Radio frequency interference

ANFR Investigates!

25 missions conducted by ANFR agents to find the source of mysterious interference

Radio frequency interference

ANFR Investigates!

ANFR
AGENCE NATIONALE DES FRÉQUENCES

Radio frequency interference, open investigations

Teleworking, the massive arrival of the Internet of Things, the *cloud,* mobile applications... Our society and economy are increasingly dependent on wireless communications and the radio spectrum. The digitisation of exchanges and the massive processing and storage of data are accompanied by a growing use of radio frequencies and an unprecedented increase in the amount of data exchanged over radio links, with ever-increasing bandwidth needs. This change in habits generates increasing numbers of frequency spectrum users and therefore greater risk of interference.

Interference: a critical threat

The threat of radio frequency interference (RFI) is a critical as a cyber-attack. Frequency band interference hinders or even prevents all uses of that band in a given area. Depending on the services concerned, interference can cause dangerous or economically damaging situations.

Interference, regardless of whether it's deliberate or unintentional, similarly impacts applications using radio waves. Examples include DTT (digital terrestrial television), mobile phones, weather forecasting systems, radio stations, law enforcement communications networks, the fire brigade radio network, satellite arrays, industrial 4.0 applications, GPS (*global position system*) signals used by aircraft and ships, etc.

ANFR the "Guardian of the spectrum" in the field

The French National Frequency Agency's (ANFR) preventive and curative actions protect the radio spectrum from interference. This purpose of this spectrum control mission is to guarantee the continuity of the State, economic and societal applications that depend on it.

This is why the ANFR monitors radio sites and networks to make sure they comply with regulations, and investigates reports of interference. The ANFR also rolls out actions targeting the relevant players to raise their awareness of proper frequency uses to limit the risks of interference. Despite these preventive actions, every

year, the ANFR processes many cases of interference, whether intentional or not: the latest statistics show 1,800 cases of interference per year and the trend is on the rise.

A strong territorial presence and state-of-the-art measurement equipment

Thanks to its territorial coverage and the expertise of its agents, the ANFR successfully conducts its monitoring missions and investigations to find and identify the causes of radio-frequency interference. Its teams are deployed throughout France from its regional services and overseas branches. Its sworn, authorised officers have investigative and evidence-collecting powers to investigate and record cases of breaches of the radio-communications legislation.

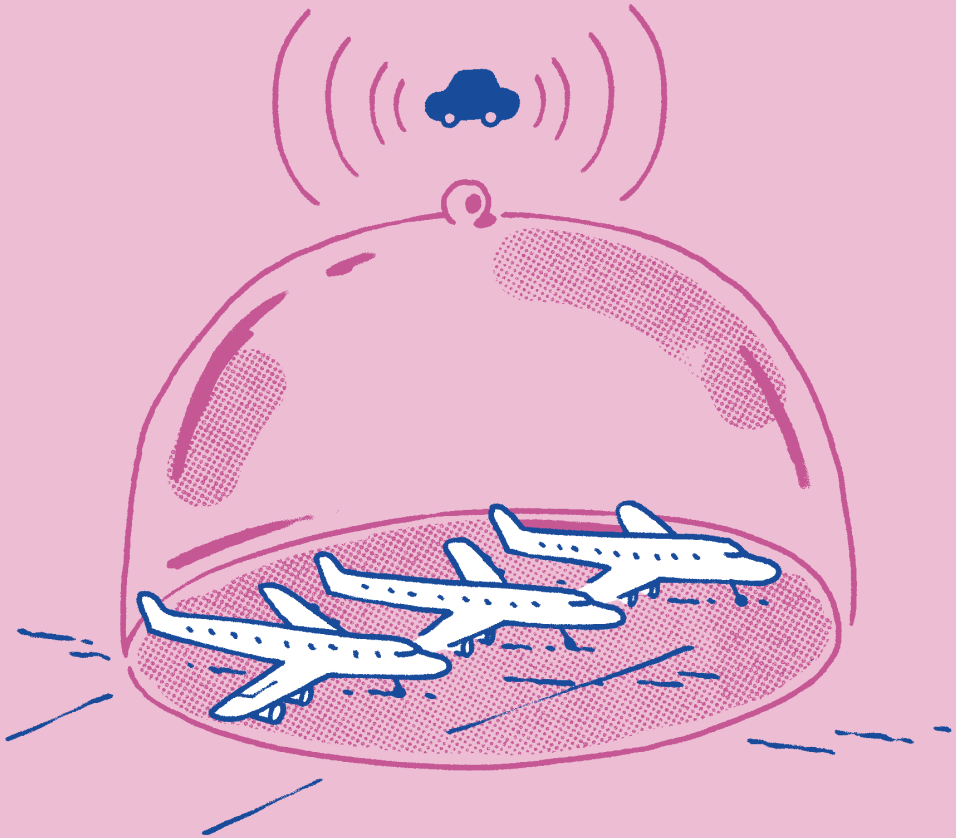
Its experts have both static and transportable state-of-the-art equipment, which will be described in these investigations, and are continually testing new equipment (drones, innovating sensors, etc.) so that their checks are increasingly effective and efficient.

This *Radio frequency interference, ANFR investigates!*) document is intended to raise awareness of the many, sometimes unusual, cases of interference that our agents deal with daily in the field. It also has an educational role: everyone uses frequencies and should be aware of the rules to follow when doing so.

We have chosen to tell you the story of twenty-five missions, conducted in cities, mountains, the countryside and even at sea, which look very much like actual investigations: suspense and twists guaranteed! Enjoy ...

Investigation no.1

Take-off or grounded?



Or how to ground several planes

21st April 2017, 9am, Nantes-Atlantique airport. Several smartly uniformed pilots and fully prepared cabin crew are preparing for take off in their spic-and-span aircraft. However, they are unable to initialise their aircraft's GPS coordinates as usual. As a result, the control tower is unable to manage the aircraft flight schedules. Take-off is impossible... Strangely enough, they are all located on the airport's aircraft parking zones 6 and 7.

THE AIRCRAFT ARE TOWED further onto the tarmac one by one, outside the area suffering interference, to be able to carry out the GPS operations required to position themselves and take off. And the passengers have to be taken to their plane by bus. These technical and human manoeuvres cause flight delays and the saturation of the airport call platform! Aircraft parking zones 6 and 7 are put on standby and deserted.

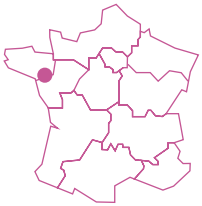
When contacted, the airport security department corroborated the pilots' testimonies and detected significant disturbances in the GPS signal, on frequency L1 (1575.42 MHz) precisely, as the French Civil Aviation Authority (DGAC) explained to the ANFR, which was quickly contacted.

At 10.30 am, after having informed the Nantes Court of First Instance public prosecutor, two authorised and sworn agents from the ANFR's Donges regional service arrive in the area, near aircraft parking zones 6 and 7. With their state-of-the-art measuring equipment, they detect a signal emission characteristic of a GPS jammer. All they have to do is find it!

In battle order

Accompanied by a Border Police officer, airport security officers and the civil aviation authority security representative for West France, the ANFR technical team continues its investigation using a receiver and a directional antenna. This search takes them to the airport's covered car park adjacent to aircraft parking areas 6 and 7. The small group stops its search on the second level, in front of a parked vehicle: an inoffensive-looking sedan... But the jamming signal is coming from there!

After investigation by the police, the owner of the vehicle is identified and contacted. But he's on a trip abroad! He nevertheless admits to the investigators that he has a GPS jammer that he must have forgotten to disconnect, and allows the police to enter his car to disable the device.



Nantes-Atlantique Airport (Loire-Atlantique, France)
7.2 million passengers per year

21 April 2017
Intervention date

14:30
Time the interference was identified

Did you say "interference"?
Radio frequency interference (RFI) is electromagnetic energy that deteriorates or interrupts the operation of radio communications transmitters and receivers. It can have a wide variety of causes, such as unauthorised radio sources or electromagnetic interference emissions from non-compliant, old or simply incorrectly tuned electronic equipment. Interference on a frequency band hinders or even prevents all uses in a given area.

Hidden in the trunk

At 2.30 pm, after the police opens the vehicle, the ANFR discovers the GPS jammer in question, of the cigarette lighter type, in a corner of the trunk. It is then immediately deactivated and confiscated by the police.
Why did the owner have such an "accessory"? The jammer simply allowed him to avoid being located by the *tracking* system installed by his employer on his work vehicle. However, the emissions of such jammers, even at very low power, are not confined to the vehicle. Such devices, harmless as they may seem, can jam GPS signals up to an altitude of about 2 km and 500 metres horizontally!

Collateral effects

The GPS signals received from satellites located more than 20,000 km from Earth are extremely weak and therefore "vulnerable" to these jammers. Collateral effects can thus have serious or even dramatic consequences. Indeed, the GPS satellite navigation signal, in addition to being used by civil aviation, is used by many other applications such as land, sea and river transport, communications networks and power transmission networks.

Authorised and swon agents

Authorisation requires a positive opinion from the French public prosecutor. It is in the form of an order of the Minister in charge of electronic communications. This authorisation gives the person concerned investigative powers to find and record violations of regulations on the use of the radio spectrum.

Swearing in
Authorised officers must be sworn in before the judicial courts. They are then issued a professional card mentioning, among other things, the possibility for a sworn agent to request the assistance of a judicial police officer in the performance of his or her duties.

"The small group then stopped their search on the second level, in front of a *parked vehicle*: an inoffensive-looking town car..."

This jammer, which had remained switched on, interfered with the on-board GPS of aircraft parked within 500 metres of the vehicle's parking space, with all the consequences we know of and delays for hundreds of passengers.

Guilty and accountable

The jammer is confiscated. A report is drawn up and sent to the public prosecutor. The owner of the jammer is subsequently summoned to the Nantes judicial court on 9 August 2017. The ANFR and the Civil Aviation Authority are present.

The secretive owner is found guilty and sentenced to pay a € 2,000 fine. He must also pay the costs of opening his car and a fee of € 450 notified by the ANFR for intervention costs incurred by the administration. Leaving his car in the airport car park will have cost him more than he expected...

WHAT THE LAW SAYS

In France, the possession and use of a wave jammer is - except for state services in a specific context - strictly prohibited. These are offences subject to a criminal sentence of up to six month in prison and a € 30,000 fine (Articles L.33-1 and L. 39-1 of the French Post Office and Electronic Communications Code). The Post Office and Electronic Communications Code similarly punishes interference with the radio transmission of an authorised service as well as the unauthorised use of frequencies. Furthermore, any intervention by ANFR staff to search for the source of interferences, in this case a jammer, generates the application of a € 450 tax* to cover the incurred costs.
Article L 39-1 of the French Post Office and Electronic Communications Code

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

"The GPS signals received from satellites located more than 20,000 km from Earth are extremely weak and therefore *vulnerable* to jammers."

GPS jammers

GPS jammers, which are prohibited in France, emit a parasite signal that scrambles satellite geolocation service frequencies. Their emissions are never limited to a small space such as the inside of a car or a home, and can have serious consequences for neighbouring services.

Why can using a GPS jammer be serious?

The American GPS system is part of the Global Navigation Satellite System (*GNSS*), similarly to the European Galileo system, the Russian Glonass system, the Chinese Beidu system, etc. GPS sends signals from satellite arrays located at more than 20,000 km from the Earth (in medium orbit) to users equipped with GPS receivers. The signals provide data for precise positioning, but also for synchronisation and time reference (universal and local time) for a wide range of public and private activities: transport (land, water, air or sea); search and rescue services; securing the exchange of goods; mobile telephone and internet services, broadcasting and electricity networks, banking transactions, ...

Everyone understands why the availability and integrity of this data is crucial! GPS signals are received from very distant satellites and by design are very weak[1] and are therefore vulnerable to frequency jamming. GPS jamming can have a wide variety of causes, ranging from radio emissions from unauthorised sources or outside regulatory conditions, to electromagnetic emissions from any kind of non-compliant, faulty or obsolete electric, electronic or radio equipment. Whether intentional or not, and as long as it hasn't been resolved or eliminated, GPS interference can cause signals to drop or deteriorate in a more or less extended zone depending on its power.

Contrary to what their fans believe, for example to prevent them being tracked, the range of action is often wider. A low-power jammer (a few milliwatts) can disrupt all the services that use GPS within a radius of several hundred metres horizontally and several thousand metres vertically!

[1] The signal issued by a mobile phone is weak, yet it's more than a million times stronger than the GPS signal received on Earth, ...

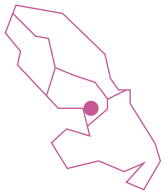
Investigation no.2

Is there a pirate in the radio?

Or how a radio station becomes a... hijacker

2nd March 2018, Aimé-Césaire airport, Martinique. For some time now, radio communications between the control tower and the aircraft have been disrupted by parasite signal, mainly at night and intermittently. This signal, transmitted in the frequency band reserved for the Civil Aviation Authority, greatly hinders airport operations. It's urgent to find out what it is, ...

The local branch of the ANFR is a permanent presence in the Antilles-Guyana zone and is able to detect and locate all unauthorised transmissions to protect radio space from interference. Following the request from the Civil Aviation Authority to investigate, the head of the French West Indies ANFR branch goes on alert, ready to take action.
He doesn't have to wait very long: on Thursday 8th March at around 6.30 p.m., the airport control tower informs him that the interference has reappeared. Within minutes, the manager arrives on site with his sophisticated measuring equipment and starts his investigations on the ground. Night has fallen in Fort-de-France the agent works with his gaze fixed on his instruments.



Aimé-Césaire Airport,
Le Lamentin (Martinique)
2.5 million passengers
per year

8th March 2018
Intervention date

Electromagnetic parasites

Using his directional antenna and receiver, he manages to identify the source of the interference in a residential area: an FM radio station, to be precise - the suitably named - Power FM!
Its transmitter, which is visibly insufficiently filtered, is producing electromagnetic interference that disrupts the frequencies used by aviation, frequencies close to those of FM radio stations. Furthermore, the radio is broadcasting without an Arcom authorisation, the audiovisual and digital communications regulatory authority. We are therefore dealing with a pirate radio station... But in the middle of the night and in a dense neighbourhood, it's difficult to accurately locate the transmitter and especially its

"Night has fallen in Fort-de-France and the agent *works* with his gaze fixed to his instruments."

Pirate radio stations
A pirate radio station is one that broadcasts without a government authorisation. These radio transmitters had their golden age during the pop culture explosion, before the arrival of the many free radio stations (authorised in France in the early 1980s) which were gradually replaced by private radio stations covering the whole territory.

WHAT THE LAW SAYS

The unauthorised use of frequencies is a criminal offence punishable by up to six months in prison and a € 30,000 fine under the provisions of Article L. 39-1 of the French Post Office and Electronic Communications Code.

Interfering with a properly authorised frequency through using radio equipment in non-compliant conditions is also an offence subject to the same criminal sentence. Furthermore, users may be charged a tax* of € 450 (see Article 45 II of the French 1987 Finance Act, amended) to compensate for the costs incurred by the public authority that carried out the investigation.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

aerial relay - a dipole antenna - amongst the multitude of antennas on all the surrounding roofs. Our agent decides to return the next day.

The explanation

At dawn the next day, Friday 9th March, the ANFR returns to the scene with Arcom as backup. The first step is for the agents to precisely determine which antenna to target. They find the antenna in the lower corner of a roof over a building containing several dwellings. A small neighbourhood enquiry is then conducted and the officers quickly identify the dwelling in which the radio is located. The ANFR agent leaves to announce the location of the pirate transmitter to the civil aviation representative and the Aviation law enforcement brigade which is waiting for the information to take action.

Police custody

Under the control of the Fort-de-France public prosecutor's office, a joint intervention is conducted on the same day by the air transport gendarmerie brigade and the ANFR. The incriminated transmitting equipment is found in a sort of box room and is disconnected and confiscated. The offender, who is present during the intervention, is immediately taken into custody. The suspect is prosecuted by criminal order. He is sentenced to pay a fine of € 400 and to the destruction of the confiscated.

How can an FM radio interfere with aviation frequencies?

The answer is simple... Neighbourhood conflict! The 87.5-108 MHz frequency band assigned to FM radio neighbours the 108-137 MHz band used in aviation. This latter is an international VHF *(very high frequency)* band used for security communications: national and international mobile aviation services, aerodrome surface communications, distress beacons, instrument landing systems, very high frequency omnidirectional magnetic bearings, etc.

If FM transmitters suffer faults, neighbourhood conflicts between these two bands may occur and deteriorate critical civil aviation communications.

Thus, as in our Fort-de-France airport case, interference or intermodulation products caused by a faulty or insufficiently filtered FM radio station can cause interference to frequencies assigned to civil aviation.

Priority processing

This interference on security services is dealt with as a priority by ANFR agents to re-establish the good communications required for the continuity of essential missions.

The Arcom, which is in charge of authorising FM radio stations and assigning broadcasting frequencies, often participates in these FM radio station interference cases to facilitate their elimination.

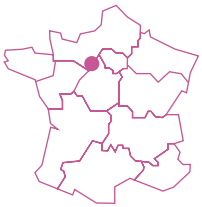
Investigation no.3

Every cloud has a silver lining

Or how a selfie kiosk does a rain dance

Late 2018, Trappes, in the Yvelines region of France.
The Météo-France radar used to locate and measure precipitation levels (rain, snow, hail) detects rain near Paris, in the 72° azimuth precisely. However, not a single drop of rain falls on that day... The weather is even fine. It's a clear case of interference characterised by large lines appearing on the radar screen, imitating rain.
Météo-France contacts the ANFR to find the origin of this misleading signal.

A TEAM OF TECHNICAL CONTROLLERS from the Rambouillet International Control Centre, a regional ANFR branch, is assigned the case. The technical elements provided by Météo-France show that the disturbance is intermittent, which makes its detection and finding its location especially complex.



Trappes (Yvelines, France)
Population 32,645
13.47 km²

18th April 2019
Intervention date

Enjoying the weather

The search begins with ANFR measurements conducted on the powered off radar itself, to gather as much information as possible about the interfering signal. An appointment is made with the Météo-France technical department in February 2019, in good weather.

In fact, good weather is needed because radar image acquisitions have to be stopped to allow the ANFR teams to connect their measurement equipment. The ANFR agents then record the spectral signature of the interfering signal: it is characteristic of an RLAN (local wireless network) or wifi transmitter. The experts also determine the MAC (*Media Access Control* - address, the access command to the medium) for the equipment, making unique identification possible. But where exactly is it?

So where's the wifi?

The investigation begins to find the guilty wifi. The search, on board the laboratory vehicle and on foot using a directional antenna and receiver, promises to be complex and time-consuming as the density of wifi use in the Paris region is very high. And as weather radars are very sensitive, we know that the cause of the interference could be a faulty RLAN in the 5 GHz band located anywhere in the direction of the azimuth in question and up to over 100 km from the radar!

The agents prepare their search by studying the terrain in the scrambled azimuth. An elevation profile is drawn up to see if there are any obstacles that could narrow the scope of the search. The search begins in the urbanised area of Saint-Quentin-en-Yvelines up to the first natural obstacle about 7 km away, it is unsuccessful. The controllers carry on their search until they reach the next obstacle:

Azimuth
Comes from the Arabic word "*az-samt*" which means path. The azimuth is an angle measured from true north in degrees from 0° to 359° clockwise: the east is at 90°, the south at 180°, and the west at 270°. On a weather radar image, the azimuth is the angle between the direction of true north and the direction of the object created by a cloud mass, wind speed or the line generated by interference.

WHAT THE LAW SAYS

When an authorised application in the 5 GHz band suffers interference, it requests the intervention of the ANFR.
The Agency searches for the origin of the interference, applies a € 450 tax* to the owner of the incriminated RLAN network for ANFR intervention costs (Budget Act) and files a criminal complaint with the public prosecutor. Indeed, users of radio equipment or installations in non-compliant conditions, which also cause interference, are guilty of two offences subject to the same criminal sentences which can be up to six month in prison and a € 30,000 fine (Article L. 39-1 of the French Post Office and Electronic Communications Code).

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

the Fausses-Reposes forest. The intermittent nature of the interference and the density of the wifi force the ANFR agents to take action in this area several times. Still unsuccessfully.

Be careful of the high rise building!

After these unsuccessful interventions and the passing weeks - here we are at the beginning of April 2019 - the other possible obstacles located in the azimuth are defined: the Ufimeg building in Bagnolet (Seine-Saint-Denis) and the Montparnasse Tower (Paris). The searches in Bagnolet are unsuccessful.
On 18th April, the agents go to the top floor of the Montparnasse Tower... Eureka! At last they can clearly view the offending RLAN equipment's MAC address on their devices.

Guilty *selfies*

A thorough search leads them to a Wifi access point, which turns out to be used to transfer data from a *selfie* photo booth located on the viewing deck. The users have no idea that a series of *selfies* could simulate a rain zone on a Météo-France radar!
The ANFR agents and the owner of the wifi photo booth put an end to the interference. The owner is notified of a € 450 tax for intervention costs following the offence.

"On 18th April, the agents go to the top floor of the Montparnasse Tower... *Eureka!*"

What are the rules that protect the Météo-France frequencies?

Météo-France has several C-band hydro-meteorological radars. They are distributed throughout France to locate and quantify precipitation - rain, snow, hail - and measure its intensity. A C-band weather radar has a parabolic antenna that emits a beam of electromagnetic waves in the 5 GHz frequency band.

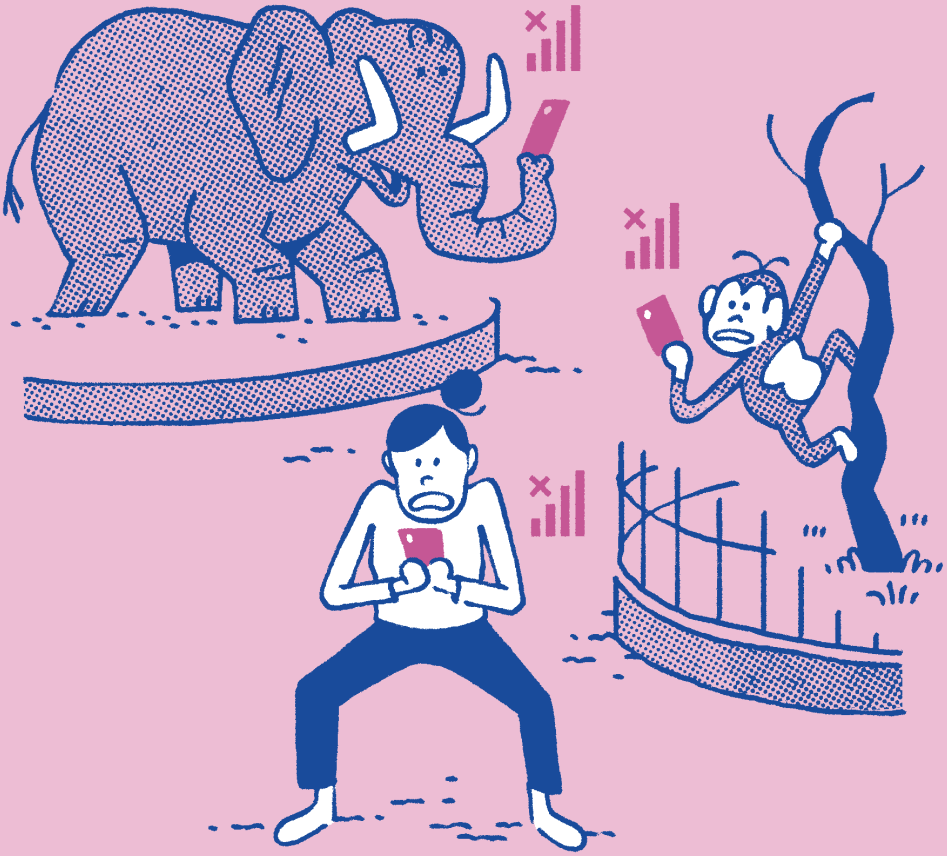
When moving in the vertical and horizontal planes, the radar scans the surrounding space up to a range of about 100 km. The emitted waves are reflected by raindrops, hailstones and snow. Their echoes, which correspond to an infinitesimal part of the received wave, are received by the highly sensitive radar which analyses them. The radar calculates the distance between itself and the drops and thus locates the precipitation areas. A precipitation map is then drawn up for weather forecasting.

Weather radar interference

Non-compliant use of the 5 GHz frequency band can interfere with images collected by weather radars using the same frequency band, and prevent or alter Météo-France's forecasts of future rainfall.
We know how critical this information is for the safety of people and property, as well as for air transport.
This is why the use of RLANs or wifi in the 5 GHz band must follow strict rules. A faulty or improperly used RLAN can thus alter the collected images.
The 5 GHz frequency band is "free" because there is no individual licence to obtain, but this does not mean that there are no rules to follow. These include a ban on transmitting above a defined maximum power and the duty to use a dynamic frequency selection system, or DFS, to avoid interfering with radars. RLAN owners in the 5 GHz band are the guarantors of the proper use of the frequencies and are liable if their equipment causes interference.

Investigation no.4

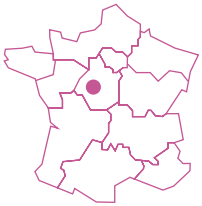
Internet trouble at the zoo



Or how a TV preamp can be very deceiving

Spring 2019, Beauval Zoo in the Loir-et-Cher region of France. Some visitors and employees who all have subscriptions with the same operator experience problems with their telephone and 3G mobile internet connections. It becomes complicated to send souvenir *selfies* with the pandas, to look for stuff on Wikipedia about big cats, but also to just communicate and work inside the zoo. The jammed radio site turns out to be located near the arrival of the elephant park cable car.

IT IS THE MOBILE OPERATOR IN QUESTION that refers the matter to the ANFR for this blatant interference impacting its frequencies in the 900 MHz band. The quality of its service is impacted beyond the perimeters of the zoo. So the ANFR starts a field investigation with its sworn and authorised experts from its International Control Centre in Rambouillet. They visit the site on 5th May 2019 equipped with their state-of-the-art measuring equipment.
The agents accurately measure the interfering signal on frequency 910.690 MHz, next to the disrupted radio site. They carry on the search on board their laboratory vehicle, tracking the signals. These eventually guide them to the village of Saint-Aignan, 2 km away from the disrupted site. The interference signal seems to come from a house, ...



Beauval Zoo
(Loir-et-Cher, France)
35,000 animals
0.4 km²

20 May 2019
Intervention date

In the attic

Our agents contact the owner of the premises to continue their investigation. The owner doesn't allow the ANFR to enter his home on the same day. He is therefore sent a letter reminding him of frequency regulations and requesting an appointment.
On 20th May, the agents return with their portable measuring devices and identify the cause of the interference: a basic television pre-amp installed in the attic! This faulty device is producing unwanted emissions in the 900 MHz frequency band, which are impacting the mobile operator's 3G network.
A further letter requests that the owner of the installation carry out works (repair or replacement of the TV pre-amp) to end the interference within a given time limit... A time limit that has to be extended because the TV installer couldn't work due to the heat wave that is raging at the time... Once the necessary work is been carried out, the ANFR receives confirmation from the mobile operator that the interference has come to and end. Beauval Zoo interconnectivity was back!
The person at the origin of the interference was in good faith and quickly remedied the interference, so the ANFR did not resort to legal proceedings.

WHAT THE LAW SAYS

For interference caused by non-compliant radio equipment, the ANFR can charge the party responsible for the interference a flat tax* of € 450 for intervention costs (French Act no.86-1317 of 30 December 1986 on the 1987 budget).

Such interference is an offence subject to a criminal sentence of up to six months in prison and a € 30,000 fine (Article L39-1 of the French Post Office and Electronic Communications Code). Furthermore, the use of radio equipment, in this case a TV pre-amp, in non-compliant conditions is also an offence subject to the same criminal sentencing.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

How can a TV pre-amp interfere with phone systems?

A television pre-amp is an electronic device that improves digital reception quality when the level of the signals received by a rake TV aerial is not sufficient to guarantee it. Useful in a private home located at the limit of DTT (Digital Terrestrial Television) coverage, pre-amps are often essential in apartment buildings, where the distribution of the signal to several dwellings splits its power.
These devices don't normally interact with the outside world: their signals are confined to the dwelling distribution cables. However, if they are not compliant or when their electronic components start to age, they can sometimes produce unwanted or parasite emissions. If these reach the rake aerial which acts as a transmitter, they are broadcast throughout the neighbourhood and can disrupt the services that legitimately use the frequencies in question.

Vigilance

Every year, the ANFR deals with a large number of cases of interference caused by faulty TV pre-amps that impact the mobile phone bands (180 in 2018).
It's therefore important to be careful when purchasing such equipment: its compliance with European regulations (RED directive), which is shown on the CE marking, and any conditions for use in its documentation must be checked.
It must then be kept in good condition and regularly replaced to avoid obsolescence.

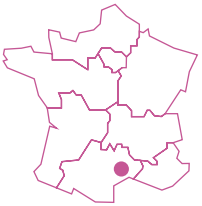
Investigation no.5

Rescuing the fire brigade

Or how watching TV can undermine the work of the fire brigade

September 2019, Lodève, Hérault area of France. Summer and its major forest fire risks are receding, but the firemen at the fire, search and rescue centre remain on the alert, 24 hours a day. Fire protection and fire-fighting, the exclusive remit of the fire brigade, never really let up! Recently, however, their radio transmissions are suffering intermittent interference, which is highly inconvenient for our fire-fighting teams. For a change, they're the ones who need to be rescued.

THE MINISTRY OF THE INTERIOR, which assigns the frequencies suffering interference, reports the problem to the ANFR Aix-Marseille regional department agents on 12th September 2019. The interference specifically impacts the 86 MHz band frequencies on the Lodève fire and rescue centre pylon's radio installations. This is an especially complex case of interference because it is occurring randomly: it can only be traced when it occurs! On the day in question, ANFR agents go to the centre equipped with a portable spectrum analyser, a directional antenna and signal recording and analysis equipment. They note the interfering signal's characteristics, which is emitting two carriers on the 86.015 MHz frequency, plus or minus a few kHz. They are one step closer! The agents then get ready to look for the culprit, but the interference disappears. A few days later, they again make an attempt which is unsuccessful for the same reasons, the signal is playing hide-and-seek... They will try again later.



Lodève (Hérault, France)
7,477 inhabitants
23.17 km²

21 November 2019
Intervention date

Third time lucky

It's isn't until their third try, on 21st November 2019, that the agents finally make progress, the signal seems to be holding... Luckily, they don't have to go very far. Their investigations using sophisticated measuring equipment, gradually lead them to the a person's flat, located just under 100 m from the fire station.
The tenant agrees to let the agents pursue their investigations inside the flat. The agents find an HDMI cord in his living room that is poorly insulated and radiating. The cause of the interference had at last been identified: it's the HDMI cord between the box and the television!

The problem with intermittence

The intermittent nature of the interference experienced by the fire brigade had been explained: the interference only happened when the person started watching his television. And during this third and final intervention, the tenant of the flat had watched the television long enough for the ANFR agents to be able to knock on his front door.

HDMI
Means *high definition multimedia interface*. It's a digital standard that's used to send encrypted streams consisting of uncompressed video data and audio data that can be compressed. An HDMI cord connects an audio/video source such as a computer or game console to a compatible device such as a TV or a video projector.

WHAT THE LAW SAYS

Interference generated by electromagnetic compatibility issues with electric or electronic equipment, according to the provisions in 2.b of Article L.39-1 of the French Post Office and Electronic Communications Code, is subject to criminal sanctions. It is punishable by six months in prison and a € 30,000 fine. If the person at the origin of the interference is in good faith and remedies the interference quickly, the ANFR has the possibility of not undertaking legal proceedings. However, if necessary, the ANFR can issue a report to inform the public prosecutor for criminal proceedings.

After questioning the person, the dates on which the fire brigade suffered interference were found to be consistent with the times he was at home and watching the television.

Untimely parasites

The HDMI cable, which might have been defective due to a lack of shielding, was radiating parasite electromagnetic signals in a frequency band reserved for the Ministry of the Interior for fire brigade communications!
The tenant immediately stopped using the cord, and the fire brigade confirmed that the interference had stopped on the very same day. The rescue centre could safely resume its activities in peace.

"The dates on which the fire brigade suffered interference were found to be *consistent* with the times the tenant was at home and watching television."

What causes electromagnetic compatibility problems?

Over 35% of the interference reported to the ANFR is caused by electromagnetic compatibility (EMC) issues, namely parasite signals emitted by an electric or electronic, industrial or household device, or a radio device.
It's therefore important when buying electronic or electric equipment to make sure it's compliant with European regulations (CE marking) and requirements covering electromagnetic compatibility. It's also important to keep such equipment in good condition: any radio (TV pre-amplifier, aerial, transmitter, etc.), electric or electronic (LED lighting, electric fence, etc.) industrial or household equipment, can become defective and non-compliant for a variety of reasons (obsolescence, incorrect settings, incorrect use, etc.). That's when it's likely to generate parasite signals on various frequencies.

Collateral damage

These parasite signals may then impact the availability of radio-communication services (mobile phones, audiovisual broadcasting, aeronautical communications, etc.) that legitimately use these frequencies in a more or less extensive surrounding area. This impact may range from the alteration to the unavailability of the wireless services in question, the collateral damage being the activities and infrastructures that use these wireless communications to send data or orders. It's easy to understand that the consequences can be serious when it comes to critical or emergency activities or infrastructure.

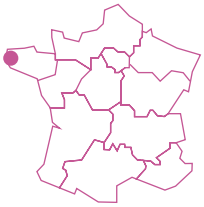
Investigation no.6

Transmissions in troubled waters

Or how fishing for information can get complicated

October 2019, off the coast of the Finistère area of France.
An experiment intended to improve maritime safety information (MSI) radio transmission resources is severely disrupted on the communication frequencies it uses.
A highly problematic situation for a project that's supposed to facilitate exchanges!
Fishing boats are present in the vicinity at the same time, happily chatting with each other over the airwaves. But before concluding that...

FRANCE HAS BEEN PUSHING the NAVDAT project **FOR SEVERAL YEARS**, as part of the modernisation of the Global Maritime Distress and Safety System (GMDSS). The purpose? To facilitate the use of on board MSR radio transmissions and offer shore-based entities more flexible maritime safety information broadcasting. These are, for example, urgent notices when changes to sailing conditions occur that may lead to dangers for pleasure boaters or sea-going professionals.
In October 2019, an experiment in the 4 MHz band is being conducted by the Corsen CROSS (Regional Operational Surveillance and Rescue Centre). This specialised Ministry of Transport and the Seas centre is located in the town of Plouarzel in the Finistère area of France. Unfortunately the experiment is severely disrupted by unwanted users! The Cerema (French centre for the study and expertise of risks, the environment, mobility and planning) then asks the ANFR to help end the interference so that the experiment can be conducted in good conditions.



CROSS Corsen (Finistère, France)
1,000 operations per year

21 October 2019
Intervention date

Hello Finistère, Yvelines calling!

The ANFR then calls on its International Control Centre (ICC) in Rambouillet, in the Yvelines area of France. It's from there that the Agency controls the radio frequencies reserved for coastal stations using specialised equipment to monitor HF (high frequency) networks and in particular its antenna field. It's the only civilian control station in France for frequency bands below 30 MHz, i.e. HF bands. The ICC agents are able to intercept conversations between fishing boats and find that, to speak to each other in the zone, they are illegally using the 4,351 kHz and 4,354 kHz channels, which are frequencies reserved for coastal stations. This isn't the first time the ANFR witnesses such interference caused by fishing boats either seeking to hide their fishing zones from their competitors who respect the authorised channels, or simply wanting to chat to each other on these bands, which is prohibited since they are reserved for exchanges relating to navigation and its safety.

NAVDAT
This is the name given to the coordinated transmission and automatic reception of maritime safety information (MSI) on the 500-518 KHz and maritime HF bands.

Case closed

The Brigadier on duty butts in to the discussions by using the ICC's HF transmitter to broadcast a message ordering the offenders to free up the frequencies. To make sure the message has been received, the ICC asks its colleagues at the ANFR regional service in Donges, close to the maritime zone in question, to repeat the message to the offenders. This local relay made it possible to insist.

The HF transmitter at Donges is then used to send a new message to the fishing boats, asking them to use channels authorised for ship-to-ship communications, in this case 430 (4,146 kHz) and 431 (4,149 kHz). As a result of these repeated contacts, the fishing boats comply and switch to an authorised frequency. As the interference had ceased, the NAVDAT experiment was able to resume in good conditions.

"The agents intercept discussions between fishing boats and find that they are *illegally* using frequencies reserved for coastal stations."

CROSS
The regional operational surveillance and rescue centres have the general mission of coordinating safety and surveillance activities for the benefit of seafarers, professionals and pleasure boaters.
These are decision-making centres that take charge of all rescue operations as soon as an incident occurs in the maritime domain. Five CROSS centres cover the mainland France coastline. In the French overseas territories, there are two CROSS centres.

How does the Rambouillet ANFR centre monitor at such distances?

The ANFR's International Control Centre has specific static resources used by its brigadiers to monitor HF band emissions - i.e. the low bands below 30 MHz - on the European continent but also a large part of Africa, the Near East and the Middle East. It also treats cases of HF band interference.

An antenna field

To do that, it has an antenna field covering some thirty hectares, composed of six high-gain directional diamond-shaped antennas opening up the possibility of monitoring all continents, as well as direction-finding tools that make it possible to identify the country from which the faulty HF emission originates: a static direction finder and access to an inter-ministerial direction-finding chain.
To try and locate HF emissions in the field, the ICC has a mobile direction finder installed on a laboratory vehicle.

The case of the fishing boats

Maritime bands host distress bands! Thus, the illegitimate use of frequencies by fishing boats can have critical consequences for the safety of maritime and aviation navigation. This is especially the case for the use of unauthorised frequencies reserved for distress and safety calls and communications, both in the maritime and aviation mobile service, which are defined in the Global Maritime Distress and Safety System (GMDSS).

"This is the ANFR International Control Centre calling, this frequency is not assigned to ship-to-ship calls, please immediately switch to a frequency reserved for ship-to-ship communications. Using this frequency is an offence punishable by law."

Message broadcast to the fishing boats by an ICC brigadier

Investigation no.7

Days aren't always rainy Brittany!

Or how to simulate rain and fool the weathermen

21st January 2020, Plabennec, Finistère area of France. The weather radar is experiencing significant disturbance impacting the echoes over a wide observation area ranging from 350° to 10°. This interference is creating a series of parasite lines on the screen, altering forecasting capabilities, and the weathermen are no longer sure of anything! The fact that a very large area is suffering interference is characteristic of disruptive emissions close to the radar... Which is already a good start to the field investigation.

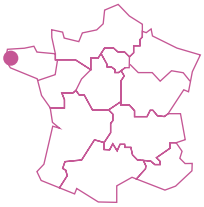
THE AGENTS FROM THE REGIONAL ANFR SERVICE in Donges, the closest to the zone suffering the interference, are alerted and plan their intervention. They arrive on site on 30th January with their laboratory vehicle and measuring equipment. The first readings are taken near the radar, in the vicinity of the local stadium. An emission on the weather radar frequency is detected from that point, but it is of low amplitude and seems rather to come from the town centre.

Another measurement point is therefore organised in the town centre, near the church. The agents quickly detect the presence of numerous wifi links emitting on the weather radar frequency. They look up: there are RLAN (wireless local area network) antennas used for wifi connections on the church itself, but also on the street lights. The installations seem to be relatively recent... Is there a connection with the weather radar interference?

Beaten at their own game

Further measurements at other points in the town centre indeed show that the interference is coming from the video protection system using wifi wireless links that is being installed. On the recommendation of the ANFR, on the very same day, the town hall's service providers physically disconnect wifi antennas installed in the town leaving no doubts as to the cause: the antennas are indeed the culprits! The ANFR notifies the town hall that it has breached the frequency regulations and demands that the necessary corrections be made to remedy the interference before the network can be put back into service. In especially has to check that all installed RLAN terminals are compliant and have a properly functioning Dynamic Frequency Selection (DFS) system to avoid the frequencies of authorised radars such as weather radars.

Météo-France has since confirmed that untimely rain no longer appears on their radars... And so people can once again leave their umbrellas at home.



Plabennec (Finistère, France)
8,515 inhabitants
53.43 km²

30 January 2020
Intervention date

WHAT THE LAW SAYS

People causing interference by breaching regulations are liable to be sentenced to six months in prison and a € 30,000 fine under Article L39-1 of the French Post Office and Electronic Communications Code. Users of radio equipment or installations, in this case RLANs, in non-compliant conditions are liable for a second offence subject to the same criminal sentencing. They are also subject to a tax* of € 450 for the ANFR's intervention costs.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

Why can wifi networks interfere with weather radars?

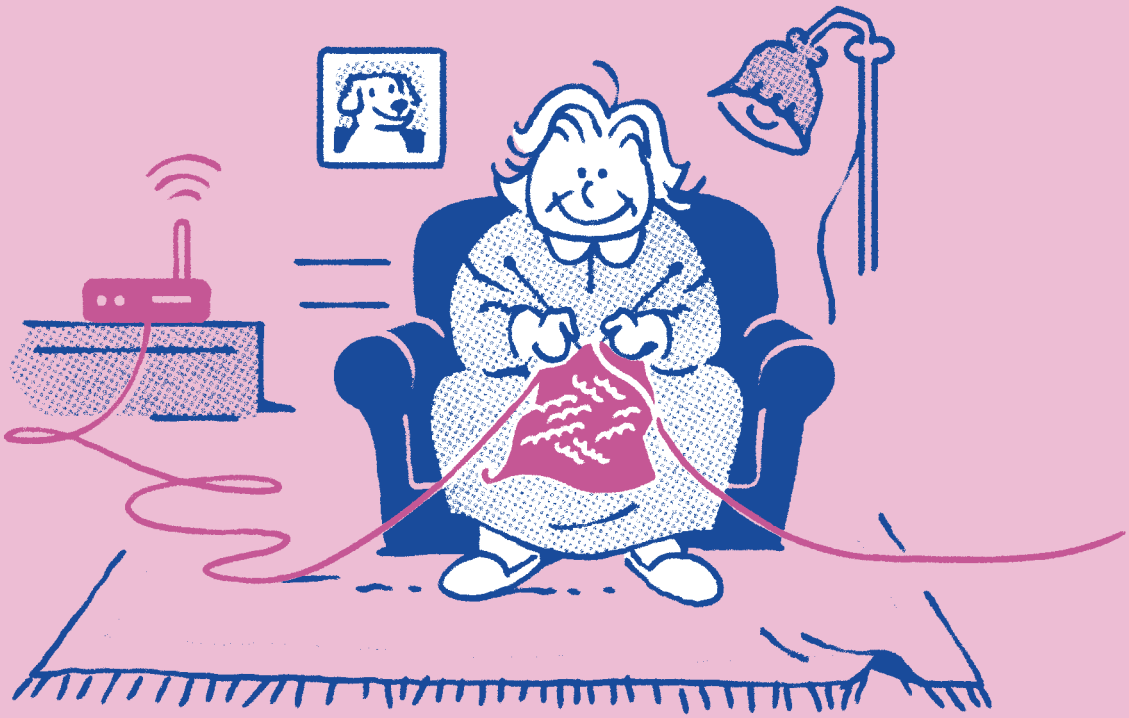
When wireless local area networks (RLAN) are installed in the 5 GHz frequency band, such as wifi networks, it's essential to follow the applicable rules. Indeed, this band is also used by the Météo-France weather radars. They are used to locate precipitation (rain, snow, hail) inside a radius of over 100 km, and to measure their intensity to generate precipitation maps for weather forecasting. Everyone knows how critical this information is for the safety of people, goods and air transport.
Non-compliant use of the 5 GHz band by wireless systems (wifi/RLAN) can alter the data collected by these radars and thus prevent or alter Météo-France's rainfall forecasts.

Rules to know

Wifi terminals and RLANs in the 5 GHz frequency band must therefore follow certain rules, which is unfortunately not always the case. The use of the frequencies in this band is exempt from fees and does not require an individual authorisation from the French regulating authority (Arcep). As other services also use the band, certain rules must however be followed.
In all cases, 5 GHz band use must allow different applications using it to cohabit and must not interfere with the authorised users of these frequencies. The maximum authorised installation output power values must especially be used to limit the wireless connection lengths and thus the extent of the network. The equipment must also continuously scan the frequency band in which it operates to make sure there is no weather radar (or other authorised application) on the same frequency.

Investigation no.8

Beware of geek grannies!



Or how to innocently completely jam the activity of a business

13th February 2020, somewhere in the Drôme area of France. A business specialising in the development of professional GPS and Galileo equipment for high-precision geolocation has its activities disrupted by interference.
The business starts out by conducting its own internal checks without finding anything amiss.
It manages to characterise the interfering signal though, which will make the rapidly alerted ANFR's work easier.

THE MEASUREMENTS MADE BY THE BUSINESS suffering the interference using a portable spectrum analyser, have already found the direction from which the transmissions are coming and their type: pulsed interference centred on the 1,581.15 MHz frequency, which permanently impacts the reception of the GPS and Galileo signals in the frequency band centred on 1,575.42 MHz. Valuable clues for the ANFR specialists, who arrive on site on 25th February 2020.

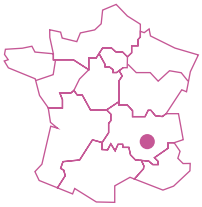
Trusted direction finder

The Lyon Regional Service agents begin by noting the actual existence of the interfering signal. Then, using the direction-finder receiver on the roof of their laboratory vehicle, they set off to find the source of the interference. The direction finder easily identifies the building from which the signal is coming. The agents park and continue on foot with their portable receiver equipped with a directional antenna. It leads them to the front door of a ground floor flat. All they then have to do is to find the culprit device. Luckily, the occupant, an elderly lady, is at home and lets them in.

The box was doing overtime

There's no longer any doubt: it's the internet box that's gone rogue! It's transmitting unwanted radiation precisely in the frequency band reserved for the GNSS. The agents turn it off and ask the business to check if the problem is solved: yes, the interference has disappeared. Although defective, the box had carried on providing the elderly lady Internet access, while interfering with a sensitive frequency band reserved for civil aviation, defence and space!

The operator was contacted to remedy the fault, and three days later a new box was installed. In the meantime, however, the business that had suffered the interference had kindly agreed to let the lady carry on using her defective device for a few more days: without it, she wouldn't have been able to make phone calls, watch television or connect to the Internet!



Valence (Drôme, France)
64,750 inhabitants
36.69 km²

25 February 2020
Intervention date

WHAT THE LAW SAYS

Causing interference on an authorised frequency, in this case a GNSS frequency, using non-compliant radio, electric or electronic equipment is an offence subject to a sentence of up to six months in prison and a € 30,000 fine (L.39-1 of the French Post Office and Electronic Communications Code). Of course, the fact that the offence was deliberate or not is taken into account. A tax* of € 450 may also be charged to the user of the radio equipment in question, to cover the cost of intervention by the ANFR to find the origin of the offence.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

GNSS systems

GPS and Galileo are part of the GNSS (*Global Navigation Satellite System*) family of satellite navigation devices which are essential for location but also for synchronisation in many sectors of activity: transport, search and rescue services, telephone and internet services, electricity transport networks, etc.

How do you protect from GNSS signal interference?

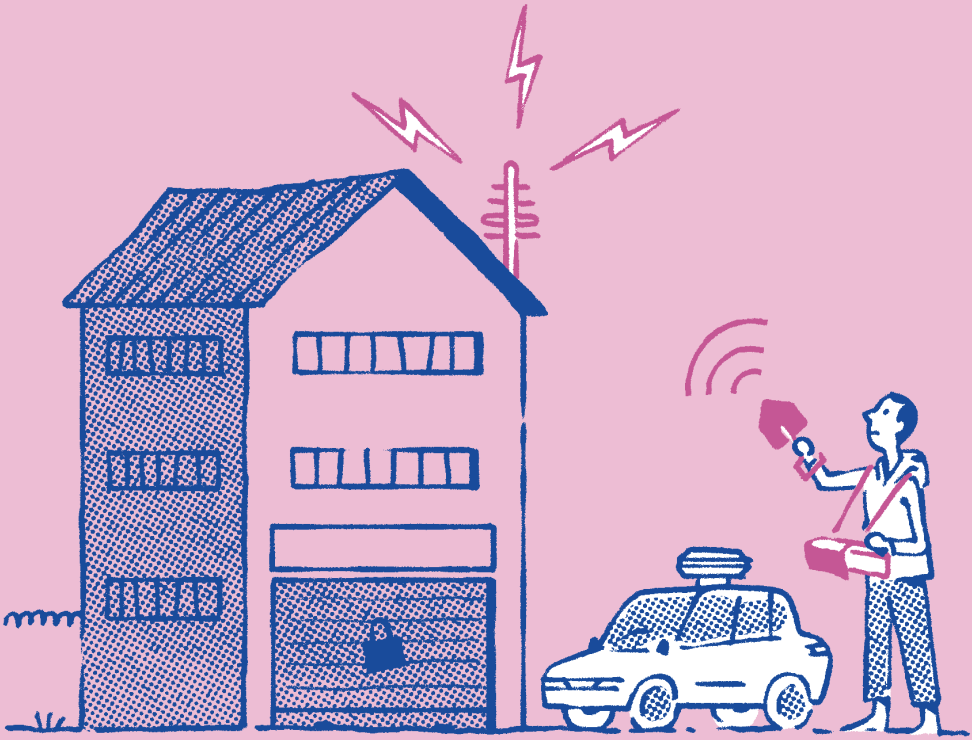
GNSS (GPS, Galileo...) signal protection is essential because they provide positioning and clock information that has become vital to a growing number of industrial, professional and personal applications (see page 11).
GNSS signals from satellites are very weak, making them vulnerable to interference. Interference prevents the supply of positioning and clock reference information for all services in the interference zone.
The source of interference may be radio, electric or electronic equipment which does not comply with the essential requirements of the European marketing directives because of its defective design or because it has drifted: it emits electromagnetic energy, radiation or electromagnetic induction which interferes with authorised service radio transmissions.

Safety issues

While there are no practical ways of completely eliminating risks of GNSS interference, steps can be taken to significantly reduce its impact. And it's essential that all the sectors that make critical use of GNSS signals know how to detect interference, or at least suspected interference. Indeed, such detection makes it possible to increase global safety levels by supporting response operations, including the implementation of available resilience resources and reporting to the ANFR so that it can investigate the interference and contribute to its resolution.
If the victims of GNSS interference are GNSS frequency assignees, they can call upon the ANFR by sending an interference investigation request form for their frequencies. If the victims of GNSS interference are players other than the assignees, the ANFR has a specific interference report form available on its website. On receipt, the Agency will look at the complaint and launch an investigation if necessary. It was this form that the Drôme-based business issued to report the interference.

Investigation no.9

How many times do we have to say it...?



Or how repetition isn't always a good idea

January 2020, Éauze, in the Gers region of France.
A mobile operator is receiving complaints from a large number of customers. The 3G network is showing signs of weakness over a wide area, both when phoning and when browsing the internet. And the fact that Éauze is the capital of Armagnac - a speciality alcoholic beverage proudly promoted by the town hall - has absolutely nothing to do with it, we promise!

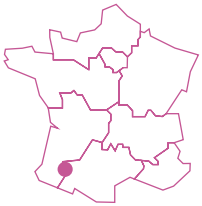
ON 29TH JANUARY, the mobile operator contacts the ANFR to report the interference which is having an impact on its 3G network in the 900 MHz frequency band in the town. The interference is having an impact on both the availability and the quality of its mobile voice and internet services. The Élusates - the inhabitants of Éauze - feel short-changed.
On 18th March, an agent from the ANFR regional service in Toulouse arrives to investigate the source of the interference. First finding: although it's observable, the interfering signal appears to be unstable, both in terms of strength and transmission frequency.
Back on site the next day in his laboratory vehicle equipped with a direction finder, our technician manages to find the direction the transmission is coming from. Then everything speeds up as he moves on foot, with his portable analyser. His directional antenna leads him straight to locked business premises.

Confessions

Contacted by phone, the manager immediately admits to having installed a mobile phone repeater to amplify the signals and improve, according to him, mobile communications inside the business without any authorisation from the operators in question. The repeater is causing interference, deteriorating the coverage and quality of the operator's services in a vast area around the business premises. Besides the risk of creating congestion, preventing emergency calls, this breach of frequency regulations could cause the deterioration or even denial of service to applications that need to receive or send information or orders *via* the wireless network in question.
On the same day, 19th March 2019 at 11:30, the device is silenced, immediately eliminating the interference, which the mobile operator quickly confirms.

No lockdown for ANFR agents

During the lockdown, the ANFR control agents stayed active in the field, and were very heavily called upon!



Éauze (Gers, France)
3,975 inhabitants
69.26 km²

19 March 2020
Intervention date

WHAT THE LAW SAYS

The unauthorised use of frequencies is a criminal offence punishable by up to six months in prison and a € 30,000 fine (Article L.39-1 of the French Post Office and Electronic Communications Code). Disrupting a service by using unauthorised frequencies is a second offence punishable by the same sentences. These breaches also generate a tax* of € 450 when the ANFR takes action. Installing an unauthorised mobile phone repeater makes the owner almost certain to be detected sooner or later, and risk a sanction.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

Interference caused by repeaters
Almost 150 such interferences required intervention by our sworn and authorised agents in 2018. There was an exponential increase to over 350 cases in 2021, one of the consequences of the lockdown that overstretched the use of mobile networks inside buildings.

What are mobile phone repeaters?

Mobile phone repeaters, also known as mobile signal amplifiers, are used to strengthen the signal, usually to improve reception inside a building. They pick up the signal using the outdoor antenna, amplify it, and then broadcast it using the indoor antenna. As this is radio equipment, it must, amongst other things, comply with the so-called European RED Directive 2014/53/EU of 16 April 2014, and therefore bear a CE mark.

A strict regulation

The installation and use of 2G, 3G, 4G or 5G mobile phone service repeaters or amplifiers on one's own initiative is prohibited without the consent of the operator in question. Otherwise, it's an illegal use of their frequencies. It's also a sword of Damocles hanging over the head of the person using the repeater: indeed, if they are most often properly configured on the day they're installed, repeaters never change frequencies. But operators regularly adjust theirs! Repeaters carry on transmitting on the same frequencies, and turn into jammers! Repeaters can therefore deteriorate mobile phone and internet service coverage and quality of service in large areas overnight.

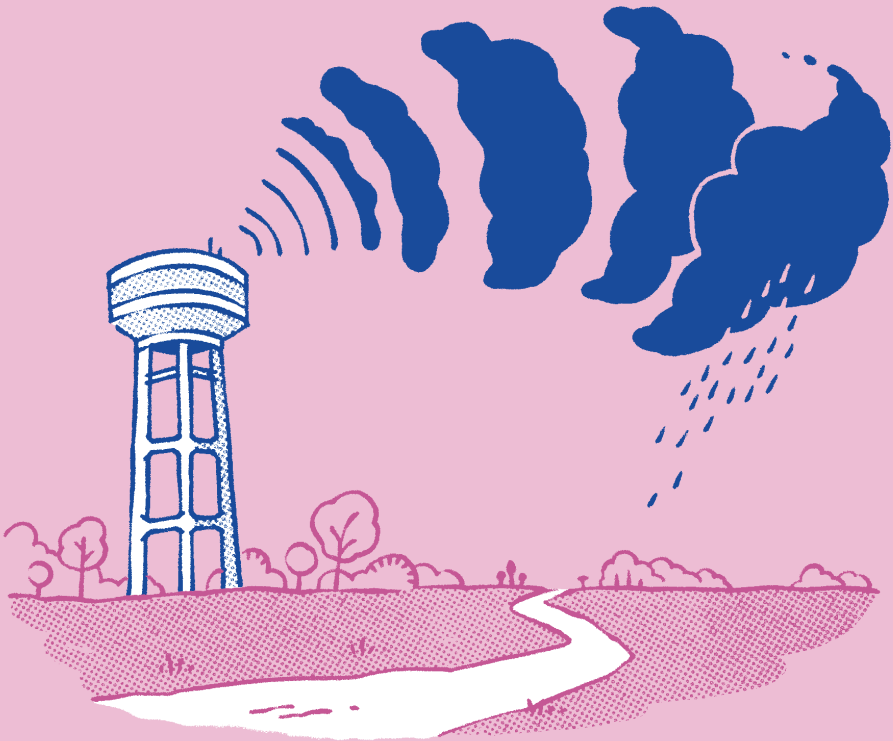
What are the solutions?

There are several solutions available to the general public or businesses[1] to remedy poor mobile coverage inside a building: for voice and text messages, calls can be made using the voice-over-wifi solution, provided of course that a fixed high speed internet access is available along with compatible mobile phones and a suitable offer. This solution doesn't require the prior consent of the operators. There is also the Distributed Antenna System (DAS), which is more suitable for larger locations. It's a network of antennas connected to telecommunications equipment deployed by one or more operators, depending on whether the offer is single or multi-operator.
In all cases, it's useful to contact the mobile operators beforehand to check that there aren't any temporary technical problems on the network, and to look for a suitable solution together. It could be an opportunity for them to upgrade their mobile network to provide better coverage.

1 - https://www.arcep.fr/cartes-et-donnees/new-deal-mobile.html#Indoor

Investigation no.10

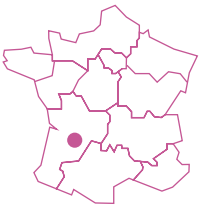
There's a storm on the radar



Or how to create clouds with a magic wifi wand

End of 2019, Montclar, in the Alpes-de-Haute-Provence in France: 406 inhabitants and an ultra-modern weather radar which covers the Tarn and the Aveyron areas, a flood risk sentinel. It constantly scans the horizon, and is capable of detecting rain clouds more than 100 km away. Yet, for several weeks now, Météo-France engineers have been puzzled by a permanent string of static clouds to the west. A few quick calls make it clear that there's no rain on the horizon, so the phenomenon isn't weather-related.

on the Météo-France Toulouse site, the diagnosis is quick: in specialist jargon it's a false echo caused by a distant transmitter. Indeed, the radar regularly sends out 5 GHz wave trains and then listens to detect clouds of which the threatening load (rain, hail, or even snow) sends back the echo. If a transmitter in the same direction, even a weak one, uses this frequency, the radar's highly sensitive sensors see a signal which they can interpret as an echo. An unusual cloud then forms on the screen.
Toulouse is also home to a regional ANFR service and the two administrations often work together: between satellites and radars, it's been decades since weather is no longer a matter of visual observations, but of frequencies.



Montclar
(Alpes-de-Haute-Provence, France)
406 inhabitants
23.38 km²

02 April 2020
Intervention date

A correctly identified signal

The interference is on the Montclar weather radar 5,645 MHz frequency, azimuth 265°. The alert is given, and the regional service goes into action. The first unavoidable step is to go to Montclar. On 24th March 2020, in the middle of the lockdown, they quickly drive the 140 km between Toulouse and the site. On site, the ANFR agents connect their devices to the weather radar which has been shut down prior to their arrival, to record the characteristics of the signal picked up by the ultra-sensitive echo receiver antenna. At first glance, it looks like a wireless local area network (RLAN). But the received signal is too weak to be able to tell anything else: none of the network identifiers can be decoded.

Looking for a wifi in a stack of waves

Before going back to their vehicle, the disillusioned ANFR agents watch the sunset: the view is most definitely superb from this spot, but how can they find an unknown wifi network in a 10° angle cone (between 260 and 270°), which could, if powerful enough, be as far away as 100 km? It's like looking for a needle in a haystack! And the hills and winding roads in the Aveyron, Tarn and even Tarn-et-Garonne regions won't make it any easier to stay on course! Of course, by helicopter, full throttle to 265°... But let's get back down to Earth. The next morning, the

RLAN
Means *radio local area network*. Numerous RLAN systems use the 5 GHz frequency band. They are used to provide wireless Internet access or to provide wireless data transmission between multiple sites.

ANFR laboratory vehicle sets off on the roads. With all the required lockdown certificates in their pockets, the controllers start their hunt in the Tarn area, around Albi. First the west: the first day is spent exploring the 20 km between Senouillac and Albi. The next day, they cover 10 km between Saint-Grégoire and Lescure d'Albigeois, and on the 3rd day, the twenty or so kilometres as the crow flies between Sérénac and Cadix.
Every network transmitting in the 5 GHz wifi band must be detected! A challenge. The truck then changes into a *Google Car* for the 50 km between Montclar and Albi. The instruments register no less than 1,901 active 5 GHz wifi networks!

No lockdown for waves

Due to the lockdown, it's a fact that all exchanges use electronic networks, and wireless is more essential than ever. When they get back, they look at the characteristics of each network and compare them with the data extracted from the radar and the possibilities end up being more manageable: only sixteen of the networks were transmitting frequencies that are actually compatible with the interference being experienced.

"Due to the lockdown, all exchanges use electronic networks, and the wireless network is more *unavoidable* than ever before."

Out of the sixteen, there are three plausible transmitters: three networks operating at 20 MHz around 5,620 MHz that could interfere with the radar, which operates at 5,625 MHz. So all that's left to do is to find the owner of each transmitter and get them to shut it down, and then to check the effect some 50 km further east, at Montclar.

No more room for doubt

So the solution is to return to the site, which occurs on 31st March, to characterise each of the suspect transmitters and lift any doubts. On 31st March, the team starts by the east of Albi, closest to the radar. But in Saint-Grégoire-Église, despite the temporary shutdown of the network, the interference remains... The same day, the Saint-Cirgue RLAN network is shut down. No change! This leaves only one possibility: the last transmitter is in Gaillac, to the west of Albi. So, on 2nd April, our agents finally succeed in silencing a wifi transmitter located on a water tower in a Gaillac hamlet, in Vors to be precise. Confirmation comes in: the interference has finally stopped. The transmitter is located 61 km as the crow flies from the weather radar. The company in charge of the system then finds that its equipment is defective: the power management had failed and the device was not only transmitting continuously, but at full power! The equipment was replaced a few days later and the network was never heard of again.

WHAT THE LAW SAYS

The owners of RLAN or wifi equipment are responsible for the correct use of frequencies and are criminally liable if their equipment is used improperly! They are liable to criminal sentences of up to six months in prison and a € 30,000 fine under Article L.39-1 of the French Post Office and Electronic Communications Code. The fact that the radio equipment or installation in question, in this case an RLAN, causes interference is another offence subject to the same criminal sentences.

Users also incur a tax* of € 450 for the ANFR's intervention costs.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

What's happening in the 5 GHz frequency band?

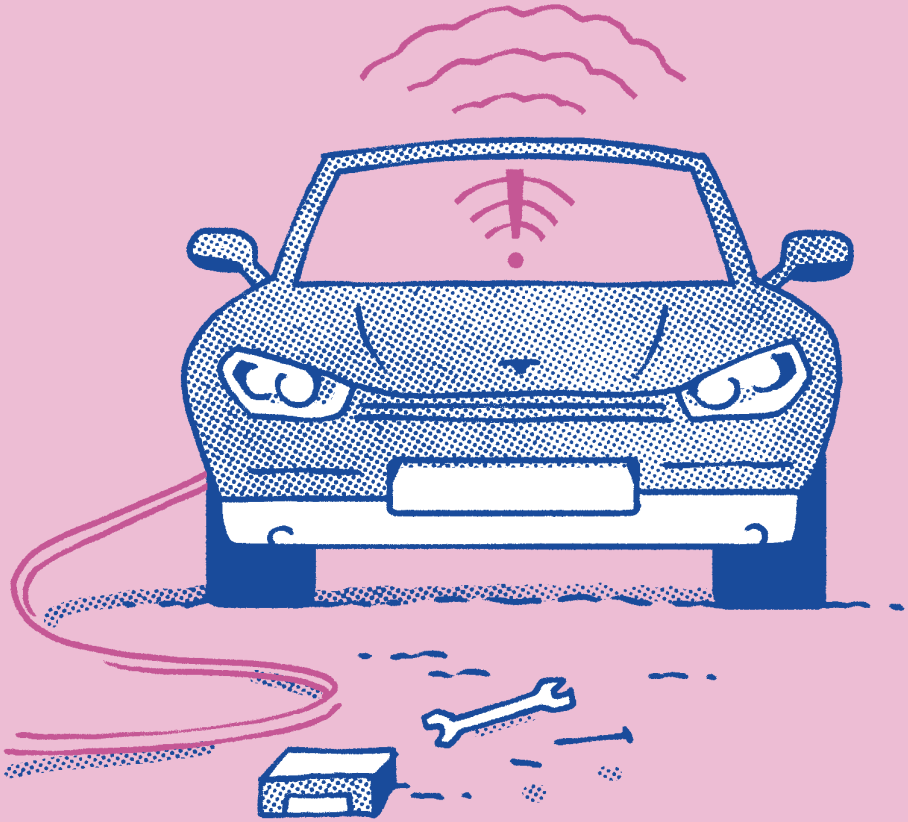
Part of the 5 GHz frequency band hosts authorised applications such as Météo-France weather radars. They are used to locate precipitation (rain, snow, hail) inside a radius of over 100 km, and to measure their intensity to generate precipitation maps for weather forecasting. When installing a radio local area network (RLAN) in the 5 GHz frequency band such as a wifi network, it's essential to follow the applicable rules, in particular to protect the weather radars.
The emissions from this defective RLAN equipment are picked up by weather radars,distorting their observations.
The weather radar detects a non existent shower.

The rules

5 GHz RLANs must have a DFS (dynamic frequency selection system): they can then recognise weather radar pulses and automatically switch to different frequencies.
RLANs in the 5 GHz band must also comply with maximum power limits.
All the rules are set out in an educational booklet that the ANFR published in 2018 and which is available on its website.

Investigation no.11

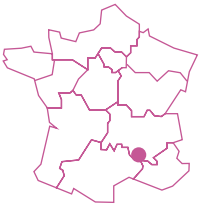
Too many connections spoil the Internet



Or how to disconnect others when you connect yourself

End of 2019, Saint-Ambroix, in the Gard area of France. A mobile operator sends the ANFR a request for an intervention due to interference impacting its 3G services in the town. The entire 900 MHz band is impacted and a cell tower is being disrupted. But not just any antenna, this one is erected on the grounds of a car garage. Could there be a connection between the interference and the garage activity? The best way to find out is to go there and see.

BEFORE THE ANFR SETS OUT, and to collect evidence for the investigation, the mobile operator goes to the garage to see what's going on there. Its suspicions are focused on the vehicles being repaired and more specifically on an electric vehicle. After all, to transmit frequencies, you need electricity: could all those four-wheeled batteries be the source of the interference?



Saint-Ambrois (Gard, France)
3,200 inhabitants
11.74 km²

27 January 2020
Intervention date

Well-founded suspicions

Informed and called to the rescue, the ANFR Aix-Marseille regional service agents want to be certain. They go to the garage on 21st January 2020. A spectral analysis close to the vehicle in question confirms that the interfering signal is indeed coming from it. But it's not because it's electric that makes it radiate; rather, it's its equally modern nature as a... connected car!

Hyper-connection

In fact, it turns it has a discrete communications box, a TCU*(Telematics Control Unit)* which is found on some electric vehicles. Using its SIM card, the TCU communicates with the dealer network, in particular to inform it of battery use, mileage or correct GPS operation. It can even be used to launch the car pre-heating *via* a smartphone, the ultimate comfort that's hardly seasonal at the beginning of this summer in the south of France...!

Untimely and rebellious

But here's the thing: this defective TCU produces untimely, permanent, abnormal radiation in the 900 MHz frequency band, disrupting the cell tower and all the surrounding phones.

To put an end to this interference, the idea seems simple enough: disable the TCU's SIM card. But it's important to know that connected cars don't take kindly to losing their connection! In fact, the vehicle would have been permanently immobilised: no TCU, no way out! Another option is therefore preferred: to find a qualified garage that can correct this fault, which is done after several attempts, including the complete dismantling of the vehicle's

Connected cars
The term connected object refers to any domestic or industrial object that has sensors and can use various types of wireless networks to connect to other terminals and systems on the Internet to exchange data for collection and analysis. The numbers of these connected objects are increasing: watches, smart irrigation, thermostats, scales, smart meters, refrigerators, etc.
They are part of what is known as IoT *(the Internet of Things)*.

dashboard to reach the offending TCU. On 27th January, after several hours of labour, the mechanic succeeds in resetting the TCU, which puts a final stop to the disruption.

Tracked

In the end, the car was tracked twice: by its dealer, *using* the TCU, and by the mobile operator, who saw alerts wandering around on its network supervision console! This malign interference moved every time the car was driven. However, it stopped moving from time to time: in the garage where it was at last identified, at the vehicle owner's place of work, and in the evening and at night, in the area around his home. Logical!

WHAT THE LAW SAYS

According to Article L.39-1 of the French Post Office and Electronic Communications Code, the non-compliant use of a frequency, equipment or a radio installation is punishable by a sentence of six months in prison and a € 30,000 fine. Furthermore, disrupting the radio transmissions of an authorised service by this non-compliant use is also an offence subject to the same criminal sentences.

The ANFR may also charge the offending person a tax* of € 450 to cover the cost of finding the radio installation used outside legal and regulatory conditions that caused the interference of a legally assigned frequency (French Finance Act).

Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.

"The alerts were wandering around on the supervision console... This very *malign* interference moved every time the car was driven."

Connected cars, a potential new source of interference?

The ANFR remains especially watchful because, following its intervention in the Gard region, two other cases of interference on mobile operator services caused by connected electric cars have been reported. They were solved, and the car manufacturer analysed and tested the radio module to prevent further interference.
The connected vehicles market is growing, and an increasing number of cars have a TCU with a SIM card to send data to the manufacturer's network and provide access to service packages tailored to these vehicles. Access to the mobile network is also required for all cars that have an *eCall* emergency call system that alerts emergency services in the event of an accident. Finally, these connections prepare the ground for the major industrial developments of driverless cars.

Vulnerability to interference

This increasing connectivity creates vulnerability to cyber-attacks, but there are also threats caused by interference. The M2M *(machine to machine)* connectivity of IoT (Internet of Things) is indeed vulnerable to interference, whether intentional or not. Conversely, as in the case of the garage, all connected objects are potential sources of interference.
To limit these risks, the radio modules of connected objects must especially comply with the essential requirements of European Directive 2014/53/EU of 16 April 2014 known as the "RED" directive. This means they must have a CE marking and have an EU declaration of conformity.
The use of frequencies by connected objects must also comply with the applicable regulations for each specific use, so that the different users of the frequency band in question can cohabit in good conditions and not encroach on neighbouring frequencies reserved for other devices.

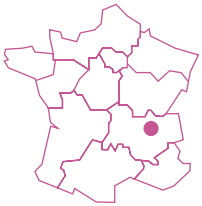
Investigation no.12

Hello 999, is anyone there? Pager off the air

Or how to disconnect the fire brigade without them knowing

During the summer of 2020, the activity of ANFR agents in the field to deal with radio interference wasn't very relaxing. The Lyon regional service intervented at the Rhône fire brigade, after proactively detecting potential interference thanks to its preventive monitoring of the use of the radio frequency spectrum.

IN AUGUST 2020, as part of its spectrum monitoring operations in the VHF bands (from 30 MHz to 300 MHz), and the UHF bands (from 300 MHz to 3 GHz), using the ANFR's national static network of direction finders, our experts detect a permanent and powerful emission on the 173.5125 MHz frequency
This frequency, which isn't intended for permanent use, is used to alert the fire and rescue services and to "beep" the teams using a pager. The pager is a small device that's part of fire-fighters' equipment: they all have one on their belts. It vibrates and rings to instantly activate the necessary resources when an intervention is triggered after a 999 call. The pager displays the type of alert, the vehicle to use and the location to go to.



Lyon (Rhône, France)
523,000 inhabitants
47.87 km²

11 August 2020
Intervention date

Beep? Beep beep?

The ANFR must react quickly to restore the emergency communications which are compromised by this permanent transmission. Firstly, it must immediately notify the frequency user of the anomaly: the Rhône fire and rescue service (SDIS 69). The fire brigade confirms the disruptive nature of the transmission, which does indeed impact pagers on the fire brigade's alert frequency, and immediately sends a request to the ANFR so that it can take action on the interference.
The technical investigation is carried out on 10th August by the Lyon regional service* control agents on board a laboratory vehicle.

Drive straight ahead!

Thanks to the azimuth indicated by a shot from one of the static VHF-UHF monitoring network direction finders installed at Saint-André-la-Côte, our investigators drive straight to the origin of the interference. But although the device indicates which direction to go in, it doesn't give any accurate information on the distance to the source.

Direction finders
or direction finding stations measure the incoming direction of an electromagnetic wave relative to the North Pole reference direction. Using triangulation, the precise location of a radio transmission can be calculated.
To locate sources of interference, the ANFR has static direction finders installed in permanent locations, and mobile versions to be placed on sites of interest. They are also installed on the top of its laboratory vehicles.

** Since end 2021, the Lyon and the Nancy regional services have merged to form the East inter-regional service (SIR EST)*

WHAT THE LAW SAYS

According to Article L.39-1 of the French Post Office and Electronic Communications Code, the non-compliant use of a frequency, equipment or a radio installation is punishable by a sentence of six months in prison and a € 30,000 fine.

Furthermore, disrupting the radio transmissions of an authorised service by this non-compliant use is also an offence subject to the same criminal sentences.
The ANFR may also charge the offending person a tax* of € 450 to cover the cost of finding the radio installation used outside legal and regulatory conditions that caused the interference of a legally assigned frequency (French Finance Law).

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

At the wheel of their vehicle, the agents progress and drive miles through the Rhône and Isère valleys...
The direction is continuously refined by the measurements of the mobile direction finder installed on the roof. They are getting close to the transmitting location when all of a sudden... The interference signal disappears from the radar! Our experts turn back and schedule another mission the next day, hoping to close the case.

Up on the mountain

On 11th August, their search finally leads them to a defective transmitter in Oriol-en-Royans in the Drôme region, on the Musan mountain. About 90 km as the crow flies but 160 km by road! Ironically, the transmitter was operated by another fire and rescue department, that of the Drôme region, which shut it down it immediately. Problem solved.

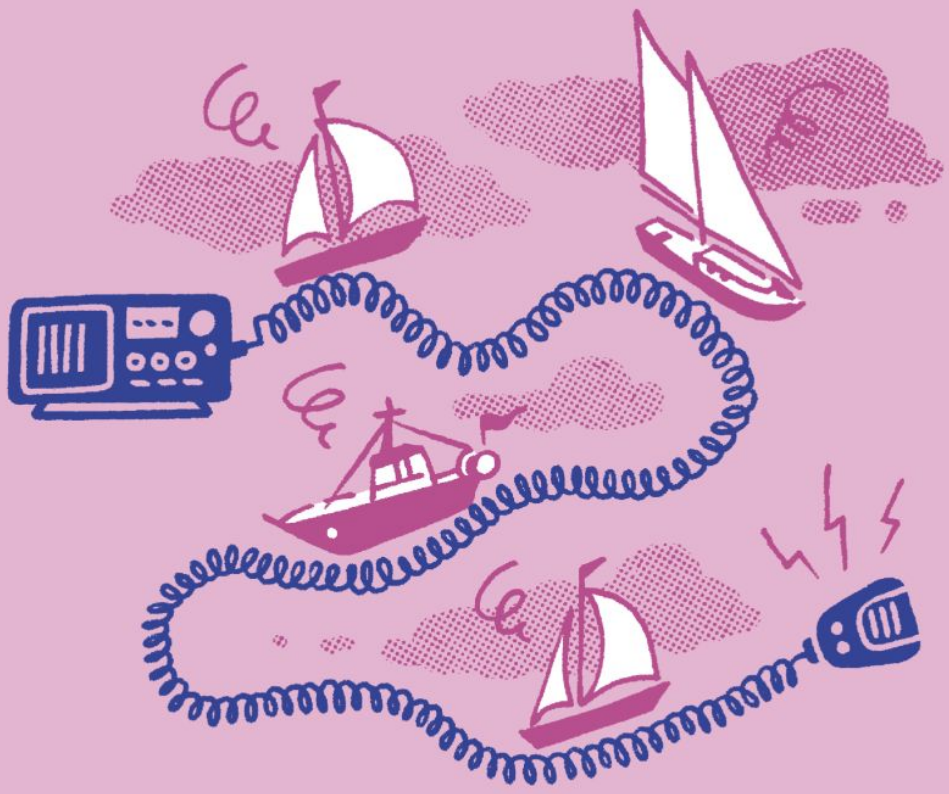
"At the wheel of their vehicle, the agents progress and drive *miles* through the Rhône and Isère valleys..."

What is the ANFR network of static control stations for?

The ANFR's static station network (direction finders and directional antennas) is used to monitor the spectrum in the VHF (from 30 MHz to 300 MHz) and UHF (from 300 MHz to 3 GHz) bands. It very accurately assesses the direction of transmissions in these bands and is used for preventive monitoring or to locate sources of interference.
The VHF and UHF bands are used for professional and security applications: police and law enforcement networks (e.g. ACROPOL, TETRA), health networks, fire and rescue networks, aviation, maritime, railway and defence applications. These bands are also used by applications of interest to the general public in the field of broadcasting and mobile services: FM radio, DAB radio, television, local networks, professional networks and wireless terminals. They must therefore be carefully monitored, especially as some people are tempted to use radio equipment operating on unauthorised frequencies and likely to generate interference, or to use bands that are little used in normal circumstances but which are strategic during a crisis or in exceptional circumstances.
The ANFR's static station network, which can be queried remotely by controlling agents, is a valuable ally in helping to monitor these frequency bands and to solve interference impacting security services in particular. The "goniometer shots" carried out by these static stations - judiciously placed on strategic high points with visibility over areas of dense wireless network use featuring an airport, a port, an urban centre or a border - help increase the ANFR's reactivity in solving certain cases of interference. The use of this static network saves time, either by giving a direction or, if direction finding cross-checks can be used, by defining the boundaries of a search area. Agents are then sent out in a laboratory vehicle to find the actual location of the source of the interference.

Investigation no.13

Magnetic panic on board



Or how a sailing boat disrupts traffic without leaving its mooring

End of September 2020, La Rochelle marina, France. Channel 9, marine VHF frequency 156.45 MHz, reserved for communications between the port and vessels, is showing signs of weakness. It's definitely a case of interference. The harbour master's office, a sort of port organiser, or conductor to use a musical term, ensures the fluidity of sea traffic and the mooring of ships. So how can musicians play to the beat when the conductor disappears from time to time?

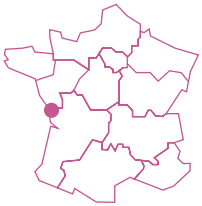
ALERTED BY THE HARBOUR MASTER'S OFFICE, the ANFR's Donges regional service takes on the case on 28th September and schedules an on site intervention within the hour. Authorised and sworn agents, equipped with receiver and spectrum analysis equipment go to the marina on 1st October to carry out a meticulous investigation to find the source of the interference.

Things gets complicated

When they arrive, the disturbance has disappeared! The investigation seems to be compromised... Before leaving, they carry out a few checks to better understand the port's electromagnetic environment. Strangely, an unstable signal appears on their screens, but on channel 5 (156.25 MHz), which is reserved for the port authorities. This instability is not minor: from time to time, this signal does drift... all the way to channel 9! But, in this case, not enough to recreate the interference that triggered this mission in La Rochelle. A false lead?...

Caught in the act

Unfortunately, there's a lot of interference in the area, and our agents can't prolong their investigation any further: the ANFR team therefore resigns itself to take to the road to tackle another interference case in the region. But a few hours later, the disruptive signal makes a remarkable comeback - this time smack bang in channel 9. U-turn! They need to hurry to catch the jammer in the act.
The signal is still there on site. All that's left to do is to search the port to find the source. However, although the ANFR's laboratory vehicle is equipped with a high-performance direction finder, it has one (minor) defect: it's not amphibious...
La Rochelle is home to the largest marina in France and one of the largest in the world... So now it's a matter of finding the right boat amongst over 5,000, but from land!



Port of La Rochelle (Charente-Maritime, France)
5,157 moorings
0.7 km²

1st October 2020
Intervention date

Why marine VHF is so important
The use of a VHF radio is essential for the safety of human lives at sea. It is used for communication between ships, to send and receive distress and safety calls at a range greater than that of a mobile phone network. VHF (*very high frequency*) radios use radio waves in the VHF band (156 to 174 MHz) reserved for the maritime service and more specifically for marine VHF (156 - 162 MHz).

WHAT THE LAW SAYS

Defective radio equipment may start illegitimately transmitting on a frequency. It's therefore important to buy compliant equipment (CE marking) and to keep it in good condition.
The unauthorised use of a frequency or its use outside regulatory conditions is an offence punishable by a maximum sentence of six month in prison and a € 30,000 fine (Article L. 39-1 of the French Post Office and Electronic Communications Code).

Disrupting the radio broadcasts of an authorised service by using a frequency in non-compliant conditions is also an offence subject to the same criminal sentences (L. 39-1 of the French Post Office and Electronic Communications Code).

Persons committing these offences are also liable to pay a tax* of € 450 to cover the costs of the ANFR, whose sworn and authorised agents discovered the offence, under the terms of the French Finance Law.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

From pontoon to pontoon

Since it's impossible to drive a truck on the many pontoons that structure the port, there are still quays that can be driven on. A few drive pasts, some angle readings, a bit of geometry, and they find two pontoons that are definitely suspect, no. 11 and no. 12... They have to make sure. Finding interference is a fully fledged sport: you need to use your head and your legs! The hunt for the jammer ends on foot, with a portable receiver. Soon there's no more room for doubt: the signal is coming from a sailing boat on which the owner lives permanently.
On board, the agents identify the device in question: a simple but defective VHF transmitter! But the equipment isn't immediately accessible because it's installed behind the dashboard. Our investigators therefore ask the owner of the boat to contact the harbour master's office to carry out the necessary work as soon as possible to stop the interference.
In early October, the harbour master's office calls in a specialist company to disconnect the defective VHF transmitter on board the sail boat. Since then, the harbour master's office has gone back to orchestrating the comings and goings in the La Rochelle marina in complete safety...

"Although the ANFR's laboratory vehicle is equipped with a high-performance direction finder, it has one (minor) defect: it's not *amphibious*..."

How is marine VHF managed?

The VHF (*very high frequency*) band, which covers from 30 MHz to 300 MHz, is shared for many uses - aviation, maritime, private, military, and and FM radios as well as amateur services. Fifty-nine channels are available in the VHF maritime mobile service band (156-162 MHz): this list is available in Appendix 2 of the ANFR manual for the preparation of the CRR (restricted maritime mobile service radio-telephone operator certificate).
This VHF maritime mobile service is shared by three different systems:
- Analogue voice telephony, the most important form of communication in the maritime mobile service.
- DSC (Digital Selective Calling) used for distress alerts, emergency and safety announcements and routine calls.
- AIS *(*automatic identification system), an anti-collision system to improve navigational safety.
These communication systems that use the maritime mobile service VHF band provide efficient exchanges of navigation data between ships, and between ships and shore stations, thereby improving safety at sea.

To be declared, and controlled

Marine VHFs, whether static or portable, must be declared to the ANFR, which issues an operating licence free of charge, as well as the maritime mobile service identifiers (call sign and MMSI - *Maritime Mobile Service Identities*).
The original copy of the current year's operating licence (posted if possible) must be on board as well as the CRR (or the pleasure boat licence in French territorial waters).
Boaters sailing abroad and using static or portable maritime VHF radio equipment are required to have a radio operator certificate at least equivalent to the CRR.
Since 2011, the CRR is no longer mandatory in French territorial waters for pleasure boaters using a portable VHF without the DSC function.
But with the DSC function and in French waters, you need to have *at least* a pleasure boating licence or the CRR.

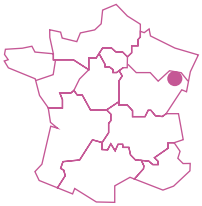
Investigation no.14

The robots attack

Or how jamming doesn't recognise borders

October 2020, in south-western Germany, in the Baden-Württemberg area. An environmental protection organisation suffers interference. It's the 459.55 MHz frequency used by a network of probes installed along the Rhine to measure radioactivity levels, that suffers interference. The German counterpart of the ANFR takes on the case and quickly suspects a French source of interference...

A REQUEST FOR ACTION for "border interference" is sent, as provided for by the Radio Regulations (RR) published by the ITU (International Telecommunication Union), to the ANFR's National Centralisation Office (NCO) on 7th October 2020. The NCO sends two agents from the Nancy regional service* to investigate.
The experts, who are authorised and sworn to investigate offences impacting the radio spectrum, must first define the search area and characterise the transmission causing the interference. They launch several measurements from the ANFR direction-finding station installed in Lutterbach (Haut-Rhin, France). This equipment is part of a static direction-finder network operated by the ANFR on French territory. They are used to very accurately assess the direction of transmissions in the UHF and VHF bands, as well as their spectral signature. These measurement results are combined with those of a German direction finder located near Strasbourg, on the highest peak in the Black Forest, the Hornisgrinde.



Mulhouse (Haut-Rhin, France)
108,312 inhabitants
22.18 km²

14 October 2020
Intervention date

To university

The verdict comes in: the source of the interference is somewhere south of Mulhouse, France. The ANFR agents focus their investigation in the defined zone, and take additional measurements from on board their laboratory vehicle. Their instruments lead them to a university site. The search ends on foot, arms outstretched, with a spectrum analyser and a directional antenna leading them straight to the roof of one of the buildings!
The source of the interference is in fact an RTK *(real time kinematic)* base used in the research and development of an autonomous robot.

Spectral signature
The spectral signature is the characteristic electromagnetic transmission of an object, particularly in terms of frequency (centre frequency and spectrum width) and power.

RTK *(Real Time Kinematic)*
Rather than relying solely on the GNSS signals received from the GPS, Galileo, Glonass and/or Beidu satellite positioning systems, RTK also receives signals from another module called the base, which allows for greater positioning accuracy, in the centimetre range.

Since end 2021, the Lyon and the Nancy regional services have merged to form the East inter-regional service (SIR EST)

A question of accuracy

RTK, which is widely used today for precision agriculture, is emerging as a suitable solution for autonomous robots, which herald the driverless vehicles of the future. RTK-based geolocation systems require the programming of frequencies in the 444 - 449 MHz band, reserved for professional mobile communications (PMR). However, the university research institute RTK base in question was using the 459.55 MHz frequency without any authorisation! On the other side of the border, this same frequency is used, with an authorisation, by the German organisation for its network of radioactivity level sensors.

Robots laid off

On 14th October 2020, the immediate stoppage of the unauthorised transmission eliminated the interference, and the German organisation could resume its monitoring as usual.

A fee of € 450 for the intervention costs is sent by the ANFR to those who caused the interference, along with the process to follow to apply for an authorisation to use the frequency and thus be able to use the RTK system legally. Until they comply with the regulations, the owners of the robot and the RTK terminal are no longer allowed to carry out their experiment. The ANFR will not tolerate any recurrence of the interference!

"The search ends *on foot, arms outstretched,* with a spectrum analyser and a directional antenna..."

How are frequencies managed for professional mobile networks (PMR)?

It should be remembered that the use of frequencies for professional mobile communications services (PMR) is governed by the French Post Office and Electronic Communications Code (CPCE) and requires an authorisation. Each user of an RTK system or differential GPS must apply to the French Electronic communications, post office and press distribution authority (Arcep) for an individual authorisation to use frequencies assigned to PMR.

The ANFR manages PMR frequency authorisation requests on behalf of the Arcep and has set up a specific portal to do so[1].

It should be noted that in border areas, some frequencies are shared between countries. After negotiations, frequencies are classified as preferential for a given country. In this investigation, the 459.55 MHz frequency was a German preferential frequency. If the French research institute had applied for a frequency authorisation in that band, it wouldn't have been successful because of the high risk of interference, which by the way did occur, and another frequency would have been proposed.

[1] www.anfr.fr/licences-et-autorisations/reseaux-professionnels/

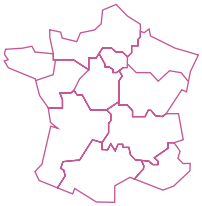
Investigation no.15

Game over

Or how to blow the whistle on a threatening radio amateur

End of 2019. Many letters and emails are sent to the ANFR complaining about the particularly inappropriate comments of an unscrupulous individual while the web is also buzzing, *on* Twitter and in forums. The objective is therefore clear: to stop the actions of the person who we will refer to as Mr X.

IT ALL STARTS WITH a strong mobilisation of the amateur radio community to denounce the inappropriate behaviour on the air, including insults and death threats, to the ANFR. The first priority is to make records of these excessive and threatening statements. It's thanks to static monitoring equipments specific to HF frequency use, in particular the antenna field installed on some thirty hectares at the ANFR's International Control Centre (ICC) near Rambouillet (78), that the sworn agents manage to establish these findings.



Somewhere in France…

December 2020
Intervention date

A welcome omission

Upon further investigation, the ANFR agents discover that Mr X had failed to declare his radio installation to the ANFR: such failures to declare a station of more than 5 Watts of power by a radio amateur is an offence under the French Post Office and Electronic Communications Code (CPCE), which can be punished by six months in prison and a € 30,000 fine. This surprising oversight immediately provides a legal reason to seize Mr X's radio equipment, by first referring the matter to the public prosecutor. The troublemaker's address is quickly found in the database of amateur radio call signs kept by the ANFR and the use of direction finders.

Exposed

A visit to the site by ANFR agents equipped with a laboratory vehicle confirms the existence of an amateur service installation, they take pictures of the external antennas. In November 2019, the ANFR requests the support of the gendarmerie from the area where Mr X lives. An on-site operation is decided upon. At the request of the gendarmerie, the ANFR takes part in the operation to identify the offending equipment.

Surprise visit to Mr X's home

One December day, in the early hours of the morning, briefing: the ICC and regional service agents from Villejuif are present. At around 7 a.m., the search warrant is executed: the premises are quickly secured. The ANFR experts enter

A radio amateur is a person who, without any financial interest, has a hobby making it possible to experiment transmission techniques and to set up radio links with other radio amateurs from all over the world. To chat with their peers, radio amateurs have reserved frequency bands.
The regulatory conditions for operating amateur radio installations in France are specified by the Arcep.
Radio amateurs must, in particular, have passed the exam to obtain an amateur service operator certificate, following which ANFR issues them a call sign.

the scene to inspect the radio equipment, make some measurements and carry out checks. The equipment in question is quickly identified and immediately seized. Mr X's custody can begin...
The next morning, he is brought before the public prosecutor who informs him that he will soon be summoned to appear before the criminal court. In the meantime, he is placed under judicial supervision.

At it again!

The hearing, originally scheduled for 3rd June 2021, is finally postponed to 20th January 2022. In the meantime, another search warrant was executed by law enforcement with ANFR agents as experts on 7th January 2022 at the radio amateur's home: he had continued to make insulting comments and death threats on the air despite his judicial control! Other transmission equipment used for the broadcast of these remarks was seized on this occasion and again locked up as evidence. The radio amateur was auditioned by the gendarmerie.
On 20th January 2022, we head to Versailles for the criminal court hearing Mr X doesn't attend, he's represented by his lawyer. Two radio amateurs who were victims of the threats are present with their lawyer as plaintiffs. The ANFR, also a plaintiff in this case, also attends the hearing with its lawyer. Its two representatives shed technical light on their spectrum monitoring missions, their investigative

"He carries on making insulting comments and death threats on the air despite being under *judicial control!*"

powers as sworn and authorised agents and the findings made in this case. The atmosphere is tense, the exchanges lively and long... The hearing lasts more than three hours and ends around midnight.

Verdict

The verdict, delivered on 28 March, finds the radio amateur guilty on all counts. He is given a suspended sentence of one year imprisonment and placed on probation for two years, with a ban on all amateur radio activities and an obligation to compensate the Inland Revenue and the plaintiffs. Furthermore, as part of an administrative sanction procedure, a few weeks later he is informed that his call sign has been revoked for failure to comply with the regulations on amateur service and that the repeated insulting comments on the air were aggravating circumstances.

No more swearing

The cooperation between the ANFR and the gendarmerie made it possible to combine expertise and investigative powers to protect the radio spectrum, with the help of the entire amateur radio community!

WHAT THE LAW SAYS

The use of radio installations by amateur radio services must comply with the regulatory conditions set out in the French Post Office and Electronic Communications Code and specified in ARCEP decisions, on pain of being an offence subject to a criminal sentence of up to six months in prison and a € 30,000 (article L.39.1 of the French Post Office and Electronic Communications Code).

Furthermore, users of frequencies outside the regulatory conditions or people causing interference through the use of a frequency outside regulatory conditions may be charged atax* of € 450 (see Article 45 II of the French 1987 Finance Act) to compensate for the costs of intervention by the ANFR in the event of interference or non-compliant use of frequencies.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

What are the obligations for radio amateurs?

Amateur radio activity allows experimentation and radio communication by making multiple contacts on frequency bands, either reserved for that purpose or shared with other users of the radio spectrum. To carry out this activity, radio amateurs must, amongst other things, obtain an operator's certificate which recognises their qualifications and a call sign which identifies them as authorised frequency users. Among the obligations for the use of frequencies by amateur service radio stations or amateur satellite services, maximum transmission powers are defined according to the frequency bands used. Transmitting stations of more than 5 watts must be declared to the ANFR. Furthermore, detailed information on the transmission activity must be provided. Thus, the holders of radio station call signs in the amateur or amateur-satellite service have a duty to record the activity of their station in a logbook: the date and time of each call, the call signs of the user and the correspondents, the frequency used, the transmission class, the transmission location.

Logbook

The logbook must be presented at the request of any controlling authority. It must be kept for at least one year from the last registration, according to Article 6 of Arcep decision no. 2012-1241 of 2nd October 2012.

In addition to criminal sanctions, breaches of the amateur service regulations may lead to administrative sanctions: withdrawal or suspension of the amateur radio call sign.

And, of course, compliance with these administrative and regulatory rules does not exempt radio amateurs from respecting other peoples' rights, starting with those of other radio amateurs.

Investigation no.16

The sound that shut down 4G

Or how music doesn't always soothe the savage beast

December 2020, Sernhac in the Gard area of France. Old stones and a relaxing lifestyle make the reputation of this village located not far from the Pont du Gard. But nothing is going right this year in the town and in a 10 km area around it, 4G services in the 800 MHz band are out of order! The only cell tower in the town, and another one located 6 km away, are experiencing mysterious interference.

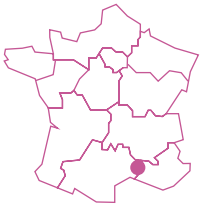
FOLLOWING THE REPORT by the mobile operator in question to the ANFR, a sworn and authorised spectrum control officer from the the Aix-Marseille regional service - based in Aix-en-Provence - arrives on site on 18th December. Equipped with the appropriate state-of-the-art instruments, he starts his technical investigation: spectral readings initially make it possible to obtain the interference signal's signature, i.e. the characteristics of the electromagnetic transmission causing the interference. Now we have to find out where it's coming from...
The laboratory vehicle's receiver and a directional Yagi antenna guide the search and lead the agent to a private home in a village 3 km from one of the two scrambled cell towers.

Against all the odds

With the owner's consent, the investigations continue at his home and eventually lead to the offending object... which is nothing less than a pair of wireless headphones! This equipment, which is widely used in these times of increased teleworking, at first sight seems inoffensive. But the agents detect that it is transmitting outside its assigned frequency band and encroaching on the 4G band which transmits in the 800 MHz band. The headphone even generates interference for several kilometres around it.

Time drift

Although CE marked, the headphones had started to "drift" over time. It was impossible for the owner to be aware of the fact: they were in perfect working order! After disconnecting it, the interference to the 4G identified over a 10 km radius disappears instantly. The owner of the equipment permanently stops using the headphones on the very same day.



Sernhac (Gard, France)
1,765 inhabitants
8.93 km²

18 December 2020
Intervention date

WHAT THE LAW SAYS

Under Article L.39-1 of the French Post Office and Electronic Communications Code, the use of radio equipment in non-compliant conditions, which also creates interference on the radio transmissions of an authorised service, constitutes two offences under the law, each subject to a criminal sentence of six months in prison and a € 30,000 fine.

The ANFR may also charge the person causing the interference a tax*of € 450 for the costs of the intervention caused by the use of a radio installation outside legal and regulatory conditions, which has caused interference on a legally assigned frequency.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

How can headphones become a source of interference?

Interference can be caused by radio equipment - such as, for example, connected headphones - that has drifted, i.e. is transmitting outside its normal frequency range.
It then no longer complies with the interference prevention requirements.
The causes may, for example, be the ageing of a component, poor maintenance, equipment that has broken down but hasn't been disconnected, improper use or equipment that isn't suitable for the European market (without CE marking).
As part of the essential requirements that the ANFR can control and that radio equipment must meet to be placed on the French market as defined by the Radio Equipment Directive (RED) and its enactment into national law, radio transmitters must not generate interference.

Compliance issues

Thus, if a device generates interference, this means it isn't compliant with the essential requirements for radio equipment. Its owner is then liable for a breach of radio frequency regulations.
So people should be wary when purchasing radio equipment and make sure it complies with European regulations, by respecting any restrictions on use, and maintaining it in good condition so that it doesn't malfunction. Other essential requirements include health protection, safety of persons, pets and property, electromagnetic compatibility, and efficient use of the radio spectrum.
In late 2021, the European Commission furthermore proposed to add measures to improve wireless device cyber-security, by adopting a specific delegated act.

As the supervisory authority for the market surveillance of radio equipment, the ANFR's mission has to make sure such equipment in France complies with the applicable essential and administrative requirements.
To this end, the ANFR's sworn and authorised agents make random spot checks in the sales areas or professional premises of any economic player concerned - distributors, manufacturers, importers, wholesalers, etc. - in accordance with a procedure governed by articles L. 40 and L. 43 of the French Post Office and Electronic Communications Code to carry out the necessary checks on the spot or by taking samples.

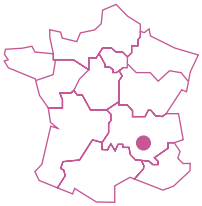
Investigation no.17

Mid-air neighbourhood conflict

Or how to bother the air from the ground

Late 2020, around Valence, in the Drôme area of France. During a routine flight of a French Civil Aviation Authority (DGAC) control aircraft, the pilot experiences interference on the critical communications network.
There's no doubt that a device is generating interference impacting a frequency band assigned to air navigation. The pilot records the characteristics of the interference, which are immediately forwarded to the ANFR experts.

THANKS TO THE WORK CARRIED OUT UPSTREAM by the French Civil Aviation Authority - which has aircraft available to check the correct operation of flight instruments and equipment as well as the spectral "cleanliness" in the VHF band assigned to air navigation - the ANFR can start the investigation with serious leads on the possible source of this interference.
The recording of the interference leaves no doubt: music, news flashes,... it's an FM radio that is being received by the pilots instead of the usual messages with the control tower!



Saint-Péray
(Ardèche, France) 7,580 inhabitants
24.05 km²

1st December 2020
Intervention date

Off we go!

A sworn and authorised spectrum monitoring officer from the Lyon regional service* is sent to the site on 1st December 2020 to investigate. Driving his laboratory vehicle and equipped with his monitoring equipment, he heads for the location of the parasite transmissions.
Measurements taken on site confirm the diagnosis: the interference is indeed coming from an FM transmitter. But there isn't only one, or even two transmitters on the pylon, there are numerous FM transmitters on the pylon located in Saint-Péray, in the Ardèche region, in front of which our expert is standing! The site features several antennas used to broadcast many national and local radio stations! Luckily, he can use the measuring equipment to determine the exact FM transmitter in question: it belongs to a local radio station broadcasting programmes promoting the area.

Radio gaga

This FM transmitter produces unwanted radiation (non-essential radiation and radiation from out-of-band transmissions) at too high levels. Moreover, unluckily, one of these radiations matches the 114.990 MHz aviation frequency band!
Now, unwanted radio wave transmissions, such as those from FM radio in adjacent bands, must be limited to a level that avoids harmful interference.

Unwanted radiation from a radio transmitter can be caused by:
- non-essential radiation, i.e. radiation on a frequency or frequencies outside the bandwidth necessary for transmission and of which the level can be reduced without impacting the transmission of the corresponding information;
- out-of-band transmissions, i.e. emissions adjacent to the bandwidth required for transmission.

** Since end 2021, the Lyon and the Nancy regional services have merged to form the East inter-regional service (SIR EST)*

WHAT THE LAW SAYS

The unauthorised use of frequencies is a criminal offence punishable by up to six months in prison and a € 30,000 fine under the provisions of Article L. 39-1 of the French Post Office and Electronic Communications Code.

Under the same article, creating interference on the radio broadcasts of an authorised service by using a frequency in non-compliant conditions is also subject to a criminal sentence of six months in prison and a fine of € 30,000. A tax* of € 450 for the ANFR's intervention costs must also be paid.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

To stop the interference, the defective transmitter must be repaired. The FM radio representatives, who were surprised by the interference but very cooperative, quickly complied: in the presence of the ANFR, a cavity "bandpass" filter was installed on the transmitter to reduce its bandwidth, improve its polarization and thus put an end to the interference.
In this case involving an audiovisual service, the Arcom (French audiovisual and digital communications regulation authority) worked alongside ANFR to to enable upgrading the equipment to compliance quickly.

"Measurements taken on site confirm the diagnosis: the *interference* is coming from an FM transmitter."

What does FM radio have to do with aviation?

The 87.5 - 108 MHz frequency band assigned to FM radio is adjacent to the 108 - 137 MHz VHF band used by aviation. The latter is used for safety communications: national and international aviation mobile services, aerodrome surface communications, distress beacons, instrument landing systems (ILS), very high frequency omnidirectional *range (VOR)* magnetic bearings. Neighbourhood conflicts between these two bands can arise, for example if an FM broadcast is not sufficiently filtered, resulting in the deterioration of critical Civil Aviation communications.

Interactions

Insufficient decoupling or a lack of filters placed when installing FM transmitters on a mast can also cause harmful interference, as the interaction between active antennas in this case can generate intermodulation products (IMPs), i.e. the appearance of radio transmissions on one or more new frequencies that were not present in the original signal. IMPs are a common cause of interference encountered by ANFR agents.
There are also cases of perfectly installed and compliant FM transmitters that generate IMPs due to the poor condition of the support on which they are located. These phenomena are called "structure IMPs" because they are caused by the faulty design, construction, modification, or maintenance of a support. These might be antennas that are no longer in use but left in place, cut transmission chains or a pylon with traces of rust, hence the term "*Rusty bolt effect*" used by the ITU in one of its reports.
These infrastructure maintenance or radio station site defects are a threat because they can generate interference in bands assigned to civil aviation or other authorised radio services.

Preventive actions

The ANFR, which is regularly called upon to solve such cases of interference, also acts preventively to encourage site spectral cleanliness. During its campaigns to check station and network compliance, it checks the condition of the structures, in particular thanks to its drone pilot agents operating drones carrying high-precision cameras. Interference impacting safety services such as aviation communications is dealt with as a priority by the ANFR.

Investigation no.18

The culprit was hiding in the dressing room

Or how one interference can hide another

Early 2021, in Saint-Brevin-les-Pins, in the Loire-Atlantique area of France. An amateur radio operator experiences interference on his receiver on the 80, 40 and 17 metre HF bands.
Alerted, the regional ANFR service in Donges takes on the case and arrives on site at the end of April 2021 to look for the source. They won't be disappointed with the trip.

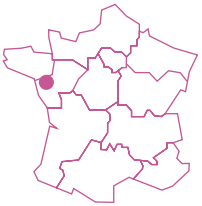
On 28th April, at the radio amateur's home, the ANFR control agents, after taking a few measurements, realise that there isn't just one source of interference, but two! They start looking for neighbouring sources of interference... At first, the measurements indicate a strong rise in noise in the HF band (3 to 30 MHz). The directional antenna, like a dowsing rod, points to a house in the same street as the radio amateur. The occupant of the premises agrees to allow our experts investigate further in his home.

Uncooperative neighbour

But it isn't always easy to detect the origin of a transmission in these frequency bands inside a house. Desperate situations call for drastic remedies: the interference disappears by cutting off the electricity supply to the house. The source of the interference therefore has to be one of the electric or radio devices in the home. It needs to be identified... Tests and measurements in the home make it possible to identify the device in question... An electric fence installed to prevent stray cats from entering the garden and damaging the vegetable plot! The owner is requested to replace or repair it within the required deadline.

And then there were two

The second source of interference now had to be found... The ANFR controllers leave the house with the interfering fence and resume their search on 28th May 2021. In the amateur radio operator's street, they are still measuring a strong rise in noise in the HF band. Once again, their search leads them to a house in the same street! They start over: taking their measuring equipment from room to room, our investigators soon find themselves in a dressing room lit... by an LED strip! It turns out that it's power supply is sending out spurious radiation on one of the frequency bands used by the radio amateur. The owner is asked to have this appliance repaired or replaced, as it radiates well beyond the dressing room. Double interference!



Saint-Brevin-les-Pins (Loire-Atlantique, France)
14,287 inhabitants
19.29 km²

End of April 2021
Intervention date

WHAT THE LAW SAYS

The offender is liable to a criminal sentence of up to six months in prison and a € 30,000 fine under the French Post Office and Electronic Communications Code.

People should therefore be careful when buying any electronic or electric equipment by making sure it complies with European regulations (CE marking) and keeping it in good condition so that it doesn't malfunction when in use.

What causes electromagnetic interference?

The double interference in the investigation came from two innocuous items of household equipment, which, unknown to their owners were converted into sources of electromagnetic interference. Both devices were permanently powered by the mains and had started to drift and corrupt the HF bands due to an electromagnetic compatibility (EMC) problem. Such EMC interference is a frequent cause of interference, it was the cause of 37% of the interference identified in 2020.

Miscellaneous causes

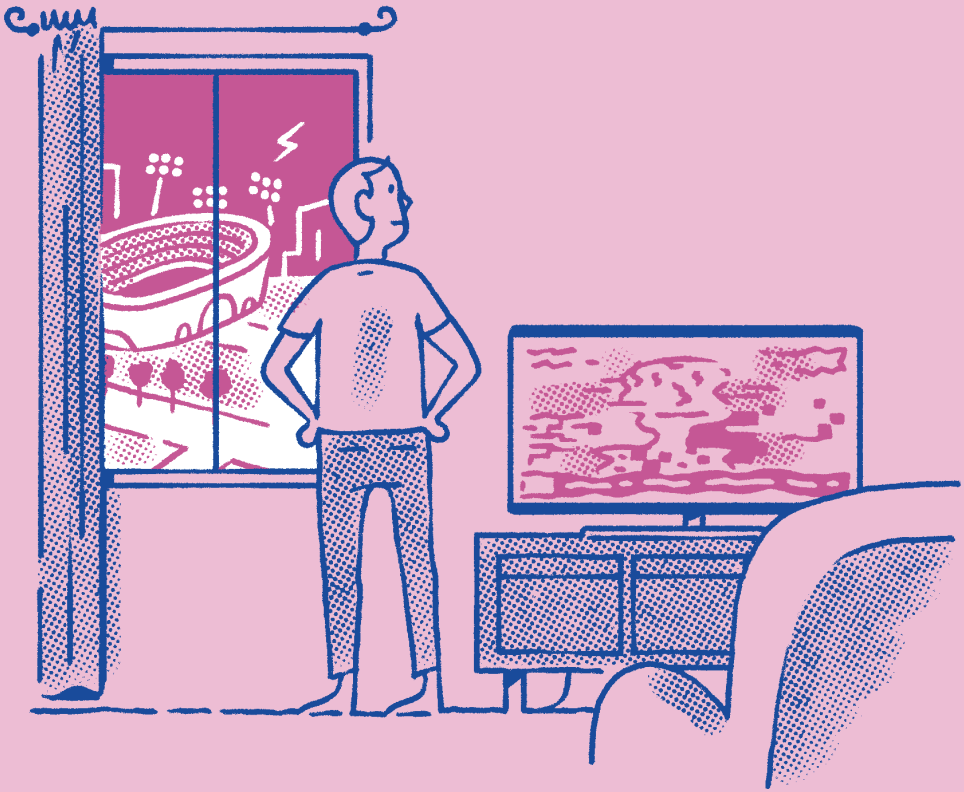
Electric or electronic devices can produce interference signals depending on their condition: poor design, obsolescence, incorrect settings or use, malfunctions, etc. In material terms, the causes can be the loosening or alteration of a cable, the ageing of a component, poor earthing, equipment that has broken down but is still powered up, or equipment that does not comply with European EMC marketing regulations (e.g. without CE marking).

They can then impact the availability of radio services. The range of this interference is more or less distant, depending on the power involved.

If an electric or electronic device generates electromagnetic interference, it does not comply with the electromagnetic compatibility regulations. Owners are then liable for an offence for misuse of electrical or electronic devices, under the French Post Office and Electronic Communications Code.

Investigation no.19

The lamp post was too impulsive



Or how a street light can pixelize a television

End of 2020, Saint-Nicolas-de-Port, near Nancy, France. A viewer complains of poor DTT reception: on his television, the images are pixelized, but... only after 6 p.m. and until late at night. The ANFR is sent out to solve this unusual interference...

USUALLY, there are three reasons for poor television reception: a technical problem with the transmitter, too great a distance between the house and the transmitter, or interference from a 4G cell tower. However the information collected by the ANFR agents is inconsistent. And the house must have good DTT (Digital Terrestrial Television) coverage: the main transmitter in Nancy is very close by! A trip to the site to investigate this night-time disturbance is therefore on the cards. One evening, the Nancy regional service* agents go to the viewer's home.

High-flying measures

They first take measurements on the television and its aerial socket: the interference isn't coming from any equipment in the home. They return to their technical vehicle and deploy its 10-metre pneumatic mast equipped with a rotating directional antenna which they use to pick up the same radio waves as the roof antenna receives. Sent to on-board analysers, the interference reveals its secrets: the DTT programme appears chopped up by powerful impulse noise (70 dBµV) emitted between 400 MHz and 600 MHz.

And then there was light

Now equipped with a directional antenna, the mast begins to rotate while our experts investigate the origin of this disturbing transmission. *Eureka*! It's coming from the lighting of a sports complex housed in a nearby municipal building! In this case, the signal is due to a halogen floodlight installed in line with the viewer's rake aerial. This floodlight was defective and flickered continuously as soon as it was switched on, and as long as the evening training sessions lasted. It's an electromagnetic compatibility problem: interference produced by regular circuit breaks impacts DTT signal reception. The ANFR agents immediately inform the sports centre manager and ask him to repair the lighting system. The next day, the town hall replaced the flickering lamp and the viewer could once again watch his favourite programmes on DTT.

Saint-Nicolas-de-Port (Meurthe-et-Moselle, France)
7,417 inhabitants
8.23 km²

17 November 2020
Intervention date

WHAT THE LAW SAYS

The owner of the offending equipment is liable for a breach of the proper use of frequencies under the French Post Office and Electronic Communications Code. . Creating Interference on an authorised frequency using electric or electronic equipment under conditions that do not comply with the applicable provisions on electromagnetic compatibility (EMC) is an offence subject to a penalty of up to six months in prison and a € 30,000 fine (L 39-1 of the French Post Office and Electronic Communications Code).

People should therefore be careful when buying any electronic or electric equipment by making sure it complies with European regulations (CE marking) and keeping it in good condition over time so that it doesn't malfunction when in use.

** Since end 2021, the Lyon and the Nancy regional services have merged to form the East inter-regional service (SIR EST)*

What regulations apply to electric equipment?

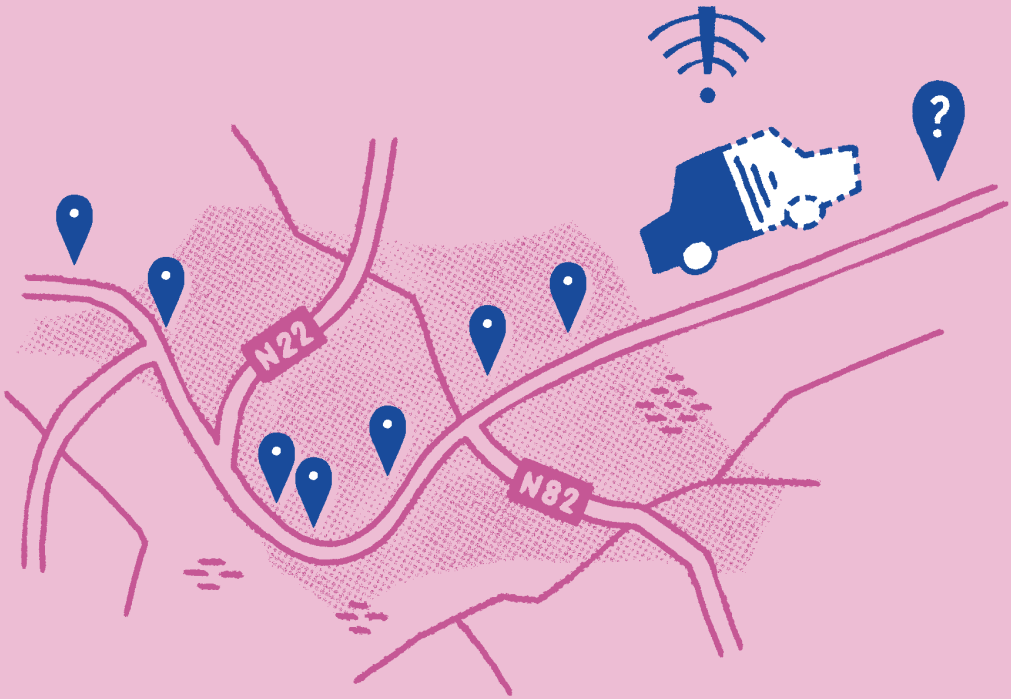
All electric or electronic devices can produce parasite signals that prevent radio equipment from operating normally, whether due to a design or construction defect, poor maintenance, a loose or altered cable, poor earthing, etc. You may also be dealing with a device that shouldn't have been on the French market because not compliant with the European "EMC" directive on electromagnetic compatibility and its enactment into French law. In these cases, the CE marking does not appear on the devices.
Depending on the frequency or frequencies on which this energy, radiation or electromagnetic induction is transmitted, different services using wireless connections may be impacted. Depending on the power involved, the range of the interference will be more or less distant.
The impact can range from impairment to the unavailability of services using the frequencies suffering the interference.

The EMC Directive

The EMC Directive, which is intended to guarantee the functioning of the internal market by requiring equipment to comply with an adequate level of electromagnetic compatibility, defines essential requirements, both general and specific, which must be strictly complied with. The general requirements especially impose that all finished devices or combinations of devices made available on the market, must be designed and manufactured in accordance with the state of the art, to guarantee that electromagnetic interference does not exceed the level above which radio and telecommunications equipment cannot operate as intended. In other words, that they will not cause interference on them.
The same provision applies to all fixed installations under the specific requirements.
The Directive reminds that fixed installations must be installed according to good engineering practice and in accordance with the intended use of their components.
In France, the controlling authorities in charge of monitoring electric and electronic equipment market as part of the national enactment of the EMC Directive, are the Competition, Consumer, and Fraud prevention department (DGCCRF) and Customs.
The electromagnetic compatibility requirements for radio equipment are governed by the Radio Equipment Directive (RED). By law, however, it's the ANFR that controls marketing of equipment covered by the RED.

Investigation no.20

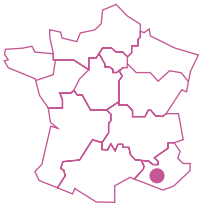
The secret to invisibility



Or how prevention is better than cure also applies to interference!

1st June 2021, near Marseille-Provence airport, Marignane, France.
During a preventive check while returning from another mission when they were passing close the airport, ANFR agents detect a suspicious signal in the GNSS (GPS, Galileo...) frequency band. Surprise... The spectral reading shown on the analyser has all the characteristics of a GPS jammer.
They just have to find the vehicle it's installed in!

COMPLAINTS RECEIVED BY THE ANFR for geolocation interference are not yet widespread, but unfortunately this type of anti-social behaviour has become common and interference detection must be increased by those who are victims of it. The ANFR's Aix-Marseille regional service agents have therefore got into the habit when on their travels in their "hedgehog vehicle" of monitoring the frequencies reserved for satellite radio navigation (GNSS) in the Marignane airport sector, where GPS is used for aircraft approach and take-off phases. In the past, our agents have solved several cases of interference in the area that were disrupting civil aviation services.



Marignane airport (Bouches-du-Rhône, France)
4.66 million passengers per year

1st July 2021
Intervention date

Car in sight

So on 1st June, thanks to the cutting-edge equipment installed in their laboratory vehicle, our experts spot and then follow the suspect vehicle and confirm that it is indeed housing a GPS jammer: it's a professional vehicle of which the driver no doubt wants to fly under his employer's radar! The investigation becomes a priority: there isn't a minute to lose, as this type of jammer, even if not very powerful, can impact aircraft flying at up to 2,000 m altitude, i.e. in the middle of critical take-off or landing phases!
The ANFR immediately alerts law enforcement and a judicial police officer to put an end to the offence. A joint smoking gun operation is organised by the police and the ANFR. Alas, the first attempt fails: at the last moment, the driver decided to change vehicles for his trip!

Caught in the act

There was no question of giving up, and a second attempt was organised on 1st July, successful this time as the suspect is caught in the act. For this operation, the ANFR uses suitable measuring devices that make it possible to record the offence.
The police then arrests the driver of the vehicle and discovers that the GPS jammer is disguised as a simple USB thumb drive which looks totally harmless! However, despite its small size, this jammer causes interference

"Hedgehog" vehicle
An ANFR laboratory vehicle is a vehicle fitted with measurement equipment such as receivers and spectrum analysers. It's sometimes referred to as a "hedgehog" vehicle because it can house various types of directional or omni-directional antennas adapted to the frequency band in question, on its roof or on its up to 10 m high telescopic mast. Some vehicles also have a disc-shaped direction-finding antenna installed on the roof.

Such vehicles are used to make measurements either while on the move or when parked in an area of interest. It's essential to searches for sources of interference in the field.

in a large area around the vehicle in which it is installed. Its owner thought he had found the secret to invisibility; on his boss's map he had indeed disappeared; but in the eyes of the ANFR, he had suddenly become... dazzling! He was arrested and will have to answer for his acts before the justice.

WHAT THE LAW SAYS

The possession and use of a GNSS jammer is an offence punishable by six months in prison and a € 30,000 fine. It should be noted that this prohibition applies more generally to all wave jammers, whether for wifi, mobile phones or GPS (Article L. 33-3-1 of the French Post Office and Electronic Communications Code). Furthermore, the use of a jammer causing interference to a radio service is a third offence subject to the same level of criminal sentence of six months in prison and a € 30,000 fine (Article L. 39-1 of the French Post Office and Electronic Communications Code).

An additional flat tax* of € 450 is charged by the ANFR for its intervention costs.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

"There isn't a minute to lose, as this type of jammer, even if not very powerful, can *impact* aircraft flying up to 2,000 metres altitude."

Why is preventing the reception of GPS signals prohibited?

In 2019, the ANFR raised the awareness of several tens of thousands of businesses that geolocate their vehicle fleets of the risks generated by GNSS jammers. It also encouraged them to remind their staff of applicable legislation. Indeed, in companies that use geolocation to manage their fleets of vehicles, GPS jammers might be used without the managers' knowledge. The unexplained disappearance of the geolocation of some of its vehicles, even though they are normally above ground, may be a sign that a jammer is being used.

Sensitive signals

GNSS refers to satellite radio navigation systems such as GPS, Galileo, Glonass or Beidu. The possession and use of GNSS jammers is strictly prohibited in France, except for a few regulated governmental uses.
A GNSS jammer impacts the proper reception of signals such as GPS or Galileo over a more or less wide area.
Now, GNSS signals carry essential geolocation and synchronisation information. Impaired reception of these signals can have an adverse effect on the proper operation of a wide range of services such as land, air, river or sea transport, mobile communications and broadcasting networks, electricity transport networks, search and rescue services, smart towns and cities, precision agriculture, connected objects and sensors, and Industry 4.0, to name but a few.
Furthermore, contrary to what is often believed by those who use them, for example to thwart their tracking by GPS beacons, vehicle bodywork does not limit the effect of a GPS jammer to the space inside the vehicle. These devices have a much longer range: a low-power GNSS jammer can disrupt all services that use GPS several hundred metres around it in the horizontal plane and several thousand metres in altitude!

Investigation no.21

No surfing in Tahiti

Or how the connected happiness of some can be the misfortune of others

July 2021, Papeete waterfront, French Polynesia. The customers of a mobile operator complain that they can no longer surf the web from their mobile phones. 4G is failing! The operator's initial analyses are clear: its cell tower antennas are being dazzled by a high-powered transmitter, which everything suggests is located in the middle of the city's harbour.

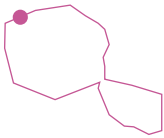
THE OPERATOR CONTACTS THE ANFR to investigate the case, which could have even more adverse consequences: in French Polynesia, 4G is also used, more than in continental France, for a large number of static accesses to the web, in offices or at home.
Without further ado, an ANFR agent packs his measuring equipment and drives to the waterfront. A first pass defines the area the interference is coming from: the yacht dock. But the investigation has to stop there, as it isn't open to the public.

Captain ahoy

The port of Papeete is contacted at dawn the next morning to get the necessary authorisations to continue the hunt for the jammer. From the yacht dock, the ANFR agent easily manages to confirm the origin of the interference using his portable direction-finding equipment: the interference is coming from a specific ship. The third phase of the investigation begins: the yacht must be boarded to find the incriminating equipment and have it shut down.
It's our investigator's mysterious equipment that paves the way: intrigued by his comings and goings, the skipper disembarks from his yacht onto the dock to find out more. Cooperative, he even arranges to meet him the next morning - a Saturday - making sure the person in charge of the yacht radio installations will be there.

Prepare to board!

On the third day, everyone is present for a thorough inspection of the yacht. The ship's radio operator is incredulous: in his opinion nothing on the yacht can generate such a jamming signal... And yet! The teams find the culprit in a technical room: a mobile phone repeater installed to improve mobile service on board the yacht by amplifying the signals from the shore, but also from the passengers' phones. It was this too high-powered amplification coupled with an equipment failure, that was causing the interference! It was preventing nearby smartphones from making uplink contact with the cell towers.



Autonomous Port of Papeete (French Polynesia)
2,250 ha of maritime domain and 80 ha of public land domain

24 July 2021
Intervention date

Remember voice over wifi
In an area without coverage or with poor 2G/3G/4G/5G coverage in mainland France, voice over wifi (VoWiFi) makes it possible to make calls and send text messages when connected to wifi. This solution doesn't require prior consent from operators.

All you need is:
- high-speed or very high-speed internet access,
- a mobile phone subscription and a compatible mobile phone.
You then need to enable the VoWiFi feature on your mobile phone.
The VoWiFi experience may vary depending on internet access speed, the router location in the building, the wifi use levels in the neighbourhood, etc.

WHAT THE LAW SAYS

The penalties in French Polynesia for this type of offence are set out in Article D.231-23 of the French Polynesian Post Office and Telecommunications Code: "The act of moving, deteriorating or damaging the installations of a network open to the public in any way, or of compromising the operation of such a network is punishable by a fine of up to 178,997 F CFP."

The device is immediately switched off and 4G service instantly returns to the area. As for the repeater, never again will it wreak havoc on the shores of French Polynesia. Everything is back to normal: the operator's customers can surf the web again - as well as surfing on the waves of the Pacific Ocean, which will be hosting the 2024 Olympic Games.

"The ship's radio operator is *incredulous*: in his opinion, there's nothing on board that can cause this interfering signal... And yet! It was in a technical room that the teams found the culprit."

What are the problems caused by mobile signal repeaters?

When looking to improve '*indoor*' mobile coverage in a building or on board a ship, it's important to check the regulations and look at all the authorised options, such as Voice over wifi, to find the one that best meets your needs. For those who want to purchase a repeater, it's best to make sure you have the consent of the mobile operators in question first, to avoid ending up with an unusable item.

Regulations in French territorial waters

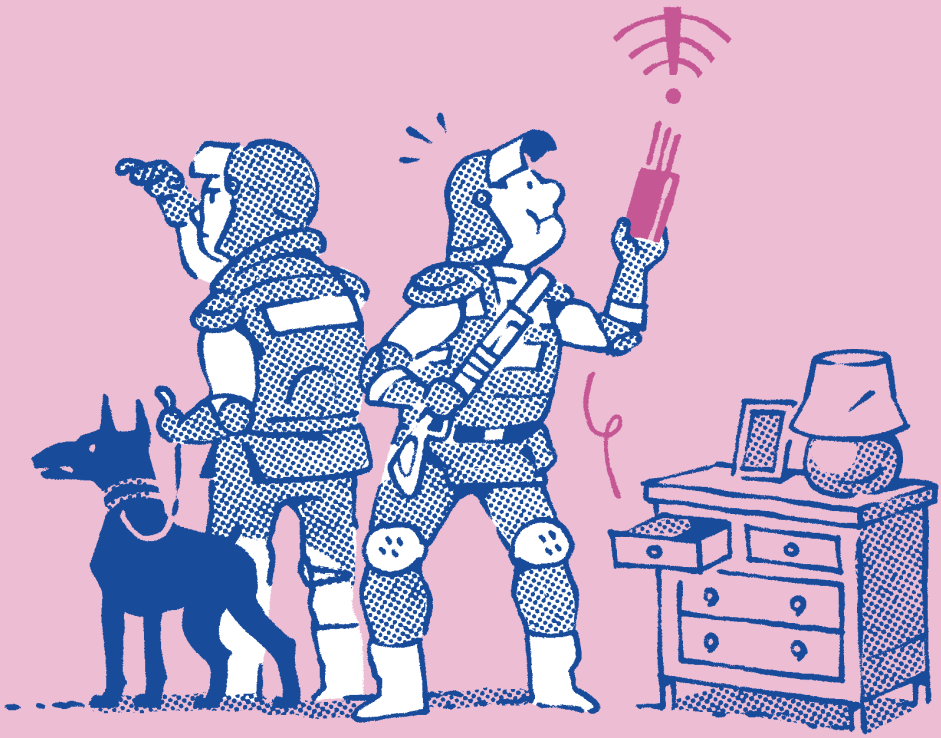
The 1800 MHz band is subject to special conditions (Arcep decision n° 2011-1339 of 15 November 2011) for use by radio installations such as repeaters, intended to provide mobile communication services on board vessels in French territorial waters.

In particular, at a distance greater than two nautical miles from the baseline, the use of this frequency band (1710-1785 MHz and 1805-1880 MHz duplex band) is not subject to individual authorisation.
It must not, nevertheless, cause interference on terrestrial mobile networks. The operators of MVC installations in particular, should eliminate the risk of connections to systems providing mobile communication services on board ships whenever a land-based mobile network connection is possible. They must not use the system providing MVC services at less than two nautical miles from the baseline as defined by the United Nations Convention on the Law of the Sea. At between two and twelve nautical miles from the baseline, only interior antennas for ship base stations may be used.

Finally, there are limits for mobile terminals when used on board and for ship base stations, e.g. in terms of maximum transmission power.
These provisions, however, are not applicable in French Polynesia, where the electronic communications controlling authority is not the Arcep but the French Polynesian government *via* the General Digital Economy Department.
The Polynesian regulating authority requires that an individual authorisation be obtained to use frequencies in the 1800 MHz band for networks open to the public on a vessel at less than two nautical miles from the baseline. This individual authorisation is mandatory on entry into the exclusive economic zone for this type of network.

Investigation no.22

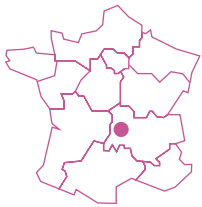
Organised (multi-) band jamming



Or how trouble between neighbours can create vast white spots

July 2021, Clermont-Ferrand and surroundings, in the Puy-de-Dôme, France.
Over a period of a few days, the ANFR receives three interference investigation requests from the same area from two different mobile operators. By a rare coincidence, these reports start on the same date and cover the same areas: Clermont-Ferrand and several neighbouring towns.

THE INITIAL ANALYSES CARRIED OUT by the ANFR identify more than twenty-four mobile sites that are suffering interference in several frequency bands and for several technologies, amongst which UMTS 900 (3G) and LTE 800 (4G) are particularly impacted.
To conduct this investigation, which is particularly sensitive considering the extent of the interference, two ANFR agents from the Lyon regional service* decide to team up.
On 21st July, after having informed the Clermont-Ferrand public prosecutor, they go to the neighbouring town of Orcines to take measurements at the foot of one of the cell towers in question. Signals indeed cause interference on several bands assigned to mobile networks. There is a jammer at work in the area!



Clermont-Ferrand
(Puy-de-Dôme, France)
147,865 inhabitants
42.67 km²

21 July 2021
Intervention date

Hare and hounds

In the time it takes to connect a directional antenna to their analyser, the chase is on: there's no doubt that the interference is coming from Clermont-Ferrand... The source of the interference just needs to be pinpointed - which, in this town with a population of over 140,000, is like looking for a needle in a haystack!
Luckily, the laboratory vehicle has a last generation direction finder on its roof. On the road to Clermont, our two investigators follow its directions. Less than a hour later, they park. But they're puzzled by the target neighbourhood: it has many apartment buildings and dozens of homes...
So they decide to start by taking advantage of the fact that the jammer is close by to identify its type. Its signature leaves no doubt as to the troublemaker: it's a mobile phone jammer!

Multi-band jammer
A jammer is multi-band if it has several antennas for the different frequencies it can jam. Depending on its antennas, it can jam services such as mobile phones, wifi or GPS.

** Since end 2021, the Lyon and the Nancy regional services have merged to form the East inter-regional service (SIR EST)*

WHAT THE LAW SAYS

Radio jammers are purely and simply prohibited: importing, advertising, transferring free of charge or for a fee, putting into use, installing, keeping and using them are offences except for public order, national defence and security, or justice uses governed by a strictly defined framework (Article L.33-1 of the French Post Office and Electronic Communications Code). A criminal sentence of up to six months in prison and a € 30,000 fine can be applied to each of these offences (Article L. 39-1 of the French Post Office and Electronic Communications Code). Using a jammer also means being liable for jamming a legally assigned frequency, which is also an offence subject to the same criminal sentences.

Authorised and sworn ANFR agents can investigate and book these offences and issue a ticket (Article L. 40 of the French Post Office and Electronic Communications Code). They can also issue a tax* of € 450 for the costs of the intervention to find the origins of interference.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

Reinforcements

Several passages through the neighbourhood with the measurement vehicle are then needed to find the building with the jammer.

Reinforcements have to be called in at that point as the area is considered sensitive... The use of a jammer can also be a sign of attempts to conceal criminal activity. Our agents go to the Clermont-Ferrand police station to request the assistance of a judicial police officer. The police, after contacting the public prosecutor, decide to set up an operation immediately using personnel to guarantee safe intervention.

Commando sting

In the early afternoon, the ANFR agents and the police force go to the identified building. An ANFR agents tells what happened: *"We park quite far away and finish on foot. The building is a nine-storey block of flats with two stairwells. We inspect every floor with the police and identify the flat using a hand-held directional antenna, although there is still some uncertainty. Before knocking on the door, the police officers call the research and intervention brigade (BRI). Six BRI officers wearing balaclavas and helmets carrying assault rifles join us. They also have the equipment needed to open the door (a jack and a compressed air tank). As backup, there are three uniformed police officers on the ground floor of the building to protect the vehicles and keep bystanders away. A policeman knocks on the door, a lady opens... The BRI enters the flat and things are quick. After checking the identities of the occupants, we enter the premises and look for the jammer. It's a multi-band jammer installed in a TV cabinet drawer. We disconnect it immediately and a police officer seizes it. A police officer from the drug squad is called in to check the scene with his sniffer dog.* The search for drugs, which the police conducted here because being in possession of a jammer could have been a sign of illegal activity, was not conclusive.

Excess power

As the owner of the jammer was absent at the time of the intervention, the police sent a summons to one of the family members present. Indeed, owning and using a jammer are criminal offences. Our investigators were suspicious of the reason the owner of this powerful jammer gave: he claimed he had only used it to prevent his neighbours from connecting to the wifi router in his flat! Why didn't he use a password or connect his own devices by cable? In fact he had potentially turned his entire neighbourhood into a white zone for wifi, GPS or mobile...

"The jammer owner said he had only used it to *prevent the neighbours* from connecting to his home wifi router!"

How are jammers linked to criminal activity?

Using jammers (mobile phones, wifi, GPS, etc.) can also be part of the criminal toolbox used to commit misdeeds: neutralising wireless transmissions to security centres for burglaries, jamming the waves sent by electronic keys to unlock doors and steal cars, disabling vehicle location systems to steal luxury cars or trucks transporting valuable goods In addition to being used for criminal activities, jammers can have a collateral effect, putting human lives at risk by preventing emergency calls or emergency service pagers such as fire-fighters, police or doctors from reaching their destinations.

What's a radio jammer?

Jammers are devices designed to scramble, disrupt or block radio signals or services. Usually, they emit noise in the target frequency band to "crush" useful signals which are no longer received by their legitimate users. They are most often electronic boxes with one or more small antennas, depending on the number of frequency bands they can disrupt. In those cases, they are known as multi-band jammers.

The jammed zones are never limited to a small space such as a room or a vehicle. They are often much larger than one might believe or than vendors may suggest. They especially depend on the power and sensitivity of the legal signal receivers, some receivers such as GNSS receivers being particularly sensitive when they depend on the reception of signals from satellites tens of thousands of miles above the Earth. The installation location can also have an effect on the interference range.

Users are often overwhelmed by the range of the equipment and the resulting collateral damage which can be dramatic.

For example, a jammer used in a classroom to prevent students from using their mobile phones can shut down the mobile telephones of an entire neighbourhood! Similarly, a GPS jammer used by an employee who wants to stop being tracked by their employer can interfere with aircraft flying at 2,000m or parked at 500m. Using jammers is deliberate and malicious interference with the radio spectrum.

Investigation no.23

To the rescue of the Marion Dufresne scientists

Or how too much closeness can bother communications

Mid-October 2021, somewhere off the French Southern and Antarctic Lands. Kerguelen, Tromelin, Terre Adélie... Locations that bring to mind loneliness and a total absence of waves - except of course for those of whipped up by the windy seas. It's the last place anyone would think interference would need to be investigated by the ANFR. However, that's exactly what's happening to the team of scientists on board the "Marion Dufresne", a large supply ship used for logistics, tourist and scientific rotations with the French Southern and Antarctic Lands.

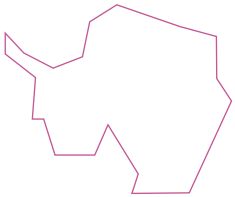
IT'S THE SCIENTISTS, for whom collecting and transmitting data are essential, who alert the ANFR to a case of interference that is, to say the least, unusual: a GNSS (GPS, Galileo) receiver on the Marion Dufresne is experiencing interference. This problem prevents an on-board system which is part of the MAP-IO *(Marion Dufresne Atmospheric Program Indian Ocean)* programme, which physically measures aerosol distribution, from operating properly. The purpose of the scientific programme is to study the composition and behaviour of the atmosphere, as well as the ocean-atmosphere processes that impact regional climate and digital weather forecasting. The data acquired by a GNSS antenna is finely analysed. The GNSS signal propagation delays caused by their passage though the atmosphere are in fact partly related to its water vapour content. Here the GNSS is not used as a positioning tool, but as an atmospheric observation tool!

Time is of the essence

This interference is critical, to the point of jeopardising the ambitious scientific programme. An exciting case to deal with for our agents but... located several thousand kilometres from mainland France: the Marion Dufresne is in fact based in Reunion and makes constant rotations to the French Southern and Antarctic Lands! Luckily for the scientists, the ANFR is present throughout mainland France and the French overseas territories: its control agents and measuring equipment can be deployed wherever the French flag flies. For our case, it's the Reunion Island ANFR branch which takes on the case...

Self-scrambling on board

While our agents begin looking at the precautions they need to take to avoid disturbing the penguins, they get some reassuring news: additional elements provided by the Atmosphere and Cyclone Laboratory (LACY) at Reunion University have identified the source of the interference as being on the ship itself, as it continues regardless of whether the boat is at sea or at the dock. So maybe just going on board with measuring equipment to more accurately



The Marion Dufresne
120.50 m long
650 m² of laboratories
114 passengers

27 October 2021
Intervention date

MAP-IO
The purpose of MAP-IO *(Marion Dufresne atmospheric program Indian ocean)* is to advance the understanding of ocean-atmosphere exchanges, monitor global atmospheric changes and improve digital climate forecasting models. This scientific programme provides unique observations of the entire south-western Indian Ocean and the corresponding southern seas. Some of these are atmospheric and some are related to the biological state of the ocean surface.

The sensor in question in the investigation collects data on the water vapour content of the atmosphere.

Iridium
Iridium is a satellite telephone system based on a constellation of satellites in low earth orbit, some 780 kilometres from the earth. It provides global coverage, including the poles. Regardless of where users are on land, at sea or in the air, Iridium provides network coverage for communications.
It's used with mobile, land or sea terminals for telephony and data transmissions.

The main users are maritime, oil and gas and air transport sector professionals, government agency employees, researchers and explorers.

identify the source of the interference will be enough? The forty-day expedition to the confines of the planet becomes *ipso facto* a carefully timed mission: the aim is to wait for the Marion Dufresne to return to its dock between two rotations to the southern lands. The intervention is hastily scheduled on 27th October 2021, as the ship will be docked for three days in Réunion.

Intervention in the midst of the health crisis

Due to the Covid-19 crisis, this intervention on board the ship requires very strict sanitary measures and controls to avoid any potential contamination of the quarantined crew. This measure is essential to protect the Southern Territories to which the ship will be returning. Our agent, in charge of the ANFR Reunion-Mayotte branch, as well as an engineer from the MAP-IO research programme, must be equipped and wear white overalls, a mask, cap and overshoes to get on board.

No need to look very far

Using a portable receiver and a directional antenna, the agent boards the ship and makes several spectral measurements in the vicinity of the GNSS antenna, located at the very top of the mast. Our investigator's attention is soon drawn to an Iridium antenna recently installed very close to the GNSS antenna. This antenna participates in monitoring seismic-volcanic activity on the seabed. Its installation on the ship coincides with the start of bad GNSS reception quality.
To verify his assumption, the agent requests that the Iridium system be requested to transmit data. By pointing the spectral measurement receiver directional antenna in its direction, the expert can see random noise feedback on the GPS system L1 signal. A certainty! The Iridium antenna is indeed the cause of all the interference.

Out of sight, out of mind

However, shutting down the Iridium system is out of the question as it's used as a safety backup when the ship's V-SAT (Very Small Aperture Terminal used for two-way communication over a satellite network) has a technical problem! It's essential on the Marion Dufresne for communications as it's the only satellite network that covers every spot on the planet including the poles. To deal with the situation quickly, as the ship is due to sail without delay, our agent starts by recommending better decoupling of the two antennas on the ship: materially, that means moving the GNSS antenna away from the Iridium antenna. The next few stopovers between the ship's rotations will make it possible for the work to be carried out properly so that the GNSS antenna can continue to fulfil its mission: to collect data on the water vapour content of the atmosphere in order to contribute to a better understanding of the climate.

WHAT THE LAW SAYS

Interference with a legally authorised frequency by the non-compliant use of radio equipment is an offence under article L. 39-1 of the French Post Office and Electronic Communication Code.
The ANFR may, if necessary, notify the person causing the interference of a fixed tax* of € 450 for intervention costs, and if it wants the case to be prosecuted, draw up report of the offence which is sent to public prosecutor.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in* these situations.

"Elements provided by the Atmosphere and Cyclone Laboratory of Réunion University have *identified* the interference as coming from on board the ship itself."

What are the different types of GNSS interference?

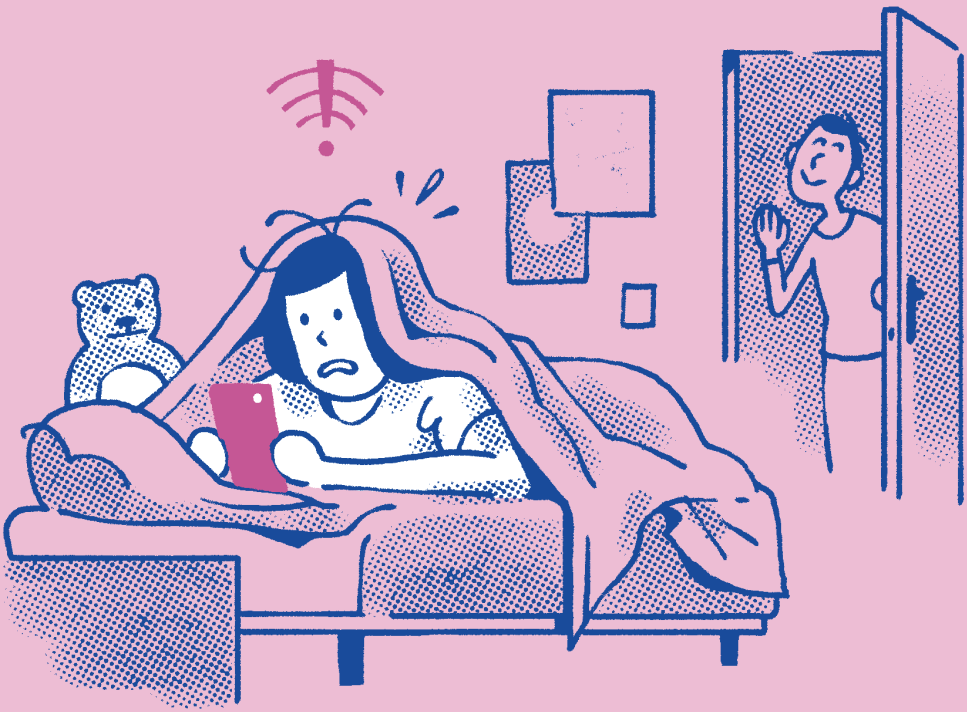
The GNSS frequency assignees in France are the DGAC (Directorate General for Civil Aviation), the CNES (National Space Studies Centre) and the Ministry of the Defence. They can call on the ANFR to investigate interference on their frequency bands.
Interference on reserved GNSS frequencies prevents the proper reception of GNSS signals sent from satellites, and may alter the performance or availability of services that require this data. The cause of GNSS interference may be intentional, such as the use of a GNSS jammer, or unintentional, such as electromagnetic interference resulting from malfunctioning radio or electric systems. GNSS signals that are received from satellites are very weak, making them vulnerable to interference. As part of its spectrum policing mission, the ANFR has taken the measure of the major challenge of protecting GNSS and preventively and pro-actively contributes to the fight against GNSS interference. Dealing with such interference is a real technical investigation carried out in the field by sworn and authorised agents, equipped with sophisticated equipment to search for, identify, and locate the origin of the interference.
Once the equipment and the person causing the interference have been identified, the ANFR provides recommendations to stop the interference.

Education and prevention

Securing GNSS frequencies is not just for radio frequency experts. The importance of the safety and economic stakes that GNSS interference poses indiscriminately on public and private structures of all sizes and in all sectors requires the involvement of as many people as possible. To mobilise all the players concerned, the ANFR conducts several educational actions, in particular to fight against the spread of illicit GNSS jammers and to encourage critical GNSS users, as in the present case, to detect the interference they experience and report it using the appropriate form. The ANFR benefits from the expertise and strong territorial presence of its Spectrum Control Department in mainland France and the French overseas departments and territories, as well as two branches in New Caledonia and French Polynesia.

Investigation no.24

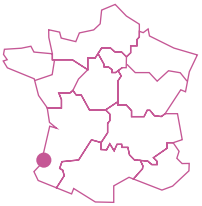
Brush your teeth, switch on the jammer and to bed!



Or how to punish your children and all your neighbours at the same time

August 2020, Messanges, Landes, France. An unusual complaint from a mobile phone operator arrives at the ANFR. There is interference on the telephone and internet services on all mobile frequency bands in the town.
So far, unfortunately, nothing other than routine. But our investigators are intrigued by one detail: the interference never occurs before midnight and usually stops around 3 a.m., every day of the week, day in day out!

IT'S IN THE MIDDLE OF THE NIGHT of 26th to 27th August that the ANFR's regional service in Toulouse begins its investigation... What could be generating such interference when the whole town is asleep? As his watch indicates midnight, our agent, standing at the foot of the complaining mobile operator's radio site, watches the spectrum analyser screen in his laboratory vehicle.
Suddenly, the graph takes on a characteristic shape. The interpretation of the measurement is conclusive. It's the signature of a wave jammer, equipment of which the possession and use are prohibited in France!



Messanges (Landes, France)
960 inhabitants
34 km²

27 August 2020
Intervention date

In the deep of the night

Without further ado, our vigilante goes in search of the jamming signal. Even in the middle of the night, the invisible waves remain clearly visible on his state-of-the-art equipment: with his direction finder on the roof of the vehicle and his portable receiver for use on foot, no signals can resist him!
His search leads him to a house in a neighbouring town near the coast. At 1:30 a.m., the source of the signal is identified, and unmistakable... But the unusual hour and the absence of a judicial police officer means that the investigation has to be put on hold: it's impossible to get in touch with the home owners until the next morning.

Tomorrow is another day

After a short night's sleep, our agent resumes his investigation. The occupant of the premises unabashedly admits that he is using a jammer purchased on the internet... The device in question even turns out to be a multi-band jammer, capable of neutralising both mobile phones and wifi.
One mystery remains: why does the device only work at night, between midnight and 3am? The explanation is very simple: the jammer was installed by the father of the family to prevent his teenage children from surfing the internet with their smartphones instead of sleeping! His children had become addicted to social media and other apps, especially since the lockdown imposed by the

Statistics
On average, 13-19 year-olds have three personal screens.
31% of 11-18 year-olds wake up or stay awake at night to be on their screens.
3-17 year-olds spend an average of 3 hours a day on screens, and over 7 hours for 23% of 15-17 year-olds.
Sources: Ipsos, Génération numérique, ministère de la Culture, Francetvinfo.

WHAT THE LAW SAYS

It plainly and simply prohibits radio jammers: their import, advertising, transfer free of charge or for a fee, putting into circulation, installation, possession and use (Article L.33-3-1 of the French Post Office and Electronic Communications Code). A criminal sentence of up to six months in prison and a € 30,000 fine is provided for (Article L. 39-1 of the French Post Office and Electronic Communications Code). Interfering with a legally assigned frequency is also an offence subject to the same criminal sentencing.

The ANFR agents, who are authorised and sworn, can investigate and record these infringements and issue a ticket. They can also apply a flat tax* of € 450 for intervention costs.

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

Covid-19 epidemic. After consulting forums on the internet, the father decided that a jammer was the best solution to stop the excesses!

Indoor and outdoor effectiveness

A radical solution, which above all is illegal and... disproportionate. Because the equipment wasn't only jamming inside the house. It was severely disrupting all the mobile phone and internet services in the area around his home, depriving not only his children but also his neighbours, the inhabitants of his town and the neighbouring town of a good mobile connection! By wanting to ban the internet in his home, he was applying the same punishment to his entire neighbourhood. The next day, the mobile operator was relieved to confirm that a first night had passed without any interference on its network.

Police confiscation

Today, this father is at risk of prosecution, as both the unlawful possession and use of a jammer are subject to a criminal sentence of up to six months in prison, and a € 30,000 fine. The ANFR agent, in addition to demanding that he turn off the jammer and stop using it, reminded the equipment owner of the regulations. The father also had to pay an intervention tax of € 450.

Verdict and summons

The ANFR drew up a ticket for the offence and sent it to the public prosecutor in Dax, requesting that the equipment be handed over to the police or confiscated.
Subsequently, the prosecutor told the Agency that he had referred the matter to the police for investigation and requested that the respondent be summoned and hand over his jammer. Confiscated!

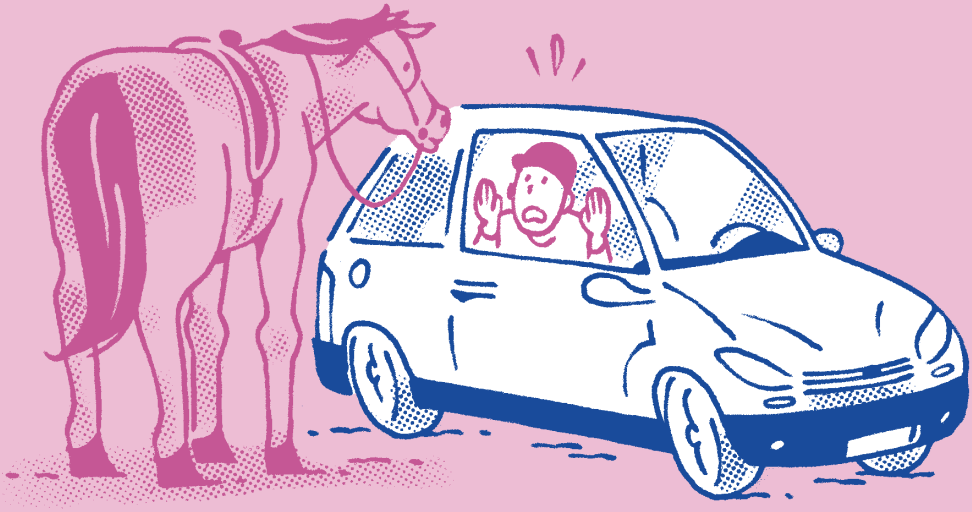
What is a radio wave jammer?

A jammer is an item of equipment specifically designed to scramble, disrupt or block radio communication signals or services.
In general, it works by transmitting louder than the wanted signals in the targeted frequency band. Receivers then stop detecting the useful signals.
The use of jammers, outside strictly monitored state entity uses, is deliberate and offensive interference with the radio spectrum.

Radio jammers are most often an electronic box with one or more small antennas, depending on the services it can interfere with: mobile telephony and internet: 2G, 3G, 4G, 5G; wireless transmissions for internet connectivity, business or private communications: wireless RLAN or wi□ local area networks, WiMax, professional mobile networks; satellite services such as GNSS signal reception (GPS, Galileo...)
The collateral effects of the illegal use of jammers can be dramatic, especially as their users don't realise the range of this equipment, which is never confined to a small space such as a room or a vehicle!

Investigation no.25

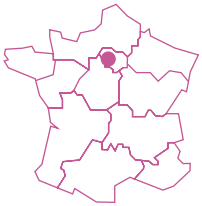
5, 4, 3, 2, 1, free the punters!



Or how a countdown takes on a new role

It's the first weekend in October 2021, Paris-Longchamp racecourse, 100th edition of the "Qatar Prix de l'Arc de Triomphe". It's the most famous event in the world for horse racing fans, the punters' biggest gathering! During such major media events, the ANFR may be called upon by the organisers, to supervise the frequencies essential to their smooth running and to deal with potential interference. And sometimes fast action is needed...

TO GUARANTEE THE SMOOTH RUNNING OF the races, ANFR agents arrived at the racecourse the day before to check that the frequencies had been correctly assigned to the numerous users, whether they were organisers, participants or the media. In addition to the ANFR's "Major Events" coordinator, two spectrum monitoring agents from the Villejuif regional service were on site in their laboratory vehicle parked in a strategic location with spectrum measurement and location equipment.



Hippodrome de Longchamp (Paris, France)
30 race days in 2022
Surface area: 57 Ha

02 October 2021
Intervention date

A stickler for the rules

Several horse races take place during the day on 2nd October 2021. There's no room for error for our agents who carefully monitor the different frequency bands active on the site. And, in fact, everything goes smoothly. But as the races come to an end, a routine check highlighted a strange transmission that had become permanent installed on the 433.8 MHz frequency. Although this frequency is part of the so-called "free" 433.05 - 434.79 MHz band, i.e. not subject to individual authorisation, precise rules must still be followed to allow harmonious sharing between users of this band. One of these rules is that it mustn't be used more than 10% of the time, which is obviously not being respected... It's therefore important to find the source of this disturbance.

Unlocking not possible

Important, and even urgent, because the first unexpected effects are beginning to show: some spectators who have come by car, parked in the racecourse central car park, are using their key fobs to unlock their cars and absolutely nothing happens! The permanent use of the 433.8 MHz frequency is interfering with the car key fobs, which use the same frequency... As a result, the punters are stranded in the racecourse car park, for an indeterminate period of time because they can't unlock their cars! Note that the main uses of the 433.05 to 434.79 MHz frequency band are remote controls (including for cars, garage doors, gates, etc.) and LoRa (a low-speed wireless network protocol reserved for connected objects).

Major events
The ANFR is sometimes called on for "Major events", for which it manages radio spectrum scheduling and checks. The Agency makes sure the events run smoothly regarding the use of all the required frequencies and takes action if interference occurs. These actions may result from requests from ministries and local authorities, but also from private companies on a contractual basis: G8 summits, 14th July parade, Tour de France, 24 hours Le Mans, Roland Garros, ...

WHAT THE LAW SAYS

The unauthorised use of frequencies or the use of frequencies outside regulatory conditions is an offence under the French Post Office and Electronic Communications Code, as is the interference it causes to an authorised radio service. These are offences subject to criminal sentences of up to six months in prison and a € 30,000 fine (Article L. 39-1 of the French Post Office and Electronic Communications Code). The discovery of these offences by ANFR agents may also result in a tax* for an intervention fee of € 450 (French Finance Act).

** Since January 2023, the French Finance Law no longer provides for a tax for ANFR's intervention costs in these situations.*

Hurry up!

The source of the interference must therefore be found without delay before someone is tempted to borrow a racehorse to get home... Luckily for our investigators, their laboratory vehicle wasn't locked! Using the direction finder on the roof, they determine the area from which the interfering signal is coming. The search continues at a pace, using a portable receiver and a directional antenna. It leads our agents to a transmitter placed high up on the edge of the racecourse, on the other side of the track. This too talkative transmitter, activated for the countdown to the start of the race, had stayed switched on!
The ANFR had this transmission stopped and made sure the non-compliance issue was permanently resolved to avoid any further captures of punters at the racecourse.

"As a result the punters find themselves *blocked* on the racecourse car park with their cars locked for an undefined period of time!"

What is a “free” frequency band?

Just because a frequency band is said to be "free" it doesn’t mean there are no rules to follow! It’s true that this type of band can be used without having to pay a fee (free use) and without having to request an individual authorisation from the Arcep. However, there is an authorisation scheme for these frequencies - a general use authorisation - and rules to be followed, because their use is a collective right which must allow spectrum occupation to be optimised. The various so-called "free" frequency bands are reserved for specific uses and subject to restrictive technical conditions of use, such as limitations on transmission power (i.e. range) and "cycle time" (i.e. rate of use).

These technical conditions are intended to allow better cohabitation between the different band users, who can be numerous, and to limit the risks of saturation and mutual interference.

Authorised devices

The TNRBF (French National Frequency Assignment Table) describes, for each "free" band, the authorised categories of devices. These must comply with power and use rate limits and any other possible restrictions. Categories of short-range devices that can use so called "free" bands include: wifi, *Bluetooth,* RFID, alarm systems, microphones, audio systems, smart transportation systems, vehicle radars, vehicle-to-vehicle communication, telemetry, wireless charging systems, radio tracking applications, inductive applications, active medical implants, other non-specific short-range devices, etc.
The holders of equipment which uses frequencies, whether under a general or individual authorisation, are accountable for the proper use of the frequencies. They are responsible for the correct use of frequencies and for complying with the applicable regulations covering the use of frequencies and the conformity of their radio equipment, which must have a CE marking.

The ANFR on on all fronts!

The French National Frequency Agency ("Agence nationale des fréquences", or ANFR) is a public establishment attached to the Ministry of the Economy and Finance and manages all radio frequencies in France. These frequencies are used for all wireless communications, and entire sectors of the economy depend on them: mobile communications, transport, the Internet of Things, television, national defence, industry, etc. The ANFR also takes action to guarantee the coexistence of all frequency uses for all users. The number of services and equipment using wireless links is increasing and constantly evolving: over past twenty-five years, the ANFR has been anticipating these changes to guarantee access to the spectrum for everyone.

At the international level, the Agency is in charge of cooperation and negotiating French positions. As true "spectrum diplomats", ANFR agents prepare and defend French interests in the various bodies in which European and international frameworks are defined. The Agency is also the entry point for satellite operators to register their frequencies with the International Telecommunications Union.

At the national level, the ANFR is the contact for of the major frequency spectrum users. It authorises the installation of transmitter sites and checks their electromagnetic compatibility. Since 2020, it has been monitoring the deployment of 5G in France. The ANFR also controls frequency use thanks to the everyday work of its agents in the field. As the guardian of the spectrum, it takes preventive action through monitoring and awareness-raising operations, and curative action by the resolution of interference. Furthermore, the ANFR schedules and controls the frequencies issued for major events.

The ANFR's work with the general public is essential. It monitors public exposure to radio waves and enforces compliance with the limit values that guarantee the absence of adverse health effects. It also enforces the conformity of radio equipment and carries out specific absorption rate (SAR) measurements of mobile phones and connected objects. Finally, it watches over DTT reception protection and deals with viewer complaints.

Editorial management, author
ANFR

Graphic design, rewriting and editorial secretariat
Marge Design

Illustrations
Quentin Vijoux

Printed on
Book composed in *Mercury* and *Sansation* - Média Graphic+
Legal deposit June 2022

Network lost? Static on the radio? Confused GPS? Weather radar gone haywire?
The ANFR comes to the rescue, investigates and tracks the source of the interference back to the perpetrating equipment generating the interference.
This work narrates twenty-five of the thousands of missions conducted by ANFR agents every year, on land, in the air and on the sea.

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

ANFR
GENCE NATIONALE DES FRÉQUENCES

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