

Educational tools for GNSS

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ICG-3 Pasadena, California - 10 December 2008

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 and UN OOSA



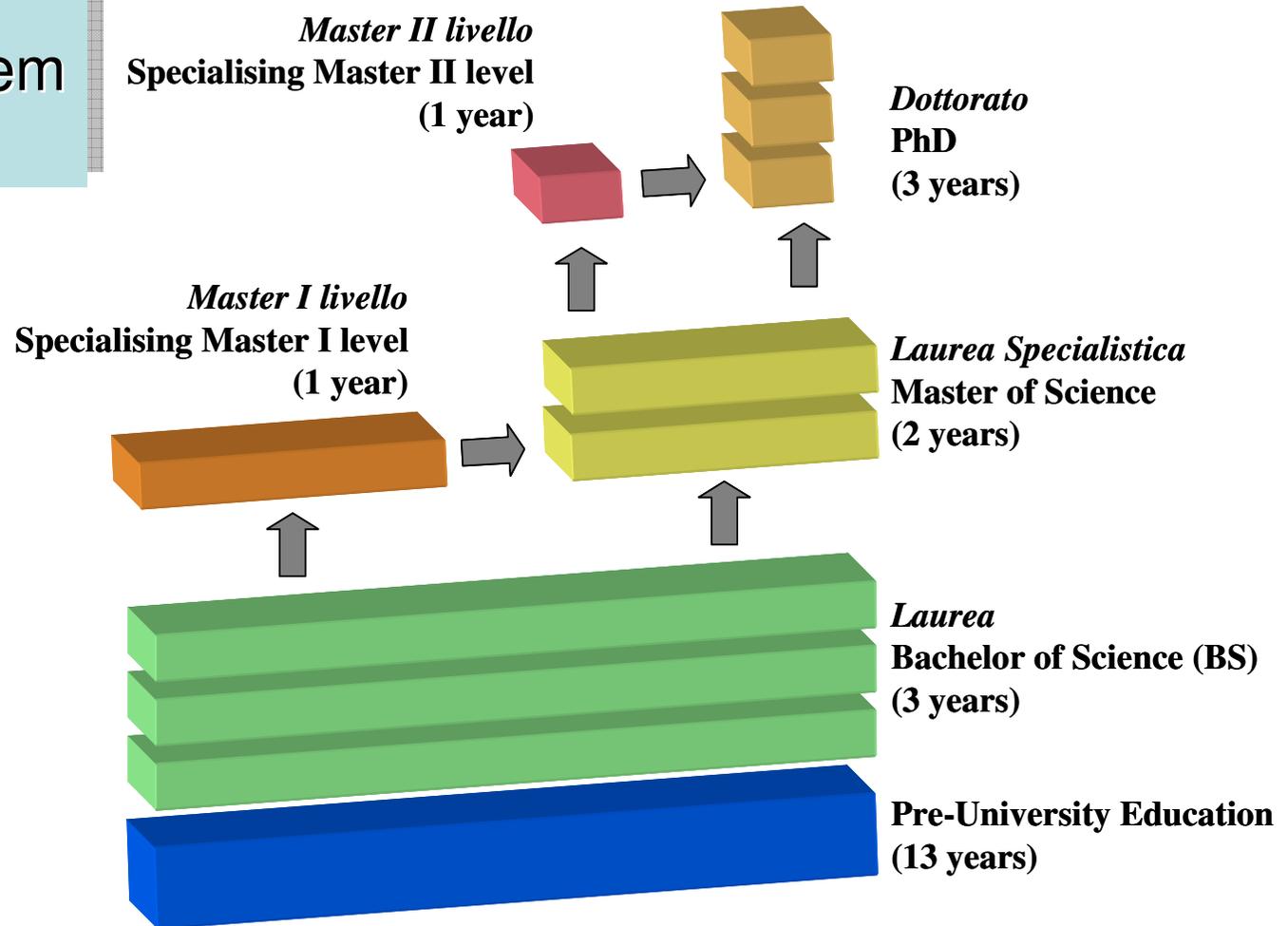
**United Nations
Office for Outer
Space Affairs**



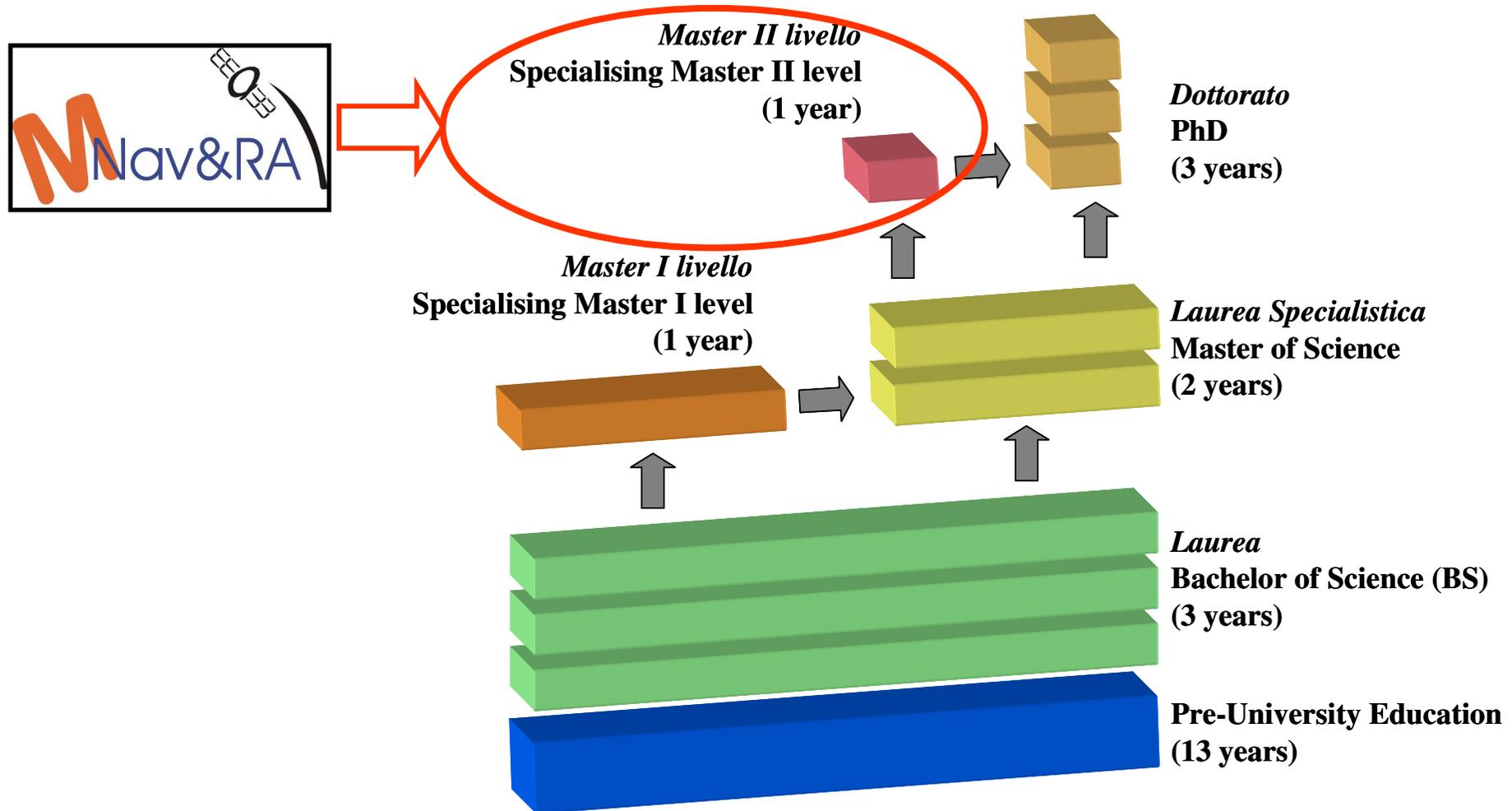
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Structure of Education in Italy

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 Project

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 as a task of the **ERIG** project “Education Research and Innovation in GNSS” funded by the GNSS Supervisory Authority within the VI FP



- The tool can be accessed **via Web** (www.navsas.eu) or can be installed as an application on **your own PC**

What is NavKIT

- The tool is designed for students but also for **technicians and professionals** in need of a starting training in the field
- 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

Synchronized viewgraphs

Teacher's video

Possibility of selecting the various sections for play and replay

Exercises & Questions

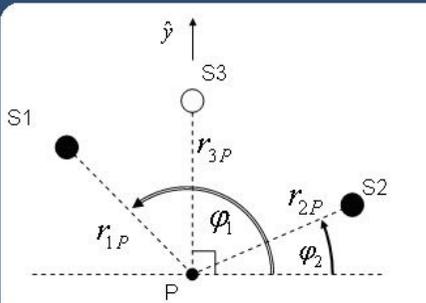
Printable version of the viewgraphs



Exercises - Windows Internet Explorer
<http://www.navsas.polito.it/erig/exercises/demo/U1/DoP/DoP.htm>

Dilution of Precision - Exercise 1

A two-dimensional positioning system is implemented by means of three synchronous transmitters S1, S2 e S3, as in Figure.
 Using the two transmitters S1 and S2 and suppose the user has a receiver synchronized with the transmitters:



1. Evaluate the geometric matrix H of the system for a user in P.
2. Evaluate the horizontal dilution of precision HDOP in the following cases:
 $\phi_1 = 3\pi/4, \phi_2 = \pi/4$
 $\phi_1 = \pi, \phi_2 = 0$
3. Justify the results discussing for which case of ϕ_1 e ϕ_2 the minimum value of HDOP is reached.
4. Add the S3 transmitter as in Figure. Supposing the user is not synchronized with the three transmitters, write the H matrix for this case, evaluate the geometric matrix and the HDOP.
5. Verify the results writing a Matlab program for the evaluation of the DOPs.

Internet | Modalità protetta: attivata 100%

Exercises on positioning problems and processing of satellite signals

2.htm

for a user in P.

in which

k is synchronized with the clocks on the transmitters

$$= \begin{bmatrix} a_{x1} & a_{y1} \\ a_{x2} & a_{y2} \end{bmatrix}$$

$$y_{xj} = \frac{x_j - \hat{x}_u}{\hat{r}_j}$$

and:

$$r_{i,P} = \sqrt{(x_i - x_P)^2 + (y_i - y_P)^2} \text{ for } i = 1,2$$

Internet | Modalità protetta: attivata 100%

Methodologies for problem solving



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1 – Master on Navigation

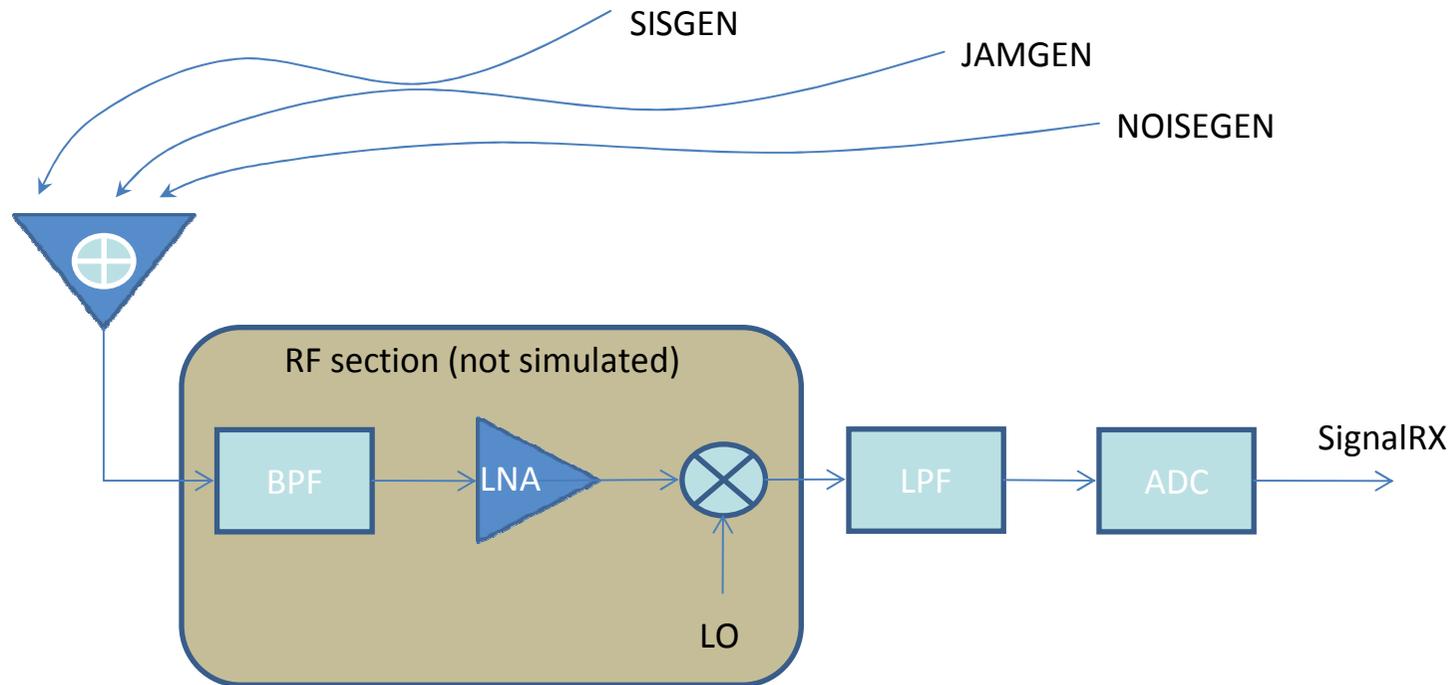
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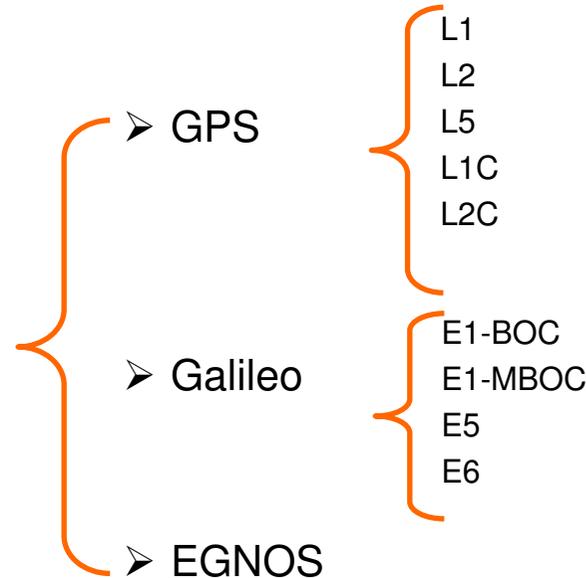
SW package: Signal Generator



The signal generator is a software package which simulates the **received signal** at the output of the front-end analog to digital converter

SWAN: SISGEN & JAMGEN

SIS Modulations



Interference Types

- **Intra/Inter-system interference (IS):** one ore more signals among GPS, Galileo, and EGNOS;
- **Multipath (MP):** one ore more attenuated and delayed versions of the SIS;
- **Narrowband interference (CW):** continuous wave (CW) signal;
- **Wideband interference (WB):** wideband signal modeled as filtered white noise.

Signal Analysis Tool

MONMIS module executes measurements at different points of the receiver chain or at the receiver's ADC stage and shows the results.



- Spectral Analysis
- Path Loss
- Group delay
- Pulse Shaping
- Power flux density
- Tracking jitter
- Code interference

QCFUN module executes measurements and compares the results with ideal situations (measurements with no anomalies).



- *Modulation analysis*
 - Correlation;
 - Discrimination function;
 - Spectrum;
 - RMS bandwidth;
- *Interference analysis*
 - Spectral threshold
 - Spectral Separation Coefficient
- *Multipath analysis*
 - Multipath Error Envelope;
 - Running Average.

Signal generator (student edition)

- Available free of charge
- To have the free package for students contact:

davide.margaria@polito.it

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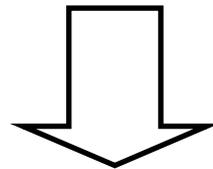
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GPS/Galileo/EGNOS SW-Receiver

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 real time receiver
is ready!



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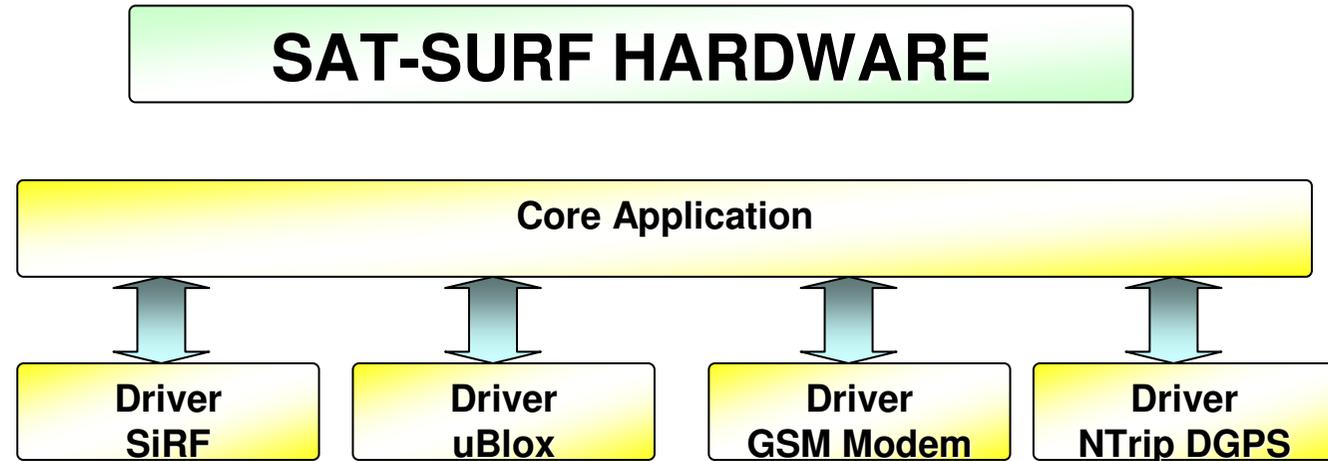
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SAT-SURF & SAT-SURFER

A Tool for Practical Training on
Satellite Navigation



SAT-SURF Architecture



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

- uBlox Modules
- SiRF Modules

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

SAT-SURF & SURFER Features



The screenshot shows the SAT SURFER software interface with the following sections:

- Navigation Data:**

Position (m)	X: 4472416.69	Y: 601433.6	Z: 4492690.93
Velocity (m/s)	0	0	0
Error 3D (m)	4492691.75362081		
Latitude	45°354.972	Altitude	305.499
Longitude	7°39'32.297	Speed	0
- DOP Data:**

GDDP	1.97	PDOP	1.73
HDOP	1.08	VDOP	1.35
- GNSS Time Data:**

wN	1504	TOW	486085.001
Leap Seconds	14		
- Satellite Data:**

Satellites in View	12	List of Satellites in View	3 6 7 15 16 18 19 21 22 25 26 27
Satellites in Fix	11	List of Satellites in Fix	3 6 7 15 16 18 19 21 22 25 27
- GPS Time:** 15:01:25
UTC Time: 15:01:11
GPS Date: 07/11/2008
UTC Date: 07/11/2008
- Receiver Raw Data Table:**

SatID (PRN)	Pseudorange (m)	Doppler [Hz]	Carrier Phase [Cycles]	CNO [dBHz]	TOW [s]	wN
25	23849701.28	822.8	106425924.324	41.0	486084.998	1504
7	23531208.42	1966.6	123657247.989	40.0	486084.998	1504
27	24405480.49	2439.7	128251693.466	38.0	486084.998	1504
15	24473978.82	2418.7	128611594.106	40.0	486084.998	1504
6	19562112.84	2782.7	71396284.255	50.0	486084.998	1504
21	21388097.42	-393.8	80939422.310	46.0	486084.998	1504
22	20774959.45	4188.0	90266111.272	49.0	486084.998	1504
16	20403999.40	-260.8	75715396.309	51.0	486084.998	1504
18	20904564.85	1995.0	90949199.977	48.0	486084.998	1504
3	19552767.62	3444.5	83845682.799	50.0	486084.998	1504
19	21886267.12	4684.8	115013133.820	45.0	486084.998	1504
26	24132901.29	1769.5	126819258.294	37.0	486084.998	1504

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

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

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



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



For information visit:

www.navsas.eu

*Thank you
for attention*