

2nd EGNOS Receiver Workshop

EGNOS Receiver Tests

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2nd EGNOS Receiver Workshop



Introduction

- ▶ ENL & Euterpe Laboratory Facilities
- ▶ Types of Receivers to be Tested
- ▶ Test Philosophy
- ▶ Questions Needing Answers
- ▶ Conclusion

Current ENL Facilities

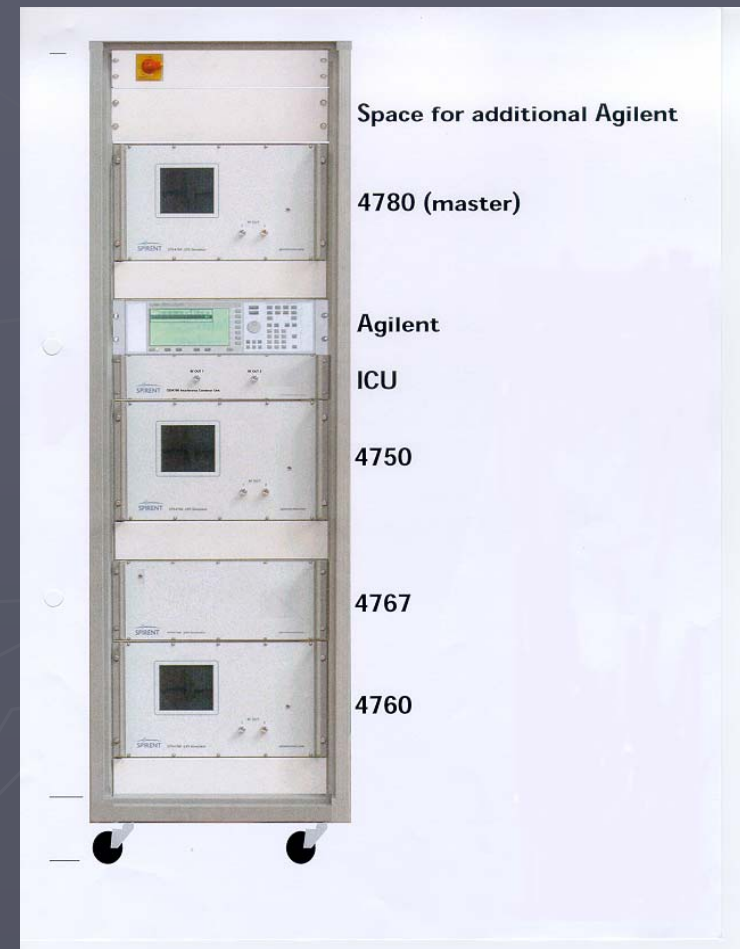
- ▶ GNSS RF Simulators
- ▶ Sisnet (EGNOS messages on the Web)
- ▶ Post Processing Software

GPS/GLONASS RF Simulators

- ▶ Developed by Spirent Communications
- ▶ RF signal generated replicates a real environment including (Doppler, power, multipath, atmosphere)
- ▶ Scenarios are user definable
- ▶ L1/L2, relative navigation, attitude determination, RTCM differential

RF Simulator Hardware

- ▶ STR4780 12 channels GLONASS
- ▶ Agilent Noise Source
 - CW
 - AWGN
 - Pulsed
- ▶ STR4766
 - Single output Interference Combiner Unit (ICU)
- ▶ STR4750
 - 12 channels L5
- ▶ STR 4767
 - Timing unit and control unit
- ▶ STR4760
 - 16 channels GPS L1 & L2
 - or 32 channels L1



GSVF 2

Galileo RF Simulator

- ▶ Generates all RF signals
- ▶ Full constellation
- ▶ Currently no navigation messages
- ▶ Capable of generating multipath
- ▶ Introduction of clock, iono, tropo errors possible

Sisnet

- ▶ 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.



Post Processing Software

- ▶ ESA already has at its disposal post processing software
 - Teresa
 - Tango
- ▶ Specialised software will be developed in house where necessary

Euterpe



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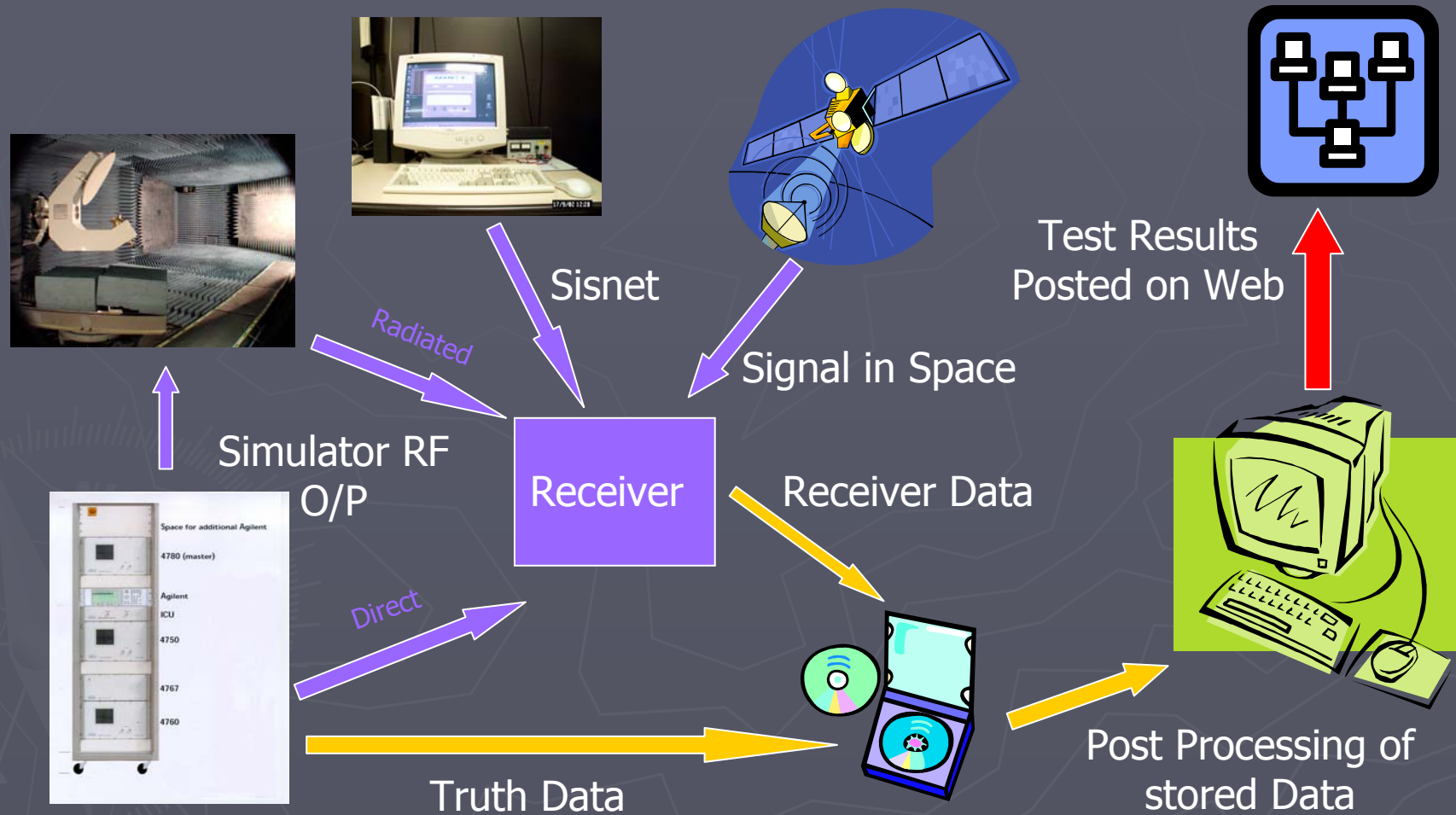
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Euterpe Proposed Facility

- ▶ Separate room solely for Euterpe
- ▶ ISO 9000 compliant
- ▶ L1 Spirent simulators
- ▶ Use of existing or if necessary, developed post processing software tools
- ▶ Connection to surveyed antenna location
- ▶ Adequate room for Galileo expansion
- ▶ Use of Anechoic chamber for built in antenna receivers

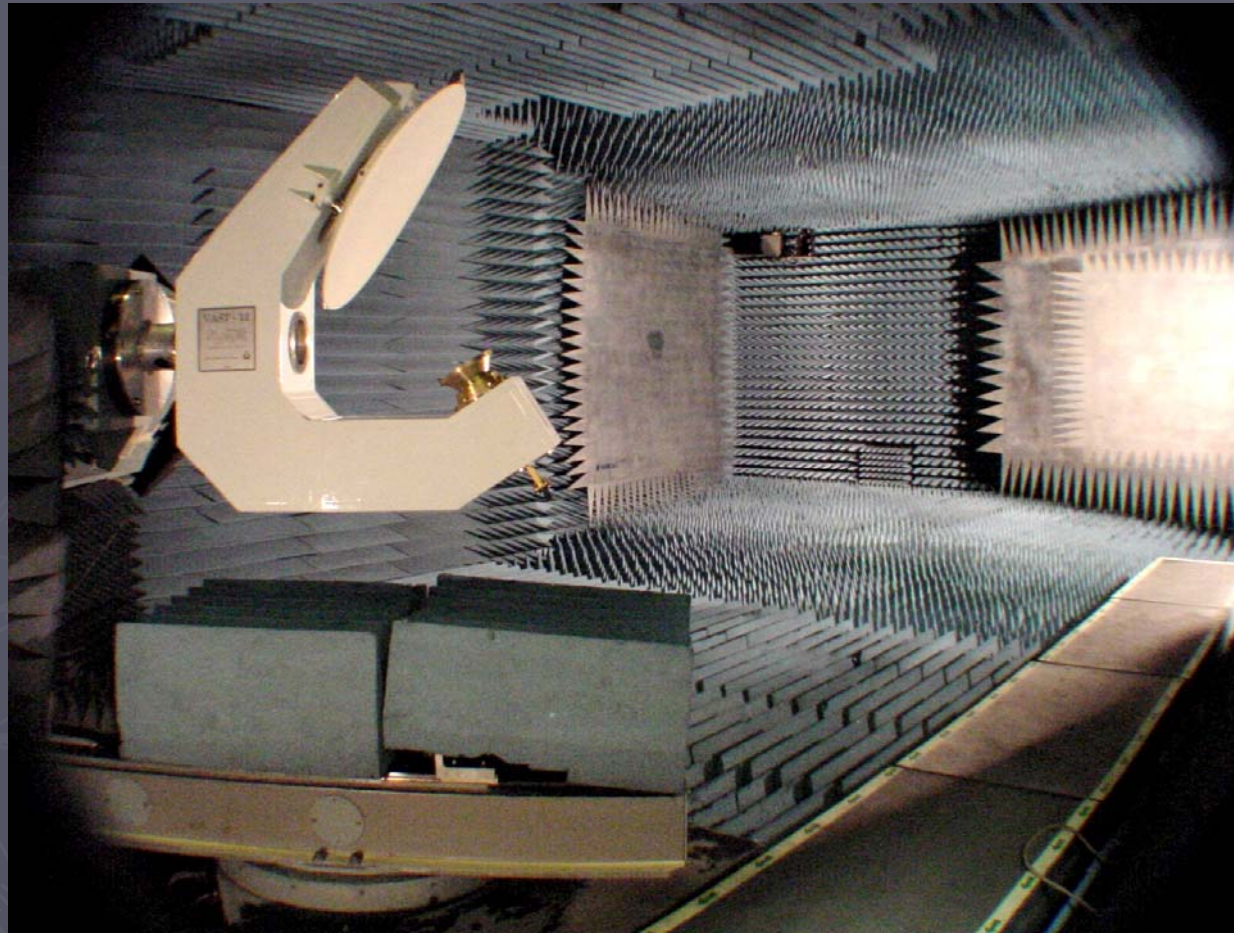
Euterpe Overview



Anechoic Chamber Set-up

- ▶ Simulator would feed a horn antenna from outside the chamber.
- ▶ The whole system would be calibrated to determine the flux density at the receiver antenna
- ▶ ESTEC has a long experience with such tests on satellite antennae

Compact Payload Test Range (CPTR)



Types of Receivers to be Tested

- Euterpe would
 - Test all receivers from high to low end
 - Test Receivers using Sisnet
 - Test Receivers with built in antennae

- Data Formats supported
 - RINEX
 - NMEA

Note: For some tests additional data is needed not found in either RINEX or NMEA formats

Test Philosophy

Tests would be grouped into two different categories

- ▶ EGNOS Functionality tests
 - Required for EGNOS compatibility stamp
- ▶ Navigational performance tests

EGNOS Functionality Tests

Test	Name	Purpose
1	PRN Mask	Confirm receiver rejects masked satellites (MT1)
2	Fast Corrections Integrity	Confirm receiver applies σ^2_{UDRE} according to mask (MT6)
3	Fast Correction degradation	Confirm receiver applies correction degradation factor (MT7)
4	GEO in Navigation Solution	Confirm GEO can be used in navigation solution (MT9)
5	RSS flag	Confirm $RSS_{udre/iono}$ used when calculating XPL (MT10)
6	Integrity	Confirm receiver implements integrity (MT17)
7	Ionospheric Grid Mask	Confirm receiver implements Ionospheric grid mask (MT18)
8	Fast and Slow Corrections	Confirm receiver implements fast & slow corrections (MT24)
9	Velocity Codes implementation	Confirm velocity codes are implemented in receiver (MT25)
10	Grid Point Masks	Confirm receiver rejects bad grid points (MT26)
11	Initial Acquisition Time (Cold & Warm start)	Cold & Warm start acquisition times to navigational fix
12	Positional Accuracy Improvement	Delta position error relative to antenna reference location with and without EGNOS corrections
13	XPL Accuracy	Comparison of actual and expected XPL values $\pm 5\%$
14	SBAS satellite selection	On loss of GEO switch to another SBAS satellite or GPS only

Note: These tests will evolve along with future EGNOS and GPS developments

Navigational Performance Tests

Test	Name	Purpose
1	Satellite Acquisition Time	Acquisition time from appearance of satellite above 5° elevation.
2	Satellite Re-acquisition Time	Re-acquisition time after brief signal loss
3	C/No thresholds for Acquisition and tracking	To determine minimum C/No for acquisition and tracking
4	Positional Accuracy	Position error relative to reference antenna with and without EGNOS corrections
5	Carrier cycle slips	Over a 24 hour period
6	Clock error	During a 24 hour scenario
7	Inter-channel Bias	Interference between channels
8	Receiver noise on code & carrier	Determine receiver noise on code and carrier
9	Multipath mitigation	Added error with simulated multipath. Antenna?
10	Interference Rejection	CW, noise
11	Acquisition & Tracking with max Doppler	Receiver accuracy within severe Doppler
12	Update rate and latency	Rate of updating position and time taken to do so.

Test Scenarios

- ▶ Tests would be performed under predefined scenarios
- ▶ Initially only static tests would be considered
- ▶ A matrix of tests would be created for each receiver dependent on data output and manufacturers requirements
- ▶ A validation phase would take place on a set of benchmark receivers with collaboration from different manufacturers

Questions Needing Answers

- ▶ Should Euterpe test for only EGNOS compatibility?
- ▶ Are tests including L2 necessary?
- ▶ Should Euterpe aim at testing all types of receivers?
- ▶ Should antennae be included in tests or not?
- ▶ Should tests other than static tests be performed?

Conclusion

- ▶ There is a need for Euterpe in Europe
- ▶ A set of tests has been identified for discussion
- ▶ The full set or a sub-set of the tests could be performed as requested by the customer
- ▶ Receivers with and without external antennae could be tested
- ▶ ESA considering hosting Euterpe in ESTEC
- ▶ The results would be posted on an ESA website if agreed by the customer