

## Expert seminar on Natural and Artificial Threats to GNSS – Summary of Outcomes

Positioning services are becoming an essential part of our daily life, but how much can we trust the “position” we obtain using Satellite Navigation Systems such as GPS and Galileo? Reliability is the key word for positioning and navigation applications of every kind: public and safety-critical services, consumer and leisure products. However, Global Navigation Satellite system technology is highly vulnerable to a range of threats, both artificial and natural.

The search for answers to these questions was the rationale behind the organization of the Expert seminar on Natural and Artificial Threats to GNSS that took place between May 7<sup>th</sup> and 9<sup>th</sup> in the Politecnico di Torino Campus.

The event has been organized within the the **e-KnoT** project’s activities<sup>1</sup>, by **Politecnico di Torino** in cooperation with **Istituto Superiore Mario Boella (ISMB)** and with the **United Nation - Office for Outer Space Affairs**, which supports the specializing [Master on Navigation and Related Applications](#) of Politecnico di Torino, ISMB, and Istituto Nazionale di Ricerca Metrologica (INRIM), through a long-term fellowship program.



The seminar has been scheduled in five thematic sessions: the opening session on May 7<sup>th</sup>, two technical sessions on May 8<sup>th</sup>, a PhD session, and a company session on May 9<sup>th</sup>.

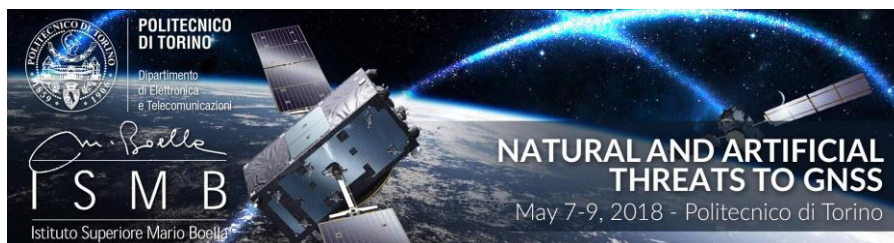
Attendees were welcomed by the prof. **Sabrina Corpino** on behalf of the rector of Politecnico di Torino, by the president of the bank foundation Compagnia di S. Paolo, **prof. Francesco Profumo**, and by the director of ISMB, **dr. Massimo Marcarini**.

*“Politecnico has been involved in the development of the Galileo system since the beginning, since it saw in it a great opportunity not only for education but also for research, as witnessed by its involvement in a large number of projects of the European Commission, in particular several funded by the GSA, and in ESA activities (also with a coordination role).”*, said prof. Sabrina Corpino during the welcome address that she brought on behalf of the Rector.

Prof. Francesco Profumo, President of the Compagnia di S. Paolo and former Italian Minister of Research and Education, recalled how *“Space is a sector that is vital to both innovation and security. Today, Galileo and Copernicus are the two major space programmes of the European Union”*. Prof. Profumo underlined how *“the cooperation with industries has always been a key point for the strategic involvement of the different actors in Galileo initiatives”*.

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<sup>1</sup> The e-KnoT project is funded by the European GNSS Agency under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 641529



**Figure 1 – Welcome address: prof Fabio Dovis with M. Marcarini, F. Profumo and S. Corpino**

The core of the opening session included distinguished talks by international guests, namely, Prof. **Jade Morton** of the University of Colorado at Boulder, Dr. **Keith Groves** of the Boston College, Mr. **Gian Gherardo Calini**, Head of the Market Development Department of the European GNSS Agency, and Ms. **Sharafat Gadimova** of the United-Nations Office for Outer Space Affairs.

Prof. Morton, stressed how GNSS could be vulnerable to interferences, but also how it could be a resource that allows the study the interference features, while dr. Groves recalled how natural interferences are still an issue on which researchers should focus in order to find the best mitigation techniques being then able to improve the GNSS performance.

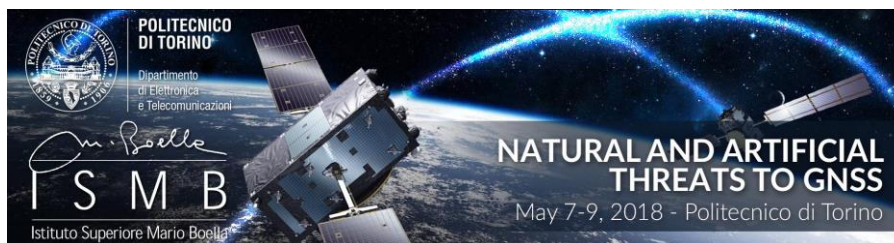
Mr. Calini underlined what are the advantages of the authentication strategies put in place for the Galileo signals, and the talk of Mrs Gadimova inserted the topic of the seminar in a global and international picture where GNSS and space play a fundamental role.



Prof. Jade Morton  
(University of Colorado, Boulder)



Dr. Keith Groves  
(Boston College)



Mr. Gian Gherardo Calini  
(European GNSS Agency)



Mrs. Sharafat Gadimova  
(United Nations – Office for Outer Space Affairs)

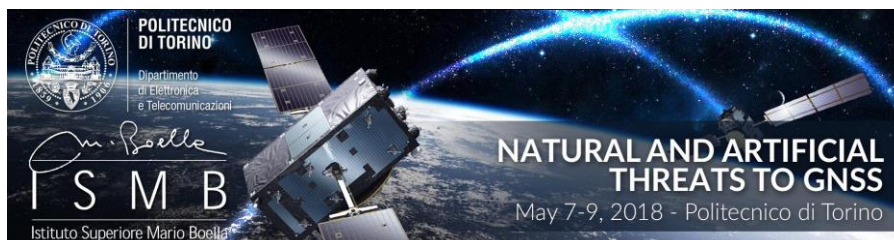
**Figure 2 – International Speakers during the opening session of the workshop**

Two sessions addressed the artificial and natural threats to GNSS respectively, with contributions from scientists and companies.



**Figure 3 - Dr. Daniele Borio of the Joint Research Center of the European Commission doing his talk during the scientific session on artificial threats to GNSS**

A session has been specifically devoted to presentations by PhD students and young researchers, who had the possibility to discuss benchmark and get advice about their own research work by meeting some of the best non-European and European researchers, maximizing the cross-fertilization of the different experiences and interfacing with relevant industrial actors. The announcement of the event included a specific call for the PhDs to candidate as presenters in the session.



Two Ph.D students were awarded of a travel grant sponsored by the International Committee on GNSS.



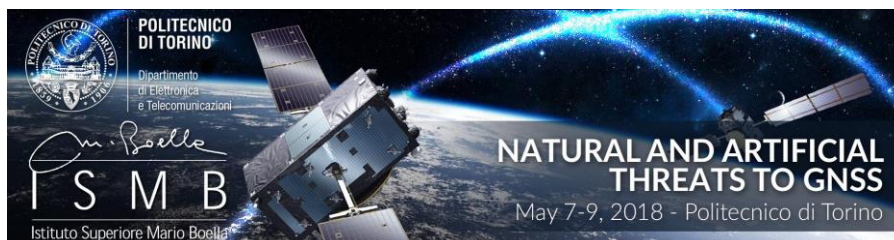
**Figure 4 - Mrs. Sharafat Gadimova with Darshna Jagiwala and Virendra Patel whose trip to attend the workshop was supported by a travel grant sponsored by the IGC**

The last session hosted a presentation on the GNSS market and business development in the field by the company AlphaConsult, and acted as an introduction to 5 presentations by European companies: Nottingham Scientific Ltd, Septentrio, QASCOM S.r.l., SpaceEarth Technology S.r.l., Thales Alenia Space – Italy, Spirent communication Inc.

The invited companies were selected to represent both large and small cases, and both more science-oriented business as well as downstream commercial applications.

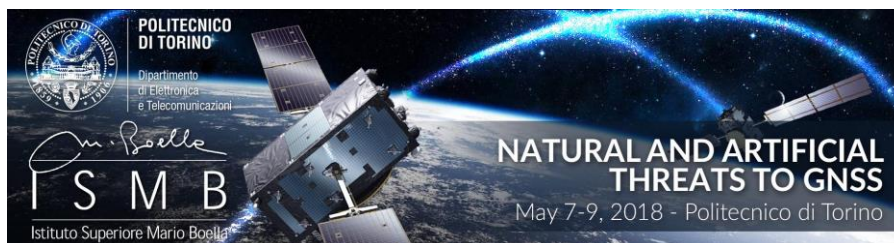
The full agenda with the topic of the presentations is reported below.

	Monday 7 <sup>th</sup>	Tuesday 8 <sup>th</sup>
9.00 am		Technical session I - Intentional threats to GNSS Chair: N. Linty (POLITO)
9.15		Daniele Borio (Joint Research Center)   Robust Signal Processing for GNSS Signal Reception
9.40		Ilaria Sesia (INRIM)   Timing for critical infrastructure and GNSS vulnerabilities: the DEMETRA project
10.05		Sabrina Ugazio (Ohio University)   GNSS Signal Quality Monitoring and Phase Anomalies detection
10.30		Coffee break
11.00		Darshna Jagiwala (SVNIT)   Effects of RFI on IRNSS



11.25		Beatrice Motella (ISMB)	SNAP: An Authentication Concept for the Galileo Open Service
11.50		Q&A time, moderated by the chair	
12.30		Lunch	
2.30 pm	Opening session	Technical session II - Natural hazards to GNSS Chair: Lucilla Alfonsi (INGV)	
2.45	Welcome by Politecnico di Torino, Links foundation, Istituto Superiore Mario Boella	Joanna Rupiewicz (European Satellite Services Provider - ESSP)	TECH-TIDE: Warning and Mitigation technologies for travelling ionospheric disturbance effects on GNSS and HF communication
3.10	Mr. Gian Gherardo Calini (European GNSS Authority - Head of Market develop. dept.)	Lucilla Alfonsi (INGV)	Ionospheric Research at INGV
3.35	Mrs. Sharafat Gadimova (Office Outer Space Affairs, UN)	Alfredo Favenza (ISMB)	A Machine Learning Approach to GNSS Scintillation Detection
4.00	Coffee break	Coffee break	
4.30	Prof. J. Morton (University of Colorado, U.S.A)	Virendra Patel (SVNIT)	The very severe cyclonic storm OCKHI and effects on GNSS
4.55	Dr. Keith Groves (Boston College, U.S.A)	Nicola Linty (Politecnico di Torino)	A novel approach to ionospheric scintillation detection based on an open loop architecture
5.20		Gabriella Povero (ISMB)	Scintillation monitoring in South East Asia: results and perspectives
5.45 pm	end of session	end of session	

	Wednesday 9 <sup>th</sup>	
9.00 am	Students presentations	
9.15	Calogero Cristodaro (Politecnico di Torino)	Deeply coupled visual/INS/GNSS integration for robust navigation
9.40	Alex Minetto (Politecnico di Torino)	A theoretical framework for collaborative estimation of distances among GNSS users and tight integration in EKF positioning algorithm
10.05	Caner Savas (Politecnico di Torino)	Performance comparison of GPS L5 signal acquisition methods under phase scintillations
10.30	Coffee break	



11.00	Wenjian Qin (Politecnico di Torino)	GNSS jammer signals mitigation by using adaptive notch filters
11.25	Neil Gogoi (Politecnico di Torino)	Design of High Accuracy Navigation Systems for Robotic Vehicles
11.50 am	Companies presentations Chair: Marco Pini (Istituto Superiore Mario Boella)	
12.00	Claudia Maltoni (AlphaConsult)	Examples of methodologies to assess the socio-economic benefits of GNSS robustness
12.30	Lunch	
2.00	Oliver Towlson (Nottingham Scientific Ltd)	STRIKE3: Characterizing the GNSS Threat Environment through Long-Term Monitoring
2.25	Bruno Bougard (Septentrio)	Protecting GNSS-dependent professional applications from accidental interference and spoofing
2.50	Oscar Pozzobon (QASCOM S.r.l.)	State of the art in anti-spoofing technologies and preliminary tests on the Galileo Open Service Navigation Message Authentication (OSNMA)
3.15	Vincenzo Romano (SpaceEarth Technology S.r.l.)	Tackling Ionosphere to enhance GNSS high accuracy: SpaceEarth Technology solutions
3.40	Coffee break	
4.00	Andrea Emmanuele (Thales Alenia Space)	A diffuse protection layer against RF threats and signal distortions: a portfolio approach for trusted and robust PVT
4.25	Talini Pinto Jayawardena (Spirent communication Inc.)	The importance of updated testing equipment to assess receiver capabilities against environment, ionospheric effects, and threats
4.50 pm	Final remarks	

## Attendance

With a participation of 70 people and a series of qualified presentations, the workshop has been a remarkable success.



Figure 5 – Attendees at the workshop

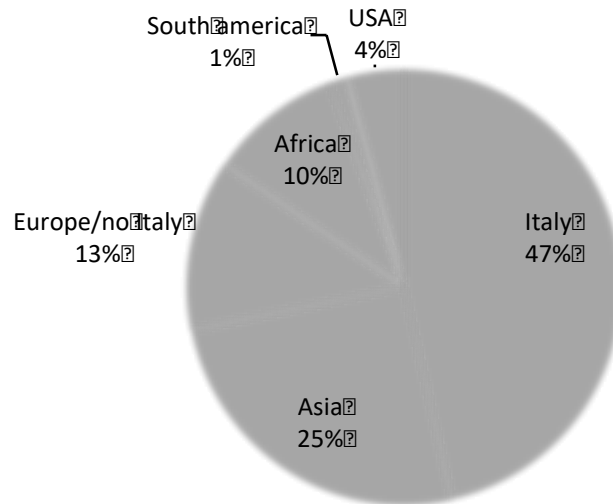


Figure 6 - Country of origin of the registered participants

As shown in Figure 1 the workshop had a good attendance also of people coming from outside the hosting country, giving to seminar a strong international flavor.

Figure 2 on the other hand shows how the seminar has been able to attract a good number of PhD students who were able to present, or just attend the technical sessions and interact with the senior researchers and the representatives of the companies during the breaks and the evening reception that was part of the program.

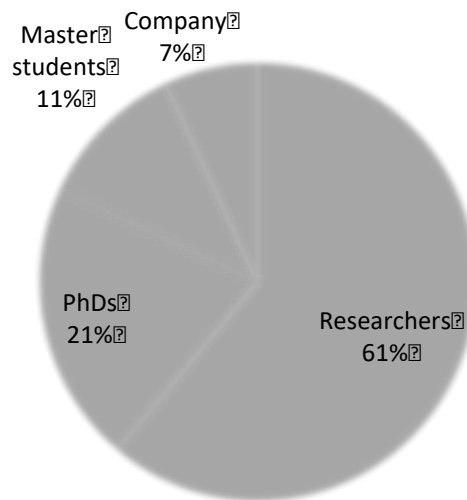


Figure 7 - Classification of participants

## Presentations

The presentations that can be shared under the author consent can be downloaded from:

<https://detstorage.polito.it/files/sharing/bnMzomlak>

## USEFUL LINKS

NavSAS group of Politecnico di Torino/ISMB	<a href="http://www.navsas.eu">www.navsas.eu</a>
e-Knot project website	<a href="http://www.eknotproject.eu">www.eknotproject.eu</a>
Master on Navigation and Related Applications	<a href="http://didattica.polito.it/master/navigation/2018/introduction">didattica.polito.it/master/navigation/2018/introduction</a>
Politecnico di Torino	<a href="http://www.polito.it">www.polito.it</a>
ISMB	<a href="http://www.ismb.it">www.ismb.it</a>
INRIM	<a href="http://www.inrim.it">www.inrim.it</a>

