Radio Navigation Laboratory (TOS-ETL) European Space Agency (ESA)

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Receiver Technical Workshop

3rd July 2003

Paris

Objectives of the Navigation Laboratory

1. To provide a modern simulation and test facility for supporting ESA projects involved in navigation.
2. To offer a European facility to manufacturers for testing GNSS related receivers or systems.
3. To constantly monitor GNSS health and performance.
4. Monitor and test EGNOS receivers on the market.
5. To research new techniques or anomalies in the area of navigation.
6. To keep pace with developments in the field of navigation.

Description of the Laboratory Facilities

1. Broad Selection of Navigation receivers
2. GNSS Signal Simulators
3. GPS/GLONASS Health Monitoring Unit
4. Evil Waveform Generator
5. SisNet
6. SW tools

ESTEC Receivers

Manufacturer	Receiver	Type	Antenna	Comments
Allen Ashborne Ass.	TerboRogue	SNR-8000	Choke-Ring Assembly	Not EGNOS
Ashtech	Aquarius	5001MD	NAP001	General Use
	Aquarius	02 Series	NAP002 (L1-L2)	Not ordered (TBD)
	GPS Receiver XII	M-XII	L1-L2 Antenna	General Use
	GPS Receiver XII	M-XII	L1-L2 Antenna	General Use
	GPS Receiver XII	M-XII	L1-L2 Antenna	General Use
		Z-Surveyor	-	HMU
		GG24C Surveyor	Multipath Antenna	HMU
	OEM Sensor	DG16 Sensor	DG-ProAntenna	ESTB/EGNOS Reports
CT GmbH	Star Track	GSW12	Rx built into antenna	General Use
G3 Navigation	GNSS-300	-	Aero antenna	HMU
Javad	GNSS Receiver	Legacy	Regent	General Use
Novatel	Millennium	PwrPak-II-STDW	L1-L2 Antenna 503	SisNet
	Millennium	PwrPak-II-STDW	Ashtech surface mount	Dakar Flight Trials
	Millennium	PwrPak-II-GENERIC	L1-L2 Antenna 503	ESTB/EGNOS Data collection for reports
	Millennium	PwrPak-II-G-RT10	Antenna 502	On Loan
	Millennium	PwrPak-II-3151W		Evil Wave Form Generator
	OEM4	ProPak-OEM4-G2-3151W	Antenna 600	Future AFI Trials
	OEM4	ProPak-OEM4-G2-3151W	Antenna 600	Future AFI Trials
	WAAS Receiver Subsystem	3 x OEM3 receiver cards	-	GUS RIMS
Septentrio	GNSS Receiver	PolaRx2 Prototype	-	ESTB/EGNOS Data collection for Reports
	GNSS Receiver	PolaRx2		General Use
Garmin	eTrex	Vista	Internal	Handheld
	eTrex	Legend	Internal	Handheld
	eTrex	Venture	Internal	Handheld
Magellan	Meridian	Platinum	Internal	Handheld
	Meridian	Gold	Internal	Handheld

EGNOS Receiver Evaluation

To help in the evaluation of EGNOS receivers a test document has been written entitled *EGNOS Receiver Evaluation – Test Plan*. Its purpose is to:

1. Test a receivers compatibility with EGNOS
2. Quantify the major parameters of the receiver
3. Provide a basis for comparison of receivers

Some of the tests require the use of a GPS simulator

EGNOS Receiver Evaluation Document Ref. TOS-ETT/2001.168/SJ/sj

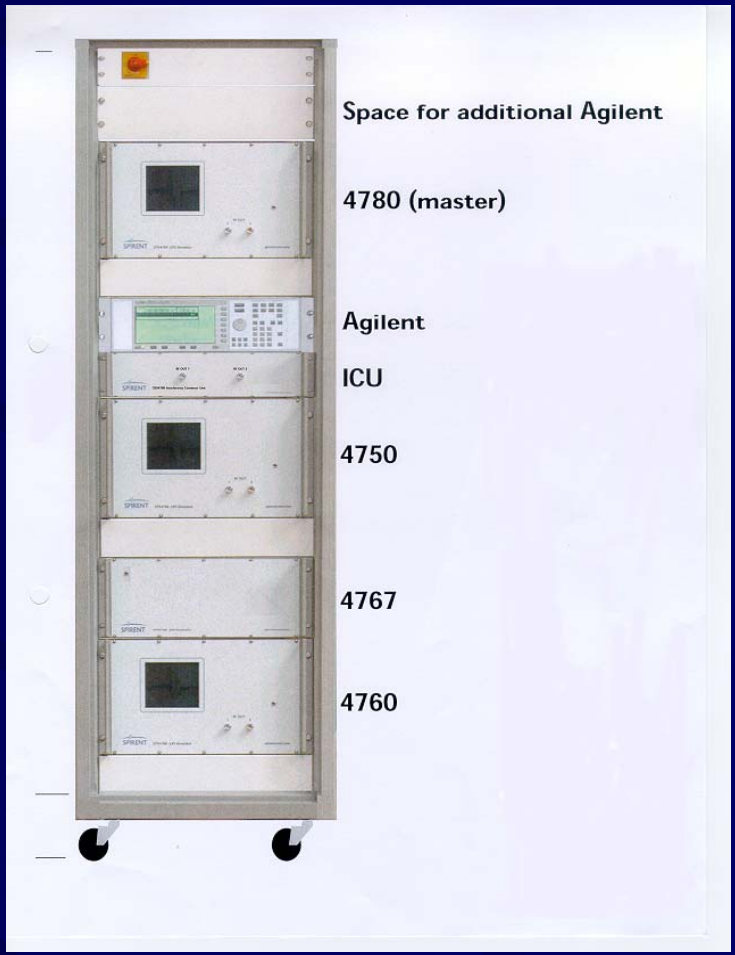
- The document covers 17 different tests (RINEX data)
- However due to the differing data available from receivers it will probably only be possible to perform a subset of these.
- The documents main purpose is to measure the compatibility of the receivers with EGNOS including.
  - Improvement in positional accuracy
  - Integrity and Alerts etc.
- Where possible the tests will go much further and include:
  - Clock bias and drift
  - Cycle slips etc.

RF Signal Simulators

- Developed by Spirent Communications
- RF signal generated as in a real environment (Doppler, power, multipath, atmosphere)
- GPS/GLONASS/EGNOS/Interference (L5 in August)
- Scenario inputs user definable
- L1/L2, relative navigation, attitude determination, RTCM differential

Future Fully Integrated Simulator

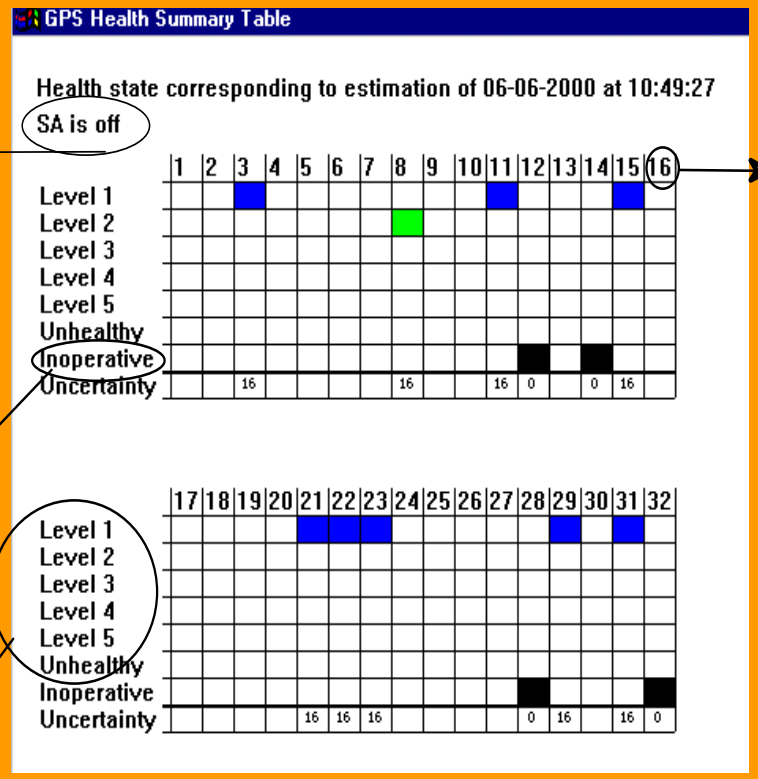
- STR4780 12 channels GLONASS
- Agilent Noise Source
  - CW
  - AWGN
  - Pulsed
- STR4766
  - Single output Interference Combiner Unit (ICU)
- STR4750
  - 12 channels GPS L1 & L2
  - or 24 channels L1
- STR 4767
  - Timing unit and control unit
- STR4760
  - 12 channels L5



Health Monitoring Unit

- Developed by GMV
- GPS/GLONASS status and range errors
- Health status/definitions
- Environment-related error sources (iono, tropo, mpath)
- Satellite signal power assessment
- Accumulated statistics of its monitoring functions

HMU Health Summary

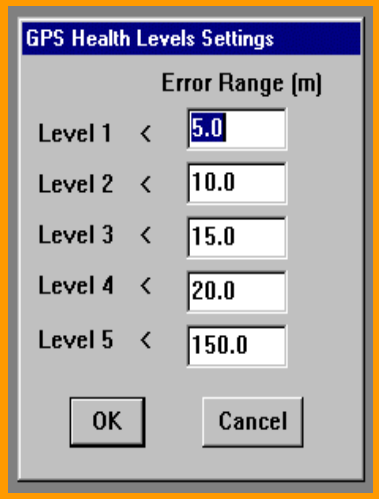


SA status

Satellite prn

Unhealthy declaration due to the almanac message

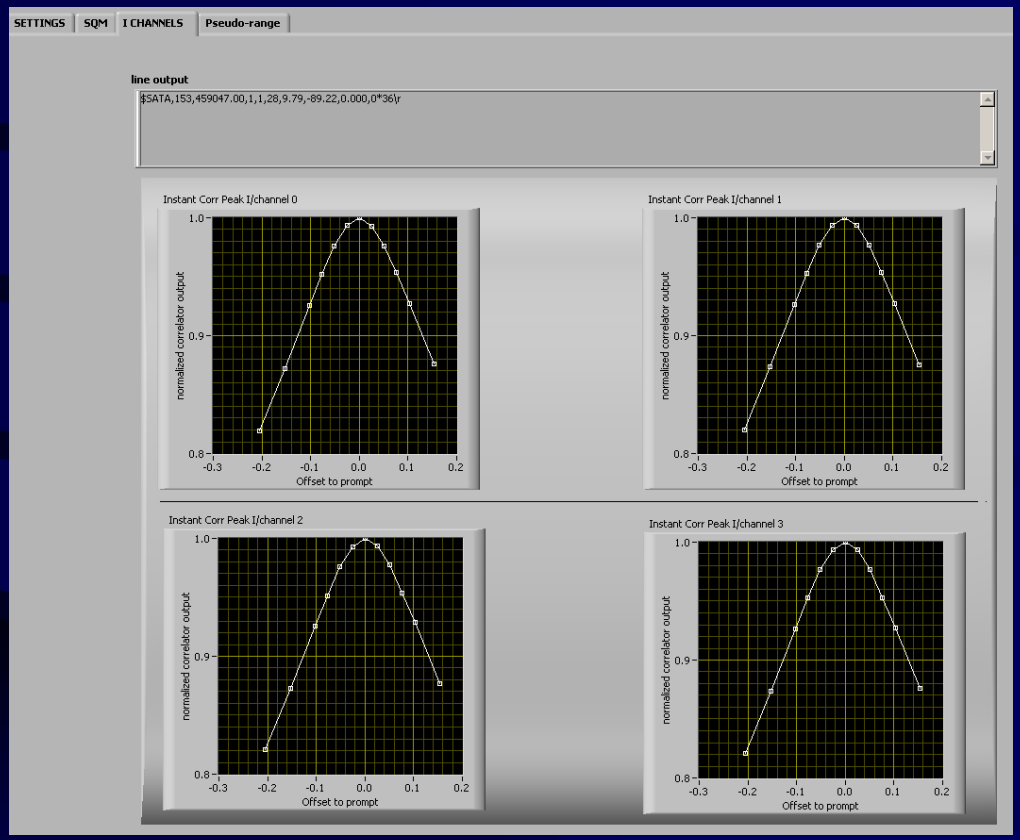
Health levels defined for the HMU



Evil Waveform Generator

- An equipment to replicate the GPS timing errors introduced by satellite PRN 19 failure.
- Incorporates
  - a multi-correlator receiver
  - Analysis software
- Can be used to analyze the effects of the so called evil waveform on receivers

Correlation Results



SisNet within ESTEC

- Millennium receiver decoding EGNOS messages 24 hours per day.
- Base station computer interfaces between receiver and Server.
- Server placed outside of ESTEC's firewall allows EGNOS messages to be received across the internet.

Software Tools Available

Michel Tossaint

TOS-ETT

Software Navigation Tools
Receiver solution software

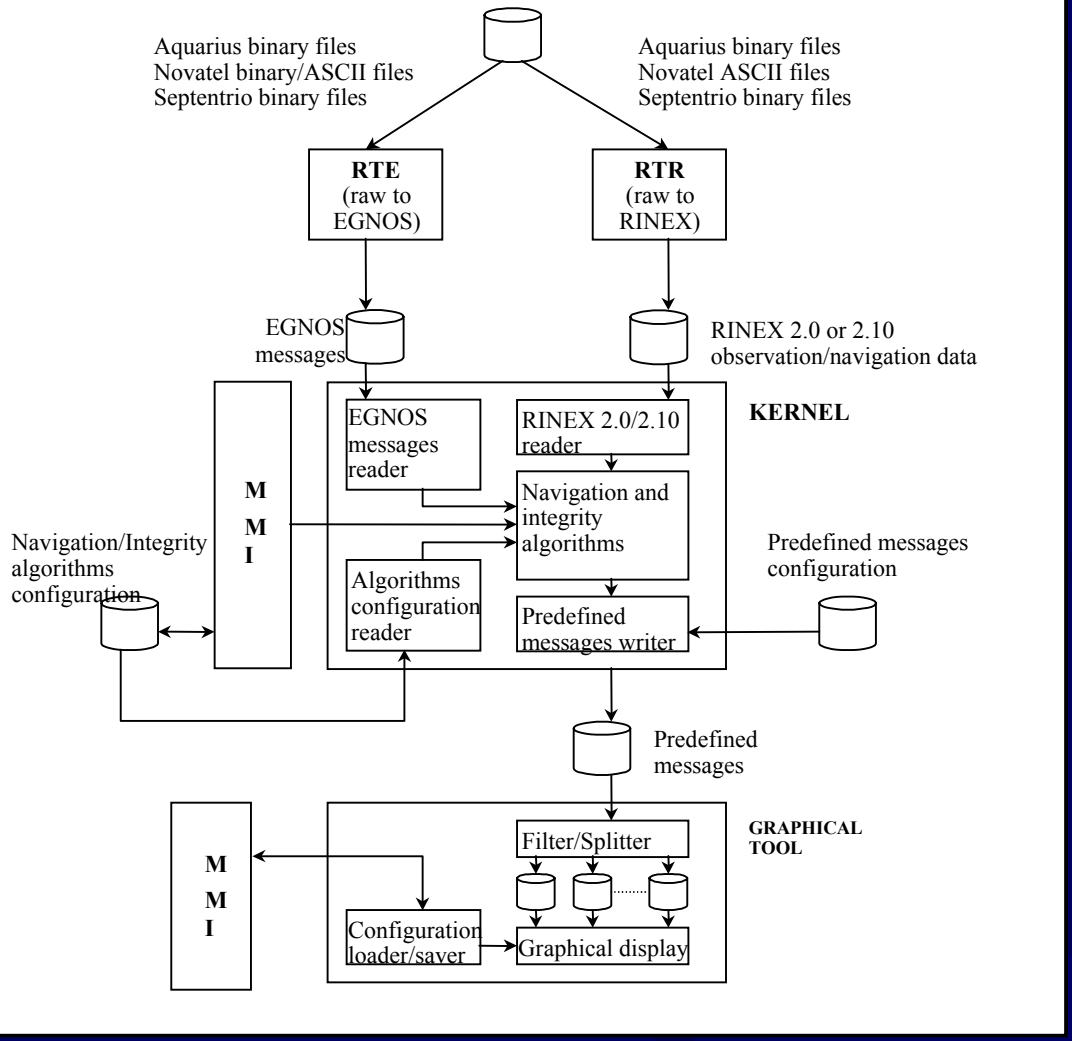
- Offline GPS/GLONASS/EGNOS processing: TERESA v2.1
- Baseline Processing: Trimble Total Control v2.7
- Network Processing: Bernese v4.2
- Relative processing space: SKAME v1.0
- Error budget investigation: TANGO v1.3

Software Navigation Tools
TERESA

Key Features

- Process GPS/GLONASS/EGNOS data from several receivers based on RINEX + (GEO) standard.
- Friendly MMIs.
- Multiple configuration capabilities
  - SIS standard, Phase of flight, navigation solution, weighted solution, smoothing interval...
- Batch processing for mass analyses.
- Data management based on scenarios.

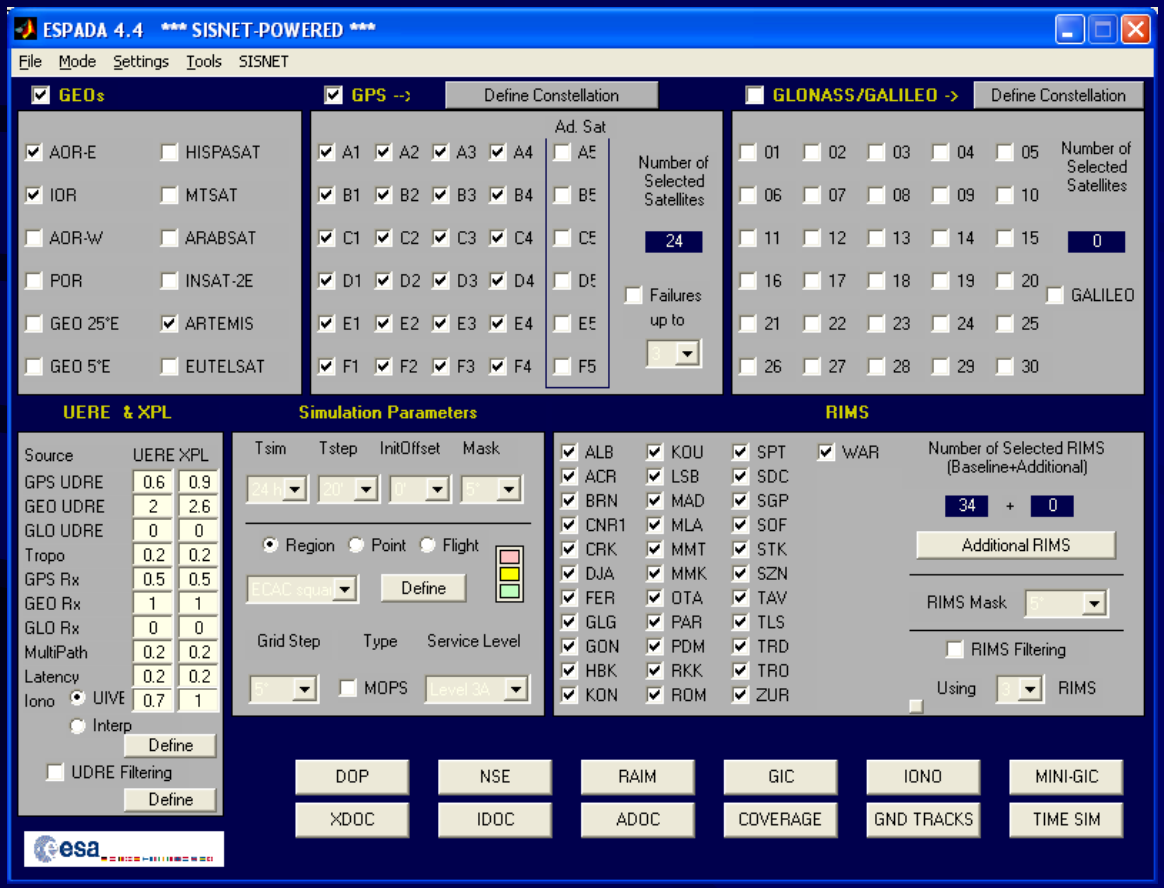
TERESA


Aquarius binary files
Novatel binary/ASCII files
Septentrio binary files
Aquarius binary files
Novatel ASCII files
Septentrio binary files
RTE
(raw to
EGNOS)
RTR
(raw to
RINEX)
EGNOS
messages
RINEX 2.0 or 2.10
observation/navigation data
KERNEL
EGNOS
messages
reader
RINEX 2.0/2.10
reader
Navigation and
integrity
algorithms
Algorithms
configuration
reader
Predefined
messages writer
M
M
I
Navigation/Integrity
algorithms
configuration
Predefined messages
configuration
Predefined
messages
GRAPHICAL
TOOL
Filter/Splitter
Configuration
loader/saver
Graphical display
M
M
I

Software Navigation Tools
Simulation Software

- Matlab EGNOS Service Volume Simulator: ESPADA v4.4
- C/C++ EGNOS Service Volume Simulator: ESVS v2.2
- Galileo Service Volume Simulator: GSVS v1.0
- Galileo Service Volume Simulator: GSSF v2.0
- Galileo Raw Data Generator: GSSF v2.1

Software Navigation Tools
ESPADA



Use of ESTEC Facilities by External Customers

- The following ESTEC Navigation facilities are available to external customers subject to availability:-
  - Use of Software and Simulators within ESTEC.
  - Use of Evil waveform generator.
  - The loan of EGNOS receivers when available.
- The use of the facilities are in essence free of charge, although man hours are costed for any assistance required.

Contact Points

- General questions about EGNOS, ESTB or receivers should be sent via e-mail to the ESTB helpdesk: estb@esa.int
- For the use of the laboratory facilities send an e-mail to: simon.johns@esa.int

  or

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