GENIUS Professional Training Programme

GENIUS
GNSS Education

PRESENTATION OF THE GENIUS TRAINING PROGRAM:

- The GENIUS professional training program is an ambitious program aimed at **providing GNSS training to employees of industry, research centres and institutions**. It is based on the provision of ten **3-day free-of-charge tutorials** over 2 years (5 in 2013 and 5 in 2014).
- This program is supported by the European Commission and the European GNSS Agency (GSA) through the GENIUS project under the grant agreement 287191.

PRESENTATION OF THE GENIUS PROJECT:

- The GENIUS project aims at **building strong links between universities, research institutes and industry**. It provides direct benefits to industry by implementing measures to strengthen GNSS education and fostering the co-operation between education, research and business. For more information, please consult: www.gnss-education.eu.

INSTRUCTORS

- The instructors of the GENIUS professional training program are GNSS experts from the **Ecole Nationale de l'Aviation Civile** (France), the **University of Nottingham** (UK), and **Politecnico di Torino** (Italy).

TRAINING PROGRAM SCHEDULE FOR 2013 (see following pages for details)

Course Title	Date	Location	Registration Deadline
Fundamentals of GNSS	4-6 March 2013	GSA, Prague, Czech Republic	4 Feb. 2013
GNSS Receiver Signal Processing for Current and Future Signals	2-4 April 2013	GSA, Brussels, Belgium	2 March 2013
GNSS Integrity Monitoring	18-20 June 2013	ENAC, Toulouse, France	18 May 2013
Vulnerabilities of GNSS	8-10 Oct. 2013	Univ. of Nottingham, UK	8 Sept. 2013
GNSS Principles & Differential GNSS	19-21 Nov. 2013	UPC, Castelldefels (near Barcelona), Spain	19 Oct. 2013

[1] *27 EU countries + Switzerland, Norway, Albania, Bosnia & Herzegovina, Croatia, Feroe Islands, Iceland, Israel, Liechtenstein, Macedonia, Montenegro, Serbia, Turkey.*

REGISTRATION GUIDELINES

The registration is **free-of-charge** (coffee breaks and lunches are included). Travel costs, hotel and living expenses have to be covered by the participant.
The tutorials are **open to any employee** coming from a company, an international/national institution or a research centre.
The registration deadline is **1 month before the start of the tutorial**.
The selection process will follow a **first-come-first-served** basis. Priority will be given to employees coming from an FP7 company/institution/research centre (see box on the left for the list of FP7 countries).

CONTACT INFORMATION

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The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA
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Oberpfaffenhofen
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GNSS Research & Applications Centre of Excellence
European Commission
GSA
SEVENTH FRAMEWORK PROGRAMME

Tutorial 1: Fundamentals of GNSS

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OBJECTIVES:

This course provides a beginners' guide to GNSS technology. It introduces current systems and presents future systems that will be available. The course discusses the concepts of global positioning, how the signal is used to determine location by the receiver and its accessibility to its various end-users. Later in the course the sources of GNSS error are discussed, and the various augmentations systems available for service enhancement. A concluding talk is presented on the future of GNSS and the European Galileo system.

TOPICS COVERED:

What is Navigation? Fundamentals of Satellite Navigation
- Position fixing
- Dead reckoning
- Space segment and SV blocks
- Ground control & improvement programmes
- User segment and applications

GNSS Systems
- GPS, GLONASS, Galileo, regional navigation systems

Practical Activity
- Measuring the size of the Earth using GPS / Investigating view of sky on satellite lock

Fundamental Concepts of GPS Positioning
- position and time determination,
- GPS signal structure formats

Coordinate Frames
- Frame Transformation
- Earth Surface & Gravity Models

Receivers & Antennae
- Data acquisition & data formats
- Data processing – from measurements to coordinates

Practical Activity
- Using GNSS / receiver hardware & antenna

Range Error Sources
- Satellite clock and ephemeris prediction errors
- ionosphere and troposphere propagation errors
- tracking errors
- multipath

Differential GNSS / Augmentation Systems
- Spatial and temporal correlation of GNSS errors
- EGNOS / WAAS

Practical Activity
- GNSS on the move (tracking and navigation)

Looking Forward
- Galileo / GNSS modernisation

INSTRUCTORS:

Prof. Terry MOORE *is Director of the Nottingham Geospatial Institute at the University of Nottingham; where he is the Professor of Satellite Navigation. He holds a BSc degree in Civil Engineering and PhD degree in Space Geodesy, both from the University of Nottingham. He has almost 30 years research experience in surveying, positioning and navigation technologies and is a consultant and adviser to UK and European governments and industry. He is a Member of Council and a Fellow of the Royal Institute of Navigation; a Fellow of the Chartered Institution of Civil Engineering Surveyors; and a Fellow of the Royal Astronomical Society.*

Dr. Fabio DOVIS *is assistant professor at Politecnico di Torino, working at the Department of Electronics and Telecommunications, where he contributed to the creation of the Navigation, Signal Analysis and Simulation (NavSAS) group. His research interests are focused on Global Navigation Satellite Systems and on positioning techniques. His scientific work addresses the design of architectures for GNSS receivers and of advanced algorithms for interference detection and multipath mitigation, considering for both current and modernized GNSS signals. He has a relevant experience in international projects in GNSS as well as cooperation with industries and research centers. He acted in several occasions as external technical support to the European GNSS Agency and he is member of the Mission Evolution Advisory Group of the European Commission, the experts group that has the task to propose and evaluate evolutions of the mission objectives for the European satellite navigation programmes Galileo and EGNOS.*

Maximum Number of Participants
32

When and Where
4-6 March 2013
European GNSS Agency (GSA)
Janovského 438/2
170 00 Prague 7 – Holesovice
Czech Republic

Participation Fee
Free of charge
Coffee breaks and lunches are included

Registration Deadline
4 February 2013

Information and Registration
Paul BHATIA
E.mail: paul.bhatia@grace.ac.uk
Phone: +44 7825 753940

Tutorial 2: GNSS Receiver Signal Processing for Current and Future Signals

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OBJECTIVES:

This course provides a presentation of GNSS receiver signal processing. The course starts with in introduction on the requirements on the GNSS signal structure and the general architecture of a GNSS receiver. It then addresses the fundamental principles of receiver signal processing for the acquisition and the tracking of the current GPS L1 C/A signals. Finally, the course presents the receiver signal processing adapted to the structure of the future GNSS signals, including those from the European Galileo system.

TOPICS COVERED:

Course Overview and Introduction

GNSS Signal and Desired Properties
- Structure of the transmitted signal
- Structure of the received signal
- The correlation operation

Typical GNSS Receiver Architecture
- Receiver front-end
- Receiver signal processing
- Receiver data demodulation and position computation

GPS L1 C/A Receiver Signal Processing
- Acquisition
- Carrier and carrier phase tracking
- Code delay tracking
- Data demodulation

Review of New GNSS Signals and Their Innovations
- Main innovations: PRN codes, data/pilot architecture, BOC and BOC-derived modulation, secondary codes, navigation message coding
- Presentation of the transmitted civil GNSS signals
- Correlation functions of the main GPS and Galileo main correlation signals

Acquisition of Future GNSS Signals
- Review of typical acquisition techniques for data/pilot signals
- Impact of new signal structures on acquisition performance,
- Introduction to secondary code acquisition strategies

Phase tracking of Future GNSS Signals
- Impact of new signal structures on phase tracking,
- Phase tracking performance

Code tracking of Future GNSS Signals
- Use of the pilot channel and secondary code,
- Impact of the BOC modulation on code tracking schemes
- Tracking performance

Multipath Effects on Code and Carrier Tracking
- Typical multipath model
- Carrier and code tracking multipath envelopes and general performance

Interference Effects on Code and Carrier Tracking
- Main interference threats and models
- Inherent GNSS signals capability to mitigate continuous interference
- Pulsed interference effects and mitigation

INSTRUCTORS:

Dr. Christophe MACABIAU *is the head of the TELECOM lab of ENAC (Ecole Nationale de l'Aviation Civile), Toulouse, France. He graduated as an electronics engineer in 1992 from ENAC and received his Ph.D. in 1997. Since 1994, he has been working on the application of satellite navigation techniques to civil aviation. His research also applies to vehicular, pedestrian and space applications, and includes advanced GNSS signal processing techniques for acquisition, tracking, interference and multipath mitigation, GNSS integrity monitoring, as well as integrated GNSS-inertial systems and indoor GNSS techniques.*

Dr. Olivier JULIEN *is the head of the Signal Processing and Navigation (SIGNAV) research group of the TELECOM lab of ENAC (Ecole Nationale de l'Aviation Civile), in Toulouse, France. He received his PhD in 2005 from the department of Geomatics Engineering of the University of Calgary, Canada. His research activity focuses on positioning and navigation for a wide range of applications including civil aviation, pedestrian and vehicular applications. He has a significant experience regarding advanced GNSS receiver signal processing and receiver design with a special interest in the design and use of future GNSS signals. He has been involved in numerous projects with industry and national/international institutions.*

Maximum Number of Participants
40

When and Where
April 2-4, 2013
European GNSS Agency (GSA)
Rue de la loi, 56
1049 Brussels
Belgium

Participation Fee
Free of charge
Coffee breaks and lunches are included

Registration Deadline
2 March 2013

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Tutorial 3: GNSS Integrity Monitoring

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OBJECTIVES:

This course provides a solid foundation of GNSS signal integrity monitoring. The course starts with an introduction on the need for integrity monitoring of GNSS signals, an overview of civil aviation requirements (pioneer application for GNSS integrity monitoring). Then, the different architectures to augment the basic constellations (RAIM, SBAS and GBAS) to provide GNSS integrity monitoring are described. Finally, the foreseen evolution of integrity monitoring and the extension of integrity monitoring to applications that are not related to civil aviation are presented.

TOPICS COVERED:

Introduction
- GPS principles
  - Concepts
  - Constraints
  - Measurement Models
- GPS precision and error budget (UERE)
- Definitions of Reliability and Confidence
- Practical examples

Civil Aviation Requirements as a Reference Case

Ground-Based Augmentation System (GBAS)
- GBAS typical architecture and implementation
- GBAS correction, integrity message
- Protection levels computation

Satellite-Based Augmentation System (SBAS)
- SBAS typical architecture and implementation
- SBAS correction, integrity message
- Protection levels computation

Airborne Based Augmentation System (ABAS): Case of RAIM
- Least Square Residual Method
  - Least Squares Position Solution
  - Detection criterion
  - Protection levels computation
- Solution Separation Method
  - Detection criterion
  - Protection levels computation
- Algorithm specifications from high level requirements
  - Threat model
  - False alert
  - Missed detection
- Practical examples

Integrity for non-Civil Aviation Users
- RAIM for other applications

Future of RAIM
-GPS/Galileo RAIM
- Advanced RAIM

INSTRUCTORS:

Dr. Christophe MACABIAU *is the head of the TELECOM lab of ENAC (Ecole Nationale de l'Aviation Civile), Toulouse, France. He graduated as an electronics engineer in 1992 from ENAC and received his Ph.D. in 1997. Since 1994, he has been working on the application of satellite navigation techniques to civil aviation. His research also applies to vehicular, pedestrian and space applications, and includes advanced GNSS signal processing techniques for acquisition, tracking, interference and multipath mitigation, GNSS integrity monitoring, as well as integrated GNSS-inertial systems and indoor GNSS techniques.*

Dr. Anaïs MARTINEAU *is the head of the Electronics, Electromagnetism and Signal division of ENAC (Ecole Nationale de l'Aviation Civile), Toulouse, France. She graduated in 2005 as an electronics engineer from the ENAC and she received her Ph.D. in 2008 from the University of Toulouse Since 2005, she has been working at the Signal Processing and Navigation (SIGNAV) research group of the TELECOM lab of ENAC where she carries out research on integrity monitoring techniques.*

Dr Carl MILNER *is an Assistant Professor within the Telecom Lab at the Ecole Nationale Aviation Civile, Toulouse, France. He completed his Masters degree in Mathematics from the University of Warwick in 2004 and obtained a PhD in Geomatics from Imperial College London in 2009. He completed the graduate trainee programme in 2005 at the European Space Agency in Darmstadt, Germany. He currently lectures on many aspects of navigation science and technology including radio navigation aids, signal processing, positioning algorithms and GNSS for aviation. His research work addresses the design of integrity monitoring algorithms and performance for civil aviation applications including the use of GNSS augmentation systems both for current GNSS signals and the projected multi-constellation multi-frequency environment of the future. He has participated in French and British national research programmes for civil aviation authorities as well as for European funded grants such as SESAR.*

Maximum Number of Participants
40

When and Where
18-20 June 2013
Ecole Nationale de l'Aviation Civile (ENAC)
7, Avenue Edouard Belin
31055 Toulouse
France

Participation Fee
Free of charge
Coffee breaks and lunches are included

Registration Deadline
18 May 2013

Information and Registration
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Tutorial 4: Vulnerabilities of GNSS

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OBJECTIVES:

This course provides an introduction to the vulnerabilities of GNSS. The course begins with an overview of GNSS systems and technologies and then proceeds with sessions on the vulnerabilities of GNSS to interference, failures and errors. The course concludes with an overview of how the satellite navigation system architecture may be designed in the future to overcome these vulnerabilities.

TOPICS COVERED:

GNSS Overview
- Position fixing, dead reckoning
- Space segment and SV blocks
- Ground control & improvement programmes
- User segment and applications

GNSS Applications
- Critical applications of GNSS, including: aviation, road transport, rail, autonomous vehicles, timing, precision agriculture, resource exploration, emergency services, scientific applications

Receivers & Antennae
- Data processing

Practical Activity
- Investigating view of sky on satellite lock, ionosphere effects

Vulnerability of GNSS (1)
- System vulnerabilities
- Propagation channel vulnerabilities

Vulnerability of GNSS (2)
- Accidental interference
- Deliberate interference

GNSS failures & characteristics
- Satellite clock and ephemeris prediction errors
- ionosphere and troposphere propagation errors
- timing & tracking errors

Practical Activity
- Commercial jammers and jamming experiment

Assessment of Levels of Risk

Resilience to disruption of GNSS
- Position & navigation, timing, vulnerability mitigation strategies

Looking forward
- Galileo / GNSS modernisation – increasing resilience

INSTRUCTORS:

Prof. Terry Moore *is Director of the Nottingham Geospatial Institute at the University of Nottingham; where he is the Professor of Satellite Navigation. He holds a BSc degree in Civil Engineering and PhD degree in Space Geodesy, both from the University of Nottingham. He has almost 30 years research experience in surveying, positioning and navigation technologies and is a consultant and adviser to UK and European governments and industry. He is a Member of Council and a Fellow of the Royal Institute of Navigation; a Fellow of the Chartered Institution of Civil Engineering Surveyors; and a Fellow of the Royal Astronomical Society.*

Prof. Alan DODSON *is the former Director of the Nottingham Geospatial Institute (NGI: formerly known as the IESSG) and Pro-Vice-Chancellor of the University of Nottingham. He is currently a Professor of Geodesy at the NGI. He has vast experience in large project management and has been principal- or co-investigator on research projects valued at over £6m, has published over 200 scientific papers and supervised 28 PhD students. Prof. Dodson led the EU FP5 WAVEFRONT project, the first European project to explore the use of GPS for meteorological (water vapour) measurement, which has eventually led to several national meteorological offices adopting GPS in their operational systems. He has also initiated and was inaugural co-chair of FP5 COST716 action and coordinated the IESSG Marie Curie Training Site for the last 6 years. He has considerable scientific and teaching expertise and experience on GNSS vulnerabilities and especially ionospheric effects*

Dr. Marcio AQUINO *is a Principal Research Fellow at the NGI, with a background in geodesy, surveying and satellite positioning. He has contributed to various international collaborative projects, relating to user requirements, civil-military interface, certification and standardisation of GNSS, market analysis and architecture studies for GNSS and Galileo. His current main interest is on ionospheric effects on GNSS. He is currently co-ordinator of FP7 Marie Curie ITN TRANSMIT - Training, Research and Applications Network to Support the Mitigation of Ionospheric Threats' (2011-2015). In the last 7 years he has co-authored more than 50 publications in refereed journals and international conference proceedings and has been the leader of ionospheric research at the NGI.*

Maximum Number of Participants
40

When and Where
8-10 October 2013
Nottingham Geospatial Building,
Triumph Road, University of Nottingham,
NG7 2TU
UK

Participation Fee
Free of charge
Coffee breaks and lunches are included

Registration Deadline
8 September 2013

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Tutorial 5: GNSS Principles and Differential GNSS

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OBJECTIVES:

This course provides an overview of the principles of differential GNSS. The course starts with an introduction on the principles on GNSS including the main sources of error and typical performance. It then addresses the different concepts of differential GNSS and their respective performance

TOPICS COVERED:

GPS Principles
- Concept and constraints
- Spatial, ground and user segments
- Reference frame and timing reference

GPS Signal Structure
- PRN sequence properties
- GPS transmitted signal

GPS Propagation Channel
- Payload
- Atmospheric effects
- Multipath, interference

GPS Signal Processing
- Antenna and front-End
- Correlation operation, acquisition, tracking, data demodulation

Single Point Positioning and Error Budget
- Pseudorange measurement model and main corrections
- Least square position computation and - DOP concept
- Concept of UERE
- GPS error budget

Differential GNSS Concept and Architectures
- Correlated and uncorrelated error sources Code vs. carrier-based DGPS
- Local-area, regional and wide-area DGPS architectures
- Design Considerations (Range vs. Position Domain Corrections, Data Links, Network)

Carrier-Phase Differential Techniques
- Single, double and triple differencing
- Carrier phase integer ambiguity resolution (LAMBDA and other algorithms)
- Use of multiple frequencies
- Error sources
- Performance

Code-Based Differential GNSS Services
- SBAS concept (WAAS, EGNOS etc.)
- GBAS concept
- Maritime DGPS
- CORS+IGS networks
- Commercial Services

INSTRUCTORS:

Dr. Fabio DOVIS *is assistant professor at Politecnico di Torino, working at the Department of Electronics and Telecommunications, where he contributed to the creation of the Navigation, Signal Analysis and Simulation (NavSAS) group. His research interests are focused on Global Navigation Satellite Systems and on positioning techniques. His scientific work addresses the design of architectures for GNSS receivers and of advanced algorithms for interference detection and multipath mitigation, considering for both current and modernized GNSS signals. He has a relevant experience in international projects in GNSS as well as cooperation with industries and research centers. He acted in several occasions as external technical support to the European GNSS Agency and he is member of the Mission Evolution Advisory Group of the European Commission, the experts group that has the task to propose and evaluate evolutions of the mission objectives for the European satellite navigation programmes Galileo and EGNOS.*

Dr Carl MILNER *is an Assistant Professor within the Telecom Lab at the Ecole Nationale Aviation Civile, Toulouse, France. He completed his Masters degree in Mathematics from the University of Warwick in 2004 and obtained a PhD in Geomatics from Imperial College London in 2009. He completed the graduate trainee programme in 2005 at the European Space Agency in Darmstadt, Germany. He currently lectures on many aspects of navigation science and technology including radio navigation aids, signal processing, positioning algorithms and GNSS for aviation. His research work addresses the design of integrity monitoring algorithms and performance for civil aviation applications including the use of GNSS augmentation systems both for current GNSS signals and the projected multi-constellation multi-frequency environment of the future. He has participated in French and British national research programmes for civil aviation authorities as well as for European funded grants such as SESAR.*

Maximum Number of Participants
40

When and Where
19-21 November 2013
Universitat Politecnica de Catalunya (UPC)
EETAC
Esteve Terradas, 7
08860 Castelldefels
Spain

Participation Fee
Free of charge
Coffee breaks and lunches are included

Registration Deadline
19 October 2013

Information and Registration
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