NavSAS Research activities

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Introducing NavSAS

NavSAS is a joint research group of ***Politecnico di Torino*** and ***ISMB***, operating in the satellite navigation, localization technologies and embedded solutions sectors

ISMB
Istituto Superiore Mario Boella
Private Research Center

Politecnico di Torino
Top Technical University

NavSAS

Introducing NavSAS

- NavSAS is part of a cluster of 8 laboratories that are the core of ISMB, a prominent center of applied research in wireless technologies
- Research is focused specifically on advanced technologies for GPS / EGNOS / Galileo receivers and applications, as well as advanced SW and FW for embedded solutions.
- NavSAS cooperates with major industrial and institutional players operating in the field (e.g. European Commission).

NavSAS in Figures

- 8 permanent staff members
- 12 researchers under grant
- 7 Ph.D. students
- 4 external members

Total of 31researchers (2009)

- Publications in 2009: 34 (8 journals)
- Owned patents: 5
- On-going project in 2009: 15 (with different size)
- In 2009: 46 submitted proposals

30% **14** ACCEPTED

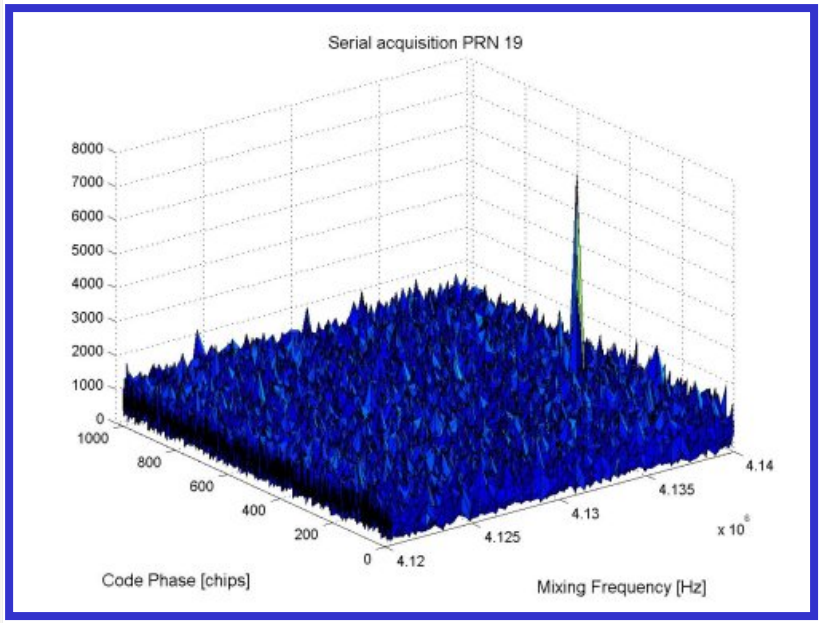
41% **19** REJECTED

13 NO DECISION TAKEN YET

NavSAS on Core Nav Technologies

NavSAS Keywords on Galileo and EGNOS:

- Galileo receiver core technologies and algorithms (mass-market, professional, Safety-Of-Life)
- Fully SW and SW Radio implementations for Galileo mass-market receivers
- Assisted-Galileo and Assisted-GPS as a core element (OMA-SUPL)
- Interference detection and mitigation algorithms
- Jamming and Spoofing



NavSAS on Embedded Solutions

NavSAS Keywords on Technology Platform Development:

- Design and development of NAV/COM embedded systems (e.g. Tetra+EGNOS, DMR+EGNOS)
- Assisted-Galileo and Assisted-GPS implementation on embedded systems (OMA-SUPL)
- e-112 emergency call system for automotive applications
- Ad-hoc design and development of embedded solutions (HW and FW)
- EGNOS and EDAS
- SW+FW interfaces toward third party applications
- Mapping & GIS

N-GENE: in the Future of GNSS

N-Gene is a Real Time Galileo, EGNOS and GPS Fully Software Receiver supporting the following modulations

Feature	Acquisition	Tracking	Navigation & PVT
L1 – GPS C/A	✓	✓	✓
E1 – GIOVE A and B BOC(1,1)	✓	✓	X
E1 – Galileo BOC(1,1)	✓	✓	✓
E1 - EGNOS	✓	✓	✓

N-Gene can be uses for:

doing R&D, testing new solutions, INS+GPS, A-GPS, spoofing, anti-spoofing monitoring, interference monitoring, ...

N-GENE Performance

The software approach makes N-Gene quite flexible, but at the same time N-Gene provides performance equivalent when not better than other receivers on the markets

N-Gene Software Receiver - Performance	
Max. n. satellite tracked	- Selectable by the user; - Up to 12 channels in real time, with a sampling frequency of ≈17.5 MHz and 8 bits per sample.
Signal tracked	- GPS L1 C/A code; - Galileo E1 BOC (1,1), MBOC; - GIOVE-A and GIOVE-B signals; - EGNOS and EDAS
Positioning accuracy	- r.m.s<10 m using code-based measurements;
Pos. fix update rate	- Selectable by the user; - Up to 20 Hz
Cold start	- 45 s; - The user set the target probability of false detection.
Warm Start	- Possibility to use assisted information to reduce the Time to First Fix coming from the Communication (GSM/UMTS) network

N-Gene Software Receiver – Enhanced Characteristics	
Front end Interface	- Any front end using a USB 2.0 interface; - The receiver is able to process both I and Q samples at baseband and real samples at IF.
Quantization	- Up to 8 bit per samples.
Sample Recording	- Possibility to store raw samples to binary files
Assisted GPS	- The receiver is equipped with Assisted-GPS software routines that recover A-GPS data employing the OMA-SUPL protocol.
Modular Approach	- Receiver easily reconfigurable; - Access to low level signal processing routines;
Output files	- NMEA standard; - RINEX 3.0 standard; - Proprietary Log files.

N-GENE test in the SMAT project (1/4)

SMAT is a project, funded by the Piedmont Region Research Council, devoted to applications of UAV (Unmanned Air Vehicle).
Alenia Aeronautica leads the project.
NavSAS is studying how to support the UAV missions with new generation GNSS receivers.

For the time being, we are testing N-GENE on-board of small air vehicles.

N-GENE test in the SMAT project (2/4)

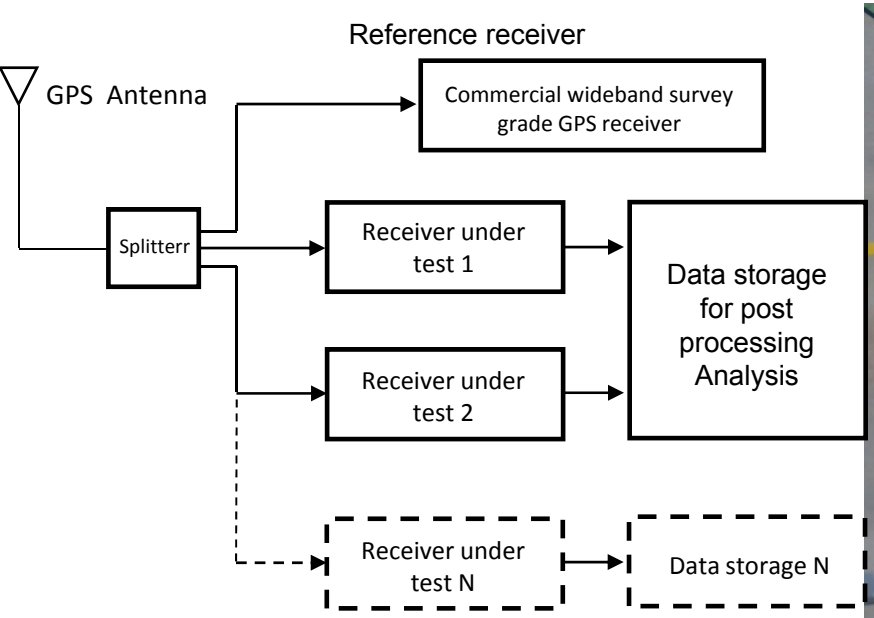
Testing board

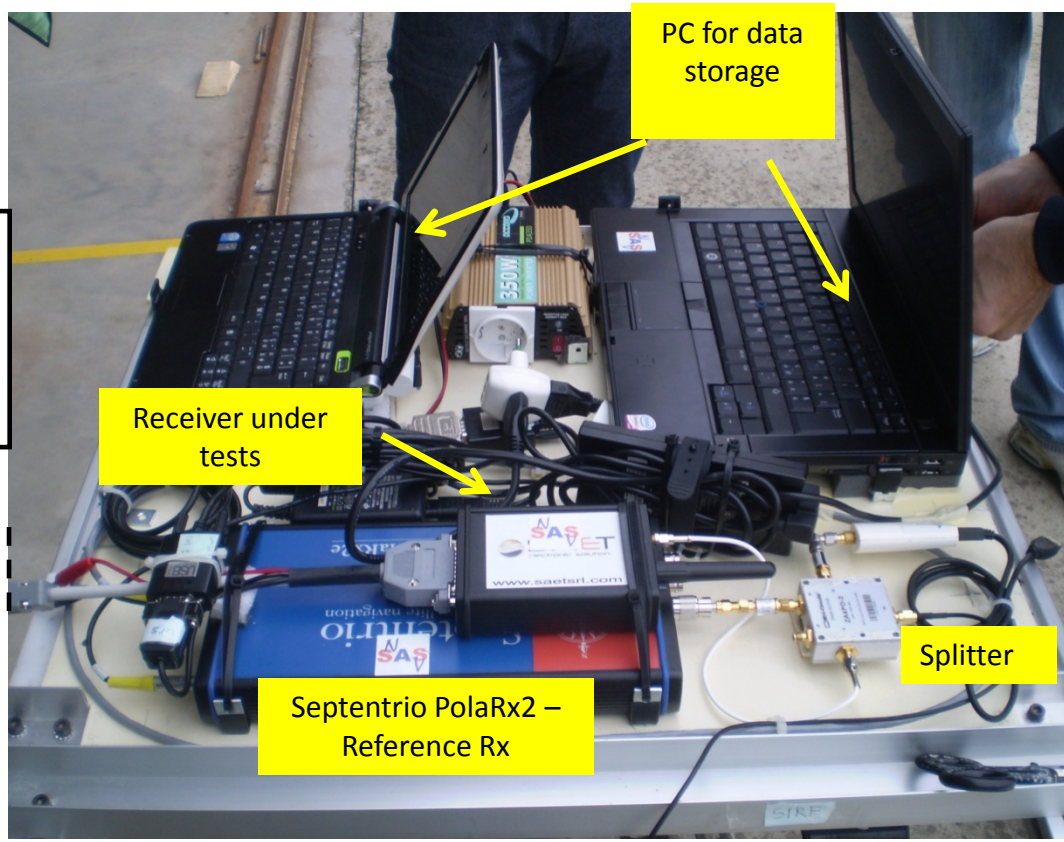
- Dual frequency GPS Receiver Septentrio PolaRx2e (Reference receiver);
- Single frequency GPS Receiver u-blox 5T (already used in SMAT-F1);
- Single frequency GPS Receiver Pilot III Pro (already used in ultra-light airplanes);
- N-Gene software receiver

Test objectives:

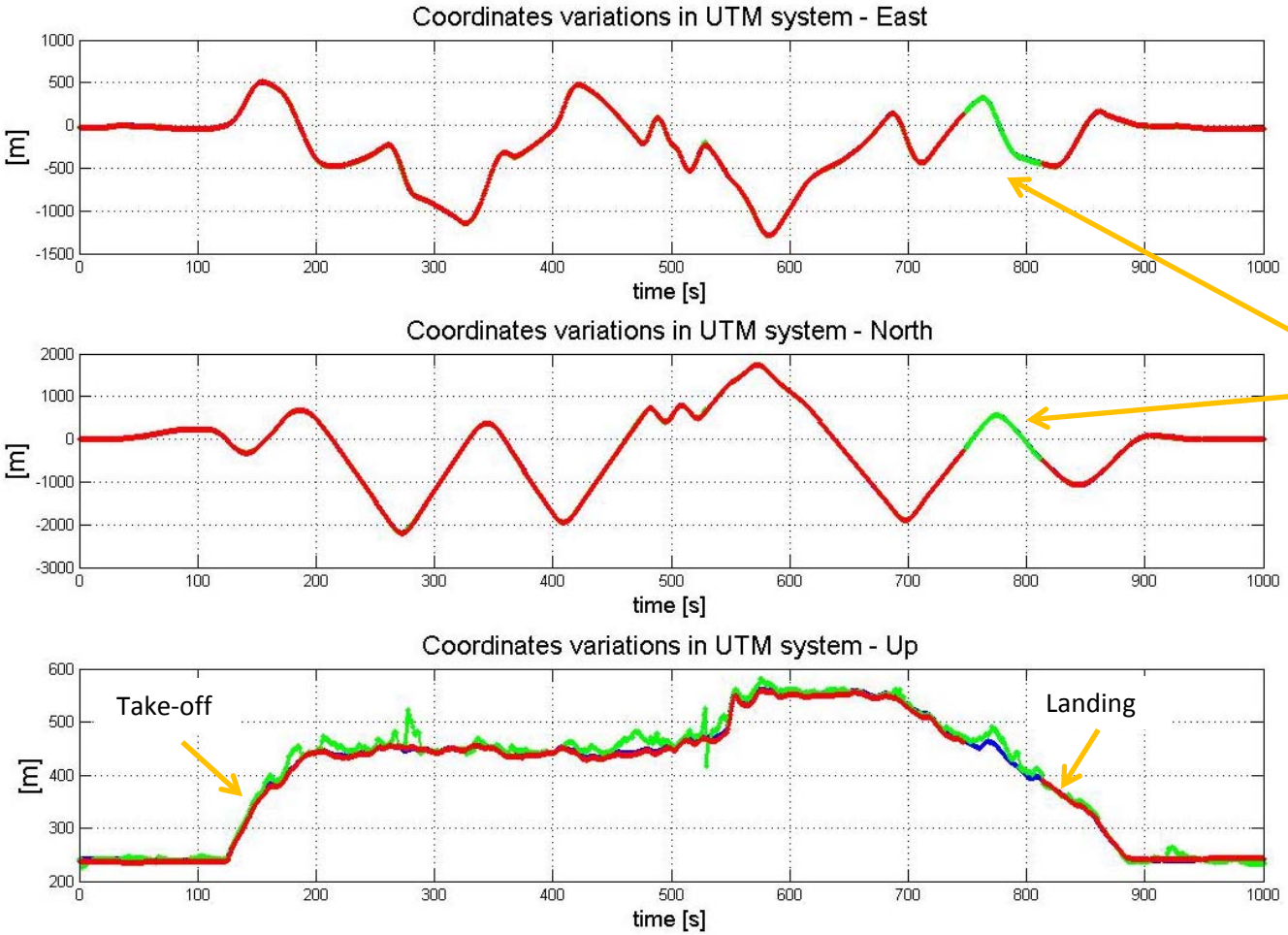
- Compare N-Gene performances with the other receivers
- Evaluate the EGNOS coverage in the area of the SMAT experiments
- Prepare an environment for A-GNSS, based on N-Gene

N-GENE test in the SMAT project (3/4)





N-GENE test in the SMAT project (4/4)



Blue: reference receiver
Green:N-Gene software Receiver;
Red: Garmin GPS III Pilot

The GARMIN receiver failed to provide location data for 1 minute and 30 seconds.

The UP coordinate of N-GENE is less accurate. .

NavSAS Tools

Details on www.navsas.eu

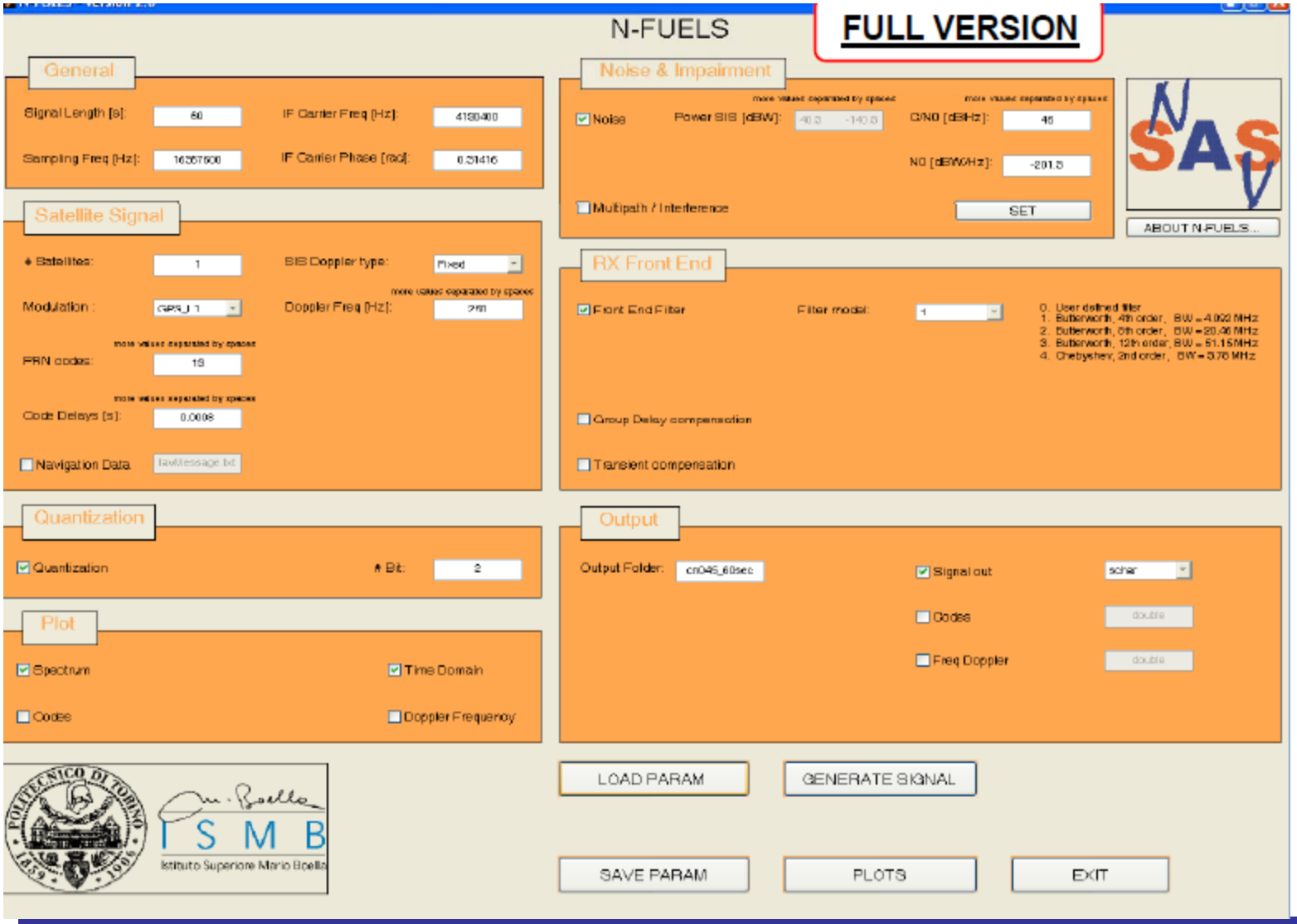
N-FUELS

Signal simulator designed to offer a flexible and complete tool able to reproduce off-line GNSS signals at the ADC output of a navigation receiver, either at intermediate frequency or at baseband.

- GPS, Galileo, new generation signals
- Multipath, Doppler, interferences of different nature (i.e., intra-system, inter-system, bandlimited, continuous wave, etc...), AWGN and receiver front-end characteristics.

The "Student Version" is downloadable free of charge. It is limited in its features with respect to the full generator.

N-FUELS: Graphical interface



SAT-SURF

A platform for both R&D and training on GPS and EGNOS. It allows logging in a multi-format (including Excel® and Matlab®) all the measurements made by the GPS receiver (of different manufacturers) and the GSM module. It is, then, a sort of super-evaluation kit for studying, developing and testing hybrid NAV/COM strategies as well as new Location Based Services.

SAT-SURFER is the SW Suite able to control SAT-SURF and external receivers

NAVKIT

NAVKIT is a multimedia HTML-based education toolkit developed in the framework of ERIG (Education Research and Innovation in the field of GNSS), a project funded by the Galileo Supervisory Authority through the 6th Research Framework Programme (FP6) – 3rd Call.

It is an educational tool for engineers or technicians not already trained in navigation topics but with a mathematical background.

A technical/scientific approach is adopted but the main topics are presented with a tutorial approach, inessential technicalities are omitted.

NAVKIT

NAVKIT is freely available on our website.

You have to register and you will receive username and password to use NAVKIT through e-mail.

Overview on National and International projects

National&International Projects

Past Projects

- GREHDA Galileo Receiver for High Dynamics Applications
  - Integrated GPS/Galileo RX for small LEO satellites
- GIRASOLE Galileo Receiver for Safety of Life Equipment
  - Interference detection and mitigation studies
- ARTUS Galileo User Professional Receiver Development

GJU 2nd call

- NASIA Localisation technologies for Localisation Applications in Airport
- DANGER monitoring of dangerous goods

Italian Space Agency

- JEAGAL Setup of Galileo Labs in China and Vietnam, awareness actions and preparation of open learning material on GNSS

EC Europe Aid

National&International Projects

Past Projects

- IRGAL Development of a real-time fully SW Galileo/GPS Receiver
- GAL-PMI GPS/EGNOS for emergency and traffic monitoring applications

Piedmont Region

- ERIG Analysis of educational and research needs in the field of GNSS
  - development of educational kits for Galileo
- HARRISON New applications based on the precise time broadcast by Galileo satellites detection and mitigation studies
- PROGENY HW-SW educational kit for GPS and Galileo

GJU 3rd call

- SWAN development of a SW Galileo/GPS receiver

Italian Space Agency

National&International Projects

On-going Projects

- SIGNATURE New strategies for road tolling
- SEAGAL Design and development of a Europe-South East Asia Collaboration Centre on GNSS based in Vietnam
- GSC EGNOS test for automotive applications
- Tender Galileo Consolidation Support the evolution of the integrity concept
- TIGER development of a highly innovative security platform based on a GNSS receiver technology for access control and position attestation applications.

FP7 -GSA 2007

- EASY-RIDER development of A-GPS solutions for automotive applications

Italian Ministry of Industry Industria 2015

National&International Projects

On-going Projects

- JRC-ISPRA innovation on interference monitoring systems — EC
- Ricevitori SoL development of core tech for Galileo SoL receivers — ASI
- GOLDEN-ICE innovative EGNOS-based solutions for salt-spreading systems — FP7 -GSA 2007
- SAFEPORT introduction of EGNOS for ships management — FP7 -GSA 2007
- P2P research for cooperative (peer-to-peer) positioning — ESA

National&International Projects

On-going Projects

- Marelli TBOX FW development for tracking & tracing applications

} Companies

- SALICE Analysis and implementation of satellite-assisted localization and communication systems for emergency.

} Italian government

- SMAT Design and development of an innovative system for monitoring and surveillance that integrates already existing infrastructures

} PiemonteRegion

Higher Education

The Master on Navigation and Related Applications aims at creating specialists and technicians able to operate within Galileo framework both at core system and services level.

The Master is a joint initiative of ISMB and Politecnico di Torino university, with the support of INRIM Galileo Ferraris and the United Nations Office for Outer Space Affair.

ISMB
Istituto Superiore Mario Boella

POLITECNICO DI TORINO
1859 1906

UN-OOSA

The Academia&Industry Cooperation

Peer-to-peer positioning

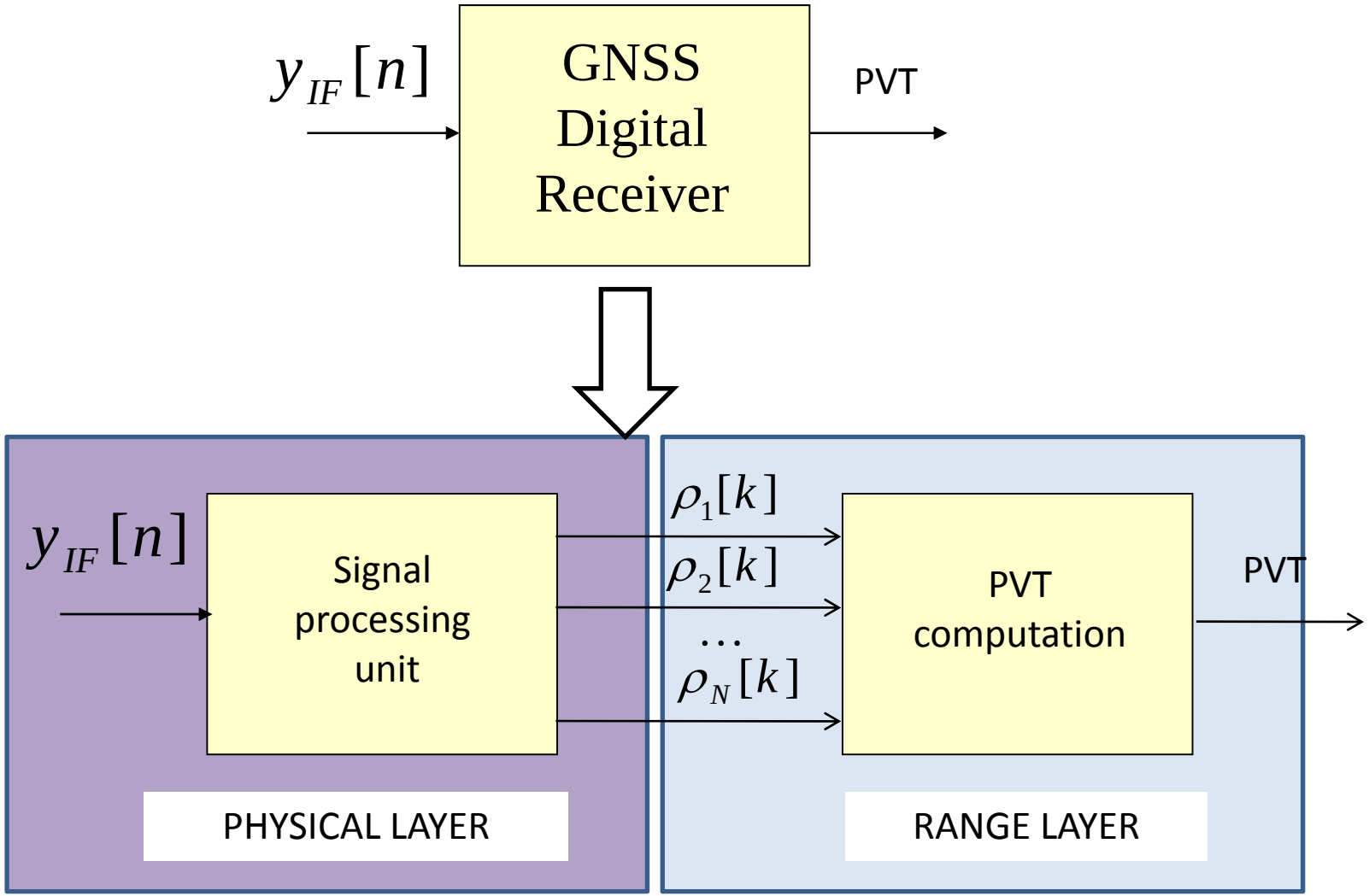
ESA ITT AO/1-6084/09/NL/AT

The paradigm of peer-to-peer (P2P) cooperative localization relies on the possibility to exploit the existence of direct communication links among nodes of a network, generally equipped with GNSS receivers, to transmit *collaboration data* thus enabling determination of nodes location anytime and anywhere.

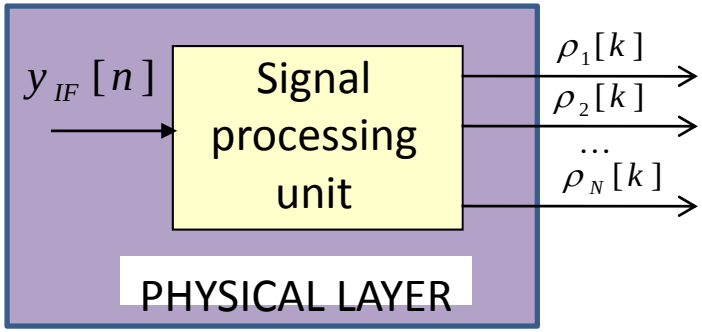
P2P: collaborative methods

- **Methods based on GNSS-data only, with the support of external aiding**. In the P2P paradigm of interest here, they represent localization methods performed by a GNSS receiver (the target receiver) aided by an external source providing collaboration data that, within this class of methods, includes *GNSS data* only.
- **Methods which integrate GNSS with terrestrial ranging between peers**. These localization methods use both measurements obtained from GNSS satellites and terrestrial ranging data to estimate the location of network nodes.
- **Methods based on terrestrial ranging between peers which do not rely on GNSS sensors**.
- **Methods based on the integration with other sensors.**

P2P: GNSS-data only methods



P2P: aiding at the physical layer

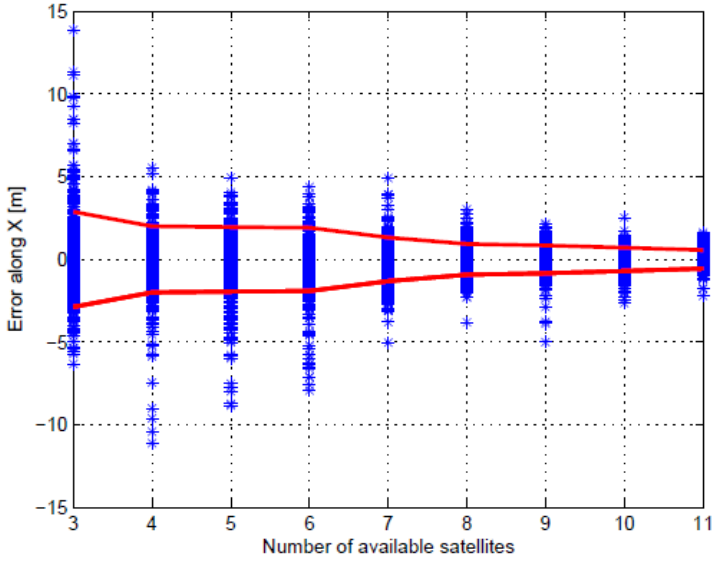


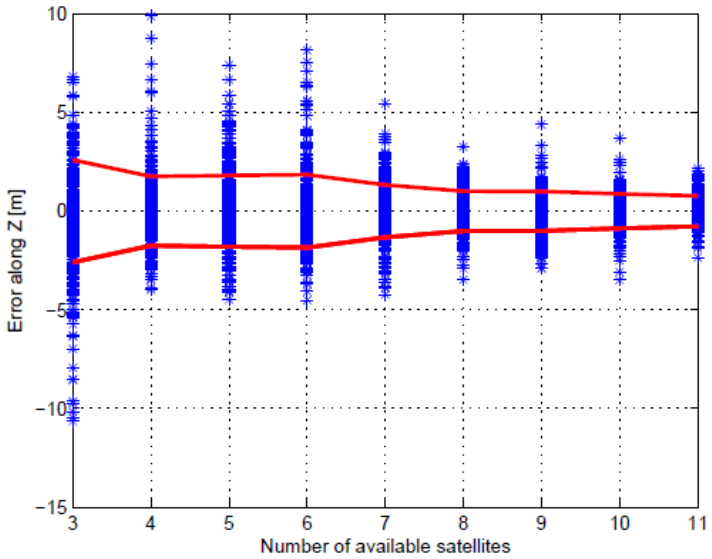
A concept of local integrity has been introduced, where the word “integrity" is here used with its lexical meaning, that is “the state of being unimpaired",

In a hostile environment the SIS reception can be degraded because of impairing factors, as multipath, interference, low C/N0, etc... In this context a peer which receives assistance data from an AGNSS-equipped tower will not be able to select the less degraded SISs, because the tower is always located in open sky.

P2P: aiding at the range layer

- Altitude aiding.
- PVT based on Kalman filter





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