

Educational tools for GNSS

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NavSAS research group



NavSAS is a joint research group of *ISMB* and *Politecnico di Torino* University operating in the satellite navigation and localization sectors.

- NavSAS staff consists of 28 researchers.
- Research is focused specifically on advanced technologies for GPS / EGNOS / Galileo receivers and applications.
- NavSAS cooperates with major industrial and institutional players operating in the field.
- See <http://www.navsas.eu> & <http://www.galileoblog.eu>



Outline

1 – Master on Navigation

2 – NAVKIT

3 – Signal Generator / Analysis

4 – Software receiver

5 – SAT SURF / SAT SURFER

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Master on Navigation and related applications



The one-year Master is a **joint initiative** of



with the **cooperation** of

INRIM Galileo Ferraris

and

UN OOSA

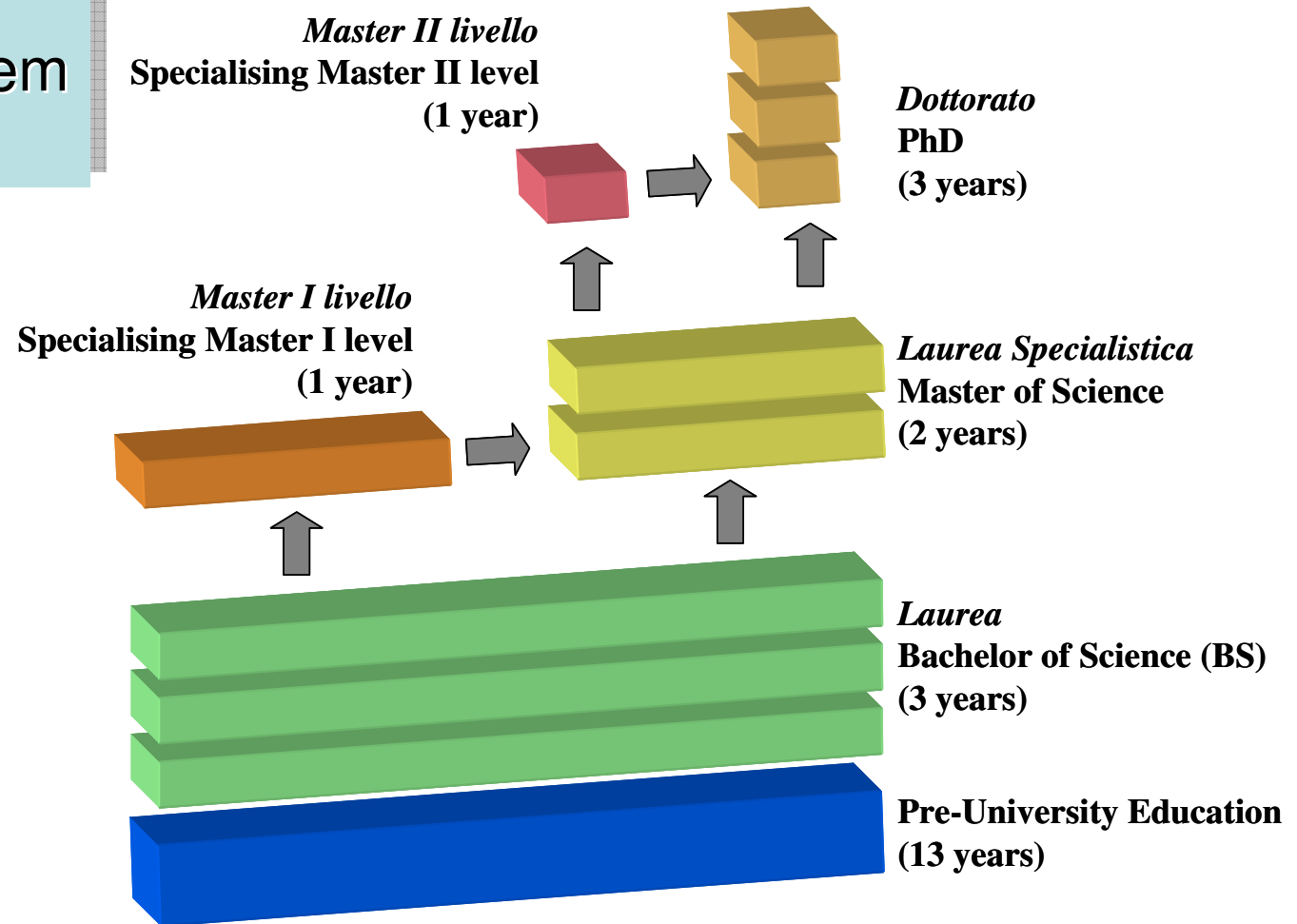


**United Nations
Office for Outer
Space Affairs**

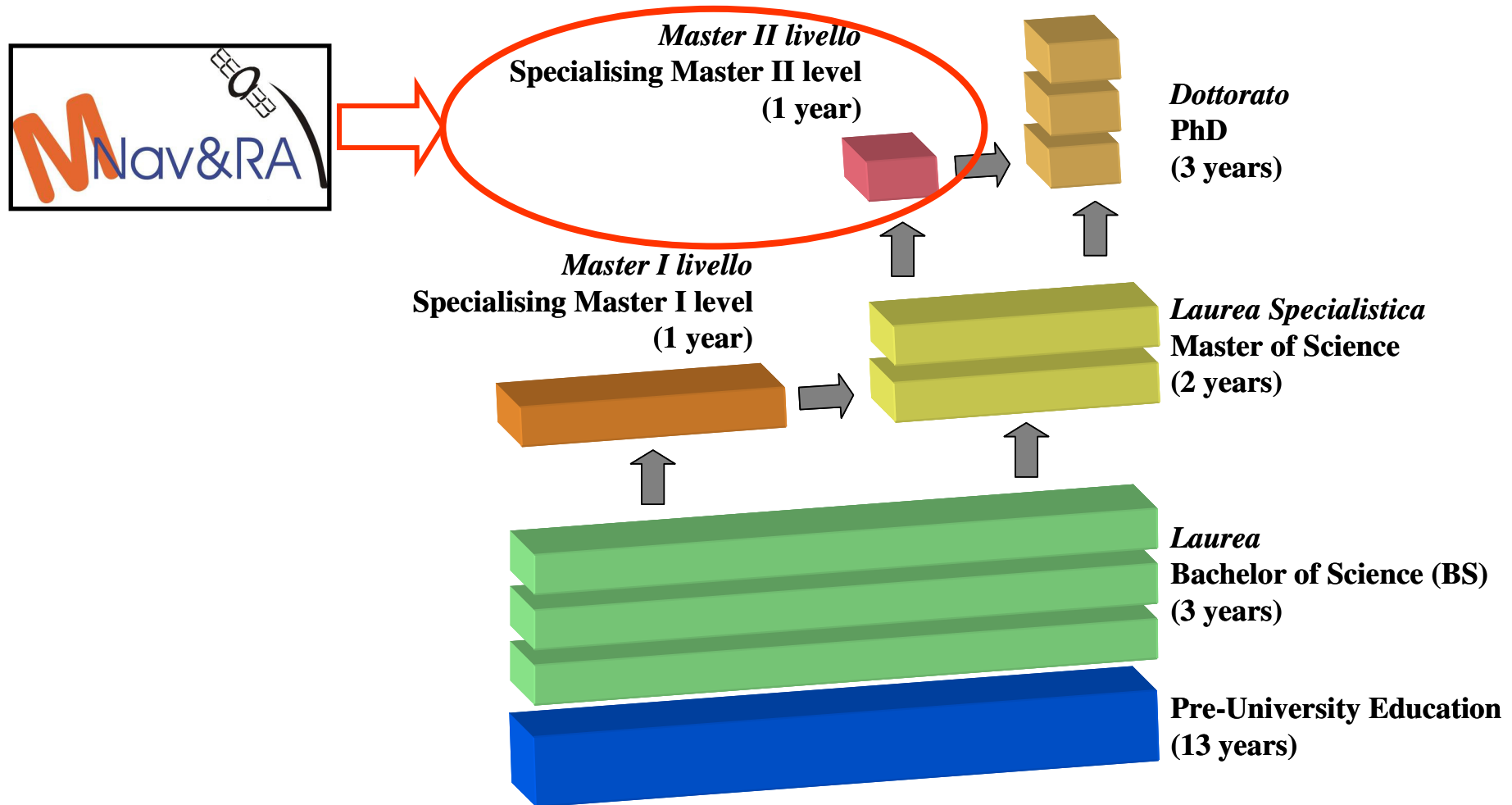


Structure of Education in Italy

The Italian University system after 1999



Specializing Master



The first five editions

UN/ISMB Project

Country - Students	
Algeria - 1	Madagascar - 1
Egypt - 1	Mexico - 1
Georgia - 1	Mongolia - 1
Ghana - 1	Nigeria - 2
Haiti - 1	Pakistan - 3
Iran - 1	Sri Lanka - 1
Jordan - 1	Vietnam - 2

ALPIP-Meftia Projects

Country	
Argentina - 4	Ecuador - 2
Brazil - 2	Mexico - 1
Colombia - 1	Peru - 1

JEAGAL

Country
China - 6
Vietnam - 4

National funds

Country	
Bangladesh - 1	France - 2
China - 1	Italy - 16
Colombia - 2	Lebanon - 1
Ecuador - 2	Pakistan - 3

ASIAN-Zhong Guò Projects

Country
China - 3
Indonesia - 1
Vietnam - 1

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What is NavKIT

- NAVKIT is a tool for autonomous training on satellite navigation subjects
- NAVKIT has been developed by professors and researchers of the NavSAS Group
- NAVKIT has been developed as a task of the **ERIG** project “Education Research and Innovation in GNSS” funded by the GNSS Supervisory Authority within the VI FP



European GNSS Supervisory Authority

ERIG

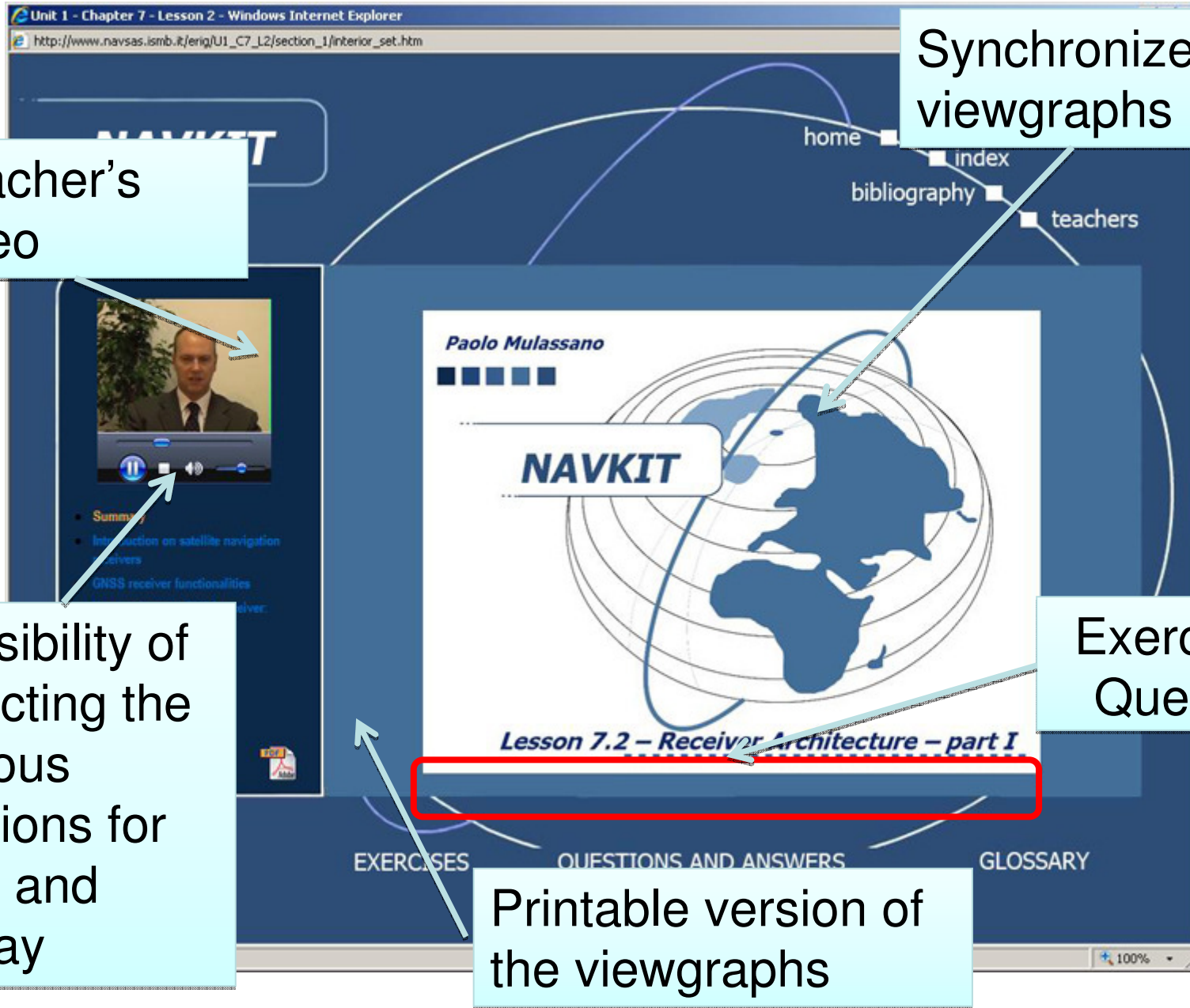
Education, Research & Innovation in GNSS

What is NavKIT

- The tool can be accessed **via Web** (www.navsas.eu) or can be installed as an application on **your own PC**
- It allows **to learn the basic concepts** of satellite navigation by means of a **multimedia approach**
 - ✓ Videos (lectures)
 - ✓ Exercises fully solved step by step
 - ✓ Self evaluation tests
 - ✓ Frequently asked questions

The Target Audience

- The content of the lesson is organized in order to provide **technical concepts** also to **non specialists**
- The tool is designed for students but also for **technicians and professionals** in need of a starting training in the field



Teacher's video

Synchronized viewgraphs

Possibility of selecting the various sections for play and replay

Printable version of the viewgraphs

Exercises & Questions

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1 – Master on Navigation

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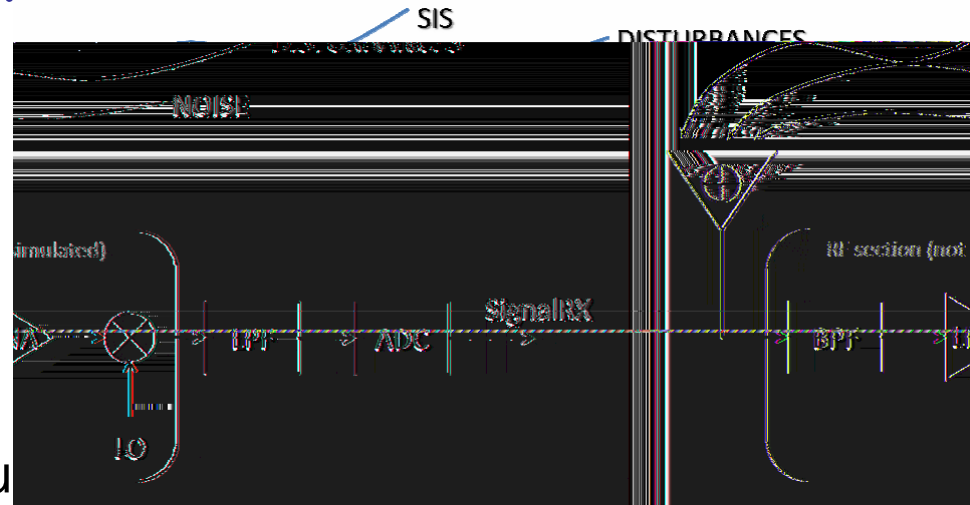
5 – SAT SURF / SAT SURFER

N-FUELS: GNSS signal generator

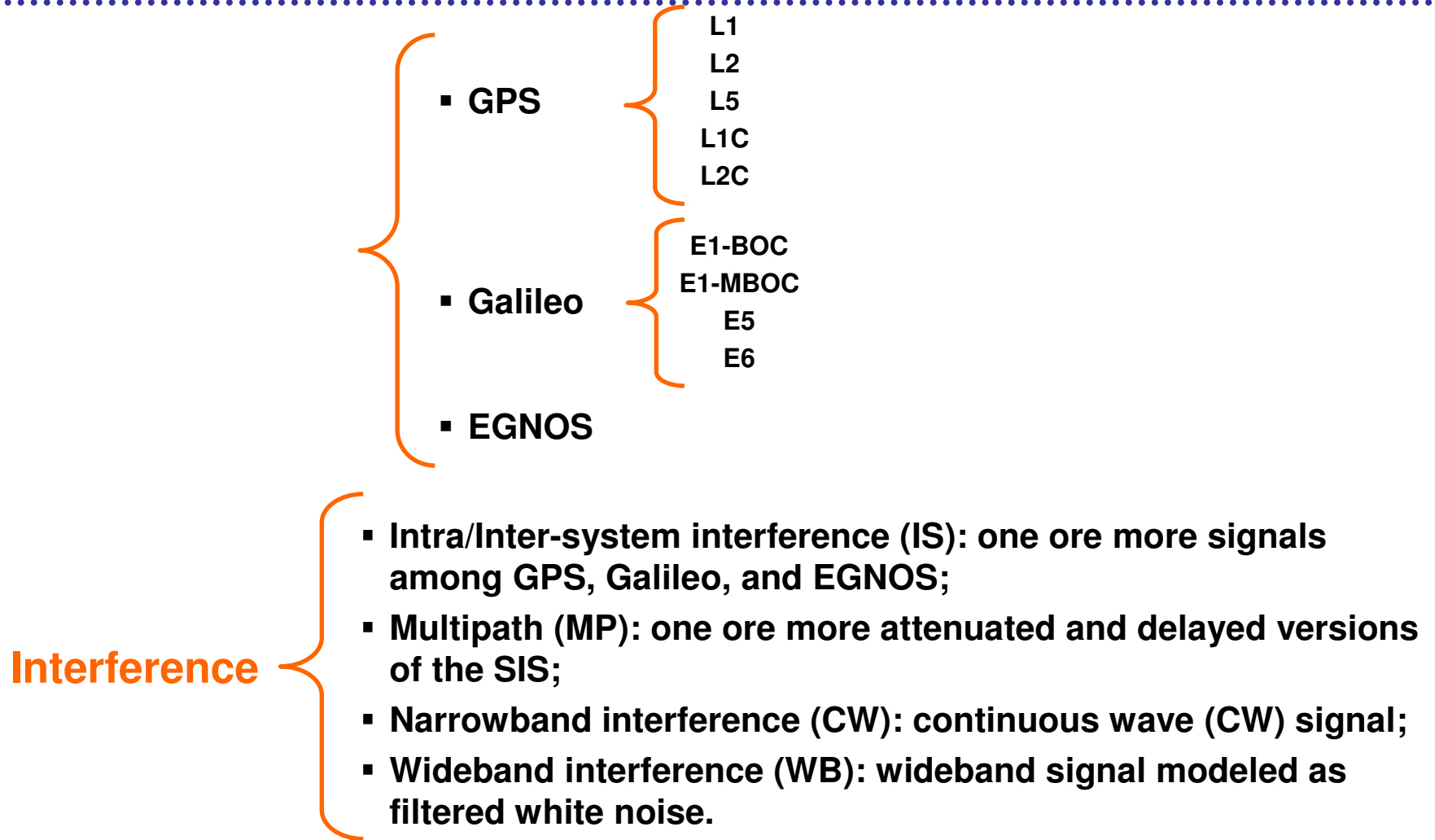
N-FUELS (Full Educational Library of Signals for Navigation) is a **MATLAB®-based** GNSS signal generator; It allows the simulation of **physical layer** signal structure for GPS, Galileo and EGNOS systems in all the current and future bands.

N-FUELS has been created both for **research** and **educational** use. First of all, the study of signals and systems innovation generates the need of manipulating all the different GNSS signals.

This helps in comparatively analyzing signals performance and testing novel processing algorithms.



N-FUELS: SISGEN & JAMGEN



N-FUELS

General

Signal Length [s]: IF Carrier Freq [Hz]:

Sampling Freq [Hz]: IF Carrier Phase [rad]:

Satellite Signal

Satellites: SIS Doppler type:

Modulation: Doppler Freq [Hz]:

PRN codes:

Code Delays [s]:

Navigation Data

Quantization

Quantization # Bit:

Plot

Spectrum Time Domain

Codes Doppler Frequency

Noise & Impairment

Noise Power SIS [dBW]: C/N0 [dBHz]:

Multipath / Interference NO [dBW/Hz]:



ABOUT N-FUELS...

RX Front End

Front End Filter Filter model:

Group Delay compensation

Transient compensation

0. User defined filter
 1. Butterworth, 4th order, BW = 4.092 MHz
 2. Butterworth, 8th order, BW = 20.46 MHz
 3. Butterworth, 12th order, BW = 51.15 MHz
 4. Chebyshev, 2nd order, BW = 3.78 MHz

Output

Output Folder:

Signal out

Codes

Freq Doppler



N-FUELS

General

Signal Length [s]: IF Carrier Freq [Hz]:

Sampling Freq [Hz]: IF Carrier Phase [rad]:

Satellite Signal

Satellites: SIS Doppler type:

Modulation: Doppler Freq [Hz]:

PRN codes:

Code Delays [s]:

Navigation Data

Quantization

Quantization # Bit:

Plot

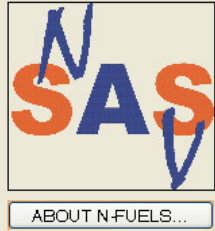
Spectrum Time Domain

Codes Doppler Frequency

Noise & Impairment

Noise Power SIS [dBW]: C/N0 [dBHz]:

Multipath / Interference NO [dBW/Hz]:



RX Front End

Front End Filter Filter model:

Group Delay compensation

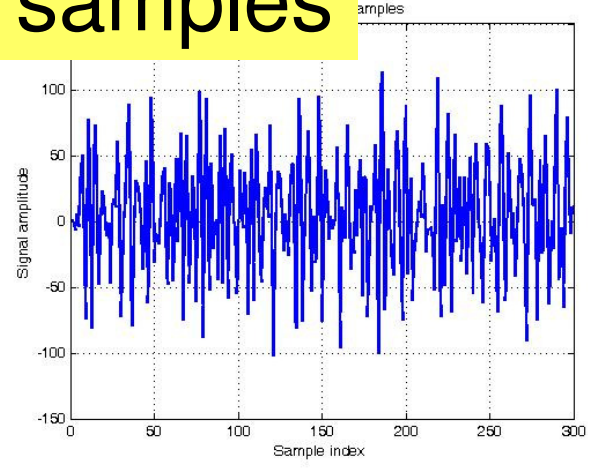
Transient compensation

0. User defined filter
 1. Butterworth, 4th order, BW = 4.092 MHz
 2. Butterworth, 8th order, BW = 20.46 MHz
 3. Butterworth, 12th order, BW = 51.15 MHz
 4. Chebyshev, 2nd order, BW = 3.78 MHz

Output

Output Folder:

Signal samples



N-FUELS

General

Signal Length [s]: IF Carrier Freq [Hz]:

Sampling Freq [Hz]: IF Carrier Phase [rad]:

Noise & Impairment

Noise Power SIS [dBW]: C/N0 [dBHz]:

Multipath / Interference NO [dBW/Hz]:



ABOUT N-FUELS...

Satellite Signal

Satellites: SIS Doppler type:

Modulation: Doppler Freq [Hz]:

PRN codes:

Code Delays [s]:

Navigation Data

RX Front End

Front End Filter Filter model:

Group Delay compensation

Transient compensation

0. User defined filter
 1. Butterworth, 4th order, BW = 4.092 MHz
 2. Butterworth, 8th order, BW = 20.46 MHz
 3. Butterworth, 12th order, BW = 51.15 MHz
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Quantization

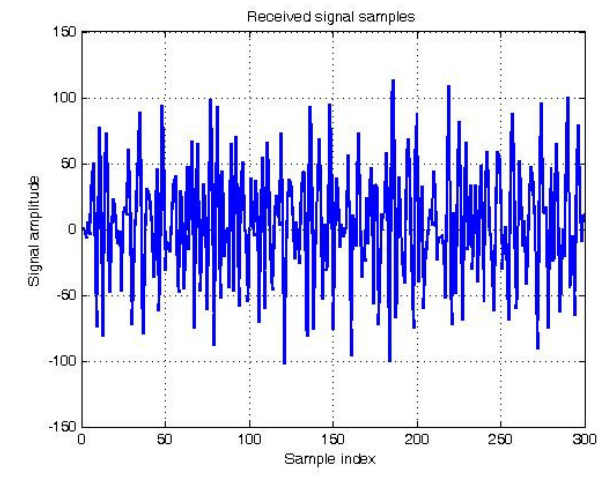
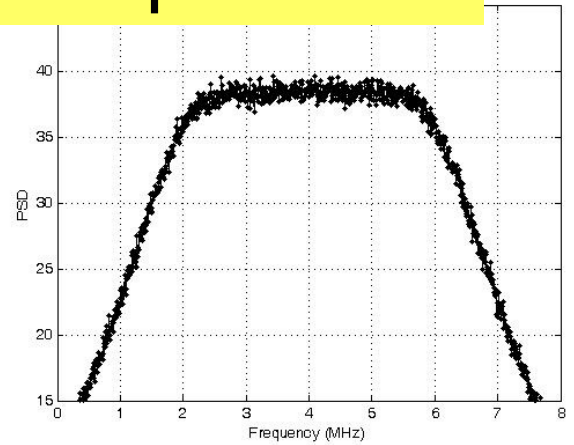
Quantization

Plot

Spectrum

Codes

Signal spectrum



SAVE PARAM PLOTS EXIT

N-FUELS

General

Signal Length [s]: IF Carrier Freq [Hz]:

Sampling Freq [Hz]: IF Carrier Phase [rad]:

Noise & Impairment

Noise Power SIS [dBW]: C/N0 [dBHz]:



Satellite Signal

Satellites: SIS Doppler type:

Modulation: Doppler Freq [Hz]:

PRN codes:

Code Delays [s]:

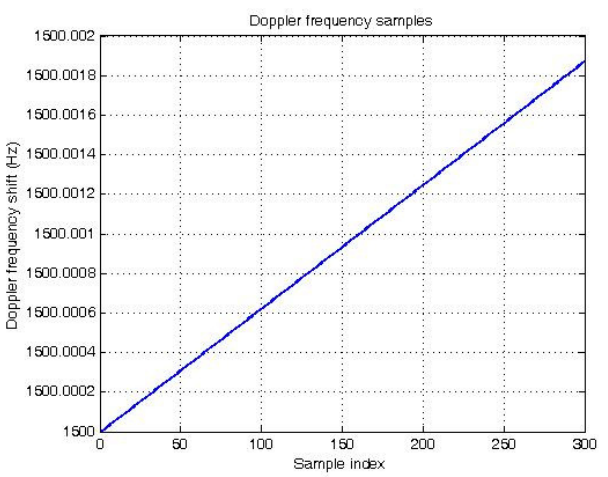
Navigation Data

Doppler profile

Front End Filter Filter model:

Group Delay compensation

Transient compensation



Quantization

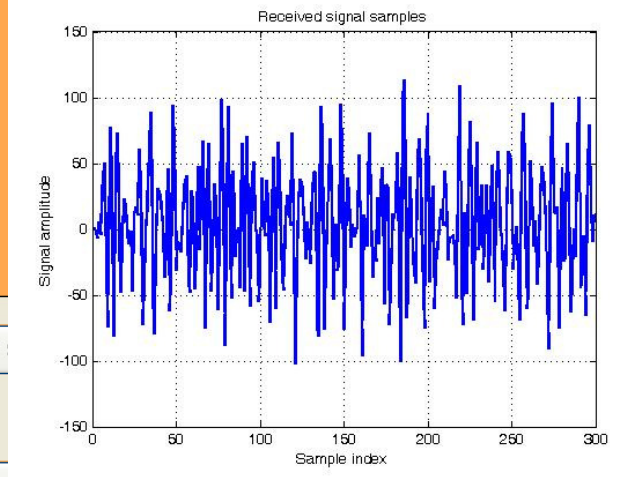
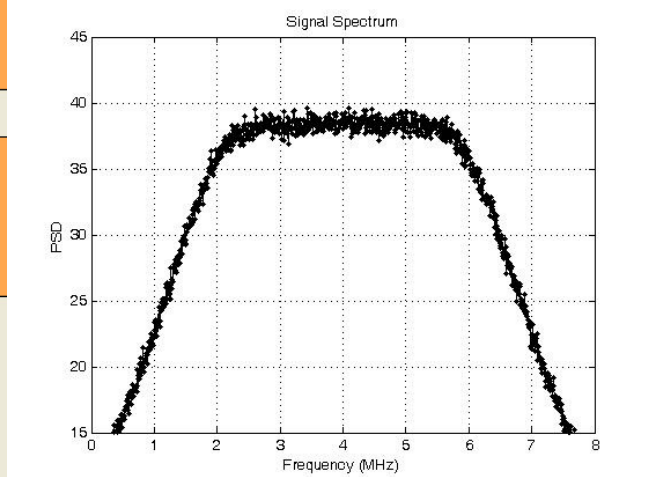
Quantization

Plot

Spectrum

Codes

Output



GENERATE SAVE PARAM PLOTS EXIT

N-FUELS – Student Version

Go to <http://www.navsas.eu> and click here

NavSAS Technologies and Tools

Education on Galileo and GPS

Latest News from NavSAS Group

- SAT-SURF & SAT-SURFER Platform v2.0 is now available
- 7th IEEE Consumer Communications & Networking Conference
- New Home
- 8/5/2009 Seminar from Andrew Dempster of the University of New South Wales
- SEAGAL project kick-off meeting

Reserved Area

- Shared

NavSAS People

- People

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We have 1 guest online

Visitors Counter

0119384

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Username

Companies

Researchers

Students

NavTube

NAVKIT

Galileo Day

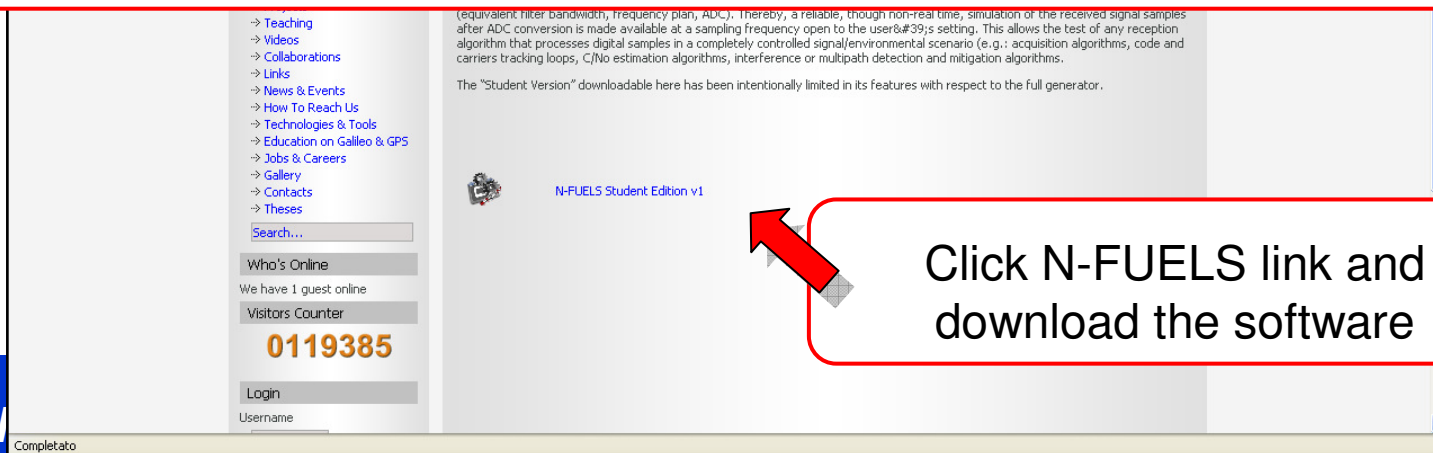
Completato



N-FUELS – Student Version



The folder contains both the software and the user's manual
In order to run the generator, MATLAB® has to be pre-installed (or at least the
MATLAB Component Runtime library)
All the instructions to get starting are included in the user's manual



Click N-FUELS link and
download the software

Outline

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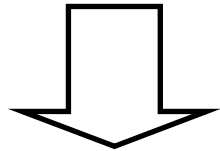
3 – Signal Generator / Analysis

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Research on GPS/Galileo Receivers

NavSAS started its R&D activities applying advanced signal processing strategies to Galileo and GPS receivers



TODAY on Galileo receiver

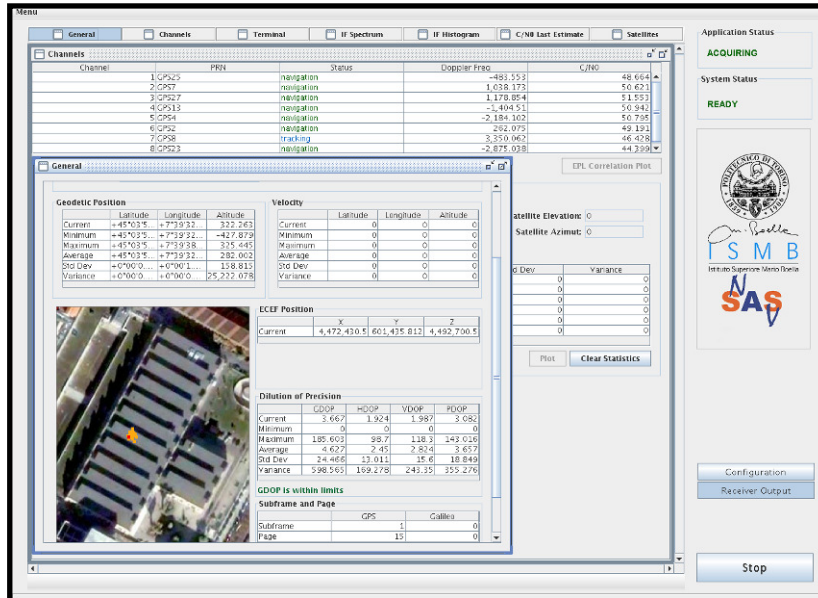
The first
release of the
N-GENE fully
SW receiver
is ready!



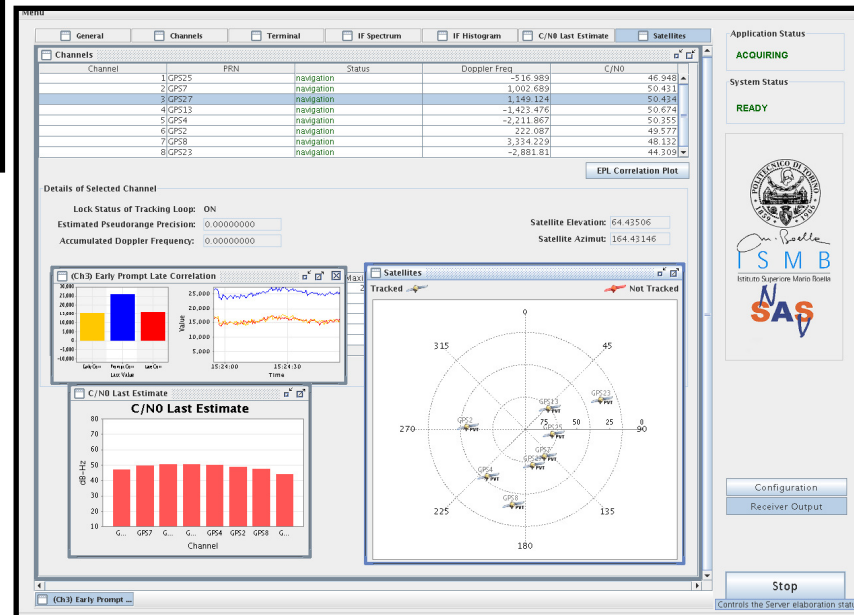
R&D Activities:

- Receiver core technologies
- Fully SW and SDR implementations
- NAV/COM integration and data fusion
- Interference detection and mitigation
- Quality Control

N-GENE Software Receiver: Performance



- Position Accuracy: r.m.s < 10 m using code-based measurements and without applying carrier smoothing techniques
- Time to First Fix in Cold Start mode lower than 45 seconds
- Up to 20 channels



- GPS L1 8 bits quantization at a sampling rate of 17.5103 MHz
- Galileo E1, GIOVE-A & GIOVE-B signals, upgradable to Multiplexed Binary Offset Code (MBOC) easily
- EGNOS, WAAS & A-GPS



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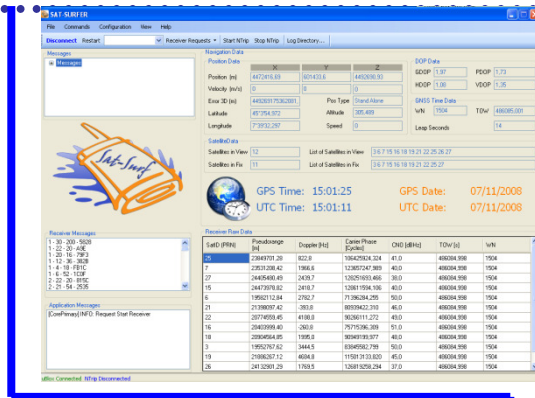
5 – SAT SURF / SAT SURFER

SAT-SURF & SAT-SURFER

A Tool for Practical Training on
Satellite Navigation



SAT-SURFER Software Architecture



Graphical User Interface

File Logs



Settings

Data Logger Matlab, Text, Rinex, KML

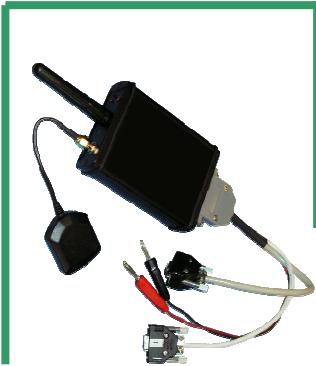
Core Application

Driver SiRF

Driver uBlox

Driver GSM Modem

Driver NTrip DGPS



SAT-SURFER HARDWARE



SAT-SURF & SURFER Features



1 – Allows to log all the raw GPS and GSM data (both binary and NMEA Protocols)

2 – Embeds different GPS modules depending on the user needs:

- uBlox Modules
- SiRF Modules

3 – Equipped with a quad-band GSM/GPRS modem (worldwide coverage) for NAV/COM integration

4 – Raw data storage in the various file formats for an easy post-processing:

- ASCII, Excel® & MATLAB® files
- RINEX 2/3 Log

The screenshot shows the SAT-SURFER software interface. It includes a menu bar (File, Commands, Configuration, View, Help) and a toolbar with buttons for Disconnect, Restart, Receiver Requests, Start NTRIP, Stop NTRIP, and Log Directory. The main window is divided into several sections:

- Navigation Data:** Displays Position (m) with X, Y, Z coordinates; Velocity (m/s); Error 3D (m); Latitude and Longitude; Pos Type (Stand Alone); Altitude; and Speed.
- DOP Data:** Shows GDOP, HDOP, and VDOP values.
- GNSS Time Data:** Shows WN, TOW, and Leap Seconds.
- Satellites Data:** Shows Satellites in View and Satellites in Fix.
- GPS/UTC Time and Date:** Shows GPS Time, UTC Time, GPS Date, and UTC Date.
- Receiver Raw Data:** A table with columns: S/uid (PPHF), Pseudorange (m), Doppler (Hz), Carrier Phase (Cycles), CNO (dBHz), TOW (s), and wN.
- Receiver Messages:** A list of messages with timestamps and content.
- Application Messages:** A list of application messages.

SAT-SURF & SURFER Features

NAV/COM
Integration
Capabilities

SAT-SURF is made of components of the shelf. The HW + SW tool is an innovative and complete GPS+GSM evaluation kit. It can be effectively used to test all the receiver features, Assisted-GPS strategies (OMA-SULP compliant) and/or Differential GPS techniques.

Specific Educational
Tool

SAT-SURF & SAT-SURFER is a complete educational tool. It includes several exercises with solutions for students. This is then a perfect tool for a lab dedicated to ICT technologies.

A Ready to Use Tool

SAT-SURF & SAT-SURFER is a ready-to-use tool. The tool has already been delivered to many education institutions such as Hanoi University of Technology (Vietnam), Asia Institute of Technology (Thailand) and Politecnico di Torino (Italy).

Partnership

- SAT-SURF and SAT-SURFER have been designed and developed by the NavSAS Group and represents a technology transfer example;
- SAT-SURF is manufactured and distributed by SAET s.r.l., a high-tech Italian SME;
- SAT-SURFER has been written by the NavSAS Group.



www.navsas.eu



www.saetsrl.com



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Thank you for attention