EXECUTIVE SUMMARY REPORT

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1. INTRODUCTION

1.1. Purpose and scope

This document presents the achievements of the Digital ground segment management through integrated MBSE and IT provisioning (MBSE-IT) project, undertaken by CGI Estonia, CGI Germany and SpaceCube.

1.2. Acronyms and abbreviations

Acronym	Meaning
CoCKPIT	Configuration, Change, Knowledge, Problem, Incident management Tool
DASP	Data Systems Plan
ECB	ESTRACK Configuration Database tool
GSEF	Ground Segment Engineering Framework
MBSE-IT	Digital ground segment management through integrated MBSE and IT provisioning
SFRID	Station Facilities Interface Requirements Document
UCMDB	Universal CMDB

2. CONTEXT AND OBJECTIVES

In many organisations and agencies, the teams developing the ground segment system software (software for mission data systems, flight dynamics, ground station systems, …) are distinct from the teams provisioning and maintaining the physical or virtual IT infrastructure, including the baseline operating system and packages/dependencies, on which the software runs.
As a result, information such as which physical or virtual resources are supporting which mission on which infrastructure baseline version and with which version of infrastructure or mission-specific software is loosely coupled and not easily queried. Moreover, as the ground segment moves to a service-oriented and multi-mission architecture, multiple missions may rely on the same physical or virtual IT resources.The main objective of MBSE-IT was to provide a digital link between ground segment systems and the infrastructure on which the software is deployed, this includes:

- analysis and improvement of existing approaches to capturing software system deployment information within ESOC;
- extension of the GSEF system models to capture the physical architecture / deployment viewpoint;
- providing a query-able mapping of functional models/software to the associated physical IT infrastructure (including the networking elements);
- the integration of the resulting modelling environment with external information sources and other domain specific tools.

3. MAIN ACHIEVEMENTS

In order to identify the needs, selection of tools for IT management in ESOC (DASP, CoCKPIT/UCMDB, and ECDB) and missions were analysed. The selection was done in cooperation with ESA based on the relevance to this study. The objective was to generate requirements for the MBSE-IT framework in the context of ESA Ground Segment Engineering processes and to provide justification to the software development choices to be made. It is important to note that not all requirements derived from the analysis were a final commitment of their respective implementation - the project followed an agile methodology where requirements were implemented according to the defined priority by the customer.IT management tools were analyzed and described, including the their respective data model, and the proposed requirements for the MBSEIT framework.Three SCOS missions were chosen to be analyzed in order to collect feedback on a set of use cases for the MBSE-IT project. To ensure representativeness across the different mission families, the chosen missions are all from different families (Astronomy & Physics, Earth Observation, and Interplanetary & Solar Systems). The following list presents the agreed SCOS Missions that were analyzed (and interviews conducted) followed by their respective mission family:

- EUCLID - Astronomy & Physics
- AEOLUS - Earth Observation
- SOLO - Interplanetary & Solar Systems

The analysis was based on a set of documents received for each mission followed by an interview. The goals of the interview were to:

- understand the deployment of the missions and how it is documented,
- discuss what information is most relevant and required to be document and obtain around the deployment of functions and interfaces,
- collect feedback on which related use cases are most relevant to be supported by the MBSE-IT project,
- collect feedback on the what is required from the MBSE IT implementation for the function to be used.

MBSE-IT provides an extension to the GSEF, which in turn provides the underlying collaboration and modelling capabilities. GSEF updates include:

- **MBSE-IT Library:** The original GSEF Core library does not have types for describing hardware, networks, and various environments, where the software should be deployed. The Core library has been updated in order to enable mapping relations between service and performers. The new MBSEIT library was created in order to represent software deployments as well as multimission resources.

- **SFIRD Library:** The new SFIRD library was created in order to faciliate the creation of the SFIRD documents. The document template is included as part of the library and can be used to automatically generate the data.
- **Example MBSEIT project:** An example project was created in order to demonstrate and verify updates to the code base and metamodels. MBSEIT project can be created using the esa.adge.services.mbseit-create module. The example project includes Core, MBSEIT, and SFIRD libraries. The project is filled with data that demonstrates new relations and types from new libraries. In addition to this, the project contains two example documents: SFIRD and Freeze note.
- **UI Config propagation from libraries:** Each library defines new types and therefore requires library specific UI configuration. The system was updated to allow the definition of the configuration as part of the library. Moreover, it is possible for a project to include several libraries which each has a different UI configuration. In this case, the system gracefully merges the configurations in order to avoid conflicts between libraries.
- **Sharing table views from the libraries:** The query functionality is a powerful tool to aggregate data into a single table. However, various projects might need the same table and thus the table has to be defined for each project individually. The system was updated to allow the definition of tables as part of the library which allows the table to be defined once and then to be included automatically in all the projects containing the same library.
- **Derived relations in UI configuration and web interface:** The system allows to define complex relations between elements. One way of displaying such relations is to use the query functionality. However, this approach makes the working flow cumbersome. The updates to the system allow the definition of such derived relations as part of the UI configuration. As a result, derived relations can be displayed in the property editor view and can be used to easily navigate between different project elements.
- **Server side jobs:** Server side jobs were added to the system in order to allow the creation and execution of plugin-like processes on the projects from the server. Such server side jobs have to be specifically created for the GSEF system and deployed by the system administrator. The plugins might be created to integrate the project with external task tracking systems (e.g. Jira), or testing environments. Another possibility is to use this plugins to automate some tasks or to fetch data from external systems. If the system administrator has registered the plugin, then the system user is able to define a job in the Jobs view. After this the job can be triggered any time.
- **CoCKPIT CSV Importer Job**: CoCKPIT (Configuration, Change, Knowledge, Problem, Incident management Tool) is used for storing and maintaining the information about any item present in the Configuration Management DataBase such as the actual deployment of software/hardware

baselines, systems, and network information for missions (i.e. which configuration is deployed for a particular mission). The data exported from CoCKPIT can now be imported into the GSEF using the CoCKPIT CSV Importer job. It is a server side job created specifically for parsing the data and preparing the csv files and attribute mapping files for import into the GSEF.

4. CONCLUSIONS

The core objective of MBSE-IT was to provide a digital link between ground segment systems and the infrastructure on which the software is deployed and it was implemented by the definition of a physical deployment model for the system as a dedicated viewpoint on the overall system model for the ground segment. The MBSE-IT activity outcome aids the provision of a holistic view of the system with traceability across functional and logical architecture through to physical architecture, offering a single source of truth for the overall system design, configuration, and deployment, including software and operating system baseline versions. It enables improved resource utilization forecasting and clarity on deployment plan and deployment status and provides the ability to have a machine-readable and query-able, bi-directional link between IT systems and ground segment software deployment. It can make queries based on the information of the model which will be developed / extended and enables impact analyses of unavailability of systems e.g., of planned or unexpected downtime or of security incident occurrence on IT infrastructure verses the resulting mission / functional impact.The software changes are implemented as updates to the GSEF and an additional domain model library for MBSE-IT is provided with the GSEF source code and available in the deployment. The latest version of GSEF is available on the ESA CoDev Platform.