GNSS interference and Commercial Aviation – Real World Impacts

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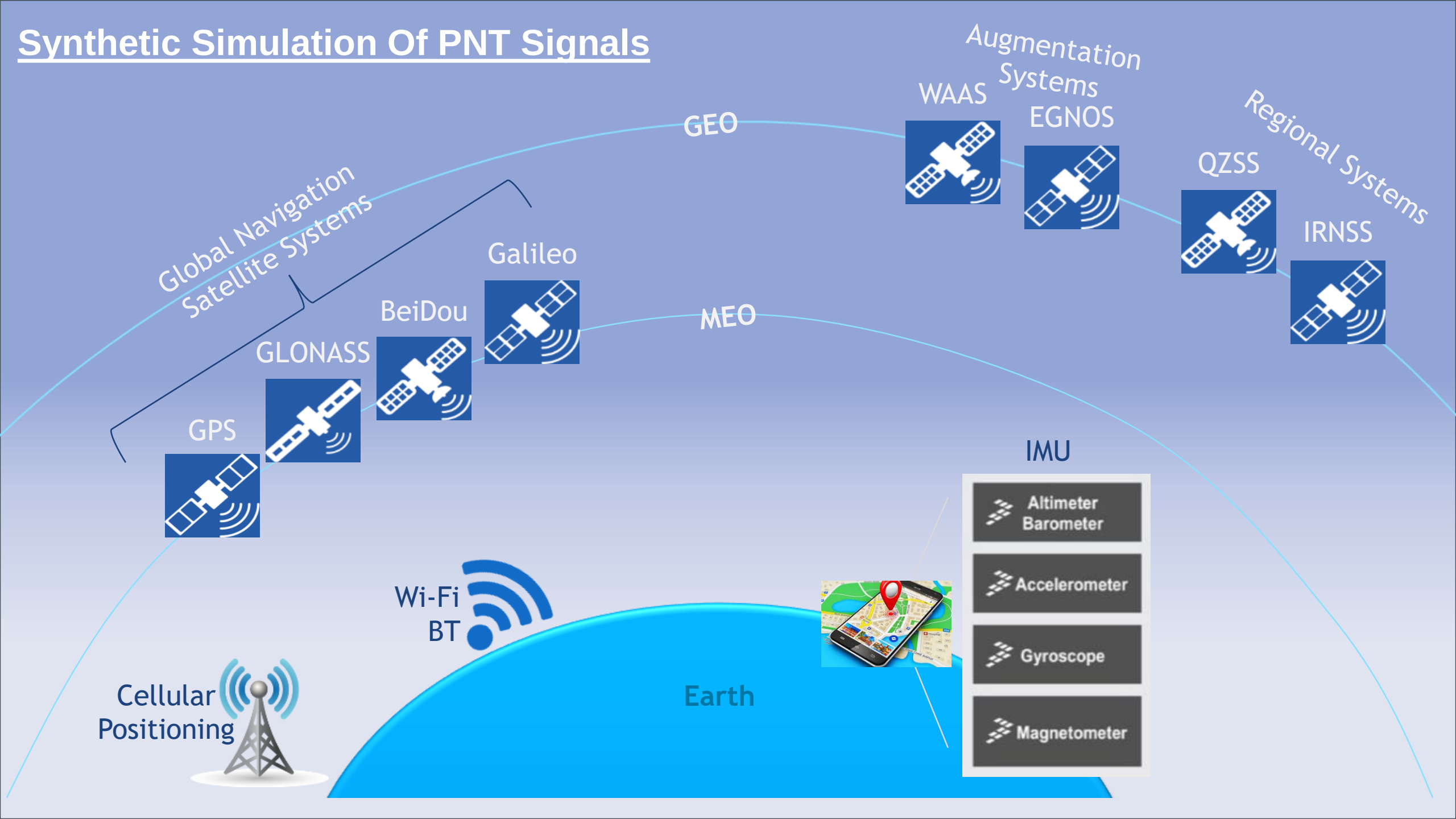
Synthetic Simulation Of PNT Signals



Introduction

GNSS interference and Commercial Aviation

- Space-based position and navigation enables three-dimensional position determination for all phases of flight from departure, en-route, and arrival, to airport surface navigation
- Increasing reliance on GNSS for aRea NAV (en-route and approaches)
- GPS also an essential component for many other aviation systems, such as the Enhanced Ground Proximity Warning System (EGPWS) and ADS-B
- Interference to systems reliant on GNSS is a real issue – many recent examples of disruption…

GPS Jamming – Real Examples

Hannover Airport, Germany, 2010

- A GPS repeater was set-up in a hangar, less than 1000m from the runway threshold to test GPS equipment on business jets. The operator did not realise that what they were doing was illegal…. Airlines started to experience Ground Proximity Warning Alarms and Displaced runway threshold alerts whilst taxying to take off.
- Subsequent investigations found that the power of the repeater was too high; also the hangar door was sometimes left open when the repeater was operated, causing GNSS interference at the runway threshold…
- One incident has come to light since which showed that the repeater also acted as a GPS spoofer

Image courtesy CNBC.com

GPS Jamming – Real Examples

- More than 250 incidents of GPS disruption reported by pilots through NASA's Aviation Safety Reporting System (ASRS) since 2013

- 815 incidents of GPS disruption reported to Eurocontrol so far in 2018 (Europe and adjoining areas)

  - 2017 Unknown location, USA; "The GPS signal briefly went away…..within 30 seconds everything was normal again……..GPS loss seemed an illusion. ATC said no one else has reported an outage so I wondered if I had encountered a trucker with a GPS jammer on a highway or similar. So I continued - into the rain, clouds and turbulence……Then all hell broke loose; GPS signal failure, ADSB failure, multiple cascading messages on the GTN."

  - 2017 Fresno Yosemite airport, USA ; "The aircraft appeared to turn toward the waypoint however ATC asked us if we were turning toward FRAME yet. At that point it appeared the GPS had lost position and we declared a lost signal to ATC and asked for vectors. We were not able to regain accuracy with the GPS and navigated on vectors and VOR tracking for the remainder of the trip."

  - 2018 Cherry Capital Airport, USA: Pilot reported that while instructing in the vicinity of LADIN intersection, northeast bound towards PLN, Pellston VOR, experienced a GPS anomaly. The GPS displayed scrambled characters that were indiscernible. This event lasted approximately 10 seconds then cleared up.

  - 2018 Near North Korean airspace: We received an EICAS message, ADS-B L out. A few minutes later we got an ADS-B L out. I wrote them both up and we then started discussing if this was a GPS jamming event since we were just north of North Korea. The FO and I referenced the B777 GPS Jamming update and our situation was the first example listed.

  - 2017: El Dorado Airport, USA: I experienced a failure of the WAAS GPS antenna in flight. The antenna failed in such a manner as to create spurious emissions that caused all other GPS antennas on my aircraft to also lose signal.

  - 2017: "Passing FL260 on climb out from LLBG (Ben Gurion Int'l, TelAviv), got "ADS B OUT R" EICAS message. Performed checklist and received "ADS B OUT L" message. 5 minutes later at FL300 in cruise received "UNABLE RNP", "RUNWAY SYS", "TERR POS", "GPS" additional messages. RNP showed 2.75 miles right of course. Contacted Nicosia Center to verify position and used RDS VOR for navigation.. Operations returned to normal when passing into Greek airspace. All navigation systems returned to normal. Everyone involved seemed to believe we were being "jammed" by possible military aircraft. Continued to destination

GPS Jamming – Real Examples

- August 2017
- NTE (Nantes Atlantique), France
- La Rochelle man fined 2000Euros for leaving his car parked in airport car-park with GPS jammer activated
  - Departed from Airport for holiday and left the jammer in his vehicle
  - The jamming device *“disrupted the tracking systems of planes arriving and taking off from the airport, leading to delays on several flights before it was located and disabled”*

GPS Jamming – Real Examples

- September 2017 - Commercial Flights in Norway and Finland experienced GPS jamming for one week
- East Finnmark area
- Widderoe and SAS flights were affected

Støy fra Russland slo ut GPS-signaler for norske fly

I en ukes tid måtte flygerne fra Widerøe og SAS klare seg uten GPS-signaler på flyplassene i Øst-Finnmark. Det skjedde samtidig som russerne forberedte den største militærøvelsen på mange år.

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Journalist

Oppdatert 05.10.2017, kl. 12:10

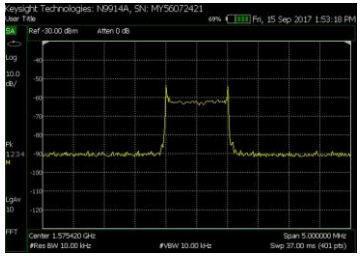
JAMMET? Widerøes fly mistet GPS-signal fra Berlevåg til Kirkenes i september.
FOTO: JAN HARALD TOMASSEN / NRK

UPDATE – November 2018

- Further GPS disruption during NATO exercise Trident Juncture
- Pilots reported the loss of GPS while flying into airports in the northern Norwegian region of Finnmark and in Lapland.
- Norway's aviation authority, Avinor, issued a notice to airmen of irregular navigation signals in airspace over eastern Finnmark between October 30 and November 7.
- Reports that Finland has summoned Russia´s ambassador to answer allegations that Moscow was behind the jamming of GPS signals in Lapland during recent NATO exercises

På forhånd var det ventet at russerne ville øve også på elektronisk krigføring under øvelse Zapad i september.

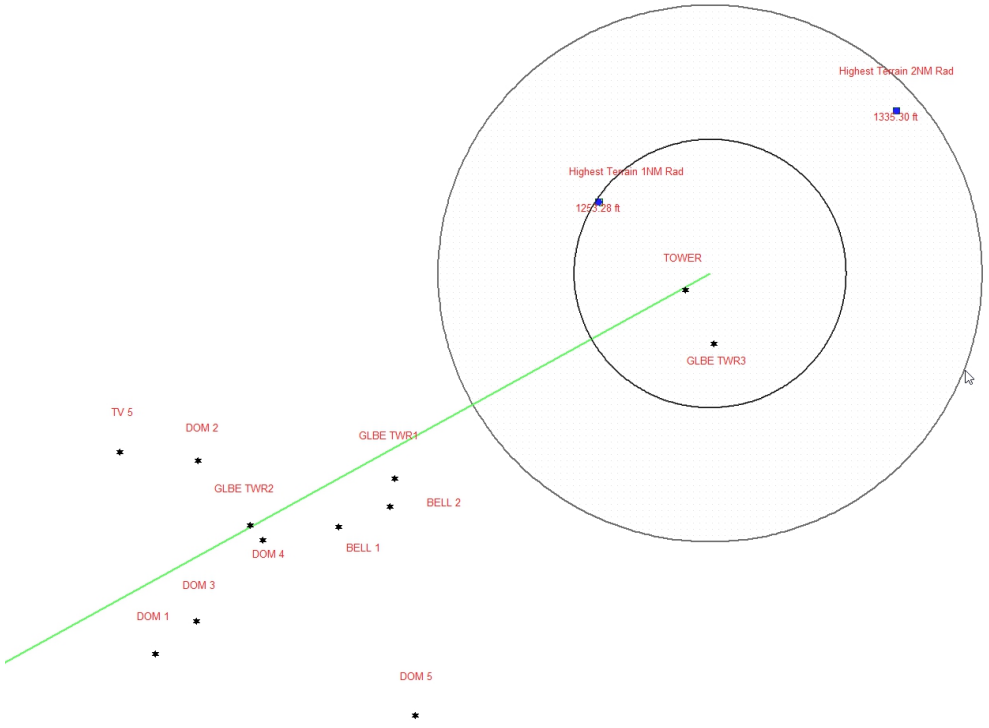
Forsvaret kan ikke bekrefte at jamming var årsaken til at GPS-signalet falt ut, men Nasjonal kommunikasjonsmyndighet har gjort gjentatte



Images courtesy Resilient Navigation and Timing Foundation

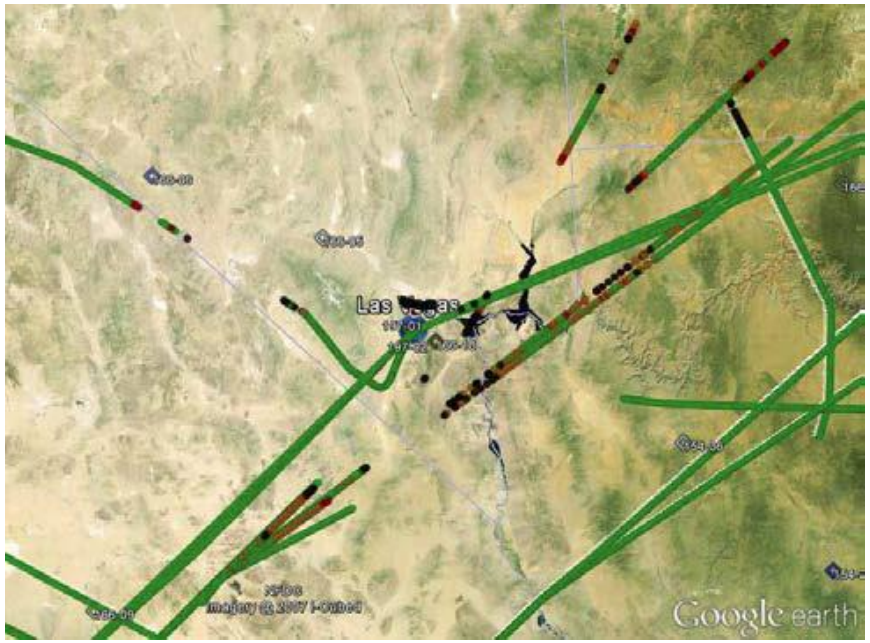
GPS Jamming – Real Examples

- Multiple reports of GPS interference on approach to Runway 24 at Manila International Airport,
- More than 50 reports in the 2nd quarter of 2016
  - Loss of on-board GNSS functionality
    - [GPS-L INVALID] and/or [GPS-R INVALID] messages appear.
  - Decrease in navigation performance leading to RNP alert
    - through increasing aircraft horizontal error, Actual Navigation Performance (ANP) decreases beyond RNP requirement. - [NAV UNABLE RNP] message appears.
      - **This sometimes has led to missed approaches.**
    - in some aircraft, navigation reverted to inertial (IRU) or DME/DME after GNSS loss.
  - Impact on Navigation Display
    - a large “map shift” was observed.
  - Impact on GPWS - [TERR POS] and [EICAS TERRAIN POSITION] messages appear.
  - **Loss of auto-land and ADS reporting capabilities**



GPS Jamming – Real Examples

- 2018- RTCA report “Impacts of Intentional GPS Interference” contains the results and recommendations from their Tactical Operations Committee who were tasked to conduct the study for RTCA.
- RTCA report highlights that not all aircraft experience GPS problems in areas where jamming exercises take place. It shows captured ADS-B data from an event from 03 May 2017 (UTTR 17-01).
    - Multiple aircraft lose GPS reception whilst many others experience degraded integrity or lose reception altogether.



ADS-B Track Data from UTTR 17-01 - May 3, 2017 (source: RTCA report)

Spirent Insights

- Commercial Aviation well aware of GNSS vulnerabilities and has been proactive in assessing risks and protecting against them
  - Developed Receiver Standards for robustness
  - High levels of GNSS integrity/availability specified for RNAV use
  - Use of Ground or Space Based Augmentation
  - Back up Radio Navigation Aids kept in service
- GNSS Disruption not likely to be a SOL issue for Commercial aviation but obvious economic impacts
- Need to monitor GNSS signal quality and spectrum near major airports
  - Troubleshooting(e.g., Manila…)
  - Operational warnings (NOTAMs)
- Test all PNT equipment against real-world threats as part of risk assessment programmes – Repeat as necessary

Trust but Verify..

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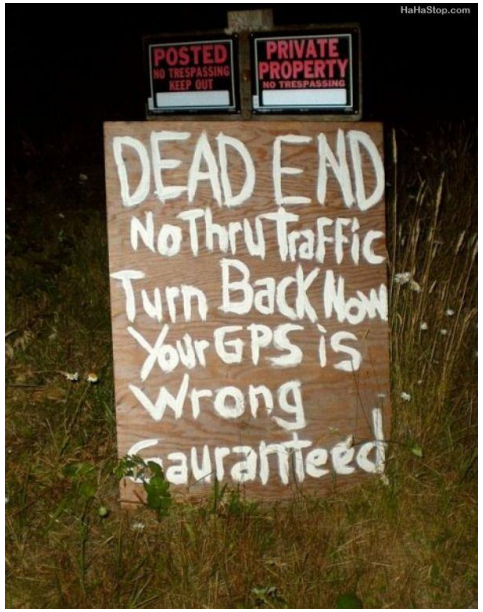
https://www.spirent.com/PNT/Measuring-Resilience



Join the GNSS Vulnerabilities group on Linked In to find out more about GNSS jamming and spoofing