GNSS UNDER ATTACK

CAN WE STILL TRUST THE GPS WE RELY ON EVERY DAY?

GNSS Under Attack

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A course for technical professionals and policy makers on the risks, failures, and safeguards of satellite-based navigation and timing systems (like GPS)

DATES: 5 and 6 February 2026

LOCATION: Budapest University of Technology and Economics, Általános- és Felsőgeodézia Tanszék, 1111 Budapest, Műegyetem rkp. 3. K épület mf. 26.

TIME: 09:00–12:00 & 13:30–16:00 Daily
Free attendance for invitees
Students welcome (space-permitting)

To reserve a space, please pre-register at our website integricom.hu and select the "GNSS under Attack" menu item. For more information, send us a mail at gnss_under_attack@integricom.hu.

WHO SHOULD ATTEND?

This course is designed for professionals who work with GNSS-enabled systems:

- Software and systems engineers
- Policy makers, regulators, and risk planners
- Aerospace, telecom, energy, and transport professionals
- Advanced students in engineering or public policy

PARTICIPATION TRACKS

Track A – Policy & Strategy Focus (half-day, 5 February morning):

For professionals focused on regulation, societal impact, or oversight. Attend a structured morning block on GNSS risks, dependencies, and mitigation — no technical background needed.

Track B – Technical Focus (2 days):

For engineers, developers, and analysts seeking a working understanding of GNSS signals, error modeling, and mitigation — including live data labs and expert sessions. Contains Track A as an introduction.

COURSE OVERVIEW

Time	Topic	Lecturer(s)
DAY 1 PART 1 – GNSS CONTEXT, CONCEPTS & IMPACT		
08:45-09:15	On-site Registration of Participants	
09:15–10:00	What Is GNSS, and How Do We Depend on It?	Dr. Ober
10:05–10:35	How GNSS Works – A Technical Primer for All	Prof. Uijt de Haag
10:40–11:00	Break	
11:00–11:35	Emerson Demonstration Block: GNSS Simulation	Szabolcs Berki
11:40–12:15	What Makes GNSS Vulnerable?	Prof. Berglez
12:15–13:30	Lunch Break	
DAY 1 PART 2 – GNSS DATA, TOOLS		
13:30–14:00	GNSS for Timing and Safety-Critical Applications	Prof. Uijt de Haag, Dr. Ober
14:05–14:45	GNSS Error Sources	Prof. Sanz, prof. Rovira
14:45–15:05	Break	
15:05–15:30	Differential GNSS and Correction Services	Prof. Rózsa
15:30–16:15	GNSS in Aviation & Sensor Integration	Prof. Uijt de Haag
DAY 2 PART 1 – TOOLS, LOGS, AND ANALYSIS		
09:00–09:25	GNSS Data Formats and Tools	Prof. Rózsa
09:30–10:30	Hands-On Lab: Processing GNSS Data I	Prof. Sanz, prof. Rovira
10:30–10:50	Break	
10:50–11:30	Hands-On Lab: Processing GNSS Data II	Prof. Sanz, prof. Rovira
11:35–12:00	Emerson Demonstration Lab: disturbing GNSS	András Bükkfejes
12:00–13:30	Lunch Break	
DAY 2 PART 2 – VULNERABILITIES: SPOOFING AND JAMMING		
13:30–14:00	GNSS Signal Tracking	Prof. Berglez
14:00–14:30	Spoofing and Jamming	Prof. Berglez
14:30–14:50	Break	
14:50–15:30	Future Developments	Prof. Uijt de Haag
15:30–16:00	Course Recap	Dr. Ober

DETAILED COURSE SCHEDULE

DAY 1 PART 1 – GNSS CONTEXT, CONCEPTS & IMPACT

What Is GNSS, and How Do We Depend on It?

Goal: Introduce GNSS as a core infrastructure enabling timing and positioning globally.

Takeaway: Understand the societal reach of GNSS across aviation, energy, telecom, and finance.

- Overview of satellite-based navigation and timing
- Applications in society: aviation, telecom, power, finance
- GNSS as critical infrastructure

How GNSS Works – A Technical Primer for All

Goal: Explain the basic operation of GNSS systems and receiver functions.

Takeaway: Gain a foundational understanding of positioning, timing, and key sources of error.

- Satellites, signals, timing, and position
- What receivers compute — and how
- Sources of error
- Accuracy and reliability

Demonstration Block: Real-World GNSS Failures

Goal: Illustrate GNSS operation and signal degradations.

Takeaway: See real-world effects of signal degradations on signal integrity.

- Possible examples:
    - multipath and non-line-of-sight conditions
    - Weather and space weather
    - Interference and spoofing

What Makes GNSS Vulnerable?

Goal: Explore vulnerabilities in GNSS due to environmental and intentional threats.

Takeaway: Recognize real-world GNSS risk scenarios including jamming, spoofing, and warfare.

- Environmental and intentional disruption (jamming/spoofing)

- Electronic warfare
- Case examples: impact on critical systems
- Mitigation options, including the role of GNSS monitoring

DAY 1 PART 2 – GNSS DATA, TOOLS

GNSS for Timing and Safety-Critical Applications

Goal: Highlight how critical sectors rely on GNSS for positioning and timing.

Takeaway: Understand safety risks from GNSS failure and explore mitigation strategies.

- GNSS as a precise positioning and timing source (telecom, energy, finance)
- Safety-critical transport use: aviation, rail, maritime
- Single points of failure in timing and positioning
- Resilience strategies overview: sensor fusion, holdover, redundancy, differential corrections

GNSS Error Sources and Accuracy Limitations

Goal: Explain the types of errors affecting GNSS accuracy.

Takeaway: Understand the components of the GNSS error budget and basic error mitigation.

- Satellite orbit and clock errors
- Ionospheric and tropospheric delays
- Multipath and signal obstruction
- Receiver-specific noise and biases
- Error combination and variability in different environments
- Basic strategies to reduce error impact

Differential GNSS and Correction Services

Goal: Introduce the principles of differential GNSS and high-accuracy corrections.

Takeaway: Learn how SBAS, RTK, and PPP correct raw GNSS to improve accuracy.

- Principles of DGNSS: base and rover
- Correction types: SBAS, RTK, PPP
- Accuracy improvements: uncorrected vs corrected data
- Use cases: surveying, agriculture, autonomous systems

GNSS in Aviation & Sensor Integration

Goal: Discuss the integration of GNSS with other navigation sensors in aviation.

Takeaway: Recognize how aviation ensures navigation resilience through sensor fusion.

- GNSS use in aircraft navigation
- Augmentation systems (SBAS, ARAIM)
- Combining GNSS with INS/barometer for safety

DAY 2 PART 1 – TOOLS, LOGS, AND ANALYSIS

GNSS Data Formats and Tools

Goal: Introduce data standards used for GNSS logging and analysis.

Takeaway: Become familiar with NMEA, RINEX, RTCM formats and live GNSS viewers.

- NMEA, RINEX, RTCM formats
- Live demo of receiver or GNSS viewer
- Understanding satellite visibility and fix quality

Hands-On Lab: Processing GNSS Data

Goal: Apply GNSS analysis tools to interpret receiver data.

Takeaway: Build practical skills using RTKLIB/GLAB and real or simulated data.

- Use GLAB

Demonstration Lab: GNSS Failure Events

Goal: Demonstrate how to deliberately degrade GNSS signals.

Takeaway: GNSS signals are more and more at risk

DAY 2 PART 2 – VULNERABILITIES, TIMING & INTEGRITY

GNSS Signal Tracking

Goal: Explain how GNSS signals are received and tracked below the noise floor.

Takeaway: Understand signal spectrum, power characteristics, and challenges in tracking.

- Power levels, spectrum, and noise

Guest Lecture: Spoofing and Jamming

Goal: Present real-world interference and spoofing attacks on GNSS.

Takeaway: Learn about detection, system impact, and responses.

- Real-world spoofing/jamming cases
- Detection methods in commercial receivers
- Industry and regulatory response

Future Developments

Goal: Provide insight into GNSS modernization and emerging capabilities.

Takeaway: Be aware of future risks and new technologies improving GNSS resilience.

Course Recap

Goal: Summarize key topics, demonstrations, and technical insights.

Takeaway: Reinforce knowledge and outline next steps for learning or implementation

LECTURERS

Our international team brings together leading experts from Technische Universität Berlin, Graz University of Technology, Universitat Politècnica de Catalunya, and the Budapest University of Technology and Economics, offering a uniquely comprehensive perspective on GNSS resilience.

- Prof. Maarten Uijt de Haag (TU Berlin) contributes long-standing experience in GNSS, INS, and integrated navigation, with a strong focus on how real-world systems behave when signals degrade or fail.
- Prof. Philipp Berglez (TU Graz) adds deep industrial and academic insight into interference detection, software-defined receivers, and robust positioning algorithms.
- Prof. Jaume Sanz Subirana (UPC) offers recognized expertise in GNSS data processing, ionospheric effects, and augmentation systems, supported by extensive publications and ESA collaborations.
- Prof. Adrià Rovira García (UPC) brings research strengths in high-accuracy navigation, advanced ionospheric modelling, and scintillation analysis—core themes in resilient GNSS performance.
- Prof. Szabolcs Rózsa (BME) contributes decades of work on atmospheric impacts, integrity monitoring, and precise satellite positioning, linking environmental effects directly to system reliability.
- Dr. Pieter Bastiaan Ober provides practical experience in redundancy strategies, disturbance mitigation, and aviation-grade integrity algorithms.

Together, these instructors offer a balanced combination of academic depth and practical insight, creating a course that equips participants with the knowledge and tools needed to understand, evaluate, and design resilient GNSS solutions.