Advances in Direct to Device Emergency Communications Networks

Assessing what impact Direct to Device satellite communications could have on access to emergency services in Europe

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EXECUTIVE SUMMARY

This paper provides an analysis of existing space-based telecommunications services, new developments in Direct to Device Communications, and the challenges and opportunities which this will create for public safety.

Smartphones are now capable of connecting with satellites in Low Earth Orbit to send emergency communications in areas without a terrestrial cell connection. The capability to transmit public warning messages directly to smartphones from satellites may also become available in the next months.

The use of Direct to Device Satellite Communications will likely remain limited in the EU, due to the very high population coverage of terrestrial mobile networks in the EU. **However, it may be particularly useful in situations where the parts of the terrestrial network fail, such as following a natural disaster.** In these situations, satellites could be used to send public warnings to citizens, or to allow distressed citizens to make calls to 112.

Direct to Device Satellite Communications can therefore significantly enhance the resilience of 112 in Europe.

The Report aims to:

- Provide an overview of existing space based communications networks and their use in emergency communications, including Direct to Device.
- Assess the need of emergency communications end users for newer generations of space based communications such as Direct to Device.
- Provide an overview of the legal frameworks and stakeholders for this technology in Europe.

However, **the rise of satellite-based communications services also comes with risks**. While overall it appears unlikely that space-based communications could replace terrestrial telecoms networks, it is possible that providers could claim that a space-based system could be used to fulfil universal service obligations in remote areas. This would undermine public safety, unless if the capacity and reliability of this new technology is proven to be equivalent to terrestrial networks.

1 | LIST OF ACRONYMS

AML	Advanced Mobile Location
D2D	Direct to Device
EECC	European Electronic Communications Code
FCC	Federal Communications Commission
GEO	Geostationary Orbit
GNSS	Global Navigation Satellite System <
IRIS^2	Infrastructure for resilience, interconnectivity and security by satellite
ITU	International Telecommunications Union
LEO	Low Earth Orbit
MNO	Mobile Network Operator
PSAP	Public Safety Answering Point
TPSP	Third Party Service Provider

Background to Satellite Communications:

Higher and Lower Earth Orbit and Existing Satellite Communication Systems

Summary: This section will explain the key concepts of high and low earth orbit, and their relative strengths and weaknesses for communications satellites.
Following this, three existing satellite communications systems which are relevant to emergency communications will be considered: GNSS satellites, which provide location services to mobile devices and could soon be used for public warnings, satellite internet, and mobile satellite phones, which provide access to emergency communications in areas without cellular coverage.

1 | Higher or Lower Earth Orbit?

All satellites orbit the earth at a specific altitude, and can therefore be defined as being in higher, medium or lower orbit.

- **Low Earth Orbit (LEO)** covers all altitudes between 160-2000km above sea level. Satellites at this altitude orbit the earth every 128 minutes or less. This is the most important orbit for emergency communications and will be discussed in detail in this paper.
- **Medium earth orbit (MEO)** covers altitudes between 2000 km and 35,786km above sea level. Orbits range from 129 minutes up to 23 hours, 56 minutes and 3 seconds.
  - 35,786km is also known as **geostationary orbit (GEO)**, as at this altitude satellites orbit the earth at the same speed at the earth rotates, meaning the satellite can always cover the same area of the Earth.
- **Higher earth orbit (HEO)** covers altitudes above 35,786km.

LEO Satellites

LEOs are orbits in the "lower region" of space, which covers an altitude of between 160 km and 2000 km above the Earths surface. **The majority of satellites in space are in this altitude**.

Within this area, there are three sub areas:

(i) Higher LEO, with an altitude between 1200 and 2000km
(ii) Lower LEO – with an altitude between 160-1200 km; and
(iii) Very Low Earth Orbit (VLEO), with an altitude of 160-450 km.

Most satellites are in lower LEO but not VLEO.

LEO offers several advantages over higher altitudes:

(i) **Lower cost:** Launching a satellite to LEO requires less energy than launching to higher altitudes.
  - As the launch cost of satellites is a large proportion of overall costs, this makes satellites considerably cheaper.

- The shorter distance to Earth also means simpler (and cheaper) amplifiers can be used for communications with Earth.

(ii) **Lower radiation** in LEO means cheaper components with lower radiation resistance can be used with a lower risk of radiation induced electronic failure, compared to satellites in higher orbits.

(iii) **Its economically feasible to launch larger numbers of LEOs** with overlapping fields of vision/communication, due to the lower cost of individual satellites. In contrast, the smaller number of geo stationary satellites will have less overlap, and therefore have more gaps in coverage.

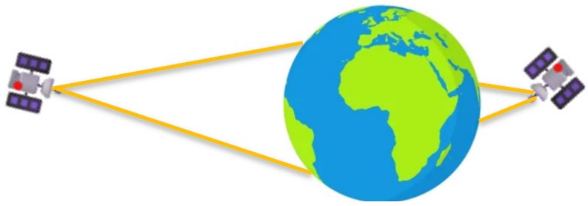
(iv) **Lower latency** between lower orbits and the earth compared to higher orbits, allows for faster and more efficient data transmission.

Disadvantages of LEO include:

(i) **LEO satellites have shorter lifespans than other satellites**. As there is higher atmospheric drag LEOs will re-enter the atmosphere sooner after losing their power. For example, SpaceX claims that its satellites at 600km altitude would naturally deorbit from atmospheric drag within 5 years if they did not use fuel to maintain their orbit.[1] Maintaining orbits in these areas with higher drag therefore requires more fuel.

(ii) **More satellites are needed to fully cover the entire earth.** In contrast, as few as three equally spaced satellites in geostationary orbit (36,000 km altitude) can provide near global coverage.

(iii) The higher number of LEOs in space means space in this orbit has become increasingly cluttered, increasing the risk of crashes between satellites.



An Indicative example of how satellites further from earth can cover a greater proportion of its surface

Why is Low Earth Orbit becoming popular for communications?

Traditionally, satellites used for communications were positioned in geostationary orbits, about 36,000 km above the Earth. However, there has been a shift towards deploying large constellations of smaller communications satellites in LEO by companies such as Eutelsat, SpaceX, OneWeb, AST Space Mobile, Lynk Global and Amazon (Project Kuiper).

The advantages of LEO over higher orbits includes much lower latency, higher bandwidth, and higher levels of coverage. LEO services such as Starlink and Eutelsat's OneWeb service offer similar levels of connectivity to rural users as terrestrial networks, which legacy geostationary internet providers simply cannot match.

[1] *https://api.starlink.com/public-files/Commitment%20to%20Space%20Sustainability.pdf*

2 | Existing Satellite Based Communications Systems

Three existing satellite-based communications systems may have some use for emergency communications. There are non-direct to device LEO internet services, geostationary GNSS satellites, and satellite mobile phones.[2]

Non-Direct to Device LEO Internet

Non-Direct to device LEO internet satellites are the fastest growth area for LEO communications services. These LEO satellites function similarly to legacy satellite internet services, in that they send data directly to satellite dishes, which connect to a modem and provide Wi-Fi services in the satellite owner's home. However, due to the satellites being in LEO instead of geo-stationary orbit, the service works effectively with a much smaller satellite dish, can transfer higher bandwidths of data, and has significantly lower latency than legacy satellite internet providers. These improved capabilities mean that LEO satellite services can now provide levels of connectivity which are almost comparable with fibre internet. As a result, this wi-fi connection could be used to facilitate emergency communications by users in areas which lack terrestrial cellular coverage.

LEO satellite internet services have the capacity to improve coverage for the very small percentage of European citizens living in homes without mobile coverage, estimated by the ITU in 2022 at about 1% of Europe's rural population.[3] It may also improve connectivity in homes with low mobile coverage. People can also use portable satellite dishes while travelling in remote or mountainous areas which lack mobile coverage.

As an example of a non-Direct to Device LEO satellite communications system, Starlink operates around 6,000 satellites at an altitude of 650 km. Its primary function is to provide WI-FI services to homes without a connection to terrestrial communications networks. These satellites send signals to portable satellite dishes, weighing around 3kg, which Starlink users attach to their home or vehicle. The satellite dishes act as a Wi-Fi network for nearby devices.[4]

LEO internet services are competitive with traditional internet:
It can reach average speeds of 100mbps:

- For some context, streaming a film in 4k with 60fps requires 25-35 Mbps.
- 100 Mbps is comparable to fixed broadband in the EU, though not with standalone 5G.[5]

Its latency is worse than terrestrial networks, but is manageable:

- While Starlink has managed to lower latency to below 30ms in best case scenarios, average latency is 60-90ms in most EU countries,[6] and 60ms in the USA.[7]

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[2] There are several older types of satellite communications, such as geostationary satellite internet.
[3] *https://www.itu.int/itu-d/reports/statistics/2022/11/24/ff22-mobile-network-coverage/* It claimed that in Europe, while 100% of urban populations had 4G coverage, 3% of rural populations had only 3G, 1% had only 2G, and 1% appeared to have no coverage at all.
[4] *https://www.starlink.com/specifications*
[5] *https://www.mobileeurope.co.uk/starlink-speeds-stay-more-than-100mbps-in-14-european-countries-during-q2/*
It should be noted that SpaceX claims that its speeds are 25-220 mbps or downloads, with upload speeds between 5 and 20 mbps, and latency of 25-60ms. These claims differ from the study referenced above.
[6] *https://www.mobileeurope.co.uk/starlink-speeds-stay-more-than-100mbps-in-14-european-countries-during-q2/* .
[7] *https://www.ookla.com/articles/us-satellite-performance-q3-2023*

- This is significantly lower than the latency offered by some geostationary internet providers, of 500-600ms.[8]
- However it is significantly higher than those experienced in Belgium, where average latency is 13ms for fixed broadband, and 25ms for mobile networks.[9]
- Starlink's latency of 60ms (0.06 seconds) is fine for most purposes, such as phone calls, as humans will not notice latency below 125ms each way (250 round trip) in conversations, while the ITU recommends a maximum of 150ms each way for latency in phone calls.[10] However it will cause issues for certain uses of the internet, such as gaming.

This latency could be reduced in the future:

- Latency can be reduced by moving the satellites closer to earth. However, a recent SpaceX request to have internet satellites at very low orbits of 240-360 km was rejected by the US FCC.[11]
- It can also be reduced by having more ground-based stations so that satellites are closer to the terrestrial network at any given time.
- Developments in inter-satellite laser communications could reduce latency in the future, though this technology is not currently feasible.

Limitations of LEO Internet Services include:[12]

- **Weather Sensitivity**: Weather conditions impact on connectivity with satellites, reducing reliability and performance.
- **Power consumption for modems is high**, at 75-100 kw, compared to under 10kw for traditional modems.
- **Limited Bandwidth**: The total capacity is shared among all users in an area, which could lead to congestion as more people connect.
- **Initial Costs**: The cost of the user terminal (several hundred euro) and the higher subscription costs might be prohibitive for some users.
- **Satellites modems are not always omnidirectional**, and need to be manually pointed towards satellites
- **Satellites internet is not competitive with 5G**, which can reach speeds of over 1000mbps, and also have up to 1,000 times more capacity than 4G.
- **The Keppler effect:** as more objects orbit at extremely high speeds in low earth orbit, the likelihood of individual collisions increases. If there is a high enough number of satellites in LEO, fragments from an individual collision could start a chain reaction of collisions until LEO as a whole is rendered unusable due to space debris.

All of these problems, other than the cost of a modem, also apply to Direct to Device Satellite Communications, which will be discussed later in this paper.

8 *https://reliasat.com/satellite-communications-evolution-from-geo-to-leo/* & *https://gsoasatellite.com/wp-content/uploads/2017-04-Latency-in-Communications-Networks.pdf*

9 *https://www.speedtest.net/global-index/belgium?fixed* As of February 2025, the last month for whcih records exist. Please note these figures are updated regularly.

10 *https://itrinegy.com/satellite-communications-blog-part-2/*

11 *https://spectrum.ieee.org/starlink-vleo-below-iss*

12 *https://newspaceeconomy.ca/2024/02/25/will-starlink-replace-fiber/*

Geostationary GNSS Satellites

Geostationary satellites are not a new development in satellite to device-based communications, but remain a key space-based feature which enhances device experience, and public safety, such as through AML. It is important to note that phones never connect with GNSS, instead, they use signals which are transmitted to earth by GNSS to ascertain their connection.[13]

How GNSS works:

(i) GNSS satellites send regular signals towards the earth giving their location and the time.
(ii) Devices connect to at least four of these satellites at once (or three if the device knows its exact altitude).
(iii) The device calculates its exact location based on its knowledge of the locations of the satellites, and the time which the signal was sent compared to when the device received the signal.
(iv) The device never sends signals to the satellite. It only receives signals from the satellite.

Satellite Mobile Phones

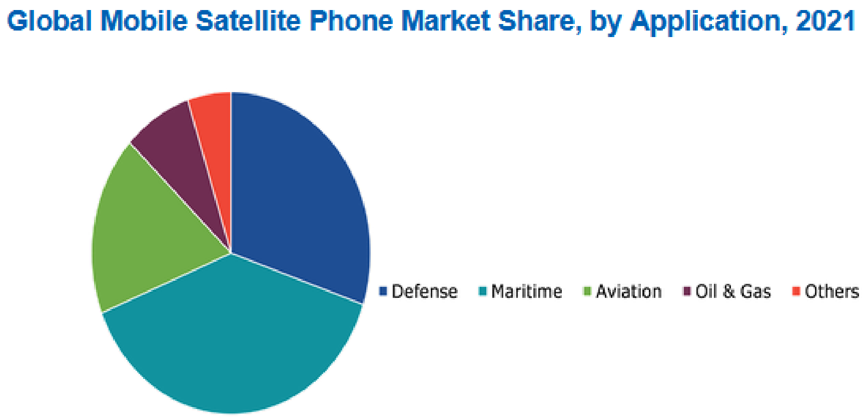
A satellite telephone is a type of mobile phone that connects to other phones or the telephone network by radio link through satellites orbiting the Earth instead of through terrestrial cell sites. They can work in most geographic locations on the Earth's surface, as long as open sky and line-of-sight between the phone and the satellite are provided.

The first satellite relayed phone calls were achieved early in the space age, with the first broadcast considered to be by NASA's SCORE satellite in 1958.[14] However the technology only became commercially viable in the 1990's.

Satellite phones provide similar functionality to terrestrial mobile telephones; and can process calls, SMS and low bandwidth internet browsing. They normally require clear sky to operate, and have very poor connectivity indoors.

The cost of satellite phones is considerably higher than those of terrestrial network phones, ranging from 400 – 1700 USD, and have considerably higher costs for calls, SMS, and internet browsing.[15] As a result, the service is limited in use, with the global mobile satellite phone market estimated at USD 553.6 million in 2021, and was primarily used in the defence and maritime sectors.[16]

[13] https://globalgpssystems.com/gnss/gnss-constellations-how-they-work-and-how-they-improve-gps/
[14] https://en.wikipedia.org/wiki/SCORE_(satellite)
[15] https://satellitephonestore.com/catalog/sale/satellite-phones
[16] https://www.researchdive.com/8353/mobile-satellite-phone-market



Uses of Satellite Phones in Emergency Communications

Satellite phones have two main uses for emergency communications.

- Disaster Response teams use satellite phones to communicate during natural disasters which impact cellular networks, such as the 2023 Turkey earthquakes. [17]
- Satellite phones are also used to contact emergency services in areas with no cellular coverage. In these situations the calls are routed to a dedicated emergency call relay centre provided by the satellite phone provider, which asks the caller for location information and then routes the call to the most appropriate PSAP based on that information.

[17] *https://hazards.colorado.edu/quick-response-report/communication-and-coordination-networks-in-the-2023-kahramanmaras-earthquakes*

Direct to Device Communication

What it is and how it works

Summary: This section will consider the potential impact of a new technology, known as Direct to Device communication, which will allow smartphones to directly connect to communications satellites when they lack terrestrial cellular coverage. It will discuss how this technology works, and its advantages and disadvantages compared to terrestrial cellular networks.

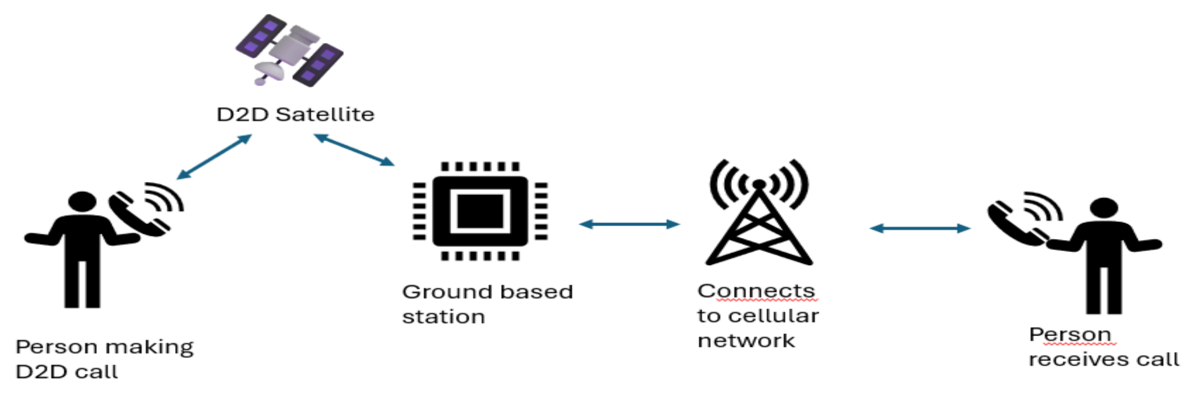
1 | Introduction

While phones have been able to “hear” signals from satellites such as GNSS for several years, phones have until recently been unable to communicate directly with satellites, with the exception of custom-built satellite phones. This is about to change, meaning that all smartphones might soon be able to receive public warnings or contact emergency services using a satellite.

Some Satellite providers are now experimenting with **Direct-to-Device Communication**. Direct to Device means that the device, such as a smartphone, connects directly with the satellite, without the use of a cell tower or other connecting device, such as a local satellite dish. This technology could allow for emergency communications between a device and a satellite in areas without terrestrial mobile coverage, or non-emergency uses of the signal, such as SMS, or in the near future calls and limited internet browsing.

Planned uses of Direct to Device Communications include emergency communications, IoT connectivity for machinery in remote areas, and low bandwidth messaging. However, some actors envisage expanding these services to include real time conversation and internet browsing in the near future.

2 | How Direct to Device Communications Work



An indicative diagram of how Direct to Device Communications function

1. **Constellations of LEO Satellites provide lower latency, stronger signals and overlapping global coverage:** This stronger signal, lower latency and better coverage makes direct communications with smartphones possible. Providers of these large constellations include SpaceX, AST SpaceMobile, and Lynk Global.

2. **These Satellites have Cellular Compatibility with Smartphones:** Direct-to-device satellite systems can operate on the same 4G or 5G spectrums as cellular networks, meaning smartphones don't need hardware modifications to connect to the satellite network.

3. **LEO satellites have improved technology**, such as better beamforming, allowing for more focused connections between LEOs and mobile devices. In addition, the satellites have modifications for directly connecting with smartphones, such as having larger antennas.[18]

4. **The Satellites can communicate Directly with Devices or through the Ground based network:**

   - Where there is no terrestrial cellular coverage, the satellite will directly connect with the smartphone. **This is called Direct Link transmission.**
   - Where the device receiving a satellite communication is in an area with terrestrial cellular coverage, the satellite will instead transmit the message to a ground station, which then routes the communication to the phone through existing terrestrial telecommunications networks (Satellite signal transmission).

3 | Implementation of Direct to Device Communication Services.

There are now several players in direct to device satellite communications, including Apple/Globalstar, SpaceX, AST SpaceMobile, Eutelsat and Skylo. Two main ways of providing direct to device to consumers have been identified; Network based access, in which a terrestrial network provider allocates a small part of their spectrum to a satellite provider, who then offers Direct to Device services for customers on that network, and Device based access, where a handset manufacturer enables its devices to connect to a dedicated satellite provider.

An overview of how two initial companies which developed Direct to Device Communications for mass use, Apple and SpaceX, is set out below. Apple's service is operational, and is limited to low bandwidth SMS for emergency communications, while Starlink intends to provide broader services such as calls, SMS and internet browsing.

Device Based Access to Direct to Device– Apple and Globalstar[19]

Apple iPhone 14's and above can currently send emergency SMS' to satellites. Calls are not possible due to the limited bandwidth of the connection.

[18] *https://spectrum.ieee.org/satellite-cellphone-starlink*
[19] *https://www.apple.com/newsroom/2022/11/emergency-sos-via-satellite-made-possible-by-450m-apple-investment/* and *https://support.apple.com/en-us/101573* See also *https://sec.report/Document/0001366868-22-000059/*

When an iPhone user makes an Emergency SMS via satellite, the SMS is received by one of Globalstar's 24 LEO satellites. Apple claims that the satellite sends the message down to ground stations, which route the SMS directly to PSAPs, or to a relay centre by Apple trained specialists if PSAPs cannot receive SMS.[20]

One website claimed: A direct view to the sky is necessary to send SMS. While a text message can take just 15 seconds to send in ideal, clear conditions, it can take more than a minute if sent from under trees.[21]

The technology is limited to newer iPhones, which contain an updated wireless chip that allows for a connection to the GlobalStar constellation.[22] Due to the constrained bandwidth with the satellite, Apple created a compression algorithm that makes text messages three times smaller for faster communication.

The service is currently free, but Apple envisages charging for the service in the future.[23] Apple is now expanding this service to include non-emergency texts for users in areas with no terrestrial cellular connection. Apple spent USD 450 million on space infrastructure to make this system work, most of which was to purchase 85% of Globalstar capacity.[24]

Network Based Access to Direct to Device– Starlink and T Mobile [25]

Over the course of 2024, Starlink began testing a new Direct to Device Constellation, in partnership with T-Mobile. As of November 2024, it had 400 satellites in orbit, with a short-term objective of 840 satellites.[26]

Starlink's service will work on unmodified cell phones. Tests during 2024 included sending SMS, posting a Tweet, and a low-quality video call.[27] The service was also used to provide emergency communications connectivity in areas affected by hurricanes in the USA in October 2024. Download speeds of 17mbps have been achieved in tests, though SpaceX clarified that this was peak performance by a device in an area with no competing cellular signals, and using a large beam. In other words, the 17mbps was not reached in real world conditions. In addition, the loss rate for data for this download was 15%.[28]

In filings to the FCC in March 2024,[29] SpaceX noted that tests had met or exceeded expectations, and that the satellites have been able to communicate with multiple models of unmodified Samsung, Apple, and Google devices, including in urban and rural areas, indoors and outdoors, in clear sky and under tree cover. It also emphasised the potential use of the service for 112 and public warning communications in areas without cellular network.

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[20] *https://www.apple.com/newsroom/2022/11/emergency-sos-via-satellite-made-possible-by-450m-apple-investment/*

[21] *https://www.tomsguide.com/news/iphone-14-emergency-sos-via-satellite-how-it-works-and-how-it-could-save-your-life*

[22] https://www.reuters.com/technology/new-iphones-have-qualcomm-satellite-modem-new-apple-radio-chips-2022-09-17/

[23] https://support.apple.com/en-is/101573 see also, *https://www.apple.com/newsroom/2023/11/apple-extends-emergency-sos-via-satellite-for-an-additional-free-year/*

[24] *https://support.apple.com/guide/iphone/text-via-satellite-iphb9262f4dd/ios*

[25] *Starlink's Plan for Free Global Emergency Services*

[26] *https://www.starlink.com/public-files/DIRECT_TO_CELL_SERVICE_FEB_25.pdf*

[27] *https://www.pcmag.com/news/spacexs-cellular-starlink-hits-17mbps-download-speed-to-android-phone* & *https://www.pcmag.com/news/spacex-demos-cellular-starlink-tech-powering-video-call-between-phones* *https://www.space.com/spacex-starlink-satellites-direct-to-cell-first-text-messages*

[28] *https://www.pcmag.com/news/spacexs-cellular-starlink-hits-17mbps-download-speed-to-android-phone*

[29] *https://www.fcc.gov/ecfs/document/1030712968789/1*

Following these tests, on 26 November 2024, The FCC authorised SpaceX to provide D2D services in the US using 7,500 satellites, including some at very low orbits of 340-360km to reduce latency.[30]
The FCC opinion emphasised the potential value of the service in improving coverage for communications and emergency communications in rural areas which may lack coverage, and noted the successful use of Starlink to provide emergency communications coverage in the USA following hurricanes in October 2024.

The decision also found that Starlink had taken sufficient steps in its partnership with T-Mobile to avoid harmful spectrum interference.

Despite this progress, the system is not yet commercially available, though SpaceX announced that it could be used for emergency communications in September 2024, and exceptionally made it available for people who lost connectivity following Hurricanes Helene and Milton the following November. As of February 2025, T-Mobile, SpaceX's carrier partner, has begun public beta testing of this new technology, with full service being planned in July 2025. However the capabilities currently under testing in this beta are limited to SMS messaging.

This service would work differently to Apple's. While Apples service requires devices to have a special, proprietary chip, SpaceX's service is designed to work with any smartphone without modifications. In contrast to Apple's Globalstar satellites, which operate at just over 1,400 km altitude, SpaceX will operate its communications satellites at 340-360 km, making it easier for phones to connect to it without modifications.

In addition, Apple's SOS service uses compressed SMS which require less data to transmit than standard SMS. In contrast, SpaceX would like standard SMS' to be sent through Starlink, and has also experimented with phone calls, and video calls. Therefore it is possible that it could facilitate emergency calls, in addition to emergency SMS in the near future.[31]

Challenges and Considerations

While these tests are impressive, the system will face several challenges:

- Current tests are taking place with satellites at a very low altitude of 360km. The FCC has allowed some Starlink satellites to operate at this altitude, but future regulatory reviews may reassess this authorisation if they interfere with the operation of existing or future space stations. This shorter distance to earth improves connectivity and reduces latency.
- Downloads using the service had a loss rate of 15%.[32]
- 17mbps is considerably slower than terrestrial speeds, and was only possible in an area with no signal interference, and when using a wide beam.
- Latency stats aren't provided. The video call shown was very grainy, and appears to have very high lag.[33]

[30] *https://docs.fcc.gov/public/attachments/DA-24-1193A1.pdf*
[31] https://www.starlink.com/business/direct-to-cell
[32] *https://www.pcmag.com/news/spacexs-cellular-starlink-hits-17mbps-download-speed-to-android-phone*
[33] *https://x.com/SpaceX/status/1792981845296160791?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1792981845296160791%7Ctwgr%5E11c2bde66da1a1aca4456241f3d5ccea22df7976%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fspaceexplored.com%2F2024%2F05%2F21%2Fspacex-starlink-t-mobile-satellite-service%2F*

- Phone providers have claimed that this service will interfere with their networks. However, the FCC found in November 2024 that SpaceX has provided sufficient evidence that its service would not interfere with T-Mobile's spectrum, which it has agreed to share as a secondary user, or in other users' spectrums. [34]

4 | Proprietary and Open Approaches to Direct to Device Communications

While the technology allowing smartphones to connect to satellites for emergency and other communications is now being implemented, it is not guaranteed that all smartphones will be able to connect with these systems. Companies providing these solutions have taken different access models , choosing to take a proprietary, open or mixed approach.

Cellular Partnerships: Players such as SpaceX, Lynk Global, and AST Space Mobile aim to share cellular spectrum through mobile network operator partnerships, allowing the users of those MNOs to also use the constellation in areas with no terrestrial coverage.

To implement this, Mobile Network Operators would allocate a small amount of their existing spectrum to satellite operators. This system is expected to be implemented by a significant number of Mobile Network Operators such as Vodafone in 2025 and 2026.[35]

Proprietary system: Apple's Messages via Satellite will only be accessible by devices with specialised hardware which allows them to connect to Globalstar's constellation of satellites.

Open System: SpaceX has claimed that any standard smartphone will be able to access its satellite constellations for emergency communications.

A mixed approach: Iridium Communications, a global operator of Mobile Satellite Services recently decided to change from a proprietary direct-to-smartphone network for an open network approach after discussions with Qualcomm didn't result in an agreement.[36] Iridium has said it may design specialised chips to improve its services in the future. [37]

Open Network: The MSSA, the association of satellite providers which are seeking to roll out Direct to Device Communications, will promote legal frameworks that encourage widespread adoption of the service in alignment with standards used by the cellular industry, enabling direct-to-device users to roam across their networks.[38]

5 | Can Direct to Device Communications Replace Terrestrial Networks?

While Direct to Device capability will likely continue to improve in the coming decades, it has several challenges which limits its usability for now. These include:

[34] *https://docs.fcc.gov/public/attachments/DA-24-1193A1.pdf*
[35] *https://www.politico.eu/sponsored-content/why-europes-satellite-policies-must-support-a-new-era-of-connectivity/*
[36] *https://spacenews.com/iridium-pivots-to-standardized-direct-to-device-satellite-services/*
[37] *https://spacenews.com/iridium-pivots-to-standardized-direct-to-device-satellite-services/*
[38] *https://www.mss-association.org/*

(i) **Latency:** While LEO satellites have significantly lower latency than geostationary satellites, there is still a noticeable delay compared to terrestrial networks. This is manageable for SMS but is more difficult for real time calls and internet browsing.

(ii) **Power Consumption:** Communicating directly with satellites requires more power than connecting to nearby cell towers, as phones need to amplify their signal.

(iii) **Spectrum/Bandwidth Limitations**

Wireless signals have to compete with other signals in the environment. In contrast, fibre optic cables, which are used for terrestrial communications networks, do not interfere with one another.

Spectrum is a finite resource. If all users relied on wireless technology, the resulting signals interference would cap the available capacity of the network. This would likely be an issue in urban areas, but might not be an issue in remote areas, where there is a lower density of data users.

In addition, ground-based networks are currently transitioning to 5G, due to the significantly higher capacity of the network. 5G uses very small wavelengths compared to 4G, making 5G less practical for communicating with satellites compared to 4G.

(iv) **Weather Sensitivity**: Weather conditions impact on connectivity with satellites, reducing reliability and performance.

(v) **Device modems may not be omnidirectional**: With Apple services, the device needs to be manually pointed at a satellite to connect. In contrast, current smartphones can connect to cell towers without pointing directly at them.

(vi) **Weaker signal**

Due to longer distances between the device and the satellite, signal strength will be weaker and as a result may struggle in areas without a direct view of the sky, such as when indoors, in urban canyons, forests, or underground.

Signal weakness is relative, and it is not clear how the different direct to device signals will perform in each of these areas. For example, neither service is intended to be used indoors[39] while both services will be impacted by tree cover or other obstructions, though they may still function.[40]

Assuming that Direct to Device will not replace terrestrial networks, some of these issues may also be irrelevant to this new technology's usability. For example, connectivity problems in urban canyons or when indoors will likely be irrelevant if the system is only used in areas where mobile or fibre connectivity does not exist.

(vii) **Secondary Spectrum license issues**

Space communications providers are often designated as secondary service users of a spectrum, and not a primary service user.[41] This means that while it is allowed to use a

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39 *https://support.apple.com/en-us/120930* & *https://www.starlink.com/business/direct-to-cell*

40 *https://www.apple.com/ci/newsroom/2022/10/iphone-14-plus-available-in-stores-friday/* See also *https://interpine.nz/nz-wide-mobile-coverage-a-game-changer-for-the-forestry-sector/*, https://www.pcmag.com/news/testing-cellular-starlink-tmobile-beta-shaky-signal-high-potential

41 *https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2459-2019-PDF-E.pdf* see also as an example, https://connectivity.esa.int/sites/default/files/ASCENT%20strategic%20recommendations%20-%20Whitepaper.pdf

certain band for transmitting information, it cannot interfere with the use of that same spectrum by the primary operator.[42] In addition, the secondary user does not have the right to protect itself from interference by other authorised users of that frequency.

In practice, satellite providers are experienced in managing this issue, while decisions authorising them to use secondary allocations may oblige the satellite provider to cease operations where interference with primary spectrum users occurs..[43] However, this lack of prioritisation could be an issue if it meant that emergency SMS were not being prioritised compared to the needs of the primary user of the spectrum.

This issue could be avoided by providing an EU/global constellation with primary access to a specific spectrum for emergency communications.

(viii) **The Kessler effect:** as more objects orbit at extremely high speeds in low earth orbit, the likelihood of mass collisions increases.

Space-based networks therefore would likely require several technological developments to replace ground-based networks, including:[44]

- The development of a high-capacity technology like 5G that uses larger wavelengths.
- Highly narrow beaming technology to limit signals interference.
- Stronger signals which could reach all standard smartphones, without requiring excessive battery use, under all weather conditions and in situations where there is not a clear line of sight with a satellite, such as when under tree cover, and
- The ability to transmit significant amounts of data between satellites through lasers, in a similar manner to fibre optic networks.
  - This could theoretically work better in space than in fibre optic cables, as light travels faster through a vacuum than through fibreglass.
  - For example, in the future inter-satellite lasers could transfer large amounts of data between satellites without connecting to ground networks, in a similar manner to the terrestrial network which uses fibre optic cables to transfer large amounts of data.

[42] *https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2459-2019-PDF-E.pdf* See also, Article 4.4 ITU Radio Regulations, available here: *https://www.itu.int/pub/R-REG-RR-2024*

[43] Article 15 Section VI ITU Radio Communication notes the procedures to be taken to avoid harmful interference while Article 22.1 ITU notes that satellite providers must cease transmissions where they are found to be operating in contravention of the ITU Radio Regulation. See also for example, FCC decision of 26 November 2024 here: *https://docs.fcc.gov/public/attachments/DA-24-1193A1.pdf* which noted that in accordance with Article 4.4 ITU Radio Regulation, the assignee of the license must cease operating if harmful interference occurs.

[44] *Direct-to-device satellite service: a complement to mobile networks -*

Using Direct to Device Satellite Communications for Emergency Communications.

Summary: The section will consider the potential impact of Direct to Device Satellite Communications on Emergency Communications. It will assess its potential advantages and disadvantages for emergency calls and public warning, consider technical issues including routing of communications, AML and the costs of establishing emergency satellite communications. Finally, it will outline some emergency communications obligations which should be linked to licenses for direct to device communications.

1 | Introduction

Direct to Device communications could greatly enhance emergency communications in remote areas. One of the main uses being discussed for early Direct to Device Communications is emergency communications by SMS, or perhaps by phone call, in areas without terrestrial network coverage. An example using both Direct Link and Satellite Signal transmission is outlined below:[45]

(i) An emergency SMS/call is sent directly to a satellite from a mountainous area without terrestrial cell coverage (by Direct link transmission).

(ii) The Satellite which receives this communication routes the message to its nearest ground station.

(iii) The communication is then received by an emergency satellite relay centre, which receives the caller location either automatically or by asking the caller for their location, and then routes the communication through telecommunications networks to the most appropriate PSAP (A satellite signal transmission).

(iv) The response from the PSAP is then routed through the ground station to the satellite, which beams this response back down to the device which made the emergency communication.

However some PSAPs might not welcome the potential availability of SMS Emergency Satellite Communications:

- The current technology for direct to device emergency communications is limited to SMS, and there is no guarantee that voice and internet services will be possible in the near future. If this is the case, emergency satellite communications will be limited to SMS.
- Some PSAPs are against SMS communication as some people might use it instead of calls out of personal preference, despite it being a less efficient means of communication.
- However, emergency SMS could be configured as a fall-back system, meaning the device will only offer the user the option to use it when terrestrial phone-based communication is not possible.

Emergency communications can be prioritised compared to other communications:

[45] Please see the figure on page 20, which outlines this process.

- As satellite communications use packet switched technology, the heading of the package for emergency communications could specify that it should be prioritised
- Apple has taken a different approach, and purchased 85% of Globalstar's capacity for the purpose of using emergency communications.[46] As satellites typically provide large areas of connectivity with lower amounts of bandwidth for a comparatively low cost, it could be relatively cost efficient to create constellations which are dedicated to emergency communications.

2 | Routing Emergency Satellite Communications.

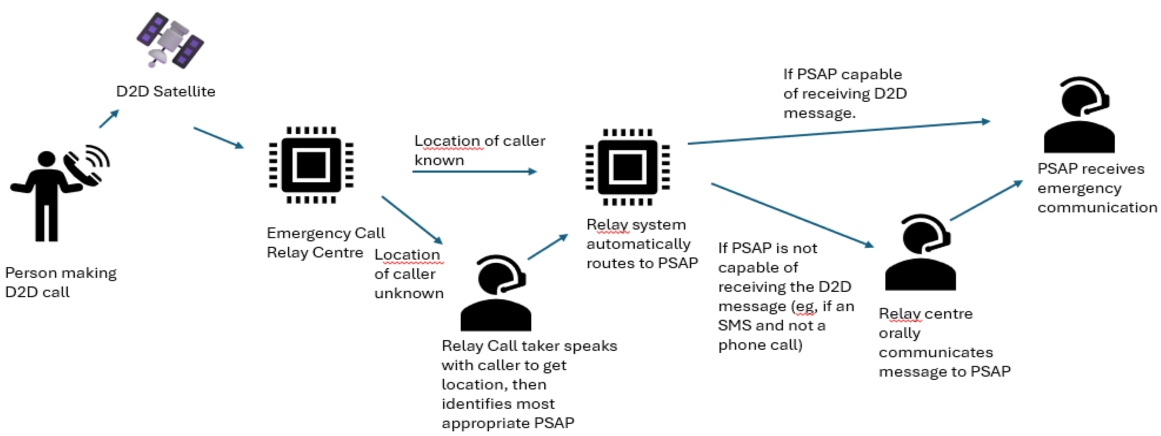
There are thousands of PSAPs using the same emergency numbers for emergency communications (112, 911, 999). As a result, dialling 112 is not sufficient to link a device to the appropriate PSAP. Instead, the network has to identify the most appropriate PSAP, traditionally through cell-based stations.

While Cell based routing works quite well for cell towers, which individually cover a limited geographic area, each satellite will cover large, constantly changing areas as it orbits the earth. Therefore, Satellite ID routing will not work for satellite emergency communications.

Existing satellite services which provide emergency communications services for satellite phones do not route emergency calls directly to a PSAP. Instead, emergency satellite communications are routed to a Third Party Service Provider (TPSP) which routes it to the most appropriate PSAP based on the caller's location..[47]

Where the geolocation data is absent, communications are instead routed to the company's emergency communication relay centre, which responds to the communication, asks the caller for location information, and then routes the call to the most appropriate PSAP based on that information.

An example of an emergency satellite call relay centre:



[46] https://spacenews.com/apple-to-be-largest-user-of-globalstars-satellite-network-for-iphone-messaging/
https://www.cnbc.com/2024/11/01/apple-commits-1point5-billion-to-globalstar-for-iphone-satellite-services.html
[47] https://www.intrado.com/blog/satellite-solutions-emergency-communications

3 | Handset Derived Location in Emergency Satellite Communications

A significant development in emergency communications over the last 10 years has been the implementation of handset derived caller location, which uses GNSS positioning and other location information, such as nearby Wi-Fi signals, to calculate the handset's location and then send this to emergency services by SMS or HTTPS. Within the EU, this information is typically transmitted in a protocol known as "Advanced Mobile Location" or AML. Handset derived caller location, whether using AML or another format, can provide a highly accurate location to emergency services, and as a result significantly reduces response times for emergency services.

The standard connected to AML, ETSI 103625[48] part 8 notes that AML information should be sent to a single AML endpoint for each country. Where there is more than one PSAP in that country, the location can be sent to the most appropriate PSAP in two ways:

(i) The AML endpoint decodes the location, then uses this location to decide which PSAP is most appropriate, before sending the information to that PSAP.
(ii) The most appropriate PSAP, which will have received the emergency communication, will ask the AML endpoint if it has received an AML message from the number which has contacted the PSAP.[49]

In principle, it appears that the caller location could could also be automatically sent using AML by a device when it dials 112 to contact emergency services through a satellite, in the same manner as when it dials 112 in a terrestrial network. What is less clear is how this location sent using AML message would then be routed to the most approprieate PSAP.

One option would be AML location message to be sent directly to the emergency communication relay centre. This centre which would then route this AML message to the most appropriate national endpoint in a similar manner to how it would route the accompanying emergency communication to the most appropriate PSAP.

An alternative option would be to allow the emergency communication relay centre to use the AML information which it receives to identify which PSAP it should route the emergency communication to. Once the AML information has been used by this centre to identify the most appropriate PSAP, the location information could then be routed to the most appropriate national end point.

One potential issue for AML could occur where emergency communications were made over a very low bandwidth connection. In this situation, it is possible that there would be insufficient bandwidth for HTTPS based caller location to be transmitted. Lower bandwidth should not affect SMS based AML however.

As emergency satellite communications would be relayed by a Third Party Service Provider (TPSP) to the most appropriate PSAP based on the caller's location, AML based location could aid TPSPs in routing emergency satellite communications to the most appropriate PSAP.

[48] *https://www.etsi.org/deliver/etsi_ts/103600_103699/103625/01.03.01_60/ts_103625v010301p.pdf*
[49] *https://www.etsi.org/deliver/etsi_ts/103600_103699/103625/01.03.01_60/ts_103625v010301p.pdf*

4 | Direct to Device Communications for Public Warning

A key feature which makes public warning differ from other uses of direct to device satellite communications is that the communication is one way. While satellites are still required to capable of sending a strong enough signal to directly reach devices in the affected area with the public warning, they are not required to have the capacity to receive signals from the devices themselves.

As a result, operating satellites in higher orbits may be more feasible, as the relatively weak handset transmission capabilities which normally limits the maximum orbit of direct to device satellites is no longer a factor. One effect of this is that satellites in geo-stationary orbit may be usable for direct to device public warning, as devices can currently receive certain signals, such as GNSS signals from satellites in these orbits.

The European Union has played a leading role in the development of geostationary space based early warning through its Galileo Early Warning Satellite Service.[50] This service would use the EU's system of geo-stationary GNSS satellites to provide public warnings to smartphone or certain fixed devices during emergencies.[51]

It is important to note that this technology is not intended to replace terrestrial public warning, but to complement it. It would provide public warnings in remote areas which may lack connectivity, or by providing a fallback system in areas where the terrestrial network has become

[50] *https://defence-industry-space.ec.europa.eu/leveraging-upcoming-galileo-emergency-warning-satellite-service-ewss-safer-more-resilient-future-2024-04-11_en*

[51] *https://www.euspa.europa.eu/newsroom-events/news/galileo-emergency-warning-satellite-service-underway* see also *https://www.gsc-europa.eu/sites/default/files/sites/all/files/EWSS-CAMF_v1.0.pdf*

congested, or damaged due to an ongoing disaster. EENA has been a partner in EU Projects to develop this technology, such as Project AWARE.[52]

The use of LEO constellations to provide Direct to Device Public Warnings is also developing in parallel and could offer some advantages and disadvantages over geostationary satellite based public warning. The lower latency and higher bandwidth of LEO satellites allows for more date to be provided faster to citizens when sending a public warning compared to using a satellite in geostationary orbit.

However technical questions for LEO public warning might include whether it can beam information to large areas instead of to specific devices, and whether it can limit such beams to specific areas, such as an individual city.

Starlink recently successfully tested a LEO based public warning system with its US partner, T-Mobile.[53] While detailed information on the test is not available, T-Mobile claimed that smartphones with 4G connection were able to pick up the signal, while emergency operators were able to send out in seconds due to the lower latency. T-Mobile also claimed that as LEO satellites have higher bandwidth, more detailed public warning messages could be sent out compared to public warnings by geostationary satellites.[54]

Using LEOs for public warning comes with advantages and disadvantages compared to geostationary satellites.

- LEO constellations under development could connect with current smartphones for public warnings, while geostationary GNSS satellites do not yet have the capacity to transmit these messages.
- LEO's may be able to transmit more detailed messages due to their higher bandwidth compared to GNSS satellites, which could send very limited bandwidth messages.
- However, while LEO satellites can provide more detailed public warnings, their capacity might be in high demand for other uses during emergencies, such as to facilitate emergency calls.
- In an extreme scenario, such as a conflict, geostationary satellites, which are significantly further from earth than LEOs could be harder to destroy with anti-satellite weapons. On the other hand, LEO constellations are highly numerous, offering critical redundancy.[55]
- The Kessler effect, which could form the basis of an emergency requiring a public warning, would render LEO Reverse 112 constellations unusable. GNSS satellites would be unaffected.

Therefore, to improve resilience, both LEO and geostationary public warning satellite systems should be utilised.

A particularly important use case of satellite based public warning is in natural disasters when terrestrial communications networks may fail.

A satellite based public warning system could effectively communicate with mobile devices in these situations. The higher bandwidth of LEO public warning systems could also allow for more regular, detailed warnings and guidance compared with geostationary public warning systems, and potentially use non-text information, such as images.

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[52] *https://euproject-aware.eu/*
[53] *https://www.satellitetoday.com/connectivity/2024/09/11/t-mobile-sends-wireless-emergency-alert-via-starlink/*
[54] *https://www.satellitetoday.com/connectivity/2024/09/11/t-mobile-sends-wireless-emergency-alert-via-starlink/*
[55] *https://www.abc.net.au/news/2024-05-21/space-weapons-how-the-world-is-preparing-for-war-in-space/103634106*

5 | Would direct to device satellite communications have added value for EU public safety?

The main benefit of Direct to Device in Europe would not be increased population coverage, but increased network resilience.

Satellite communications systems could provide an important fallback network for emergency communications during natural disasters, such as earthquakes or storms, when terrestrial communications networks can fail.

For example, during the 2023 earthquakes in Turkey, power outages and damage to the telecommunications system meant that standard mobile communication was not possible in many areas for several days. While emergency response teams were equipped with satellite phones to aid coordination, local inhabitants were left without any means to electronically contact family members and friends to ensure they were safe, contact emergency services for help, or use the internet to get updates or advice on how to stay safe.[56]

Similarly, following the January 2025 Irish storms, 900 mobile cell towers were temporarily knocked out, resulting in loss of access to 112 and other communications networks for hundreds of thousands of people.[57] In situations like this, Direct to Device could provide fallback connectivity for people to access emergency services.

This type of resilience would also allow PSAPs to send public warnings to people following a network collapse. This could not only provide them with advance warning of further disasters, such as a tsunami following an earthquake, but also to provide advice for citizens on how to protect themselves and others. As a result, **emergency satellite communications could not only enhance network resilience, but also enhance societal resilience following a disaster.**

Increased coverage in unpopulated areas: While there is clear added value for emergency satellite communications in areas without mobile coverage, its value is very limited in areas where 2G or higher coverage is available. Within the EU, the Universal Service Obligations in Article 84 of the European Electronic Communications Code (EECC) results in almost universal mobile coverage in populated areas States. The ITU claims that all but three EU Member States have at least 99.9% population coverage, with the remaining Member States, Czechia, Hungary and France having 99.8%, 99.2% and 99.0% coverage respectively.[58]

However, universal service obligations are based on population, and not geographic coverage. Article 84 EECC requires Member States to provide internet and voice services to all consumers at a **fixed location**, meaning some unpopulated areas can lack mobile coverage. In mountainous regions, mobile signals can also be disrupted, creating additional areas with inadequate mobile reception.

[56] *https://hazards.colorado.edu/quick-response-report/communication-and-coordination-networks-in-the-2023-kahramanmaras-earthquakes*
[57] *https://www.ookla.com/articles/storm-eowyn*
[58] *https://datahub.itu.int/data/?i=100095&e=USA&s=194*

As a result, Direct to Device could be particularly valuable for individuals in remote, unpopulated areas like forests or mountains, such as hikers. A map of emergency communications made in 2023 using Garmin satellite phones (*available here*) suggests that existing emergency satellite services are most often used in mountainous areas, such as the Alps, and Northern Spain.

In addition, Direct to Device could improve access to 112 for victims of car accidents on rural roads. Many frequently travelled roads run through unpopulated areas, and as a result satellite connectivity could increase the likelihood that the occupants of the car can successfully contact 112.

6 | Emergency Communications Licensing Obligations for Direct to Device Satellite Communications

As several satellite providers are now seeking to provide a service which allows people to send communications through their satellite constellations when no terrestrial connection is equivalent or available, these services should be licensed on the condition that they can also be freely used for emergency communications where terrestrial services are not equivalent or available. Some potential examples of obligations are listed below:

(i) Any user of a device which can communicate with a satellite should be able to use the service for emergency communications.
(ii) Direct to device services should be capable of transmitting public warnings if technically feasible.
(iii) Direct to device services should be obliged to provide fallback coverage in situations where the terrestrial network fails, such as following an earthquake.

7 | Cost of Implementing Emergency Satellite Communications

One additional cost burden for implementing Emergency Satellite Communications will be to finance the operations of emergency call relay centres which will route emergency communications to the most appropriate PSAP based on the caller's location. Deciding whether it is MNOs, satellite communication service providers or public authorities who should finance this could be contentious.

Provided that any system of emergency satellite communications is limited to use by phones which are capable of direct to device satellite communication, there should be almost no implementation costs for Member States or PSAPs, other than the cost of relay centres discussed above.

When a device makes a direct to device emergency communication, the satellite receives the communication and transmits it to the terrestrial telecommunications network through a ground-based station. Once it is in the terrestrial communications network, it should function similarly to any other call/SMS, and therefore there should be no additional costs for PSAPs to be capable of receiving these communications. Some additional costs could exist in testing the system, such as to ensure that callbacks to, or AML SMS from, emergency satellite communications work effectively.

The EU could mandate that all smartphones be capable of communicating directly with satellites. This could be seen as an onerous obligation given that terrestrial networks are sufficient for emergency communications in most circumstances. In any case, this obligation would likely not be necessary as market leaders such as SpaceX intend to make their service available on existing unmodified smartphones.

In recent months, several Mobile Network Operators have begun working with Direct to Device providers to allocate a small part of their spectrum for emergency satellite communications.[59] While this trend is at an early stage, for now it appears that market forces are encouraging MNOs to adopt this new technology, and that MNOs are willing to finance the related cost of relay centres.

One cost related risk could occur if satellite communications services remain of limited use in the EU, but are tied to high emergency communications obligations such as to fund an emergency call relay centre and allow their constellations to be used for public warnings. In this situation, it is possible that satellite communications providers could decide to not provide services in the EU, due to the high costs and low likely revenue.

[59] See for example, *https://totaltele.com/ast-spacemobile-and-vodafone-ink-long-term-agreement-to-boost-global-connectivity/* & *https://www.starlink.com/business/direct-to-cell*

EU Space and Communications: Policy and Stakeholders

Summary: This section considers existing EU policies in space and telecommunications, and outlines the key stakeholders in the sector.

1 | What is the EU policy on Space?

In 2021 the EU launched the **EU Space Programme** which grouped together its existing projects in space including Copernicus, the Earth observation programme, and Galileo, the EU's GNSS system.

In 2022, it **recognised space as a strategic domain**, and developed the **EU Space Strategy for Security and Defence** to defend the continent's military interests in space.

Eleven Member States have space laws.[60] To avoid market fragmentation, The European Commission is planning to publish a proposal for a European Space Act in Q2 2025. This law should create a framework for the conduct of European space operators and provide a stable, predictable, and competitive business environment. It will also address related issues such as space debris, and, according to some sources, seek to improve cybersecurity. **This would include licensing requirements and could be an opportunity to include satellite for emergency communications in EU law.**

In order to increase the usefulness of EU Space Assets to improve EU resilience, the EU's 2025 ***Union Preparedness Strategy*** proposed to use the Copernicus Emergency Management Service and the upcoming Galileo Emergency Warning Satellite Service (EWSS) to empower national civil protection authorities to have timely access to space-based early warning information to disseminate directly alert messages to the population.

EU's secure connectivity programme for 2023-2027: This programme sets goals for the European Union to deploy an EU satellite constellation called **'IRIS²'** (infrastructure for resilience, interconnectivity and security by satellite), that will provide ultra-fast and highly secure communication services by 2027.[61] This program would be primarily for use by government agencies, to allow for communications services when terrestrial communication networks have been disrupted. It will be aimed for lower orbits. It will protect critical infrastructure, as defined in *Directive 2008/114/EC*, cover civil protection, and connect key infrastructures, such as institutional communications between embassies.[62]

The *Regulation* creating IRIS notes in Article 3(2) that its general objectives are to enable the provision of commercial services, to facilitate, inter alia, the further development of worldwide high-speed broadband and seamless connectivity as well as removing communication dead zones and increasing cohesion across Member States' territories, and contributing to the general objectives of the EECC.

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60 *https://data.consilium.europa.eu/doc/document/ST-9370-2024-INIT/en/pdf*

61 *https://www.consilium.europa.eu/en/press/press-releases/2023/03/07/secure-space-based-connectivity-programme-council-gives-its-final-approval/*

62 *https://defence-industry-space.ec.europa.eu/document/download/b57d68a0-bb1f-4fb6-a64e-2e544731eef9_en?filename=IRIS%C2%B2_Factsheet%20%28EN%29.pdf*

In October 2024, the SpaceRISE consortium was provided with a contract by the European Commission to develop, deploy and operate IRIS². The consortium includes European satellite operators SES, Eutelsat and Hispasat, and telecoms operators such as Deutsche Telecom and Orange. This consortium will be responsible for launching a network of 290 Low Earth Orbit and Medium Earth Orbit satellites to improve connectivity and enhance the resilience of connectivity in Europe by 2030.[63]

In addition to this, the EU has several other space programmes, including Galileo, Copernicus, GOVSATCOM and EGNOS, with less relevance for Direct to Device communications.[64]

2 | What is the EU policy on (Space) Communications?

DG CONNECT

The Directorate-General for Communications Networks, Content and Technology is a Directorate-General of the European Commission and is responsible for European Union investment in research, innovation and development of critical digital technologies. One of its responsibilities is to ensure the roll out of high-capacity connectivity infrastructure across the EU.

DG CONNECT has been responsible for several measures which facilitate the advancement of digital connectivity in the EU, and therefore are of relevance for the potential use of space-based assets to facilitate connectivity. Some of these measures are outlined below.

Gigabit Infrastructure Act

This seeks to expedite the rollout of advanced Gigabit networks by streamlining regulatory processes and reducing administrative burdens for network deployment. It simplifies permitting procedures, enhances coordination between network operators, and ensures that new buildings are equipped with fibre connectivity.

EU Digital Decade

The Digital decade aims to promote the deployment and the use of digital capabilities with a view to reducing the geographical digital divide and granting access to digital technologies and data on open, accessible and fair terms. It sets measurable goals for connectivity, digital skills, digital business, and digital public services. This includes a goal for gigabit connectivity and high speed 5G mobile coverage for all populated areas in the EU.

The Commission provides an annual report to the European Parliament and to the Council a comprehensive report on the state of the Digital Decade. The July 2024 Report, found insufficient progress in this area, with fibre networks reaching only 64% of households, while high-quality 5G networks reaching just 50% of the EU's territory, and having insufficient performance to deliver advanced 5G services. The report also found that the EU continued to face challenges in spreading advanced digital technologies beyond large cities.

Connecting Europe Facility (CEF)

63 *https://www.spacerise.eu/article/iris-lifts-off-as-european-commission-and-spacerise*

64 *https://defence-industry-space.ec.europa.eu/eu-space/eu-space-programme_en*

This provides funding for key infrastructure projects in transport, energy, and digital sectors. Regarding digital connectivity, it supports projects that aim to deploy very high-capacity networks and ensures cross-border connectivity. This includes strategic projects that connect rural areas, or create secure and resilient digital infrastructure across Member States.

European Electronic Communications Code (EECC)

The EECC establishes a harmonised framework for the regulation of electronic communications networks and services.

The directive seeks to ensure a framework which works for EU competitiveness, and its consumers with two overarching aims for industry and consumers respectively. Its first set of aims are to implement an internal market which results in the deployment of high-capacity networks, sustainable competition, interoperability, accessibility, security and end use benefits. The second are to ensure the provision of good quality, affordable publicly available services which are accessible, and to establish necessary end user rights.

Satellite based communications systems are under the scope of the EECC. Article 1(a) establishes that the directive harmonises the regulation of electronic communications networks, while the definition of electronic communications network in Article 2(a) explicitly includes satellite networks.

Do the Objectives of the EECC enable or inhibit satellite communications?

The objectives of the EECC would suggest that the Directive provides an open framework for new technologies like space-based communications, which would improve access to telecommunications in rural areas.

The EECC includes promoting connectivity and access to, and take-up of, very high-capacity fixed, mobile and wireless networks as one of its objectives.[65] The EECC also seeks to promote efficient investment and innovation in new and enhanced infrastructures, including by ensuring that any access obligation takes appropriate account of the risk incurred by the investing undertakings. [66] This makes it possible that the access obligations for Direct to Device could initially be less onerous due to the commercial risks in investing in this new technology.

At a glance, the EECC could therefore be read as supporting new technologies and infrastructures, such as space-based telecommunications infrastructure.

However, the EECC's provisions on spectrum give mixed signals for Direct to Device.

The objectives of the EECC for radio spectrum management would suggest an openness to new technologies and market participants, such as Direct to Device.

Member States are obliged to ensure effective management of radio spectrum for electronic communications networks and services in accordance with the objectives of the EECC,[67] and to provide primary access to the spectrum based on objective, transparent, pro-competitive, non-discriminatory and proportionate criteria.

[65] Article 3 EECC
[66] Article 3(4)(d) EECC
[67] Article 45 EECC

In managing spectrum, Member States are also obliged to pursue wireless broadband coverage of their national territory and population at high quality and speed, facilitate the rapid development of new wireless communications technologies and applications, and promote the shared use of radio spectrum between similar or different uses while preventing harmful interference from other users.

However, the criteria for providing a specific spectrum to a user suggest that the EECC might inhibit, rather than support use of Direct to Device Communications services.

When authorising the use of the spectrum to a user, Article 46 EECC requires Member States to consider criteria including the characteristics of the spectrum concerned, the need to protect from harmful interference, whether there are reliable conditions for spectrum sharing, the need to ensure good technical quality of communications and service, and the need to safeguard the efficient use of the spectrum.

Some of these criteria might make it more difficult for Direct to Device communications services to be granted access to a given spectrum.

- **If granted secondary (shared) access to a specific spectrum:** Member States would need to ensure that the service did not interfere with the primary user of the spectrum, and that there were reliable conditions for spectrum sharing.
- **If granted primary access to a given spectrum**: conditions such as the need to ensure technical quality, and an efficient use of the radio spectrum could prove problematic. Direct to Device Communication has several drawbacks compared to Earth-based communications, including lower accessibility during poor weather, vulnerability to the Keppler effect, and lower bandwidth compared to 5G.

How would Article 109 and 110 EECC, which create emergency communications obligations, apply to satellite communications systems?

Any Direct to Device connection which allows users to make calls or send SMS using their number would also be obliged to comply with Article 109 EECC and provide access to 112. Article 109(2) EECC notes that providers of publicly available number-based interpersonal communications services, where those services allow end-users to originate calls to a number in a national or international numbering plan" must ensure access to 112.

Article 2(6) EECC defines 'number-based interpersonal communications service' as an interpersonal communications service which connects with ... numbers in national or international numbering plans, **or which enables communication** with a number or numbers in national or international numbering plans.

Satellite Communications systems are also expressly included in the EECC, as Article 2(a) EECC defines "electronic communications network" as "transmission systems ... which permit the conveyance of signals by wire, radio, optical or other electromagnetic means, including satellite networks".

As a result, even if the Direct to Device provider does not themselves allocate numbers, it is obliged to provide access to 112 if it allows users to make phone calls or send SMS to other numbers.

This would mean that direct to device satellite providers providing number based interpersonal communications would need to comply with all obligations of Article 109 EECC, including to provide access to 112 free of charge, route this to the most appropriate PSAP, include handset derived caller location, and ensure equivalent access for people with disabilities, where technically feasible.

It is less clear how Article 110 EECC would interact with using satellite based public warning in the future, if this technology becomes widely available.

Article 110(1) notes that Member States with public warning systems shall ensure that public warnings are transmitted by providers of mobile number-based interpersonal communications services. It is unclear whether this obliges Member States to require all providers of mobile number based interpersonal communications, however.

Article 110(2) notes that Member States may determine that public warnings should be transmitted through publicly available electronic communications services other than mobile number-based interpersonal communications services, provided that the effectiveness of this alternative system is equivalent in terms of coverage and capacity to reach end-users.

It is also possible that a Member State could decide that a Direct to Device public warning system is equivalent to a terrestrial provider, and therefore limit its public warning system to satellite based warnings, as is allowed under Article 110(2).

The EECC and Universal Service Obligations

The EECC creates universal service obligations for Member States, including to ensure that all consumers have access to broadband and voice communications services,[68] and to determine what is the most efficient approach to ensure the availability of this service.[69] Article 84(3) EECC notes that the quality of this service must provide sufficient bandwidth to allow the user to socially and economically participate in society.[70]

The EECC therefore provides Member States with the discretion to determine the most efficient approach to ensure the availability of broadband and communications services. However, given the low capabilities of Direct to Device compared to terrestrial communications networks, it seems unlikely that Member States could interpret Direct to Device as meeting the quality requirements set out in Article 84(3) EECC.

Could the EECC require Member States to invest in Direct to Device to ensure coverage during crises?

Article 108 EECC requires Member States to take "all necessary measures" to ensure the fullest possible availability of voice and internet service provided over public electronic communications networks in the event of catastrophic network breakdown or in cases of force majeure, and to ensure that providers of voice communications take all necessary measures to ensure uninterrupted access to emergency services and public warnings.[71]

[68] Article 84(1) EECC
[69] Article 86(2) EECC
[70] Article 84(3) EECC
[71] Article 108 EECC

Ensuring the fullest possible availability of voice and internet services in force majeures or catastrophic network breakdowns could be interpreted as obliging Member States to supplement existing terrestrial networks with space-based services once these become available, to ensure alternative coverage in those situations.[72]

Potential reforms to telecoms:

A 2024 Commission White Paper on *Mastering the EU's Digital Infrastructure Needs* called for the EU to develop EU, rather than Member State, licensing regimes for satellite based communications.

This new regime would facilitate safe, resilient and sustainable space activities, and ensure consistency for all operators of space infrastructure. The white paper also called for a more coherent spectrum management approach outside of satellite capacities, which it claimed would ensure the EU's digital sovereignty. As an alternative, the paper suggested that the EU could control spectrum usage decisions where the uses concerned would impact on the cybersecurity, independence and integrity of EU communications networks.

The Digital Networks Act (DNA) is expected to be proposed by the European Commission in Q4 2025 and will amend the European Electronic Communications Code. The DNA will create opportunities for cross- border network operation and service provision, enhance industry competitiveness and improve spectrum coordination. **Some actors such as Vodafone have called for this review of the EECC to be used to ensure an effective framework for direct to device communications.[73]**

EENA will advocate to ensure that ther Digital Networks Act improves clarity for emergency satellite communications.

3 | Stakeholders

- BEREC - Body of European Regulators for Electronic Communications
- EENA – the Emergency Number Association
- European Commission - Directorate-General for Communications Networks, Content and Technology
  - Directorate B - Digital Decade and Connectivity
  - Directorate E – Future Networks,
  - Unit HADEA.B – Digital, Industry and Space
- European Commission - Directorate-General for Defence Industry and Space;
  - DEFIS B - Secure and Connected Space Directorate
  - DEFIS C - Space Navigation and Earth Observation Directorate
- European Defence Agency;
- EUSPA
- European Space Agency;
- Eurospace – the main EU Association for Space.
- European Metrological Network (Eumetrep);
- EMEA Satellite Operators' Association (ESOA);
- European Association of Remote Sensing Companies (EARSC);
- Global Satellite Operators Association (GSOA);

[72] Article 108 EECC
[73] https://www.politico.eu/sponsored-content/why-europes-satellite-policies-must-support-a-new-era-of-connectivity/

- Mobile Satellite Services Association (MSSA)
- National Space Agencies – CNES (France), DLR (Germany), BNSC (UK), ISA (Italy);
- Network of European Regions Using Space Technologies (NEREUS);

Conclusions

(1) In its current form, new LEO satellite services do not present a threat to legacy terrestrial operators. Earth based infrastructure already covers 99% of the population and is more efficient than satellite communications. Instead, direct to device connections, and related satellite internet services address a new market, which is the small portion of the global population which are not connected to terrestrial networks.

(2) A key risk is that terrestrial providers try to claim this new service is equivalent, and therefore avoid their universal service obligations in unpopulated areas. This would be problematic if satellite services are not as reliable as terrestrial networks.

(3) Direct to Device satellite communication can offer emergency communications to smartphones in areas without terrestrial coverage. Whether this will be in the form of an SMS or voice communication is unclear, but it will expand the availability of 112 for citizens.

(4) Public Warnings may soon be effectively transmitted to devices by LEO satellites. In order to ensure redundancy, satellite based public warning should be made available on both GNSS and LEO communications satellites.

(5) Direct to Device satellite communication also have the potential to act as a fallback network for emergency communications or public warnings in situations where the terrestrial network fails, such as during earthquakes.

(6) LEO satellite providers appear happy to support emergency communications. Given the global coverage which can be achieved with a handful of satellites, it could be feasible to build a constellation which is dedicated to emergency SMS.

(7) The upcoming Digital Networks Act is an opportunity to improve clarity for Direct to Device satellite communications networks, to ensure that these services contribute to access to 112, and improve EU resilience during emergencies.