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Satellite communication as a vessel to deliver news and information to censored countries

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Satellite Communication is a technology, that can deliver news and information to censored or restricted countries, bypassing the control and censorship mechanisms that governments may impose on traditional media and the internet. In this presentation we will focus on the traceability of satcom ground stations with existing radio location finders. At the end of the presentation questions are welcomed from the audience.

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Satellite technologies have played a crucial role in delivering news and information to censored or restricted countries. These technologies enable the transmission of data and communications via satellites orbiting the Earth, bypassing the control and censorship mechanisms that some governments may impose on traditional media and the internet. Here's how satellite technologies can be used for news delivery in censored countries:

- Satellite TV
- Direct-to-Home (DTH) Services
- Satellite Radio
- Internet Satellite Constellations (e.g. Starlink or OneWeb)
- Satellite Phones (e.g. 5G via satellite)

While satellite technologies provide a means of delivering uncensored news and information, they are not entirely immune to interference. Governments in censored countries jam satellite signals or use other methods to disrupt access to outside news sources. To counteract these efforts, news organizations often employ encryption and other security measures to protect the transmission of information.

The electromagnetic signals transmitted and received by internet satellite constellations user terminals (e.g. Starlink) , ground stations, and satellites, have distinct signatures . Radio Direction Finder equipment can detect these signals, making it possible for authorities to geo-locate users due to their transmissions. Nowadays these detection technologies work in real-time.

In one-way satellite data distribution network, data flows in only one direction, typically from a centralized source to multiple receivers. The one –way satellite service signal can be detected from ground, similar top TV broadcast channels, but it is difficult to detect the receivers as antennas are usually in the aperture range of 60cm to 80m cm.

In the presentation the traceability of satellite links are explained on the Starlink constellation and mechanisms to mitigate the traceability. In the follow-up discussions solutions and techniques and risks can be discussed.

- **Satellite communication frequency bands**

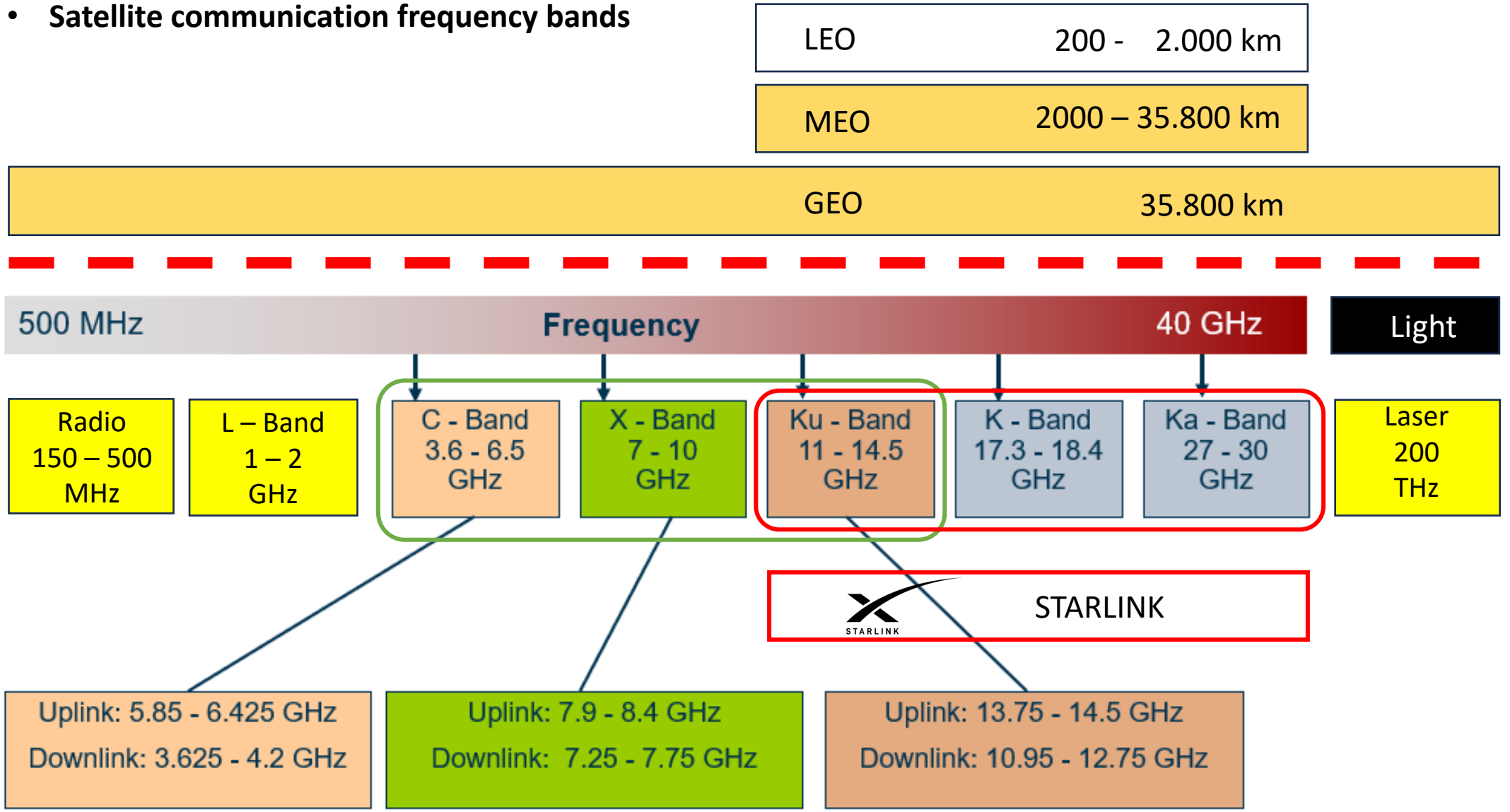

Fig.1: satellite frequency bands

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- **Starlink Constellation Basics**

- Frequency band: Ku (12 - 18 GHz) and Ka (26 - 40 GHz)

- Satellite to gateway communiaction: 17.8-18.6GHz, 18.8-19.3GHz, and 37.5-42.5GHz
- Gateway to satellite communiaction: 27.5-29.1GHz, 29.5-30GHz, 47.2-50.2GHz, and 50.4-51.4GHz

- Satellite to terminal communication: 10.7-12.7GHz and 37.5-42.5GHz
- Terminal to satellite communication: 14-14.5GHz, 47.2-50.2GHz, and 50.4-51.4GHz.

- tracking, telemetry and control:
- 12.15-12.25GHz, 18.55-18.6GHz, and 37.5-37.75GHz (Downlink)
- 13.85-14GHz and 47.2-47.45GHz (Uplink)

- **Antenna pattern**

- Starlink user terminal antennas consist of approx. 1264 active elements
- The active elements are used to produce an antenna beam in receive and transmitt with tilting capability
- Communication is done via main and side lopes of the antenna pattern
- Side lobes can be used to ranging to the adjascent satellite
- The active elements also can control the polarisation which is necessary for frequency re-use
- Antenna patten is aproximately 60 degrees wide and makes it possible for signal detection and direction finding

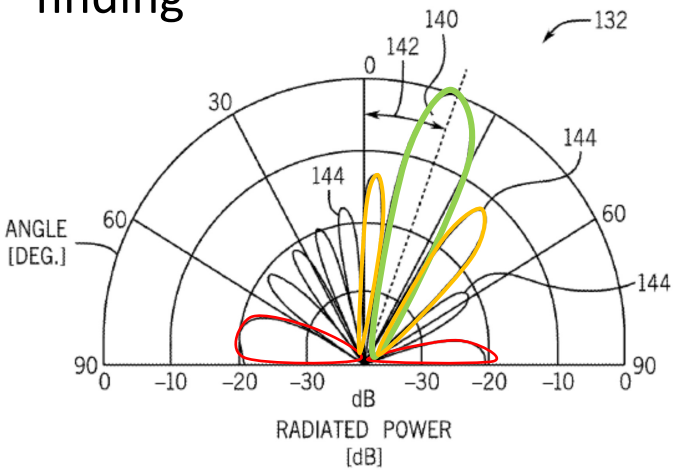

Fig.3: antenna pattern user terminal

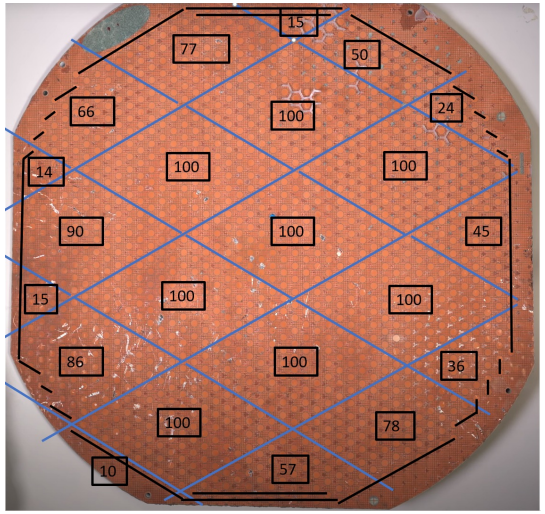

Fig.4: antenna structure user terminal

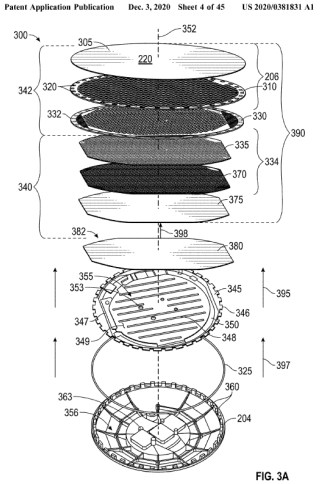

Fig.5: antenna design user terminal

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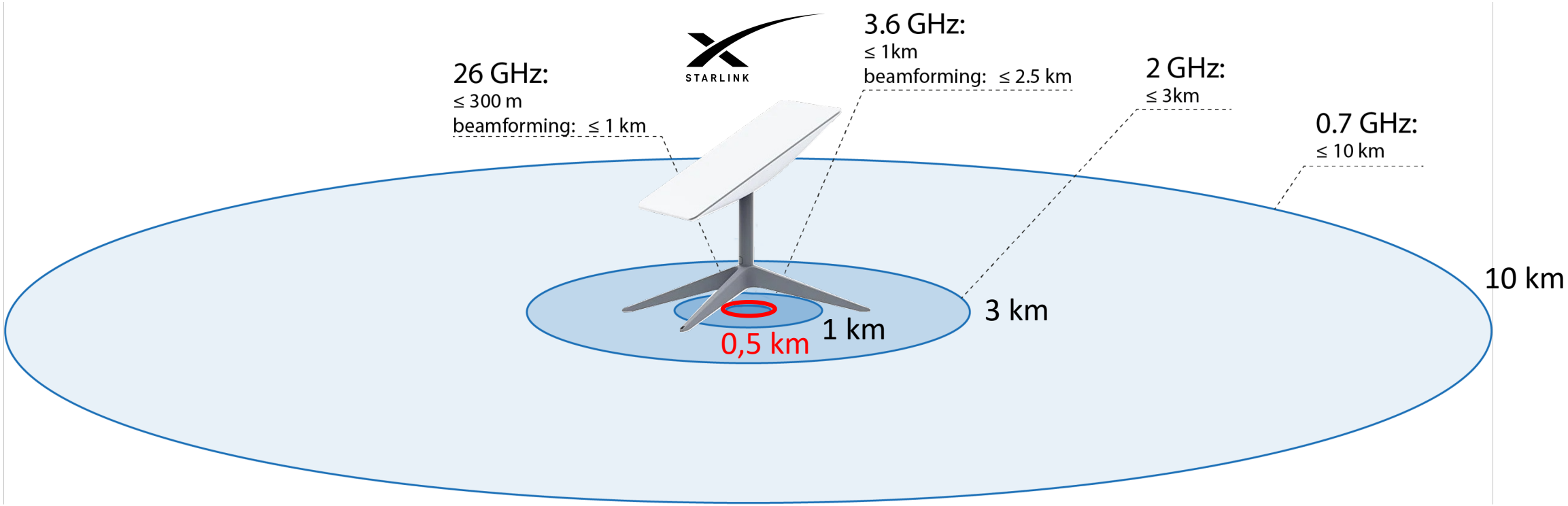
- **Frequency versus Propagation**



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- **Signal Detection and Analysis**

- Signal detection, analysis and direction finding of STARLINK ground stations is possible with a diversity of techniques
- Direction finding with a direction finder system working in the frequency bands:
- 14-14.5GHz, 47.2-50.2GHz, and 50.4-51.4GHz
- L-band direction finder system works from 8 MHz to 8 GHz and can be extended via converters to Ku and Ka bands.
- As signal structure of STARLINK communication links is known, further analysis techniques can be applied for interception of data.
- BUT: THE EFFORTS GET HIGHER WHEN THE FREQUENCY GET HIGHER !

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- **Radio direction finder**

- RF interference emission identification
- RF Emission identification of fixed location
- RF Emission identification of on the move position
- Tracking on the move
- Big event interference & illegal emission identification
- Homeland Security / border control missions.
- Situational Awareness
- Radio communications surveillance & interception
- Radio localization & direction finding. (AoA / TDOA)

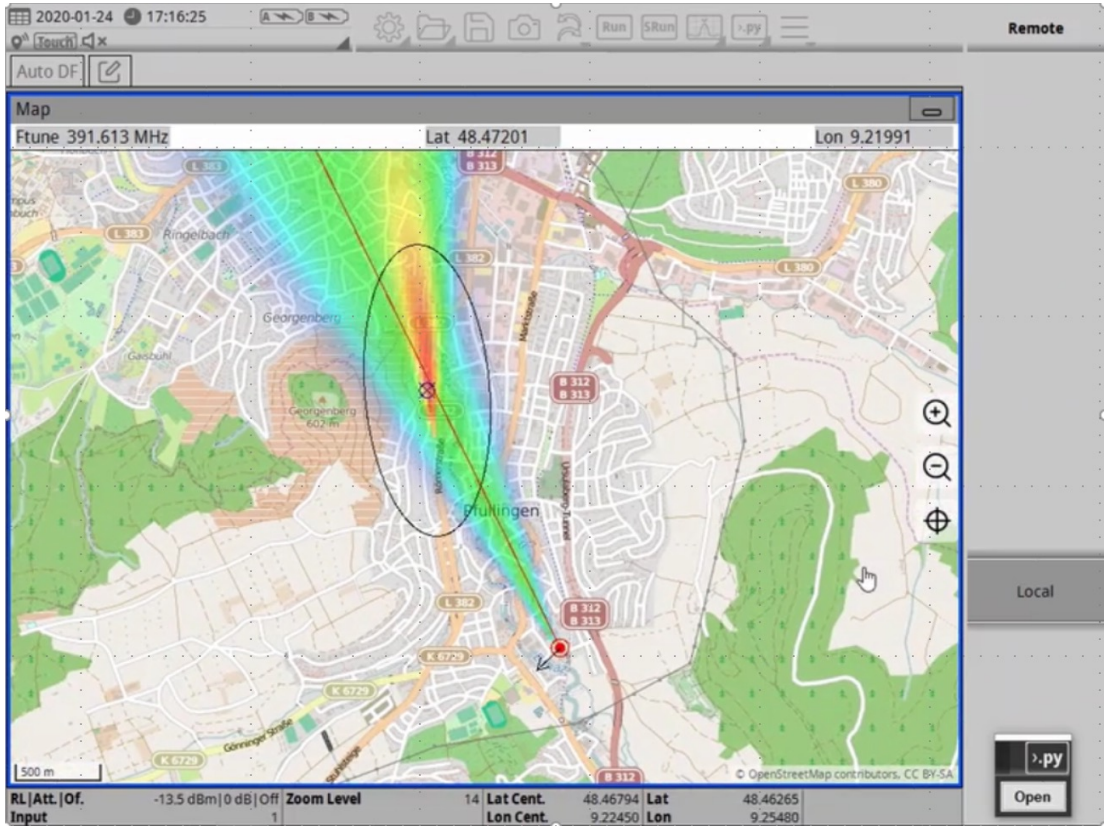

Fig.6: heat map displayed on the radio direction finder.

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- **Signal Detection and Direction Finder Kit**

Fig.7: portable radio direction finder equipment

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- **Portable & mobile radio direction finder**

Fig.8: portable radio direction finder equipment

Fig.9: mobile radio direction finder equipment

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- **Fix Radio direction finder**

Fig.10: fixed radio direction finder equipment

- **Radio direction finder on an UAV**

Fig.11: mobile radio direction finder equipment

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- **Mitigation the traceability of satellite links**

- Starlink constellation uses the feature of its uplink antennas with an antenna pattern of 60 degrees opening. The constellation elevates the flat antenna to the most optimal direction of the satellite fleet for the antennas region. Usually this is 90 degrees into the sky in north/south direction.

  ⇒ Find a lowered area where the antenna can only see elevation above 45 degrees. This prevents horizontal sidelobes to be detected.

  ⇒ If possible make an installation in rural area and not close to roads, as a radio direction finders usually are mobile installations on vehicles.

- Starlink is available as moveable and on the-move-service on land/sea and air.

  ⇒ Moving or on-the-move Starlink terminals are more difficult to be detected and need more technical effort and a cluster of radio direction finders.