**A Concurrent and Collaborative Design Facility for End to End Space Mission modelling and design: an integrated approach from mission requirements to satellite operations and service delivery engineering**

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**Abstract**

Since the early definition of a Concurrent Engineering Facility for Space design and modelling, this environment has never been extended and properly tailored for studying Space Missions deeply considering also the Design of the Ground Segment (G/S), the Satellite & Mission Operations and the Science Data Services. Thus, the objective of this engineering research work is to describe the applicability of the Concurrent Engineering (CE) concept to the design and Feasibility Studies of a complete Space Mission, thus including also the Modelling, the Design aspects and configurations related to a complex System based on a single satellite or a satellite constellation, on the Ground (Control/Mission/User) Segment and the related Satellite Operations. Starting from the heritage of some previous works about the exploitation of Model-Based System Engineering approach for the Satellite Ground Segment, a sort of tailoring of a complete CDF has been carried out in *TELESPAZIO Company* (TPZ) by considering a concept analysis based on the following main key segments: Process, multidisciplinary Team (People), Integrated Design Model and Tooling, Facility and overall novel IT Infrastructure.

In this context a deep assessment of the SE processes, Expertise and Domains vis-a-vis the common practice related Tools has been performed at central level in TPZ.

Starting from this analysis, TPZ has improved its awareness of System Engineering (SE) needs tailored for its Lines of Business (LoB) organization across different Countries; in particular:

* LoB Satellite Service Operations: involved in: i) ​​SatNav missions definition and GNSS downstream services, ii) Earth Observation (EO) G/S Payload Data Ground System (PDGS) design, iii) end-to-end Integration Verification, Validation & Qualification (IVV&Q) activities, iv) Satellite Operations (Launch, Commissioning, Station-keeping) and orbital manoeuvres procedures, v) Integrated Logistic Support, vi) In-Orbit Services, vii) Precise Orbit Determination services (POD), future Space Traffic Management and Situation Awareness engineering;
* LoB SatCom: involved in the activities of Communication link budget analysis and design & IVV of: i) Satellite Communication Networks, ii) Ground Data Networks, iii) Earth Station & Teleport, iv) Communication on-the-move service, v) Hybrid Networks systems/services;
* LoB Geo-Information: focused on the activities of: i) Mission Definition & Requirement Analysis phases for new and existing EO missions, ii) management of the User Ground Segment tailored on the GEO-Information Stakeholders needs (e.g. including IMINT, GEOINT), iii) configuration & tasking of the EO PDGS, iv) Science Data Services processing, bid-data analytics and v) Community Data Delivery/dissemination services.

In particular TPZ, with the support of the *e-Geos* *company* (controlled by TPZ and Italian Space Agency), is leading new concept modelling & analysis devoted to deepen the feasibility study of new Missions able to match new coming stakeholders needs, thus requiring a structured model-based approach applied to CubeSat/NanoSat constellations systems, which of course includes the Ground Segment, the Satellite, the Launch & Mission Operations and mostly the Science Data processing and delivery Services. At this aim, as well known, a Modelling & Simulation Based SE (M&SBSE) approach would also support the developing of an end-to-end system model carrying on the whole project, from the stakeholders requirements and initial design & prototyping to the decommissioning and the life-cycle system operations phases. It is an integration of discipline-specific system engineering models and simulations.

The abovementioned Telespazio’s ambitions led to launch an internal study for a concurrent and collaborative environment embracing the space missions, the launch segment, the ground & user segment and the service operation segment, with a clear goal to improve the study (Phase 0 / A-B-C) of different space missions in every aspect, thus allowing the different partners to actively collaborate on the project thanks to the TPZ facility. Therefore, a new Concurrent & Collaborative Design Facility (C2DF) architecture has been defined and finally proposed by the TPZ SE department, fostering the future opportunity to allow the modelling and design of Ground Segment, Satellite & Mission Operations and Science Data Services to become part of the traditional Concurrent Engineering activities for an End to End Space Mission Modelling & Design.

Finally, in the present paper the novel architecture framework of Telespazio Concurrent & Collaborative Design Facility relying on an innovative Virtual Machine infrastructure will be described.