

New Concepts in Document Management for Space Projects

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Introduction

Managing complex scientific projects like ESA's Integral mission (to be launched in April 2002) requires a high degree of collaboration with numerous mission participants. ESA's major external project partners are the industrial consortium, contracted to develop the

spacecraft, the instrument teams, the spacecraft and science operations centres, and the launch authorities. The project also involves in-house expertise for such activities as mission planning and operations, and spacecraft testing. During the development phase, the ESA project team plays the pivotal role in directing the information flow and the decision-making process across the project organisation (Fig. 2).

The Integral Project based its documentation-management approach from the outset on electronic document sharing and archiving. Faster and wider availability of the most current information to all parties, rather than creating the 'paperless office', was the main objective. Implementation of the new approach required the capturing of documents in an appropriate electronic format at source, establishing new procedures for project-wide information sharing, and the deployment of a new generation of Web-based tools. Key success factors were the early adoption of Internet technologies and simple procedures for improved information flow.

It is acknowledged that effective information sharing among all project participants is a critical success factor for completing the project on time and within budget. However, the wealth of technical and managerial information has traditionally been stored and distributed in tens of thousands of documents. (Table 1). While documents have been



Figure 1. The Integral Structural Thermal Model being readied for testing in the Large Space Simulator (LSS) at ESTEC in Noordwijk (NL)

Figure 2. Main documentation flows. The main participants in Integral are the prime contractor (Alenia) and the industrial consortium of about 30 companies, the instrument teams, the Mission Operations Centre (MOC) at ESOC, the Integral Science Operations Centre (ISOC) at ESTEC and the Integral Science Data Centre (ISDC) in Geneva. The Proton launcher is being provided by Rosaviakosmos

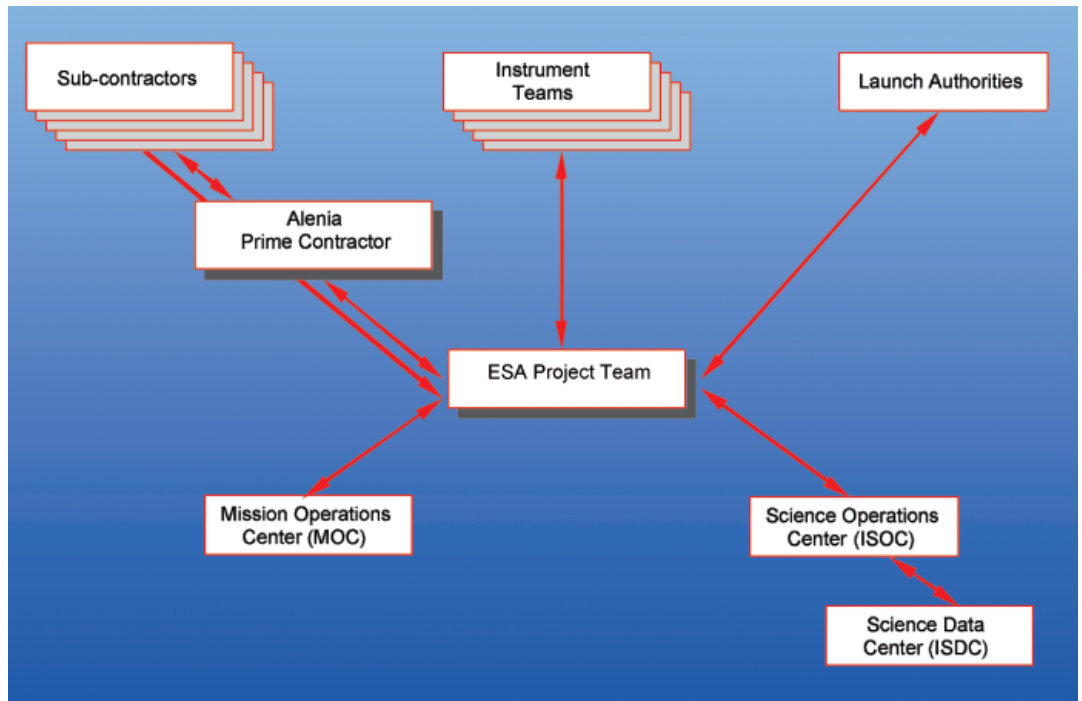


Table 1. Scaling the problem

Project	Number of documents over project lifetime
Integral*	36 000
XMM	64 000
Cluster-I/II	51 000
SOHO	41 000
ISO	79 000

*Two more years to go

produced with computers for a considerable time, incompatible, constantly changing technologies have limited progress in document management. Paper has been the preferred medium for storage, with facsimile and mail being the main distribution services. Paper documents are still best for reading and red lining, but their content is not easily accessible and sharable with a geographically dispersed team.

Focused on efficiency improvements, the ESA Integral project team saw in emerging Internet technologies an opportunity to ensure the timely availability and easy access to the most current documents for all project participants, whilst at the same time reducing the effort involved in document management. By taking a broad view, the Integral project considers documents to include any kind of information, ranging from technical specifications, reports and design drawings, to correspondence and minutes of meetings. A system for electronic document distribution and archiving was devised and implemented in cooperation with the industrial Prime Contractor, Alenia Spazio,

in 1995, at the beginning of the project definition phase.

Choosing a system-independent document exchange standard

In a large project environment, documents are produced with a variety of tools and platforms, ranging from simple word processors to complex engineering design systems. In such a heterogeneous environment, and one that is subject to frequent information-technology changes, electronic document sharing can be unreliable and costly. Even though some proprietary document formats are in principle cross-platform compatible, documents may still appear very different when viewed or printed on different equipment. Different implementations of document styles or variations in the rendering of graphics are typical elements impacting the visual integrity of electronic documents. Considering the project's mixed technical — scientific — commercial environment, with many diverging needs and specific constraints, it was clear that a comprehensive 'one-size-fits-all' document preparation tool was not available on the market.

A key decision for Integral in implementing electronic document distribution and archiving was to use a system-independent document exchange standard. While technical capabilities played a significant role in the analysis, company policies and cultures had to be taken into account as well.

Two options were considered at that time (1995):

– *Use of the Standard Generalised Markup Language (SGML)*

The most promising hardware- and software-independent standard at that time was SGML. Although the prime contractor Alenia had already gained SGML experience within the International Space Station programme, the complexity of implementing the concept across all participants was beyond the scope of the Integral project.

– *Use of the Portable Document Format (PDF)*

While the life span of such a proprietary format was not assured, this option was retained because of its simplicity and cost-effectiveness. At the end of the document-preparation process, it is converted into a PDF file, readable across a wide range of platforms whilst still preserving its original appearance. The minimal investment and the compatibility with the installed document-preparation tools made this a cost-effective solution, attractive to all project partners.

Setting up distribution and archiving tools

In the light of the different needs for automating engineering and management processes, ESA and Alenia implemented different – though complementary – systems. Beyond the standard features present in both systems, like providing controlled document access (both internal and external), the ESA system focuses on project-wide document distribution and archiving (see accompanying panel 'The ESA Science DMS'). The Alenia system offers additional functions to control the engineering information. By relating all the data to the product structure, the system allows detailed configuration management down to each configuration item of the spacecraft (see panel 'The Alenia Integral PDM').

Simple procedures

Based on the above tools, procedures have been devised within the project to register, distribute and archive the documentation effectively. The main flow of information is between the spacecraft industrial team and the ESA project team. Typically, a subcontractor issues a document in PDF format to Alenia, with a working copy to ESA. The Prime Contractor registers the document and forwards it with the appropriate index information. When it reaches the ESA communications server, the document and its index are automatically pre-registered. After verification, the document registration is confirmed and the distribution process can be performed electronically both within the ESA team and to outside participants. In addition to this main link between industry and the Agency, the other flows of information between the project and the other participants are handled in a similar

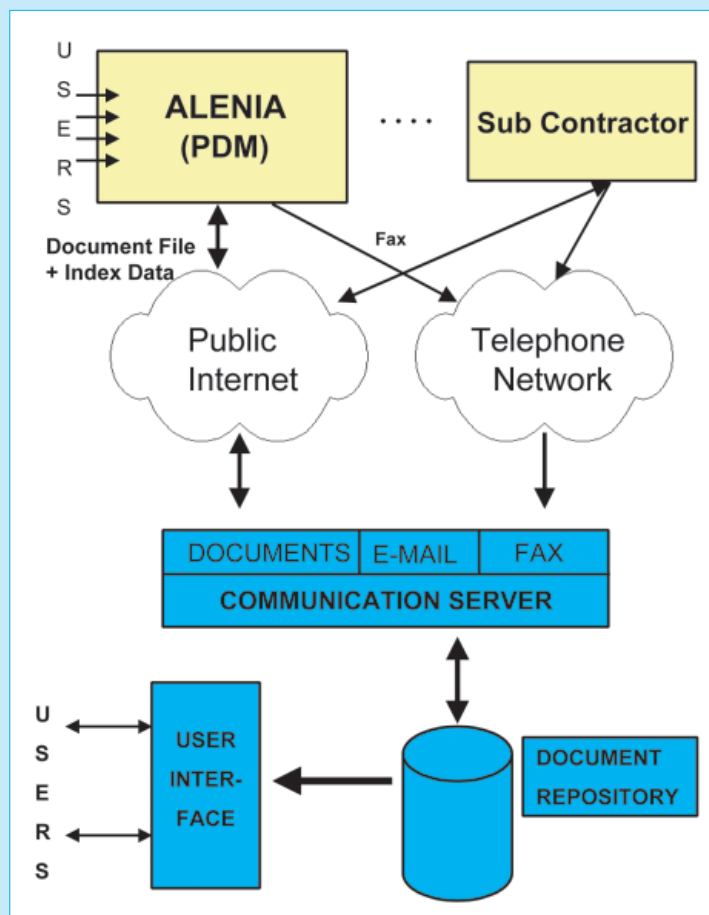
manner. Where the source documentation is not available electronically, the paper document is incorporated into the system through scanning, either at Alenia or at ESA.

The system is effective in that:

- It affords the ESA and Alenia project teams immediate access to the entire project documentation, ranging from formal technical documents to the latest correspondence, faxes and e-mails. The Alenia staff also have detailed product configuration information readily available.
- Support staff within ESA and Alenia with appropriate access privileges can also remotely consult the entire archive, which is particularly helpful, for example, for operations based in ESOC, for test campaigns at ESTEC, or for launch-related matters involving ESA's Moscow Office and in the future the Proton launch site.

The ESA Science DMS

The ESA Science Document Management System (DMS) enables electronic distribution and archiving. Documents transferred via the public Internet to the ESA communication server are automatically moved to the document repository, registered and distributed to the final recipients. Likewise, faxes are automatically converted to PDF format, archived and distributed. An Internet search-engine-like interface provides easy access for authorised users.

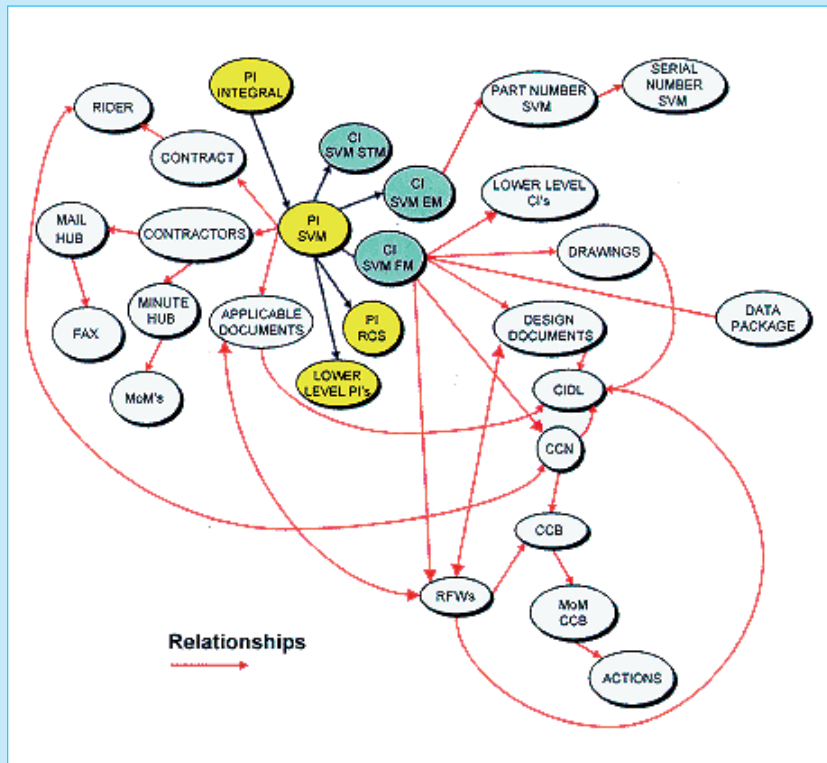


The Alenia Integral PDM

The core of the Alenia Product Data Management System (PDM) is the product tree, a hierarchical structure breaking down the spacecraft into all of its lower-level elements. Each relevant element in the product tree can be associated with all of its documentation, which includes engineering, configuration and management information, such as design data, drawings, contract changes, applicable specifications, technical assessments and minutes of meetings.

Based on this key data set, the system can monitor:

- the evolution of the baseline product information
- the planning and release of new product information, such as specification updates
- multiple spacecraft configurations, such as the various development models or specific test configurations
- critical spacecraft properties and technical capabilities, such as mass or power-consumption budgets.



- Paper copies are still circulated, in particular for reference documents requiring detailed scrutiny. However, transfer times have been reduced significantly and a document can be issued and distributed to all participants under full configuration control within a few hours.

The initial implementation challenge was coping with the wide range of platforms and the large number of minor adjustments necessary to individual set-ups. These system issues could appear in any of the many components and links between the user's desktop and the document repository. More stable configurations and wider experience and acceptance of web-based tools has largely helped to overcome this. More procedural aspects have been the allocation of individual user access rights to the system, and definition of appropriate distribution lists. This issue is much more evident in the electronic environment than in the paper one, because of the wider awareness of the available documentation among the users.

Outlook

Based on such an infrastructure, information flows between the project participants can be further enhanced. An application that has been successfully implemented provides support to project reviews for both ESA and industry. Using the electronic documentation system, a data package can be posted on the web for

consultation by the review team. Comments or discrepancies identified by that review team can then be registered and tracked until all issues are closed. Similar extensions have been deployed in support of document-intensive product-assurance activities, although not yet fully implemented in the Integral project. The Nonconformance Control application, for example, allows the systematic recording, reporting and tracking of nonconforming items and of the associated corrective actions.

Conclusion

A key transition was made in the Integral project by basing the documentation management on electronic document sharing and archiving, covering the main aspects of a document's life, from creation to distribution. The approach has been particularly well received by Alenia and its industrial team. Based on this positive experience, documentation is being managed in a similar way for all new ESA science projects. With some variations, the concept and the ESA Science DMS are also being used successfully for other major ESA missions, such as the Metop project.