French Spectrum national Authority (ANFR) ‘s activities for protecting GNSS from interference in France

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ANFR’s activities for protecting GNSS from interference in France

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1. The threat of GNSS interference

- The availability of GNSS (Global Navigation Satellite Systems, like GPS, Galileo) data is crucial for maintaining in operational condition an ever growing number of key applications which rely on GNSS for positioning, navigation and timing services (PNT)
  - transportation (rail, road, aviation, maritime, waterway)
  - logistics;
  - safety and emergency services;
  - guiding agricultural machinery;
  - scientific applications;
  - services that need a time reference, such as mobile phone and internet services, broadcasting and power transmission networks, and banking transactions.
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1. The Threat of GNSS interference

- GNSS (GPS, Galileo, Glonass, Beidou) signals are vulnerable to interference.
  - Received from satellites approximately 20,000 km away, they have very low levels. Mobile phones have a typical transmitted power of 0.1 to 1 W, which is still more than a million times stronger than that of GNSS signals.

Figure: The red circles indicate where the GNSS satellites are located, relative to other satellite systems. Near-Earth LEO satellites are around 200 to 2,000 km above the surface, while the most distant GEO satellites are 36,000 km above the surface.
Source: https://commons.wikimedia.org/wiki/File:Orbitalaltitudes.svg
1. The Threat of GNSS interference

- GNSS interference, intentional or unintentional, is no less severe than a cyberattack

- GNSS interference causes the GNSS receiver to die.
  
  Interference compromises (degrades, hinders or interrupts) the operation of GNSS receivers
  
  - It prevents proper reception of GNSS signals carried from satellites and can affect the performance or availability of services that require these data for localization or timing purposes. **It can lead to the denial of service of these applications**
  
  - The size and duration of the interference participate in the severity of the interference case.

- Spoofing causes the GNSS receiver to lie.
  
  - GNSS spoofing is the provision of false GNSS-like signals to fool the GNSS receivers.

Source: When GPS gets lost, by Katherine Dunn, Fortune, 1rst February 2020
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1. The Threat of GNSS interference

- Impacts: GNSS interference may affect different activities, some critical, in terms of:
  - Safety of people
  - Safety of goods
  - Environmental damage
  - Economic implications

- The operational consequences vary according to the robustness of the GNSS receivers and the resilience measures put in place, as well as according to the amplitude and duration of the disturbance.

- Cf. “GNSS impact study” (January 2022) public final report by FDC
  - https://first-tf.fr/le-reseau/organisation/groupes-de-travail/etude-dimpact-de-perte-de-signaux-gnss/
  - This study mandated for the FIRST-TF research Federation (a French national network of time and frequency metrology stakeholders) in collaboration with the French Ministry of Ecology, was conducted in France by the FDC company. It presents the effects of an alteration or an unavailability of GNSS information (including from interference causes) on the functioning of systems used by some infrastructures of civil society. This study especially covers the following sectors: Transports (road, railway, air, maritime, waterway), Energy, Water management, Finance, State Civil activities (Metrology, Meteorology, Geographic information), Electronic communications, audio-visual and information, Space and Industry.
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1. The threat of GNSS interference

GNSS interference may have different causes such as:

- A GNSS jammer or a multiband jammer including antennas to interfere GNSS frequencies. Installed at a fixed location or in a moving vehicle.
  - ANFR’s agents often discover, during their investigations on GNSS interference cases, jammers embedded in vehicles used by their owners. The jammers owners use them to evade the geolocation system set up for vehicle tracking or to attempt to hide criminal activities.
- The easiness to find GNSS jammers on Internet sites is a threat.
- Contrary to what those who use them often think, the range of action of jammers is quite large.
  - The range of GNSS jammers is significant: a low-power GNSS jammer (a few milliwatts) can disrupt all services that use GNSS several hundred meters around on the horizontal plane and several thousand meters in altitude!
  - Not to mention the threat represented by the use by personalities of jammers against paparazzi drones (cg article in the Netherlands media about a case reported in March 2021).

- A radio equipment in default or not compliant, or used outside the regulatory framework.
- A faulty electric, electronic or radio equipment emitting excess electromagnetic parasites (EMC issue).

- Note : A GNSS repeater or pseudolyte installed without the necessary authorizations and whose emissions are not confined inside a closed place may act as a spoofing device.
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2. ANFR’s response

2.2. ANFR’s mission of Spectrum Monitoring and Enforcement

Spectrum Monitoring and Enforcement entails checking whether uses comply with regulations and eliminating any interference that might occur despite all precautionary measures.

- In France, this duty falls on ANFR, the National Frequency Agency (www.anfr.fr), public administrative establishment placed under the Minister of Economy and Finance, as part of its role to plan, manage and control the entire spectrum frequencies in France.

- ANFR uses both types of control - preventive and curative, in order to improve the global resilience to interference.
2. ANFR’s response
2.2. ANFR’s mission of Spectrum Monitoring and Enforcement

Spectrum Monitoring and Enforcement

- ANFR is composed of around 300 employees. Among them, about 120 employees belong to the Spectrum Monitoring Directorate.

- ANFR eligible and sworn agents have the authority to investigate and ascertain infringement of the rules set up for spectrum use. They establish technical reports and can report facts to Public Prosecutors.

- A strong territorial presence of ANFR for spectrum monitoring: in mainland France (Aix-Marseille, Donges, East, Toulouse, Villejuif, Rambouillet International Control Center) and in the French overseas departments (Antilles-Guyane and La Réunion - Mayotte) as well as in two branches in New Caledonia and French Polynesia.
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2. ANFR’s response

2.2. Reducing the risk of GNSS interference

Dissuading current and potential users of GNSS jammers by awareness raising actions

ANFR shares information towards different publics on the risks created by GNSS jammers, the legislation and regulations in force and the related sanctions.

- Educational brochure

- Resolved cases presented in the ANFR newsletter, section "ANFR investigations"

- Media coverage
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2. ANFR’s response
   2.2. Reducing the risk of GNSS interference

Limiting the risk and impact of interference through knowledge sharing

- Everyone has to be as cautious with the radio frequencies as in the digital or physical space.
  - Since protecting the spectrum is partly based on following the conditions set for using radio frequencies, **one axis of the ANFR’s work is to conduct information campaigns** to make stakeholders aware of these issues.

- Informative actions are carried out by the ANFR towards different public in order **to promote a correct use of the spectrum** according to the rules in order to limit the risks of interference.
  - ANFR, through various actions, **recalls the rules to apply when using radiofrequencies in order to limit the risks of interference.**
  - Diverse educational actions aimed at different public are carried out: General
    - Specific information on risks of interference and how to prevent them: leaflets, web site, ANFR’s newsletter;
    - Media coverage
    - **Book published in July 2022** presenting 25 interference cases handled by ANFR and reminders about the regulation framework for using frequencies and equipment: “Brouillages d’Ondes. L’ANFR enquête!”, *Interferences, ANFR investigates!*
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2. ANFR’s response
2.2. Reducing the risk of GNSS interference

Fighting the spread of illegal GNSS jammers sold on the Internet

- It is important to enhance the legal capacities to fight illegal selling of jammers on internet web sites, which is a complex subject as the vendors are mostly outside the European union
  - Most of jammers are sold via Internet on websites outside jurisdiction of EU market surveillance authorities.
  - Obligations of e-commerce platforms and web sites to check in advance or not for legality of “jammers” that are sold on their sites (e-commerce directive and digital service act)

- Note: Not all CEPT member states have adopted a legislation that forbid the ownership of GNSS jammers, when use is forbidden in all member states except for some specific State uses for security or defense. (cf. WG FM and FM22 Questionnaire to CEPT Administrations on their actions against GNSS jamming and GNSS illegal jammers).
2. ANFR’s response

2.3. Reducing the impact of GNSS interference

Encouraging all critical users of GNSS frequencies to develop efficient response capacities including detection capacities.

Some sectors (e.g. civil aviation) have already taken this risk into account but other sectors may not be as advanced.

- **Awareness that the zero risk of GNSS interference does not exist is essential.**
  - There is no practical way to completely eliminate the risk of GNSS interference
  - GNSS interference has to be considered as a risk by any company, an infrastructure or administration using GNSS for positioning or timing information

- **Critical GNSS spectrum users benefit from increasing their capacity to detect interference and report it to ANFR in order to increase their resilience and response in case of interference** (robust equipment, redundancy, the capacity for operating in a downgraded mode, etc.).
  - **Detection is the first and essential action:** The implementation of effective responses to GNSS interference relies on knowledge of the event; Detection will trigger useful actions both internally and towards the authorities concerned, including the ANFR. Also, without detection of a loss of GNSS signals, the risk is to rely on equipment that will either be in denial of service or that give an erroneous position or time information.
  - **Reporting GNSS interference cases in France to ANFR for investigation and resolution:** Suspicion of GNSS interference must be reported to the ANFR, because it permits ANFR to conduct if necessary an investigation to locate the source of interference and stop it. Sanctions may also be applied to the person responsible of the interference.
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2. ANFR’s response
2.4 Building capacities to resolve GNSS interference cases

Ensuring that investigation and enforcement capacities cope with the growing menace

- ANFR is vigilant for that the French and European legal frameworks respond to the growing menace of GNSS interference.

- It is necessary to dispose of legal tools strong enough allowing investigation and repression of activities relative to interference as well as all activities (ownership, advertising, selling, using) illegal jammers.

- Sanctions must be dissuasive enough to participate in prevention.
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2. ANFR’s response

2.4 Building capacities to resolve GNSS interference cases

ANFR continually strengthens its technical and operational response to the threat of GNSS interference, whether caused by GNSS jammers used on board moving vehicles, drone jammers aboard yachts or any radioelectric, electric or electronic devise in default.

In 2022, ANFR acquired several GNSS jammers detection equipment from to be used by its regional services to solve GNSS interference cases caused by jammers installed aboard vehicles.
2. ANFR’s response
2.4 Building capacities to resolve GNSS interference cases

ANFR encourages cooperation with other administrative entities such as police forces, customs, port and maritime authorities, in order to gather competencies and capacities for resolving interference cases (detection phase, investigation phase, judicial phase) and fighting the spread of illegal GNSS jammers.
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2. ANFR’s response
2.5 Examples of GNSS interference cases handled by ANFR

April 2017: a GPS jammer installed in the trunk of a vehicle parked in the parking lot of Nantes airport near the tarmac at Nantes airport delayed the departure of several planes. It prevented the pilots of four planes from using their GPS, essential before take-off. The ANFR was called in to locate the device and, in collaboration with the police, deactivate it.

The owner of the jammer was sentenced by the Nantes court to a fine of 2,000 euros. He also had to pay the costs of opening his car and an administrative tax of 450 euros notified by the ANFR for intervention costs. His jammer was also confiscated.
2. ANFR’s response

2.5 Examples of GNSS interference cases handled by ANFR

June 2021: a GPS jammer resembling a USB key discovered in a professional vehicle.

GNSS interference cases being critical, ANFR’s agents have become accustomed, when traveling in a laboratory vehicle, to monitor the frequencies dedicated to satellite radio navigation (GNSS). This is what agents from the Aix-en-Provence regional center of ANFR were performing while driving in the area of the Marignane airport in the spring of 2021.

The spectral reading that was displayed on the analyzer had all the characteristics of a GPS jammer.

ANFR’s agents soon identified the professional vehicle housing the GPS jammer.

ANFR immediately alerted the police and a judicial police officer to put an end to the offense. A flagrant operation was therefore organized jointly between the Police and ANFR.

For this operation, the ANFR was equipped with suitable measuring devices which enabled it to observe the infringement. The Police then proceeded to arrest the driver of the vehicle and discovered that the GPS jammer was nothing other than a simple USB key, apparently completely harmless! However, despite its small size, this jammer disturbed a large area around the vehicle in which it was installed, allowing the ANFR to detect it from a good distance. He was taken into police custody.

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2. ANFR’s response
2.5 Examples of GNSS interference cases handled by ANFR

2019 : GNSS interference report from the Civil Aviation directorate to ANFR. GNSS interference mainly impacting helicopters near Marignane airport.

ANFR searched for GNSS jammers with a in house developed sensor (NMEA frames analysis and SNR measurement) placed by a high traffic road. The data collected showed regular times when vehicles equipped with GNSS jammers were passing by the sensor. ANFR controllers were posted by the road in their technical to confirm the detection and identify the vehicles at stake.

Cooperation with police forces was necessary to organize an interception in the flow of traffic of one of the suspected vehicles. The offender was arrested by the police. One jammer was seized by the police and analyzed by ANFR. The case was about tanker trucks equipped with GPS jammers to steal gasoline from oil refineries, in fact, deliverymen stole gasoline during deliveries

- Large media coverage including the TV evening news on TF1 channel.
- Note : a similar GNSS interference case was resolved in 2022 by ANFR in cooperation with the police near Marseille.

Source : TF1
2. ANFR’s response
2.5 Examples of GNSS interference cases handled by ANFR

2022: ANFR discovers the use of GNSS jammers in trucks.

Tanker trucks equipped with GPS jammers to steal gasoline from oil refineries, in fact, deliverymen stole gasoline during deliveries.

The case was solved with cooperation with police forces.

2. ANFR’s response
2.5 Examples of GNSS interference cases handled by ANFR

September 2021 – January 2022: 4 multiband jammers, including the GNSS band, seized in Sarreguemines, in the east of France

Declaring to suffer from “electrosensitivity”, a man had decided to equip himself with jammers and neutralized the use of mobile networks in the whole neighborhood. Its jammers could also interfere with GPS. It happened three times as the man is a repeat offender. ANFR and the police had to intervene three times and the result was 4 seized jammers (see photo).

The offender was presented to court in May 2022. ANFR participated in the audience to explain the risks caused by jammers.

- [https://www.republicain-lorrain.fr/faits-divers-justice/2022/05/21/son-brouilleur-d-ondes-perturbe-tout-un-quartier](https://www.republicain-lorrain.fr/faits-divers-justice/2022/05/21/son-brouilleur-d-ondes-perturbe-tout-un-quartier)

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2. ANFR’s response
2.5 Examples of GNSS interference cases handled by ANFR

February 2021: ANFR was alerted by a technology company located in the South of France. Its activity, the development of professional GPS and Galileo equipment for high-precision geolocation, was disrupted by interference of the GNSS frequencies.

Sworn and eligible agents of the regional service of Lyon of ANFR intervened quickly on site. They first observed the interfering signal: a pulsed interference, centered on the frequency 1581.15 MHz, which affected permanent reception of GPS L1 and Galileo E1 signals in the frequency band centered on 1 575.42 MHz. Then, using the direction finder receiver of their laboratory vehicle, they set off to the source of the interference. Soon the goniometer identified a building from which the signal seemed to be emitted. Continuing on foot with a portable receiver fitted with a directional antenna, they reached the door of an apartment on the ground floor.

The occupant, an elderly lady, allowed them into her accommodation. Soon there was no longer any doubt: it was just ... an internet box, used to access Internet, telephony and TC services, emitting unwanted radiation in the frequency band reserved for GNSS.

A request was made to the operator to remedy this defect with new equipment.


Source: TF1
Thank for your attention

Any questions?
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ANNEX
French regulatory and legal framework about interferences and jammers

- About interferences:
  - Criminal sanctions
    - Interference caused by non-compliant equipment or emissions is an offense and may, in addition to the application of an intervention tax by the ANFR (Finance Law), be punished with a penalty of imprisonment for 6 months and a fine of € 30,000 under 2° and 2° bis of article L. 39-1 of the CPCE (French postal and electronic communications code)

    - Free translation of the legal text: Article L39-1 of the CPCE (French postal and electronic communications code)

      "Is punished by six months imprisonment and a fine of 30,000 euros :(...)"

      2° To disrupt, by using a frequency, equipment or radio installation, under conditions that do not comply with the provisions of Article L. 34-9 or without having the authorization provided for in Article L. 41-1 or outside the conditions of said authorization when this is required or without having the operator’s certificate provided for in article L. 42-4 or outside the general regulatory conditions provided for in article L. 33-3, Hertzian broadcasts from an authorized service, without prejudice to the application of article 78 of law n° 86-1067 of September 30, 1986 relating to freedom of communication;

      2° bis To disrupt, by using a device, equipment or installation, under conditions that do not comply with the applicable provisions in terms of electromagnetic compatibility of electrical and electronic equipment set out in the Consumer Code, the radio emissions of a service authorized, without prejudice to the application of article 78 of law n° 86-1067 of September 30, 1986 relating to freedom of communication; (...) “
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ANNEX

French regulatory and legal framework about interferences and jammers

About jammers:

- **Prohibition**
  - Under Article L. 33-3-1 of the CPCE, the sale, possession and use of wave jammers, and therefore in particular GNSS jammers, are strictly prohibited except in very exceptional cases. strictly defined for state uses.
  - Free translation of Article L33-3-1 of the CPCE (French postal and electronic communications code)

I. Any of the following activities are prohibited: the importation, advertising, free or expensive transfer, the putting into circulation, the installation, the possession and the use of any device intended to render inoperative radio equipment or devices incorporating radio equipment of all types, both for transmission and reception.

II. By way of derogation from the first paragraph, these activities are authorized for the needs of public order, defense and national security, or the public service of justice.

The use by State services of devices intended to render the radio-electric equipment of an aircraft traveling without anyone on board inoperative is authorized, in the event of an imminent threat, for the needs of public order and defense, and national security or the public service of justice or in order to prevent the overflight of an area in violation of a ban imposed under the conditions provided for in the first paragraph of Article L. 6211-4 of the Transport Code. A decree in the Council of State determines the modalities of implementation of these devices, in order to guarantee their necessity and their proportionality with regard to the objectives pursued, as well as the competent authorities to carry them out.

- **Criminal sanctions**
  - Violation of this prohibition exposes the offender to a maximum penalty of six months in prison and a fine of 30,000 euros, in application of 4 ° of Article L. 39-1 of the Post and Electronic Communications Code.
  - Free translation of Article L39-1 of the CPCE (French postal and electronic communications code)

Is punished by six months imprisonment and a fine of 30,000 euros (..) 4 ° To have practiced one of the activities prohibited by I of article L. 33-3-1 except in the cases and conditions provided for in II of this article.