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The Egyptian Space Agency (EgSA) Concurrent Design Facility

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ABSTRACT

The Egyptian Space Agency (EgSA) is currently developing its Concurrent Design Facility (CDF) to support the definition and the feasibility assessment of its future space missions. The EgSA CDF is located in the complex of New Cairo where the EgSA is located, as part of the developments and considerable investments done by the government in that area. Starion Group (at that time RHEA Group) was contracted by the Egyptian Company iTechs to support them in the definition, implementation, and operations of the facility. Starion support to iTechs and the EgSA includes not only the definition of the Concurrent Design Facility but also the provision of the Software, CDP4-COMET, together with training and pilot programs to ensure EgSA personnel and industry will have the right capabilities to use the facility at best for the benefit of EgSA future missions. This paper is going to provide details on how the Project is structured, the current status and details on the current design of the EgSA CDF. The paper will include lessons learned about designing and implementing a CDF from scratch, and with much less constraints on the design than previous CDF introductions Starion Group has supported in the past in for instance marine industry and defence organisations. The Project starts with a requirement definition phase and a number of on-site visits from the Starion team to the EgSA premises to get familiarity with the location and available room and space distribution to define the new facility. The design of the EgSA CDF takes inspiration from the ESA CDF and includes analysis of new equipment currently on the market while keeping consideration of the scalability possibility and especially project time and budget constraints for the physical facility developments. This enables us to better embed the design in the physical space compared to CDF facilities that have to fit in an existing space. The current assessment includes provision of all the main CDF functions in the short term while ensuring the proper implementation of the Concurrent Design process. A main feature of the current design is the scalability possibility in case of future upgrades and additional functionalities. Once the EgSA CDF infrastructure will be ready to use, Starion Group will provide support in the installation and customization of the CDP4-COMET tool, widely used for Concurrent Design and MBSE applications, and as known, in the ESA CDF. The CDP4-COMET installation will allow the initiation of the Concurrent Design Sessions in the newly built facility starting with training session for the EgSA and Industry personnel followed by Pilot Programmes with the support and leadership of Starion Group experts. The Project has a duration of one year and is planned to last until the end of 2024 with possible extensions due to the longer construction work required at the EgSA premises. In the paper we will elaborate on the lessons learned from this transition with respect to the facility, the process, the modelling platform and the cultural adoption.

DESCRIPTION OF THE ACTIVITY

Starion is supporting iTechs to provide a mix of services, training, consulting to support the initiative in developing and exploiting a Concurrent Design Facility to support Egyptian/African Space Missions at the EgSA. To operate a full Concurrent Design Facility and reap the benefits of such facility, five pillars must be in place:

• A Multidisciplinary Team: In Concurrent Design we work with a Multidisciplinary team of experts that we call 'Subject Matter Experts' These experts are domain experts and trained in the concurrent design method and software. Furthermore, we need presence of the client and key decision makers in the study. Finally, a support team guides the team of experts. This support team typically consists of a System Engineer, a Team Lead and a System Assistant.

• The Concurrent Design process: In Concurrent design we work according to a specified process with an initiation phase, preparation, a sequence of weekly sessions and a closing phase. Organisational embedding of this process is a critical success factor.
• The Concurrent Design Facility: To work effectively, CD requires a facility consisting of hard- and software as well as a network and infrastructure.
• Methods and tools for decision support: To support the team in their effort, the method offers a library of decision-making tools and techniques.
• Software and skills to develop an integrated design model: This model is a conceptual representation of the design and is used to offer the team a single point of truth for fact-based analysis of the integral aspects of the design. The software allows all subject matter experts to manage and update their information in real team, and to share this information with the team.
Figure 1 provides an overview of the proposed Work Breakdown Structure to support the EgSA to realize the 5 pillars. The following high-level work packages can be identified:

• WP0000: Project Management
• WP1000: CD Facility Consulting
• WP2000: CD Process Consulting
• WP3000: COMET-EE licenses

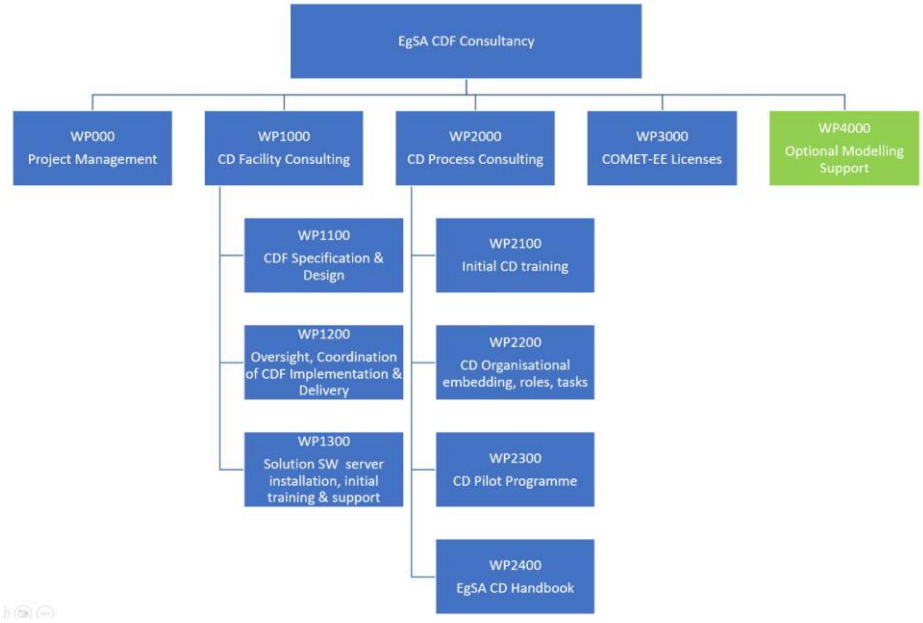

Fig. 1. Work Break-Down Structure

The purpose of the **CDF Specification and Design Work Package** work package is to create a requirements specification and high-level design of the interior setting and IT infrastructure of the EgSA CDF. These activities will be performed in close cooperation with the implementation manager of the EgSA as well as the system integrator that will implement the CDF. The contact with the implementation manager is required to make sure the requirements are validated, the contact with the system integrator is required to cross check the feasibility of the requirements (vis-a-vis cost and lead times) and the validity of the design.

The purpose of the **Oversight, Coordination of CDF Implementation & Delivery** work package is to advice on the CDF implementation as is documented in the requirements specification and design documentation. The Starion expert(s) will require close contact with the EgSA implementation manager as well as with the system integrator. The activities executed during this work package include:
• On-site observation of the construction works related to the CDF implementation
• Perform off-site observation of the construction works related to the CDF implementation via web conferencing.
Report to the EgSA Implementation Manager on the status of the implementation and advice on implementation solutions and improvements.
The Starion expert will be available on-site for one week at a time. A total of four trips are proposed and included in the travel plan. The remainder of the time the Starion expert will be in contact with the EgSA implementation manager and local System Integrator via telephone, web conferencing tools and email.

The purpose of the **Solution SW server installation, initial training & support** work package is to support the SW solution and server installation as well as an initial COMET administration training. Starion will provide the COMET Community Edition to the EgSA which will be supported for the duration of the activity. The COMET software needs to

be hosted on an operational environment. The COMET server, which acts as central repository, needs to be hosted on a server (a virtualized environment is recommended). The COMET server can be hosted on premise or using a local cloud provider, including Microsoft Azure or AWS. Starion offers installation support as well as a training for server management. After the activity the EgSA can decide whether to move forward with COMET Enterprise Edition which is provided with a support contract.

CD PROCESS CONSULTING

For a team to become proficient at Concurrent Design a 1-week training program is offered in which the various aspect of the methodology is explained. This will make sure the team has a detailed understanding of the success factors and effects of the approach. During this program we will explain the approach in detail and explore the implications of the CD approach to system engineering. This initial training will include training on the basics of COMET™. The training will be delivered by 3 Starion Concurrent Design experts.

A successful embedding of the approach and the facility is crucial. Based on existing documentation such as the EgSA organization chart, organization description and several (offsite) interviews, we will go through the tasks and responsibilities that need to be organised to manage and effectively use the facility. This will be an important basis for budgeting and staffing of the facility. The results will be documented in the CD Implementation plan.

Starion is planning to perform 3 distinct Concurrent Design studies to further embed the CD process in the organization. Depending on the speed of procurement and realization of the facility these pilot studies can be executed on site in het CDF or in a 'temporary set up'. With professional support from the Starion team, these initial studies will help the facility to create a first benchmark success.
The approach per pilot study, is to perform 6 collaborative working sessions, spread over 3 weeks.

Starting from the Starion CD Handbook a customized version will be created that is adapted to the organisation and processes of the Egyptian Space Agency. The resulting handbook can then be used by the Agency make sure the process is followed and repeatable for the subsequent Concurrent Design activities that will be performed in the new facility.
Next to the handbook, Starion will also create EgSA specific CD Procedures, Templates (agenda, reporting and presentation) as well as CD checklists.

COMET

COMET™, is the main engineering tool to support multidisciplinary teams to perform Concurrent Design in cooperation with and participation of the customer. It provides all the required integrated design and modelling capabilities to support the multidisciplinary team in their collaborative work, allowing them to come up with a solution for the customer, taking the full life cycle perspective of the system into account. COMET™ is an implementation of ECSS-E-TM-10-25A Annex A, Annex B and Annex C.
ECSS-E-TM-10-25A is a technical memorandum, under the ECSS-E-10 System Engineering in the engineering branch of ECSS series of documents, defines the recommendations for model-based data exchange for the early phases of engineering design; it is the foundation of COMET™.

COMET™ provides 7 major software components:
• COMET-IME (Integrated Modelling Environment): A windows desktop application that allows a user to interact with the COMET™ information
• COMET-Excel Add-in: A Microsoft Excel integration that allows a user to interact with a subset of the COMET™ information from within excel. The Excel Add-in is distributed together with the COMET-IME
• COMET-Web: a web application that provides various dashboards that provide insight into the status of a model including a simplified 3D geometry.
• COMET Server: the application server and database that stores all the information and provides a JSON REST API; COMET -EE includes LDAP authentication.
• COMET C# SDK: A C# software development toolkit that allows developers to build COMET™ integrations using the C# language
• COMET Java SDK: A Java software development toolkit that allows developers to build COMET™ integrations using the Java language
• COMET Typescript SDK: A Typescript software development toolkit that allows developers to build COMET™ integrations using the Typescript language.

COMET-CE (Community Edition) is distributed with an open-source license and is distributed free of charge and support is provided based on availability of the Starion team which cannot be guaranteed. The COMET-EE (Enterprise Edition) is distributed with a commercial license and Starion support is guaranteed.

Starion develops so-called Domain Specific Tool integrations with the COMET™ ecosystem. Domain Specific Tools are tools (software applications) used by the various engineering domains that make up a Concurrent Design Team and benefit from an automated link/data exchange with the COMET™ server. The following tool integrations have been developed:

• Capella
• MagicDraw – SysML
• Enterprise Architect – SysML
• STEP-TAS (for integration with ESATAN-TMS)
• STEP-AP244 – STEP 3D CAD (for integration with 3D modelling environments)
• Catia v5
• Ecosim Pro
• Matlab
• ASTOS

These tool integrations are available in the public domain, except for the ASTOS integration which is only available from ASTOS solutions. The integration does not include the tools themselves; these will have to be acquired from the respective suppliers.

Figure 2 provides an overview of the typical domains of expertise for Space Mission Design and a non-exhaustive list of engineering tools used by those domains.

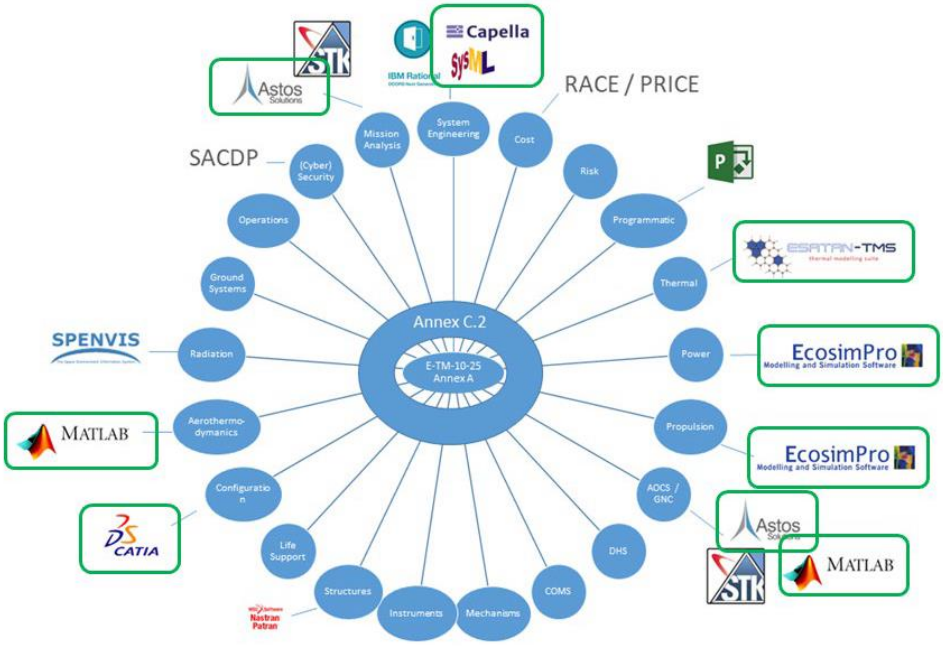

Fig. 2. Digital Engineering Hub

TRADE-OFF FOR EQUIPMENTS AT EGSA CDF

CURRENT STATUS OF THE PROJECT

The Project is currently in break between the two phases. At the end of 2023 Starion performed an on-site visit in Cairo to assess the location where the CDF was supposed to be built. After the visit design documentation has been developed with continuous interface to iTechs and EgSA teams in order to define the best architecture and items to be fulfilling the EgSA needs while meeting budget constraints. The Phase 1 of the project has been completed with delivery of the related deliverables: Bill of Material, Requirement List, CDF Design.

Construction work in the EgSA room has been completed in terms of electrical cabling and infrastructure. The next step is the procurement and installation of the workstations. It is expected the Facility to be ready by the end of 2024 with a Phase 2 of the project to start at the beginning of 2025.

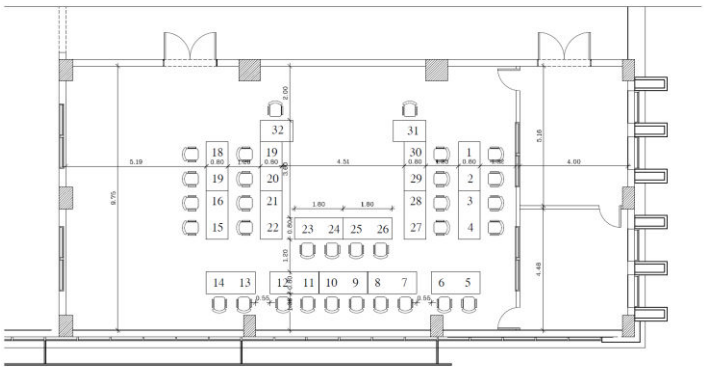

Fig. 3. EgSA CDF room layout

CONCLUSIONS

The main challenges to develop a new Concurrent Design Facility like in the case of the EgSA is related to the need for clarity of the requirements and the objectives that want to be met. It is also very important to build awareness of the available equipment on the market in a way to create the right amount of customization in accordance with the available budget. The main recommendation for any organization willing to building their own CDF is to have a scalable approach, even if budget constraints at the first version of the Facility is allowing limited functionality or customization, scalability can give the opportunity to apply modifications in case of new budget availability and/or technological innovation.

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