Metop HRPT/LRPT User Station Design Specification

	Responsibility - Company	Date	Signature
Prepared by A. LE BER	Engineer - ALCATEL		
Approved by (Technical) F. DIDELOT	Technical Manager - ALCATEL		
Approved by (Quality) M. QUERE	Quality Assurance Manager - ALCATEL		
Authorised by D. JAN	Project Manager - ALCATEL		

Configuration Item number:
if applicable

Summary: This document defines the design specification of an HRPT User Station and an LRPT User Station.

Document submitted to EUMETSAT for:

☒ **Approval** ☐ **Review** ☐ **Information**

Signature

CHANGE RECORDS

ISSUE	DATE	§: CHANGE RECORD	AUTHOR
1.0	03/05/02	First issue of the document	ALB
1.1	05/03/03	Update due to CGS CDR : 1. CGSCDR-M-H/L-SDS-EST-EN-002 Bullet 1) closed no update Bullet 2) closed no update Bullet 3) updated Bullet 4) updated Bullet 5) updated Bullet 6) closed no update Bullet 7) closed no update Bullet 8) updated Bullet 9) closed no update Bullet 10) closed no update 2. CGSCDR-M-H/L-SDS-EUM-RGC-049 3. CGSCDR-M-H/L-SDS-EUM-RGC-050 4. CGSCDR-M-H/L-SDS-EUM-RGC-051 5. CGSCDR-M-H/L-SDS-EUM-RGC-052 6. CGSCDR-M-H/L-SDS-EUM-RGC-054 (Refer to DJ-0673) 7. CGSCDR-M-H/L-SDS-EUM-JGP-288 8. CGSCDR-M-H/L-SDS-EUM-JGP-309 (with reference to CGSCDR-M-H/L-SDS-EUM-JGP-288). 9. CGSCDR-M-H/L-SDS-EUM-JGP-302 10. CGSCDR-M-H/L-SDS-EUM-JGP-303 Bullets 1-2-3) was checked but no additional information is available (Industrial proprieties). Bullet 4) ASP still states that these information are already in the document (cf. 3.4.5.1.1.1).	ALB

TABLE OF CONTENTS

CHANGE RECORDS 2

TABLE OF CONTENTS 3

LIST OF FIGURES 5

LIST OF TABLES 6

1. INTRODUCTION 7

1.1 PURPOSE OF THE DOCUMENT 7

1.2 DOCUMENT STRUCTURE 7

1.3 APPLICABLE AND REFERENCE DOCUMENTS 8

1.3.1 Applicable Documents 8

1.3.2 Reference Documents 8

2. GENERAL DESCRIPTION 9

3. HRPT USER STATION 11

3.1 OVERALL DESIGN CONCEPT 11

3.2 RELATION TO OTHER SYSTEMS 11

3.3 CONSTRAINTS 13

3.4 DESCRIPTION 13

3.4.1 Antenna 14

3.4.2 Receiver 20

3.4.3 Time and Frequency Reference 21

3.4.4 Tracking unit 22

3.4.5 Local M&C 23

3.4.6 Front End Processor 28

4. LRPT USER STATION 47

4.1 OVERALL DESIGN CONCEPT 47

4.2 RELATION TO OTHER SYSTEMS 47

4.3 CONSTRAINTS **49**

4.4 DESCRIPTION **49**

4.4.1 Antenna 50

4.4.2 Receiver 53

4.4.3 Time and Frequency Reference 53

4.4.4 Local M&C 54

4.4.5 Front End Processor 55

5. TEST MODULE **57**

5.1 INTRODUCTION **57**

5.2 SOME TESTING MODULES **58**

5.2.1 Output card 58

5.2.2 Test Unit 58

6. GLOSSARY **61**

ANNEX A: US PRODUCTS **63**

ANNEX B: ENVIRONMENTAL CONSTRAINTS **65**

ANNEX C: ADMINISTRATIVE MESSAGE **67**

ANNEX D: DECRYPTION KEY FILE **71**

ANNEX E: TAPE FORMAT **73**

LIST OF FIGURES

Figure 3.2-1 : HRPT US Physical Interfaces high level diagram 12
Figure 3.4-1 : HRPT US Block Diagram 14
Figure 3.4-2. HRPT Power Flux Density 16
Figure 3.4-3. L-Band Antenna Drive Block diagram 17
Figure 3.4-4. L-Band Pre-amplifier 19
Figure 3.4-5. L-Band to VHF Frequency Converter 19
Figure 3.4-6. VHF Receiver Block Diagram 21
Figure 3.4-7. F&T S/S functional diagram 21
Figure 3.4-8. Tracking unit functional diagram 23
Figure 3.4-9. Local M&C connections 23
Figure 3.4-10. Station Mimic Block Diagram 24
Figure 3.4-11. LogBook 27
Figure 3.4-12. FEP Components 28
Figure 3.4-13. SCS Overview 29
Figure 3.4-14. Subsystem Overview 32
Figure 3.4-15. L0 Overview 36
Figure 3.4-16. Adm Message Display 38
Figure 3.4-17. QuickLook Processor and Moving Window Display 40
Figure 3.4-18. Moving Window Display 42
Figure 3.4-19. Schedule Display 43
Figure 3.4-20. Subsystem Display 44
Figure 3.4-21. Eventlog Browser 45
Figure 3.4-22. Mission Planner Unit 46
Figure 4.2-1 : LRPT US Physical Interfaces high level diagram 48

Figure 4.4-1 : LRPT US Block Diagram 50
Figure 4.4-2. LRPT Power Flux Density 52
Figure 4.4-3. F&T S/S functional diagram 53
Figure 4.4-4. Local M&C connections 54
Figure 4.4-5. FEP Components 55
Figure 5.1-1. HRPT/LRPT Common testing module 57
Figure 5.2-1. Test transmitter 59
Figure 5.2-2. HRPT Testing Chain 60
Figure 5.2-3. LRPT Testing Chain 60

LIST OF TABLES

Table 3.2-1 HRPT US interfaces 12
Table 3.4-1 METOP HRPT Link Characteristics 15
Table 3.4-2. L-Band Antenna Drive and Mechanical Characteristics 18
Table 3.4-3. LNA and DC assembly characteristics 20
Table 3.4-4. Instrument Overview 40
Table 4.2-1 HRPT US interfaces 48
Table 4.4-1. METOP LRPT LINK CHARACTERISTICS 51

1. INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document gives the design aspects of the User Station (US) Facility, as a stand-alone acquisition and processing system of the Metop Satellites.

User Station purpose is to manage the HRPT or LRPT data, acquired from one Metop Satellite at a time.

1.2 DOCUMENT STRUCTURE

This document contains 6 chapters, which are structured as follows:

Chapter 1 This chapter.

Chapter 2 provides some background and context to the US

Chapter 3 gives description of the HRPT User Station design.

Chapter 4 gives description of the LRPT User Station design.

Chapter 5 gives description of the HRPT/LRPT Testing Module design.

Chapter 6 contains a glossary of abbreviations, acronyms and terms.

1.3 APPLICABLE AND REFERENCE DOCUMENTS

1.3.1 *Applicable Documents*

Document Title	Identifier	Internal Reference
HRPT/LRPT Direct Broadcast Service Specification	EPS/SYS/SPE/95413	[E-AD2]
SKU ICD	EUM/MSG/ICD/114	[E-AD78]
EUMETSAT Polar System (EPS) / Meteorological Operational satellite (METOP) Encryption System Specification	EPS.SYS.SPE.95424	[E-AD87]
C-KMC Encryption Key Update Distribution Format	EUM.EPS.GSE.TEN.00.008	[E-AD58]
LRPT Reference Compressor / Decompressor	TN-MO-TN-ESA-SY-0124	[E-RD137]
EPS Generic Product Format Specification	EPS/GGS/SPE/96167	[E-RD36]
EPS Product Convention Document	EPS/SYS/TEN/990007	[E-AD98]
Level 0 Product Generation Specification (SBUV, SEM, DCS, A-DCS, IASI)	EUM.EPS.SYS.SPE.990016	[E-AD35]
IASI Measurement and Verification Data	IA-ID-1000-6477-AER	[E-AD131]
MHS TM TC and Science Data Format Directory	MHS-TN-JA063-MMP	[E-RD141]
GOME-2 Instrument Interface Control Document	MO-DS-LAB-GO-0006	[E-RD157]
ASCAT Measurement Data Interface Specification	MO-TN-DOR-SC-0015	[E-RD143]
GRAS Measurement Data Interface Control Document	MO.IC.SES.GR.0008	[E-RD144]
HIRS ICD	MO-IC-MMT-HI-0001	[E-RD147]
AVHR ICD	MO-IC-MMT-AH-0001	[E-RD148]
AMSU A1 ICD	MO-IC-MMT-A1-001	[E-RD149]
AMSU A2 ICD	MO-ICD-MMT-A2-001	[E-RD150]
SEM ICD	MO-IC-MMT-SE-0001	[E-RD151]
A-DCS ICD	MO-IC-MMT-DC-0001	[E-RD152]

1.3.2 *Reference Documents*

Document Title	Identifier	Internal Reference
Glossary of terms and abbreviations list	EPS-ASPI-LI-0010	[A-RD0010]

2. GENERAL DESCRIPTION

The Reference User Station will be located at the EUMETSAT HQ and will constitute the reference station for the potential users of the Local Mission function (HRPT and LRPT signals reception) of the Metop satellite.

The User Stations can be located anywhere around the world.

This document contains two main sections :

- one for the HRPT US Design.
- one for the LRPT US Design.

THIS PAGE IS INTENTIONALLY LEFT BLANK

3. HRPT USER STATION

3.1 OVERALL DESIGN CONCEPT

The HRPT US shall be able to support several Metop satellite successively.

The HRPT US shall be able to run into an autonomous way, without the need for the intervention of the local operators.

The HRPT US shall be monitored and controlled through a friendly GUI.

The HRPT US is scalable to allow it to be run on suitably sized COTS platforms.

External interfaces of the HRPT US shall be based on COTS : Tape (with standard tar command), Floppy disk, CD-Rom, Ethernet LAN connectivity, Internet connectivity, Network Time Protocol for Time Synchronisation, etc ...

The HRPT US shall contain normalised injection points, to allow full or partial testing of the HRPT US.

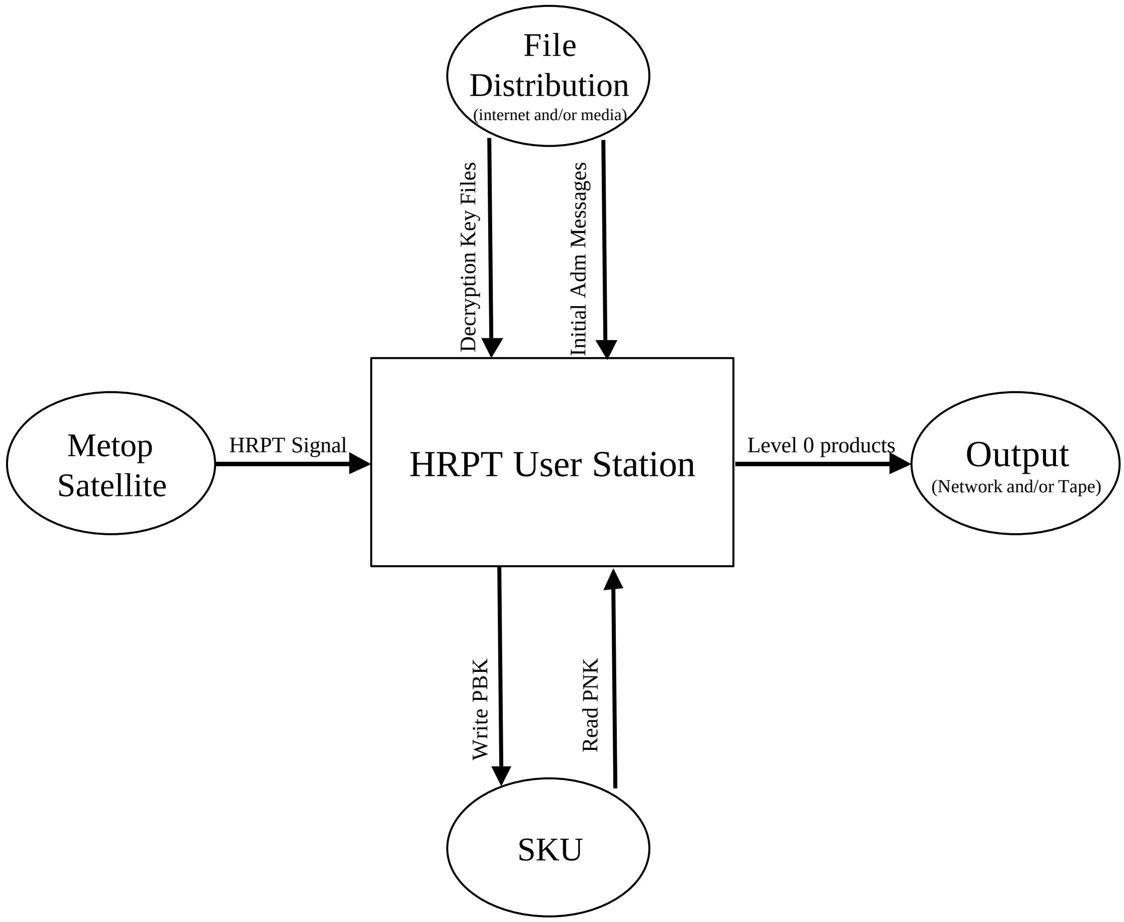
3.2 RELATION TO OTHER SYSTEMS

The US interfaces physically with:

- The Metop Satellite ;
- The Output (which can be a Tape and/or FTP server) ;
- The File Distribution ;
- The SKU.

Data flows input or output from the US have been identified through separate physical interfaces, whose decomposition is given into the following high level diagrams.

Figure 3.2-1 : HRPT US Physical Interfaces high level diagram



From all the physical interfaces described above, it is possible to regroup several instances into single common flows, as they are linked to the same external facilities and they show the same format. It is also possible to split many flux into interfaces subsets.

The physical interfaces are detailed with the Source or the Destination (to US or from US), with the support used and the format (bit level description).

Table 3.2-1 HRPT US interfaces

Physical interfaces	Source/Destination	Support	Format
Metop HRPT carrier	Metop Satellite	L-Band	Refer to [E-AD2]
Decryption key files	C-KMC	Floppy, cd-rom, web, …	Refer to Appendix
Initial Administrative Message	Eumetsat [TBC]	Floppy, cd-rom, web, …	Refer to Appendix
HRPT Level 0	User Site Operator	Tape or network	Refer to [E-RD36]
Write PBK	SKU	RS-422	Refer to [E-AD78]
Read PNK	SKU	RS-422	Refer to [E-AD78]

3.3 CONSTRAINTS

As US can be located all around the world, the Antenna of the HRPT US shall comply with environmental constraints defined in Appendix B.

The HRPT US shall contain all peripherals needed :

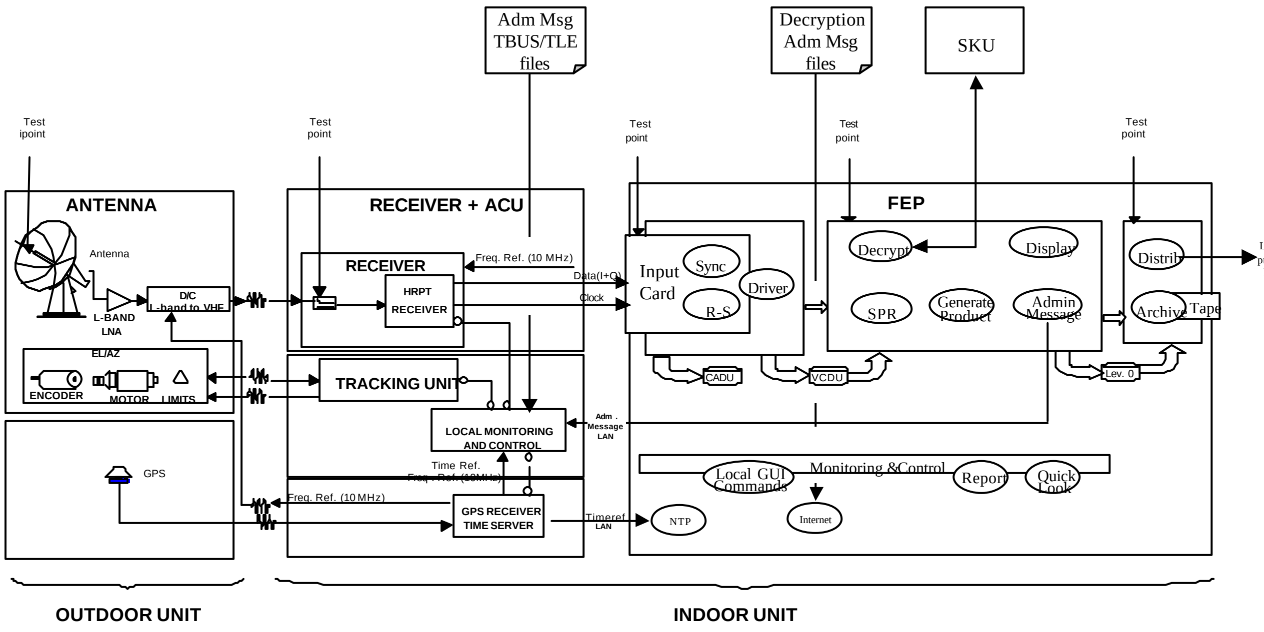
- An RS-422 interface for the SKU connection ;
- A floppy disk, a CD-Rom or an internet interface for Decryption key files update ;
- A Tape or a Network interface (LAN) for HRPT Level 0 products distribution.

3.4 DESCRIPTION

The HRPT User Station is composed of six main components :

- Antenna comprising feed, amplification and down-converter,
- Receiver comprising signal filtering, demodulator, bit synchronising, interleaving and viterbi decoder ;
- Time and Frequency Reference comprising GPS Antenna, GPS Receiver and NTP Time Server ;
- Antenna tracking unit ;
- Local Monitoring and Control able to monitor and Control the Antenna, the Receiver and the Tracking Unit ;
- FEP (Front End Processor) comprising one workstation able to process, display, archive and distribute acquired data.

Figure 3.4-1 : HRPT US Block Diagram



3.4.1 Antenna

The HRPT signal reception is based on a 1.8 meter L-band prime focus antenna, which will perform reception of the 1701.3 or 1707 MHz HRPT carrier.

After reception the HRPT signal is amplified by the LNA , then it is down converted from L-band to the VHF band between 130 MHz and 160 MHz.

Both the LNA and down converter are integrated in the antenna feed.

The VHF signal is cabled to the indoor area of the station where is housed the HRPT receiver.

The maximum distance between the Antenna and the receiver is 100 m.

3.4.1.1 RF Main Characteristics

Next table summarize the main RF parameter of the HRPT signal transmitted from the MetOp satellites.

More details are given in [E-AD2].

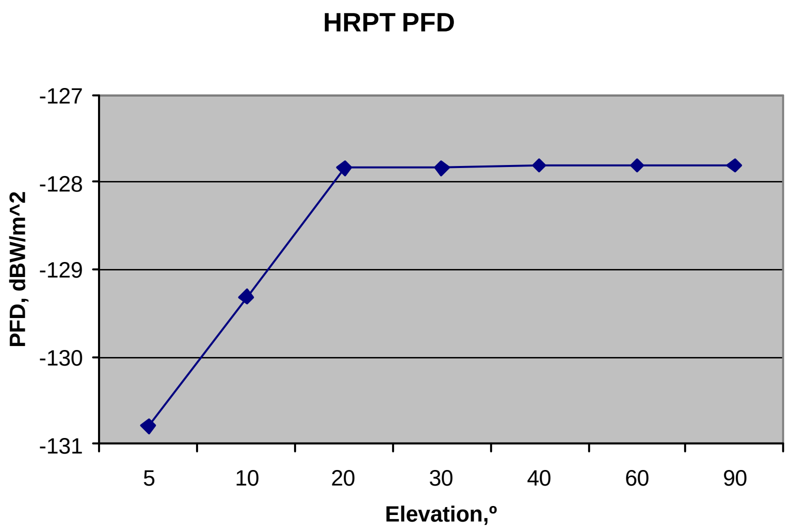
Table 3.4-1 METOP HRPT Link Characteristics

L-BAND DOWNLINK INTERFACE	
PARAMETER	**VALUE**
Signal	HRPT, High Resolution Picture Transmission
Nominal Carrier Center Frequency	Either 1701.300 MHz or 1707.000 MHz
RF bandwidth	4.5 MHz (99 % of the total signal power)
Polarisation	RHCP
Data Rate	3.5 Mbps/4.666667 Mbps
Data Modulation	QPSK FEC 3/4
Satellite Axial Polarization	< 4.5 dB
Power Flux Density evolution during satellite pass	-154 dBW/m^2 4 kHz to -133 dBW/m^2 1.5 MHz
Carrier Frequency Deviation	$\leq \pm 25\ 10^{-6}$
G/T @ 5º elevation and clear sky	6 dB/K
Ground Station axial ratio	< 1 dB
Pointing loss	< 0.5 dB

3.4.1.2 Power Flux Density evolution

The power flux density of the HPRT signal transmitted during the MetOp passes has an evolution regarding the ground station antenna elevation as it is indicated in the next figures.

Figure 3.4-2. HRPT Power Flux Density



3.4.1.3 Antenna tracking

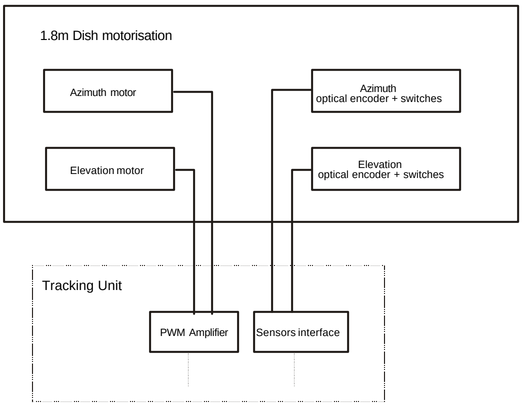
The antenna chosen for the HRPT signal is an L-band receive only antenna. It consists of a 1.8 dish on a tripod pedestal with AZ and EL motors. The tracking is performed by program tracking.

The motorization is based on a Heavy Duty motorization. This provides 190º degrees of freedom in elevation (from –5º to 185º) and 450º degrees of freedom in Azimuth. The accuracy of the encoders is better than 0.02º and the tracking accuracy is better than 0.2º.

All parts related to the antenna pedestal are made in stainless steel avoiding any corrosion in the materials.

The motorization units are fabricated in stainless steel and are in compliance with the corrosion and safety specifications. Final customer must provide an earth connection at the basis of the antenna.

Figure 3.4-3. L-Band Antenna Drive Block diagram



The antenna controller is designed by using well known servo control techniques like the PID controller (P:proportional, I: integral and D: derivative) which assures a correct antenna pointing and tracking of the satellite.

The motors are DC type with a control which is provided by the PWM. The PWM amplifiers are protected against short circuit, overload etc.

The optical encoders permits to obtain enough accuracy (24000 points per turn), and they located directly on the antenna axis. The maximum encoder error is lower than 0.02º, and the tracking is 0.2º with the antenna is at maximum velocity.

Limits determine the range of movement in axis, 190º in elevation and 450º in azimuth. The motors are stopped by making a short circuit in the inductors of the motors.

There is one motor per axis. The antenna will be stopped in case of motor failure.

The Antenna positioner proposed for the US is the conventional elevation over azimuth type.

When a quasi zenithal pass has to be tracked , for elevations above 87 degrees the satellite is tracked by using the elevation in 180º mode.

The signal loss due to the misspointing of the satellite for this case is about 0.5 dB that is compensate by 3dB higher PFD @ zenith w.r.t 5º elevation

Next table summarizes the main characteristics of the drive system.

Table 3.4-2. L-Band Antenna Drive and Mechanical Characteristics

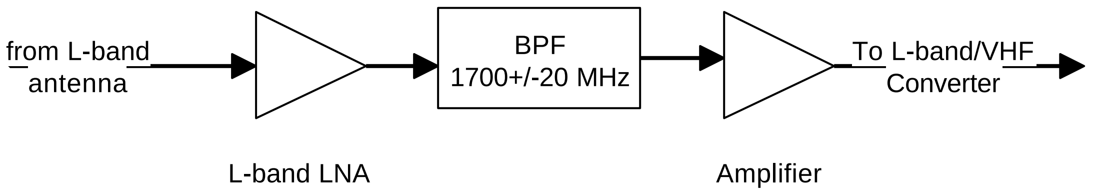
DRIVE SYSTEM CHARACTERISTICS	
Azimuth Travel	450°
Elevation travel	–5º to 185º
Azimuth speed	< 20°/s
Elevation speed	< 8°/s
Tracking Accuracy	< 0,1°
Encoder accuracy	< 0.02º
Reflector structure	Aluminium
Pedestal	Stainless steel
Weight	200 Kg without supporting structure
Finish	Stainless steel /hot dip galvanised
Foundation size	3.5 m^2
Roof load	750 kg/m^2
Operational winds	<= 200Km/h in stow mode <= 170Km/h in other case
Ambient temperature	Operational: -30 to 55ºC Survival
Consumption	220 V AC 12 A

3.4.1.4 L-band LNA

The LNA is package in a weatherproof enclosure for outdoor applications and is located at the antenna feed.

The preamplifier consists of two stages as well as a helicoidal type band pass filter. The first stage is based on a low noise HEMT transistor with adapted impedance by means of a LC circuit. Then the filter provides a good attenuation of the out of band frequencies and an amplifier permits to drive the antenna down lead cable to the down converter.

Figure 3.4-4. L-Band Pre-amplifier



3.4.1.5 L-band/VHF band Down converter

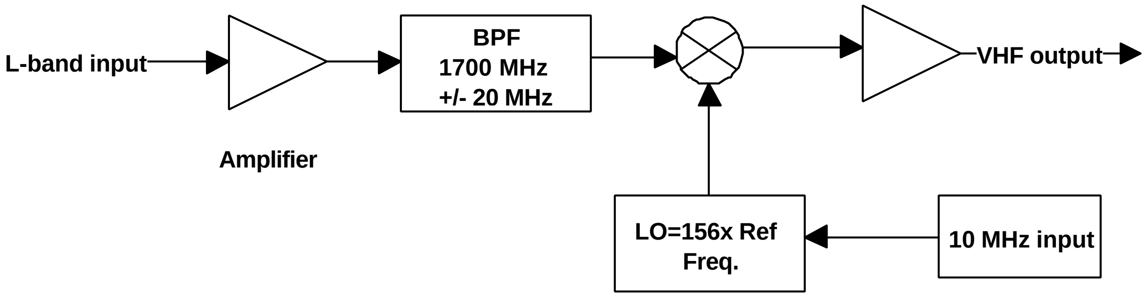
The L-band to VHF-band down converter consists of an L-band amplifier, a band pass filter, a mixer with a local oscillator working at 1560 MHz, and a VHF amplifier.

The input amplifier allows to have enough power level, after the filter allows to rejects image frequencies and spurious.

The local oscillator is driven by a external 10 MHz reference frequency for being able to provide an accurate conversion frequency and low phase noise.

The input and output impedance are of 50 ohms.

Figure 3.4-5. L-Band to VHF Frequency Converter



The LNA and the downconverter form an assembly which main characteristics are the following:

Table 3.4-3. LNA and DC assembly characteristics

LNA AND DC ASSEMBLY CHARACTERISTICS	
Noise Factor	0.6 dB
Gain	45 dB
Centre frequency	1700 MHz
Bandwidth	+-10 MHz at 3 dB
Local oscillator	1557 MHz
Oscillator drift	<30 KHz
Output impedance	500 ohms
Output connector	N type
Operational temperature	-20ºC to +60ºC

3.4.2 Receiver

The Receiver will be able to acquire the VHF signal (between 130 to 160 MHz) and deliver demodulated HRPT CADUs.

The reception frequency band is limited between 130 to 160 MHz and the input impedance is 50 ohms. The receiver has a 45 dB AGC with minimum range of –80 dBm.

A first stage compensates the antenna cable losses and adjusts the level at the receiver input. An input filter permits to eliminate the undesirable frequencies and limit the input noise to the receiver

The tuner of the receiver can be set to different frequency, and it translates the VHF signal into low IF signal (36.7 MHz for HRPT and 38.9 MHz frequency for LRPT) as well as an automatic control of the gain and frequency.

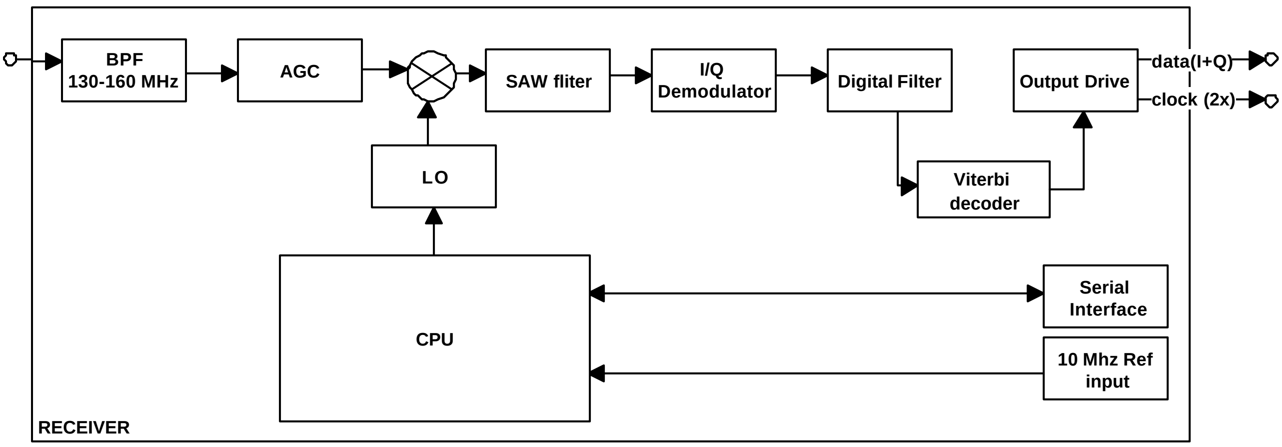
The CPU controls the frequency of the tuner, it also has a Doppler file (sent by the Local M&C) that permits a verification and a correction of the MetOp signal.

The CPU also selects the pass band of the filters (SAW) and then permits the receiver to be compatible with either LRPT or HRPT signals.

The I/Q demodulation is digital and involves a clock signal recovery. In case of signal loss, a clock signal can maintain de rhythm of the signal to avoid losses in the acquisition system.

The outputs are numerically filtered and Viterbi decoded, then they are available for the acquisition card of the FEP.

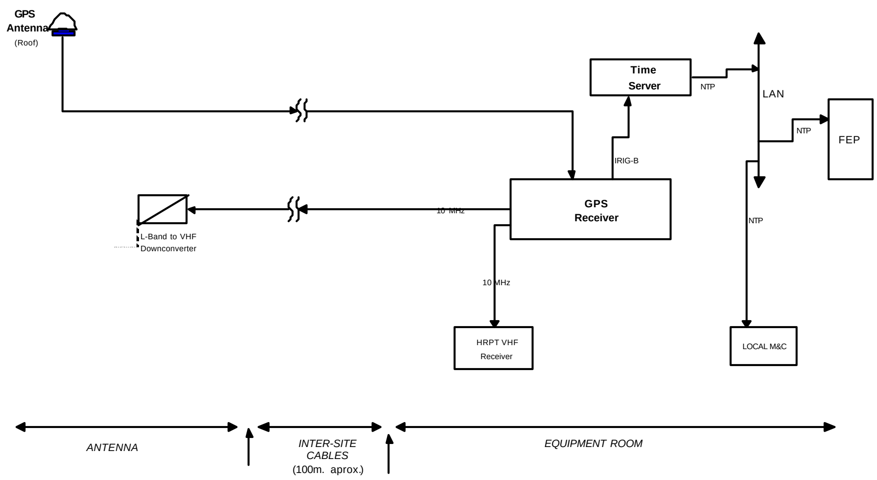
Figure 3.4-6. VHF Receiver Block Diagram



3.4.3 Time and Frequency Reference

The T&F subsystem provides GPS based time and frequency reference for different equipment of the US. The reference time (IRIG B baseline) and frequency shall be distributed appropriately to the Antenna and Receiver equipment. The reference time based on NTP shall be distributed to the LAN for FEP and Local M&C.

Figure 3.4-7. F&T S/S functional diagram



The core of the T&F subsystem will consist of a GPS antenna and receiver that will provide 10 MHz frequency reference signals and IRIG B time code reference signals to the following equipment:

▼ 10 MHz frequency reference :

(Long Term Stability : < 10^{-11} /day GPS locked, <$3x10^{-10}$ /day GPS unlocked)

(Short Term Stability : <1x10E-11 for T = 0.1 to 30 secs)

- HRPT VHF Receiver,
- L-Band to VHF Converter.

▼ IRIG-B time reference:

(Accuracy is ±300 nanosec. to UTC)

- Network Time Server.

(Accuracy is < 5 microsec, relative to IRIG-B code)

The Network Time Server will provide time reference based on Network Time Protocol to the LAN for FEP and Local M&C.

NB : More detailed information can be found into the US Elements Design Specification Document (EPS-ASPI-DS-0675).

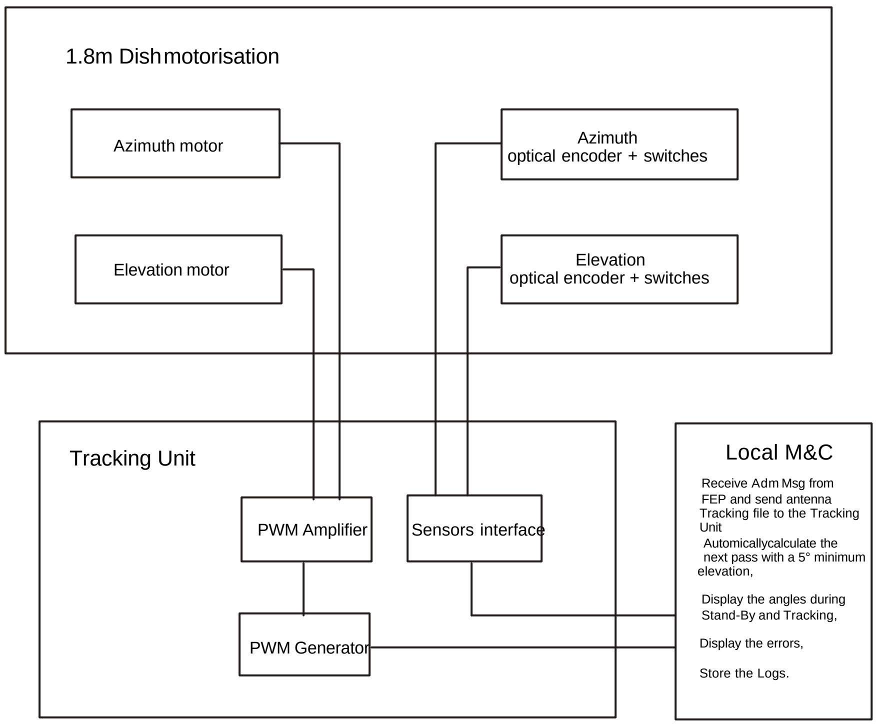
3.4.4 Tracking unit

The tracking unit is able to control and monitor antenna motorization (limit switches, etc …). The tracking unit will be able to point antenna towards the appropriate satellite according to orbital parameters extracted from the Administrative Message returned by the FEP.

The tracking unit is connected to the Local M&C computer via a PC Card. The local M&C computer receives through the PC Card, the antenna pointing data file (time, azimuth, elevation) with data, each second.

The local M&C computer computes the antenna tracking file from the administrative messages received from FEP. This antenna tracking file allows to control the L-Band antenna positions. This file is transferred to the tracking unit before the satellite pass.

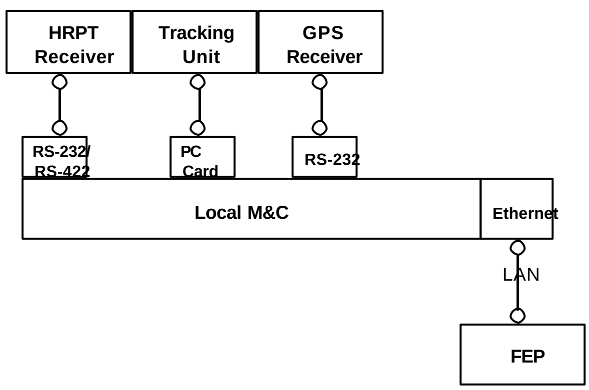
Figure 3.4-8. Tracking unit functional diagram



3.4.5 Local M&C

The Local M&C will perform the monitoring and control of the elements located in the US station via standard interfaces, RS-232/RS-422 selectable and a PC card for motorization. Next figure shows the M&C block diagram and connections.

Figure 3.4-9. Local M&C connections



The Local M&C can receive Administrative Messages from FEP through the LAN interface. Then, it automatically calculates the next pass of the satellite and sends Antenna tracking file to the Tracking Unit. In parallel, the Local M&C can receive status and errors of the antenna/receiver and can display them (with antenna angles) on screen.

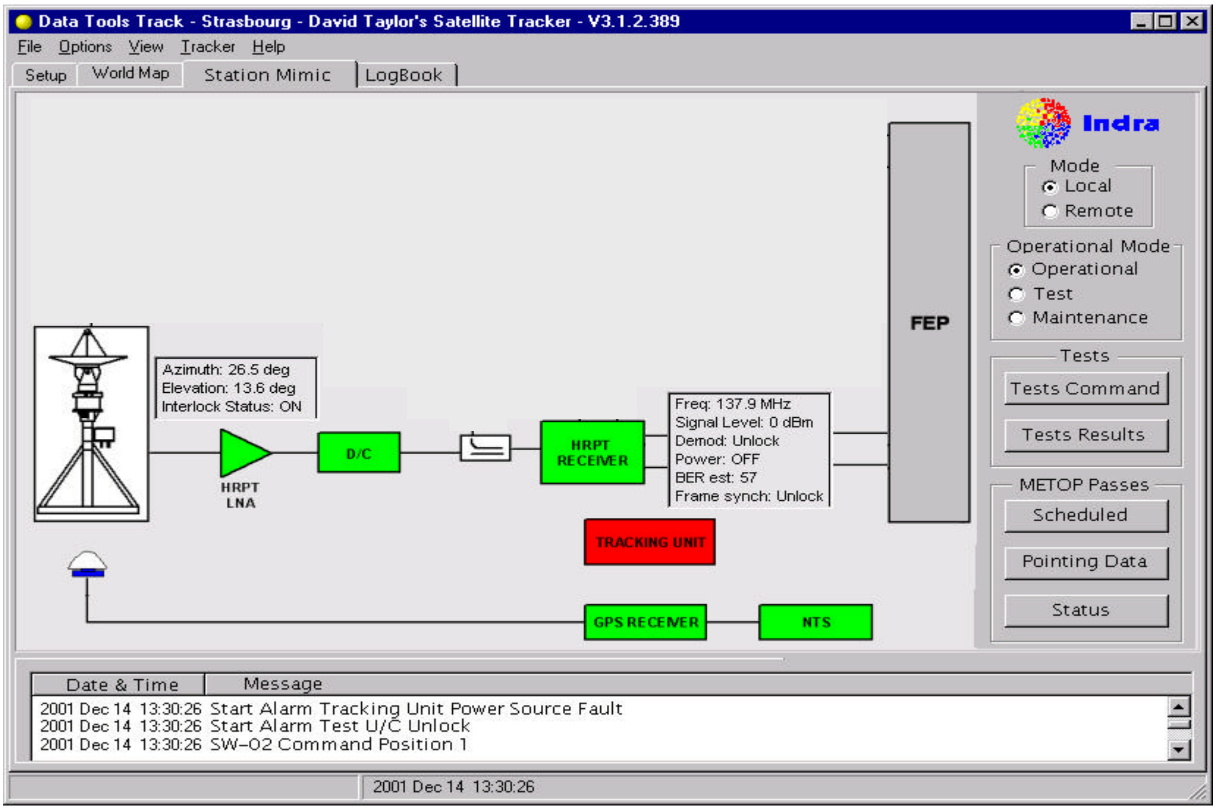
3.4.5.1 Graphic User Interface

A fully graphic interface is available for the Local M&C. It shows different information levels such as station block diagrams, logbook, etc.

3.4.5.1.1 Station Mimic

The “Station Mimic” will present the information and block diagram of Figure 3.4-1.

Figure 3.4-10. Station Mimic Block Diagram



3.4.5.1.1.1 Monitoring function:

The monitoring function will consist of:

1. The following equipments will change of color depending on their status:

   Green -------------active or OK

   Red ----------------alarm

   These equipments are : HRPT LNA, D/C, HRPT Receiver, Tracking unit, GPS Receiver, Network Time Server

2. Several equipments will show their monitoring parameters. This information could be showed in the block diagram (see above figure) or by an auxiliary window that appears when click on the equipment representation box. The following parameters are shown as an example of possible ones depending on the manufacturer specifications of each device:

EQUIPMENT	MONITORING PARAMETER
HRPT Receiver	Frequency
	Signal level
	Demodulator lock/unlock
	Power ON/OFF
Antenna position	Azimuth
	Elevation
	Antenna Interlock Status

3.4.5.1.1.2 Control function

The control function will be carried out from the buttons on the right side of the Figure 3.4-10. The control parameters will be shown when click on the buttons. These are:

1. Mode:

   The mode of the station can be displayed and controlled by the operator that will be able to select between local or remote:

   Local: when the station receives the ADMIN MESSAGE from a floppy disk or manual input. It disables the sending of data from the FEP.

   Remote: when the ADMIN MESSAGE comes from the FEP

2. METOP Passes

   Scheduled Passes: when this button is clicked an auxiliary window is displayed where the list (in chronological order) of programmed (previously sent by the FEP in the ADMIN MESSAGE) passes is shown (passes can be viewed, deleted and printed)

   Pointing Data: when this button is clicked an auxiliary window is displayed, showing the results of the calculation of the satellite pointing data extracted from the ADMIN MESSAGE.

   Passes Status: when this button is clicked an auxiliary window is displayed. This window has to show the following data extracted from the ADMIN MESSAGE:

PAST PASS	ID:XXXXX	TIME (from the last pass)
NEXT PASS	ID:YYYYY	TIME (count down until the next pass)

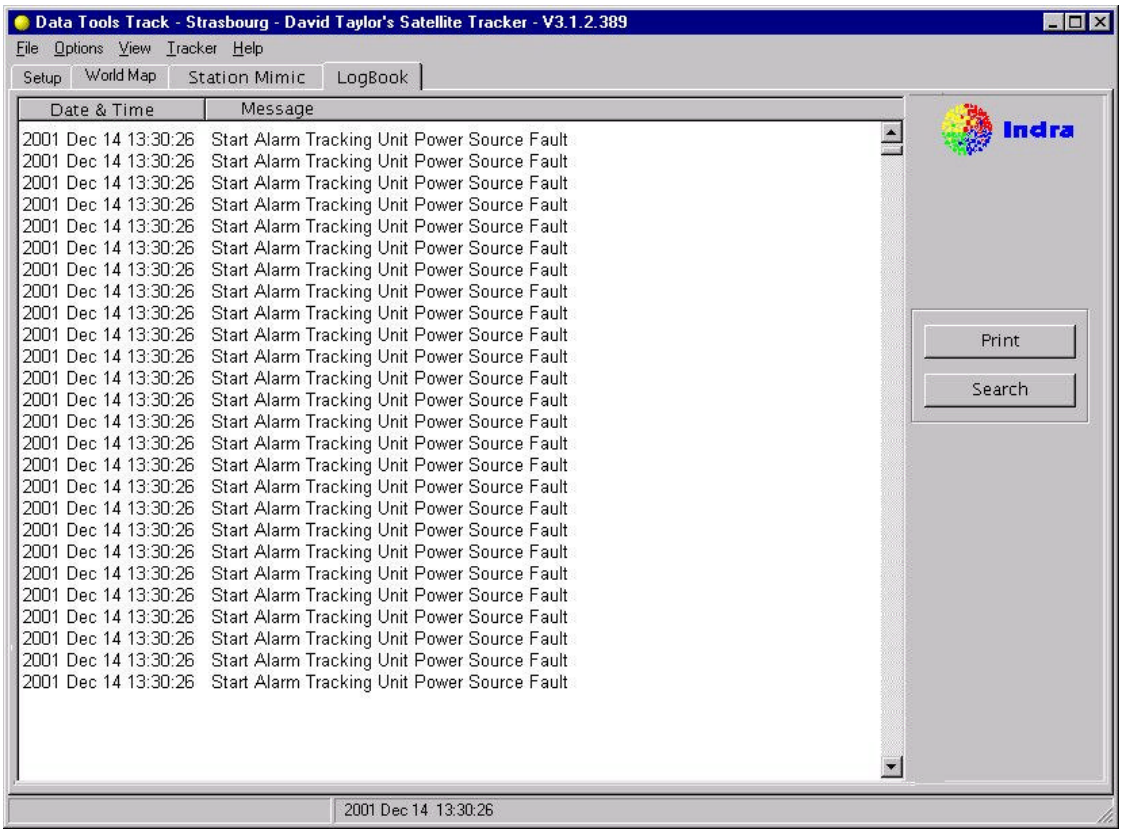
   The next pass will be the current pass when the time reaches 0

3.4.5.1.1.3 Operator messages

In the bottom side of the Figure 3.4-10 there is an operator messages list window showing the last events (alarms, commands...) and the time that occurred. Current date and time will be display in a status bar in the bottom of the figure

3.4.5.2 LogBook

Figure 3.4-11. LogBook



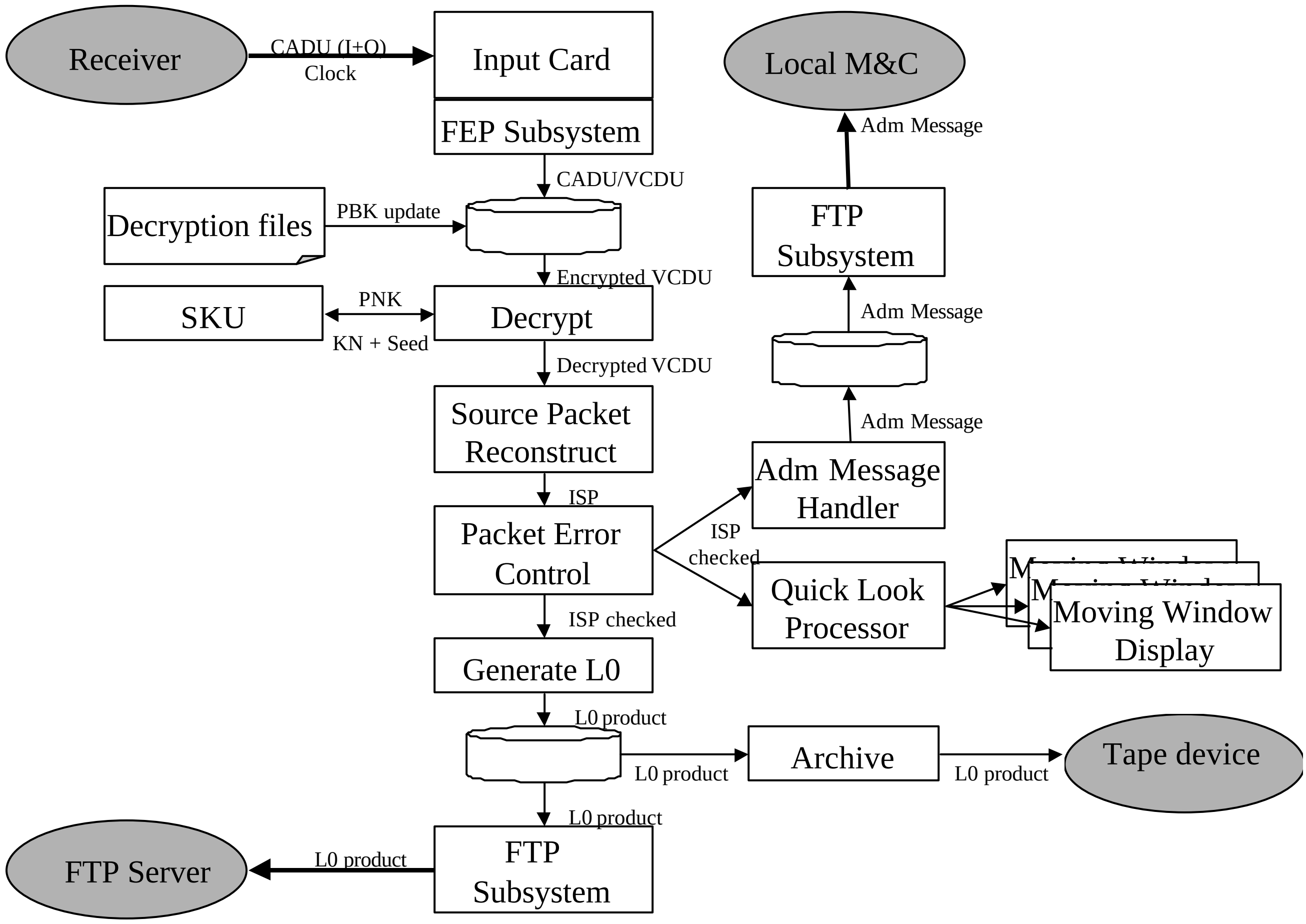
The LogBook contains all the operator list messages and permit the access to all the events stoled during application run.

This LogBook could be printed and it would be possible to search items by date, name, etc.

3.4.6 Front End Processor

The FEP will be able to receive demodulated HRPT CADUs from Receiver and build/display/store/distribute Level 0 products.

Figure 3.4-12. FEP Components



This figure shows the main components of the FEP computer.

Note that disk storage symbol is used in a logical sense. One disk symbol does not necessarily imply one physical disk.

In addition to the components in the drawing the SCS functionality is present (SCS Core: 8-9 processes). The SCS can be compared to the Main Process which schedule the other processes.

Most of the components in the drawing are based on the subsystem template, which uses two UNIX processes.

The FEP is time synchronized using the NTP time protocol. This is not visualized in above figure as this is handled by standard OS utilities.

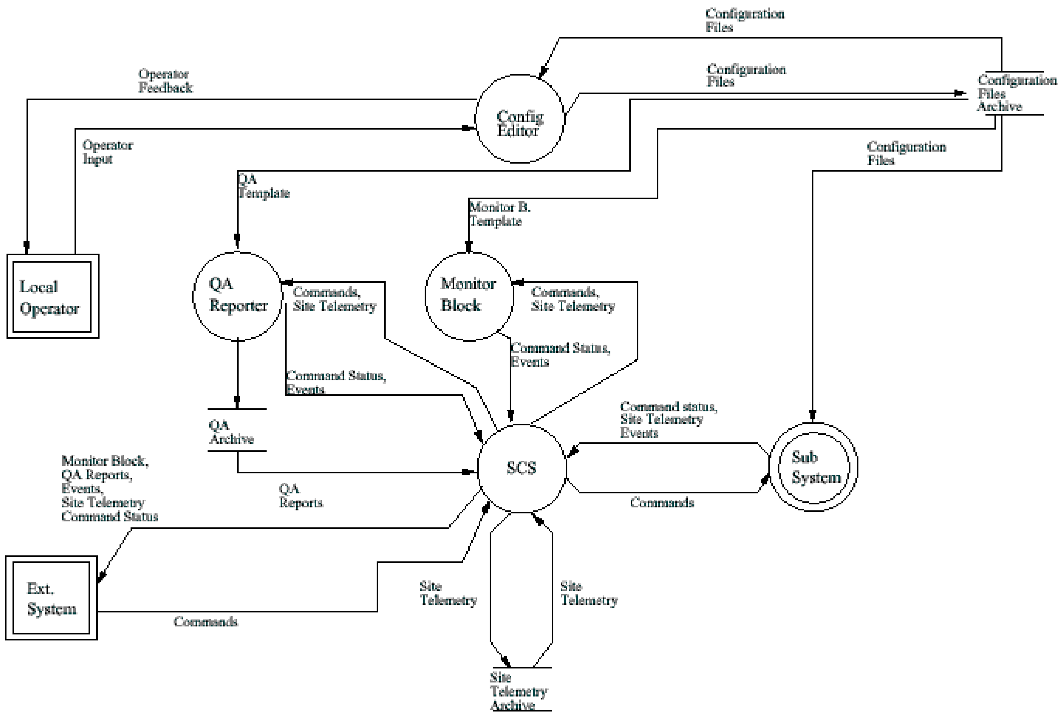
The FEP has also an internet connection to retrieve decryption key files and initial Administrative Messages.

3.4.6.1 Station Control System

The SCS is the controlling and monitoring component in KSPT's Ground Station (GS) systems.

The SCS is responsible for process management, visualization of current and planned operations in the system as a whole, retrieval and visualization of health status, and management of status events. The SCS provides the system with an external interface so that it can be interfaced by another SCS or other external control systems. An overview of the SCS is shown in the following figure.

Figure 3.4-13. SCS Overview



3.4.6.1.1 Provided services

The SCS provides the following services to the MEOS DIS (list not exhaustive):

scheduling support to schedule instructions (see 3.4.2) both immediately and at a specific time.

```
execution_time: IMMEDIATE

or

execution_time: "24-APR-2001 13:06:30"
```

subsystem interconnection mechanisms for subsystem interconnection. This includes both information passing and start constraints, as shown in the following example.

```
run FEP (... , conf_file:="test.cfg")

>> {

TERM run DECRYPT(... , conf_file:="test.cfg")

}
```

In this example, « TERM », flag will make the SCS queue the DECRYPT until the FEP has terminated. By using the « TRIGG » flag instead, the SCS will only queue the DECRYPT until the FEP sends a « trigger ». (which it will do as soon as data is ready).

site telemetry mechanisms to both collect site telemetry from all subsystems, and to make it available (see next section).

events provide common event handling (log messages).

monitor and control provide a common external interface and user interface to monitor and control the system.

3.4.6.1.2 Site Telemetry

All site telemetry is generated by subsystems (or SCS servers), but further handling is done by the SCS. This handling includes:

archiving Site telemetry sent to the SCS is archived using a Rolling Archive (RA) concept. This implies that the system is configured to store up to a certain amount of site telemetry, before deleting the oldest. The configured size is system dependent, and will vary dependent of the number of subsystems included, how long the data is to be available, etc. As long as site telemetry data is not rolled out, it is online available.

real-time reports Generated site telemetry is also available in real-time, through the Monitor Block function. Whenever a client connects to the SCS, using this function, selected site telemetry parameters (based on a template, specifying both parameters and format) is forwarded in real-time.

3.4.6.2 Subsystems

Subsystems are the basic processing parts of an MEOS DIS system. Basically, four types of subsystems exist:

input receives input to the system (i.e. FEP (or ingest), etc.)

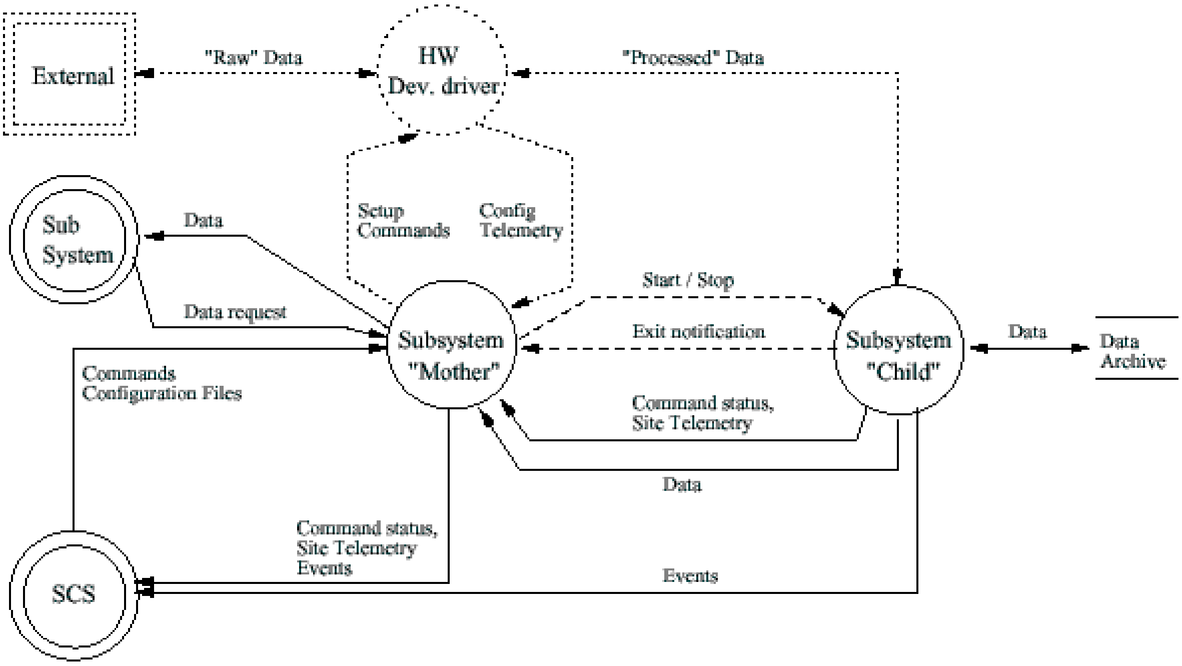
processing does some processing (i.e. decrypt, reconstruct, etc.)

output outputs data out of the system (i.e. archive, ftp-subsystem, etc.)

controllers controls and external HW device (i.e. demodulators, modulators, switch matrixes, etc.)

In addition, a template exits for easy implementation of new subsystems. This template includes all interfaces to the SCS and all interfaces necessary for communication between subsystems.

Figure 3.4-14. Subsystem Overview



This figure shows the basic design of any subsystem. For most subsystems, two processes implements the subsystem; « Subsystem Mother » and the « Child ». In addition, some subsystems also implement a device driver for communication with HW cards.

Here follow a short description of the differents FEP subsystems.

3.4.6.3 Subsystems description

3.4.6.3.1 Input Card

In the FEP context the input card will do the following:

- Frame synchronization
- De-randomization (Pseudo Random Noise)
- Reed-Solomon decoding
- Time Stamping. The reference time is retrieved by the input card from the US CPU clock (which is time synchronized by NTP) at the beginning of each dump. The time-stamping of each VCDUs is done with the internal clock of the input card.

The input Card outputs VCDUs through DMA.

This item is delivered as COTS.

3.4.6.3.2 KSPT FEP

The KSPT FEP subsystem is used as an interface to the KSPT Input Card. It configures the card with the desired configuration, and reads the VCDUs through DMA.

It can store the VCDUs to disk or send them to the decrypt subsystem.

It can be possible to configure the number of PCD annotations appended to the VCDU :

- Frame Synchronization status
- Reed-Solomon status

This subsystem can also configure the input card in order to retrieve CADUs and to be able to store them on disk.

Note : VCDU with bad Frame Synchronization and/or Reed-Solomon status are not provided to the Decryption subsystem. This event is reported.

This subsystem is delivered as COTS.

3.4.6.3.3 Decryption

The incoming METOP HRPT/LRPT data streams are encrypted (by 3DES algorithm). They have to be decrypted before further processing can take place.

3DES decryption is a COTS subsystem, developed for METOP satellite. The Station Key Unit (SKU) is new though. Note that if encryption flag is not set in VCDU Insert Zone decryption will be bypassed, and the VCDU will be outputted without modification.

The interface to the SKU is RS422, and this will be realized by using the existing KSPT library (named rs422).

On startup of the decrypt subsystem it will locate the newest 3DES public keys available (from file), and update the SKU to use them.

No manual control of the SKU is foreseen (manual test commands can be performed). All commands necessary to operate the SKU will be implemented in the subsystem.

Dataflow

Input will be Metop HRPT VCDUs (from Rolling Archive), and files containing updated public keys.

Output will be decrypted Metop HRPT VCDUs.

Decryption Verification

SKU functional The SKU communication is verified, and the status of the SKU itself is verified by SKU *perform self-test* and *inquiry SKU-status* commands.

Master Key The Master Key (MSK) of the SKU is secret, and internal to the SKU. That the correct MSK is used can not be verified.

Public Keys The use of newest available Public Keys (PBK) will be ensured, and the CRC-status after PBK uploading will be checked.

Message Keys The PBKs in the SKU are dectypted with the MSK, and the result is Message Keys (MGK). These MGKs are internal to the SKU, and can not be verified. If the MGKs are genereated uncorrect, because the SKU is malfunctioning for some reason, this will go unnoticed.

Seed The seed, together with message key (and key number), is the basis for Pseudo Noise Key (PNK). An incorrect seed will generate an incorrect PNK, and encryption will fail. The seed is composed by VCDU header and Insert Zone, and the whole VCDU is Reed-Solomon encoded. If the Reed-Solomon decoding succeeds, the seed should be correct. If Reed-Solomon decoding fails, the VCDU is severely damaged and decryption is not performed (ie. VCDU is discarded).

Pseudo Noise Pattern Given a correct seed and PNK, the Pseudo Noise Pattern generation should not fail. The algorithm is validated with respect to encryption and 3DES specifications. If, for some reason, an undetectable error occured, the decrypt subsystem will report the SKU error message to the Operator.

The decryption subsystem returns SKU error messages (ie. if PBK with CRC are not correct or if PNK generation fails). Incorrect Seed are not provided to the decryption subsystem (ie. Bad VCDUs are discarded by the FEP KSPT task), so the decryption subsystem can only reports SKU error messages.

Reconstruction

To extract the Instrument Source Packets from the METOP HRPT data streams the Reconstruct subsystem will be used. It is designed for CCSDS compliant missions, and hence supports METOP.

The KSPT Reconstruct subsystem is delivered as COTS.

Note : ISP with missing/corrupted VCDUs are discarded (ie. not forwarded to the PEC subsystem), the Reconstruction subsystem searchs for next ISP pointer header into the METOP HRPT data stream. This event is reported.

Dataflow

Input will be decrypted HRPT VCDUs (from decrypt subsystem).

Output will be (annotated) instrument source packets formatted as Version-1 CCSDS packets.

3.4.6.3.4 *Packet Error Control (PEC)*

Instrument Source Packets have a Packet Error Control Field, which can either contain a CRC or VPC checksum. The core CRC and VPC functionality will be implemented in separate libraries, and used by a subsystem based on the KSPT subsystem template.

Dataflow

Input will be (annotated) instrument source packets (from reconstruct subsystem).

Output will be error controlled instrument source packets by VPC or CRC checksum. Error control status will be flagged in PCD bytes.

Configuration

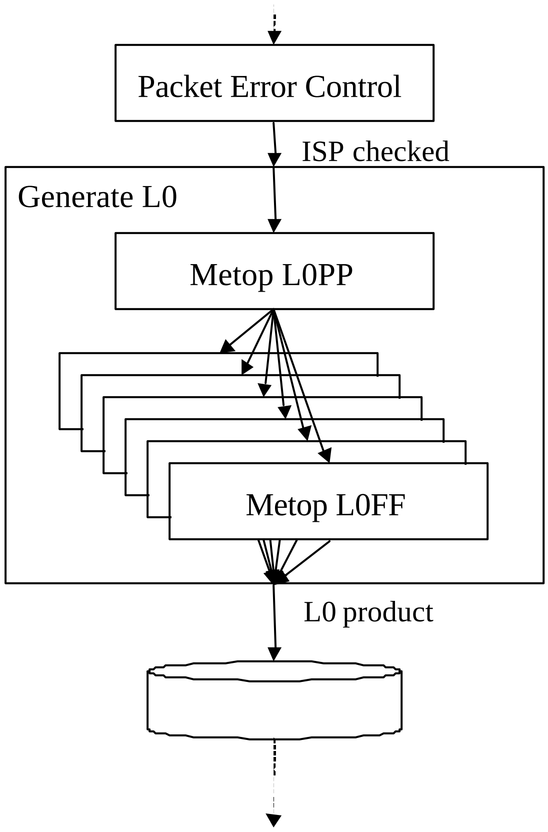
- CRC ()
  - IASI,
  - GOME-2,
- VPC ()
  - AVHRR LR/HR,
  - AMSU-A1/A2,
  - HIRS/4,
  - SEM,
  - A-DCS,
  - MHS,
  - ASCAT.

3.4.6.3.5 L0 Generation

The L0 Generation is decomposed into two subsystems :

- Metop L0PP (L0 PreProcessor) ;
- Metop L0FF (L0 File Formatter).

Figure 3.4-15. L0 Overview



Metop L0PP

The Metop L0 PreProcessor receives ISP from the Packet Error Control sub-system and transforms them into MDRs. The MDRs are forwarded to a number of Level 0 File Formatters. When doing this the Metop Level 0 PreProcessor identifies the instrument each ISP belongs to so that each Level 0 product File Formatter receives only the instrument is has asked for.

Metop L0FF

The Metop L0 File Formatter receives ISP (Instrument Source Packets) related to a specific satellite and instrument, and produce level 0 product data units (PDUs). A PDU is complete when the dump is finished, then it is archived into the Level 0 product archive.

This sub-system can flag MDRs missing and can add a blank MDR in case of failure.

3.4.6.3.6 Adm Messages Handler

Administrative Messages shall be extracted from the Spacecraft Housekeeping data flow. This will be realized as a new subsystem. This subsystem will be based on the standard KSPT subsystem template, which handles input, output, configuration handling, telemetry reporting etc.

Dataflow

Input will be Adm. Msg ISPs (APID 6) from Packet Error Control subsystem.

Output will be satellite administration messages to Local M&C, METOP Events and METOP TBUS parameters.

Processing

The administrative messages are formatted as CCSDS Version-1 Source Packets.

Based indexes over messages , a subset of Administration Messages will be written to RA file. This file will be transmitted to Local M&C through local inter-facility network (refer to FTP subsystem).

In addition METOP Events and messages will be extracted and sent as feedback events to the SCS.

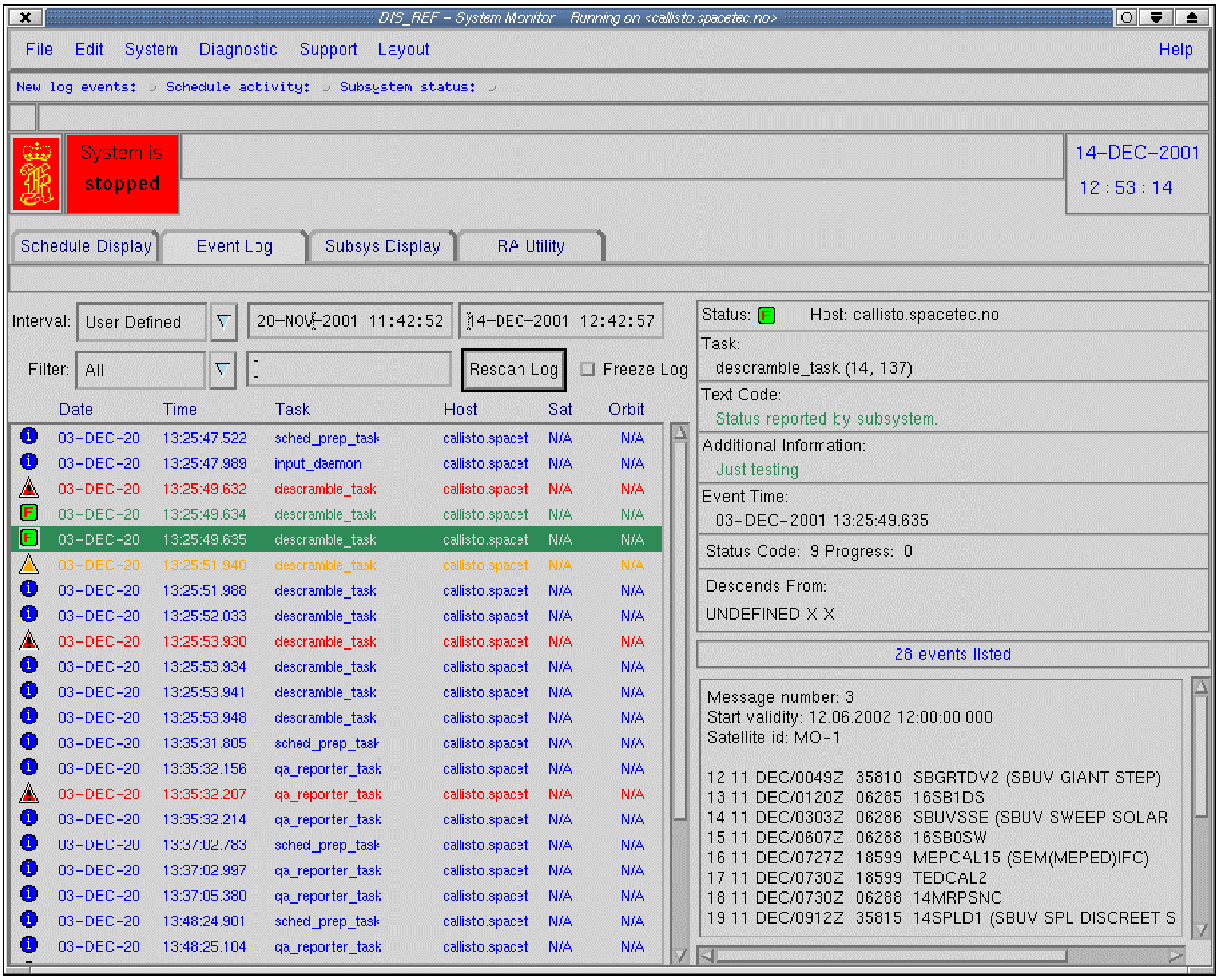
For schedule prediction, METOP TBUS parameters will be extracted and stored to RA files.

Visualization

The SCS GUIs will show the administrative messages in a way similar to the existing Event Log.

Extensive reuse of existing functionality is foreseen.

Figure 3.4-16. Adm Message Display



An event is created for each new administrative message received by the US. If operator selects that event, the displayed text will contain at least field #1 “Message Number”, #2 “Starting Time of Validity for this Admin Message”, #3 “Metop Satellite ID” and #13 “Metop Events and messages”.

Therefore, a change into Time Correlation parameters, a change into TBUS Orbital parameters, a change into SPOT Orbital parameters, a change into Compression parameters and a change into decryption keys shall also generate specific events.

The definition of the Metop Events and messages field (#13) content is not necessary, considered as a ‘free text’. So, the FEP will only display the text content without any filtering into this field. For information, the Metop Calibration parameters field (#11) and Compression parameters field (#12) contents are not used by the US.

3.4.6.3.7 FTP Subsystem

FTP transfer is required for several communication links (Adm. messages to Receiver, Level 0 products to User Site). This will be realized by a new subsystem, based on the standard KSPT subsystem template.

3.4.6.3.8 Quicklook Processor

The main objective for this subsystem is to generate data in a generic format for the Moving Window Display.

This will be realized by implementing software libraries for each instrument. Based on the APID the correct library will be used to generate appropriate output.

Two types of data will be supported; images and text (if needed).

Multi-instrument display is supported.

Dataflow

Input will be instrument source packets from HRPT PEC subsystem (for HRPT chain).

Output will be data in a format readable by the Moving Window Display.

3.4.6.3.9 Moving Window Display

The moving window display will be extended to view several instruments, as tabulator separated panels (i.e. the operator can toggle between the different instruments). If there is need for it, it will be extended with text viewing capabilities.

Following Figure shows an overview of the QL-MWD design.

Figure 3.4-17. QuickLook Processor and Moving Window Display

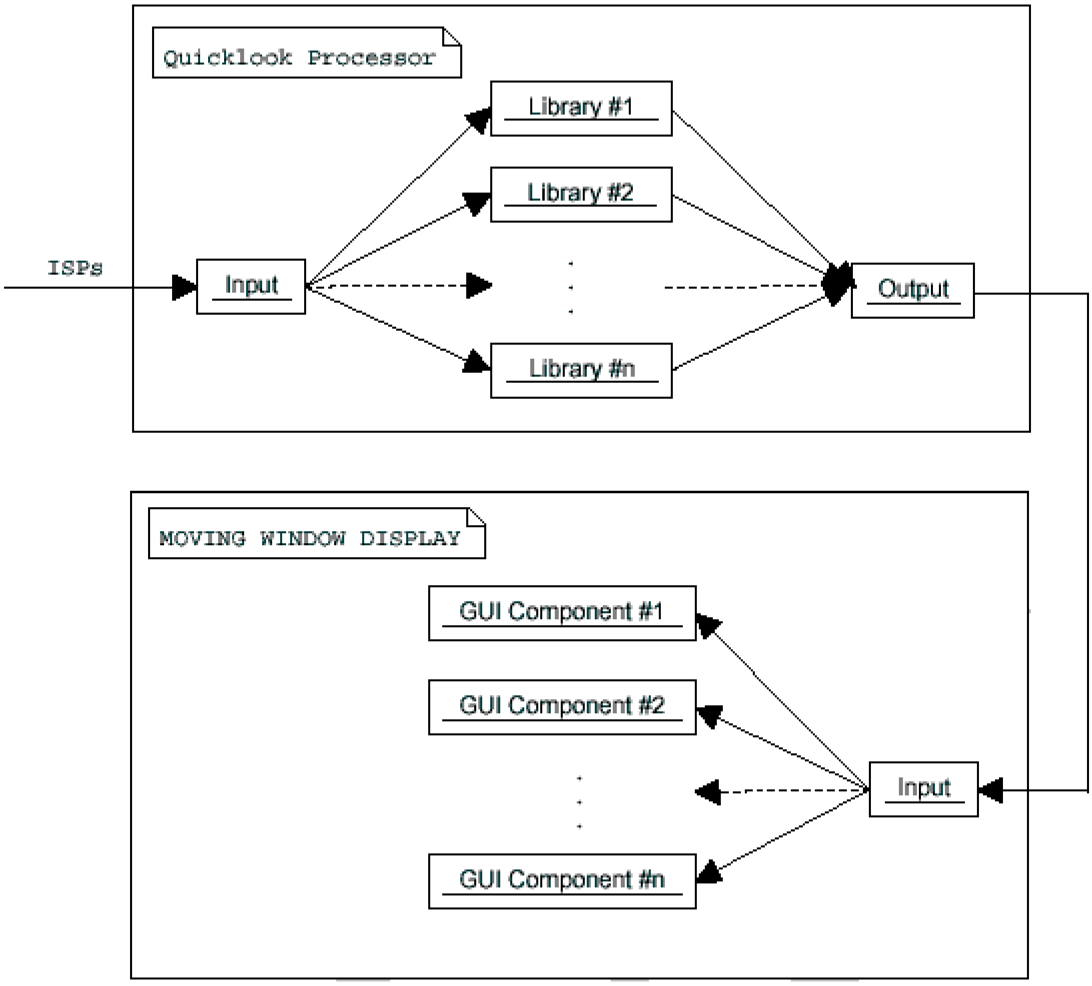


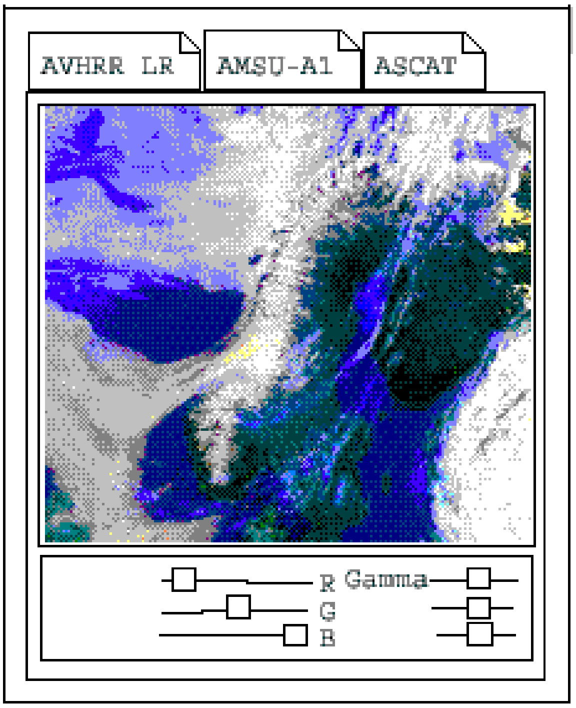
Table 3.4-4. Instrument Overview

VCID	APID	Instrument	Instrument type	Visualization
3	39	AMSU-A1	Microwave sounding 13 channels cross-track scanning	Image : Intensity is signal value X-axis is wave length (x pixels from channel 1, .. x pixels from channel 13) Y-axis is satellite track direction (i.e. time) Note : there will be 30 pixels per line, the channel selection will be done with the RGB selectors (cf. figure 3.4.22). If R=15, G=15 and B=15, only channel 15 of the AMSU-A1 will be displayed. If R=13, G=14 and B=15, the channels 13, 14 & 15 of the AMSU-A1 will be displayed at the same time, with a color associated to a channel.
3	40	AMSU-A2	Microwave sounding	As for AMSU-A1

VCID	APID	Instrument	Instrument type	Visualization
			2 channels cross-track scanning	
12	34	MHS	Microwave sounding 5 channels cross-track scanning	As for AMSU-A1 Note : there will be 90 pixels per line.
3	38	HIRS	Infrared sounding 20 channels	As for AMSU-A1 Note : here will be 56 pixels per line
5	64..70	AVHRR LR	Radiometer	Image
9	103,104	AVHRR HR	Radiometer	Image
29	448..511	GRAS sounding		Text display of selected parameters
34	2,3	GRAS pos. and timing		Text display of selected parameters
10	150 (image) 160 (verif.) 180 (Aux.) 130,135, 140,145 (Spectrum)	IASI	Sounding/radiometer	Radiometer as AVHRR for Image Packet
15	192..255	ASCAT	Radar 6 beams, 3 at each side of sat. (at 45, 90 and 135 degrees)	Text display of selected parameters
24	384..447	GOME	Spectrometer	As for AMSU-A1
3	27	SEM	Spectrometer	Text display of selected parameters
27	35	ARGOS-DCS	Data collection and location	No visualisation
34	1	Housekeeping		No visualisation
34	6	Adm Msg		Refer to Adm Msg section

Following Figure shows the look and feel of the planned moving window display (which have received data for three instruments: AVHRR LR, AMSU-A1 and ASCAT).

Figure 3.4-18. Moving Window Display



3.4.6.3.10 Archive

Transfer of METOP HRPT Level 0 products or VCDUs to long term archive (tape device) will be realized by using the existing KSPT Archive subsystem.

<u>Dataflow</u>

Input will be HRPT Level 0 products frames (or HRPT VCDUs for generation of test data tapes).

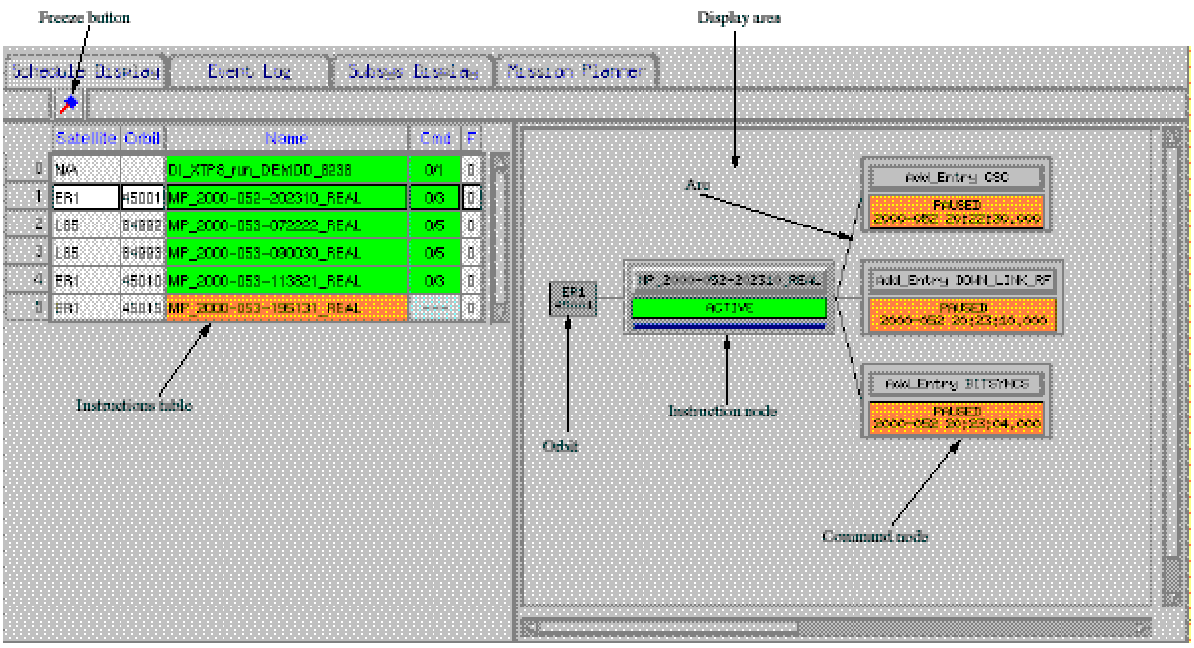
Output will be HRPT Level 0 products (or HRPT/LRPT VCDUs for generation of test data tapes) to tape device.

NB : Additional information can be found into Appendix.

3.4.6.3.11 Monitoring and Control

The FEP will have a MMI, the SCS GUIs, for local control and monitoring. Only one SCS GUIs will be used for both HRPT and LRPT chains.

Figure 3.4-19. Schedule Display

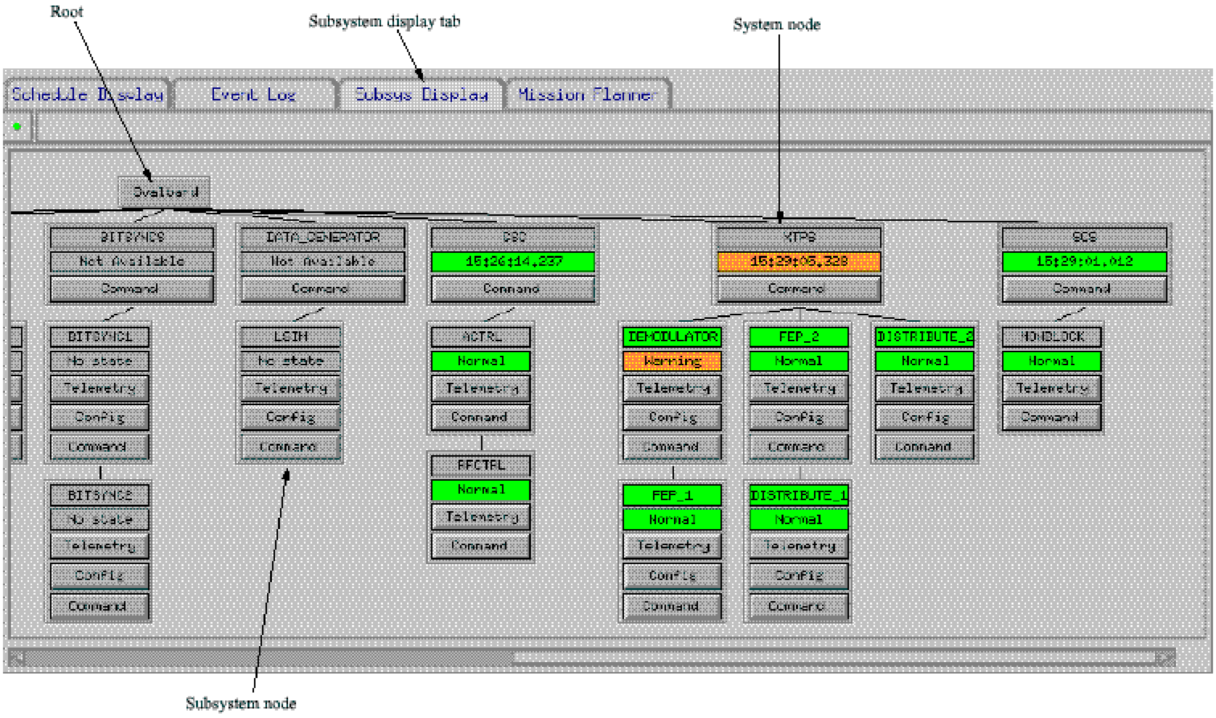


The Schedule Display display shows all scheduled and active instructions and commands, and their statuses. It consists of two parts; the « Instructions table » on the left-hand side and the « Display area » on the right-hand side.

Instructions table Contains all currently existing instructions represented as rows in the table. By selecting an instruction, the tree representation of the instruction and its commands is shown on the right hand side of the display. The function of each field is shown in figure above. An instruction tree consists of a root, the instruction nodes, the command nodes and arcs connecting nodes.

Display area Contains a more detailed outline of the selected instruction(s). When there is no selected instruction in the instructions table, the display area is empty. When a selected instruction is executing, the display area contains a tree with a branch headed by the instruction node and followed by the command nodes that make up the instruction. The tree has one branch for each active instruction.

Figure 3.4-20. Subsystem Display

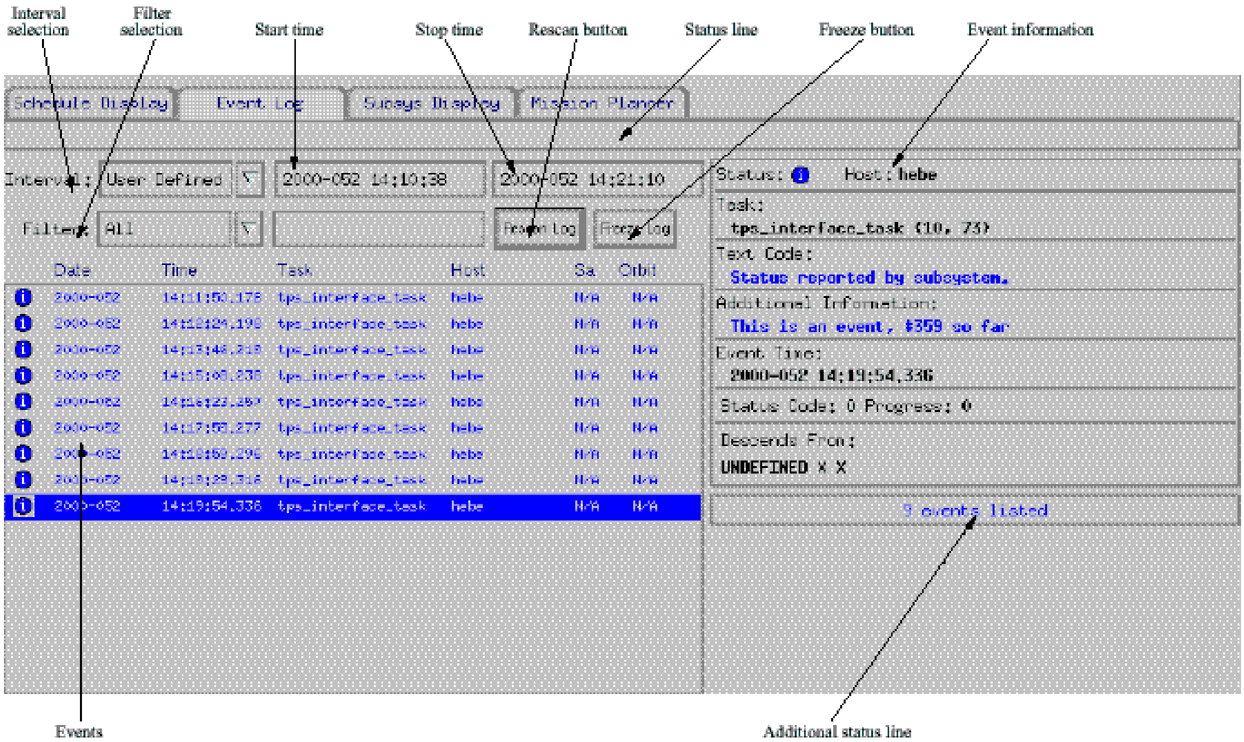


The Subsystem Display shows a tree (or forest) with all the systems and subsystems configured to be under control of the SCS at this particular site.

The system node gives the user the last update time of any of the subsystems connected to the system. The user can also directly command the system node from the pull down menu. The background color of this node reflects the most critical state (alarm/warning/normal) of all its subsystems parameters.

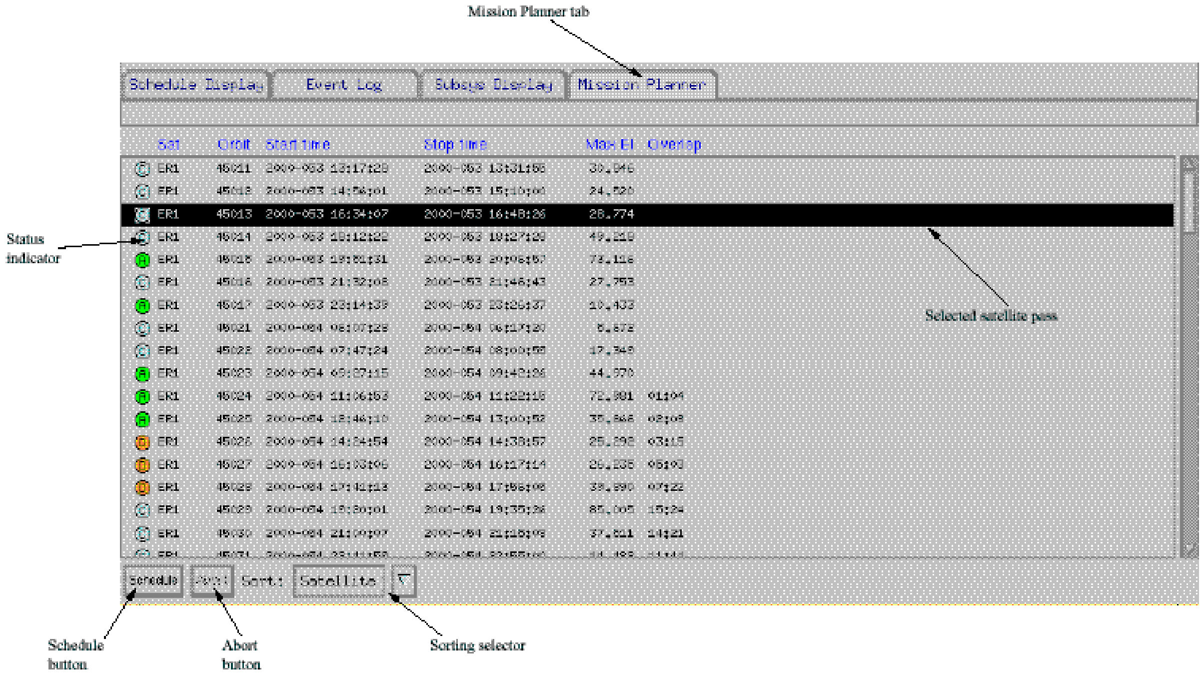
The subsystem node gives the user the ability to pop up a telemetry and configuration parameter window for the subsystem.

Figure 3.4-21. Eventlog Browser



The Eventlog Browser allows you to query the events of the system. You can query events of a specific time period, get an event list as the result of the query, observe the arriving events, and retrieve detailed information on selected events.

Figure 3.4-22. Mission Planner Unit



This Mission Planner feature of the SCS is used to schedule satellite passes for the different systems and subsystems controlled by the SCS. It activates the various subsystems involved in the support, using the correct configuration.

The Mission Planner lets the operator browse candidate passes and select which passes to enable, and with what settings.

4. LRPT USER STATION

4.1 OVERALL DESIGN CONCEPT

The LRPT US shall be able to support several Metop satellite successively.

The LRPT US shall be able to run into an autonomous way, without the need for the intervention of the local operators.

The LRPT US shall be monitored and controlled through a friendly GUI.

The LRPT US is scalable to allow it to be run on suitably sized COTS platforms.

External interfaces of the LRPT US shall be based on COTS : Tape (with standard tar command), Floppy disk, CD-Rom, Ethernet LAN connectivity, Internet connectivity, Network Time Protocol for Time Synchronisation, etc ...

The LRPT US shall contain normalised injection points, to allow full or partial testing of the HRPT US.

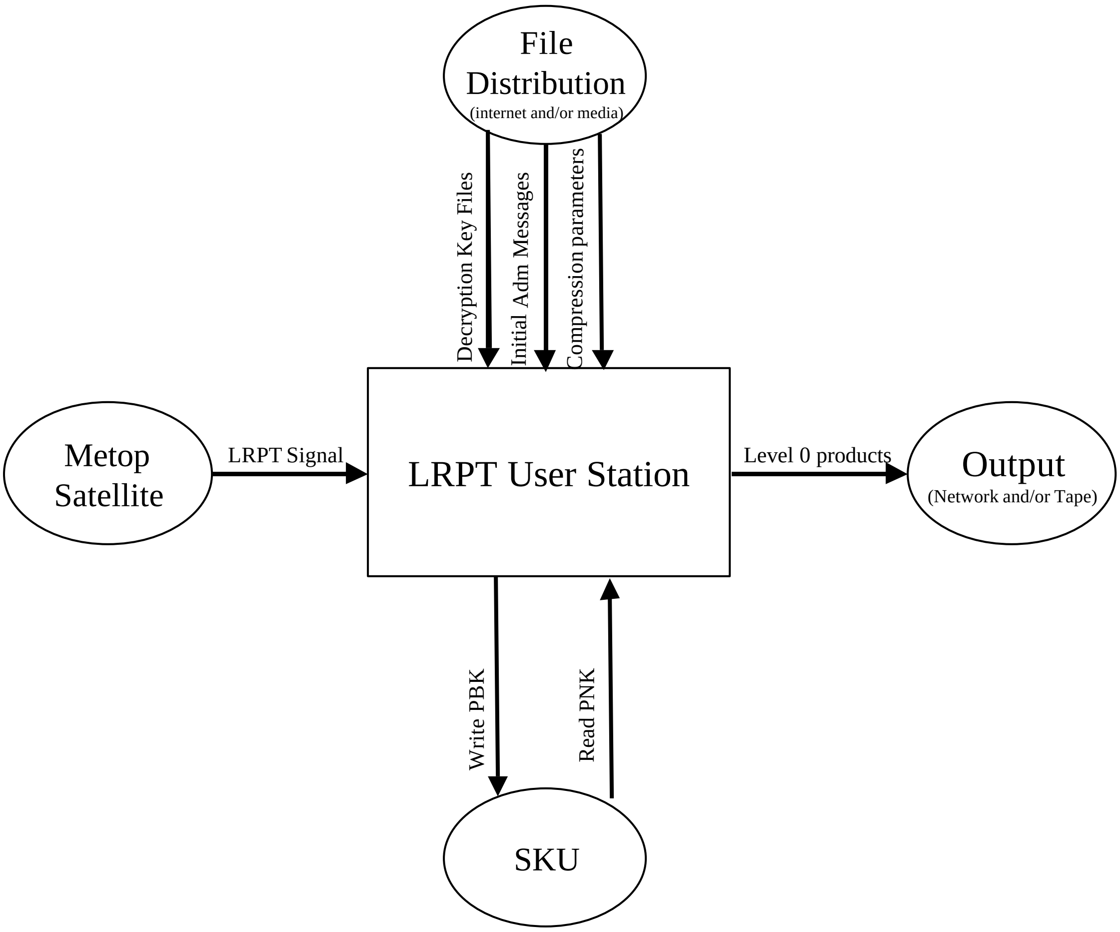
4.2 RELATION TO OTHER SYSTEMS

The US interfaces physically with:

- The Metop Satellite ;
- The Output (which can be a Tape and/or FTP server) ;
- The File Distribution ;
- The SKU.

Data flows input or output from the US have been identified through separate physical interfaces, whose decomposition is given into the following high level diagrams.

Figure 4.2-1 : LRPT US Physical Interfaces high level diagram



From all the physical interfaces described above, it is possible to regroup several instances into single common flows, as they are linked to the same external facilities and they show the same format. It is also possible to split many flux into interfaces subsets.

The physical interfaces are detailed with the Source or the Destination (to US or from US), with the support used and the format (bit level description).

Table 4.2-1 HRPT US interfaces

Physical interfaces	Source/Destination	Support	Format
Metop LRPT carrier	Metop Satellite	VHF-Band	Refer to [E-AD2]
Decryption key files	C-KMC	Floppy, cd-rom, web, …	Refer to Appendix
Compression Parameters	Eumetsat [TBC]	Floppy, cd-rom, web, …	TBD
Initial Administrative Message [TBC]	Eumetsat [TBC]	Floppy, cd-rom, web, …	Refer to Appendix
LRPT Level 0	User Site Operator	Tape or network	Refer to [E-RD36]
Write PBK	SKU	RS-422	Refer to [E-AD78]
Read PNK	SKU	RS-422	Refer to [E-AD78]

4.3 CONSTRAINTS

As US can be located all around the world, the Antenna of the LRPT US shall comply with environmental constraints defined in Appendix B.

The LRPT US shall contain all peripherals needed :

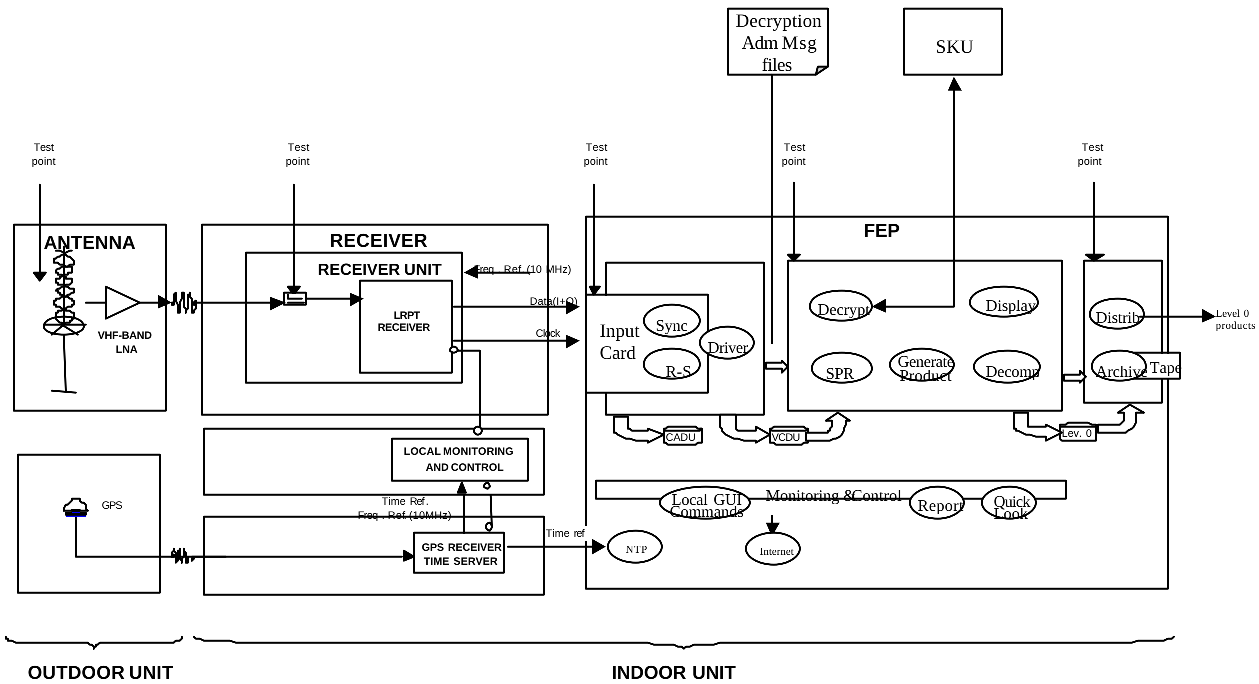
- An RS-422 interface for the SKU connection ;
- A floppy disk, a CD-Rom or an internet interface for Decryption key files update ;
- A Tape or a Network interface (LAN) for LRPT Level 0 products distribution.

4.4 DESCRIPTION

The HRPT User Station is composed of five main components :

- Antenna comprising feed, amplification and down-converter ;
- Receiver comprising signal filtering, demodulator, bit synchronising, interleaving, viterbi decoder ;
- Time and Frequency Reference comprising GPS Receiver and NTP Time Server ;
- Local Monitoring and Control comprising Monitoring and Control of the Receiver ;
- FEP (Front End Processor) comprising one workstation able to process, display, archive and distribute acquired data.

Figure 4.4-1 : LRPT US Block Diagram



4.4.1 Antenna

The LRPT functional chain will be responsible for acquiring and demodulating the VHF carrier at either 137.1 or 137.9125 MHz emitted by the MetOp satellite.

The LRPT downlink signal is received by a separated and fixed VHF cross dipole antenna then it is amplified by a LNA and sent to the LRPT VHF receiver.

The VHF signal is cabled to the indoor area of the station where is housed the LRPT receiver.

The maximum distance between the Antenna and the receiver is 100 m.

The cross dipole antenna has a gain of about 16 dB/ISO.

The cross dipole antenna can guarantee good quality reception from 5º elevation if there are no local interferences, if we have no local noise problem. This is a very important point that has to be confirmed by the site provider.

4.4.1.1 RF Main Characteristics

Next table summarize the main RF parameter of the LRPT signal transmitted from the MetOp satellites.

More details are given in [E-AD2].

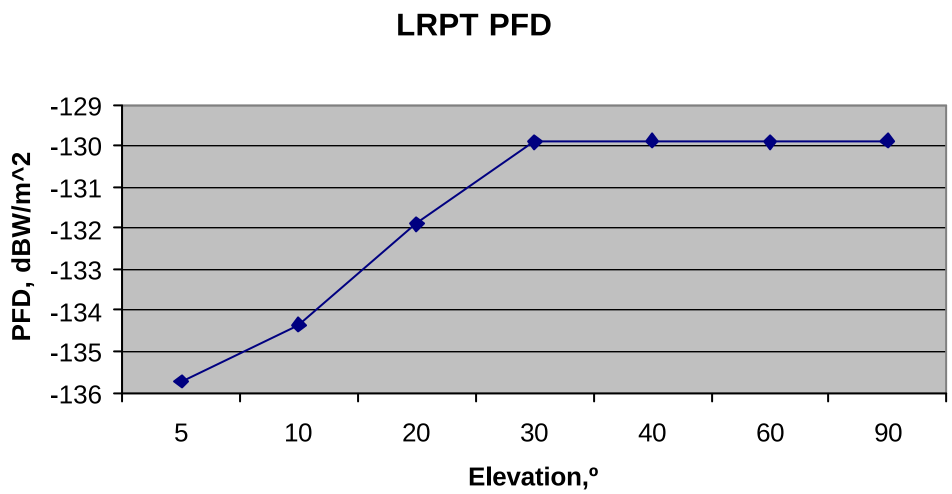
Table 4.4-1. METOP LRPT LINK CHARACTERISTICS

VHF-BAND DOWNLINK INTERFACE	
PARAMETER	VALUE
Signal	LRPT, Low Resolution Picture Transmission
Nominal Carrier Center Frequency	Either 137.1 MHz or 137.9125 MHz
Polarisation	RHCP
Data Rate	72 kbps/80 kbps
Data Modulation	QPSK FEC ½ interleaving with synchronisation markers insertion
Satellite Axial Polarization	< 4.5 dB
Power Flux Density evolution during satellite pass	See section 2.1.3
Carrier Frequency Deviation	$\leq\pm$ 15 10^{-6}
G/T at clear sky	Omnidirectional antenna: -30.5 dB/K @ 13º elevation

4.4.1.2 Power Flux Density evolution

The power flux density of the LPRT signal transmitted during the MetOp passes has an evolution regarding the ground station antenna elevation as it is indicated in the next figures.

Figure 4.4-2. LRPT Power Flux Density



4.4.1.3 VHF LNA

The signal is filtered to avoid the parasite signals then it is amplified by a dual stage low noise amplifier with a noise figure of 1 dB.

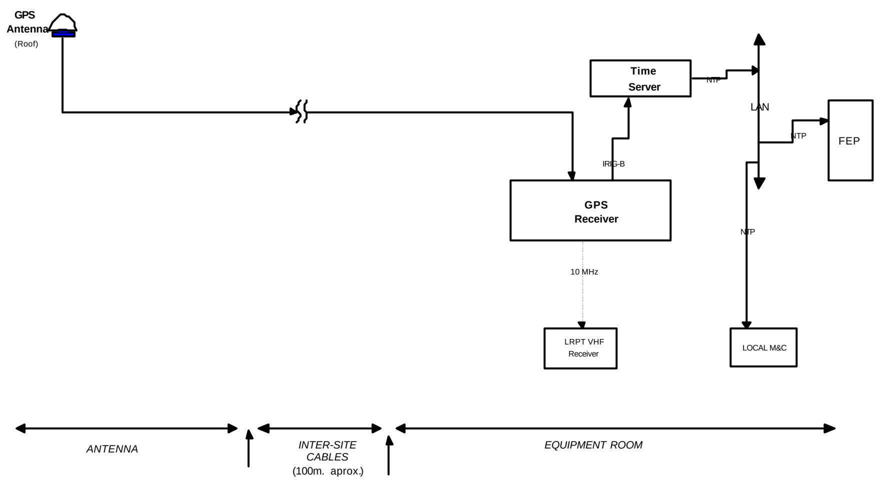
4.4.2 Receiver

Similar to the HRPT chain. In this case the IF frequency will be 38.9 MHz.

4.4.3 Time and Frequency Reference

Similar to the HRPT chain, the T&F subsystem provides GPS based time and frequency reference for different equipment of the US. The reference time (IRIG B baseline) and frequency shall be distributed appropriately to the Receiver equipment. The reference time based on NTP shall be distributed to the LAN for FEP and Local M&C.

Figure 4.4-3. F&T S/S functional diagram



The core of the T&F subsystem will consist of a GPS antenna and receiver that will provide 10 MHz frequency reference signals and IRIG B time code reference signals to the following equipment:

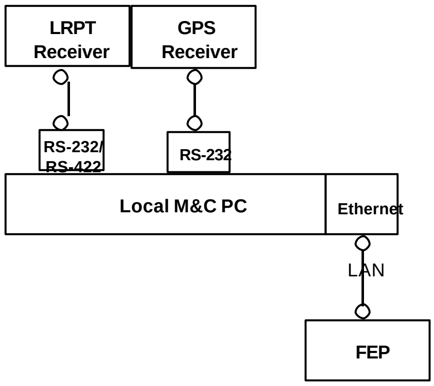
- 10 MHz frequency reference:
  - LRPT VHF Receiver.
- IRIG-B time reference:
  - Network Time Server.

The Network Time Server will provide time reference based on Network Time Protocol to the LAN;

4.4.4 Local M&C

The Local M&C will perform the monitoring and control of the elements located in the US station via standard interfaces, RS-232/RS-422 selectable. Next figure shows the M&C block diagram and connections.

Figure 4.4-4. Local M&C connections



For LRPT, the Local M&C does not receive Administrative Messages from FEP through the LAN interface, as there is no Tracking Unit. The Ethernet LAN between FEP and Local M&C is used for the NTP server.

4.4.4.1 Graphic User Interface

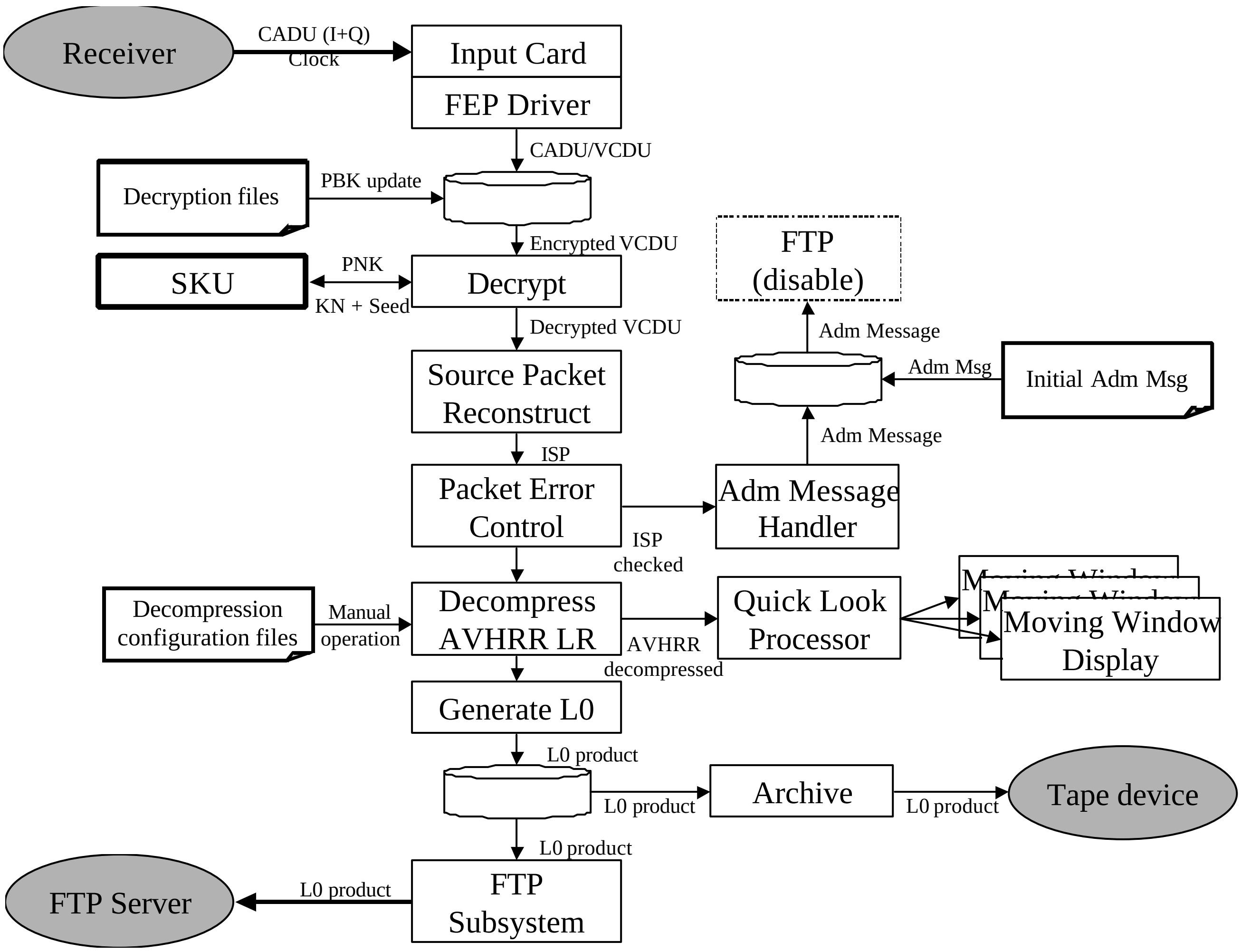
Similar to the HRPT Chain, except that there is no Antenna tracking.

4.4.5 Front End Processor

Similar to the HRPT Chain, with the following differencies :

- Distribution of Administrative Messages to the Local M&C is disable ;
- A new sub-system is added to decompress AVHRR LR ISP.

Figure 4.4-5. FEP Components



4.4.5.1 Decompression sub-system

The data field of AVHRR LR source packets shall be decompressed. This functionality will be implemented as a separate library, and used by a subsystem based on the standard KSPT subsystem template.

Note that this subsystem will receive source packets from all instruments, i.e. not all source packets shall be decompressed. Which instruments to decompress will be configurable (in this case APID 64..69). Source packets which are not decompressed will simply be forwarded to next stage of the processing chain. In this way the L0 Generate and Quicklook Processor only need to read input from one source.

New Quantization or Huffman tables to be used for decompression can be set up by an operator manually, through local configuration files.

The decompressed output will be formatted as CCSDS Version-1 source packets as well. The difference from the inputted source packet is that the data field is expanded, and the packet length field is adjusted accordingly. In this way all output from this subsystem will have the same format, and LO Generate and Quicklook Processor subsystems will only have to handle one input format.

Dataflow

Input will be (annotated) instrument source packets from the LRPT PEC subsystem.

Output will be decompressed AVHRR LR data. (Other instruments will be forwarded without modification).

5. TEST MODULE

This section describes the testing concept of the HRPT US and/or the LRPT US.

The US will include dedicated tools, forming a test harness, that will support the end-to-end verification of the US functions and performances. This test harness will allow to test the US in different ways :

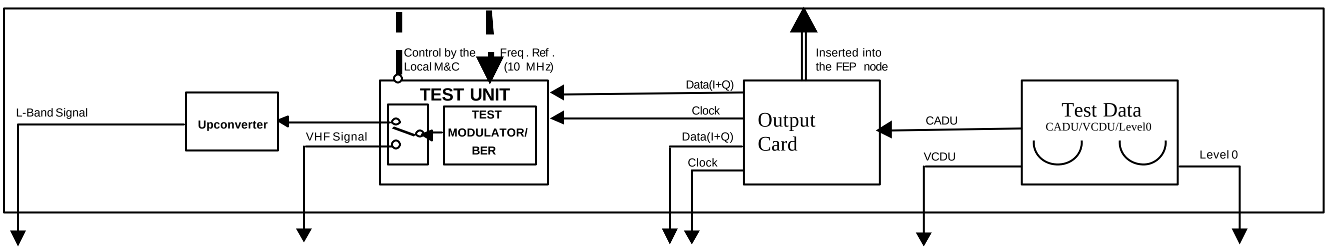
- It will allow testing each of the functional chains. It will be possible to test the functional chain as a whole or a subset of the functional chain limited to a given site ;
- It will allow testing any of the US external interfaces ;
- It will have the capacity to test the US in the most demanding nominal scenario (Metop phased, 30 mn) for a duration of 3 days ;
- It will provide the capacity to perform testing according to pre-defined scenarios that include non-nominal cases (e.g. alteration of the data flow through introduction of random noise with the RF signal, and so on).

5.1 INTRODUCTION

The HRPT/LRPT testing module is able to inject into both HRPT US and LRPT US :

- Level 0 products for FEP ;
- VCDUs for FEP ;
- CADUs for FEP ;
- VHF signal for HRPT/LRPT Receiver and for VHF-Band Antenna ;
- L-Band signal for L-Band Reception Antenna.

Figure 5.1-1. HRPT/LRPT Common testing module



Some elements are common to the HRPT and LRPT chains, some others are specific :

- HRPT and LRPT Common Testing Modules : Output Card, Test Unit, ..
- HRPT Specific Testing Modules : VHF to L-Band converter, ACU Manual test;

5.2 SOME TESTING MODULES

5.2.1 Output card

The output card is able to send CADUs bitstream at the desired speed:

- 3.5 Mbps for HRPT ;
- 72 Kbps for LRPT.

with Data (I+Q) + Clock at TTL Level :

The output card can be connected into the FEP computer, and with the use of the test software the specified CADUs file can be transmitted to the output card “Data (I+Q) + Clock”.

This output card can be connected to the input card (short loop back) or to the test unit [TBC] (long loop back).

5.2.2 Test Unit

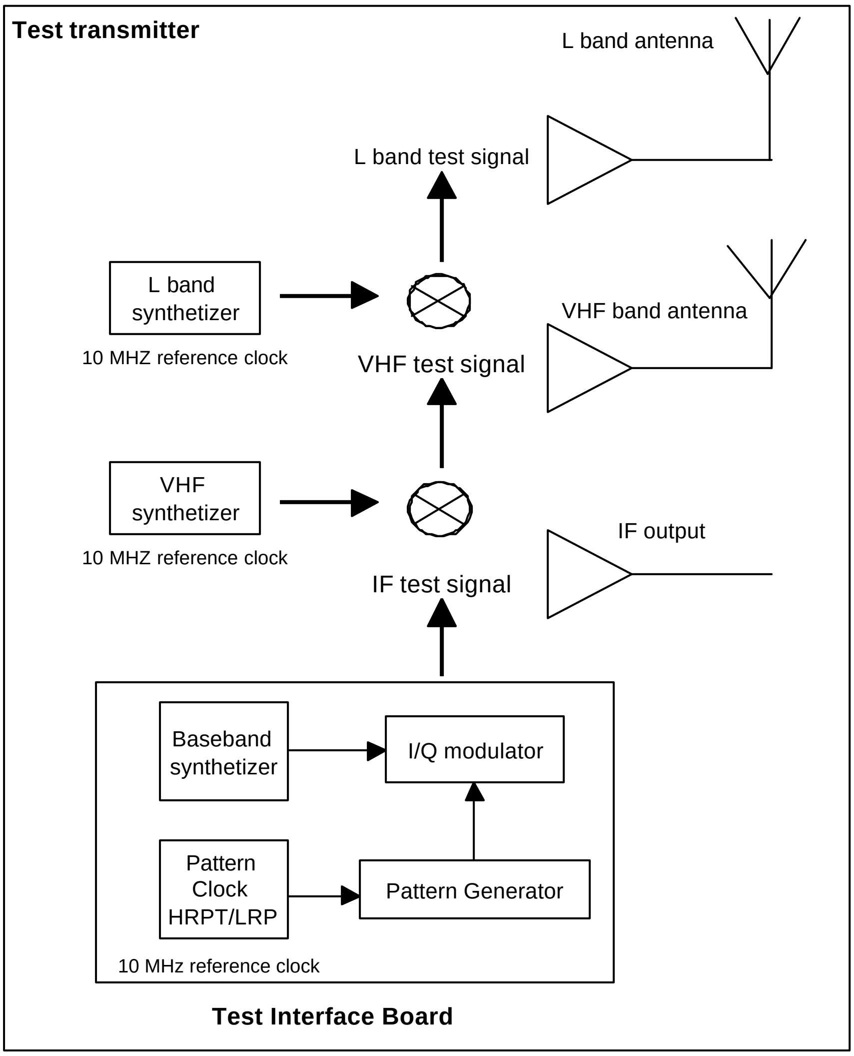
A test transmitter unit allows to verify the right operation of the system out of satellite passes.

It permits to inject , at antenna level (L-band or VHF) a test signal of the chain.

A second level of tests is foreseen at IF, close to the receptors, that permits to test the I/Q demodulation injecting data directly in I/Q modulator.

For the signal to noise test, the antenna will be directed to a noise source (sun) to perform the verifications.

Figure 5.2-1. Test transmitter



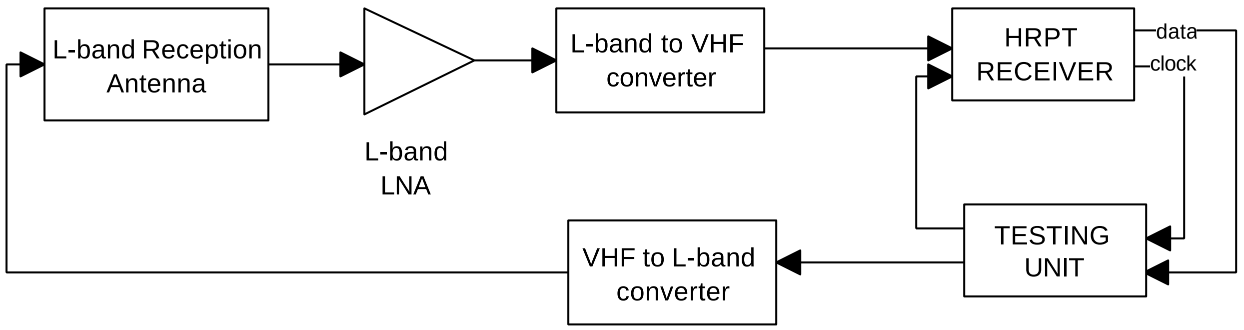
5.2.2.1 HRPT Testing Chain

Two testing loop will be used in order to verify the HRPT chain. The long loop will be closed at antenna level, by means of a antenna probe which will allow to inject L-band signals into the reception chain. The short loop will be closed at the input of the demodulator. The testing chain is able to generate a pseudo random binary sequence which will be modulated by being injected into the demodulator. Selecting the long loop, the same signal is up converted an injected at antenna input. The testing signal is set to a level which corresponds to the level obtained during the initial acquisition conditions.

The pseudo random data is demodulated by the demodulator. In this case the data are directed to the bit error unit where the bit error rate is measured. For making this test representative of the acquisition and reception conditions the antenna will be at 5º elevation. It is this condition where the BER is measured, that is, the C/N will correspond to that operational condition.

All measurements made in the RUS station shall be dated with the time of performance in UTC.

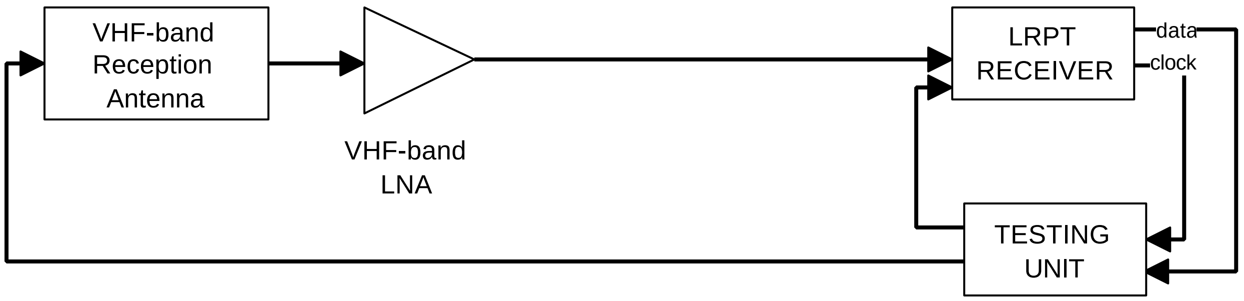
Figure 5.2-2. HRPT Testing Chain



5.2.2.2 LRPT Testing Chain

Same as HRPT testing chain.

Figure 5.2-3. LRPT Testing Chain



6. GLOSSARY

Please refer to document « Glossary of terms and abbreviation» [A-RD0010]

THIS PAGE IS INTENTIONALLY LEFT BLANK

ANNEX A: US Products

PRODUCT NAME	APID	HRPT (bps)	LRPT (bps)
ADCS_xxx_00_Mnn	35	7 462.0	0.0
AMSA_xxx_00_Mnn	39, 40	3 244.0	3 244.0
ASCA_xxx_00_Mnn	192 .. 255	60 000.0	0.0
AVHR_xxx_00_Mnn	103 or 104 for HRPT 64 .. 70 for LRPT	622 368.0	39 900.0
GOME_xxx_00_Mnn	384 .. 447	400 000.0	0.0
GRAS_xxx_00_Mnn	448 .. 511	60 000.0	0.0
HIRS_xxx_00_Mnn	38	2 907.5	2 907.5
IASI_xxx_00_Mnn	128 .. 191	1 500 000.0	0.0
MHSx_xxx_00_Mnn	34	3 924.0	3 924.0
SEMx_xxx_00_Mnn	37	165.5	165.5
HKTM_xxx_00_Mnn	1, 2, 3, 6	6 440.0	6 440.0

So, for a pass of 10 mn :

PRODUCT NAME	HRPT (KB)	LRPT (KB)
ADCS_xxx_00_Mnn	41 973.750	0.000
AMSA_xxx_00_Mnn	243.300	243.300
ASCA_xxx_00_Mnn	4 500.000	0.000
AVHR_xxx_00_Mnn	46 677.600	2 992.500
GOME_xxx_00_Mnn	30 000.000	0.000
GRAS_xxx_00_Mnn	4 500.000	0.000
HIRS_xxx_00_Mnn	218.062	218.062
IASI_xxx_00_Mnn	112 500.000	0.000
MHSx_xxx_00_Mnn	294.300	294.300
SEMx_xxx_00_Mnn	12.412	12.412
HKTM_xxx_00_Mnn	483.000	483.000

THIS PAGE IS INTENTIONALLY LEFT BLANK

ANNEX B: Environmental constraints

- Outdoor equipment
  - In operation
    - Temperature -25 to +55 °C
    - Relative humidity 100%
    - Rain Up to 13cm/hr
    - Wind Up to 150km/h
  - In survival configuration
    - Temperature -40 to +70 °C
    - Wind Up to 250km/h
- Indoor equipment
  - In operation
    - Temperature 0 to +30 °C
    - Relative humidity 5 to 90%
  - In transport configuration
    - Temperature -40 to +70 °C
    - Relative humidity 5 to 100%

THIS PAGE IS INTENTIONALLY LEFT BLANK

ANNEX C: Administrative Message

Administrative Message extracted from ISP Application data for FEP			
	Description	**Type**	**Size (Bytes)**
1	Message Number *(incremented number used as rolling counter)*	1 character	1 byte
2	Starting Time of Validity for this Admin Message. *[MJD 2000]*	1 long + 2 unsigned long	12 bytes
3	METOP Satellite ID (International Designator) *(10 ASCII characters)*	10 characters [ASCII]	10 bytes
4	METOP Time Correlation *(two parameters)*	2 double	16 bytes
5	METOP TBUS Orbital parameters for first 12 hours *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes
6	METOP TBUS Orbital parameters for hours 13 to 24 *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes
7	METOP TBUS Orbital parameters for hours 25 to 36 *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes
8	METOP “SPOT-model” Orbital parameters for first 12 hours *Validity Starting time [MJD 2000]* *12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
9	METOP “SPOT-model” Orbital parameters for hours 13 to 24 *Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
10	METOP “SPOT-model” Orbital parameters for hours 25 to 36 *Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
11	METOP Calibration parameters (50 parameters) *(Roughly estimated to 5 parameters for 10 instruments)*	50 double	400 bytes
12	METOP Compression parameters *(Number of on-board used compression table)*	20 unsigned short	40 bytes
13	METOP Events and messages (rolling buffer) (each event shall be preceded by an event serial number) *(i.e. warning for manoeuvre, Instrument events)*	unsigned short [ASCII]	5200 bytes

Administrative Message extracted from ISP Application data for FEP			
	Description	**Type**	**Size (Bytes)**
14	NOAA Satellite ID (International Designator) *(10 ASCII characters)*	10 unsigned short [ASCII]	10 bytes
15	NOAA S/C "SPOT-model" for first 12 hours *Validity Starting time [MJD 2000]* *12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
16	NOAA S/C "SPOT-model" for hours 13 to 24 *Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
17	NOAA S/C "SPOT-model" for hours 25 to 36 *a) Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
18	Spare		70 bytes
	Total :		**8000 bytes**

After each HRPT dump processing, the FEP constitutes a file with extract of administrative messages data required by the ACU to prepare next pass acquisition.

The Admin message structure sent to the ACU (for HRPT only) is dependant to the orbital model (SPOT or TBUS) chosen.

TBUS Administrative Message for ACU			
	Description	Type	Size (Bytes)
1	Message Number *(incremented number used as rolling counter)*	1 character	1 byte
2	Starting Time of Validity for this Admin Message. *[MJD 2000]*	1 long + 2 unsigned long	12 bytes
3	METOP Satellite ID (International Designator) *(10 ASCII characters)*	10 characters [ASCII]	10 bytes
4	METOP Time Correlation *(two parameters)*	2 double	16 bytes
5	METOP TBUS Orbital parameters for first 12 hours *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes
6	METOP TBUS Orbital parameters for hours 13 to 24 *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes
7	METOP TBUS Orbital parameters for hours 25 to 36 *Validity Starting time [MJD 2000]* *TBUS part IV (without spacecraft ID)*	(a) 1 long + 2 unsigned long (b) Characters [ASCII]	515 bytes (a) 12 bytes (b) 503 bytes

or

SPOT Administrative Message for ACU			
	Description	Type	Size (Bytes)
1	Message Number *(incremented number used as rolling counter)*	1 character	1 byte
2	Starting Time of Validity for this Admin Message. *[MJD 2000]*	1 long + 2 unsigned long	12 bytes
3	METOP Satellite ID (International Designator) *(10 ASCII characters)*	10 characters [ASCII]	10 bytes
4	METOP Time Correlation *(two parameters)*	2 double	16 bytes
8	METOP "SPOT-model" Orbital parameters for first 12 hours *Validity Starting time [MJD 2000]* *12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
9	METOP "SPOT-model" Orbital parameters for hours 13 to 24 *Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes
10	METOP "SPOT-model" Orbital parameters for hours 25 to 36 *Validity Starting time [MJD 2000]* *b) 12 SPOT parameters – binary coded*	(a) 1 long + 2 unsigned long (b) 13 double	116 bytes (a) 12 bytes (b) 104 bytes

The Admin Message filename for the ACU is :

<INST>_<FILE_CAT>_<PROC_LEVEL>_<SPACECRAFT>_<VALIDITY_START_TIME>_<VALIDITY_STOP_TIME>_<CREATION_DATE>_<SOURCE>_<FILE_TYPE>

Admin Message Name Field	Description	Size in characters	Possible values
INST	Instrument identification	4	xxxx
FILE_CAT	File category identification	3	PSF
PROC_LEVEL	Processing Level identification	2	xx
SPACECRAFT	Spacecraft identification	3	[E-AD-36]
VALIDITY_START	Validity Start Time	15	
VALIDITY_END	Validity Stop Time	15	
CREATION_DATE	Creation time of the file	15	
SOURCE	Identification of the file provider	4	FEPR
FILE_TYPE	Identification of the data type	10	RUSTBUSMSG for Admin Message containing TBUS model or RUSSPOTMSG for Admin Message containing SPOT model

The format for <ACQUISITION_START>, <ACQUISITION_STOP> and <CREATION_DATE> is YYYYMMDDHHMMSSZ

ANNEX D: Decryption Key File

The content of the Decryption Key file is based on the XML format.

One file can contain the Decryption Keys for all used key numbers of one or more SKUs.

Here is the definition of each field that can be found into the decryption file :

Fields	Type	Possible values	Number of characters	Description
Station Key Unit Number	CHAR : Integer	0 .. 65535	1 to 5	This number is unique for each SKU
Key Number	CHAR : Hex Representation	0x00 .. 0x3F, 0x80 .. 0xBF	2	
Public Key	CHAR : Hex Representation	24 * (0x00 .. 0xFF)	48	The public key is a 24 byte field, hence resulting in a string of 48 characters length
CRC	CHAR : Hex Representation	0x0000 .. 0xFFFF	4	

Here is an example of the decryption key file content :


```
<DecryptionDataFile>
    <SKU ID=”23”>
        <KeyNumber ID=”05”>
            <PublicKey>d656a495a7c263598900237bebdf17e24da5835694b33546</PublicKey>
            <CRC>66fb</CRC>
        </KeyNumber>
        <KeyNumber ID=”1C”>
            <PublicKey>a534bd6b4fbc75f8ad347ca758aa7fd46d15d3a64266760d</PublicKey>
            <CRC>c32a</CRC>
        </KeyNumber>
        <KeyNumber ID=”1D”>
            <PublicKey>d656a495a7c263598900237bebdf17e24da5835694b33546</PublicKey>
            <CRC>66fb</CRC>
        </KeyNumber>
    </SKU>
    <SKU ID=”147”>
        <KeyNumber ID=”05”>
            <PublicKey>45672abbd8596d556ah6512f1231eda2215593b1256a3256</PublicKey>
            <CRC>35ac</CRC>
        </KeyNumber>
        <KeyNumber ID=”1C”>
            <PublicKey>a534bd6b4fbc75f8ad347ca758aa7fd46d15d3a64266760d</PublicKey>
            <CRC>c32a</CRC>
        </KeyNumber>
        <KeyNumber ID=”1D”>
            <PublicKey>45672abbd8596d556ah6512f1231eda2215593b1256a3256</PublicKey>
            <CRC>35ac</CRC>
        </KeyNumber>
    </SKU>
</DecryptionDataFile>
```

The Decryption key filename for the FEP is :

<FACILITY>_<FILE_ID>_<CHANNEL>_<SPACECRAFT>_<CREATION_DATE>_<GROUP_ID>

Decryption key Name Field	Description	Size in characters	Possible values
FACILITY	Instrument identification	4	RUSx
FILE_ID	File category identification	3	KEY
CHANNEL	Processing Level identification	3	HRP or LRP
SPACECRAFT	Spacecraft identification	3	[E-AD-36]
CREATION_DATE	Creation time of the file	15	
GROUP_ID	Identification of the file provider	1	TBD Eumetsat

The format for <CREATION_DATE> is YYYYMMDDHHMMSSZ

ANNEX E: Tape Format

The tape format used contains :

- one Header (in ASCII format) which identifies the media, and is written when the media is initialized.

- one or several files as one tar archive (in binary format) which identifies the Level 0 files acquired.

- one or several Cumulative Table Of Contents or CTOC (in ASCII format). Cumulative Table of Contents. Accumulated for each pass, thus, growing.

An example of the layout of the tape is :

Header + Data(1) + CTOC(1) + Data(2) + CTOC(2) + CTOC(1) + Data(3) + CTOC(3) + CTOC(2) + CTOC(1) + Data(4) + CTOC(4) + CTOC(3) + CTOC(2) + CTOC(1) + etc ...

1. Header format

Header Identifies the media, and is written when the media is initialized.

There is only one Header per tape generated.

The header is always 512 bytes, using 0-padding.

The Header file is an ASCII file (it can be extracted from tape using the unix "dd" command). The mandatory fields for the EPS PGF are TapeId (identifier on 6 characters) and format (always equal to TOC002).

This header file uses ASCII format. The end of each line is marked with a new-line (\n). NB : text in bracets are defined into the following structure :

TapeId=[mediumId]\n

format=[format]\n

SiteId=[siteId]\n

LibraryId=[libraryId]\n

cluster=[cluster]\n

type=[mediaType]\n

blockcount=[blockingFactor]\n

Tape initialized on drive [initializedOn] at [initializedAt]\n

SystemID=[systemId]\n

VolumeCnt=[volumeCnt]\n

BlockSize=[blockSize]\n

CheckTime=[checkTime]\n

NB : The length of each field of the following structure has to be equal to the legnth specified by the "Dim" column, with right padding of space characters when necessary (ie SiteId=NOA1 \n and not SiteId=NOA1\n).

Name	Description	Type	Dim
mediumId	6 digit media identifer Can be any configurable value (eg. B00006)	t_char	6
format	String indicating the format of the media. Sort of version number. This field shall be set to TOC002	t_char	10
siteId	A 6-character site identifer. Possible values are CDA1, CDA2, CDA3, NOA1, NOA2	t_char	6
libraryId	A 6-character library identifer indicating the location for the storage of the media. Currently not used. Default value is None	t_char	6
cluster	Cluster identifer. Currently not used. Default value is None	t_char	6
mediaType	Device type.	t_char	10

	Possible values are DAT, DLT, LTO		
blockingFactor	The blocking factor used on the medium Default value is 256	t_char	6
initializedOn	Integer giving a reference to the physical device number. (There is no newline after this, next field follows on same line).	t_char	2
initializedAt	String giving the actual date of the tape initialization	t_str_DAT_utc_time	1
systemId	System id. Possible values are "MEOS DIS", "QBDCS" or Others	t_char	30
volumeCnt	Volume counter. Currently not used Default value is 1	t_char	8
blockSize	The block size of the medium Default value is 512	t_char	6
checkTime	Time for the initiation of the medium. Used as checksum	t_str_DAT_utc_time	1

2. CTOC format

The CTOC file is an ASCII file appended to the new data archived (it can be extracted from tape using the unix "tar" command).

This Header is accumulated for each pass. E.g. Header + Data(1) + CTOC(1) + Data(2) + CTOC(2) + CTOC(1) + Data(3) + CTOC(3) + CTOC(2) + CTOC(1).

The mandatory fields for the EPS PGF are .position (first CTOC is 1, second is 3, third is 5, etc ...), .format (always equal to TOC002), .segment_type (to be set to R), .satellite (Satellite Identifier : M01, M02, M03, N15 ,N16 ,N17 , etc ...), .orbit (orbit number), .start_time (the acquisition start time), .stop_time (the acquisition stop time), path and file_size (full path of the archive + "2 blanks characters" + size of the archive in bytes) and the separator .############# which is mandatory.

This header file uses ASCII format. The end of each line is marked with a new-line (\n). NB : text in bracets are defined into the following structure :

.position=[position]\n

.to_tape=[to_tape]\n

.writing_drive=[writing_drive]\n

.cluster_name=[cluster]\n

.tape_id=[medium_id]\n

.site_id=[site_id]\n

.library_id=[library_id]\n

.format=[format]\n

.use_in_kby=[size]\n

.tape_type=[media_type]\n

.volume=[volume]\n

.passes=[passes]\n

.segments=[segments]\n

.segment_type=[seg_type]\n

.satellite=[satellite]\n

.orbit=[orbit]\n

.start_time=[start_time]\n

.stop_time=[stop_time]\n

.checktime=[check_time]\n

[path] [file_size]\n (nb : [path] and [file_size] are separated by 2 blanks characters)

[marker]\n

NB : The length of each field of the following structure has to be equal to the length specified by the "Dim" column, with right padding of space characters when necessary (ie .satellite=NOA1   \n and not .satellite=NOA1\n), besides that [path] has no fixed length (refer to structure definition).

NB2 : The CTOC file containing CTOC(3) + CTOC(2) + CTOC(1) is one file with three entries, so it can be extracted with only one unix "tar" command like a CTOC containing only one structure (eg CTOC(1)).

Name	Description	Type	Dim
position	File number on medium (first CTOC value is 1, second CTOC value is 3, third CTOC value is 5, etc ...)	t_char	6
to_tape	Date of writing the CTOC file	t_str_DAT_utc_time	1
writing_drive	Integer giving a reference to the physical device number	t_char	2
cluster	Name of the cluster which the medium belongs to. Currently not used Default value is None	t_char	6
medium_id	Medium identifier Can be any configurable value (eg. B00006)	t_char	6
site_id	A 6-character site identifier Possible values are CDA1, CDA2, CDA3, NOA1, NOA2	t_char	6
library_Id	A 6-character library identifier indicating the location for the storage of the medium. Currently not used. Default value is None	t_char	6
format	String indicating the format of the medium. Shall always be set to TOC002	t_char	10
size	Size in kbytes of all data written to the medium so far. Includes Header, tar archives and CTOCs. Including current CTOC.	t_char	20
media_type	Device type. Possible values are DAT, DLT, LTO	t_char	10
volume	Volume counter (number of tape generated by the system) Currently not used. Default value is 0	t_char	6
passes	The total number of passes archived on the media. Currently not used. Default value is 0	t_char	10
segments	The total number of segments archived on the media. Currently not used. Default value is 0	t_char	10
seg_type	R - raw data or P - products Should be set to R	t_char	1
satellite	Satellite data was received from. Possible values are M01, M02, M03, N15, N16, N17, N18, N19	t_char	30
orbit	Satellite orbit number (eg. Start orbit number)	t_char	6
start_time	The acquisition start time for the ingestion of the raw data/products in the segment	t_str_DAT_utc_time	1
stop_time	The acquisition stop time for the ingestion of the raw data/products in the segment	t_str_DAT_utc_time	1
check_time	Checksum (Date of writing the CTOC file, can be equal to the value of the field "to_tape")	t_str_DAT_utc_time	1
path	full path and filename of the archive	t_char	1024

	(There is no newline after this, next field follows on same line, separated by 2 spaces. This field has not a fixed length but is limited to 1024 bytes).		
file_size	Size of file in bytes	t_char	10
marker	Marker to identify the end of the CTOC file Always set to .##############	t_char	15

3. Structure format

Structure layout of t_char terminal

Format: %s
Type C or Dim: char

Structure layout of t_int_unsigned_one_byte terminal

The identifier "byte" has to be defined depending of the machine implementation.

Format: %u
Type C or Dim: byte

Structure layout of t_int_unsigned_two_bytes terminal

The identifier "word" has to be defined depending of the machine implementation.

Type C or Dim: word

Structure layout of t_str_DAT_utc_time terminal

The time type utc time ascii holds two strings, one for date and one for time, separated by a space. The format is dd-mmm-yyyy hh:mm:ss.msecs.

Type C or Dim: [24]

END OF DOCUMENT