New Space paradigm implications for Software

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Abstract

In the last decade, the space industry has been transformed fundamentally due to cheaper launch costs and miniaturized technology, facilitating the development of microsatellites and the standard modular CubeSat, but also impacting a wide range of missions. It has given rise to new business models that leverage these advantages creating innovative space services and products and competing with non-space commercial solutions.

The New Space paradigm is not replacing the traditional approach to space but is rather focused on products and services for private customers supported by private investors. There is a perspective change in relation to stakeholders: institutional Agencies are not the (exclusive) final customers, and while sometimes they might provide funds and expertise, their compliance requirements are minimised (e.g. debris mitigation policy). At the same time, the business models in the space economy require cost reductions and shorter development cycles. This set of circumstances imply that risks are transferred to the New Space companies changing their attitude towards reliability and performance in spacecraft design, verification, and operation. The development of all the spacecraft subsystems is affected including Software in mainly two factors: Product and Process.

In terms of Software Product, the presence of COTS and Open-Source Software becomes widespread motivated by cost reductions. COTS and MOTS enhance the production of fast and relatively reliable Minimum Viable Products (MVP) or Core Capabilities. There is also an emphasis in design for reuse, modularity and missionisation, creating frameworks for lower design levels, as future generations of the space service will benefit from software extensively tested in operational conditions.

On the other hand, the Software Process is characterised by shorter iterations, based on MVP on which to extend new functionalities driven by business demands. This requires a high level of automatization for specification, design, coding (e.g. code generation), validation and verification (e.g. daily automatic tests and checks). In turn, the lowering of costs for hardware prototyping implies shorter iterations of HW models (based on COTS as well, like Systems-on-Chip) that could be aligned with the software development cycle in genuine System-Software co-engineering activities, rather than a slower customer-supplier approach. The Software Process is also impacted by trade-off decisions: full qualification before launch vs verification in orbit. Due to lower launch costs and access to space (e.g. transportation, hosted payload or SmallSat rideshare programs), it becomes increasingly feasible to perform in orbit testing with authentic 'flying Flatsats' or even full in-orbit product development iterations including operational concepts.

'Fail fast' has become a sort of catchphrase for the New Space industry, nonetheless the Software process development must be effective: it must deliver value to the final customer and balance the ethos of the Quality principle of being 'Right the first time'. The SW Product Assurance activity can contribute to assure the quality of the Core software elements while allowing for experimentation and innovation of new functionalities, strengthen the new processes of co-engineering, and provide guidance within new validation contexts. It can also change its focus, from the usual role of 'binary semaphore' (i.e. compliance/non-compliance), to provide a wider set of measurements and qualitative considerations, in order to make the several stakeholders aware of the maturity of the software product, so enabling an informed decision-making process.