

VOSSCA

Design Document

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1 Introduction

This document contains the technical design for

Mission	All (initially THEOS1)
Segment	Ground Segment
System	Mission Control
Subsystem	Satellite Control System

The document is structured in accordance with [ECSS-SW] for Interface Control Documents.

1.1 Purpose

The purpose of this document is to describe the Satellite Control System (SCS) interface.

2 Documents

2.1 Reference Documents

ID	Title	Reference
CCSDS	Consultative Committee for Space Data Systems	CCSDS 102.0-B-5
CCS-DD	CCS Design Description	CCS-TER-DD-001
CCS-MAN	CCS User Manual	CCS-TER-MAN-001
CCS-TN	TSC & CCS5 Technical Features	CCS-TER-TN-001
CCS-WEB	Terma CCS Web Site	http://ccs.terma.com
UTOPE	uTOPE Reference Manual	CCS-TER-MAN-002
TCL	TCL Language Reference Manual	CCS-TER-MAN-003
SYN	Synopter Reference Manual	SYN-TER-MAN-001
CCS-TP	CCS Test Procedure	CCS-TER-TP-001
DBM-MAN	Data Base Manager Reference Manual	DBM-TER-MAN-0002
MIB	SCOS2000 Database Import ICD (issue 6.9)	EGOS-MCS-S2K-ICD-0001
PSS-TM	Packet Telemetry Standard	PSS-04-106 Issue 1
PSS-TC	Packet Telecommand Standard	PSS-04-107 Issue 2
ECSS-PUS	Ground Systems & operations TM & TC packet utilization	ECSS-E-70-41A
PSS-COD	Telecommand Decoder Specification	PSS-04-151 Issue 1
ECSS-COD	Space data links – TC protocols synchronization & coding	ECSS-E-ST-50-04C
ECSS-SW	Space Engineering – Software	ECSS-E-ST-40C
CTX-TTC	ZDS Telemetry Tracking & Control	STI 10013 3.7
CTX-CRTU	ZDS Command Ranging & Telemetry Unit	STI 10013_CRT 2.16
CTX-COP1	ZDS Communication Operation Procedure (COP-1)	STI 10017 2.2
SLE-RAF	SLE Return All Frames Service Specification	CCSDS 911.1-B-2
SLE-FCLTU	SLE Forward CLTU Service Specification	CCSDS 912.1-B-3
THEOS1SIM	THEOS Simulator (THEOSIM) User Manual	THEO.UM.00005.T.ASTR
QT-MAN	In Qt Assistant, or online at http://qt-project.org/doc/	

3 Definitions

Term	Explanation
API	Application Programming Interface
ARC	Archive
CCS(5)	Central Checkout System (version 5)
CCSDS	Consultative Committee for Space Data Systems
CFI	Customer Furnished Item
CLCW	Command Link Control Word
CLTU	Command Link Transfer Unit
COTS	Commercial Off-The-Shelf
CPU	Central Processor Unit
DBM	Data Base Manager
DSS	Dynamic Satellite Simulator(s)
ECSS	European Cooperation for Space Standardization
FDS	Flight Dynamics Subsystem
FT	Fault-Tolerance
GS	Ground Segment / Station
GSFE	Ground Segment / Station Front-End
IP	Internet Protocol
LAN	Local Area Network
LEOP	Launch & Early Operations Phase
LTO	Linear Tape-Open
LUN	Logical Unit Number
MAPID	Multiplexer Access Point ID
MIB	Mission Information (data) Base
MMI	Man-Machine Interface
MOIS	Manufacturing & Operations Information System
MPS	Mission Planning Subsystem
MSTK	Manual (Command) Stack
MTL	Mission Time Line
NTP	Network Time Protocol
PCoIP	PC (desktop access) over IP
PCM	Pulse Code Modulation
PLP	Payload Planning Subsystem
PUS	Packet Utilization Standard
RAMS	Reliability, Availability, Maintenance & Safety
RDP	Remote Desktop Protocol
SAN	Storage Area Network
SCOS(2000)	Space Craft Operations System (2000)
SCS	Satellite Control System
SDE	Software Development Environment

Term	Explanation
SLE	Space Link Extension
SOM	Satellite Operations Module
SPID	SCOS(2000) Packet Identifier
SSC	Source Sequence Count
SVN	Subversion
SYN	Synopter (Terma synoptic picture software module)
TC	Telecommand
TDM	Time Domain Multiplexed
TM	Telemetry
TOPE	Test and Operations Procedure Executive
TSC	Test Sequence Console
TT(&)C	Telemetry Tracking & Control
UPS	Uninterruptible Power Supply
UTC	Universal Time Coordinated
UTOPE	UTOPE is the Terma reimplementatation of TOPE
VC	Virtual Channel
VDI	Virtual Desktop Infrastructure
VLAN	Virtual LAN
VM	Virtual Machine
VMFS	Virtual Machine File System
VNC	Virtual Networked Computing
VPN	Virtual Private Network
V-SCS	Virtualized SCS
WAN	Wide Area network

4 System Overview

This section gives a short system design overview

4.1 System Overview

In our system architecture the customer requirements are split as follows

SCS	Satellite Control Subsystem	SCS is implemented using CCS5 , a fully modernised and high-performance spacecraft monitoring & control system.
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4.1.1 System Context

Figure 4-1 below shows the context

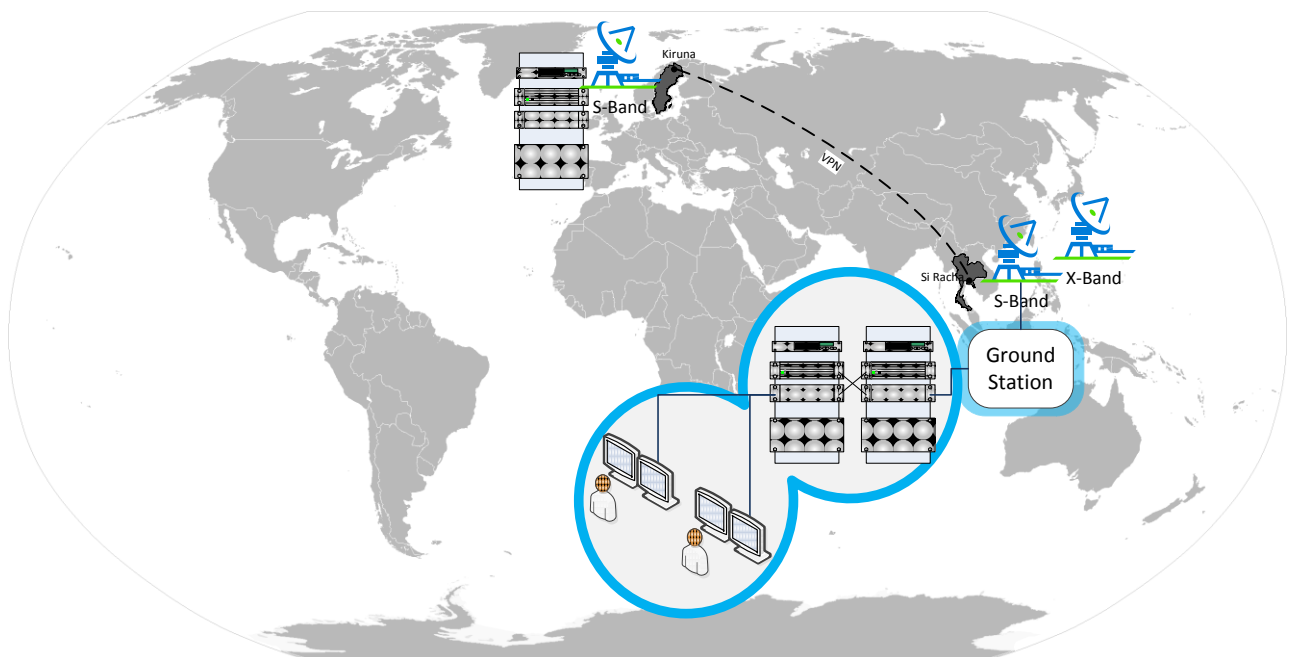


Figure 4-1 System Context

4.2 Software & Hardware Static Architecture Summary

4.2.1 Software Monitoring & Control Features

CCS5 is a generic spacecraft monitoring & control software system. It has been designed to allow a smooth transition from SCOS2000 while improving performance and modernising its user interfaces. Notably it preserves compatibility with:

- SCOS MIB database ICD
- The TOPE test and automation language.
- Variety of ground segment Interfaces.
- Common system for test & mission control
- Full TT&C support
- Touch, Gesture and next generation control

4.2.2 Standard

- **Packet & Frame Coding & Flow Control:** ECSS-E-ST-50-01C, 03C, 04C; ESA PSS-04-106,107,151; CCSDS 102.0-B-5, 201.0-B-3, 202.0-B-3, 202.1-B-2, 301.0-B-3
- **Packet Utilization (PUS):** ECSS-E-70-41A

4.2.3 Software Behaviour Summary

The operational aspects of the system behaviour are derived from the existing THEOS1 control centre. The system is entirely operated via S-band, with a downlink capability of approximately 400 Kbit/s. This information is summarised:

- Real time TM rate = 40 Kbit/s (average 40 packet/s of 125 bytes)
- Playback TM rate = 360 Kbit/s (average 360 packet/s of 125 bytes)

For THEOS1 Astrium states that the playback downlink duration is about 25s, which is confirmed by real GISTDA experience within 30s.

4.2.4 Spacecraft Database

The VOSSCA system will use [MIB] database structure. SCOS2000 MIB ICD 6.9 extended: (e.g.) unlimited field lengths, drop & load multiple databases, deduced parameters in TM & TC, variable parameters globally accessible & limit-checked, fine control of variable length parameters, big & little-endian parameters, VPD_CHOICE, dynamic HK definition. All tables accessible from TOPE. [Ref. MIB SCOS2000 Database Import ICD (issue 6.9) EGOS-MCS-S2K-ICD-0001]

4.2.5 Ground Segment Interface

The Ground Segment interface for THEOS1 consists of:

- ZDS S-band Cortex Modem (Sri Racha and Kiruna)

Current THEOS1 infrastructure is sometimes modified to use other ground stations having the same remote modem interface.

For testing the SCS, a THEOS1 satellite simulator is available that uses the interface of the Astrium THEOS1 simulator [THEOS1-SIMIF]

4.2.6 Authentication / Encryption

- Neither authentication nor encryption shall be used as a means to prevent replacement of equipment by other suppliers.
- Standard algorithms shall be used. Key shall be security stored, but usable by GISTDA.
- Process to change authentication and encryption keys shall be demonstrated.

4.2.7 COTS Software Packages

- Operating System: currently **Windows™** : works on all recent versions. Automated installer. Tested on Windows 7
- Archive RDBMS : MySQL
- Configuration Management : SubVersion (SVN) and TortoiseSVN
- Database Manager (DBM): MS Access (runtime or as part of MS Office)
- SNMP: SimpleSoft SNMP plugin: required to manage SNMP equipment from TOPE

If a virtual platform is used: this requires Base package with licenses

- VMware vSphere Hypervisor, including VMFS, vMotion and vCenter Server

For running high-performance user interfaces from remote desktop clients

- VMware Horizon View

4.2.8 Software Platform

C++ based on Qt5.4 commercial. Tcl/Tk libraries included on BSD license terms. No other free (e.g. GNU) software is packaged.

4.3 V-MMI: VOSSCA Advanced MMI

The V-MMI ("VOSSCA Man-Machine-Interface") aims to provide a more exciting and enticing user experience for satellite control. Conventionally a CCS has to provide the basic facilities for examining closely the detailed contents of TM and TC packets, however these user interfaces are extremely intricate. During routine operations, a more synoptic high-level interface is preferred.

this MMI has already been integrated into CCS, by including elements of the Qt technology QML (Qt Meta Language) in the user interface.

Some classes have been developed to give QML scripts embedded in the CCS access to the internal data of the CCS, e.g.:

- TM Parameters
- TOPE Sequences

- MIB data
- Alarms model
- Procedure model
- A QML wrapper for the existing Qt SQL table model allowing QML views to easily display data extracted from the CCS archive database (since it seems Qt do not plan to provide such a class in the short term).
- Small improvements to the features for opening a QML user interface automatically so as to either hide or give the appearance of a completely immersive user interface (completely take over specific screens)

retrieval access to the CCS archive, possibly allowing to step through parameter values, alarm events or display them on graphs.

4.4 CORTEX Interface

The baseline ground segment interface is the CORTEX interface. This equipment is so widely used as to be considered a de-facto standard. The basics of the interface are defined in [CTX-CRTU]. The interface uses TCP/IP as a transport layer. It supports:

- TM CCSDS VCDU (frames) with up to 24 connections simultaneously.
- Satellite specific TC requests (in units of bits) with only 1 TC connection at a time
- Setting to Ranging mode
- Data simulation ports

The TCP/IP ports are described in [CTX-CRTU] §2.1.4, the main ports of interest being:

Port Number	Purpose
3020	Satellite TC data (max 1 client)
3070	Real time TM data (max 24 clients)
3000	Cortex monitoring data (max 24 clients)

4.5 Simulator Interface

The THEOS1 simulator interface is consists of simple TCP/IP sockets which can be connected on one of a pair of “port-sets”. The user can choose one of two port sets, which must be selected and opened on the simulator itself. The client must select the same port set and connect to the simulator.

The port sets consist of:

- A TC port for sending CLTU
- A set of TM ports for receiving TM frames, nominally one for each VC (virtual channel).

The “protocol” is the simplest possible: CLTU and TM frames are transmitted directly on the TCP/IP ports as binary data. Since the protocol does not provide any positive or negative feedback on the command link, the implementation will simply conclude that uplink has been successful by virtue of successfully sending on the TCP/IP command socket.