

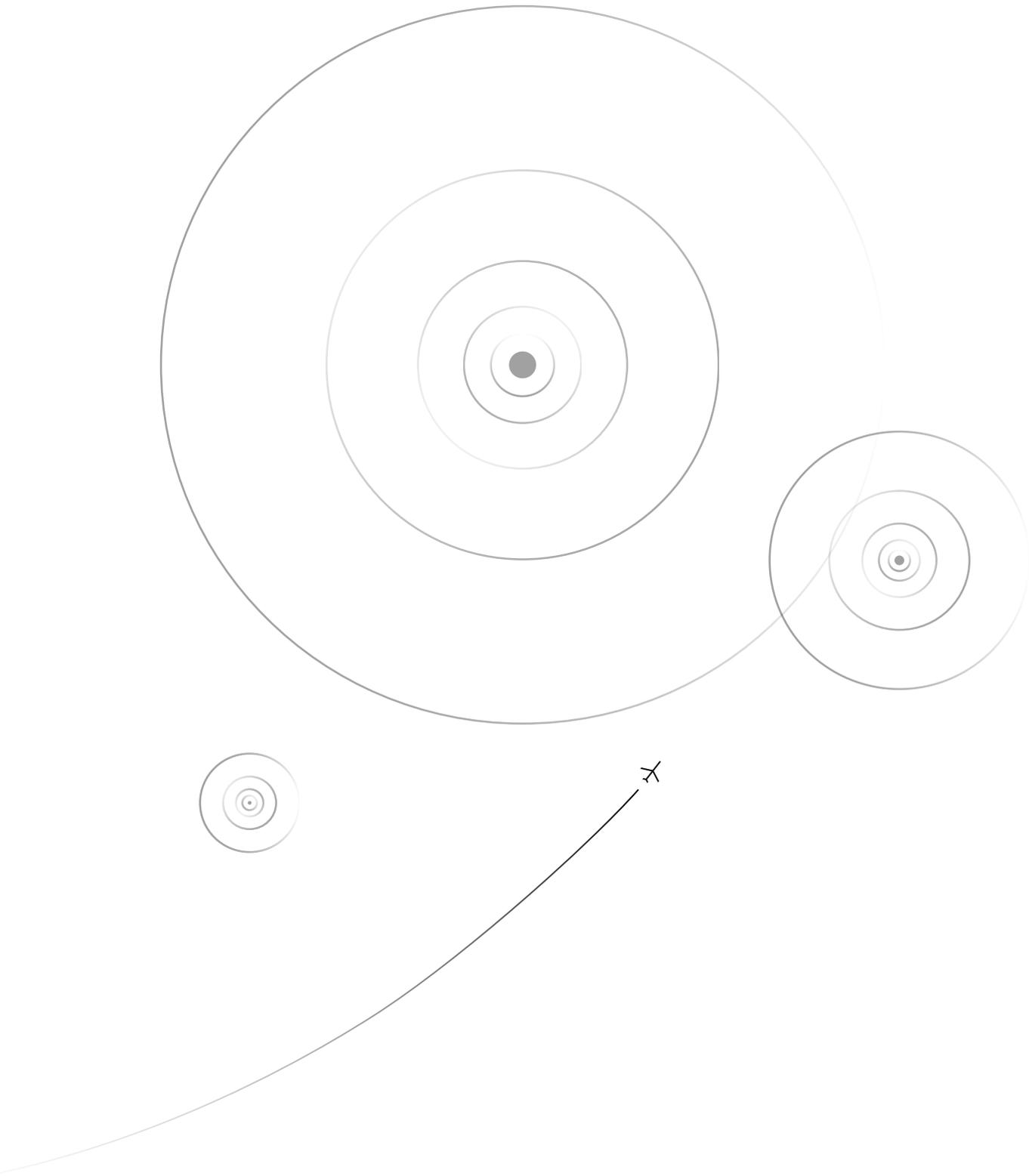
# Report from the working group on GNSS/GPS-disruptions in aviation

Submitted 19 December 2019 and endorsed by the group of State Secretaries  
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# 1 Background for the proceedings of the working group

GNSS (Global Navigation Satellite Systems) is a collective term for satellite systems in outer space that have a broad area of application, including in association with critical infrastructure. At worst, uncontrolled outage of such infrastructure can have disastrous consequences. Services provided by these systems include access to low-cost and accurate position, navigation and timing data. The US Global Positioning System (GPS) and the European Galileo system are examples of individual systems that are especially relevant in Norway.

Over a prolonged period in 2018, Norwegian aviation experienced GPS signal jamming from the Russian side of the border. Northern Norway was especially exposed, including during the NATO exercise Trident Juncture in the autumn of 2018. In light of the consequences for aviation, Norway raised the matter with Russia on a number of occasions, but this failed to change the situation. The phenomenon could thus not be assumed to be of a passing nature.

Against the background of the GPS disruptions, a meeting of state secretaries was held on 11 February 2019 in the Ministry of Transport, with representatives from the Prime Minister's office, the Ministry of Defence, the Ministry of Justice and Public Security/the Minister of Public Security, the Ministry of Foreign Affairs, the Ministry of Local Government and Modernisation/the Minister of Digitisation and the Ministry of Transport. It was decided at the meeting to appoint a working group at the civil service level to identify and assess threats and risks, consequences and management of GNSS disruptions, cf. the impact on the GPS system in particular. The working group was chaired by the Ministry of Transport.

## 1.1 About the working group and its mandate

The basis for the deliberations in the working group has been the risk that GNSS disruptions represent for Norwegian aviation. The working group was tasked with assessing the vulnerability of the different sectors involved, the consequences of disruption/interruption of GNSS signals, potential damage in the short and long term, incident management, information flow and notification procedures in each sector, as well as notification and coordination across sectors.

Further emphasis was placed on revealing the root causes of vulnerabilities and thereby the potential for preventive action, and the potential for preventing/limiting incidents, including possible backup systems and alternatives.

The working group was also requested to submit, to the extent possible, assessments and propose solutions, as well as to report other issues that it identified during its work.

The working group was asked to submit its first report to the group of state secretaries in the autumn of 2019. It is important to clarify whether there are any measures for the follow-up of the working group's assessments, cf. the summary in Chapter 8 below. Any further work will thus depend on the issues that still need to be clarified.

Participants:

Ministry of Transport: Kirsten Ullbæk Selvig (chair), Øystein Haga Skånland

Ministry of Justice and Public Security: John Arne Gisnås, Per Erik Ringstad

Ministry of Local Government and Modernisation: Jarl Kristen Fjerdingsby

Ministry of Defence: Trond Haande, Nina Borgen, (Hilde Kutschera Ravnestad)

Ministry of Foreign Affairs: Lars Ragnar Hansen, Tor Kinsarvik

The Norwegian Communications Authority (Nkom): Per Eirik Heimdal

The Civil Aviation Authority of Norway (CAA Norway): Svein Johan Pedersen

## 1.2 The proceedings of the working group

The working group has addressed the following main issues:

- The cause of the GPS disruptions that have occurred in Northern Norway and their handling in a short-term perspective.
- Vulnerabilities in aviation from the use of GNSS systems in critical infrastructure, risk assessments, possible preventive measures.
- How to prevent/limit unwanted incidents and their consequences, as well as backup systems and alternatives.
- Warnings and information flow in aviation and coordination between the sectors involved.

The basis for the work of the working group is aviation, but the group has also briefly discussed areas related to aviation, the consequences for these areas and their vulnerabilities. However, the working group's assessment is that these areas will require a large and comprehensive effort and should therefore be dealt with as a supplementary part of the group's work. The working group has concentrated its efforts on the immediate challenges to aviation and highlighted areas where there is a need for action to be taken.

To undertake technical and political assessments, cross-sectoral collaboration and possible measures, it is crucial to have a shared basis in the form of a joint picture of the situation, understanding of threats and roles, notification procedures and distribution of responsibilities.

The issues associated with GNSS disruptions are closely linked to the government's work on digital security and exemplify the vulnerability inherent in modern and critical infrastructure.

## 2 GNSS disruptions

A starting point for the work has been to establish a shared understanding of the use of GNSS. The best known GNSS systems are GPS (USA), which is the most widely used, GLONASS (Russia), Beidou (China) and gradually also Galileo (EU), to which Norway contributes. The systems are owned and managed by the respective owning nations, which thereby occupy a controlling/dominant position in critical infrastructure globally. The systems consist of a number of satellites that orbit the Earth at a distance of approximately 20 000 kilometres. To determine their position, GNSS/GPS users on the ground need to have contact with a minimum of four satellites.

GNSS services are currently free of charge. In addition to aviation, key areas of application include emergency communication networks, public mobile communication, construction enterprises, the financial market, the healthcare sector, the energy and power supply sector and the entire transport sector. All fundamental societal areas that rely on the distribution of correct time or data are dependent on time synchronisation. This dependency and vulnerability have gradually become more visible, and accordingly, there is now a pressing need for backup systems and knowledge about vulnerability and risk in each sector.

The vulnerability of GNSS systems is mainly due to the extremely low strength of the satellite signals when they reach the Earth's surface, making them easily prone to disruption by other signals.

If the disrupting source in addition is transmitting in approximately the same frequency bands that are used by the systems for satellite navigation, the GNSS service can become degraded or blocked in an area that in practice ranges from a few dozen metres to many tens of kilometres from the disrupting source, depending on its signal strength. If the disrupting source is used deliberately and knowingly and has been constructed with the purpose of disrupting or blocking electronic communication, the equipment is referred to as a 'jammer'.

Disruptions of GNSS signals can have different causes and appear as jamming (that disables the systems) or spoofing (that sends false signals). Disruptions may come from foreign powers, terrorists, other hostile parties, natural phenomena and inconsiderate use of GNSS jammers for other purposes. Spoofing requires somewhat more sophisticated equipment, but is more serious than jamming, since it can mean that users of GNSS signals can be given a wrong position or be guided in the wrong direction, without this being detected.

The working group has discussed the cause of the GNSS disruptions, which are not necessarily due to government actors. Disruptions may be of a local nature and stem from people who acquire and use GPS jammers for the purpose of blocking tracking reports in various services. Natural phenomena such as sunspot activity may also disrupt GNSS signals periodically.

## 2.1 GNSS disruptions in Norwegian airspace

The disruptions that have been observed in Norwegian aviation have a clear geographic delimitation. The GPS disruptions have affected aviation in Northern Norway in particular, including at times when no military exercises were taking place. This gives grounds for concern about the reliability of key national societal activities in Northern Norway. Growing activity and interest in the Northern areas will require secure and robust infrastructure for all kinds of activities in the area, not only in terms of aviation, but also for maritime traffic, petroleum activities, fisheries, search and rescue etc. In addition, hand-held jammers have been used by Norwegian actors in some locations elsewhere in Norway.

From September 2017 to February 2019 there were repeated occurrences of GPS jamming in the airspace above Finnmark county, especially in Eastern Finnmark. Measurements showed that the jamming signals came from the Russian side of the border. The most comprehensive incident occurred during the active part of the NATO exercise Trident Juncture in October 2018.

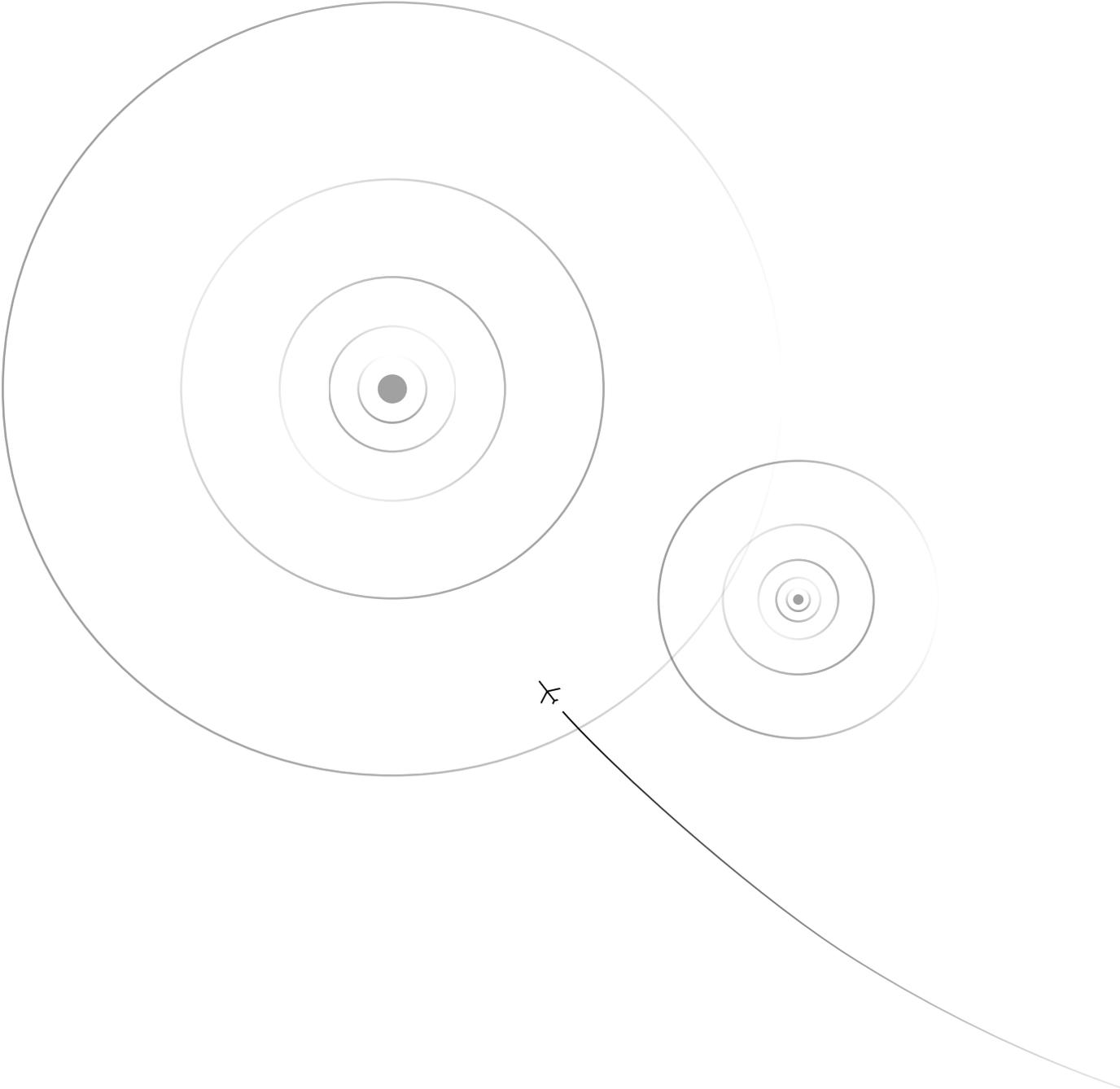
The Ministry of Foreign Affairs consistently raised this issue with Russia, emphasising that such behaviour was not conducive to trust, predictability and stability in the North, and did not engender good neighbourly relations. Reference was made to guidelines from the United Nations' International Civil Aviation Organization (ICAO) for exercises of capabilities for electronic warfare, which underscore that advance notification of such exercises must be given and that the impact on civil aviation must be minimised.

The issue was brought up by Ine Eriksen Søreide, Minister of Foreign Affairs of Norway, in her meeting with Sergei Lavrov, Foreign Minister of the Russian Federation, in December 2018. It was further addressed during senior official talks between the Norwegian Ministries of Foreign Affairs and Defence and their Russian counterparts in the spring of 2019. Detailed lists of reported incidents compiled by the Civil Aviation Authority of Norway (CAA Norway) were subsequently forwarded to the Embassy of the Russian Federation in Norway.

On Russia's initiative, a meeting of experts was held in Moscow on 20 June 2019. The Norwegian delegation was headed by the defence attaché in Moscow, since Russia had chosen to transfer the issue to the military track. However, the civilian experts from the Norwegian Communications Authority (Nkom) and CAA Norway took a leading role during the meeting, with assistance from the Norwegian Ministry of Defence and the Ministry of Foreign Affairs, which attended at the case officer level. The Russian delegation consisted of military representatives exclusively. During the meeting, the Norwegian experts gave a detailed account of the GPS disruptions that Norwegian civilian authorities had registered. The data consisted of registrations made by CAA Norway and measurements undertaken by Nkom in Kirkenes.

The Norwegian side made it clear that the disruptions stemmed from Russia. Although the Russian side did not explicitly acknowledge any responsibility, they did not express any disagreement or doubt regarding the data presented by the Norwegian side. The meeting proceeded in a constructive, collegial tone, with the Russian side asking detailed questions.

Since this meeting and until the finalisation of this report on 19 December 2019, no GPS disruptions have been registered in Norwegian airspace over Finnmark county. If, contrary to expectation, similar problems should occur in the future, this experience shows that we have both military and diplomatic communication channels available that permit such problems to be addressed.



### **3 Aviation and vulnerability to GPS disruptions**

Aviation is a key part of the transport system and crucial for local communities, business and economic development in all parts of Norway.

Aviation is facing considerable restructuring and change due to new technology, modernisation and digitalisation. Satellite-based systems such as GPS are part of modern and digitalised transport infrastructure, including aviation. The use of GNSS-based infrastructure in civil aviation also has an interface with military aviation. Military aviation makes use of the civil aviation infrastructure, for example air navigation services.

In aviation, a transition from terrestrial to satellite systems is taking place. This shift is due to both technological development and to ICAO's requirement for the introduction of performance-based navigation. Use of GNSS and performance-based navigation provides for better exploitation of airspace and helps ensure more efficient and environmentally friendly aviation. However, there is a potential security and vulnerability aspect to this dependency on GNSS. The application of satellite-based support systems in Norway involves special challenges because of the weak signal strength of geostationary satellites at high latitudes.

In addition to GNSS for positioning on board aircraft, airspace surveillance is increasingly reliant on GNSS as a source of position and time synchronisation. Previously, airspace surveillance was based on radar stations that did not depend on clock signals from GNSS. Today, many of the radar stations have been replaced by GNSS-based systems for airspace surveillance.

As a result of digitalisation, aviation is facing many of the same challenges as other sectors, but the consequences of an uncontrolled outage of signals can be considerable and fatal. Digitalisation can provide solutions that are simpler to access by their users, but also more vulnerable because of the high level of complexity the systems. The causes of system malfunction can be difficult to identify, and unforeseen problems can arise. Conventional systems in aviation services that have previously operated with no linkage to, for example, the internet, are now under pressure to establish such linkage, since this would simplify such issues as maintenance and updating. Increasing the number of linkage points also increases system vulnerability. It has gradually been recognised that GNSS systems are vulnerable, with a high risk of serious consequences for society in the event of a signal outage.

## 4 National and international efforts in aviation

At the national level, CAA Norway's work on a proposal for a Navigation Strategy for Aviation in Norway is the most important component. Its main topic is GNSS disruption, including GPS-based infrastructure, as well as necessary backup solutions. The deadline for the consultation round was 15 March 2019, and the authority aims to forward the matter to the Ministry of Transport during winter 2019/2020. This work also includes assessments of aviation vulnerability and risk made by Avinor. Avinor has undertaken an assessment of the vulnerability of its air navigation service. This assessment is classified, but Avinor has made an unclassified presentation to the working group.

Avinor is of the opinion that aviation as a whole is moving towards a situation where GNSS outages will be an increasing problem. The EU has decided that local, conventional aircraft navigation systems should be dismantled over the next ten-year period (ref. EC IR 1048/2018). This will render the navigation function especially vulnerable to outages, and for some aircraft types in the existing fleet this will present considerable challenges unless precautions are taken. Operators of medium-sized jet aircraft have INS/IRS backup systems (inertial navigation). Operators of newer regional jet aircraft also have IRS as a backup, whereas turbo-prop operators at local airports will have varying types of equipment. Some turbo-prop aircraft types will also be unable to operate from local airports. As regards the aircraft fleet of the air ambulance, these currently have INS capacity. This implies that there must be a minimum of conventional navigation facilities available to ensure sufficient redundancy. At the moment, the situation cannot be described as critical, but it can become so if conventional navigation facilities are dismantled.

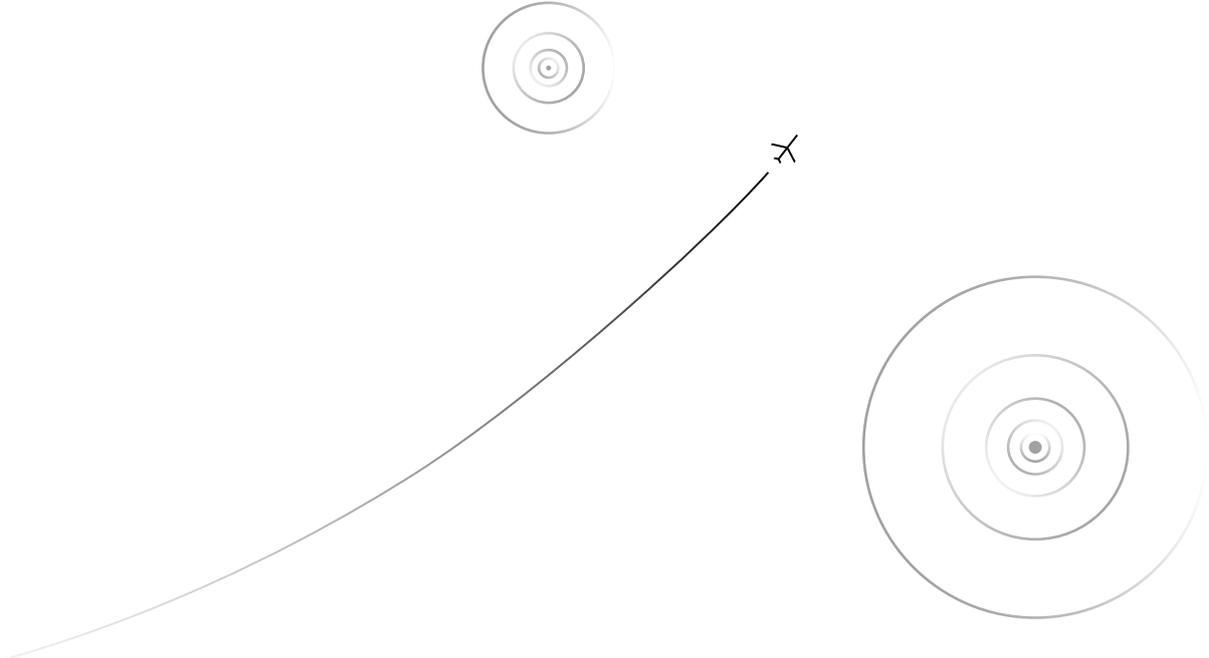
Avinor has investigated the extent to which current air navigation systems are vulnerable to GNSS disruptions. Since the air navigation infrastructure consists of many different systems that are interdependent and must communicate as one, a shared time reference is needed for all systems to function optimally. GNSS-based time synchronisation is a simple and low-cost method for ensuring the same time throughout a distributed system. For ATM systems (Air Traffic Management), the synchronisation of distributed systems will entail a vulnerability if GNSS is used as the time source. A shift towards further use of GNSS as the time source in multiple systems should be followed up by incorporating better redundancy into these systems. Avinor has therefore taken steps to procure atomic clocks that can provide time synchronisation independently of GNSS.

Aviation is an inherently global and transboundary industry. It is in Norway's interest to raise GNSS problems in international contexts where global solutions for aviation are discussed and new standards and regulations are decided, such as ICAO and the EU. Norway could also benefit from discussing the GPS situation with other countries, especially in our region in Europe.

With other European countries, Norway will follow up the problems associated with GPS disruptions in aviation in ICAO in a joint European initiative on GPS disruptions and vulnerability. This focuses mainly on the vulnerability of CNS systems (Communication, Navigation, Surveillance) and the need for more robust infrastructure, both in available terrestrial systems and equipment on board aircraft. The message to ICAO is that the work on GNSS disruptions must be prioritised and that member states have a responsibility for advance notification of exercises with GNSS jamming, including across national borders.

Despite the development in disruptions of GPS signals in aviation, the EU continues to emphasise the use of satellite-based systems in all modernisation and digitalisation in aviation in the years to come. The Norwegian Communications Authority and the Norwegian Space Agency are part of the 'GNSS Task Force', an EU initiative that seeks to benefit from each country's experience and knowledge about GNSS disruptions.

The Ministry of Transport is already involved in efforts where GNSS vulnerability in aviation is discussed, but we will consider whether, and if so how, to intensify these efforts in relation to ICAO, the EU and Eurocontrol (a European intergovernmental organisation for airspace administration), NATO, the USA, Finland and other actors as relevant.



## 5 Adjacent technical and responsibility areas

The working group has investigated how the work and responsibilities of other sectors help secure and improve the use of GPS.

### 5.1 The PNT strategy

The Ministry of Transport coordinates and holds general responsibility for civil radio navigation and the government's PNT strategy (Positioning, Navigation and Timing). The strategy highlights the overarching approach and coordination, while the sectors are responsible for follow-up and implementation.

PNT systems are terrestrial and satellite-based systems (GNSS) that are easily accessible, with a very high uptime and partly free of charge. They are therefore highly useful, both as a positioning and navigation tool and as a source of exact time and frequency. Over the last fifteen years, the use of PNT systems has increased substantially in many areas of society.

A serious failure in the PNT services will spread to other parts of society and may cause problems in maintaining services on which the population depends. PNT system failures can occur for reasons including disruption of GNSS signals.

The PNT strategy, entitled 'In the right place at the right time. National strategy for positioning, navigation and timing', which was published in November 2018, is part of the government's work to strengthen public security and facilitate technological development. It is aimed at sectoral authorities at various administrative levels, as well as developers, suppliers and users of PNT systems and services. The strategy reviews the PNT systems and their use in various areas of society, and then assesses vulnerability to PNT system failure. Against this background, measures to reduce this vulnerability are identified.

The strategy's main goals are to:

- ensure that we can continue to benefit from the PNT systems and make use of new opportunities offered by these systems;
- help raise awareness of society's dependency on PNT systems;
- help reduce society's vulnerability to PNT system failure through preventive measures and contingency planning.

### 5.2 Norwegian Communications Authority (Nkom)

Nkom is an agency under the Minister of Regional Development and Digitalisation within the Ministry of Local Government and Modernisation. The agency is the authority responsible for electronic communication and plays a key role in detecting and identifying the location of GPS disruptions.

Nkom administers frequency resources in Norway, which entails planning frequency use, allocating frequency licences and also monitoring frequency use to identify deliberate and indeliberate disruptions of wireless electronic communication. Nkom can also verify coverage of radio services and measure radiation from electronic communication to ensure the health and safety of users.

The first remotely controlled monitoring station in Finnmark county, whose capabilities include measuring GNSS disruptions, went into operation in late March 2019. In October 2019 Nkom established another monitoring station in Eastern Finnmark. Both these remotely operated monitoring stations provide an opportunity to identify the direction of a disrupting source. In combination with direction finders in specially equipped vehicles, supplemented by hand-held direction finders, Nkom can find the exact position of the disrupting source and have it turned off. The precondition for this is that the source is located in Norway.

If the disruption is found to originate outside Norway's borders, multiple remote monitoring stations/vehicles can be used to identify a likely area where the disrupting source is located. In such cases, Nkom in cooperation with the frequency authority in the country in question can receive help to locate and turn off the source, if possible. This method is reliant on the country in question acknowledging the problem and be willing to cooperate. Such cooperation is regulated through the international Radio Regulation defined by ITU. The ITU Radio Regulation is an agreement under international law that regulates intergovernmental issues including harmful interference with radio services.

## **Nkom measures**

Nkom is collaborating closely with the Norwegian Space Agency (NOSA) on issues associated with GNSS challenges. In addition, NOSA funds parts of Nkom's work in this area.

The above can be summarised in the following main topics:

- Improve the **detection** of GNSS disruptions with the aid of Nkom's own sensors and additional use of sensors operated by other civilian agencies in Norway
- Nkom and NOSA have established a **coordination forum** for sectors and stakeholders that have an interest in not losing access to GNSS for services that are critical to society. Nkom chairs the forum, and meetings are held regularly. The participants share experiences and competence, and help keep communication lines short. As of today, the coordination forum includes participants from Nkom, NOSA, the Norwegian Directorate of Civil Protection (DSB), the Norwegian Coastal Administration, the Norwegian Public Roads Administration, the Armed Forces Operative Headquarters, the Norwegian Defence Research Establishment, the Norwegian Metrology Service, the Norwegian Mapping Authority, Avinor Air Navigation Services and the Civil Aviation Authority of Norway.
- Establish effective **notification procedures** across sectors in case of incidents. These procedures should not replace notification procedures within the individual sectors, but provide a supplement through a broad analysis and further notifi-

cation as required to other sectors after receiving reports of incidents from one sector. This function is currently lacking in Norway, and it will provide major added value to society. This initiative has a relatively low threshold both economically and organisationally, but requires an organisation to serve as a 'hub' that can undertake analyses and report widely to all relevant sectors. In principle, the notifications will be sent unclassified between established communication platforms (email or telephone) in each of the organisations that want to be part of the 'notification ring'. As of November 2019, this work is underway in the coordination forum mentioned above, and many of the forum's participants point to Nkom, by virtue of being the frequency authority, as a natural point of coordination to receive notifications of incidents from individual sectors about GNSS outages and to analyse them and send out a wide alert to other sectors as required. Nkom is open to accepting such a role. As a further development in the longer term, it could be envisaged that such a 'hub' linked to detection, coordination and notification procedures for GNSS incidents in particular forms part of a large, general **'operations centre'** whose remit would include disruptions and outages of other critical electronic communications services, e.g. mobile networks, emergency communication etc. It is important to specify that DSB will invariably be involved in this work and independently consider measures in conformity with its own established procedures for measures and notification to society.

### 5.3 Security improvement and the Security Act

In recent years, the government has intensified its efforts related to security. The emphasis of this work has been on identifying exposed areas of society, vulnerability and risk assessment and preventive measures, as well as requirements for follow-up. In terms of security, the problems related to GNSS services encompass two different dimensions. The first dimension involves the security of GNSS installations. The second concerns the vulnerability of information systems etc. that are vital to national security or critical national infrastructure.

Norway has a number of installations that need to be protected to safeguard the benefits of satellite systems. As noted above, deliveries from these systems serve as low-cost sources of PNT services in key functions. Certain parts of the terrestrial infrastructure for satellite services are or can be encompassed by the Security Act and classified as critical national assets (objects, infrastructure, information or information systems).

Satellite-based communication and navigation are vital societal functions, cf. the report from The Norwegian Directorate for Civil Protection (DSB) 'Samfunnets kritiske funksjoner' ['Critical functions in society']. The Ministry of Local Government and Modernisation holds the main responsibility for this function, whereas the Ministry of Transport, with its responsibility for the coordination of civil radio navigation policy, is responsible for PNT.

The 'Instructions for the ministries' work with civil protection and emergency preparedness', laid down by the Ministry of Justice and Public Security in 2017, define a series of requirements for ministries with primary responsibility for vital societal functions.

A status assessment and report on the 'societally vital function of satellite-based communication and navigation' should be completed by 2020. The Ministry of Local Government and Modernisation is responsible for this critical function in society.

The objective of the Act relating to national security (Security Act) is to protect Norway's sovereignty, territorial integrity and democratic system of government and other national security interests through preventing, detecting and counteracting security threats. A key element in achieving the objectives of the Act is to ensure that critical national assets which are of vital importance to fundamental national functions are maintained.

In cases where PNT services support fundamental national functions, these services must be sufficiently protected so as not to constitute a vulnerability in relation to national security interests. State agencies are responsible for implementing the safeguards necessary to achieve an adequate level of security.

The Security Act also provides a legal basis for imposing security requirements where this is deemed necessary. The Act permits the King in Council to 'intervene' and make the decisions necessary to prevent activities that threaten security – or any other planned or ongoing activity – that could pose a significant threat to national security interests.

#### **5.4 Other Norwegian agencies**

The working group has also touched upon other Norwegian agencies, but has not had the opportunity to discuss their work in detail. These include the Norwegian National Security Authority (NSM), the Norwegian Intelligence Service (NIS), the Police Security Service (PST), the Norwegian Defence Research Establishment (FFI), the Norwegian Metrology Service, customs and police.

The Ministry of Justice and Public Security has informed the working group that police investigations uncovered daily outages of GPS signals in the period from 24 October to 7 November 2018. However, there were no continuous signal outages. In the assessment of the Finnmark Police District, such outages of GPS signals could periodically impact general preparedness in Finnmark county. If ambulance aircraft were unable to land, this could at worst represent a risk to life and health. Moreover, use of aircraft, helicopters etc. is often the only possible means available to the police and other emergency response services for moving personnel to the relevant area during a major incident.

## **6 Preparedness, incident management, information flow, notification procedures in aviation and notification and coordination of the sectors involved**

Over a long time, Norway has developed a preparedness and response system characterised by well-established procedures, contingency planning and coordination of measures that may have an impact across sectors. The basis for the work on preparedness and response has been traditional accidents and incidents, but the principles and experiences are also applicable to the management of GPS disruptions.

### **Notification procedures and information flow**

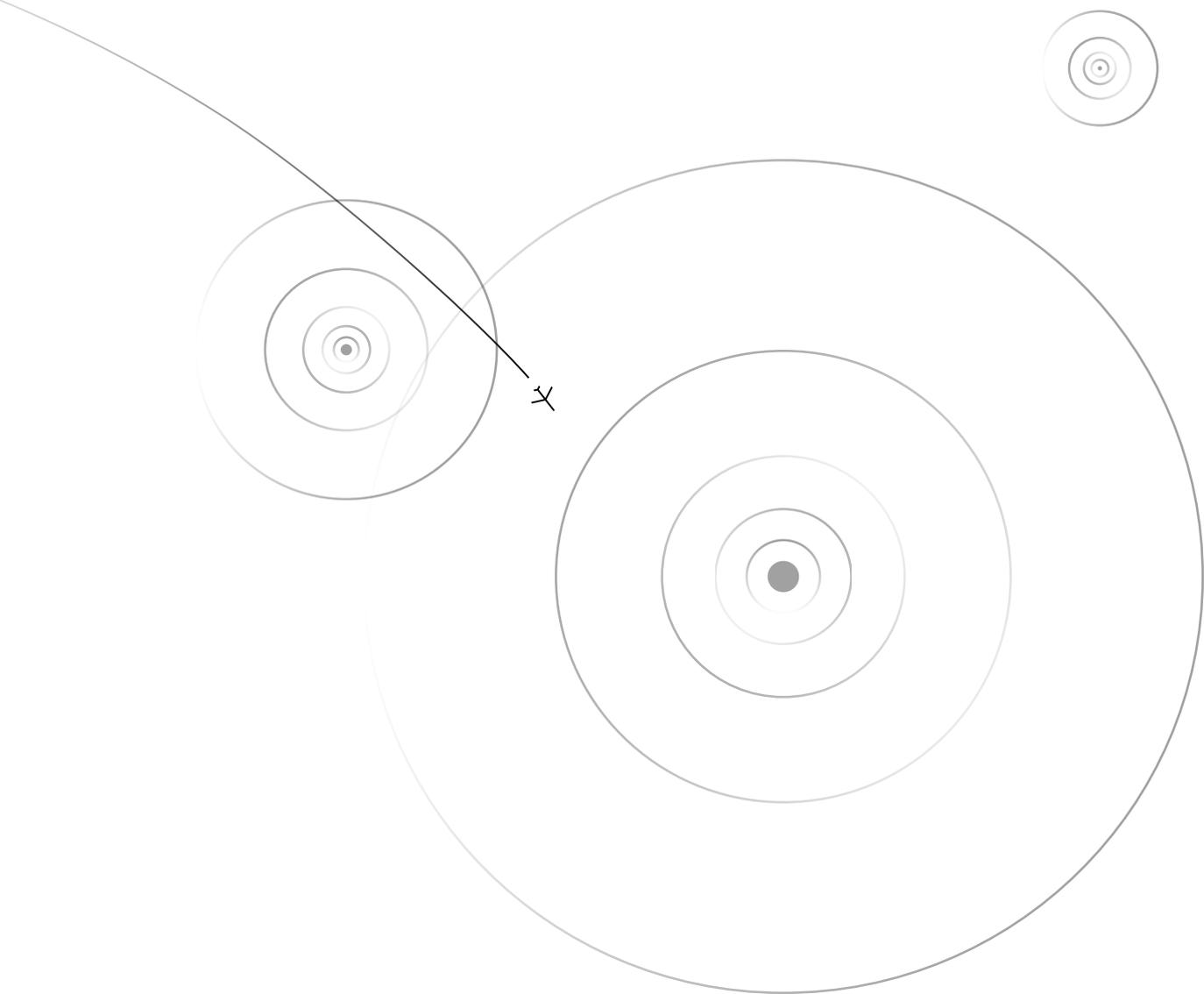
The working group has discussed the information flow, existing notification procedures and the need for better coordination, while maintaining the overall structure and facilitation in government crisis management and notification systems. Prevention will always be important, but adequate notification procedures are crucial when an incident occurs.

The working group wishes to highlight the following:

- Notification procedures must be adapted to the technical area or areas in question, while remaining easily accessible within the overarching notification system. All parties must be aware of and well-integrated in the interaction between the agencies involved.
- The notification procedures must be structured so that users involved quickly receive the necessary information to let them take the right steps, while the appropriate authorities and infrastructure owners can initiate investigations and take remedial action.
- It is important that the roles and responsibilities of the respective cabinet ministers/ministries are clarified and made visible. This is important also for handling the media.
- All involved authorities and agencies must have a clearly defined statutory basis for their activities.
- There is a need for an overview of notification systems within each sector and of the coordination between the sectors. In this context, reference is made to Nkom's work on preparing 'notification procedures across sectors', as mentioned in Section 6.2 on a possible, large general 'operations centre'.

The Civil Aviation Authority of Norway maintains a good dialogue with the air traffic services, airlines and other authorities to ensure that notification procedures work optimally when such incidents occur. Avinor Air Navigation Services has established procedures for managing and notifying the relevant agencies of reported GNSS disruptions. The Civil Aviation Authority of Norway is alerted at an early stage and notifies the airlines, and also considers whether to issue a NOTAM (Notice to airmen).

The Ministry of Transport and the Ministry of Defence including subordinate agencies, the Civil Aviation Authority of Norway and the Norwegian Intelligence Service have prepared a draft for an updated notification procedure for aviation in the event of GNSS/ GPS disruptions. The procedure specifies the kinds of information and cooperation that should be in place in connection with incidents.



## 7 Summary and measures for consideration

The working group has assessed the main issues associated with the GNSS/GPS disruptions in aviation as discussed at the meeting of state secretaries on 11 February 2019.

**The premises** for the assessments of the working group and the further work are that:

- Norwegian authorities have no ownership of or control over the GNSS systems.
- GNSS disruptions entail consequences for both civilian and military aviation.
- GNSS disruptions entail consequences for critical societal functions and fundamental national functions that are supported by such systems.
- Norwegian authorities and other Norwegian agencies have a limited scope for action.

**The working group recommends:**

- Transparency and awareness of opportunities and limitations inherent in the use of GNSS systems. This is important in preventive efforts, in considering choices of solutions in various application areas and in association with establishing backup systems and alternatives.
- There must be an explicit awareness of what is considered acceptable vulnerability/risk.
- Further development of secure and effective notification procedures and plans and tools for restoration after an incident (disruption or outage of GNSS-based services). This is an essential element in the use of GNSS-based infrastructure.

The working group has identified possible areas of action, but also sees a need for further work and assessments in a number of areas:

- Measures for the regulation of hand-held jammers.
- Overview of notification systems in each sector and coordination between sectors, cf. Nkom's work on preparing 'notification procedures across sectors', as described in Section 6.2 on a possible, large general 'operations centre'.

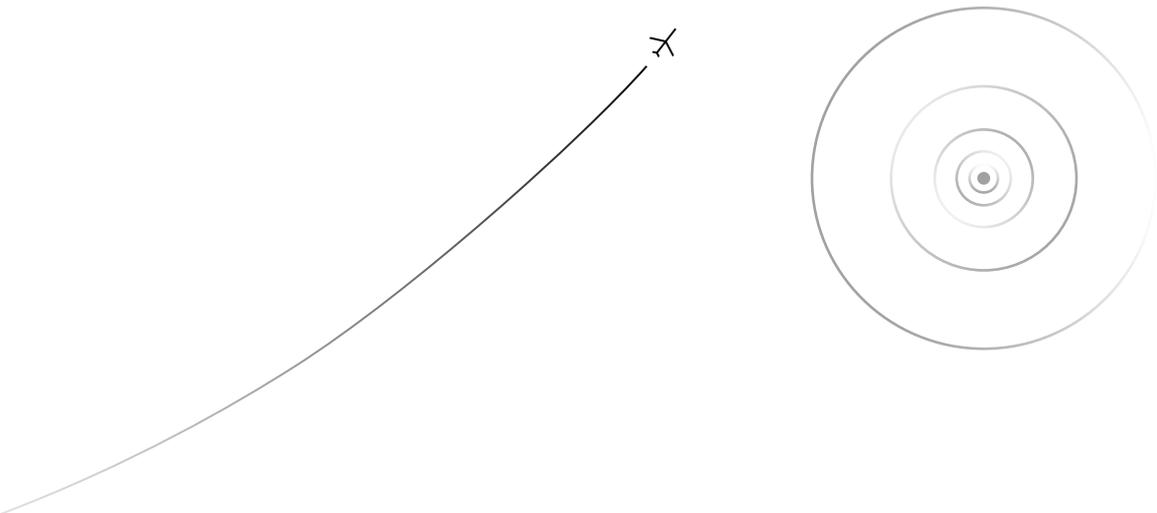
Most sectors in society are to a greater or lesser extent vulnerable to outages of GNSS signals or to such signals being compromised. In all sectors concerned, work needs to be undertaken on raising awareness of vulnerabilities, risk assessment (risk and vulnerability analyses) and relevant measures in case of outages, including the use of backup solutions as required, cf. the conclusions from the PNT strategy.

Experience from aviation is relevant and has a transfer value to other sectors. Each sector is encouraged to assess their need for, use of and dependence on GPS/GNSS, their associated vulnerabilities and potential consequences and the types of incidents that can be expected, as well as how restoration will take place.

There is a need to develop and establish a balance between the use of modern and digital technologies and an understanding of the vulnerability associated with systems that are becoming totally dominant in critical aviation infrastructure. In the development and design of new solutions, vulnerability and prevention must be taken better into consideration.

The work by the Civil Aviation Authority of Norway on a Norwegian strategy for navigation infrastructure for aviation, including the use of GNSS/GPS, will be submitted to the Ministry of Transport in the winter of 2019/2020. The Ministry will follow up this work at the ministerial level nationally, while the international dimension will be followed up in ICAO, the EU and bilaterally.

The factual approach in the dialogue between Norway and Russia on this issue appears to have produced positive results. The working group's assessment is that an important clarification has been achieved regarding the circumstances surrounding the recent GNSS/GPS disruptions in aviation, as well as a positive dialogue with Russia on the shared interest in maintaining secure and reliable conditions for aviation.



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