

Advanced SCOS-2000 Monitoring PECS final report

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1 Introduction

The PECS project 'Advanced SCOS-20000 Monitoring' was part of the ESA project '*Advanced Monitoring for a Modern Generic Mission Control System*' and its extension called '*Consolidation of the Advanced Telemetry Monitoring Subsystem*'.

The main objective of these two projects was to exploit new technologies for the monitoring and visualization subsystems of the existing ESA mission control system SCOS-2000 and to make use of the outcome of the analysis and prototypes in view of the new EGOS architecture.

In this document the first ESA project is referred as '*Advanced Monitoring Baseline*' and its extension as '*Advanced Monitoring Extension*'.

1.1 Purpose

This document summarizes results of the ANF DATA activities accomplished within the Advanced Monitoring Baseline and Extension projects, and reports financial status including related invoice documents.

1.2 Scope

The Advanced Monitoring Baseline and Advanced Monitoring Extension were combined GSTP/PECS projects performed by Siemens Austria (main contractor - GSTP), ANF Data (subcontractor - PECS CZ) and Siemens Hungary (subcontractor - PECS HU).

This document focus is only on the PECS activities dedicated to ANF DATA.

2 Glossary

Acronym	Description
ADD	Architecture Design Document
CORBA	Common Object Request Broker Architecture
CS	Command Supervisor
CSO	Czech Space Office
DML	Data Management Library
DTL	Data Transfer Library
EGOS	European Ground Operation Software
ESA	European Space Agency
ESAW	European Ground System Architecture Workshop
ESOC	European Space Operations Centre
GSTP	General Support Technology Programme
ICD	Interface Control Document
IPC	Industrial Policy Committee
MCS	Mission Control System
PDR	Preliminary Design Review
PECS	Plan for European Cooperation States
SCOS	Spacecraft Control & Operation System
SRS	Software Requirements Specification
SUM	Software User Manual
SVTS	Software Validation Testing Specification
SW	Software
SWRR	Software Requirements Review
TC	Telecommand
TCP/IP	Transmission Control Protocol / Internet Protocol
TM	Telemetry
TN	Technical Note
VAT	Value Added Tax
WP	Work Package

3 Objectives Planned

3.1 Advanced Monitoring Baseline

The ANF DATA work package 'CORBA based Packet Distribution Prototype Software' (WP-7000) was included as an option in the Siemens Austria contract for the ESA project 'Advanced Monitoring for a Modern Generic Mission Control System', and confirmed by the CSO and ESA for the PECS program in year 2005.

The main goal of this task was to replace existing TCP/IP based packet distribution in the SCOS-2000 Mission Control System by means of CORBA (Common Object Request Broker Architecture).

The following deliverables were defined:

- Software Requirements Specification (SRD)
- Software Validation Testing Specification (SVTS)
- Interface Control Document (ICD) for the CORBA layer
- Architectural Design Document (ADD) for the CORBA communication layer
- Technical Note on performance tests and recommendations for CORBA usage
- Delivery Configuration File (part of the SW Release Note)
- SCOS-2000 repository with the CORBA based communication layer
- Runtime workspace

This work package was expected to start in November 2004 and to be finished already in December 2005. The official 'GO' for the option 'CORBA based Packet Distribution Prototype Software' was received from ESA in January 2005.

A new schedule was agreed with ESA and approved by the CSO during the PECS audit in 2005:

Milestone Description		%	Price [EUR]	Date planned
M0	Kick-Off	40	35.437	17.01.2005
M1	Delivery of final prototype and documentation	50	44.296	28.02.2006
M2	ESA Final Acceptance of deliverables	10	8.859	30.04.2006
Total		100	88.592	

Table 1 – Advanced Monitoring Baseline: Planned Schedule

3.2 Advanced Monitoring Extension

Remaining ANF DATA PECS work packages were approved by ESA Industrial Policy Committee (IPC) in September 2005 as part of extension of the project 'Advanced Monitoring for a Modern Generic Mission Control System' called 'Consolidation of the Advanced Telemetry Monitoring Subsystem'.

'Command Supervisor for Remote Monitoring and Controlling of SCOS-2000 Command Sources' (WP-5000)

The Command Supervisor is a new SCOS-2000 sub-system which enables operators to monitor all commanding activities, regardless whether they are located on or off-site. It collects the state of all command sources in the system and distributes this information to all interested parties. The whole work package was done by ANF DATA within the PECS budget.

The following deliverables were defined for the CS:

- Software Requirements Specification (SRS)
- Software Validation Testing Specification (SVTS)
- Interface Control Document (ICD) for the command source CORBA interface
- Interface Control Document (ICD) for the CORBA distribution server
- Architectural Design Document (ADD) for the CORBA distribution server
- Architectural Design Document (ADD) for the WEB client
- Update of SCOS-2000 documents (Command Source ADD)
- Delivery Configuration File (part of the SW Release Note)
- SCOS-2000 repository based on SCOS Release 4.0 with the C++ code of the command source enhancements and the CORBA distribution server
- Java repository with the WEB client code
- Test data and scripts
- Runtime workspace

The initially specified work packages "High performance interface of Java based Graphical User Interfaces with SCOS-2000 processing models with Java Native Interface" (WP-4000), and "Telemetry Desktop for SCOS-2000 based on Java Component Technology" (WP-6000) were on ESA request replaced by the following new work packages marked as WP-8000 and WP-9000. The planned budget was preserved.

'EGOS Data Transfer Library' (WP-9000)

The Data Transfer Library (DTL) is a new EGOS S/W library supporting transfer of structured data between end points in a platform independent way for C++ and Java.

This whole work package was assigned to ANF DATA within the PECS program.

The following deliverables were defined for the DTL:

- Software Requirements Specification (SRS)
- Software Validation Testing Specification (SVTS)
- Interface Control Document (ICD)
- Architectural Design Document (ADD)
- Software User Manual (SUM)
- Technical Note (TN) on DTL performance measurements and analysis
- Repository with the C++ and Java source code, test data and scripts

The Java implementation of the DTL has been de-scoped in agreement with ESOC due to budget limitations.

'EGOS Data Management Library' (WP-8000)

The Data Management Library (DML) is a new quasi-operational S/W library supporting the management of TM/TC and SCOS-2000 packets data for C++ and Java.

In this work package only the TC related part of DML implementation was assigned to ANF DATA as a PECS activity. The software requirements, architectural design, and DML-TM implementation were performed by Siemens Austria within the GSTP program.

The following deliverables were defined for the DML:

- Software Requirements Specification (SRS)
- Software Validation Testing Specification (SVTS)
- Interface Control Document (ICD)
- Architectural Design Document (ADD)
- Software User Manual (SUM)
- Repository with the C++ and Java source code, test data and scripts

These three work packages were originally proposed to start in July 2005 and to be finished in November 2007. During contract negotiation a new schedule was agreed and approved by the CSO during the PECS audit in 2005:

Milestone Description		%	Price [EUR]	Date planned
M0	Kick Off	20	71.904	15.12.2005
M1	Software Requirements Review			15.03.2006
M2	Architectural Design Review	20	71.905	15.06.2006
M3a	Delivery – CS	20	71.904	15.12.2006
M3b	Delivery – DTL/DML	20	71.904	15.06.2007
M4	Final Delivery	10	35.952	15.10.2007
M5	Final Presentation			15.11.2007
M6	ESA Acceptance	10	35.952	15.12.2007
Total		100	359.521	

Table 2 – Advanced Monitoring Extension: Planned Schedule

4 Results Achieved

4.1 Advanced Monitoring Baseline

The 'CORBA based Packet Distribution Prototype Software' results:

- ◆ Kick off of the overall project was held at ESOC in November 2004.
- ◆ Official 'GO' for the 'CORBA based Packet Distributor Prototype Software' option was received from ESA in January 2005.
- ◆ Software Requirements Definition phase started already in December 2004. A first version of the SW requirements document was delivered to ESA for review in January 2005, the updated version in March 2005.
- ◆ Architectural Design phase started in February 2005. A first version of the Architectural Design Document was delivered to ESA for review in April 2005, an updated version in May 2005.
- ◆ Prototyping phase started in May 2005 and was finished by the Factory Acceptance Test in May 2006. The prototype and related documentation were delivered to ESOC in July 2006.
- ◆ Final Acceptance was received from ESA in September 2006.

Milestone Description		Date planned	Date reached
M0	Kick-Off for the CZ PECS option	17.01.2005	17.01.2005
M1	Delivery of final prototype and documentation	28.02.2006	14.07.2006
M2	ESA Final Acceptance of deliverables	30.04.2006	18.09.2006

Table 3 – Advanced Monitoring Baseline: Milestones reached

The main reason for the delay of the final prototype delivery was underestimated effort for the implementation and maintenance phases, and additional effort needed for migration of the prototype from the SCOS-2000 baseline R3.1 to R4.0 (not planned originally).

As the Advanced SCOS-20000 Monitoring project was focused on exploitation of new technologies and their reuse, it was very difficult to estimate precisely effort for implementation of the prototype before the technologies were evaluated.

We see the additional effort as investment into the future - we improved our SCOS-2000 know-how and learned procedures how to make business with ESA.

4.2 Advanced Monitoring Extension

The project Kick-off meeting took place at ESOC on 21.12.2005. It was agreed that the Software Requirements Review (M1) and Architectural Design Review (M2) is to be held separately for the Command Supervisor (CS) and for the EGOS libraries (DTL & DML).

The Command Supervisor:

- ◆ Software Requirements Definition phase started in January 2006. A first version of the SW requirements document was delivered to ESA for review in March 2006, the updated version in May 2006.
- ◆ Architectural Design phase started in March 2006. First versions of the Architecture Design Document and Interface Document were delivered to ESOC for review in August 2006, final versions in November 2006
- ◆ Implementation phase started in August 2006. In December 2006 the Automated Regression Test environment was prepared and system tests started. The Factory Acceptance Test was done in March 2007 and the software and documentation were delivered to ESOC.
- ◆ Final presentation was done at ESOC in May 2007.

The Data Transfer Library:

- ◆ Software Requirements Definition phase started in March 2006. A first version of the SW requirements document was delivered to ESA for review in April 2006, the updated version in July 2006.
- ◆ Architectural Design phase started in July 2006. First versions of the Architecture Design Document and Interface Control Document were delivered to ESOC for review in September 2006, final versions in December 2006.
- ◆ Implementation phase started in January 2007. The Factory Acceptance Test was done in September 2007, and the DTL/DML software and documentation was delivered to ESOC. The second DTL/DML delivery was done in November 2007.
- ◆ Final delivery of the DTL/DML software and documentation was done in July 2008, and in August 2008 we received the Final Acceptance for the whole project

The Data Management Library:

- ◆ DML-TC implementation phase started in April 2007. The Factory Acceptance Test was done in September 2007, and the DTL/DML software and documentation was delivered to ESOC. The second DTL/DML delivery was done in November 2007.
- ◆ Final delivery of the DTL/DML software and documentation was done in July 2008, and in August 2008 we received the Final Acceptance for the whole project

Milestone Description		Date planned	Date reached
M0	Kick Off	15.12.2005	21.12.2005
M1a	Software Requirements Review - CS	15.03.2006	06.04.2006
M1b	Software Requirements Review - DML/DTL	15.03.2006	16.05.2006
M2a	Architectural Design Review - CS	15.06.2006	08.09.2006
M2b	Architectural Design Review - DML/DTL	15.06.2006	12.10.2006
M3a	Delivery - CS	15.12.2006	26.03.2007
M3b	1 st Delivery - DTL/DML	15.06.2007	10.09.2007
M3c	2 nd Delivery - DTL/DML	N/A	30.11.2007
M4	Final Delivery - DTL/DML	15.10.2007	10.07.2008
M5	Final Presentation - CS	15.11.2007	10.05.2007
M6	ESA Acceptance	15.12.2007	25.08.2008

Table 4 – Advanced Monitoring Extension: Milestones reached

In the Command Supervisor work package we had additional effort in the design caused by migration from the SCOS-2000 baseline R4.0 to R4.1 and related modifications of scripts for Automated Regression Tests. As result the final delivery of the CS was shifted for three months.

Start of the Data Transfer Library work package was about two months postponed, because of delay on the previous project 'Advanced Monitoring Baseline' and thereby unavailability of the key personnel. Lack of the time in the SW Requirements phase had impact on quality of the SW Requirements Specification (SRS), which was not detailed enough.

Insufficiencies in the SRS and absence of technical discussion with the customer during the Architecture Design phase caused, that the full functionality expected by the customer was clarified only at the Architectural Design Review. This resulted in significant modification of the architecture design and had impact also on the effort needed for the Implementation and Validation phase.

A notable difficulty has proven to be the ESA requirement on compliance with the new EGOS concept. We had to spent considerable effort on getting through the EGOS documentation.

After negotiations with ESOC we agreed to reduce implementation of the DTL only to C++ (Java implementation of DTL was de-scoped).

In the Data Management Library work package the original split of tasks between the main contractor Siemens Austria and the subcontractor ANF DATA had to be reorganized, because of technical aspects of the development. Instead of porting whole DML from C++ to Java, ANF DATA task was to implement DML TC chain in both C++ and Java.

Misunderstanding of the SW requirements caused that part of functionality was missing in the DML-TC first delivery and had to be implemented additionally. This had impact on the final delivery of the DTL/DML software and documentation.

5 Financial Balance of the Project

5.1 Advanced Monitoring Baseline

The following table lists reached project milestones and related payments for the work package 'CORBA based Packet Distribution Prototype Software':

Milestone Description		%	Price [EUR]	Milestone reached	Milestone invoiced
M0	Kick Off	40	35.437	17.01.2005	29.04.2005
M1	Delivery of final prototype and documentation	50	44.296	14.07.2006	26.07.2006
M2	ESA Final Acceptance of deliverables	10	8.859	18.09.2006	18.09.2006
Total		100	88.592		

Table 5 – Advanced Monitoring Baseline: Payment Schedule

5.2 Advanced Monitoring Extension

The table below shows reached project milestones and related payments:

Milestone Description		%	Price [EUR]	Milestone reached	Milestone invoiced
M0	Kick Off	20	71.904	21.12.2005	22.12.2005
M1a	Software Requirements Review - CS			06.04.2006	N/A
M1b	Software Requirements Review - DTL/DML			16.05.2006	N/A
M2a	Architectural Design Review - CS			08.09.2006	N/A
M2b	Architectural Design Review - DML/DTL	20	71.905	12.10.2006	18.09.2006
M3a	Delivery - CS	20	71.904	26.03.2007	15.12.2006
M3b	1 st Delivery - DTL/DML	20	71.904	10.09.2007	25.06.2007
M3c	2 nd Delivery - DTL, DML			30.11.2007	N/A
M4	Final Delivery - DTL/DML	10	35.952	10.07.2008	07.12.2007
M5	Final Presentation - CS			10.05.2007	N/A
M6	ESA Final Acceptance	10	35.952	25.08.2008	29.08.2008
Total		100	359.521		

Table 6 – Advanced Monitoring Extension: Payment Schedule

Note: The SW Requirements Review (M1) and the Architectural Design Review (M2) were held separately for the Command Supervisor and for the EGOS DTL/DML libraries.

6 Publications/Papers presented based on the Project

The DTL/DML and the Command Supervisor were presented on the European Ground System Architecture Workshop (ESAW) at ESOC in June 2007.