



**The Abdus Salam
International Centre for Theoretical Physics**



2135-3

**Second Workshop on Satellite Navigation Science and Technology for
Africa**

6 - 23 April 2010

**Sat-Surf Suite and N-FUELS: Tools for Rapid-Prototyping, Research and Educations
in the Field of GNSS**

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Sat-Surf Suite & N-FUELS: Tools for Rapid-Prototyping, Research and Educations in the Field of GNSS

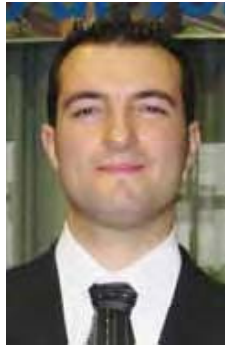
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SAT-SURF & N-FUELS Presentation



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Motivation

- **GNSS technologies** are progressively becoming a key element in many innovative wireless applications
- Most location-based services and systems are in fact employing **standalone GPS**, **GPS+EGNOS**, **Assisted-GPS** and **Differential GPS** as core technologies
- Academies and companies need to **train** engineers, technicians and students on these subjects



Motivation

- Many **educational offers** are based on a theoretical study of GNSS leaving limited space to labs or training on the job
- There is a huge demand of tools for education, R&D and rapid-prototyping in the field of GNSS

➤ **SAT-SURF & SAT-SURFER**

➤ **N-FUELS**



Outline

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1 – Introduction

2 – SAT-SURF Hardware Platform

3 – SAT-SURFER Software Suite

4 – SAT-SURFER Setup & Demo

5 – N-FUELS Signal Generator

6 – N-FUELS Demo

7 – Questions Session



Motto

*With SAT-SURF & SAT-SURFER
engineers, technicians and students
learn how to practically surf with
GNSS!*

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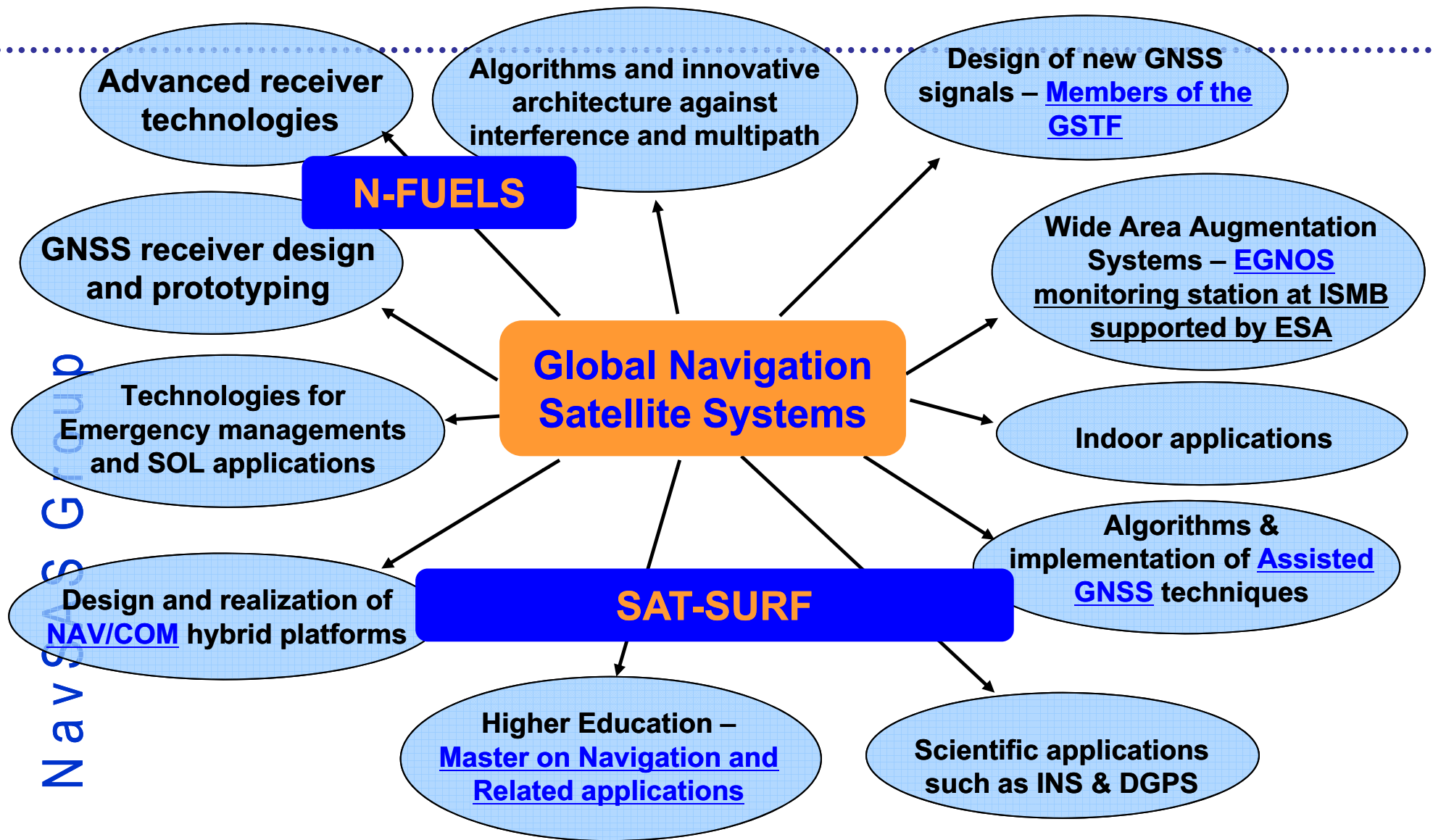


What is SAT-SURF/SURFER?

- **SAT-SURF & SAT-SURFER** are a complete tool made of hardware/software components specifically designed for R&D and educational purposes:
 - ✓ **SAT-SURF** is the **hardware box** including GPS and COM functionalities;
 - ✓ **SAT-SURFER** is the **software suite** running on standard PC that gets and process data from SAT-SURF.



Application Fields



SAT-SURF Hardware Platform

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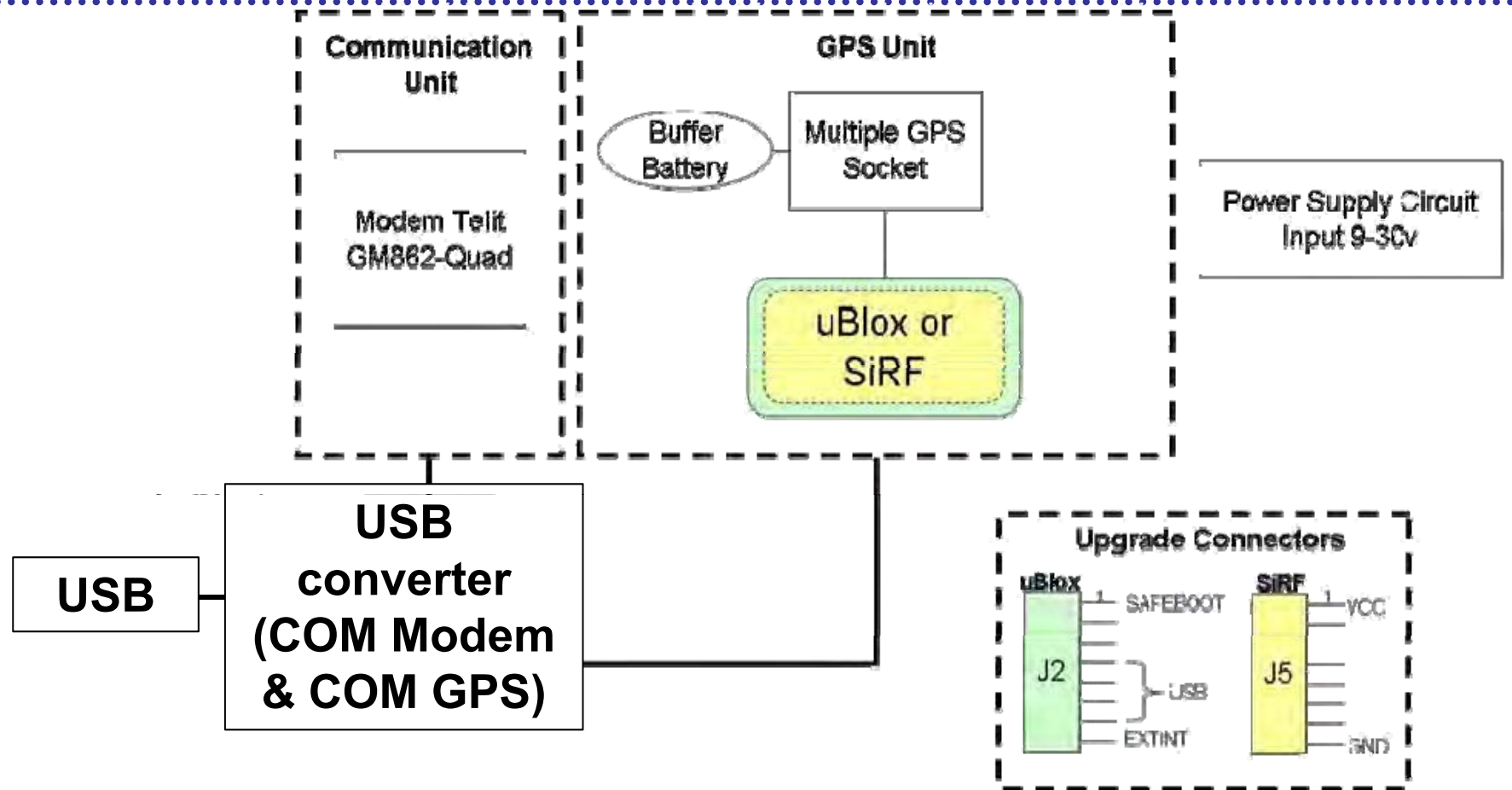
- **SAT-SURF** is an HW box integrating GPS and GSM/GPRS capabilities. It includes:
 - ✓ Different possible GPS receiver modules
 - ✓ 1 GSM/GPRS module
 - ✓ 1 standard GSM antenna
 - ✓ 1 GPS patch antenna
 - ✓ 1 USB I/O port

- SAT-SURF needs external DC power supply
 - ✓ Voltage between **9 and 30 V (12 V typical)**
 - ✓ Optional automotive connector for kinematics data log
- The USB port can be connected to a standard PC
- GSM module is used to implement A-GPS services (OMA-SUPL compliant) or to get DGPS corrections



SAT-SURF Hardware Architecture

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Note: uBlox and SiRF (and the related receiver models) are two possible options under user request.



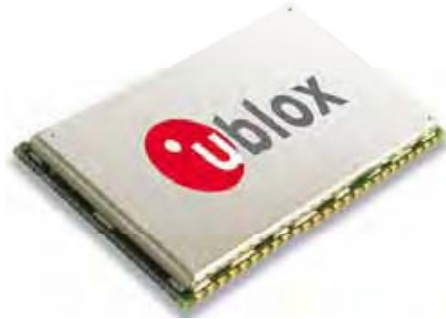
SAT-SURF Hardware Platform

GPS/Galileo receivers available in SAT-SURF:

- **uBlox 5** GPS module, OMA-SUPL compliant;
- **uBlox 4** GPS module, DGPS compliant;
- **JP13-LP** GPS module based on SiRF Star III with low power consumption;
- **JP15** High Sensitivity GPS module based on SiRF Star IIX, DGPS compliant;
- **SkyTraq Venus 6** module. It reaches data-output rate of 20 Hz.

GSM Module:

- **Telit GM862-QUAD GSM** module:
 - ✓ Multiple GPRS connection with CMUX



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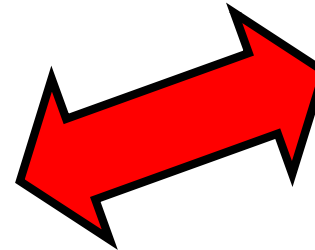


SAT-SURFER Software Suite

- **SAT-SURFER** is the software running on a standard PC that gets and process data from SAT-SURF



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SAT-SURFER Software Suite

- SAT-SURFER is able to “**talk**” with different GNSS receivers using their **binary (proprietary) protocols**
- Current version of SAT-SURFER can get data from **five receiver families:**

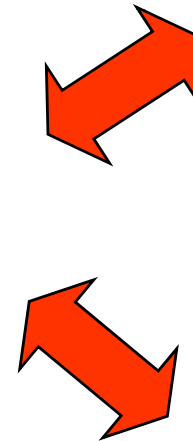
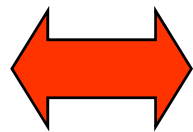
- SiRF
- uBlox
- Magellan
- Septentrio
- SkyTraq



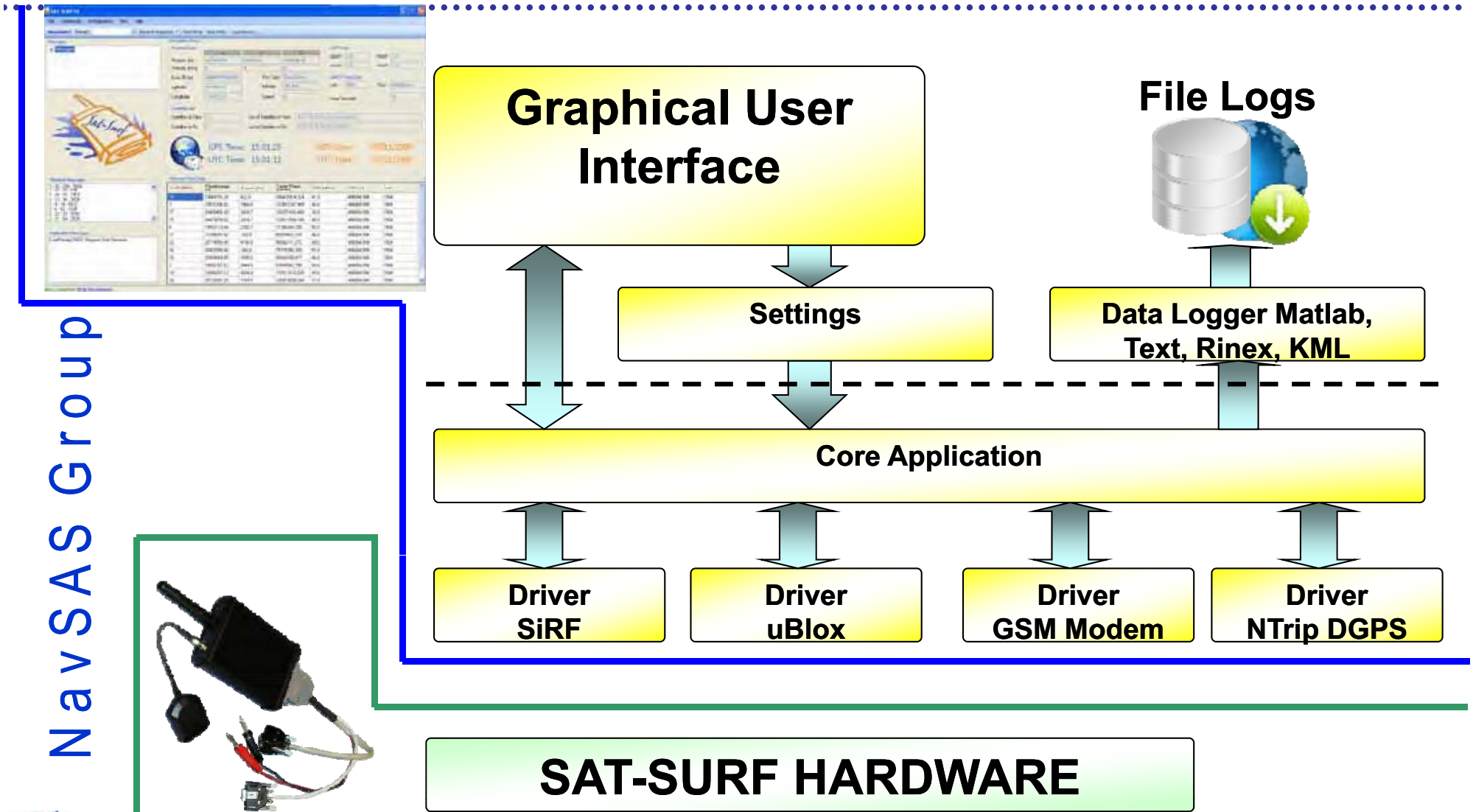
Details on SAT-SURFER

- SAT-SURFER together with SAT-SURF is an **Enhanced Evaluation Kit** managing different kind of GPS receivers
- It is also able to provide a **Communications (COM) interface** through the GSM quad-band modem

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SAT-SURFER Software Architecture



SAT-SURFER Software Functionalities

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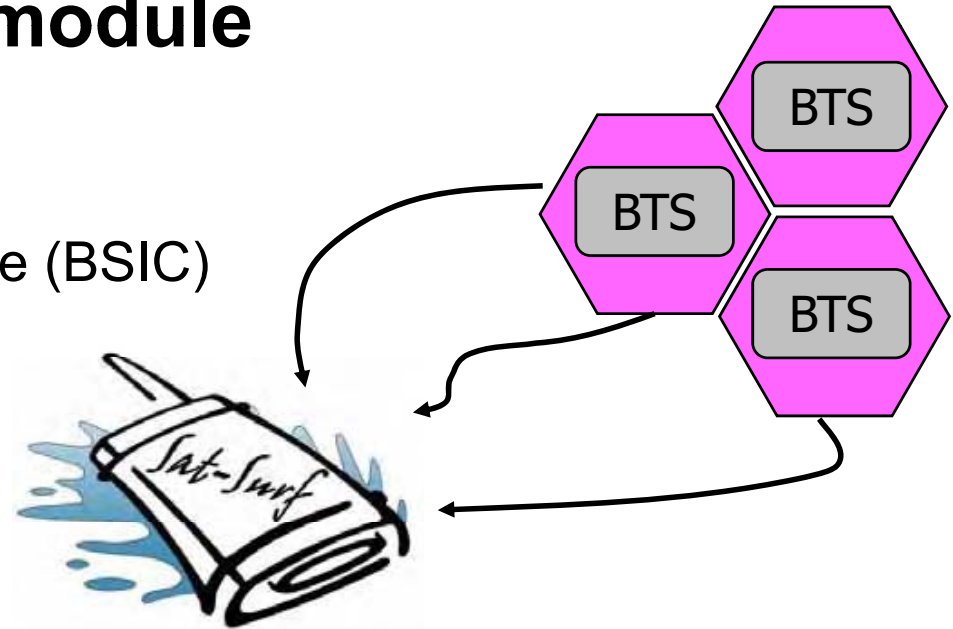
- **Display** of the most important raw data and positioning information **in real-time**;
- **Log and export** automatically any raw data for post-processing (e.g. using MATLAB[®]);
- Possibility to test **different GPS receivers** and compare their performance in different scenarios;
- **Network dispatcher functionality** for getting/broadcasting data;
- Allow test of **Assisted-GPS (A-GPS)** functionalities and performances;
- Allow test of **Differential GPS (DGPS)**.



SAT-SURFER Software Functionalities

- Management of a **GSM** module and logged parameters:

- ✓ Cell type
- ✓ Base Station Identification Code (BSIC)
- ✓ Quality of Reception (RxQual)
- ✓ Localization Area Code (LAC)
- ✓ Power (dBm)
- ✓ C1 reselection parameter
- ✓ C2 reselection parameter
- ✓ Time Advance (TA)
- ✓ Assigned Radio Frequency Channel (ARFCN)
- ✓ Cell Identification (CellId)
- ✓ Public Land Mobile Network (PLMN)



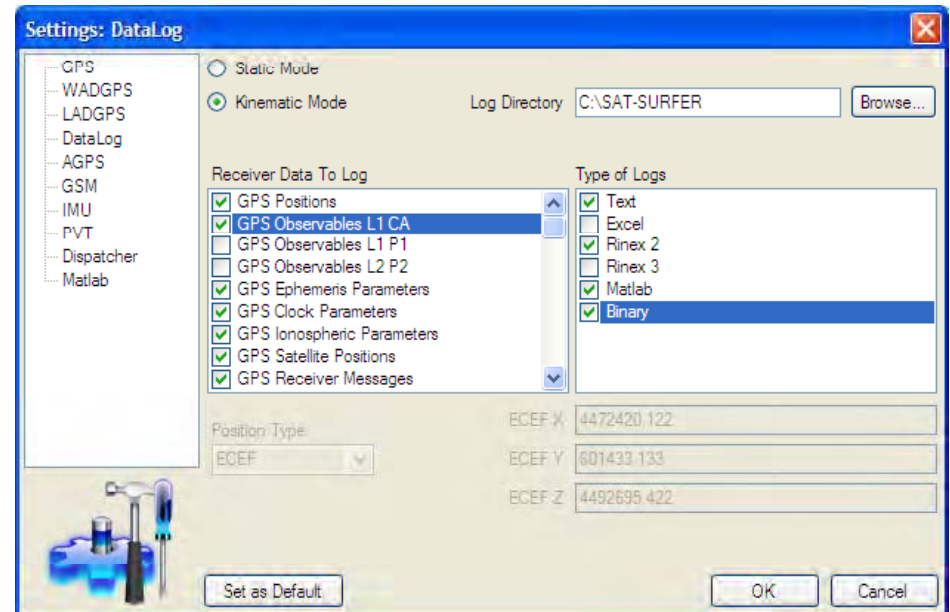
Please refer to the User Manual for the complete list of logged parameters



SAT-SURFER Software Functionalities

- Log of several GPS/GSM raw parameters using the following **file formats**:

- ✓ ASCII text (.txt) file;
- ✓ MATLAB® (.mat) file;
- ✓ MS Office Excel® (.xls) file;
- ✓ binary (.bin) file;
- ✓ RINEX 2 log;
- ✓ RINEX 3 log;
- ✓ Keyhole Markup Language (.kml) file.



Functionalities: Display Raw Data

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SAT-SURFER - Version 3.5.1.0

File Commands Configuration View Help

Disconnect Restart HOT Receiver Requests LADGPS GSM AGNSS PVT Log Directory Navigation Data Panel TML


Messages

- GPS
 - GPS Positions
 - GPS Observables L1 CA
 - GPS Observables L1 P1
 - GPS Observables L2 P2
 - GPS Ephemeris Parameters
 - GPS Clock Parameters
 - GPS Ionospheric Parameters
 - GPS Satellite Positions
 - DGPS Applied Corrections
- WADGPS
- LADGPS
- AGPS
- PVT

Navigation Data

X Position [m]	Y Position [m]	Z Position [m]	Latitude	Altitude	Error 3D (m)
4472413.94	601434.15	4492691.55	45°3'55.047	255.711	7.37
X Velocity [m/s]	Y Velocity [m/s]	Z Velocity [m/s]	Longitude	Speed	Pos Type
0.01	0.00	0.02	7°39'32.339	0.00	Stand Alone
GDOP	PDOP	Week Number	List of Satellites in View		
2.44	2.10	1577	2 4 5 7 8 10 13 16 23		
HDOP	VDOP	Time of Week	TTFF		
1.04	1.82	481840.000557953	2.596		
Leap Seconds	Satellite in View	Satellite in Fix	List of Satellites in Fix		
15	9	8	2 4 5 7 8 10 13 23		

Time


 GPS Time: 13:50:40 GPS Date: 02/04/2010
 UTC Time: 13:50:25 UTC Date: 02/04/2010

Receiver Raw Data

SatID	Pseudorange	Doppler	CarrierPhase	CNO	TOW	WN
7	20869206.7105798	2717.85229492188	75009330.0880374	50	481840.002	1577
13	22065171.2509632	319.611877441406	65539834.6781488	48	481840.002	1577
5	23118866.646519	5630.796875	102585411.105497	45	481840.002	1577
4	23396429.7227457	-512.914306640625	72535605.6326991	45	481840.002	1577
8	22011234.1956213	5218.2119140625	96764895.2606659	49	481840.002	1577
2	22093325.4808884	2006.29809570313	81442081.9496304	48	481840.002	1577
23	24114628.3990417	-296.842529296875	60555871.8446348	41	481840.002	1577
10	21263502.0175779	4352.64794921875	77081256.0094519	49	481840.002	1577

Application Status... Firmware [uBlox]: 5.00 May 11 2006 14:40:17 Firmware [uBlox]: 5.00 May 11 2006 14:40:17



Functionalities: Configuration

The screenshot displays the SAT-SURFER software interface. The 'Configuration' menu is highlighted with a red box, showing 'Settings...' and 'Configuration...'. The 'Settings: GPS' dialog box is also highlighted with a red box, showing various configuration options for the GPS receiver. The background shows the main interface with a data table and status information.

Settings: GPS

Select Receiver: uBlox

Type: COM

COM Port: COM16

COM Speed: 57600

Update COM List

Receiver DGPS Input Port (Optional)

Type: TCP

IP Address:

TCP Port: 2002

DGPS Type: Stand Alone

EGNOS Satellite: 126

Advanced >>

Rinex Source

Observable

Navigation

Set as Default

Cancel

	TOW	WN		
0	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
	469943	1577		
31	23751164.4102998	1079.6669921875	93304904.8296815	42
32	22199402.2138075	402.359191894531	59943526.3453454	47

GPS Date: 02/04/2010

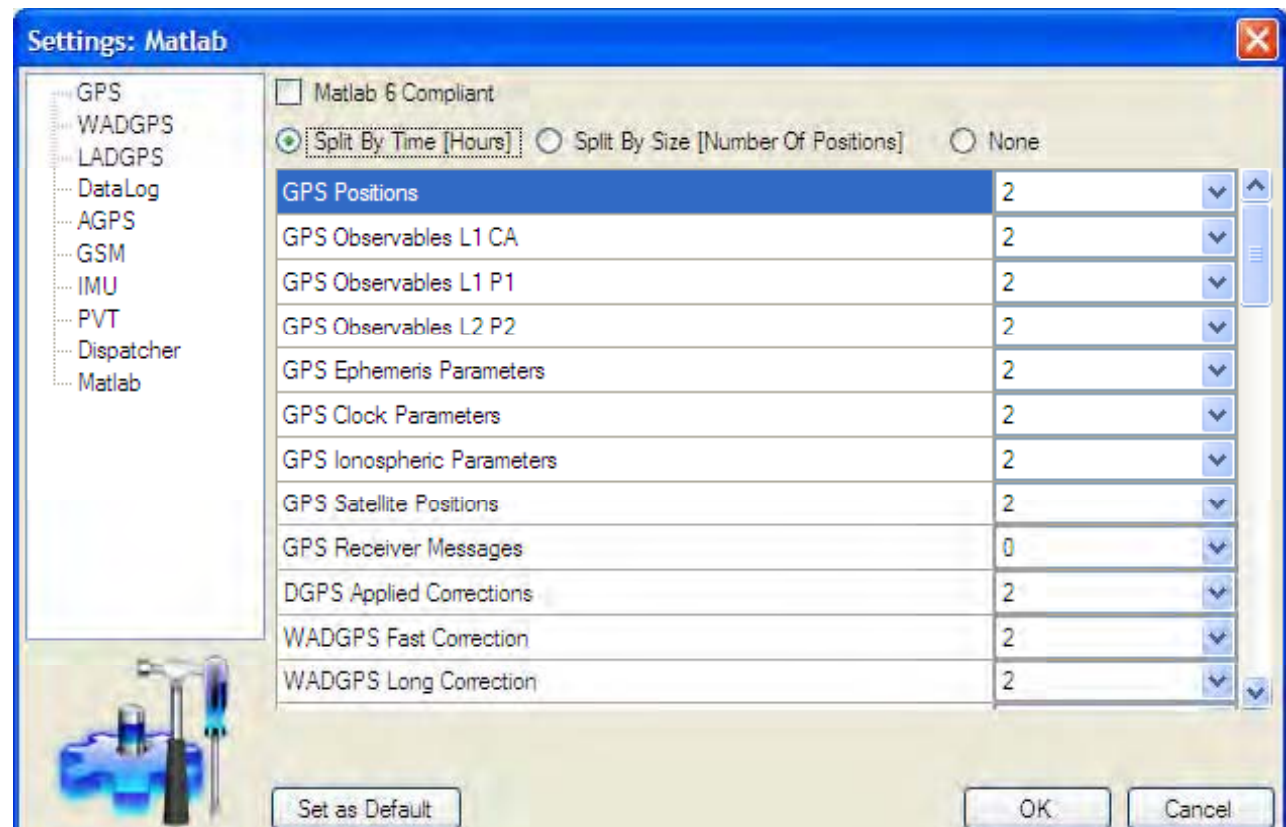
UTC Date: 02/04/2010

• This menu allows setting all the parameters for the access to the external GPS receiver and/or GSM modem (i.e. SAT-SURF).



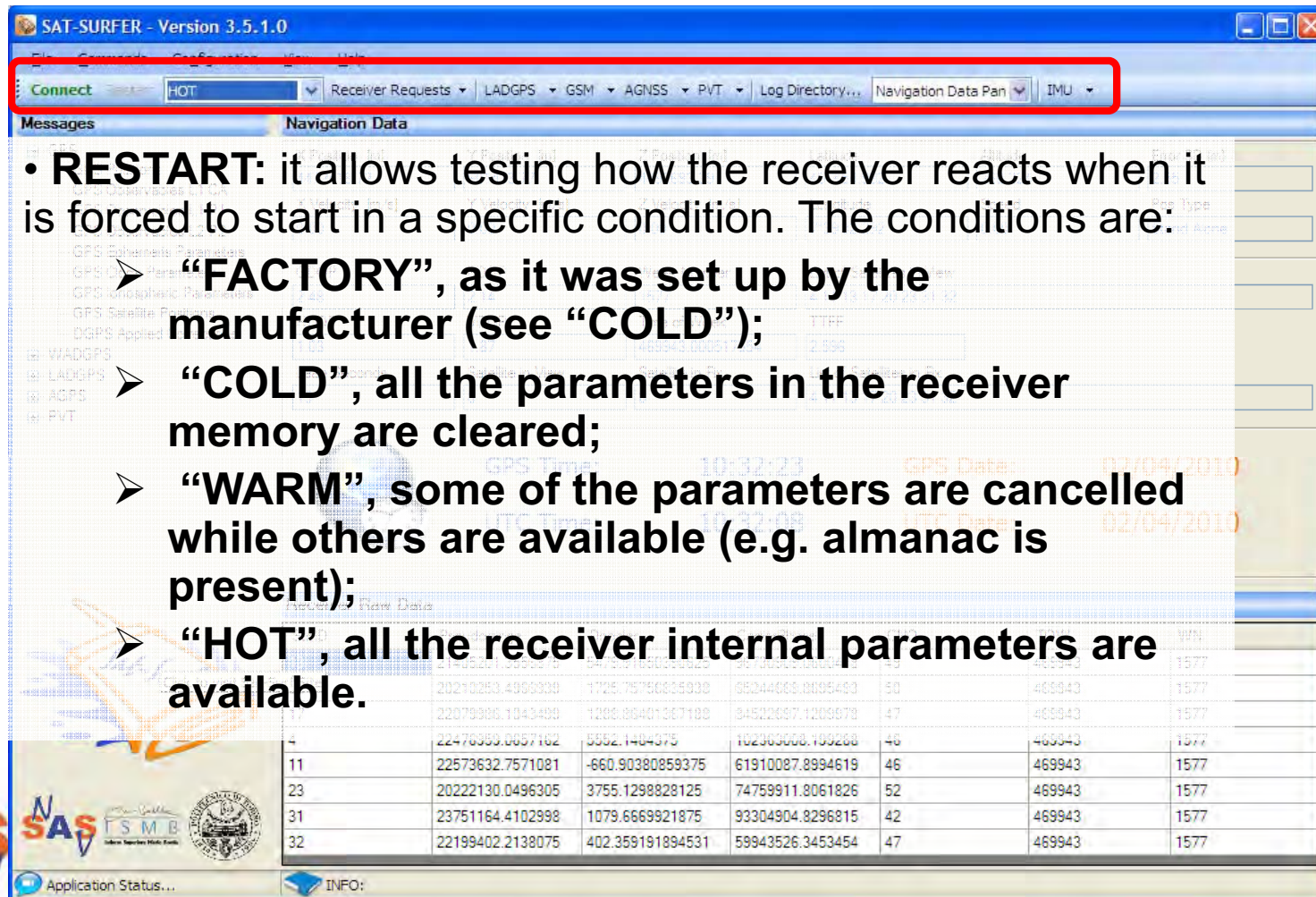
Functionalities: Configuration

- **Advanced settings** can be configured
- **MATLAB® (.mat) file logging** can be enabled
- It is possible to **split the log files** in order to achieve a better management during the post-processing



Functionalities: Toolbar

- The “**Connect**” and “**Disconnect**” buttons allow to start and stop SAT-SURF on the basis of the configuration parameters specified by the user in the “Configuration” menu.



The screenshot shows the SAT-SURFER software interface. The title bar reads "SAT-SURFER - Version 3.5.1.0". The menu bar includes "File", "Command", "Configuration", "Help". The toolbar contains a "Connect" button, a dropdown menu set to "HOT", and several other options: "Receiver Requests", "LADGPS", "GSM", "AGNSS", "PVT", "Log Directory...", "Navigation Data Pan", and "IMU". The main window is divided into "Messages" and "Navigation Data" tabs. The "Navigation Data" tab displays a table of GPS data. The "Messages" tab shows a log of system messages.

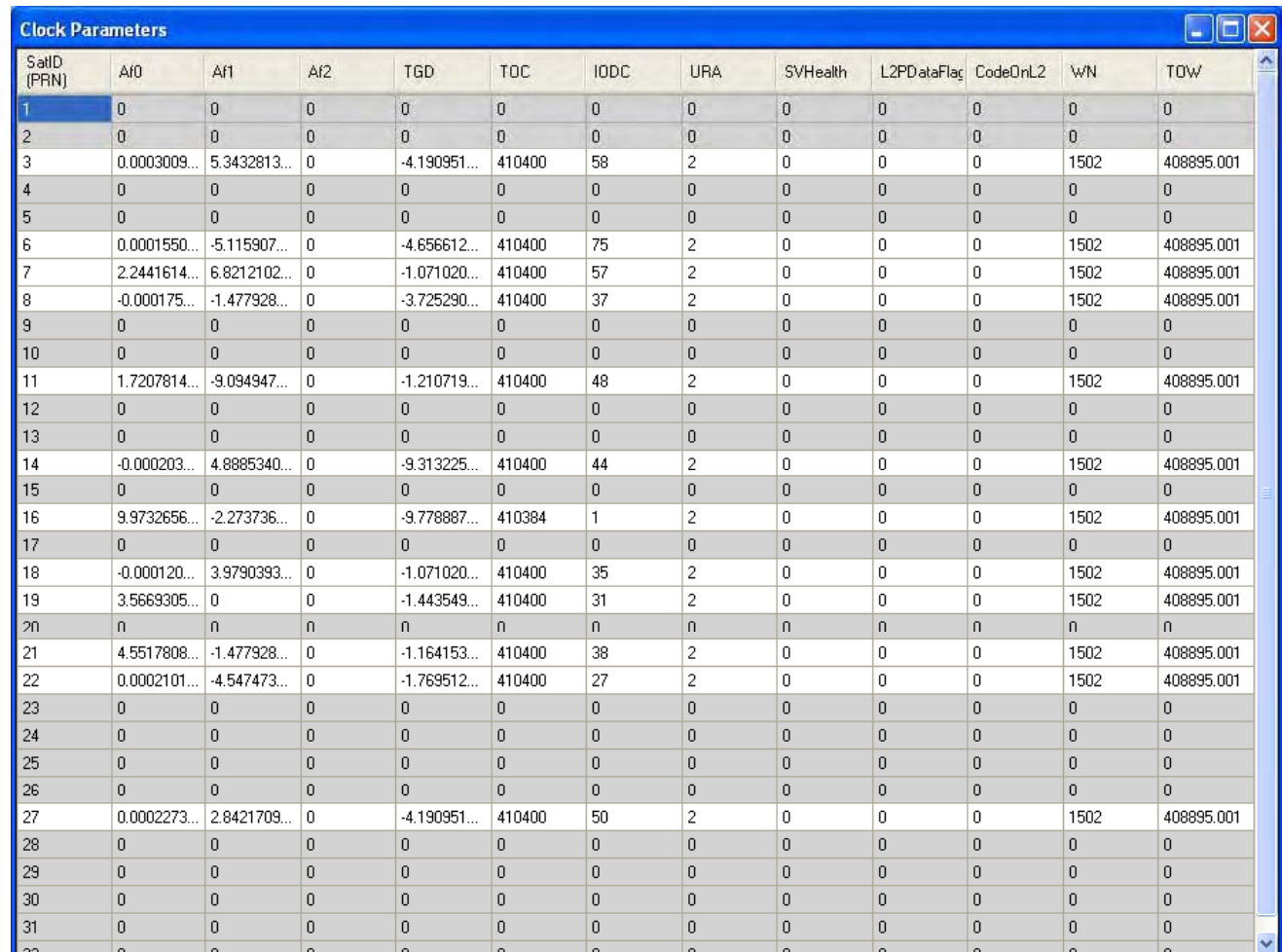
PRN	Frequency (MHz)	Longitude (Easting)	Latitude (Northing)	Altitude (m)	PDOP	HDOP	VDOP	GDOP	
4	224.76359	6657.182	5352.140	4375	162303000	193268	46	469943	1577
11	225.73632	7571081	-660.90380	859375	61910087.8994619	46	469943	1577	
23	20222130.0496305	3755.12988	28125	74759911.8061826	52	469943	1577		
31	23751164.4102998	1079.66699	21875	93304904.8296815	42	469943	1577		
32	22199402.2138075	402.35919	1894531	59943526.3453454	47	469943	1577		

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Functionalities: Info Boxes

- Double clicking on the list in the messages window it is possible to see all the **logged parameters**
- For example, “**Clock Parameters**”

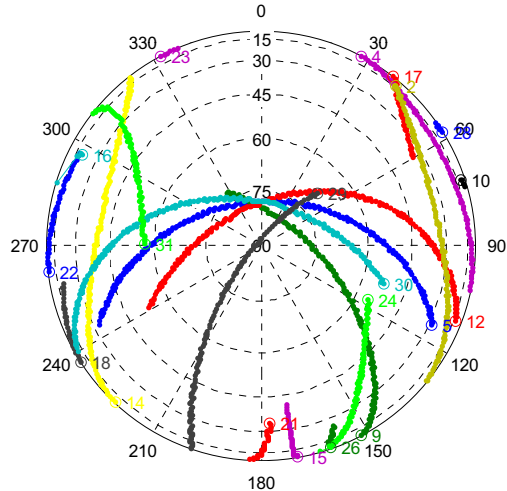


The screenshot shows a window titled "Clock Parameters" with a table of satellite data. The table has 14 columns: SatID (PRN), Af0, Af1, Af2, TGD, TOC, IODC, URA, SVHealth, L2PDataFlag, CodeOnL2, WN, and TOW. The rows represent satellites 1 through 32, with some data points truncated with ellipses.

SatID (PRN)	Af0	Af1	Af2	TGD	TOC	IODC	URA	SVHealth	L2PDataFlag	CodeOnL2	WN	TOW
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0.0003009...	5.3432813...	0	-4.190951...	410400	58	2	0	0	0	1502	408895.001
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0.0001550...	-5.115907...	0	-4.656612...	410400	75	2	0	0	0	1502	408895.001
7	2.2441614...	6.8212102...	0	-1.071020...	410400	57	2	0	0	0	1502	408895.001
8	-0.000175...	-1.477928...	0	-3.725290...	410400	37	2	0	0	0	1502	408895.001
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	1.7207814...	-9.094947...	0	-1.210719...	410400	48	2	0	0	0	1502	408895.001
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	-0.000203...	4.8885340...	0	-9.313225...	410400	44	2	0	0	0	1502	408895.001
15	0	0	0	0	0	0	0	0	0	0	0	0
16	9.9732656...	-2.273736...	0	-9.778887...	410384	1	2	0	0	0	1502	408895.001
17	0	0	0	0	0	0	0	0	0	0	0	0
18	-0.000120...	3.9790393...	0	-1.071020...	410400	35	2	0	0	0	1502	408895.001
19	3.5669305...	0	0	-1.443549...	410400	31	2	0	0	0	1502	408895.001
20	0	0	0	0	0	0	0	0	0	0	0	0
21	4.5517808...	-1.477928...	0	-1.164153...	410400	38	2	0	0	0	1502	408895.001
22	0.0002101...	-4.547473...	0	-1.769512...	410400	27	2	0	0	0	1502	408895.001
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0.0002273...	2.8421709...	0	-4.190951...	410400	50	2	0	0	0	1502	408895.001
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0

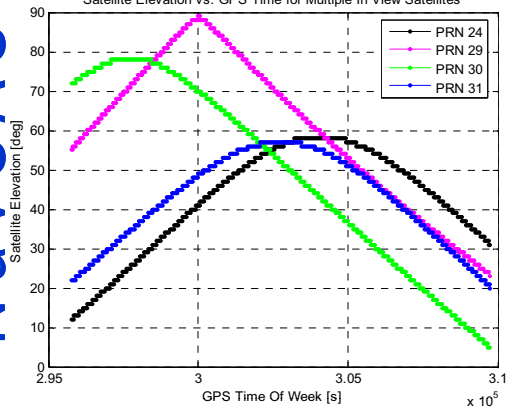
DEMO & Examples

Sky Plot for Multiple In View Satellites

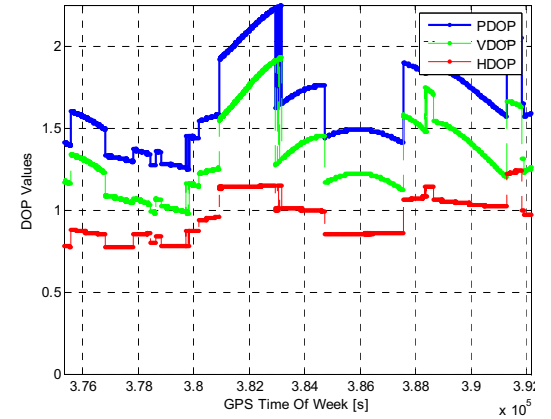


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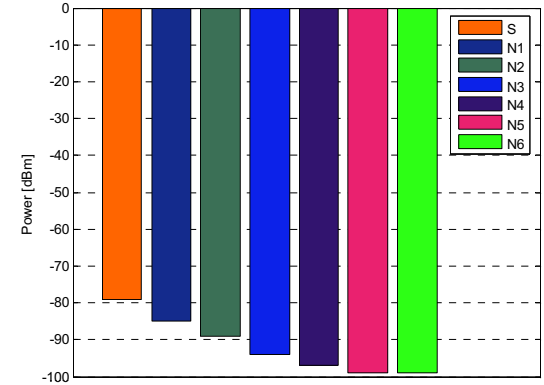
Satellite Elevation vs. GPS Time for Multiple In View Satellites



Dilution of Precision (DOP) Values

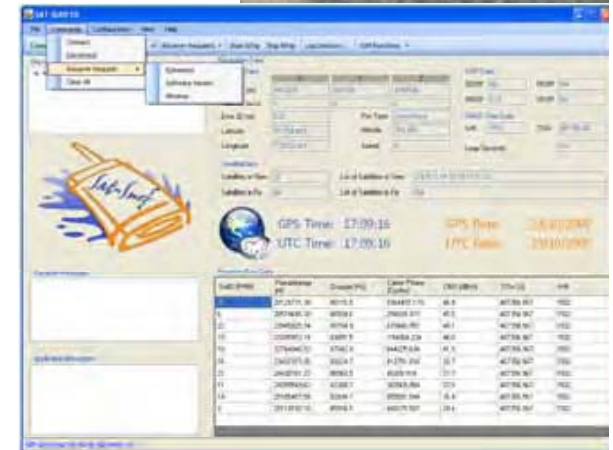
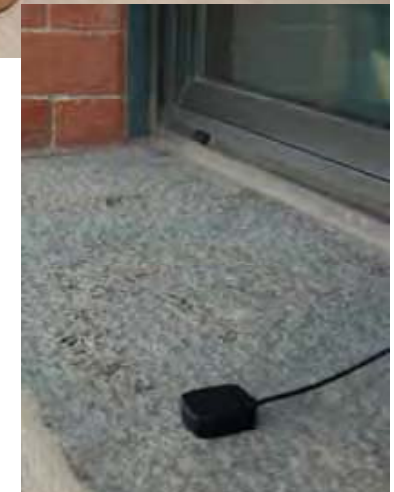


GSM BTS Power



Getting Started

- Set-up the **SAT-SURF** hardware (antenna, cable connections, power supply...). Please refer to the “Getting Started” Section of the SAT-SURF & SAT-SURFER User Manuals.
- Place the patch **antenna** of SAT-SURF in outdoor (open sky) stationary position.
- Install on your PC the **SAT-SURFER** software tool. Perform the registration (website) and set-up the software for your first data collection.



Examples

- The SAT-SURF HW allows users to obtain from the GPS receiver the available **raw measurements** (depending on the receiver capabilities), and not only the simple NMEA output.
- **Each GPS parameter is logged with a related GPS time stamp**, so that each parameter can be aligned to the evolution of all the others.



Parameters Logged by SAT-SURFER

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Name	Description
Position Data	<ul style="list-style-type: none"> ■ Position (m), the three components ■ Velocity, (m/s), the three components ■ Latitude, Longitude, Altitude ■ Error 3D w.r.t. a reference position ■ Position Type, so how the RX computes the position. It can be: STANDALONE, SBAS, DGPS, RTK FIX, or RTK FLOAT ■ Speed, the amplitude of the velocity vector
Satellites Data	<ul style="list-style-type: none"> ■ Number of satellites in view ■ Number of satellites in fix, meaning satellites used for the computation of the position, velocity, and time (PVT) ■ List of satellites in view ■ List of satellite in fix (satellites used in PVT computation)
GNSS Time Data	<ul style="list-style-type: none"> ■ Week Number (WN) ■ Time Of Week (TOW) ■ GPS Time ■ Leap Seconds ■ Time to First Fix
Dilution Of Precision Data	<ul style="list-style-type: none"> ■ GDOP, PDOP, HDOP, VDOP



Parameters Logged by SAT-SURFER

Name	Description
Raw GNSS Observables (per each satellite in view)	<ul style="list-style-type: none"> ■ Satellite Identifier (PRN) ■ Pseudorange measurements (m) ■ Doppler frequency shift ■ Carrier to noise density ratio (C/No) ■ Carrier phase ■ Ephemeris parameters ■ Clock parameters ■ Satellite positions (Azimuth, Elevation, Xs, Ys, Zs) ■ Ionospheric parameters <p>Note: All the raw GNSS measurements are saved for all the frequencies supported by the GNSS receiver.</p>
EGNOS Raw Corrections Messages	<ul style="list-style-type: none"> ■ Fast Corrections ■ Long-Term Corrections ■ Integrity Satellites Information ■ Covariance Matrix ■ Fast Corrections Degradation Factor ■ Wide Area Ionospheric Corrections ■ Wide Area Degradation Factor ■ Wide Area Service and Network Time ■ Geo-Almanac



Parameters Logged by SAT-SURFER

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Name	Description
DGPS/RTK Raw Corrections Messages	<ul style="list-style-type: none"> ■ All the messages coming from the NTRIP network
A-GPS	<ul style="list-style-type: none"> ■ Session Data: TTFF, Time for raw measure, number of raw measure acquired; ■ All the data coming from the Local Element (Reference Time and Position, Almanac, UTC model, Ephemeris and Doppler shift)
Applied Differential Corrections	<ul style="list-style-type: none"> ■ Applied Pseudorange Correction (PRC) ■ Applied Range Rate Correction (RRC) ■ Applied Iono Correction ■ Age of Applied Corrections <p>Note: These parameters are the corrections applied by the receiver for EGNOS or DGPS.</p>
Custom PVT Parameters	<ul style="list-style-type: none"> ■ Computed positions and velocity ■ Satellites used ■ Corrected pseudorange & applied corrections



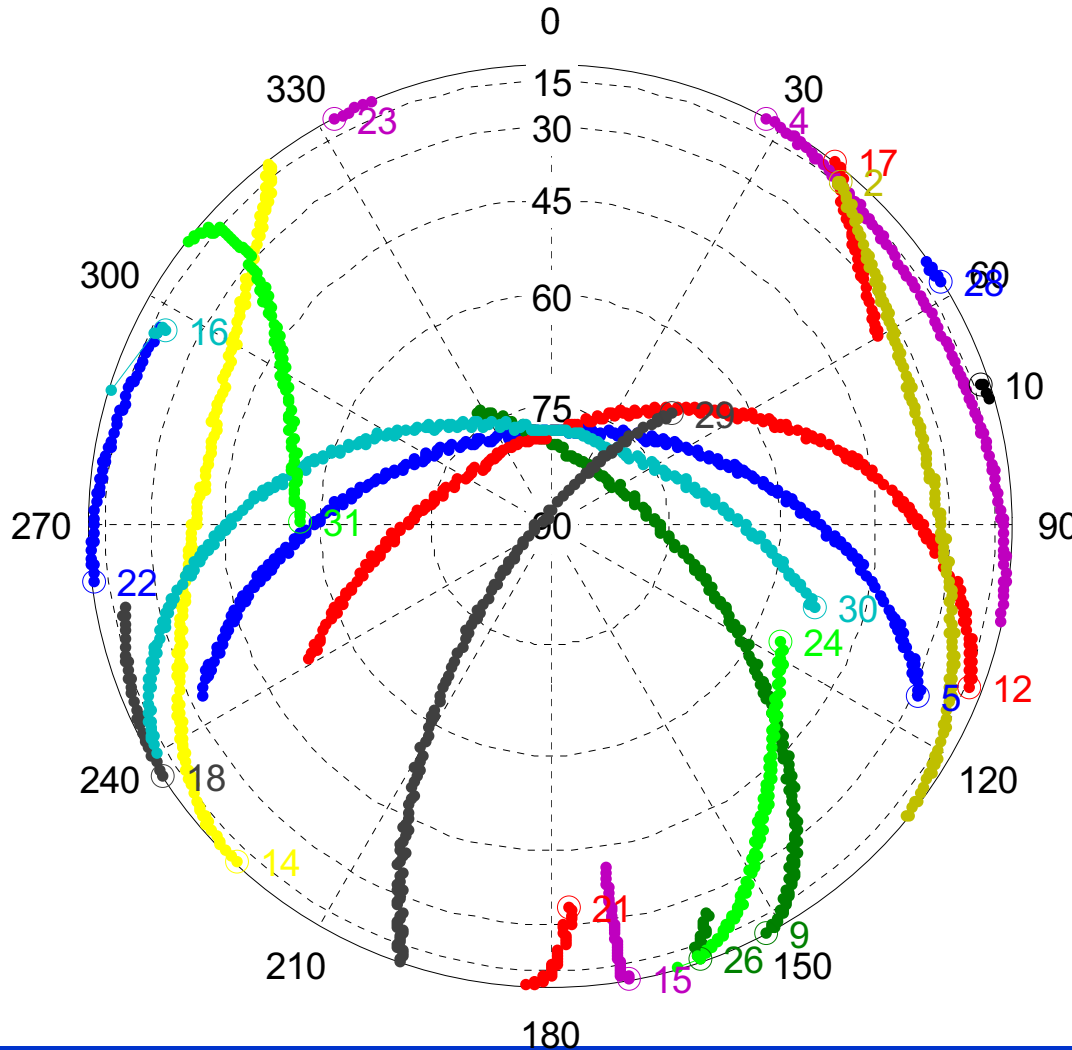
Parameters Logged by SAT-SURFER

Name	Description
GSM Network Parameters	<ul style="list-style-type: none">■ Base Station Identification Code (BSIC)■ Quality of Reception (RxQual)■ Localization Area Code (LAC)■ Power (dBm)■ C1 reselection parameter■ C2 reselection parameter■ Time Advance (TA)■ Assigned Radio Frequency Channel (ARFCN)■ Cell Identification (CellId)■ Public Land Mobile Network (PLMN)
IMU data logging	<ul style="list-style-type: none">■ All available Inertial Measurements Unit (IMU) outputs



Example: Satellite Sky Plot

Sky Plot for Multiple In View Satellites

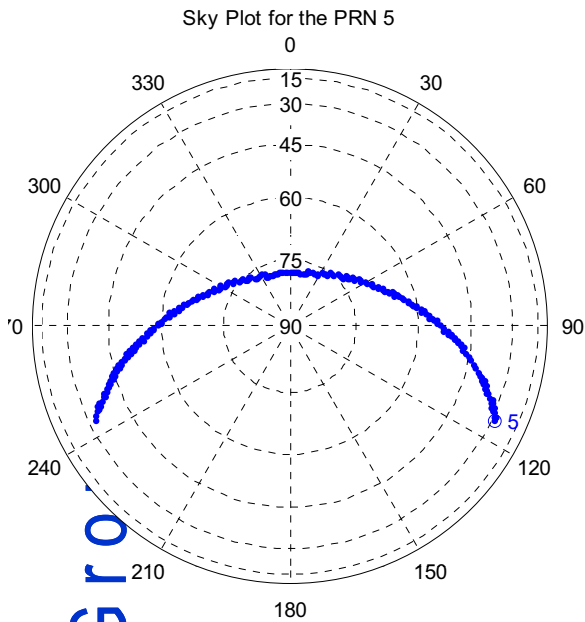


- 4 hours data collection
- Position evolution (Sky Plot) of multiple GPS satellites in view

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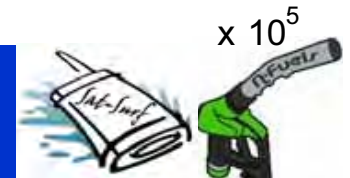
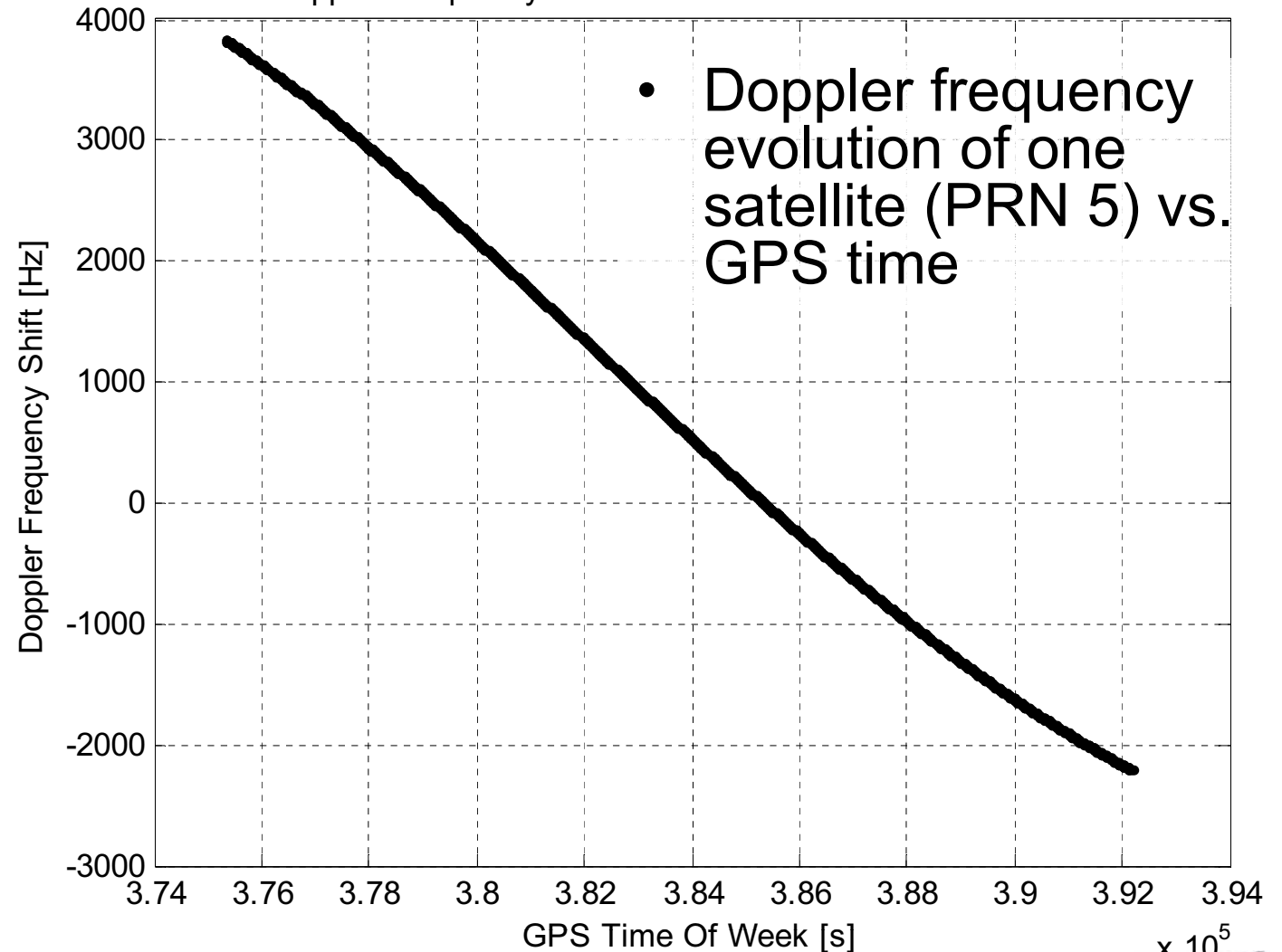


Example: Doppler Frequency Shift



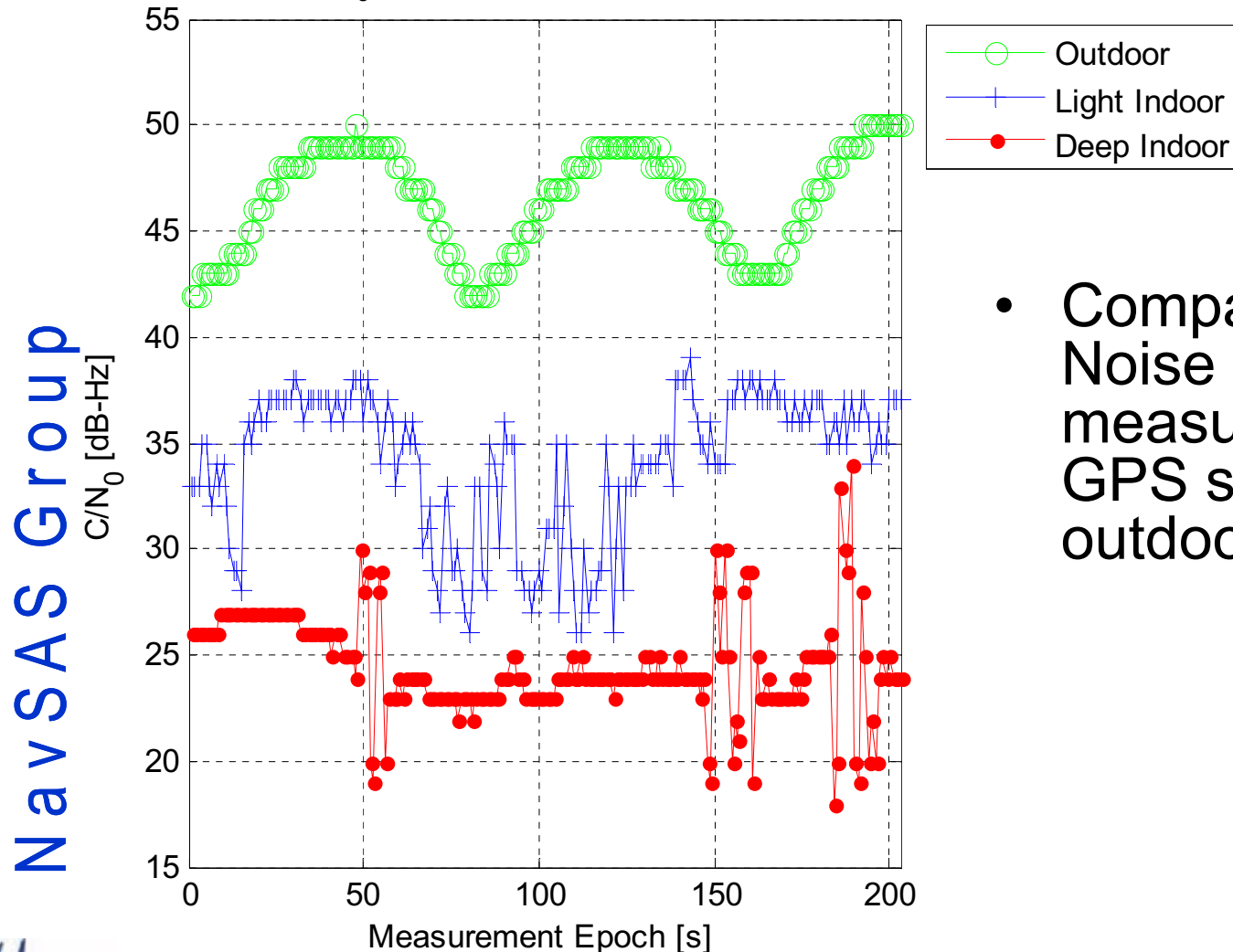
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Doppler Frequency Evolution vs. GPS Time for the PRN 5



Example: Outdoor vs. Indoor Signals

C/N₀ time evolution for the PRN 6



- Comparison of Carrier to Noise Density ratio (C/N₀) measurements for one GPS satellite in different outdoor/indoor scenarios

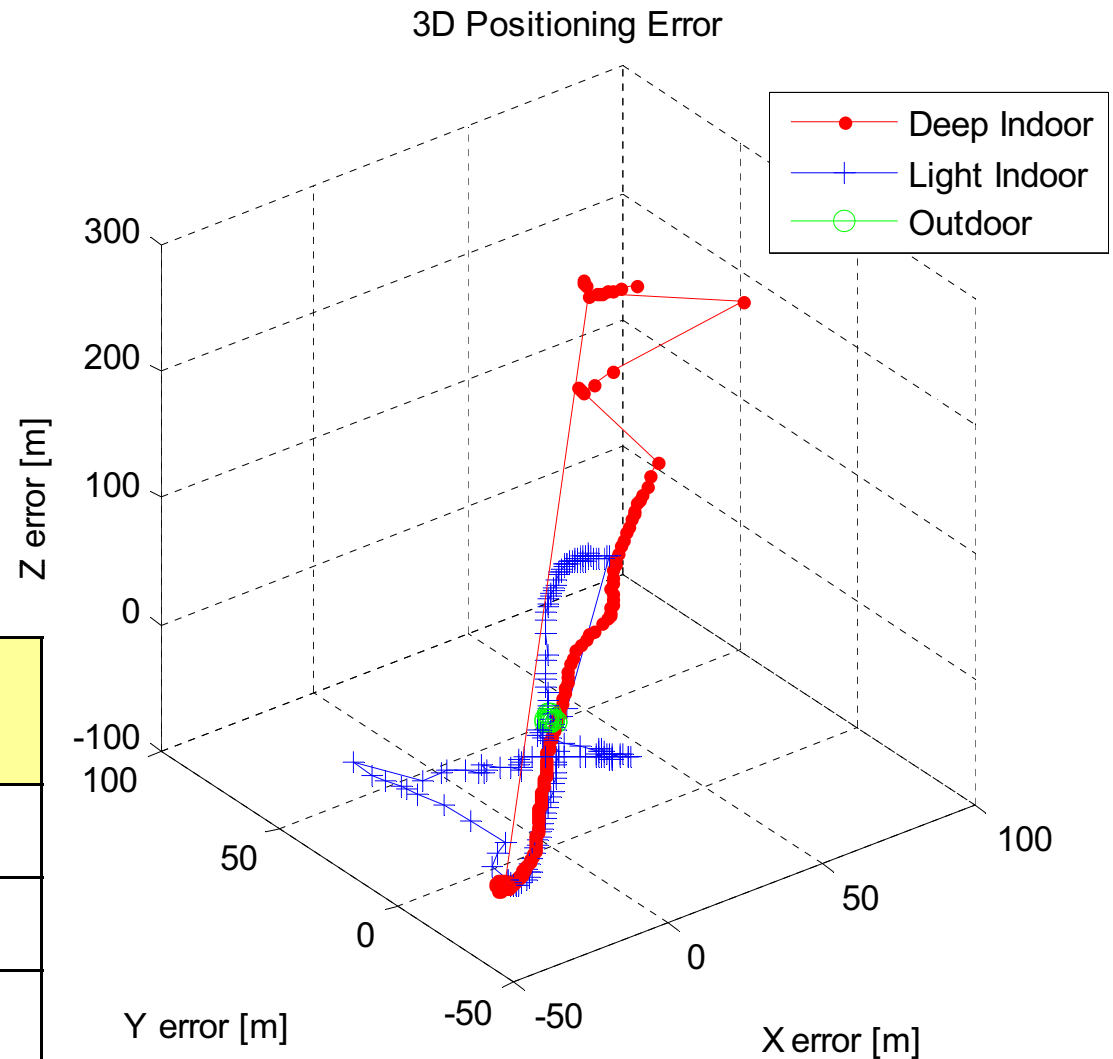


Example: Outdoor vs. Indoor Positioning

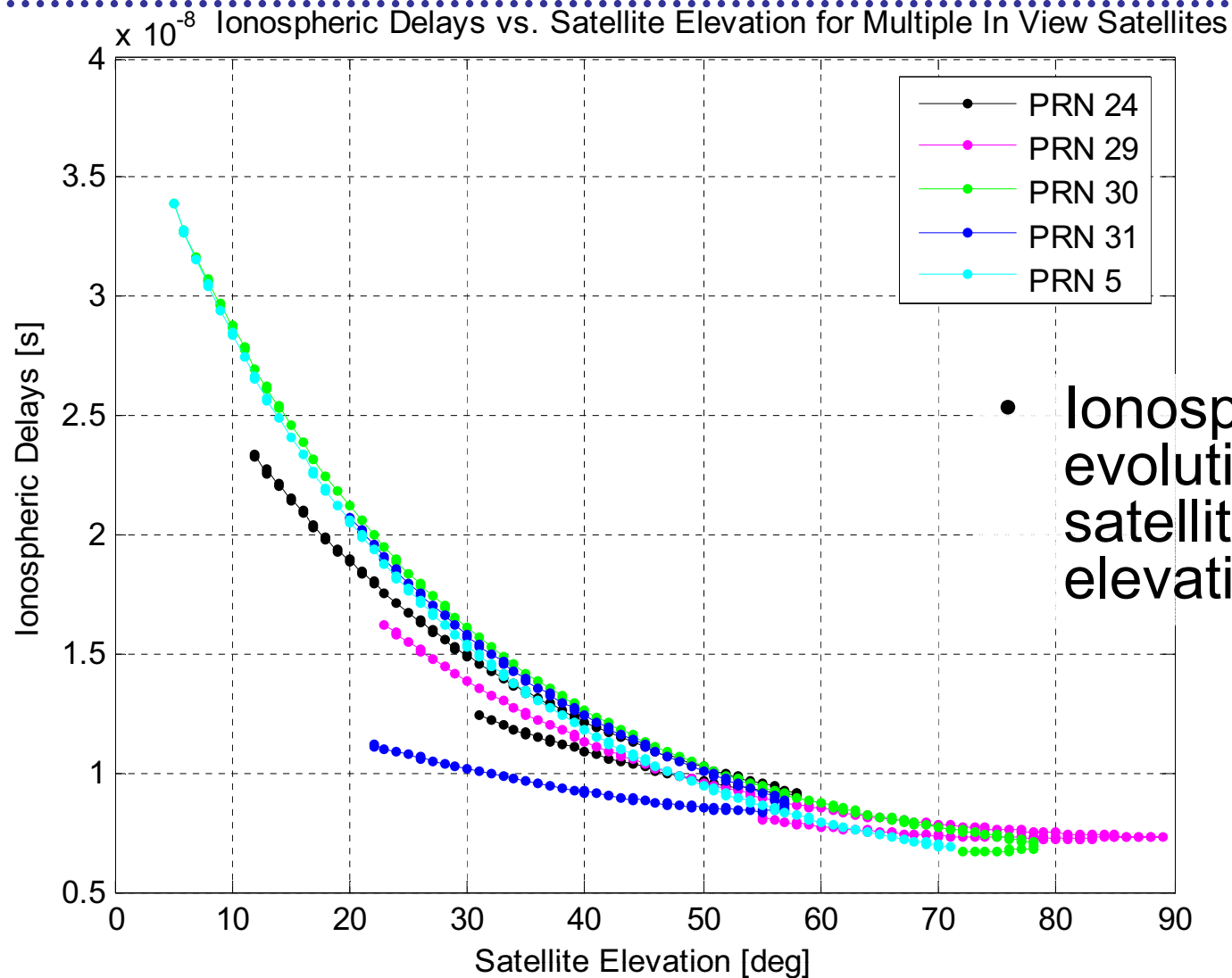
- Comparison of 3D positioning errors w.r.t. mean position (ECEF coordinates) in three scenarios
- Standard deviation of the measured positions w.r.t. the mean position

Group

Scenario	Outdoor	Light Indoor	Deep Indoor
σ_X	0.54 m	24.90 m	34.27 m
σ_Y	1.31 m	24.19 m	30.60 m
σ_Z	1.17 m	39.87 m	90.13 m



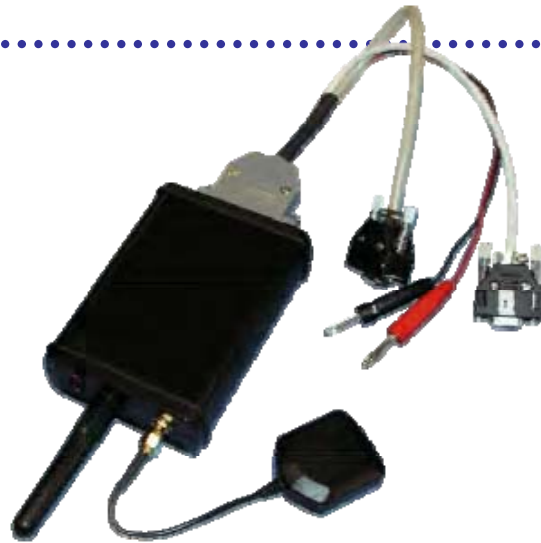
Example: Ionospheric Delays



- Ionospheric delays evolution for 5 satellites versus elevation



SAT-SURF & SURFER Summary



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

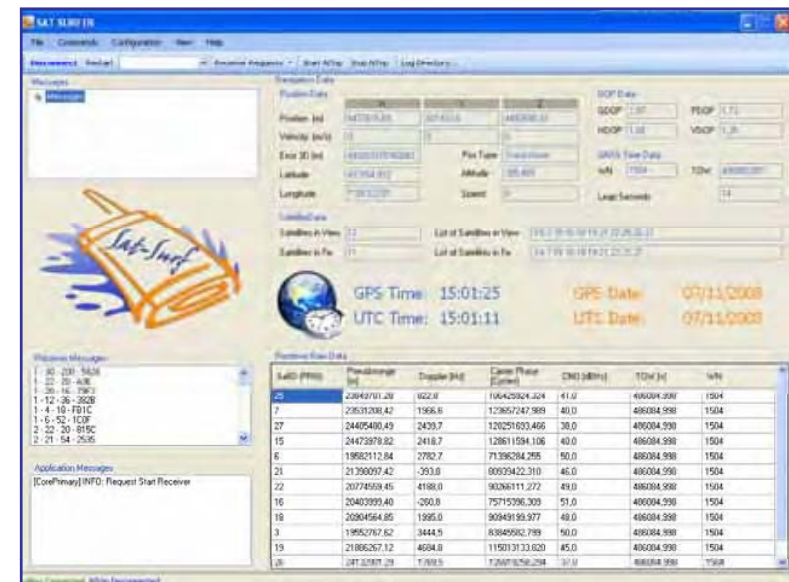
2 – Embeds different GPS modules depending on the user needs:

- 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



SAT-SURF & SURFER Summary

NavSAS Group

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).



SAT-SURF & SURFER Partnership

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

NavSAS Group



www.navsas.eu



www.saetsrl.com



Outline

NavSAS Group



1 – Introduction

2 – SAT-SURF Hardware Platform

3 – SAT-SURFER Software Suite

4 – SAT-SURFER Setup & Demo

5 – N-FUELS Signal Generator

6 – N-FUELS Demo

7 – Questions Session

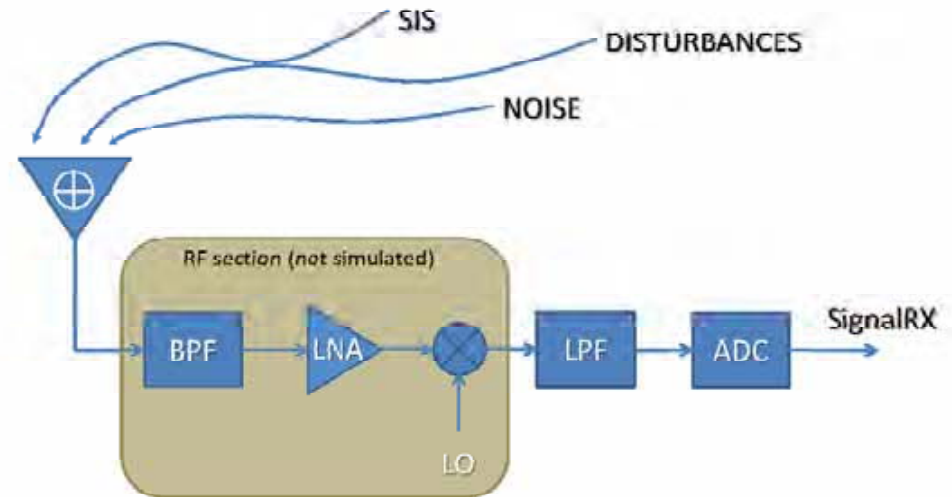


N-FUELS Introduction

N-FUELS

Full Educational Library
of Signals for Navigation

- It is a **MATLAB®-based GNSS signal generator**
- It is able to simulate the physical layer signal structure for **GPS, Galileo** and **EGNOS** systems in all the current and future bands, as seen by a GNSS receiver after A/D conversion
- 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 - Full Educational Library of Signals for Navigation

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:

Plots

Code chip samp... Received signal

Signal spectrum Doppler Frequency

Noise & Impairments

Noise Power SIS [dBW]: C/NO [dBHz]:

NO [dBW/Hz]:

Multipath / Interference **CONFIGURATION**

ABOUT N-FUELS...



RX Front End

Front End Filter Filter model:

- 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

Group Delay compensat...

Transient compensation

Output

Output Folder:

Signal out

Codes

Freq Doppler



LOAD PARAM

GENERATE SIGNAL

SAVE PARAM


PLOTS

EXIT

Interference Settings

Only available in
FULL version

Disturbances Parameters

Disturbance type: 

CW Carrier Freq. w.r.t. IF [

]

CW Phase [rad]:

CW Power [dBW]:

Disturbances Doppler Parameters

JAM Doppler type: 

Doppler Period [s]:

Doppler Phase Init [rad]:

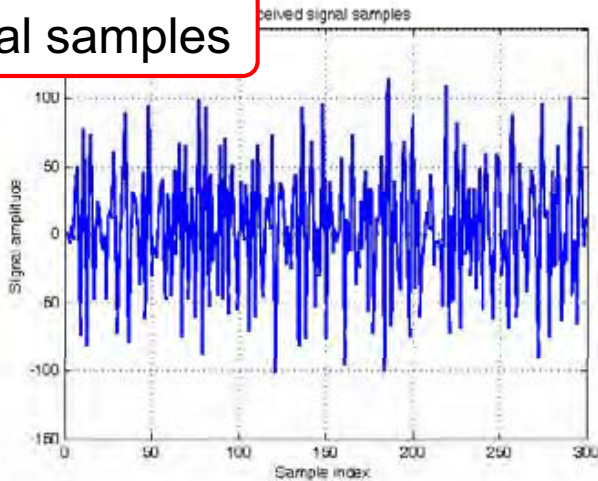
Max Doppler Freq [Hz]:

OK

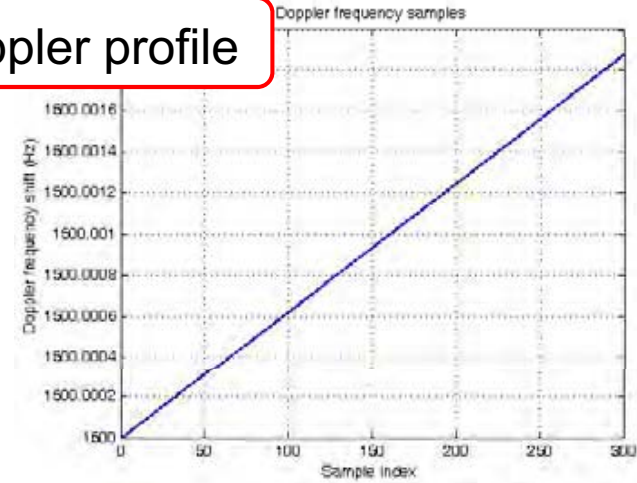


Output Examples

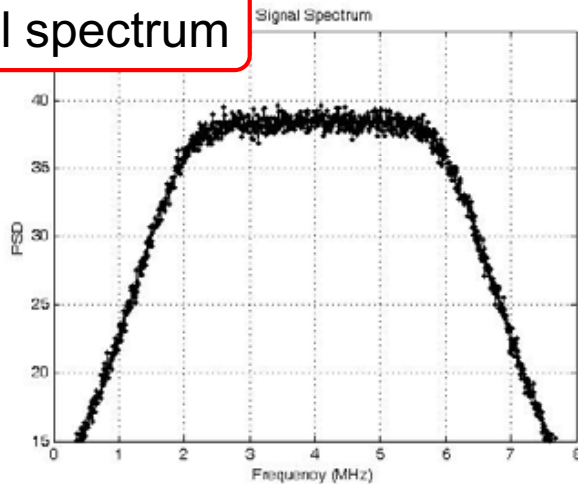
Signal samples



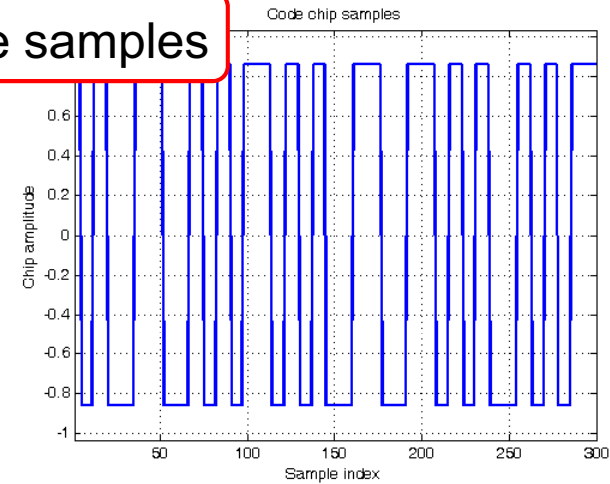
Doppler profile



Signal spectrum



Code samples

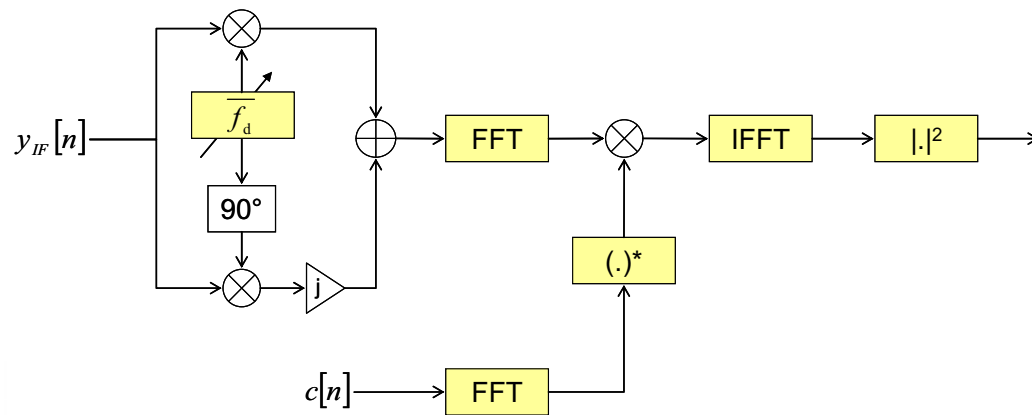


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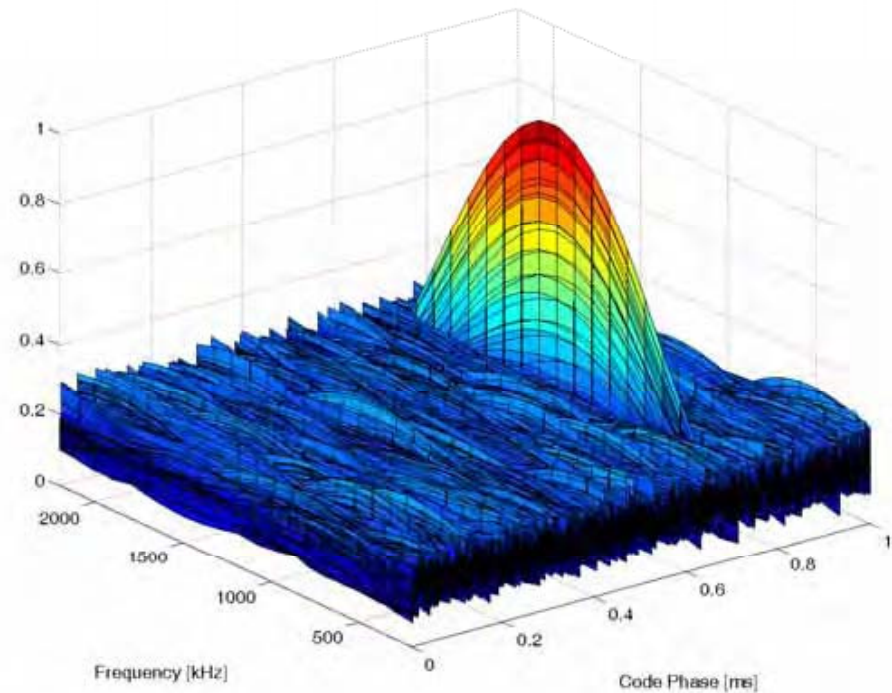
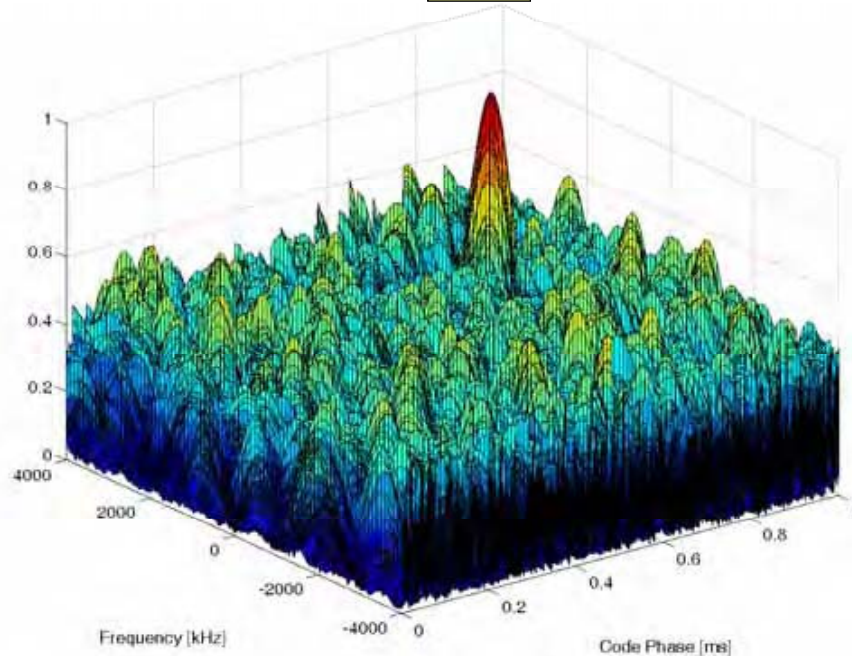


Example – Signal Acquisition

FFT parallel acquisition scheme in time domain



- Simple **set of exercises** using N-FUELS outputs
- Analysis of **acquisition parameters** (coherent and non-coherent integrations, search space bins...)
- **Cold start vs. Warm start**

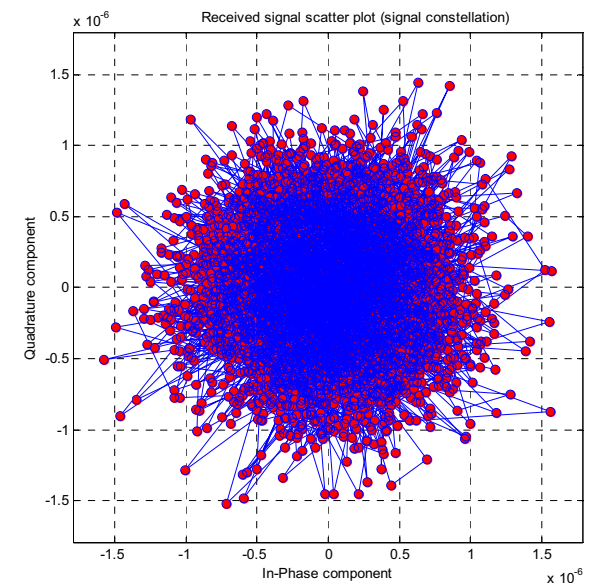
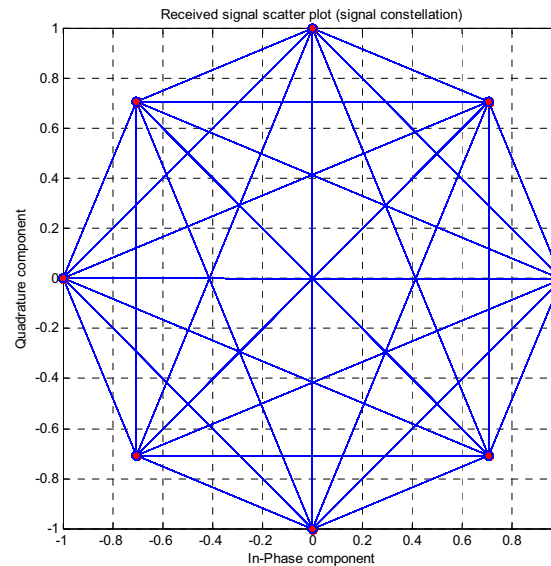


Example – New GNSS Modulations

Available GNSS signals

System	Signal
GPS	GPS_L1
	GPS_L1C
	GPS_L2C
	GPS_L5
Galileo	GAL_E1b_BOB
	GAL_E1c_BOB
	GAL_E1bc_BOB
	GAL_E1bc_CBOB
	GAL_E5
	GAL_E6bc
EGNOS	EGNOS

- A wide set of civil/not-restricted modulations of the current and future **GPS, Galileo** and **EGNOS** signals can be simulated using N-FUELS
- Example: analysis of **Galileo E5 AltBOC(15,10)** modulation in ideal and realistic conditions



How to get N-FUELS

NavSAS Group

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
- U/S/2009 Seminar from Andrew Dempster of the University of New South Wales
- SEAGAL project kick-off meeting

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N-FUELS – Student Version

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NavSAS Group - NFUELS - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

http://www.navsas.ismb.it/hs/index.php?option=com_content&task=view&id=173&Itemid=78

NavSAS Group - NFUELS

NavSAS Politecnico di Torino Istituto Superiore Mario Boella



NavSAS Technologies and Tools



Education on Galileo and GPS

Latest News from NavSAS Group

- Ceremony for the end of the fifth edition of the Master on Navigation and Related Applications
- SAT-SURF & SAT-SURFER Platform v2.0 is now available
- 7th IEEE Consumer Communications & Networking Conference
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N-FUELS Full Educational Library of Signals for Navigation



N-FUELS is a signal simulator designed to offer a flexible and complete tool able to reproduce off-line GNSS signals at the ADC (Analog to Digital Converter) output of a navigation receiver, either at intermediate frequency or at baseband. The signal generator can account for the effects of multipath, Doppler, interferences of different nature (i.e., intra-system, inter-system, handlimited, continuous wave, etc...) on all the bands of interests for the future GNSS, as well as characteristics (equivalent filter bandwidth, frequency plan, ADC). The signal samples after ADC conversion is made available at a sampling rate and a reception algorithm that processes digital samples in a completely code and carriers tracking loops, C/N₀ estimation algorithms, interference

The "Student Version" downloadable here has been intentionally limited

- Quick Tour
- N-FUELS Student Edition v1
- Further readings: N-FUELS white paper

Click N-FUELS link and download the software



N-FUELS – Student Version

- The folder contains both the software and the user's manual
- All the instructions to get starting are included in the user's manual
- In order to run the generator, **MATLAB® has to be pre-installed** (or at least the MATLAB Component Runtime library)
- The **Student (Demo) Version** has been intentionally limited in its features with respect to the **FULL version** of the generator



Contact Information

SAT-SURF, SAT-SURFER & N-FUELS

have been designed and developed by the **NavSAS group**, a joint team of researchers from **Politecnico di Torino** and **Istituto Superiore Mario Boella** (Italy).

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Our web site:

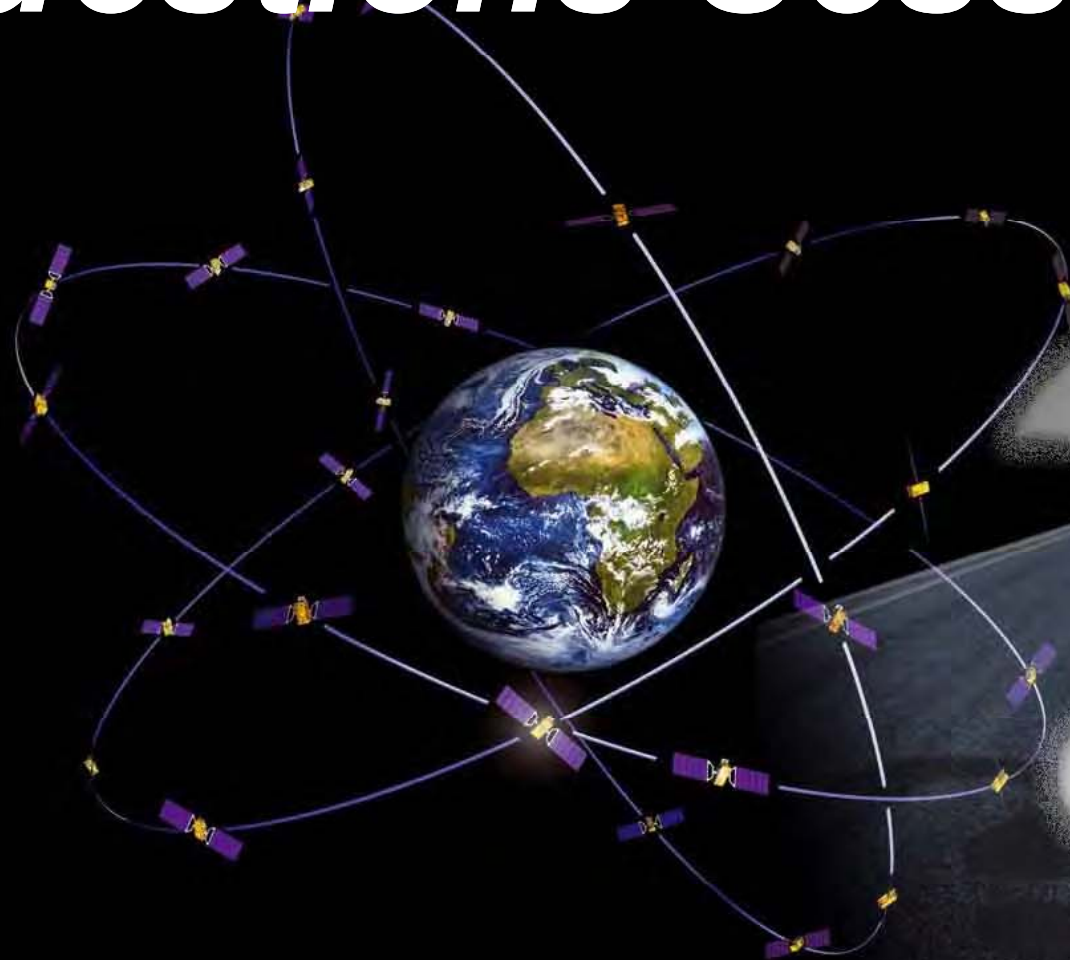
<http://www.navsas.eu>

Contact us:

sat-surfer@ismb.it
n-fuels@ismb.it



Questions Session



www.navsas.eu

www.galileoblog.eu

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