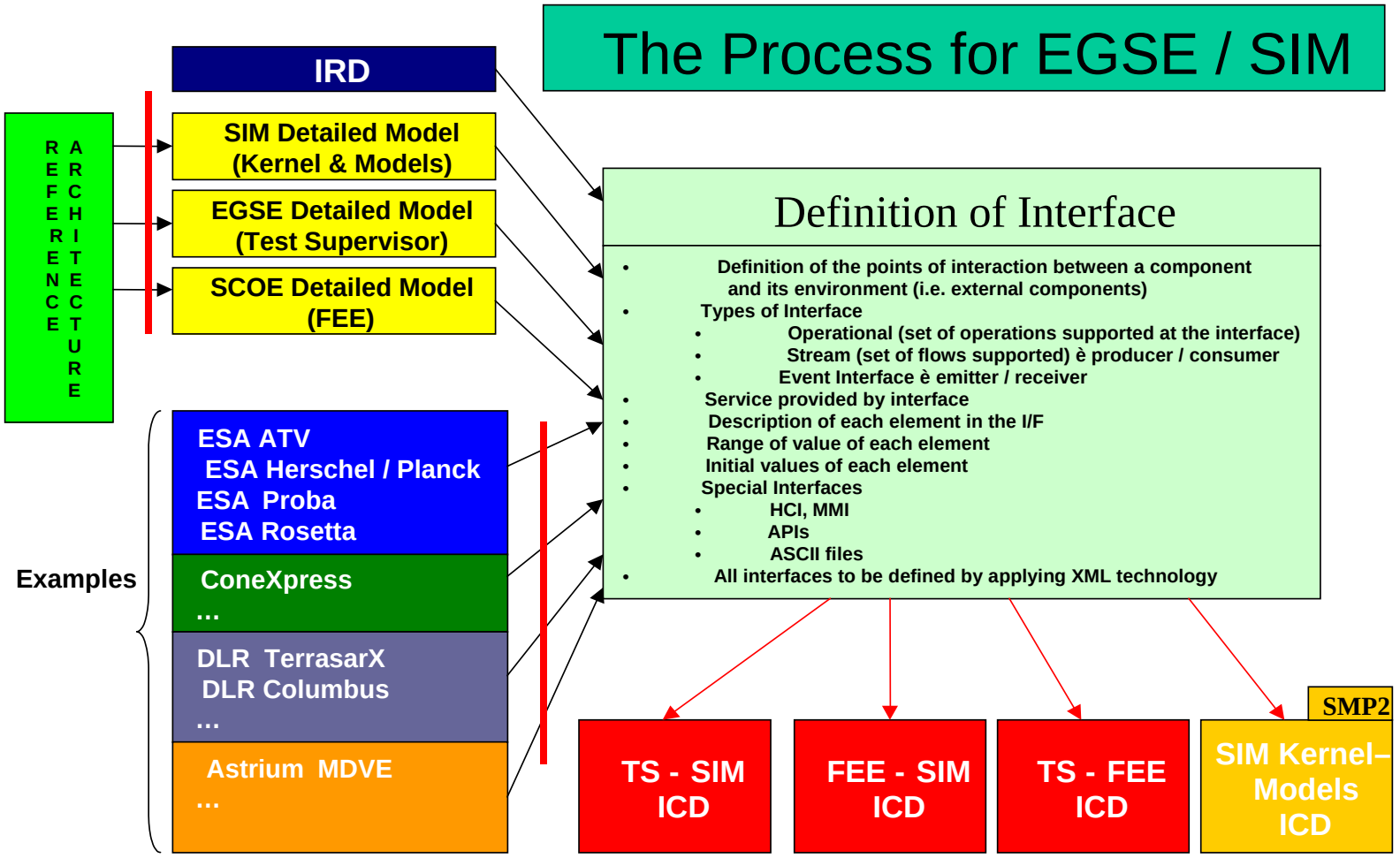
Interfaces will have

- **a common standard and compulsory part (➔ interoperability)**
- **a User Profile, which will be mission / agency specific**

Phase 2 - Typical Structure of an ICD



Phase 2 - ICD Process



Interfaces will have

- a common standard and compulsory part (➔ interoperability)
- a User Profile, which will be mission / agency specific

Phase 2 Status

- **Phase 2 started in August 2005**
  - Interface Specification Methodology completed
  - Interface Requirements Documents completed for
    - MPS-FDS-M&C Interfaces
    - Simulator – EGSE Interfaces
  - Detailed Modelling of Interfaces to be finished by end June 2006
  - Agreed first set of ICDs available by end December 2006
  - Second set of interfaces to be started in Q1 07

Phase 3 Status

- **Phase 3 to be started in Q2 2007**
  - Selection of products to be re-engineered
    - MCS
    - FDS
    - MPS
    - EGSE
  - Re-engineering to be funded by National Agencies and / or ESA

WHY WAS / IS / WILL BE SO DIFFICULT ?

- and the list is non exhaustive
  - Different interests across National Agencies, Industry, Eurospace and ESA
  - Different needs in Europe
  - Diversity of initiatives and leadership for Programmes and / or Product development in Europe
  - People interacting don't have all the same function in their organization (decision making is an issue)
  - Legacy systems are difficult and expensive to change
  - Production of standards at ECSS is a long process

WHY WAS / IS / WILL BE SO DIFFICULT ?

- and the list is non exhaustive
  - Not everything is interoperability
  - Technology push at different level across Europe
  - Industry Competitiveness
  - Evolution of needs and requirements in the long term shall be recognised and integrated at short notice
  - Not detrimental to the User side
  - Promoting and not imposing

CONCLUSIONS

- Harmonizing in Europe (or anywhere in the world) is a very complicated, dynamic and tedious process.
- Planning to finish the whole process in 3 years was too optimistic
- But every member is convinced that it is the way to go

- **It would be nice to see such a process at USA level**