Outsourcing the Development of Specific Application Software using the ESA Software Engineering Standards:

The SPS Software Interlock System

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ABSTRACT

CERN is considering outsourcing as a solution to the reduction of staff. The need to re-engineer the SPS Software Interlock System provided an opportunity to explore the applicability of outsourcing to our specific control environment. The ESA PSS-05 standards were selected for the requirements specification, the development, the control and monitoring and the project management. The software produced by the contractor is now fully operational.

After outlining the scope and the complexity of the project, a discussion on the ESA PSS-05 will be presented. The success factors and the difficulties of development under contract will also be discussed. Finally the maintenance aspect and the impact on in-house developments will be addressed.

INTRODUCTION

Outsourcing software development is being considered as a solution to the reduction of personnel at CERN in the coming years. The major goal of the SPS Software Interlock System (SSIS) project was to assess the suitability of this approach for the development of specific accelerator application software.

Today the SSIS project is finished, the application software has been successfully developed by an Italian software company and it is fully operational.

This paper shortly describes the SSIS project and explains how the use of ESA PSS-05 Software Engineering Standards [1] made the outsourcing process possible. It identifies the limitation of PSS-05 for developments under contract and summarizes the major success factors.

THE SSIS PROJECT

The system characteristics

The SPS Software Interlock System has two major functions. First, it provides a mechanism for application software to inhibit the beam in the SPS. Second, it monitors more than 150 pieces of equipment, makes sure that their state corresponds to the intended mode of operation and stops the source of particles in case of danger to costly equipment. This software system needs to be very reliable and available 24 hours a day.

Another characteristic of the system is that it is deeply integrated in the SPS/LEP control system and has to rely on many in-house developments. The hardware part of the system has been developed at CERN, the SSIS software communicates with other home-made software systems ([2],[3]) and the user interface has been developed using tools made at CERN ([4]).

Although not concerned with beam dynamics, the system contains knowledge of the properties and functionality of accelerator equipment and is thus specific to CERN.

As part of the SPS Control System Migration Project, the SSIS project was the re-engineering of an existing subsystem. There was a very strict dead-line for the replacement of the system. The first part of the system was to be ready 6 months after the development commenced and was mandatory for the SPS accelerator start-up in March 1994.

The project phases

1. Problem definition

This phase covered the definition of the scope of the project, the specification of the requirements, the analysis of the possible customer-supplier relationship and the tendering process. ESA PSS-05 standards were evaluated and selected during this phase of the project. The phase ended with the contract being awarded to an Italian company.

2. Main development and first operation

During this phase, the selected contractor developed the first version of the SSIS software based on the user requirements stated in the contract. The software was delivered to CERN in two parts. The first delivery dealt with the mandatory functionality of the system required for the SPS start-up in March 1994. The second part of the system was delivered and accepted at the beginning of May i.e. one month and an half late compared to the original planning.

The second part of the system was installed in parallel to the old existing system. The SSIS system database was gradually introduced and the performance was monitored up to the end of 1994.

3. Evolutive maintenance

Based on a first usage of the system, new requirements were identified. An updated version of the specification was produced and the original developer was asked to make an offer to implement the enhancements.

The offer from the contractor was accepted and the acceptance tests of the second version of the SSIS software took place in January 1995.

HOW DID ESA PSS-05 IMPROVE THE OUTSOURCING PROCESS

The choice

During the early phases of the project it became clear that there was a need for a well-defined terminology and for a rigorous way to structure the project.

After evaluating different software engineering standards and methodologies, ESA PSS-05 standards were selected for the following reasons:

- these standards are international in the sense that they do not favor any national standard or method;
- they are rather complete and they cover every phase of software development;
- many ESA suppliers in Europe are already familiar with these standards.

Definition of customer-supplier relationship

Potential conflicts between CERN and external suppliers were identified at the beginning of the project: interpretation of the requirements, high cost of requirements changes, unclear project completion criteria. ESA PSS-05 standards have been used to reduce the risk of such conflicts by defining as precisely as possible the relationship with the supplier.

In this regard, the standards provided guidance to specify:

- precise and structured user requirements;
- systematic acceptance tests using structured requirements;
- clear project phases and milestones;

- project functions including project management, verification and validation, and quality assurance.

Maintenance

One initial objective of the project was to avoid becoming subordinate to the contractor for maintenance. The advantage of the ESA standards where maintenance is concerned are numerous.

First, the end-of-phase documents (functional analysis, design documents, etc.) were rigorously reviewed by CERN at the end-of-phase milestones defined by the standards. This allowed CERN reviewers to strictly monitor the progress of the project but it also provided CERN technical reviewers with the knowledge of the system allowing them today to diagnose problems and fix minor bugs.

In addition, the standardized documentation should allow anybody, including other contractors, to maintain the software. This allowed CERN not to become dependent on one supplier and if the contract was prematurely canceled by either party, at least the documentation issued since the beginning would be available.

Limitations

Although the usage of PSS-05 was a key success factor, the following limitations are worth noting in the use of these standards in the frame of information system procurements:

- no support for the tender process,
- no guidance on how to allocate customer and supplier responsibilities,
- no guidance for tailoring the standards to the nature (i.e. size, criticality) of the project,
- no guidance on how to use the standards for life cycle approach other than the waterfall approach (i.e. prototyping evolutionary approach, iterative approach).

OUTSOURCING SUCCESS FACTORS

ESA PSS-05 standards made it possible to have well-defined contractual relationship. The quality of the contractual relation together with a deep involvement of CERN staff members allowed a real mutual cooperation which is probably the main reason for the project success.

The success factors can be summarized as followed:

- well-defined terminology,
- precise and structured specification of the product allowing rigorous acceptance tests, precise specification of the project activities and the responsibility for each activity (these activities are not limited to the development activities, but include project management, quality assurance, and verification and validation),
- well-defined customer-supplier interface reduced to a few people in both organizations, organization of joint reviews in order to monitor the project progress but also to technically validate the analysis, the design, the code and the associated documentation,
- technical competence of customer staff,
- systematic recording of the discussion results,
- establishment of a good communication with the supplier based on a mutual trust and an effort to understand the other party's problems.

CONCLUSIONS

ESA PSS-05 standards provided a means to specify a clear customer-supplier relationship by addressing not only the product but also the procedures required for the development. Using a methodology and applying software quality principles has a cost. Nevertheless, the quality of the product obtained in terms of documentation,

completeness, reliability, and availability has proven up to now that this cost will surely be positively balanced by the cost of operation and maintenance of an in-house solution.

In a research environment one shot developments (the so-called waterfall approach) are rarely satisfactory. A prototyping or an evolutionary approach is often more suitable. These approaches are more realistic but the customer-supplier relationship becomes more complex and difficult to define. In addition, software projects are not always pure development, they are often migration, maintenance or feasibility studies. There is obviously the need for a framework larger than PSS-05 in order to support complex procurements otherwise only simple, well-known and well-defined systems will be considered as candidates for outsourcing; such projects are very rare in our environment

The customer must be actively involved in the customer-supplier relationship. This is required not only to have successful projects but also to prevent the customer from becoming too dependent upon its supplier. New skills are thus required from CERN staff members and suitable training covering requirement elicitation, project management and communication skills should be provided.

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