

Enabling Interoperability by Enterprise Formation

Ground System Architectures Workshop 2023

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Space Safety

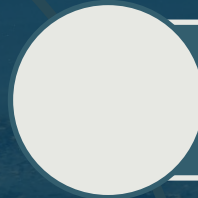


Mission Operations



Ground Systems Engineering

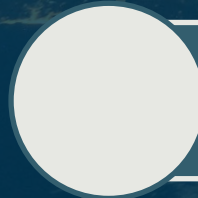




Develop multi-mission infrastructure



Perform studies, mission analysis, flight dynamics, high-precision navigation



Develop new technologies



Track spacecraft in the deepest reaches of space via our tracking station network (**ESTRACK**)

Ground System Evolution @ESOC

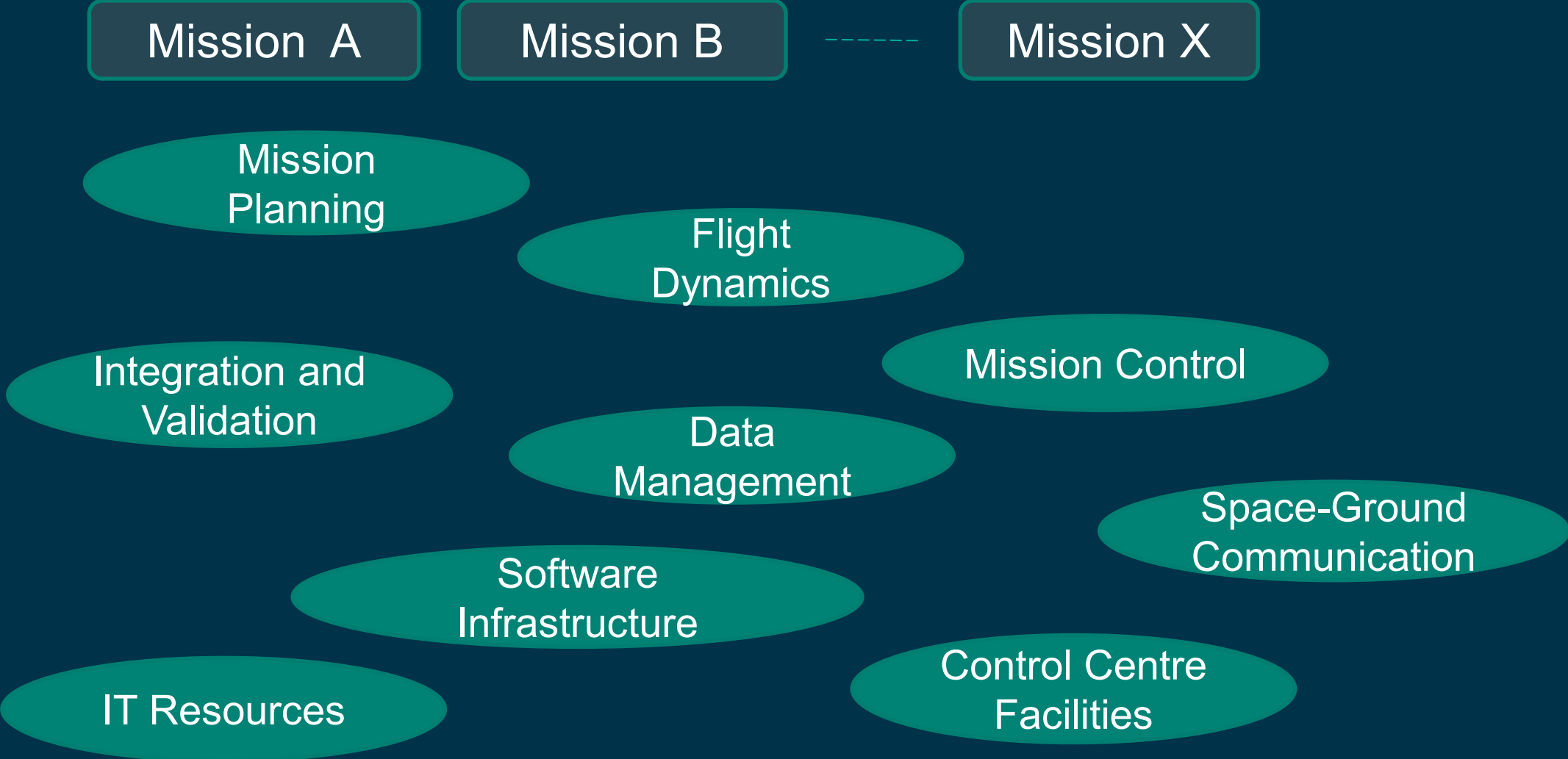


e.g. S2K, SIMSAT
Mission family products approach

e.g. EGOS-CC (MCS-CC, OPEN-M), SIMULUS-NG
Common product & service approach



The Objective: Multi-mission Services as a Commodity offered by the Enterprise



- Standardised space-ground interfaces
- Common specification of ground systems (minor mission delta)
- Generic system-to-system interfaces
- Common specification of the space segment (M&C Services)
- Implementation of re-usable library of generic software components
- 'Open' architectures that can be extended for different needs
- Horizontally layered design
- Clean separation between 'Operations' and 'Communication'
- Adoption of modern 'scalable' and 'sharable' technologies (Cloud enabled)

The 'Real Enablers' to form an Enterprise...

- Allocation of adequate funding to 'generic/multi-mission elements' development and maintenance (and reduction of the funds allocated to individual missions...)
- Introduction of 'enterprise level' governance bodies
- Cultural shift from 'mission-centric' towards 'infrastructure-centric' processes
- Set-up of a 'program tax' to fund the provision of 'multi-mission services'
- Continuous fight against the culture 'My mission is different...and is mine...'

- Managing the different perspectives of the enterprise and interoperability issues is complex
- How do all the pieces fit together? (systems, data, people, services, security, requirements, dictionaries, enterprise goals, procurement, deployment, etc.)
- Document based approach does not scale
- Model Based System Engineering (MBSE) offers an interesting approach to manage complexity – a common model that captures different perspectives of the enterprise
- We have adopted OMG's SysML & Unified Architecture Framework (UAF) as the framework for creating the variety of necessary architecture views of ESOC's enterprise
- Development of models is coordinated by a core team of System Architects and published online for review
- Design reviews have already been conducted with all stakeholders with positive results
- There are still challenges ...
 - Understanding the modelling framework is challenging for some stakeholders
 - Some stakeholders prefer paper documents and reviewing specifications in a linear format
 - Changes are difficult to visualize (not as simple as change bars in a document)

Published Enterprise Model

The screenshot displays the 'EGOS-MG System Model' web application. The main content area is titled 'Summary' and contains a table with the following information:

Characteristics	
Name	Summary
Documentation	The EGOS-MG system model presents the definition of the intended services and processes for the EGOS-MG project's deliverables as well as for the target (e.g. mission) systems which are going to be based on them.
Open in Model Editor	Summary

Below the table is a 'Content Diagram' showing a hierarchical structure of the model. The diagram includes a 'Summary' container with sub-elements like 'System Concept', 'Model Guidelines', and 'PDR Datapack'. It also features sections for 'Auxiliary Data' (Requirements, Glossary, References, EGOs-MG Profile), 'Objectives, Functional Scope, Governance Services & Processes' (Strategy, Operational, Services, EGOs-MG Objectives), and 'Solution Views' (Personnel, Security, Deployments, Resources). A 'START REVIEW HERE' callout is present near the PDR Datapack.

On the right side of the application, there is a 'Comment search' bar and a list of 11 comments, including:

- System Instance should be removed in the diagram, the middle part will be the service
- Graphical comment for Operational File ...
- Resource exchanges with IaC
- Graphical comment for System Level AIV...
- Graphical comment for DevOps Test Pipe...
- port names
- Interface notation in Rs-Tx - Systems Int...
- Graphical comment for Rs-Cn - EGOS-MG...
- Graphical comment for Rs-Tx - SIMULUS ...
- Graphical comment for Rs-Tx - EGOS-MG...
- Text comment on operational file store

Enterprise Interoperability Challenges – Multi-Mission Software

- Multi-mission software products (e.g. SCOS-2000) has been promoted for over 20 years @ESOC
- The software was not designed to be easily extensible and mission teams would take the software and fork the software with mission specific changes – adoption of new versions of products very difficult, inhibiting interoperability of the software across missions
- EGOS-MG program is promoting the move to common products that are offered as a service (AaaS) which are tailored for the mission by configuration with mission extensions added as required
- Achieving interoperability of software across the enterprise is challenging
 - Software configuration must be flexible with appropriate extension points for mission specific extensions
 - New features need to be well coordinated and ideally performed by common service team
 - Needs to be cloud friendly so that new applications can be spun up by the click of a button
- Community software approach is being adopted with well defined governance model that allows contributions from a wider community (not just ESOC) – adoption in early days
- Legacy software does not always fit well (difficult to extend, cloud unfriendly, etc.) – incremental approach is being adopted, although major updates or new developments to core software infrastructure has taken place (i.e. EGS-CC, SIMULUS, OPEN) to facilitate the new model

Enterprise Interoperability Challenges – Common Interfaces (Data, Services, Messages)

- Interoperability between systems requires common data, service and messaging interfaces
- These have traditionally been achieved @ESOC at three different levels: global standardization (e.g. CCSDS), European standardization (e.g. ECSS) and at center level (e.g. SCOS-2000 MIB TM/TC definitions)
- Good success at CCSDS level (e.g. SLE), but there has been a tendency at European and Centre level for missions to sometimes adapt interfaces (e.g. ECSS PUS for application services)
 - Loss of enterprise interoperability
 - Makes software reuse difficult as always dealing with deviations which hinders common products
- There is no easy solution to the problems, but the following helps
 - Well designed interfaces that can be extended if really needed – EGOS-MG system team involvement
 - Enterprise governance bodies to ensure proper adoption of interfaces – being put in place as part of EGOS-MG program, but still early days
 - Better involvement of operation teams with mission project teams in the definition of mission requirements to ensure interfaces are considered in the early project phases – efforts being made on six new High Priority Candidate Copernicus Missions

Thank You

