

**EGS-CC**

**System Engineering Team**

**Commonality of Ground Systems**

**Executive Summary**

Doc.: EGSCC-SET-REP-2003  
Issue: 1.0  
Date: 2013-01-31

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## 1 Introduction

This document constitutes the executive summary report of the GSP Study "Commonality of Ground Systems for Operations and Development".

More details on the study activities can be found in the Final Report, the final presentation and the output documents.

### 1.1 Scope

*The content of this final report is structured according to the following sections:*

- *Section 1: this introduction*
- *Section 2: includes an overview of the objectives of the study*
- *Section 3: presents the study team and schedule*
- *Section 4: provides a short description of the outputs of this study*
- *Section 5: comprises a conclusion on the study*

## 2 Objectives of the Study

The objective of this study is the definition of a set of building blocks comprising a common core for both EGSE and Mission Control Systems which, together with a unified data model, meets the requirements of a community of stakeholders (Agencies and space industry) with respect to space craft checkout and operations. This common core is called EGS-CC (European Ground System - Common Core)

The EGS-CC shall support the setup of Electrical Ground Support Equipments, Software Validation and Simulation Facilities as well as the Ground Segment for Spacecraft operations (Mission Control Systems, Science Operations Systems, Ground Stations etc.). The new common core shall take into account the needs for all domains and shall be maintainable as a configuration-controlled product for a long period (30 years).

The main objectives of this study are to develop arguments to justify why indeed a set of building blocks comprising such an "EGS-CC" (EGSE and Mission Control System common Core) is a viable means to unify functional testing tools and mission control systems for the next generation of space missions.

Accordingly, the tasks performed in this Study are:

- WP 2100: Perform a comprehensive domain analysis
- WP 2200: Establish User Requirements
- WP 2300: Evaluate Implementation Technologies
- WP 2400: Analyse the economic constraints of this undertaking
- WP 2500: Organisational & Industrial Issues

A summary description of the tasks performed and results achieved are presented in the next section.

### 2.1 Background for this activity

Within the European Space Industry there are many different systems for monitoring and control tasks used by companies/agencies for space system operations and Assembly Integration and Testing. Some of these systems are common to both operations and AIT, while some are specific. Often multiple systems are used during the system integration phase of a space system by different companies or at different levels (e.g. payload/system). Many of these existing systems have reached or are reaching their end of life. The systems are often using old software technologies and hardware platforms that are difficult to modernise. The maintenance and evolution costs are therefore becoming excessively complex with time. The compatibility/exchange of information with other systems is also often difficult leading to little synergy across missions and project phases.

Given the difficulties mentioned above, during 2009-2010, the European Space Agency (ESA) discussed with large European System Integrators, including Astrium Satellites, Astrium Space Transportation, Thales Alenia Space (France and Italy) and OHB System, the possibility of a collaboration to develop a European Ground Systems Common Core (EGS-CC) which would provide a common infrastructure to support space systems monitoring and control in pre- and post-launch phases. The French and German national space agencies, CNES and DLR also signalled their desire to join the initiative and a Memorandum of Understanding was finalised for the development of the EGS-CC. It was agreed that this would be done in open competition according to ESA contract conditions and processes. This would lead to the adoption of the EGS-CC for institutional missions and then for commercial missions as well.

The first phase for implementing this new EGS-CC kernel is subject of this study contract.

## **2.2 Objectives of EGS-CC**

The objectives of the European Ground Systems – Common Core (EGS-CC) is to develop a common infrastructure to support space systems monitoring and control during all mission phases including pre- and post-launch phases for all mission types. This is expected to bring a number of benefits, including:

- The seamless transition from spacecraft Assembly, Integration and Testing (AIT) to mission operations, thus maximising synergy across all mission phases
- Enable overall cost reductions by sharing development, sustaining and maintenance of a single infrastructure across organisations
- Facilitate cost and risk reduction when implementing space projects through the provision of a stable common infrastructure which can be easily tailored for the needs of a specific mission and/or organisation
- Enable the modernization of legacy EGSE and MCS systems
- Enable the exchange of ancillary implementations across organizations

The objectives of the EGS-CC are therefore very ambitious and the main system features include:

- Support of all mission types and phases
- Open, component based, service oriented architecture
- Generic and extensible functionality
- Binary compatibility
- Layered implementation
- Clear separation between generic M&C functions (kernel) and specific features of the controlled system (adaptation layer)
- Configurable level of operations abstraction
- Standardised interfaces
- Technology isolation
- Long term maintainability
- High performance and scalability

### 3 Study Team and Schedule

The study work was performed by an industrial team comprising Astrium GmbH Space Transportation (Astrum ST), Astrium Satellites, Thales-Alenia France & Italy and OHB System (see Fig. 3.1). The study schedule is shown in the Figure 3.2.

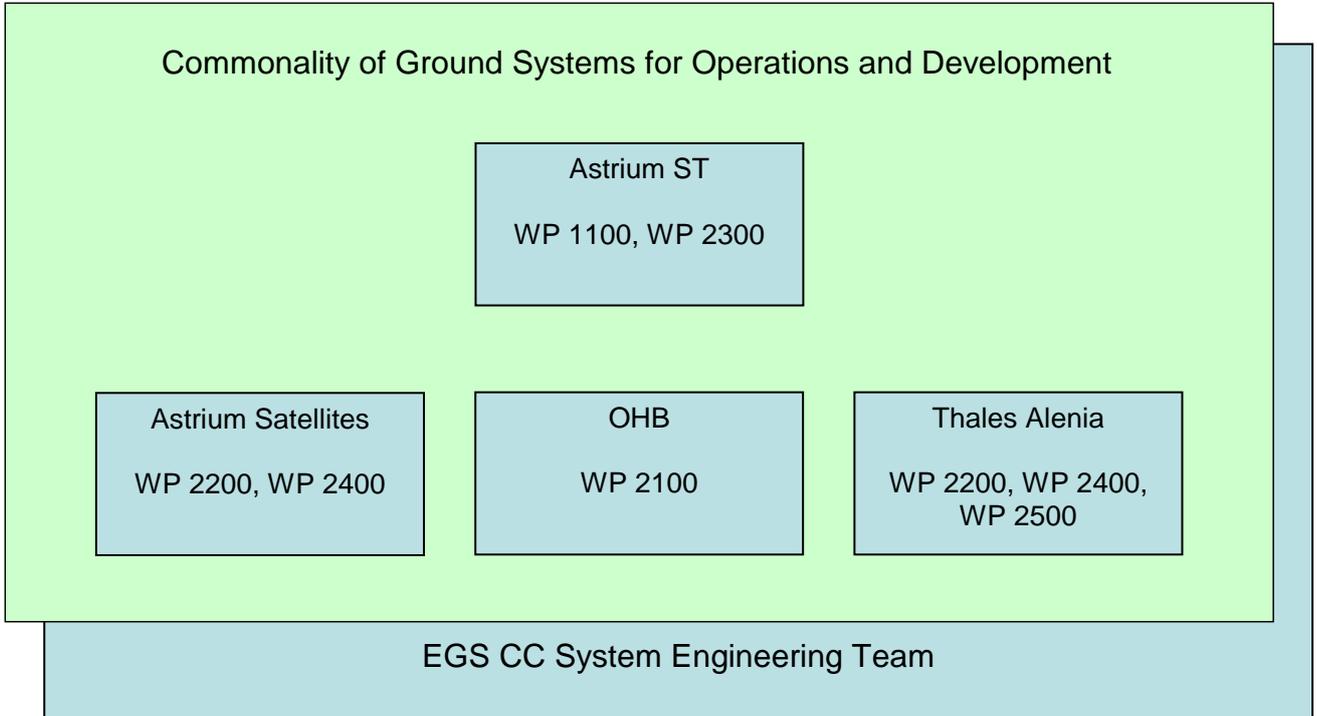


Figure 3.1: Study Team and Work-share

	2011			2012												2013		
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
System Concept Review	▼	17.-18.10																
Kick-Off Commonality Study	▼	20.10.																
Technology Workshop at ESOC		▼	8.11.															
External Workshop with SME's (ESTEC)			▼	14.12.														
Workshop #1 & #2 at Astrum Satellites Toulouse					▼	7.3.												
User Workshop for Operators (ESTEC)							▼	26.4										
SRR Data Pack								▼	30.5.									
Workshop #3: EGS-CC Cost Model (ESOC)									▼	20.6.								
EGS-CC SRR (ESOC)										▼	4.-6.7							
Release data pack for EGS-CC Phase B ITT's												▼	30.9.					
Release data pack for Phase B Technology PoC														▼	20.12.			
Final Report																	▼	31.1.

Figure 3.2: Study Schedule

## 4 Outputs of this Study Contract

### 4.1 WP 2100: Domain Analysis

The objective of this task was to

- analyze reference and applicable docs
- analyze user domains to achieve the goals of the common core
- identify and justify functions in or out-of scope

### 4.2 WP 2200: Establish User Requirements

Following the Domain Analysis, the EGS-CC User Requirements have been established after an extensive sequence of reviews and workshops with the involvement of stakeholders from Agencies and LSI contractors of the European Space Industry.

- The EGS-CC Use Cases have been derived from the usage domains
- The EGS-CC Functional User Requirements address the functions which belong to the EGS-CC functional scope. The EGS-CC functional requirements include in its current issue 743 requirements.
- The EGS-CC Non-Functional User Requirements address the constraints and guidelines to be applied for the development of the EGS-CC system, complementing the functional specification. The EGS-CC non-functional requirements include in its current issue 256 requirements.
- The EGS-CC User Requirements contained in the functional and non-functional requirements specifications have been imported into the DOORS database.
- The EGS-CC UML Model provides a repository of consistent engineering data for the EGS-CC, including the Functional Requirements, the Non-Functional Requirements, the Use Cases and the Glossary

### 4.3 WP 2300: Evaluate Implementation Technologies

The evaluation of suitable technologies for the EGS-CC was performed in four steps:

1. Identify the technology domains
2. Identify the evaluation criteria based on FURPS+
3. Perform an assessment of candidate technologies and associated products
4. Definition of a technology assessment roadmap, and a technology stack for the EGS-CC Run Time environment.

### 4.4 WP 2400: Analyse economic constraints

The work package focused on providing a cost model for the common EGS-CC software to support later management decisions, and was conducted in three steps:

1. Identification and definition of the cost elements, and cost benefits.
2. Workshop #3: discussion with stakeholders from the Space Industry and Agencies who had had responsibility over significant development projects

3. Consolidation of cost model with EGS-CC Steering Board.

#### **4.5 WP 2500: Organisational & Industrial Issues**

After re-allocation of the work package content, a EGS-CC security requirements analysis has been performed in three steps:

1. Security requirements in EGS-CC and ESA EGOS documentation.
2. Security requirements in EGS-CC requirements and CNES ISIS documentation.
3. Establishment of consolidate security requirements for EGS-CC.

## **5 Conclusions**

The first and main conclusion from this study work is that the development of the EGS-CC is feasible and beneficial as shown by the outputs of this study.

With the completion of this commonality study a solid baseline has been established for the next phase (Phase B) of the EGS-CC by providing this data set:

- EGS-CC User Requirements: use cases, functional requirements, non-functional requirements including the DOORS database and the UML Model
- Domain Analysis
- Technology Assessment
- Security requirements analysis
- Cost Model

The primary goal being the definition of a new generation of ground systems commonly understood and agreed by the European Space Industry and Agencies could be achieved thanks to the engaged work by the study team and the associated EGS-CC System Engineering team. The workshops and reviews have been supported not only by the study team and SET, but also involving important stakeholders from industry and agencies.

The level of detail reached in the output documentation is very high (in total 998 functional and non-functional requirements). All domains have been analysed and taken into account. Technologies for development and implementation have been analysed with important feedback from the industry (LSI's, SME's and operators). Special emphasis was spent on the analysis of security requirements to be prepared for applications of this new generation of ground systems outside the space business. The results of the cost analysis and workshop have already been used to prepare for the next phases towards the realization of the new ground system infrastructure based on EGS-CC.