

# A robust development process for space SW projects

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**Abstract**—The selection of an effective software development process is a crucial element in any space SW project. The waterfall software life cycle model as is can not provide an adequate solution to their relevant complexity and central role in the elicitation of spacecraft system-level requirements. Its main assumption of moving into a phase only when the preceding one is mature and complete is actually not attainable. In this paper, a tailoring of the waterfall model (named “Robust Feedback Software Life-cycle Model”) is presented. The proposed process sorts out these issues by combining a SW waterfall model with a SW incremental approach. It is currently used in satellite SW projects at OHB System AG. SW product metrics gathered from real SW space projects bear out its effectiveness and robustness against SW requirement evolution.

**Keywords**—SW development life-cycle models; Space SW projects; ECSS standard; SW baseline management.

## I. INTRODUCTION

The definition of the SW life cycle paradigm is one of the major tasks to be performed at the very beginning of any space SW project. The European space community usually adopts from the engineering activities the ECSS-E-ST-40C [1] (which defines the principles and requirements applicable to space software engineering) and the ECSS-Q-ST-80C [2] (which defines the principles and requirements applicable to space software product assurance). They are applicable to all the SW items within space flight and ground systems and cover all the space software engineering aspects. The ECSS requirements are usually tailored according to the associated SW criticality levels, ranging from Level A (software whose anomalous behavior would cause or contribute to a failure resulting in a catastrophic event) up to Level E (software whose anomalous behavior would cause or contribute to a failure resulting in a negligible event). Even though the ECSS-E-ST-40C standard does not prescribe a specific software life cycle, the waterfall model seems to be the privileged choice. This process can offer a systematic approach and is in line with the spacecraft/system level reviews. However, in space SW projects, the underlying principles of the waterfall model are usually not fulfilled since it is challenging to finish a development phase before moving into the next one. The overall SW development is time-critical and it is usually necessary to have a software available as soon as possible in order to support the overall satellite integration and testing activities. SW preliminary versions are indeed

needed in advance by different stakeholders. Additionally, they contribute to elicitation of the complex upper-level system requirements (for instance spacecraft failure management concepts).

In this paper, the SW waterfall paradigm has been combined with a SW incremental development approach in order to exploit their benefits and counterbalance their flaws at the same time. The proposed methodology is referred to as “Robust Feedback Software Life-cycle Model”. It draws on real space SW projects currently carried out at OHB System AG, such as the application SW running on the Meteosat Third Generation (MTG) satellite on-board main computer. The paper has been organized as follows. Section II compares plan-driven and agile development processes and accounts for the motivations of the proposed approach. Section III presents the principles of the Robust Feedback Software Life-cycle Model including some more concrete information derived from real space SW projects. Section IV presents some SW product metrics and gives some hands-on evidence of the benefits derived from the adoption of the Robust Feedback Model in MTG. Finally, section V concludes the paper.

## II. BACKGROUND AND MOTIVATION OF THE PROPOSED METHODOLOGY

The study on how to organize phases, people and resources along the development and the evolution of complex SW applications has been a main focus of software engineering since its inception [3]. Since then, several models and approaches have been proposed in literature.

Nowadays, we can recognize that two broad classes of software processes are in use: plan-driven and agile processes [4]. In plan-driven processes, all the activities are executed steadily downwards, from the user requirement analysis down to operation and maintenance. Plan-driven methods can be appealing to the modern industry since they assure a systematic approach in the SW development and testing. The main disadvantage of plan-driven processes is their rigidity. They demand for a set of clear and stable user requirements, where little feedback is expected from the development, and are based on the assumption that the system is needed as a turn-key only at the end of the full development process. Recycles and feedbacks from more advanced development stages are costly

# A Robust Development Process For Space Sw Projects

**Murat Yilmaz, Jörg Niemann, Paul  
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## **A Robust Development Process For Space Sw Projects:**

*Design Methodologies for Space Transportation Systems* Walter Edward Hammond, 2001 Annotation Design Methodologies for Space Transportation Systems is a sequel to the author's earlier text *Space Transportation A Systems Approach to Analysis and Design* Both texts represent the most comprehensive exposition of the existing knowledge and practice in the design and project management of space transportation systems and they reflect a wealth of experience by the author with the design and management of space systems The text discusses new conceptual changes in the design philosophy away from multistage expendable vehicles to winged reusable launch vehicles and presents an overview of the systems engineering and vehicle design process as well as systems trades and analysis Individual chapters are devoted to specific disciplines such as aerodynamics aerothermal analysis structures materials propulsion flight mechanics and trajectories avionics and computers and control systems The final chapters deal with human factors payload launch and mission operations safety and mission assurance The two texts by the author provide a valuable source of information for the space transportation community of designers operators and managers A companion CD ROM succinctly packages some oversized figures and tables resources for systems engineering and launch ranges and a compendium of software programs The computer programs include the USAF AIRPLANE AND MISSILE DATCOM CODES with extensive documentation COSTMODL for software costing OPGUID launch vehicle trajectory generator SUPERFLO a series of 11 programs intended for solving compressible flow problems in ducts and pipes found in industrial facilities and a wealth of Microsoft Excel spreadsheet programs covering the disciplines of statistics vehicle trajectories propulsion performance math utilities

*Third Annual Workshop on Space Operations Automation and Robotics ((SOAR '89)* United States. National Aeronautics and Space Administration, 1990 *Annual Workshop on Space Operations Automation and Robotics (SOAR ...)*, 1989

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