

Integrated Framework of Development and Assessment Standards for Space Systems

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Abstract. The functionality and complexity implemented by software in spacecrafts are ever increasing. Consequently, the Japan Aerospace Exploration Agency (JAXA) invests into maintaining the quality of software, by continuously verifying the quality of artifacts during system development and intensively testing the delivered product. One special situation occurs during software development for satellites. In this situation, some suppliers are in charge of both hardware and software development, and therefore, delivery to JAXA takes place only at the end of hardware-software integration. This means that typical reviews (interface between supplier and JAXA) cannot take place during development due to practical reasons. In such cases, monitoring and evaluation become complicated. This paper presents the strategy that JAXA has defined for facing these cases, which consists of the definition of a standards framework and the introduction of process assessments.

Keywords: Software Process, Process Assessment, Process Model, Process Improvement, Assurance, Quality, Process Assessment Model, Space System

1. Introduction

JAXA demands from its suppliers the application of a software design standard and a software quality management standard in order to maintain the quality of delivered products. These standards were developed with an eye on assuring compatibility with relevant standards such as MIL-STD-498[1] for software development and ISO 9001[2] for quality management.

Currently, JAXA uses tailored versions of these standards for developing various types of space systems, such as satellites, launch vehicles, and ground systems. Each domain has its own development style and contract patterns based on its mission and system characteristics. Because the differences between domain-specific development styles are quite large, tailoring the software design and quality standards for each project belonging to a given domain is quite a complex activity. This introduces new issues such as inconsistencies, wrong understanding by suppliers, and actual project practices deviating from standards.

One example can be observed in satellite development projects, where verification of quality during product development cannot be achieved. This happens because

software is developed by suppliers as a part of the contract for hardware component development. This leaves both parties with a remaining non-optimal alternative, which is to assure the quality of software only with an acceptance test of the hardware component at the end of the project. However, this particular case cannot be derived during tailoring and therefore does not appear as the tailored standard, causing confusion for both suppliers and JAXA.

In order to avoid this complexity due to the heterogeneity of standards and domain-specific characteristics, JAXA has reorganized the standards in a framework and defined a pragmatic monitoring and improvement strategy based on process assessments. The assessments have to be performed according to the domain-specific standards and domain-specific characteristics, such as contractual constraints. JAXA's main objectives to be accomplished with this strategy are 1) to involve suppliers and make them feel like owners of the standards, the assessments, and their results and 2) to avoid confusion with the current standards. The rest of this paper provides insights into the standards framework and the process assessment model and strategy. It also presents feedback obtained so far from suppliers and the work to be performed in the future.

2. Standards Framework Definition

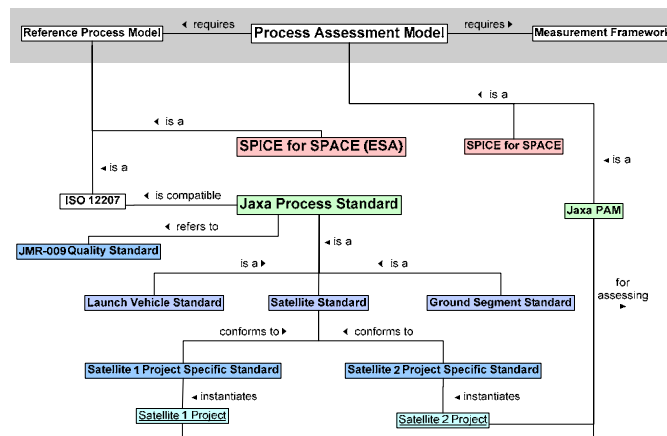


Figure 1. Standards Framework

Figure 1 presents an overview of the standards framework defined by JAXA. An initial reference development standard (based on ISO12207[3]) has been developed. In parallel, JAXA has developed an initial version of a process assessment model (PAM) organized in a similar way as ISO/IEC 15504 part 5 [4] (international standard for process assessments). This demanded revising domain-specific practices and also local existing standards (tailored standards) with the purpose of aligning them to the new reference standard. These are the domain-specific standard for satellite, launch vehicle, and ground segment. They should be tailored by each project, according to its characteristics. Then such a tailored standard can be used for creating the respective

project plan. The actual enactment of the process, which is the project plan instantiation, can be assessed by using JAXA's PAM.

3. JAXA PAM (Process Assessment Model) and Strategy

The revised version of the ISO/IEC 15504 (IS) allows to freely choose the surrounding PAM. With these change, any process may now be assessed on the basis of the ISO/IEC 15504 part 5 standard (not only software life cycle processes). Process assessments have become a more flexible analysis tool, which helps to identify domain-specific, process-related risks more effectively. Therefore, JAXA has created its own PAM (by extending the ISO/IEC 15504 part 5) with the intention of freely introducing the particularities of spacecraft development in Japan to be identified during assessments. Some criteria described in ISO/IEC 15504 part 5 do not match Japanese social behavior at both the inter-organizational and the intra-organizational levels. JAXA adjusted the criteria and added interpretations to complement understanding. The main differences between the original ISO/IEC 15504 part 5 and JAXA's PAM consist of: a new management process (needed because of special supplier-customer relationships in Japan) and four space-specific processes taken from the Space for Space standard (S4S) [5]. These four processes are: Contract Maintenance, Safety and Dependability Assurance, Independent Verification of Software & Validation of Adequacy, and Information Management. Additionally, references have been introduced to the legacy JAXA standards in order to establish transparency and traceability for suppliers. These references will help suppliers to better understand what is meant in the new assessment model.

The purpose of process assessments is to confirm that software development activities have been performed adequately, to get an insight into the processes' capability, and new opportunities for improvement. JAXA's strategy consists of three kinds of assessments, namely: i) assessment of project readiness; ii) assessment of process maturity; iii) assessment for identifying the improvement opportunities. In the case of types i) and ii), assessments are to be performed in a formal way. Assessment type iii) is to be performed in an informal way. Here, JAXA proposes involving engineers from the assessed suppliers as assessors, with the purpose of enhancing the acceptance of process assessment and therefore, improvement at the supplier's site. Currently, JAXA is deploying this strategy starting with trial assessments of type iii), i.e., pilots for introducing the assessment framework to both JAXA and suppliers. The objectives set for these first trial assessments are the identification of improvement points for currently deployed process, and detailed monitoring of the standards' application.

5. Feedback from Suppliers

It is important to note that the development period of space systems is rather long. It usually takes 3 to 5 years for one satellite. This long development period makes it difficult to reflect on the feedback from previous developments. However, feedback

about the framework and the assessment strategy has been elicited from the suppliers. Concerning the framework, it has been identified that a major standards issue is the definition of roles in multidisciplinary development contexts. There are some interfaces where system, software, aerospace, and electrical engineers, must tightly interact, and this is difficult to capture in the standard. This is due to cultural issues, namely, that engineers belonging to JAXA or its suppliers have not been used to specifying their role until now. Another important finding is that through the definition of domain-specific standards, a motivation for sharing inter-/intra organizational knowledge has come up. This means that several domain-specific projects consider the possibility of capturing and preparing reusable knowledge for projects of the same domain. Concerning process assessments, a 5-day certified provisional assessor training course was held in Tokyo at the beginning of 2008, with 11 participants attending. 6 participants belonged to JAXA, whereas 5 belonged to suppliers. The process assessment model was presented to the suppliers as was JAXA's strategy. Suppliers agreed in saying that the training provided new insights into pragmatic process improvement, and also about how to perform assessments. This opened the discussion on possible collaboration schemas for performing assessments in Japan, that are realizable in the sense that good relationships existing between JAXA and its suppliers will continue that way.

6. Conclusion and Future Work

The standards framework supports JAXA in organizing the set of software development standards and, at the same time, in harmonizing its collaboration with suppliers. In order to monitor and control standards use by suppliers, a pragmatic assessment model and strategy have been defined. Domain-specific standards are currently being used, and a trial assessment for a satellite project planned to start in 2008. This assessment will be performed based on JAXA's PAM. One objective of the trial assessment will be to examine whether the results provide adequate feedback for improvement. Equally, the results of the software process assessments will provide insights about the adequacy of the standards framework and JAXA's PAM.

References

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