SEVENTH FRAMEWORK PROGRAMME

cubist

Your Business Intelligence

Requirements Document (Space Control Centres)

Issue 2.9.1

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Table of Contents

Document Status

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Document Change Log

Each change or set of changes made to this document will result in an increment to the version number of the document.

This change log records the process and identifies for each version number of the document the modification(s) which caused the version number to be incremented.

Change Log	Version	Date
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1 Introduction

1.1 Purpose and Status of this Document

This is the **Requirements Document (Space Control Centres)** produced for the FP7 CUBIST Project. It formalises part of the work done for Work Package 8 "Use Case: Semantic Business Intelligence for Space Control Centres" which is led by Space Applications Services.

This report is a public deliverable D8.1.1, formally due by M6 (=Mar-2011).

The context of this deliverable (highlighted in grey in the table below) is as follows:

1. It is one of the 3 Requirements Documents (1 per Use Case) written for CUBIST:

Del ID	Task ID	Due Date	Description
D7.1.1	T7.1	M6	Requirements Document (Use Case: Semantic Business Intelligence for **Mouse Atlases**)
D8.1.1	T8.1		Requirements Document (Use Case: Semantic Business Intelligence for **Space Control Centres**)
D9.1.1	T9.1		Requirements Document (Use Case: Semantic Business Intelligence for **Recruitment**)

Table 1 Deliverables for Requirements Engineering task in CUBIST

2. Its Chapter 9 is to be read with an associated "Initial Mock-up" companion deliverable:

Del ID	Task ID	Due Date	Description
D8.1.2	T8.2	M6+2	Initial Mock-up (Use Case: Semantic Business Intelligence for **Space Control Centres**)

3. It has been written in compliance with the guidelines provided in D1.1.1, in order to facilitate the integration of the Requirements Analysis (which are specific to each Use Case and written by different partners) into a more general-puropose reservoir of requirements shared by all partners for CUBIST, gathered in D1.1.2, and for integrating the 3 individual Mock-ups into a common one (D1.1.3).

Del ID	Task ID	Due Date	Description
D1.1.1	T1.1	**M3**	Directives for the Requirements Analysis in the Use Cases
D1.1.2		M6	Generalized Requirements
D1.1.3		M6+2	Mockup

1.2 Scope of this Document

Task 8.1:Requirement Analysis (Lead: SAP, M1-M6)

Based on the guidelines and directives for the requirements analysis provided by T1.1 and deliverable D1.1.1, the specific requirements for this use case will be gathered. The requirements are not restricted to **technical requirements**, but will cover all aspects of CUBIST relevant for this use case, including:

- The *selection of data sources* that will be processed with ETL tools and loaded into CUBIST, together with the clarification of access strategies to various LANs and office networks, all having distinct security policies in place. A graceful data extraction strategy shall be defined in order to ensure that there is no impact on the operations.
- The *specification of a query catalogue*, that is, the queries that are expected to the be made to the CUBIST system. This section shall be done in close cooperation with the operators and the USOC staff in order to deliver accurate expectations from the end users.
- The guidelines for the *integration of CUBIST* with the existing infrastructure in USOCs, including the design of the setup environment and of the dedicated query interfaces.

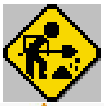
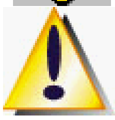
1.3 Document Overview

Apart from the rest of this chapter where the conventions and reference documents are identified, this document is structured as follows:

- Chapter 2 "Belgium User Support and Operations Centre" on page 9 tells the history of B.USOC, its infrastructure and the missions that are being run there today.
- Chapter 2.6 "Data sets to be used in CUBIST" on page 15 describes representative B.USOC users in an informal manner, preparing the reader to digest their user stories.
- Chapter 4 "Utilisation scenarios (today's operations)" on page 21 covers representative scenarios that happen in daily lives of B.USOC employees.
- Chapter 8 "Utilisation scenarios (future operations helped by CUBIST)" on page 30 reiterates on these representative scenarios by introducing potential improvements brought in by CUBIST.
- Chapter 9 "Formal requirements" on page 32 provides a list of formal requirements collected for CUBIST according to the methods, standards and conventions described in D1.1.1.

1.4 General Conventions

1.4.1 Graphical Conventions

Icon	Description
 “Look at this”	Points to a particularly important item, part of the **executive summary**. **If you have only 1 hour to read this document, follow this pointer.**
 “At work”	Identifies a section still unstable or immature. Such section is likely to contain wrong statements, and unstable brainstorming material.
 “Attention”	Highlights a point worth reading, such as a technical issue or a typical pitfall.

1.4.2 Acronyms and Abbreviations

In this document, all the words having a special meaning that differs from or refines the common understanding are indicated with an initial capital letter.

Moreover, we have made a special effort for ensuring the terminology used is consistent throughout the document: one name for one concept.

Many of the following terms come from the space control centre operations and are used throughout relevant documentation, as well as in the operator’s daily talk. They are explained in a few words below.

Concept	Definition
AD	Applicable Document
AR	Anomaly Report
B.USOC	Belgian User Support and Operations Centre
CART	Columbus Anomaly Resolution Team
CD-MCS	Columbus Decentralized Misson Control System
CEFN	Columbus Environment Flight Notes, an issue tracker eveloped as a web application in PHP and used for exchanging messages and information requests between operators of USOCs and Col-CC operators.
Col-FD	Columbus Flight Director, a 24/7 position present on voice loops
Col-OC	Columbus Operations Coordinator, a 24/7 position present on voice loops
eRoom	A Documentum™ installation for storing all kinds of Columbus-related documentation: interface control documents, specifications, technical notes, procedures, protocols, minutes, presentations, reports, manuals, operational products, databases, and emails
ESA	European Space Agency

Concept	Definition
ESA MSO	ESA Mission Science Office
ESA POM	ESA Payload Operations Manager
ESA Safety	ESA Safety group, an offline groups of people composed of Principal Investigators and payload developers that can provide advice on operational safety issues.
FP7	Framework Programme 7
FR	Columbus Flight Rules
FRC	Facility Responsible Centre
FSC	Facility Support Centre
IFN	Intra-console Flight Notes, similar to CEFN, but limited distribution, e.g. for communicating between various operations in a USOC.
IOT-TS	Industrial Operator Testing Ticketing System
IPV	International Procedure Viewer
ISS-FD	ISS Flight Director, , a 24/7 position present on voice loops
IWG	Investigators Working Group
JOIP	Joint Operations Interface Procedures. Operational interfaces and guidelines for all mission phases of the ESA Human Spaceflight programme.
MDB	Mission daabase, a machine-readable description of the telemetry parameters
OIP	Operations Interface Procedures, outlines the operational interfaces and guidelines for all mission phases of the Human Spaceflight programme.
OSTP	Onboard Short Term Planner, a web-based application displaying onboard and ground activities related to ISS.
PL Reg	Columbus Payload Regulations
PODF	Payload Operations Data File is a XML file, providing a pre-definied sequence of commands and checks to operate the payload
RD	Reference Document
SPR	System Problem Report, an online issue tracking system for ground and onboard isues about Columbus, its payloads and control centres.
TLE	Two-line elements, a coarse model of the orbit of Earth-orbiting objects, including satellites and the ISS.
Voice loops	Multichannel voice communication network for human space flight control centres.

1.5 Reference and Applicable Documents

1.5.1 Applicable Documents

Applicable Documents (ADs) are the documents providing some “binding” information, to which a compliance is expected. ADs impose constraints that must be respected.

CUBIST Deliverables	
D1.1.1	Frithjof Dau, Directives for the Requirement Analysis in the Use Cases (D1.1.1), v0.3, 10-Jan-2011

1.5.2 Reference Documents

Reference Documents (RDs) contain additional information that is not binding.

Techniques of Requirements Engineeting	
RD1	Software Requirements, Styles and Techniques, by Soren Lauesen, Addison-Wesley
RD2	Volere Requirements Specification Template, Edition 13, http://www.volere.co.uk, accessed 07/2008.
RD3	Requirements Trawling: techniques for discovering requirements. http://www.volere.co.uk/trawling.pdf, accessed 07/2008
RD4	Beaupre, A. How to create customer personas (2009). http://www.beaupre.com/blog/index.cfm/2009/7/23/How-to-create-customer-personas, accessed 2010/11
Web Pages	
WB1	Belgian User Support and Operation Centre (B.USOC) www.busoc.be
WB2	Mission Columbus: the Columbus lab. columbus.busoc.be

2 Belgium User Support and Operations Centre

2.1 Objective and Structure of This Chapter

2.1.1 Objective

The objective of this chapter is to describe the daily activities of end-users of the Belgian User Support and Operations Centre ("B.USOC") as they exist today, i.e. without any supporting CUBIST machinery yet, and this in terms understandable by the largest audience.

2.1.2 Structure

The core of this chapter provides a number of representative real-life situations, expressed as "Utilisation Scenarios" (see [D111] for explanations).

This chapter is structured as follows:

- Section 2.2 "Monitoring & Control of European Space Missions" on page 9 explains the general organisation context of a space mission (especially: the types of scientific payloads, the decentralisation principle for the monitoring & control of ISS payloads, the networks), up to the role of B.USOC in daily operation missions.
- Section 2.3 "B.USOC Operational Environment" on page 10 presents infrastructure of the B.USOC.
- Section 2.4 "Current B.USOC activities" on page 10 introduces current B.USOC activities.
- Section 2.5 "Summary of Data at B.USOC" on page 10 covers the datasets available at B.USOC.

2.2 Monitoring & Control of European Space Missions

n 1998, ESA's Manned Space Program board decided to adopt a decentralized infrastructure for the support of European payloads on-board the International Space Station (ISS). This concept was based on operating multiple User Support and Operations Centres (USOCs), each assigned to supporting a majority of tasks related to the preparation and in-flight operations of European payloads. The USOCs are based in national centres distributed throughout Europe. Depending on the tasks assigned to a USOC, they have the responsibility of a Facility Responsible Centre (FRC) or Facility Support Centre (FSC). While FRC is delegated the overall responsibility for a multi-user rack facility or class-1 payload an FSC takes up the responsibility for a sub-rack facility, class-2 payload (e.g. experiment container, drawer payload etc.) and/or self-standing experiments utilising experiment specific equipment. For example, the Biolab payload is operated from the Microgravity User Support Centre (MUSC) in Cologne, Germany. SOLAR payload is operated by the Belgian USOC located in Brussels. EuTEF and EDR (European Drawer Rack) payloads are operated from the Erasmus USOC in Noordwijk, The Netherlands. FSL (Fluid Science Laboratory) is operated from the E-USOC in Madrid.

All these USOCs use a common software and hardware infrastructure and are securely connected to the Columbus Control Centre (Col-CC). Two kinds of data streams are exchanges between USOCs and Col-CC: telemetry and telecommands, abbreviated as TM and TC, respectively. Telemetry is the downstream data from ISS while telecommands are upstream data. Unlike USOCs, Col-CC is tasked with the responsibility of the Columbus module on system level. It coordinates the overall payload activities and checks the traffic. On the way to and from ISS, data passes also through the NASA control centres in Huntsville and Houston.

From the other side, USOCs provide telemetry data to the so called Facilty Support Centres. These are usually payload develpers or domain centres. In many cases, science users at universities and research labs (usually called User Home Bases or UHBs) also receive telemetrydata through USOCs.

2.3 B.USOC Operational Environment

B.USOC is located in the premisses of the Belgian Institute for Space Aeronomy (BIRA-IASB). It is running a set of hardware and software tools and utulities common to all the USOCs. For Payload Data processing, the Columbus Decentralised Monitoring and Control Subsystem(CD-MCS) is used, where another tool, the Unified Synoptics Software, displays real-time payload data. Each USOC also has a set of its own operational utilities needed for the operational monitoring and control of the payloads. Part of the USOC infrastructure implements traditional document management facilities: wiki, shared folders, issue tracker, etc.

The network topology is built with the objective to isolate essential components. Computers are connected to different networks providing different security and isolation levels. Communication between these networks is often made difficult by firewalls and access restrictions.

2.4 Current B.USOC activities

As of beginning 2011, B.USOC operates the SOLAR payload on the 24/7 basis.

SOLAR is an integrated platform accommodating three instruments complementing each other to allow measurements of the solar spectral irradiance throughout virtually the whole electromagnetic spectrum.. SOLAR is also one of the first external payloads of the ISS. Its operations are entirely led from B.USOC.

Three instruments are deployed on the payload:

- SOVIM (Solar Variable and Irradiance Monitor) measures irradiance in the near-ultraviolet, visible and thermal regions of the spectrum (200 nanometers - 100 micrometers).
- SOLSPEC (SOLar SPECtral Irradiance Measurements) covers the 180 nanometer - 3000 nanometer range with high spectral resolution.
- SOLACES (SOLar Auto-Calibrating Extreme UV/UV Spectrometers) measures the EUV/UV spectral regime (17 nanometers - 220 nanometers) with moderate spectral resolution.

2.5 Summary of Data at B.USOC

2.5.1 Description of structured data sources

The following structured data sources exist:

2.5.1.1 OSTP (Onboard Short Term Planner)

OSTP (Onboard Short Term Planner) is a web application that displays timeline information about ground and onboard procedures, schedules, and activities. Data can be received from a remote site in a textual, structured format. However, the primary interface that OSTP presents to the user is horizontally scrollable web page displaying with a timeline over several days and various events scattered on it. B.USOC operators view OSTP in read-only mode.

2.5.1.2 IPV (International Procedure Viewer)

IPV is a web application for managing and displaying the database of onboard and ground procedures. The procedures are stored in a well-structured XML format that describes each procedure step by step, sets preconditions and control checks.

2.5.1.3 Telemetry

Telemetry is data organized into packets that is sent by the payload to the control centre.A representative telemetry contains temperature measurements, voltage and current readings, various operational states and reports, such as rotation axes of moving parts.

2.5.1.4 Science data

Although technically part of telemetry, science data belongs to the scientific community represented by the PI (Primary Investigator) and its use more restrictive than that of the telemetry.

2.5.1.5 MDB

The mission database contains a machine-readable description of the telemetry, including the size of various parameters sent in telemetry packets and their interpretation from binary to engineering values.

2.5.1.6 Telecommands

Telecommands are structured data sent to payload during the operations. They may contain control structures for shutting up or starting various modules, as well as uploads of data and scripts. A complete history of telecommands over the operating live of the payload is saved and is made available to the operational environment and to the scientific partners.

2.5.1.7 Auxiliary data

Most of auxiliary data comes from public sources. For instance, current B.USOC operations related to the SOLAR payload heavily depend on TLE (two-line elements) to predict the position of ISS and on the ISS attitude timeline (ATL) to predict the orientation of ISS towards the Sun. These two external data sources are combined in order to create e.g. an optimal shiftplan for operator’s presence.

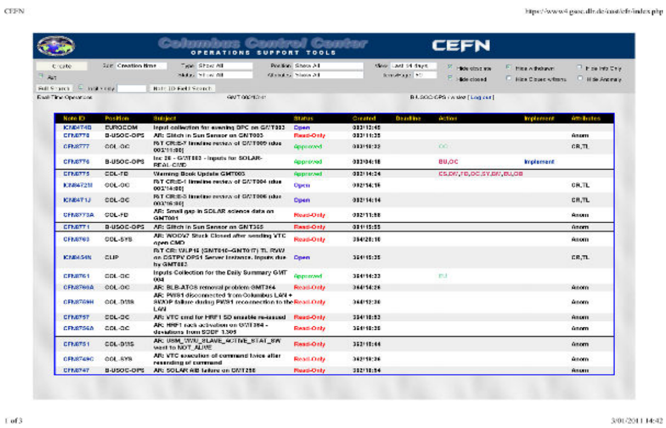
2.5.1.8 System and software logfiles

Some of the software products used throughout the operations produce logfiles that record operator actions and other supplementary information in computer-processable form. Typical examples of such log files are apache logs and windows event logs.

2.5.2 Description of unstructured data sources

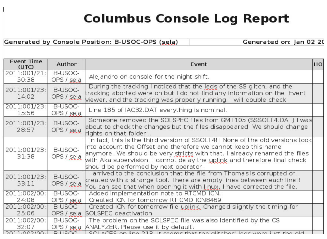
The following unstructured data sources exist:

2.5.2.1 CEFN/ICN



Columbus Flight Notes is an issue tracking web application for the Columbus environment, using by USOC operators and the personnel of the Col-CC Columbus control centre. It is coded in PHP and does not seem to provide any functionality to export the contents of the notes in machine-readable format. ICNs or Intra-Console Notes are a special datatype within the same application that is intended to be used within a single location, e.g. B.USOC and thus invisible to the rest of the Columbus environment.

2.5.2.2 Console Logs



Console logs are short timestamped messages that the operators update every time them make an operation. Examples of such messages are: “File renaming complete.“, “OC requests to provide an anomaly report for the missing data“, “Handing over to John“, etc. Console logs are primarily used for passing over information inbetween shifts and can also be used for forsenics analysis.

2.5.2.3 DOR

Daily operations reports are Excel documents that are filled semi-automatically from a large and complex Excel spreadsheet every 24 hours. They include the summary of the operations by ISS path, as well as reports on discrepancies and anomalies.SOLAR Mission Tool

This is a large Excel file that serves to generate DORs, implement configuration control, and provides a multitude of functionality in order to simplify the manual work of B.USOC operators. The file is constantly updated with payload-related information by the operators during their shifts.

2.5.2.4 PODF

PODF or Payload Operations Data File is a set of documents governing the operations of the payload in the pre-defined situations, such as power loss and particular space weather conditions. These documents are available in IPV and can be retrieved as machine- and human-readable XML files.

2.5.2.5 JOIP, FR, PL Reg

Joint Operations Interface Procedures. Just like PODF, JOIP governs the operations of the payload, JOIP governs the communications between various parties involved in the Columbus environment: NASA, ESA, Roskosmos, flight directors, columbus and and payload operators. FR (Flight Rules) and PL Reg (Payload Reguations) are similar to JOIP and cover standard situations and operations tasks for Columbus. Most of these documents are created in Microsoft Word and distributed as PDF files.

2.5.2.6 SPR, AR. IOT-TS

SPRdb (System Problem Report database) is an online issue tracking system for ground and onboard issues about Columbus, its payloads, and control centres. It is used mainly to report problems to ground segment and payload developers while CEFN is used for operations communication. It has several sections that list SPRs, ARs (Anomaly Reports) and IOT-TS (Industrial Operator Testing Ticketing System) tickets. The contents of the SPRdb database can be extracted into XML files.

2.5.2.7 eRoom

eRoom is a Documentum™ installation that serves as a repository of interface control documents, specifications, technical notes, procedures, protocols, minutes, presentations, reports, manuals, operational products, databases, and emails. Most files are kept in PDF or Office formats.

2.5.2.8 B.USOC Wiki

B.USOC Wiki is a local installation of the eGroupware™ software that serves as a handbook and is updated by operators and other ground staff when needed.

2.5.2.9 Local bugs database

The local bug database is running on Bugzilla and is used by B.USOC operators to enter bug reports related to the software running inside B.USOC.

2.5.3 Restrictions on data

The data of space centres has varying availability restrictions.

- **R3**: Requires USOC's permission only. Support of B.USOC has been obtained for granting access to this category of data: see letter of support of B.USOC in appendix. This data source is sufficient for reaching the very large data volumes required for CUBIST (telemetry datasets).
- **R2**: Property of scientists or ESA. Extra permission may be granted by data owners. The letter of support of B.USOC in appendix ensures B.USOC's support and mediation for accessing such additional data sources.
- **R1**: Restricted to ISS (International Space Station) operations environment Extra permission has tbe asked from ESA, via the B.USOC. The letter of support of B.USOC in appendix ensures B.USOC's support and mediation for accessing such additional data sources.
- **Public**: Some data used in B.USOC comes from public sources, e.g. ISS TLE and attitude data that is freely published by NASA.

The following table summarizes the restrictions applicable to each data source:

R1
OSTP (Onboard Short Term Planner)
IPV (International Procedure Viewer)
CEFN/ICN (Columbus Flight Notes/Intra-console Flight Notes)
PODF (Payload Operations Data File)
JOIP (Joint Operations Interface Procedures)
FR (Flight Rules)
PL Reg(Payload Regulations)
SPR (System Problem Reports)
AR (Anomaly Reports)
IOT-TS (Industrial Operator Testing Ticketing System)
eRoom

R2
Telecommands
Science data
MDB (Mission Database)

R3
Telemetry
System logfiles
B.USOC Wiki
Local bugs database
DOR (Daily Operations Report)

Public
ATL (Attitude timeline)
ISS TLE (Two-line elements)

2.6 Data sets to be used in CUBIST

The data to be used in CUBIST is planned to be derived from the housekeeping telemetry stream of the SOLAR payload. Next to the science data, telemetry is the buggest in size, amounting to many tens of Gbs per year. Additional data sets may be considered to be used throughout the project.

3 Personas

3.1 Objective and Structure of This Chapter

3.1.1 Objective

This section describes the people current operations involving the B.USOC

Stakeholder	Description
Payload Operator	A person working in 24/7 shifts, operating the payload remotely
Ground Controller	A system administrator for the USOC network
Operations Engineer	An engineer defining procedures for payload operations
Principal Investigator	A scientific project manager with varying degree of responsibility
Scientist	A person having privileged access to the data.

3.1.2 Structure

Each persona is described in a rather informal way, providing educational background, carreer path and current activities. A picture of the prototype real person is included, when possible.

3.2 Payload Operator

As an ESA (European Space Agency) certified Payload Operator, the PO participates in operations activities at B.USOC. He is also the leading coordinator of the Console Operators and Ground Controllers teams. He is the project manager for the implementation of the Belgian Facility Support Centre (FSC) and is participating in the implementation of the Erasmus Facility Responsible Centre (FRC).

The PO has a Master's degree in Phisics. Since the university times, the PO was involved in a number of astronomy-related community projects, including volunteering as a planetarium guide, organizing astronomy meeting and workshops and participating in observational astronomy projects.

After graduation, the PO took on small jobs for a while and finaly landed a position within a company that produced innovative hardware where he had the opportunity to participate in the development of an ISS payload. Upon completion of the payload, the PO joined the team of the payload operators and stayed there for the next ten years, becoming a team leader for the payload operations.

Currently, his days are split between working on shift together with other payload operators, coding of tools in PHP/MySQL for the needs of the operations, passing knowledge to the new members of the team, assisting the management in business development tasks and occasional participation in research projects.

With many years of hands-on expertise and a versatile knowledge, the PO is a highly demanded resource and his days are fully booked weeks in advance.

The Payload Operator is the only persona who works in shifts and according to operational schedules, such as 24/7.

3.3 Ground Controller

The Ground Controller operates the space control centre infrastructure, both hardware and software. His responsibilities are split into three areas:

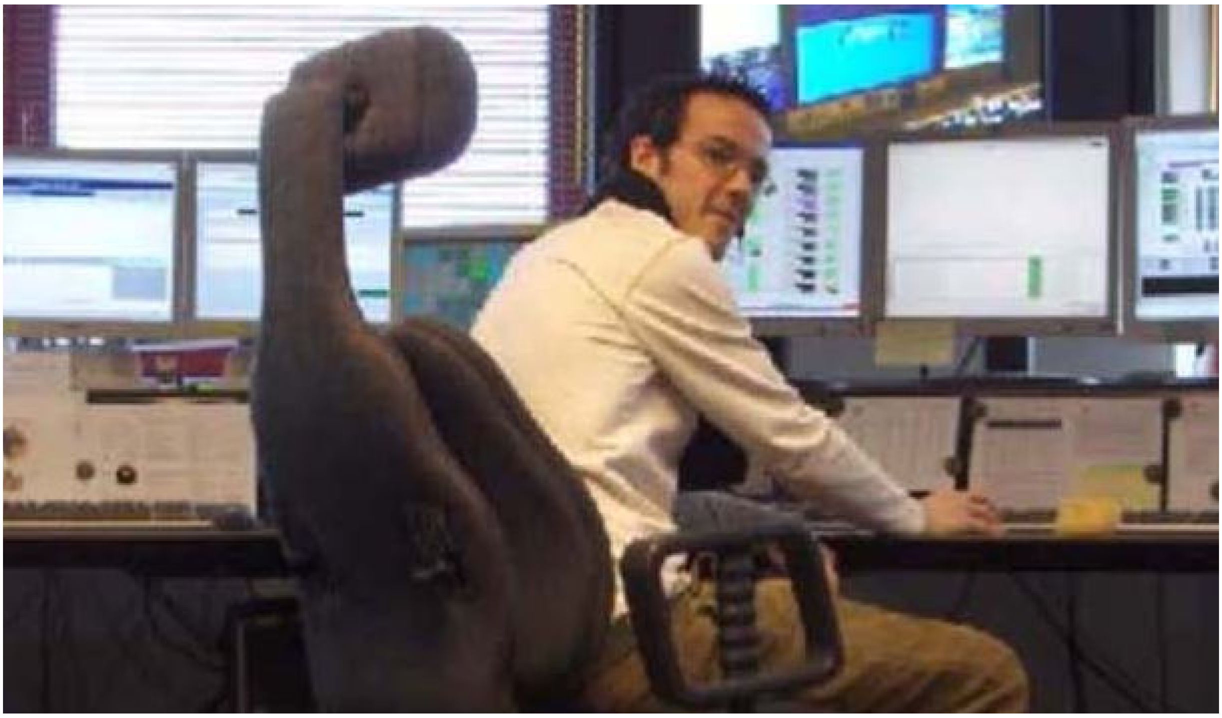
- Networking
- Hardware montioring
- Software support

Specifically, he monitors the local network infrastructure with regards to the security, oversees the execution of security guidelines, preserves the separation of LANs and participates in regular security meetings. He also receives monitoring notifications from the network monitoring systems installed at B.USOC and acts upon. Together with the software and hardware suppliers, he participates in the upgrades of the B.USOC infrastructure. As a qualified software engineer, the GC also implements software tools and utilities to fulfill the needs of the operational environment.

The GC has a M.Sc in Computer Science and has spent over 10 years in the Space business, developing software for various space payloads prior to becoming a Ground Controller.

3.4 Operations Engineer

An Operations Engineer defines the rules and procedures of the payload operations. This position is closely related to the Payload Operator, to the point that many Payload Operators play the role of the Operations Engineer at the beginning of a new mission. Indeed, while Payload Operators and Ground Controllers participate in operations throughout the mission, Operations Engineers are involved in the defintion of the mission rules at the beginning of the mission.



It is not uncommon to see a payload developer becoming an Operations Engineer for defining the rules of a new mission and then continue as the Payload Operator as the mission unrolls.

Our example Operations Engineer has a Master’s degree in Mechanical Engineering. Upon graduation, he started a carreer in the Aerospace industry, developing test procedures and equipment for airplane frames, then switched to the design and implementation of space control centres where he stayed for 6 years, fulfilling the role of the Operations Engineer.

3.5 Principal Investigator

A Principal Investigator is a lead scientist or engineer of a mission. The PI is responsible for delivering scientific results. The PI is usually an academic, often one of the initiators of the mission, although larger missions can have PI positions negotiatied within the consortium that has been assigned to the mission or even by participating countries. In such cases, PI fullfuls a managerial role rather than scientific.

PI usually presides the so called Investigators Working Group(IWG), a loosely coupled group of academics and eventually also industry representatives that define data access and distribution policies for the mission.

The IWG members usually have the right of the first night with regards to the mission data, as they are the same entity that defines the data release strategy and can postpone and sometimes even block public releases of the mission data.

Access to the mission data and dissemination polices are highly political matters. The PI is expected to manage the IWG in a way to find consensus with regards to the data policies among IWG members, the funding bodies and various public institutions.

The PI works usually on the payroll of a university or a research institute an has 10+ years of experience in the domain of research. His time is split between searching for funding, people management and eventually also teaching and conference organizing activities. Due to the high workload, PI delegates a big share of work to other IWG members.

3.6 Scientist

A mission scientist is usually a member of the IWG. The scientist can have influence on the operational decisions related to the payload and is contacted when alternative operations scenarios arise and an optimal decision involves mission data continuity and quality as a parameter.

The scientist is the first to receive and process mission data. He also provides feedback based on the mission data analysis and his scientific knowledge to IWG and sometimes to the mission operator directly.

The scientist is either a postrgaduate or a tenured researcher with 10+ years of academic experience, a dozen of papers on the subject of the mission and impressive scientific accomplishments.

The scientist is the only persona working directly on the data. He usually receives it either in batch mode through an FTP download or in near-realtime via the so called User Home Base setup.

4 Utilisation scenarios (today's operations)

4.1 Objective and Structure of This Chapter

This chapter describes typical events in the life of the B.USOC payload operators. It thus completes people portraits as depicted in Chapter 2.6 by describing typical daily activities.

4.1.1 Objective

The objective of this chapter is to describe the widest possible range of activities of the operators by describing, hour by hour, minute by minute, the operations performed by a payload operator.

4.1.2 Structure

This chapter is organized in stories, each story covering more or less completely a working day or a shift, in operations' slang.

4.2 Scenario #1 - A common space control operator working day

6:30, arrival at the control centre. Handover with the previous operator: overview of what happened, overview of the upcoming activities, overview of the open actions.

Throughout the shift, follow a checklist to perform the routine activities:

- read all logs and handover information since the last shift
- read and clean up the console mailbox, and maintain the group calendar based on these inputs
- check whether the TM archive is complete, and manually fill or investigate potential gaps in the data
- check the NASA predictions on the ISS attitude, and assess if replanning is necessary following new ISS maneuver activities
- perform timeline reviews for the upcoming days, and assess potential impacts on the shift plan; provide change inputs in a predefined format via CEFN
- verify the feasibility of upcoming activities, and initiate replanning if necessary
- verify that all necessary scripts are available in time, and uplinked to the instrument
- review or set up the detailed activity planning for the coming 24 hours, and document these in an Excel sheet, to be submitted via CEFN
- assess and discuss new CEFNs to be processed
- systematically update the Daily Operations Report as events or activities occur

At the predefined time of activities, perform the activities:

- take the corresponding PODF procedure
- contact Col-OC over the loops for the go for the activity, and to be enabled for commanding to the ISS
- Use the Commanding and Display tools to execute the commanding and verifications as per PODF

- Document the activity in the console log, CEFN and DOR
- contact Col-OC to report on the activity outcome, and to disable the commanding link

Throughout the shift, the operator also does the following:

- regularly monitor the instrument status via the realtime displays, helped by coloured LEDs and beeps in case of suspicious events.
- reporting of all activities and events in a console log.
- continuous monitoring of the voice loops for situational awareness and quick response.
- eating, going to the kitchen or sanitary, performing office tasks, not directly related to the execution of real-time operations (mail processing, document writing and review, teleconferences, etc.)

4.3 Scenario #2 - A tough day in the life of a space control center operator

6:30 Arrival at the control centre and time for the B.USOC OPS shift handover. During the night, a strange behaviour of one of the instruments was detected. Suspiciously high temperature has been reported on one of its spectrometer motors. Now the temperature is still high but slowly decreasing. The anomaly has been documented in Anomaly Report SPR-243, but apart from the description of the anomaly, there is little background information at this stage.

7:00 After the shift handover, the night shift operator leaves, and the new operator wants to analyze and further document the anomaly while keeping an eye on the decreasing temperature. A lot of questions pop up. Did we run this same script previously, and how was the temperature changing back then? Is there any trend in the peak temperatures during this activity? Is the high temperature the only deviation from normal or were there other telemetry anomalies? What are the principal parameters influencing the temperature? What design documentation do we have on this spectrometer? Were any anomalies on this part detected during the pre-launch ground tests? These questions trigger lengthy searches through archives, logs, stacks of documents and numerous TM replays, with the subsequent visualisation of the TM in Excel…

8:00 One hour later, the operatorgets a call on the loops: Columbus Flight Director (Col-FD) is worried: his night counterpart agreed with the operator that the high temperature is no threat, and the instrument can keep on running. This new Col-FD is not so sure, and wants a clear answer: who made the decision, based on which argumentation, and what does the safety analysis say on this subject. Without an answer within 30 minutes, the instrument shall be switched off, moving the whole assessment to the much slower off-line world. It’s the moment for the operator to be fast, correct and conclusive…

8:05 All actors from the night shift are asleep now, so the operator has to screen the logged data. he opens all console logs from the night shift actors: previous operators, Col-FD, Col-OC, ISS FD, ESA Safety, ESA POM. The notes are sketchy, and Col-FD apparently was easily convinced, so there are little traces of the argumentation in the logs. Still, the logs show that the discussions started at 3:37 and concluded at 4:29. Also, there is mention of ground tests in 2007 somewhere in the console logs. With 20 minutes left, there is no time to listen to the full replay of the loops for more details, so the operator tries to find this ground test report. He also needs to scan the instrument Safety Data Package (SDP) for any statements on risk mitigation of high temperatures in this instrument’s spectrometer. Luckily it’s daytime now, and an early colleague can be called by phone to search the SDP in parallel. The operator finds the temperature graph, but is unable to determine the context of the test in such a short timespan. With support of his colleague, the operator is able to provide the following approximate answer only a few minutes before the deadline: “Col-FD accepted B.USOC OPS argumentation based on a ground test in 2007 where an even higher temperature was reached. The SDP has no hazard report on overtemperatures in this instrument, so there are no hazards identified." This answer is too vague, and Col-FD requests the instrument to be switched off, which is done 5 minutes later.

8:55 ESA POM (USOC management) is not happy with this switch-off, and wants B.USOC OPS to provide a complete timeline of all events and communications that led to this decision. Moreover, they want a proper analysis of the problem, in order to decide how to proceed. A Columbus Anomaly Resolution Team (CART) teleconference is planned at 11:00 to decide on further steps.

Now, in addition to the analysis, a full replay and transcription of the loop conversations, an extract of the console logs, and a replay of the instrument TM are needed, and all this is to be ordered in time…

9:15 Since the CART meeting could give a green light on re-activation of the instrument, preparing to it becomes top priority. The operator reverts to the initial plan and continues gathering all documentation and data to start analyzing the anomaly characteristics and background information…

11:00 The operator and the backoffice colleagues managed to find out that the same script ran 5 months ago, and showed a similar temperature profile, though the overall instrument temperature was lower, and so was the peak temperature. This likely shows the behaviour is normal and there was thus no reason to switch off the instrument. The operator dials into the CART teleconference, the CART is quickly convinced that activities can be resumed, but forbids further use of this particular Command Schedule (CS) until the Instrument Developer fully analysed the temperature behaviour, and rewrote the CS or redefined temperature limits if necessary. The CART is over at 11:45.

12:15 The operator just completed documenting the outcome of the CART in AR-243, and is ready to request the go for powering on the instrument and resuming operations. Unfortunately, things are not easy: a full replanning of the upcoming measurements is needed: the interrupted CS cannot be used any more, and Soyuz relocation and Soyuz docking activities are planned for the next two days, which will temporarily prevent instrument operations. The operator calls the scientists to discuss the planning, and spends half an hour manually shuffling the the planning in order to accommodate the various planning constraints: PI science programme, orbital mechanics, ISS activities, SAA passes, and TM/TC availability.

A conclusion is reached, but then operations need to start with a CS that is not yet on-board, and this CS has to be started before 13:53. Luckily, Col-OC is not too busy with other activities, and reports to be able to support such a speedy CS uplink. The operator selects the CS from the CS repository, puts it on the dropbox for Col-OC, and announces the uplink request through a CEFN containing the file location, name, size, and MD5 checksum. From here, things go smoothly: the files arrive on-board at 13:23, the operator renames them to their desired final name, and starts the CS at 13:35.

14:12 The actual measurements start, and the TM is not in line with what is expected: it looks like another script is running! The operator now needs to find out very quickly which CS is running, to determine if it is better to leave the CS running or to stop it, and to understand what went wrong! B.USOC OPS needs to examine the content of the CS which was just uplinked, find quickly the recent history of the utilisation of the used file transfer position, and find the associated CS script in the repository.

In a first assessment, the operator finds two very different CSs sharing the same name. Obviously, some error was made in configuration control. B.USOC OPS calls the PI, and they conclude that luckily the intended one is running, so there is no need to stop it. But it's now the task of the operator to trace the history of the various CS with this same name, find out where a mistake was made, and rectify the situation.

14:35 the next operator comes in. the operator explains what happened today, and hands over the open actions to the next operator. At 15:10 he leaves the control centre ...

5 Typical searches over USOC data

5.1 Typical searches during routine operations of SOLAR

- Console Logs: go through all console logs since previous shifts to check for open issues, actions to follow up, general awareness, ...
- TM archive: Check for completeness of the archive
- TM Displays: during periods of "data connection" monitoring of the on-going activities by telemetry monitoring of the housekeeping data of the instruments and payload (temperatures, modes, command schedule tracking, ...)
- ISS ATL: check for possible reboosts of the station which requires a special SOLAR configuration
- SOLAR Mission Tool: check for upcoming activities:
  - Files needed are indeed available onboard
  - Feasibility schedule with respect to possible ATL changes, SAA passes and other constraints
  - Timeline coherence
- CEFN : assess open CEFNs, some examples and required actions:
  - Timeline review: check OSTPV and SOLAR Mission Tool, provide input through CEFN where needed
  - Requests for Powerdown: Check for payload developer's MEMO for minimal required SOLAR power consumption + provide into CEFN
  - IPV review: Check whether PODF related to B.USOC Payloads are correctly uplinked into new IPV+ provide approval (or approval with modification)
  - SOLAR Commanding (CEFN with B.USOC as author): check the SOLAR commanding plan for upcoming 24 hours, should be compliant with the SOLAR Mission Tool and using the correct PODF
  - Open ARs : check AR that may affect the payload, if needed report to COL FCT
  - Ground Segment operations, Check for CEFNs regarding ground segment maintenance or so, check impact on the SOLAR operations and inform Ground Controller
  - Older CEFNs: check previous inputs
- MDB: check command stack for upcoming activities
- IPV/PODF: retrieve correct PODF for execution activities
- IOT-AR/IOT-SPR: check open actions on B.USOC side
- SOLAR Documentation: used as background information to successfully operate SOLAR
- OSTPV: check SAA passes (instrument constraint), KU-S band (TDRSïƒ TM/TC constraint), night-day cycle (SOLAR constraint), SOLAR resources, correct planning. ....
- SOLAR Predictor Tool (tool developed by JMW)/ SOLAR Beta angle: check for Sun Visbility Windows
- BUSOC Mail: check for PIs input, files that have been provided, requests from other operations

5.2 Typical searches in anomaly situations on SOLAR

- Displays: check which parameters were off nominal
- Archive:
  - Retrieve specific parameters of the occurrence/period to insert in an Excel file
  - Replay the occurrence using the displays
- MDB/Command History:
  - Check which commands have been sent
- IPV/PODF: check which procedure has been used
- IOT-AR: check whether the anomaly has occurred before and the analysis or CARTs disposition, if so
  - CEFN: If Anomaly has occurred before check recovery procedure used back then
  - IOT-SPRs: check the offline analysis if the anomaly has occurred before
  - Check Console logs of previous occurrence
- Console Log:
  - Check the logs of all involved parties during the occurrence
- Voice (VoCS): requests replay of the loops coordination (this has never happened for B.USOC)
- COL DMS: retrieve engineering documentation to support the analysis or recovery actions (Safety DP, User Manuals, ...)
- SOLAR Documentation: check reference documentation for analysis
- SOLAR operations Documentation: check reference on the agreed operations concept
- SOLAR shiftplanner Tool (JMW tool) : check which ground controller is on call
- SOLAR POC list: check numbers of PI/Payload Developer/.. to contact them for support
- SOLAR Mission Tool:
  - retrieve current planning to update it
  - retrieve filenames to be uploaded
- SOLAR dropbox: retrieve files to be uploaded
- Flight Rules/ PL Reg: retrieve which Flight Rule or PL Reg is applicable (if so)

6 Summary of today's problems and limitations

6.1 Objective and Structure of This Chapter

6.1.1 Objective

This chapter builds on the previous chapter "Utilisation scenarios (today's operations)" on page 21, identifying problems and limitations in an attempt to suggest improvement areas.

6.1.2 Structure

The chapter is split in two sections. The section 6.2 on page 26 identifies problems and limitations of the current USOC operations while the section 6.3 on page 27 uncovers potential improvement areas.

6.2 Problems and limitations

The operations at the B.USOC are adversely affected by many constaints, but salient differnces with other control center operations are:

- Technical workflows defined by politicians
- Heavy historic heritage
- Lack of access to raw data
- Lack of integration

6.2.1 Technical workflows defined by politicians

USOC operations are dependant not only on ESA infrastructure, but also on NASA and, in some cases, also the Russian space agency (Roscosmos). For instance, ESA communicates with ISS and its various payloads supported by ESA only through NASA infrastructure. The communication protocols, the flow of information and the responsibilities of the parties involved depend on the decades-old multilateral agreements between e.g. US and EU.

6.2.2 Heavy historic heritage

ISS has been in service roughly since 1998 when its first module Zarya was launched. Most of the systems and networks used in USOC operations are even older than that. For instance, a number of computer systems and software evolved for well over 20 years and are populated with relics from previous generations. Personnel turnover and constant updates to the existing code bases render these systems ultimately user-unfriendly.

6.2.3 Lack of access to raw data

Each player in the field develops their own tools and systems that often duplicate each other's systems. This is visible not only on the level of countries (e.g. GPS vs. Galileo) or organisations (TDRS vs. EDRS), but within organisational units and suppliers. The dry outcome is that operators use half a dozen web applications to enter different types of information, sometimes copy-pasting important elements over different applications manually.

The era of Web 2.0 that gives end user control over their data via publicly available APIs did not affect the software systems of the space control centres in any way. Software supplied by vendors and institutions provides only manual access and no data manipulation APIs. Operations teams are constantly seen developing their own tools that solve their day-to-day needs through hacks and monkey-patching of existing infrastructures. Lack of APIs makes adapting the working environment particularly difficult, and the results are often highly unstable. A simple but representative example is the ISS attitude information that is published by NASA through a manually (sic!) updated HTML file that does not forego any formal, let alone computer test, albeit it is used for planning activities on SOLAR (read, in operational environment).

6.2.4 Lack of integration

During the shift, an operator routinely accesses 9 web applications, 5 desktop application, 7 document management systems and half a dozen voice channels (voice loops). Most of these applications have their own security mechanisms, which means that operators have to maintain 14 distinct credentials, including several hardware tokens, such as RSA and smartcards. Their access rights are gouverned by well over 30 security roles.

Periodic credentials management constitutes an important part of operator's activities. Certain password rotation policies require biweekly password updates, others are less restrictive, but still require regular attention. Security role attribution processes differ by application, sometime requiring paper forms to be filled, posted and approved in a lengthy decision-making process.

6.3 Potential improvement areas

6.3.1 Data aggregation

Throughout the "Scenario #1 - A common space control operator working day" on page 21, the operator access a dozen of different software applications. Some of them are web-based, some are gui applications. Certain applications are brand new while others use software that has been unsupported for years.

While communicating with the previous shift and navigating through the minefield of various software applications during the shift, the operator constructs a mental model of the current operational status. Unfortunatley, no software provides a bird's view of the operations and does not combine in one single screen the most important operational information. Big screens that are often seen in the news reports about space control centres are static and unflexible. What an operator needs is a personalized workplace, the one that home users had for years: iGoogle.

Just like iGoogle, this personalized workplace would be configurable by the operator, allowing to put forward the most important bits and pieces of information from console logs, console mailbox, tm archive viewer, ISS altitude predictions, ISS timeline, configuration control, activity planing, flight notes, daily reporting, etc.

6.3.2 Data preprocessing

Most of the information from the sources mentioned in Chapter 6.3.1 shall be preprocessed to be immeidately useful in a personalized workplace. For instance, instead of displaying the console mailbox, a personalized workplace could display the message count. Instead of displaying ISS attitue graph, it could show off the reboost time.

Albeit simple, this preprocessing is impossible unless the data is accessible through an open API, accessible not only to the system integrators but to the operators, payload engineer and ground controllers. That is, people who are actively involved in the day-to-day operations.

6.3.3 Process automation

Preprocessing data for visualisation shall be followed by more complex preprocessing in view of automation of certain tasks. Currently, automation of space control centre operations is at its stone age. One of the highly publicized achievement in this area over the last years was the introduction by NASA of an automated system for uplinking files to ISS that takes into account the size of the queue, the priority of the queue, channel availability and bandwidth prediction and some other factors.

6.3.4 Data linking

One of the biggest advantages of open APIs to is that they are a pre-condition for linking data together. A simple but representative example is the calculation of the shading of the SOLAR payload by ISS structures. The calculation was not forseen in the project, but the operations quickly identified the need. It was quite useful to know when the SOLAR payload can observe the sun. The two types of data necessary for the calculation turned out to be public. They were also available in computer-processable form which qualified as API, althgough the format of ISS attitude file was fairly inconsistent, because produced manually.

A subsecuent calculation of SOLAR shading allowed to optimize operational resources and scientific observations, as well as contributed to the total cost efficience of the operations. Such a success would not be possible without open data and data linking.

6.3.5 Knowledge generation

New knowledge can be created by combining data from various sources, available through open APIs. Such is the use case covered in the previous section. By using ISS attitude and TLE in a well-known way, the operations team could produce long-term planning for SOLAR shading.

7 Opportunities for CUBIST

7.1 Objective and Structure of This Chapter

7.1.1 Objective

This chapter builds on the previous chapter "Summary of today's problems and limitations" on page 26, and suggests improvement opportunities for each of the three technolgies present in CUBIST.

7.1.2 Structure

The chapter is split in three sections. The section 7.2 on page 29 identifies opportunities for the application of FCA, the section 7.3 on page 29 identifies opportunities for Visual Analytics and the section 7.4 on page 29 identifies opportunities for RDF databases.

7.2 Opportunities for FCA

Formal Context Analysis is a mathematical theory of data analysis using formal contexts and concept lattices. In order to function, it needs a specific data format called binary matrix. Depending on the type of data, translating it to a binary matrix may be more or less straightforward.

Scientific data tends to be difficult to translate to a binary matrix without loosing precious information. However, operations-related data, such as housekeeping telemetry and telecommands archives can be easily transformed into binary matrices.

7.3 Opportunities for Visual Analytics

A sheer lack of integration between varous applications at the operator's workplace and a vast amount of data processed manually by the operators creates an opportunity for applying visual analytics techniques.

The lack of integration does not only represent an opportunity, but also poses significal challenges to the implementation of a successful visualisation. Together with the lack of integration, multiple and complex restrictions on data access create obstacles for efficient data reuse.

The CUBIST project specifically focuses on FCA visualization.

7.4 Opportunities for RDF databases

The structure of data used in the operations is often highly complex, defying the limits of relational databases. Existing approaches in dealing with complexity focus along two axes:

- Development of extremely complex and costly RDBMS-based solutions, such as MDB
- Aggregation of data behind simple APIs, limiting access to the complex information.

In this context, RDF databases can play as alternatives for storing data in highly granular way, allowing for easy extraction and low TCO of the overall solution, as compared with RDBMs.

8 Utilisation scenarios (future operations helped by CUBIST)

8.1 Objective and Structure of This Chapter

8.1.1 Objective

For short: this chapter is the CUBIST's answer to the previous chapter.

- In chapter 4 on page 21, we first provided user stories describing current operations in the field of space control centres. Then, we highlighted several recurrent problems and limitations (section 5.2 on page 25).
- In this chapter, the utilisation scenarios are reiterated with the assumption that a CUBIST system is in place. This will show the added value that CUBIST will provide. Afterwards, we summarize what questions previously raised in critical situations and problems CUBIST will actually address.
- The **Initial Mock-up** D8.1.2 complements this chapter with PowerPoint illustrations that further details the utilisation scenarios involving CUBIST.
- This informal utilisation scenarios will serve as a starting point for listing the requirements in a formal way (chapter 9 on page 32).

8.1.2 Structure

This chapter has systematically adopted the same structure (table of contents) as for its counter-part chapter 4 on page 21.

8.2 Story #1 - Nominal Situation (with CUBIST)

6:30, arrival at the control centre. Handover from the previous operator: overview of what happened, overview of upcoming activities, overview of open actions.

Throughout the shift, follow a checklist to perform the routine activities. In addition to these activities, stay alerted to CUBIST notifications, such as:

- TM incompleteness data notifications
- ISS reboost predictions
- SOLAR shading predictions
- Any other notifications produced by CUBIST

At the predefined time of activities, perform the following CUBIST-related activities:

- Observe telemetry visualisation and warning system using e.g. an FCA-based visual analytics system.

8.3 Story #2 - B.USOC Disaster Day (with CUBIST)

This section lists possible anomalies at B.USOC that could be saved by CUBIST. Each anomaly has its roots in the real operations. Depending on the anomaly a particular usage pattern for CUBIST can be identified.

8.3.1 SDP data mining

On certain occasions, the ISS Flight Director wants to know whether a specific unforeseen configuration is safe. The operator shell then research the issue and present a well-grounded report within an hour or so. In order to produce a report. The most important source of data in this situation is the SDP (Safety Data Pack). SDP is a stockpile of document with a very limited search capabilities. Although this is barely in scope of CUBIST, a system that would allow to search through the SDP documents in a structured way and to present the graphically rich interface to those documents is likely to improve the response time of the operator.

8.4 Telemetry data mining

It may happen that a specific payload manifests an unforeseen thermal situation. That is, a situation when the temperature on one or several sensors changes in an unusual way, albeit within the nominal limits. The operator is then charged with finding similar occurrences inside the telemetry archive and with the determination of typical thermal and power profiles. Currently, the search in the telemetry archive is usually done as a real-time or faster replay of the telemetry archive. A more intelligent solution that employs Business Intelligence techniques may be implemented, so that an automated agent find the occurrences of similar situations by taking into account all the telemetry parameters.

8.4.1 Forensics analysis

A few months after the launch of the SOLAR payload, SOVIM, one of its three scientific instruments died because of an electric failure in a DC-DC converter. It is yet unknown whether this failure could have been predicted given the previous telemetry stream. The objective of the CUBIST system would be to find patterns of failure in the flow of telemetry parameters with the aim to transpose these to the prediction of future failures.

9 Formal requirements

9.1 Objective and Structure of This Chapter

9.1.1 Objective

In this chapter, the formal requirements for the CUBIST system are described.

9.1.2 Structure - Identification and Prioritisation of Requirements

The requirements are presented according to D1.1.1 Directives for the Requirement Analysis in the Use Cases.

The orignal of the requirements is a Microsoft Excel file containing the following fields:

9.1.2.1 Partner

An abbreviation of the project partner entity (SAP, SHU, HWU, SAS, INNO, ECP, ONTO)

9.1.2.2 Originator:

The name of the person who first introduced the requirement

9.1.2.3 Req #:

The sequential number of the requirement in the form <ABBR><XXX> where ABBR is an abbreviation of the project partner entity and XXX is a three-digit number.

9.1.2.4 Req. Type:

This field is a selection list of the following values:

- Purpose of the Project
- Mandated Constraint
- Functional Requirement
- Data Requirement
- Look and Feel
- Usability and Humanity Requirement
- Performance Requirement
- Operational Requirement
- Maintainability and Support Requirement
- Security Requirement
- Legal Requirement

9.1.2.5 Priority:

- mandatory
- desirable

9.1.2.6 Description:

Description of the requirement, given preferably in a single sentence.

9.1.2.7 Rationale:

In this field, a justification of the requirement is provided.

9.1.2.8 Fit Criterion

This field contain the description of the validation and verification strategy.

9.2 List of formal requirements

The four fields of the formal requirements below contain sequentially:

- Requirement number
- Priority
- Description
- Rationale
- Fit Criterion

9.2.1 Purpose of project

Req. #	Priority	Description	Rationale	Fit Criterion
SAS001	1 mand.	CUBIST software shall be used with space control centre data as delivered by SAS	This is one of the objectives of the DoW.	Via testing of the use case prototypes v1 and v2.
SAS002	1 mand.	Provide analytical features on top of existing data	Lots of data, yet no analytical features	

9.2.2 Functional Requirements

Req. #	Priority	Description	Rationale	Fit Criterion
SAS003	1 mand.	CUBIST software shall use FCA for suggesting new patterns in data	This is one of the objectives of the DoW.	Via testing of the use case prototypes v1 and v2.
SAS004	1 mand.	CUBIST software shall produce visual representation of data	This is one of the objectives of the DoW.	Via testing of the use case prototypes v1 and v2.
SAS005	1 mand.	CUBIST software shall store existing data in an RDF store and provide an extended SPARQL query interface to the data.	This is one of the objectives of the DoW.	Via testing of the use case prototypes v1 and v2.
SAS007	1 mand.	CUBIST software shall try to avoid (where possible) terminology of the underlying technology	Users come from different backgrounds	Via the review of text strings deployed in software.
SAS006	2 des.	CUBIST shall research analytical and BI solutions to space control centre document management issues	A number of potential improvement areas related to document management has been identified.	
SAS008	2 des.	Provide a FCA-based visual outlook of the data in the triple store	Space control centre operations run on tight schedule. A graphical UI for the otherwise numeric data will simplify cognitive operations	
SAS009	2 des.	Provide an interactive environment to users	Users need to navigate the data and to receive instant feedback from software.	By review of design
SAS011	2 des.	It shall be possible to incrementally update the datastore with more data	This is essential for the telemetry use case where data comes in at a constant rate.	By review of design

9.2.3 Operational requirements

Req. #	Priority	Description	Rationale	Fit Criterion
SAS012	2 des.	The installation procedure shall be scriptable and allow for automation	Easiness of system administraton and operational support is of paramount importance	By testing

9.2.4 Maintainability and support requirements

Req. #	Priority	Description	Rationale	Fit Criterion
SAS013	1 mand.	CUBIST users shall be able to have complete control over the data managed by CUBIST software and the CUBIST software as such	CUBIST users shall have complete control over the data managed by CUBIST software and the CUBIST software as such	By architecture review. See also the relevant Security requirement
SAS014	2 des.	The system shall be documented.	Inputs for user training and subsequent reference documentation shall be available.	

9.2.5 Security requirements

Req. #	Priority	Description	Rationale	Fit Criterion
SAS015	1 mand.	CUBIST software shall allow the user to host all the data locally (not locally on the PC; but in the environment)	Some data related to space control centre operations has restrictions with regards to the location of data. For instance, operational data is not allowed to leave the operations environment.	By architecture review. See also the relevant Maintainability and Support Requirement.
SAS016	1 mand.	Public cloud services shall not be used to store and process space control centre data unless complete confidentiality of such data is assured.	CUBIST users shall have complete control over the data managed by CUBIST software.	No public cloud service is used.

9.2.6 Legal requirements

Req. #	Priority	Description	Rationale	Fit Criterion
SAS018	1 mand.	The licensing agreement for CUBIST software shall not put any restriction on data use.	Space control centre data utilisation and distribution is already strictly controlled.	Absence of an data-related statements in the CUBIST software licensing agreement.
SAS019	1 mand.	The originator of the data has to be credited.	This means in practice that the data provided by B.USOC or ESA has to be credited.	By testing