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**System Reference document (SRdoc);
Short Range Devices;
Radar equipment operating in the 76 GHz to 77 GHz range;
additional applications**

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The band 76 - 77 GHz is already used by many applications including ground-based vehicle and TTT infrastructure systems (ERC/REC 70-03 [i.3] Annex 5), obstruction/vehicle detection via radar sensor at railway level crossings (ERC/REC 70-03 [i.3] Annex 4), obstacle detection radars for rotorcraft use (ERC/REC 70-03 [i.3] Annex 5), HD-GBSAR (ERC/REC 70-03 [i.3] Annex 6) and LPR/TLPR (ERC/REC 70-03 [i.3] Annex 6).

There therefore exists a large body of experience in manufacturing and use of radars in this band. Dedicated semiconductor devices are available from several manufacturers. Deployed equipment ranges from high value fixed installations that are professionally installed and operated to mass market, price sensitive devices.

The present document will describe the use of 76 - 77 GHz radars for additional applications such as:

- Fixed surveillance radars for Security and Safety Applications (FSSA)
- Fixed and moving maritime radars for collision avoidance and safety

Radar sensors on uncrewed airborne systems are described in a separate SRdoc (ETSI TR 104 078 [i.16]).

In some cases, the new application may be existing equipment put to a new use. In others it may be a case of existing technology in a new type of equipment. In some cases, it may be argued that the applications are already permitted under existing regulations, but there are some grey areas, and it would be useful to have clarification and a harmonised position.

Some countries already permit additional applications, and some examples are described in clause B.3 of a previous SRdoc ETSI TR 103 148 [i.1].

1 Scope

The present document describes applications for SRDs in the 76 - 77 GHz which may require a change in the present regulatory framework for the proposed band.

It includes in particular:

- Market information;
- Technical information regarding equipment type and typical installation;
- Regulatory issues.

For the applications described, the intended and unwanted emissions are within the current harmonized regulations for SRDs. The regulatory changes that would be required for their realization are relaxations on usage restrictions.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

[i.1] ETSI TR 103 148 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference document (SRdoc); Technical characteristics of Radio equipment to be used in the 76 GHz to 77 GHz band; Short-Range Radar to be fitted on fixed transport infrastructure".

[i.2] ECC Report 262 (2017): "Studies related to surveillance radar equipment operating in the 76 to 77 GHz range for fixed transport infrastructure".

[i.3] ERC/REC 70-03 (7 June 2024): "ERC Recommendation of 1997 relating to the use of Short Range Devices (SRD)".

[i.4] Commission Implementing Decision (EU) 2022/180 of 8 February 2022 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices.

[i.5] ETSI EN 301 091-1 (V2.1.1): "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 1: Ground based vehicular radar".

[i.6] ETSI EN 301 091-2 (V2.1.1): "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 2: Fixed infrastructure radar equipment".

[i.7] ETSI EN 301 091-3 (V1.1.1): "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 3: Railway/Road Crossings obstacle detection system applications".

[i.8] ETSI EN 303 360 (V1.1.1): "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Obstacle Detection Radars for Use on Manned Rotorcraft".

[i.9] ETSI EN 303 661 (V1.1.1): "Short Range Devices (SRD); Ground Based Synthetic Aperture Radar (GBSAR) in the frequency range 17,1 GHz to 17,3 GHz and High Definition Ground Based Synthetic Aperture Radar (HD-GBSAR) in the frequency range 76 GHz to 77 GHz; Harmonised Standard for access to radio spectrum".

[i.10] ETSI TR 103 664 (V1.1.1): "System reference document (SRdoc); Security Scanners (SSc) within the frequency range from 60 GHz to 90 GHz".

[i.11] ECC Report 344 (2022-10): "Sharing and compatibility studies of Security Scanners (SScs) within frequency range 60-82 GHz".

[i.12] ECC Report 222 (2014-09): "The impact of Surveillance Radar equipment operating in the 76 to 79 GHz range for helicopter application on radio systems".

[i.13] ECC Report 315 (2020-05): "Feasibility of spectrum sharing between High-Definition Ground Based Synthetic Aperture Radar (HD-GBSAR) application using 1 GHz bandwidth within 74-81 GHz and existing services and applications".

[i.14] ECC/DEC/(16)01 (4 March 2016): "The harmonised frequency band 76-77 GHz, technical characteristics, exemption from individual licensing and free carriage and use of obstacle detection radars for rotorcraft use".

[i.15] ERC/REC 74-01 (May 2022): "Unwanted emissions in the spurious domain".

[i.16] ETSI TR 104 078: "System Reference document (SRdoc); Short Range Devices; Radar equipment operating in 57 GHz to 64 GHz and 76 GHz to 77 GHz for applications on drones".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CP	Critical Part
e.i.r.p.	equivalent isotropic radiated power
FFT	Fast Fourier Transform
FIR	Fixed Infrastructure Radar
FMCW	Frequency Modulated Carrier Wave
FOD	Foreign Object Debris
FoF	Friend or Foe
FoV	Field of View

FSSA	Fixed Security and Safety Applications
GSV	Ground Support Vehicles
HD-GBSAR	High-Definition Ground Based Synthetic Aperture Radar
LDC	Low Duty Cycle
LPR/TLPR	(Tank) Level Probing Radar
PIDS	Perimeter Intrusion Detection System
RSM	Runway Surface Movement
SSc	Security Scanner
TTT	Transport and Traffic Telematics
WAM	Wide Area Monitoring

4 Comments on the System Reference Document

No ETSI member raised any comments.

5 Presentation of the system or technology

5.1 General overview

The band 76 - 77 GHz is already used by many applications including ground-based vehicle and TTT infrastructure systems (ERC/REC 70-03 [i.3] Annex 5), obstruction/vehicle detection via radar sensor at railway level crossings (ERC/REC 70-03 [i.3] Annex 4), obstacle detection radars for rotorcraft use (ERC/REC 70-03 [i.3] Annex 5), HD-GBSAR (ERC/REC 70-03 [i.3] Annex 6) and LPR/TLPR (ERC/REC 70-03 [i.3] Annex 6).

The technology that is discussed in the present document is that which is already in use in the 76 - 77 GHz band but limited to certain applications.

There therefore exists a large body of experience in manufacturing and use of radars in this band. Dedicated semiconductor devices are available from several manufacturers. Design and manufacture of antenna systems has been perfected.

Deployed equipment typically falls into two types: high value fixed installations that are professionally installed and operated and mass market, price sensitive devices.

In terms of technology, both types are typically FMCW radars with a total RF power of the order of 10 mW. They all rely on digital processing, such as FFTs, to extract target information from the reflected radar signals and for post processing of this information.

Many fixed installations have a single antenna that forms a very narrow beam, and the antenna is scanned mechanically to cover the Field of View (FoV). Fixed antennas with single or multiple wider beams are also found.

Mass market systems are highly integrated. They may have multiple small antennas combined with the RF circuitry into a small module.

In terms of systems, the main applications for fixed installations are TTT infrastructure (ERC/REC 70-03 [i.3] Annex 5), HD-GBSAR (ERC/REC 70-03 [i.3] Annex 6) and radar sensors at railway level crossings (ERC/REC 70-03 [i.3] Annex 4). The main application for mass market equipment is on ground-based vehicles (ERC/REC 70-03 [i.3] Annex 5).

With the band listed in multiple Annexes in ERC/REC 70-03 [i.3], there is potential for uncertainty in exactly what applications and uses are permitted. Is, for instance, monitoring an airport runway for debris a TTT function or a safety function?

In the list of applications that follow, there will be some that are permitted by many administrations. Others may be edge cases or lie in a grey area. One purpose of the present document is to seek to remove such uncertainties and to move to a harmonised position among CEPT member states.

5.2 Fixed Security and Safety Applications (FSSA)

5.2.1 System description

The scanning radar systems provide an Automatic Incident Detection solution for a range of safety/security applications for strategic or sensitive sites. These can include but are not limited to airfields, power stations, data centres, mines, and other critical national infrastructure. By continually measuring and tracking objects through a wide FoV using high frequency radar the system can generate incident alerts, whilst maintaining extremely low nuisance alarm rates.

Systems of this nature would be similar to existing fixed infrastructure radars for TTT applications as in Annex 5 of ERC/REC 70-03 [i.3].

They would meet the technical requirements in ETSI EN 301 091-2 [i.6] for fixed infrastructure radars.

Given the applications and typical deployment locations described below, fewer than 10 systems per site would be expected.

The expected number of sites is around 3 per major city. These assumptions are discussed further in clause 6.

5.2.2 Site and perimeter protection

5.2.2.1 Radar for site security and safety applications

Fixed infrastructure radar can be used to detect and track vehicles or people in and around critical national infrastructure and other important sites. This would include but not be limited to airports, power stations, refineries, ports/harbours or data centres. The threat is not limited to possible terrorist activity. For example, in UK airports, environmental protestors have breached the perimeter and caused major delay and disruption.

5.2.2.2 Perimeter Intrusion Detection System (PIDS)

The specific application is to detect breaches of the site perimeter. This could be deployed at airports, critical National Infrastructure sites as well as some civilian installations such as car storage facilities, data centres and private energy sites where a threat would typically originate from outside of the site perimeter. A key advantage of a radar for this application is the ability to detect and track in all weather conditions with continual monitoring of multiple objects in real time within a site. Traditional PIDS solutions offer an alert to breach but a radar solution can offer live and historic tracking of multiple targets of interest to enable a fast response for interception as well as historic forensic analysis of breach locations.

As has been identified in numerous airfield breaches, knowing that an intruder(s) has entered the site is one thing but the ability to monitor live locations of multiple targets once inside can prove vital to maintaining integrity of vulnerable areas of the site. In cases such as this a full situational awareness is vital in leading an effective response.

5.2.2.3 Wide Area Monitoring including Wildlife Detection

In the general security installations, the system objective is for wide area monitoring for detection and alerting to unusual movement of vehicles, people and wildlife within a site. A typical installation in an airport may see one or more scanning radars installed such that the radar FoV would cover the open area between the perimeter fence to the runway or terminal/maintenance buildings. In this case the system would be looking to detect pedestrians in restricted zones or larger wildlife that could pose a danger to aircraft or ground support equipment. Typical systems may be longer range > 1 km line of sight. This results in fewer physical systems required to achieve desired coverage as well as minimizing costs associated with ground works required for data and power to each system.

Typical installation mounting height of 4 - 8 m with a 360° FoV.

Systems such as WAM and PIDS may be combined with FoF solutions in order to reduce nuisance alarms.

5.2.2.4 Border Protection

Monitoring of border areas over long distances is becoming particularly important with increasing migration levels. Early detection and monitoring positions of objects post-breach can enable the relevant response personnel to respond in the most appropriate and timely manner.

5.2.2.5 Port and Harbour Protection

Perimeter protection is difficult for areas crossing or bordering water. Manned patrols on water or shoreline cannot cover the entire surface in time. Constant monitoring of all activities, including the water surface, can be necessary for effective security. A typical installation may include harbours shared with both military and civilian watercraft. Monitoring surface movement in shared environments is a difficult task where public access is permitted in close proximity to restricted zones around military assets. Short range fast detection of object entering or approaching restricted zones in all weather and sea conditions can be vital in ensuring integrity of those assets.

Port and harbour protect may also consist of overland monitoring or a combination of both to protect and monitor access from both. In this example the equipment used to monitor the site may be the same as that used to monitor traffic from the roadside.

5.2.3 Airport - airside protection

5.2.3.1 Runway Surface Movement

RSM monitoring is primarily a safety application used to aid control tower monitoring of aircraft and GSV in and around the runway and taxiways at major airports where line of sight can be restricted by poor whether such as fog and rain. This is a safety application aimed at reducing the chance of collisions. Typical installations would be 50 - 100 m from the runway at 2 - 3 m installation height.

Such a system would almost certainly be seen as TTT as it is in a transport environment and monitoring traffic.

5.2.3.2 Critical Part Line Monitoring

Monitoring the CP line in airports is a complex task due to the constant movement and strict security requirements. Managing the operational flow and preventing potential security threats poses significant challenges for airport authorities. Airports create a virtual line where physical barriers are not possible and are monitored to alert operators of unauthorized access. Accurately detecting and tracking objects continuously, even in adverse weather and varying light conditions is paramount importance. Typical installations would require a relatively short range of operation with a relatively high update rate. Radar mounting height would be expected at 2 - 3 m mounting height. In this example the equipment used to monitor ground traffic may be the same as that used to monitor traffic from the roadside.

Such a system would probably be seen as TTT as it is in a transport environment and monitoring traffic, although there is a major safety aspect.

5.2.3.3 FOD Detection

In this scenario a scanning radar would be used to automatically identify unwanted objects (FOD) on runways. At most airports this is a manual task completed by human observers inspecting the runway at set intervals. An automatic FOD detection system reduces the requirement for manual inspections and reduces the management overhead of ensuring safety of the inspection teams operating on active runways. In this application the installation would be expected to single digit numbers per runway with an installation height of less than 2 m and within 100 m of the runway.

Here it is less certain that all administrations would see this as TTT. It is in a transport environment, but the application is safety rather than traffic management.

5.2.4 Ports & Maritime

5.2.4.1 Situational awareness

Perimeter and site security is discussed in clause 5.2.2.5 above. Monitoring of movement within a port or harbour is also vital.

Because it is difficult to place infrastructure in the water and because of the need to operate in all weather and sea conditions, short range radar is the best, and possibly the only feasible, solution.

This application is in a transport environment and the situational awareness function would almost certainly be seen as TTT. But in practice the security function is integrated into the same equipment and system, so the installation as a whole may be seen as a grey area.

5.2.4.2 Quayside collision prevention

Vessels manoeuvring too fast and/or on the wrong heading repeatedly cause damage to port infrastructure, piers, sluices, floodgates, fairway limitation/buoy and other ships.

To prevent this, a radar on the infrastructure side (quay, jetty or pontoon) could be foreseen as part of an assistance / protection system. Such system integrates highly robust maritime radar sensors that are installed at various points on the maritime infrastructure and is in direct contact with the crew on the ships via various end devices (signal lamps, displays, etc.). The information on local conditions helps the crew to navigate the ship safely even during adverse weather conditions affecting the ship captain's sight (fog, heavy rain, snow, nighttime etc) or affecting the ship's manoeuvrability (heavy winds / gusts).

Such a system could be seen as part of TTT infrastructure, although some might argue the application is safety.

5.2.5 Scanning antennas

With a very narrow beam antenna, a long-standing method of monitoring a wide FoV is to mechanically rotate (scan) the antenna assembly in azimuth. This has the effect, for a receiver in the FoV, of simulating a very low duty cycle with a repetition frequency dependent upon the scan rate.

A narrow beam can also be scanned electronically, though usually only over a limited angle. Other electronic techniques include processing multiple fixed beams.

Antennas of a scanning nature have been mandated for fixed infrastructure radars. The reason is that the effect in the time domain of a mechanically scanned narrow beam provides mitigation to vehicular radars. One proposal of the present document is that this requirement is applied only to roadside installations. Away from vehicular radar there would be no benefit to this restriction.

5.3 Uncrewed aircraft systems

There is a precedent for Obstacle Detection Radar in the 76 - 77 GHz band, for use upon manned rotorcraft, following ERC/REC 70-03 [i.3] and ECC/DEC/(16)01 [i.14].

Extending such usage to uncrewed aircraft, e.g. drones, could be seen as a subject for the present document. ETSI members, however, have agreed to produce a separate SRdoc on airborne radar systems that considers a wider frequency range.

Information on the use of 76 - 77 GHz for airborne radar is included in this separate ETSI SRdoc ETSI TR 104 078 [i.16].

5.4 Millimetre Wave Security Scanners

The proponents of the present document are aware of previous and current work in CEPT and ETSI on Security Scanners (SScs), including:

- ETSI TR 103 664 [i.10].
- ECC Report 344 [i.11].
- ETSI is also developing a draft harmonised standard for security screening applications.

This clause explains the differences between SScs and the systems described here.

Use Case

The SSc referred to above are intended for detection and examination of small objects (e.g. concealed weapons) at close range. The systems described here are intended for detection of larger objects (e.g. vehicles, people) at larger ranges.

Technology

SSc are wider bandwidth and lower peak e.i.r.p. than the systems described here. In addition, the signal format and antenna type are usually different.

The proponents of the present document therefore conclude that the requirements and applications described here are not able to be met within the parameters assigned to mmW SSc. The systems are in different categories, in terms both of use case and the technology.

6 Market information in the EU

6.1 FSSA Market Size and Value

6.1.1 General

The European security radar market is expected to reach USD 2,4 billion by 2027, growing at a CAGR of 7,8 % during the forecast period (2023-2027).

Government security spending and increasing concerns about border security, critical infrastructure protection, perimeter intrusion detection, and aviation safety are driving the market growth.

Key market segments include:

- Critical infrastructure protection (33 %): Airports, power stations, refineries, data centres, etc.
- Border security (27 %): Land and maritime borders, including surveillance and intrusion detection.
- Airport security (18 %): Perimeter intrusion detection, runway surface movement monitoring, foreign object debris (FOD) detection, etc.
- Perimeter Intrusion Detection (17 %): Sensitive facilities, high-security zones (excluding airports).
- Others (5 %): Military applications, industrial security, and other critical infrastructure sites.

Focusing on Airport Security:

- The EU airport security radar market, specifically for runway FOD detection, is estimated to reach USD 0,2 billion by 2027. This estimation considers an average of 15 radar sensors per runway for full FOD detection coverage and the total number of runways in the EU.

6.1.2 Traffic and Equipment Density Forecasts

The deployment of security radar systems in the EU is expected to increase significantly in the coming years. EU initiatives like the Smart Borders Package and the European Investment Plan are driving investments in security technologies.

The number of critical infrastructure sites requiring advanced security solutions is also growing. Radar adoption is expected to be higher in countries with extensive land and maritime borders, critical infrastructure networks, and busy airports.

It is difficult to estimate the exact equipment density per site as it depends on factors like size, security requirements, and budget. However, reports suggest an average of:

- 2 - 5 radar systems per critical infrastructure site (excluding airports)
- 5 - 10 systems per large border area

- 3 radars per single-runway airport for full site coverage
- 15 radar sensors per single runway for complete FOD detection

These installations would be high value, low volume fixed installations that are professionally installed and operated.

6.1.3 Specific Application Data

6.1.3.1 Airport Security

The European airport security market presents a significant opportunity for advanced radar technologies, driven by the need to:

- **Strengthen perimeter security**: Airports face diverse threats, including unauthorized personnel intrusions, drone incursions, and ground vehicle breaches. Our radar technology can offer a powerful layer of defence by providing:
    - **Early detection and tracking**: Detect and track suspicious activity and objects approaching the perimeter in real-time, regardless of weather conditions.
    - **Improved situational awareness**: Gain a comprehensive view of the entire perimeter, enabling faster response to potential threats.
    - **Data fusion**: Integrate seamlessly with existing security systems like cameras and access control for a unified view.
- **Elevate wide area monitoring**: Effectively monitoring large areas within the airport can be challenging. Radar technology can address this by:
    - **Monitoring vast spaces**: Cover expansive areas like runways, taxiways, and cargo zones continuously and reliably.
    - **Identifying suspicious activity**: Detect unusual movements, loitering individuals, or potential hazards like wildlife entering restricted areas.
    - **Supporting resource allocation**: Optimize security personnel deployment based on real-time insights from radar data.
- **Optimize access control**: Secure sensitive areas within the airport with enhanced efficiency and effectiveness. Radar technology can:
    - **Monitor restricted zones**: Provide continuous surveillance of access points and identify unauthorized attempts to enter.
    - **Enhance checkpoint screening**: Integrate with existing screening systems to improve detection accuracy and efficiency.
    - **Reduce manual oversight**: Automate routine monitoring tasks, freeing up security personnel for critical interventions.

Beyond these core applications, radar technology may also have the potential to contribute to areas like:

- **Vehicle and personnel screening**: Enhance existing screening procedures with more advanced detection capabilities.
- **Foreign Object Debris (FOD) detection**: While primarily an airport safety concern, radar can offer a proactive approach to FOD detection, potentially contributing to improved safety outcomes.
- **Runway incursion monitoring**: Mitigate the risk of runway incursions by unauthorized vehicles or aircraft through real-time detection and tracking on and around runways. This can significantly enhance runway safety and prevent accidents.

6.1.3.2 Other Applications

The adoption of radar for border protection, critical infrastructure protection (excluding airports), and perimeter intrusion detection (excluding airports) is also expected to grow in the coming years.

Each application has its own specific market dynamics and challenges.

6.1.4 Conclusion

The European security radar market offers significant growth potential, particularly for applications that go beyond traffic telematics. Radar technology has a unique ability to address specific safety and security challenges in airports, ports and high value installations. The technology's cost-effectiveness, together with automation and all-weather capabilities can create a compelling advantage in many markets. These installations would be high value, low volume fixed installations that are professionally installed and operated.

7 Technical information

7.1 FSSA technical description

7.1.1 Technical parameters and implications on spectrum

The radar systems described in the present document use a continuous transmission with frequency modulation. The systems are compliant with the technical parameters of ETSI EN 301 091-2 [i.6].

The following tables list typical parameters for a range of scanning fixed infrastructure radars for safety and security applications.

Table 1: H1 Technical parameters

Equipment Name	Example H1
Frequency Band	76 - 77 GHz
Occupied Bandwidth	~940 MHz
Modulation	FMCW
Antenna type	Scanning
FoV	Up to 360° Az, 1,8° El
Instrumented Range (see Explanation 1)	300 m
Peak Power	47 dBm e.i.r.p.
Mean Power	24 dBm e.i.r.p.
Antenna Scan Rate	4 Hz
Azimuth Beam Width	1,8°
Elevation Beam Width	1,8°
Duty Cycle (see Explanation 2)	0,5 %
Typical Mounting Height above Ground level	2 - 4 m
Silent Time (see Explanation 2)	995 milliseconds per second

Table 2: H2 Technical parameters

Equipment Name	Example H2
Frequency Band	76 - 77 GHz
Occupied Bandwidth	~940 MHz
Modulation	FMCW
Antenna type	Scanning
FoV	Up to 360° Az, 3,6° El
Instrumented Range (see Explanation 1)	800 m
Peak Power	42 dBm e.i.r.p.
Mean Power	16 dBm e.i.r.p.
Antenna Scan Rate	2 Hz
Azimuth Beam Width	1,8°
Elevation Beam Width	3,6°
Duty Cycle (see Explanation 2)	0,5 %
Typical Mounting Height above Ground level	2 - 6 m
Silent Time (see Explanation 2)	995 milliseconds per second

Table 3: H3 Technical parameters

Equipment Name	Example H3
Frequency Band	76 - 77 GHz
Occupied Bandwidth	~700 - 960 MHz
Modulation	FMCW
Antenna type	Scanning
FoV	Up to 360° Az, 2,8° El
Instrumented Range (see Explanation 1)	2 000 m
Peak Power	51 dBm e.i.r.p.
Mean Power	26 dBm e.i.r.p.
Antenna Scan Rate	1 Hz
Azimuth Beam Width	0,9°
Elevation Beam Width	2,8°
Duty Cycle (see Explanation 2)	0,25 %
Typical Mounting Height above Ground level	4 - 8 m
Silent Time (see Explanation 2)	997,5 milliseconds per second

Table 4: Quayside Technical parameters

Equipment Name	Example Quayside
Frequency Band	76 - 77 GHz
Occupied Bandwidth	~700 - 960 MHz
Modulation	FMCW
Antenna type	Fixed
FoV	120° - 160° Az, 30° El
Instrumented Range (see Explanation 1)	300 m
Peak Power	55 dBm e.i.r.p. max, typically 40 dBm e.i.r.p.
Mean Power	50 dBm e.i.r.p. max typically 35 - 40 dBm e.i.r.p.
Azimuth Beam Width	As FoV
Elevation Beam Width	As FoV
Duty Cycle (depends on use-case) (see Explanation 2)	20 - 50 %
Typical Mounting Height above water level	1 - 5 m
RCS of target	20 dBsqm for smaller ships up to 40 dBsqm for larger ones

Table 5: Quayside Technical parameters with reduced duty cycle

Equipment Name	Example Quayside
Frequency Band	76 - 77 GHz
Occupied Bandwidth	~700 - 960 MHz
Modulation	FMCW
Antenna type	Fixed
FoV	120° - 160° Az, 30° El
Instrumented Range (see Explanation 1)	300 m
Peak Power	55 dBm e.i.r.p. max, typically 40 dBm e.i.r.p.
Mean Power	Typically 35 - 40 dBm e.i.r.p.
Azimuth Beam Width	As FoV
Elevation Beam Width	As FoV
Duty Cycle (see Explanation 2)	10 %
Typical Mounting Height above water level	1 - 5 m
RCS of target	20 dBsqm for smaller ships up to 40 dBsqm for larger ones

Explanation 1: Instrumented range is the range for which the equipment will deliver output. Small features may not be discoverable at maximum range display.

Explanation 2: Duty cycle and silent time in the tables above are as experienced at a given point in the FoV. They include effects of the antenna pattern and rotation as well as signal duty cycle.

Radiated powers are expressed as e.i.r.p. The actual power generated in the transmitter is of the order of 10 mW - a property of the semiconductors that are used. The e.i.r.p. is a combination of the transmitter power and the antenna gain in the relevant direction.

In the tables above, peak and mean power are radiated powers in a given direction; i.e. they are the illumination as experienced at a point within the FoV. The values are as determined in clauses 4.3.2 and 4.3.3 of ETSI EN 301 091-2 [i.6].

Table 6 shows how the illumination is affected by scanning and fixed antennas. The effects of sector blanking and equipment activity factor have been excluded.

Table 6: Effects of scanning and fixed antennas

Antenna type	Scanning	Fixed
Signal duty cycle	T_{on} / (T_{on}+T_{off})	T_{on} / (T_{on}+T_{off})
Scanning duty cycle (azimuth)	Beamwidth (H)/360°	100 %
Illumination cycle	Combination of signal duty cycle and scanning duty cycle	Identical to signal duty cycle
Peak power (e.i.r.p.)	Peak antenna gain x peak Tx power (maximum in time and maximum in direction)	Peak antenna gain x peak Tx power (maximum in time and maximum in direction)
Mean power (e.i.r.p.)	Time average of radiated power in direction of maximum (average over time and maximum in direction)	Time average of radiated power in direction of maximum (average over time and maximum in direction)
Mitigation strategy to protect vehicular radar	Scanning antenna with a narrow beam illuminates individual points in space only rarely.	Restrict installation to non-roadside locations without signal-related limitations, OR Reduced duty cycle to ensure minimum silent time.

7.1.2 Status of technical parameters

7.1.2.1 Current ITU and European Common Allocations

7.1.2.2 Sharing and compatibility studies (if any) already available

In 2017 ECC report 262 [i.2] was published following a co-existence study conducted with SE24. The study related to surveillance radar equipment operating in the 76 - 77 GHz range for fixed transport infrastructure.

The fixed radars considered in this study have a mounting location of approximately 5 m above the road surface and 2 - 3m laterally from the first running lane. The executive summary states that the incident power that may be received by an vehicular radar from this fixed radar installation is of the same order of magnitude as can be received from a second vehicular radar.

The report concluded that the scanning nature of the FIR contributed to the co-existence with vehicular radar and as such ERC/REC 70-03 [i.3] Annex 5, Note 1 states: "Fixed transportation infrastructure radars have to be of a scanning nature in order to limit the illumination time and ensure a minimum silent time to achieve coexistence with vehicular radar systems". This recommendation is considered within the present document and is discussed in clause 5.2.5.

The study considered but did not conclude on other methods that could help mitigate interference including sector blanking (ability to switch off the transmitter in azimuths outside of the area of interest), switching off the transmitters when not sampling, ability to add jitter to the ramp start frequency. It should be noted that the FSSA radar systems discussed in the present document have these mitigation methods available to minimize any potential interference.

Other studies of interest are found in ECC Report 222 [i.12] (manned rotorcraft) and ECC Report 315 [i.13] (HDGB-SAR).

7.1.2.3 Sharing and compatibility issues still to be considered

ECC Report 262 [i.2] examined the use of FIR mounted at the roadside and used for TTT applications.

One obvious consideration for FIR used for FSSA is whether there would be an increase in illumination directed at the road. The following points are noted:

1) TTT installations can be 1 m from the roadside. FSSA would not be this close; installations are expected to be a minimum of 10 m away.

2) FSSA for an area is concerned with detecting movement inside a perimeter not outside it. Installations are at the edge of the perimeter directed inwards. Sector blanking is used to avoid illumination outside the target area. A restriction preventing the direction of illumination towards roads would be acceptable.

3) Signal format. FSSA use narrower beamwidth and slower scan rates (e.g. 1 or 2 Hz) than TTT. The silence time between beams is greater which would assist compatibility with vehicular radars.

4) Deployment density. For airfield security, the expected density would be 2 sites around a city with 10 units per site.

In conclusion, the proponents of the present document believe use of FSSA will not result in a noticeable increase in illumination of vehicles on the road.

7.1.3 Transmitter parameters

7.1.3.1 Transmitter Output Power / Radiated Power

As noted in clause 7.1.1 above, the RF power generated in the transmitter is of the order of 10 mW. Further details of how this relates to radiated power are given below.

7.1.3.2 Scanning antennas

Three cases of equipment with scanning antennas are presented in clause 7.1.1. When active, these typically operate at close to 100 % duty cycle.

Peak radiated power is typically in the range of +42 dBm to +51 dBm on the antenna boresight.

Mean radiated power is in the range of +16 dBm to +26 dBm which can be calculated from to the antenna duty factor.

The three cases considered herein differ in their antenna beamwidth characteristics:

- Example H1 has an antenna beamwidth of 1,8° × 1,8° (Az x El).
- Example H2 has an antenna beamwidth of 1,8° × 3,6° (Az x El).
- Example H3 has an antenna beamwidth of 0,9° × 2,8° (Az x El).

The actual beam shapes are similar. The pattern for example H2 is representative of all three and is shown in Figure 1 below.

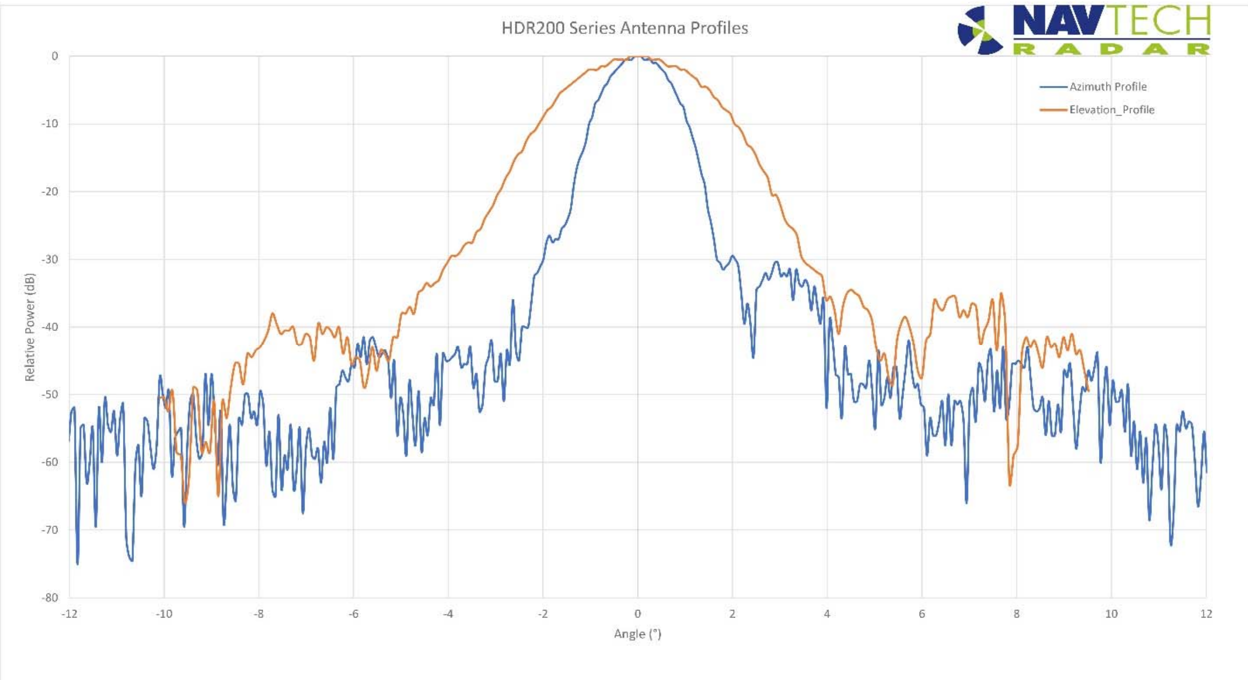

Figure 1: Example 2 antenna pattern (source: Navtech Radar)

7.1.3.3 Fixed antennas

The fourth example considered has a fixed antenna of gain approx. 20 dBi. Together with current transmitter technology, a peak e.i.r.p. in the range of 37 - 40 dBm can be achieved.

For such a radar, the mean e.i.r.p. is based on the signal duty cycle which is in the range of up to 50 %.

The fifth example is almost identical to the fourth with regard to generated power and antenna gain but has a reduced duty cycle of maximum 10 %. With this adjustment, such a radar meets the timing requirements suggested by ECC Report 262 [i.2] for fixed installations to ensure co-existence with vehicular radars. I.e. it is equivalent in this respect to the emissions from a scanning antenna.

7.1.3.4 Operating Frequency

The current operating frequency is in the band 76 - 77 GHz.

7.1.3.5 Bandwidth

The overall bandwidth is defined by the FM sweep pattern. This is typically in the range of 700 - 940 MHz.

7.1.3.6 Unwanted emissions

Unwanted emissions are within the limits specified by ETSI EN 301 091-2 [i.6] which is aligned with ERC/REC 74-01 [i.15].

7.1.3.7 Duty Cycle/Mechanical Scanning

A narrow beam scanning antenna only illuminates a given target area intermittently.

The radar boresight scans a horizontal plane parallel to the ground. The antenna duty cycle depends on the antenna beam width in azimuth systems and is between 0,25 - 0,5 %. The scan rate is model dependant but ranges between 1 - 4 Hz.

A single fixed antenna illuminates the whole FoV whenever the transmitter is active. The duty cycle experienced in the target area depends on the signal transmitted.

7.1.4 Receiver parameters

The infrastructure radar includes either monostatic (single antenna) for transmit and receive (H1) or is a bi-static, dual antenna configuration for the H2 & H3 examples. The radar receiver includes an active mixer that converts the Radio Frequency signal into an Intermediate Frequency range which covers 50 kHz to 5 MHz. The receiver Noise Figure is typically 10 dB at 1 MHz.

There is no receive only mode.

7.2 Information on relevant standard(s)

The following ETSI standards apply to short range radar equipment using the 76 - 77 GHz band:

- ETSI EN 301 091-1 [i.5]

  "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 1: Ground based vehicular radar".

  V2.1.1 was published by ETSI in 2017.

- ETSI EN 301 091-2 [i.6]

  "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 2: Fixed infrastructure radar equipment".

  V2.1.1 was published by ETSI in 2017. This is the standard applicable to the equipment described in the present document.

ETSI has current Work Items to revise both the above standards.

- ETSI EN 303 360 [i.8]

  "Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 76 GHz to 77 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Obstacle Detection Radars for Use on Manned Rotorcraft".

  V1.1.1 was published by ETSI in 2017.

- ETSI EN 303 661 [i.9]

  "Short Range Devices (SRD); Ground Based Synthetic Aperture Radar (GBSAR) in the frequency range 17,1 GHz to 17,3 GHz and High Definition Ground Based Synthetic Aperture Radar (HD-GBSAR) in the frequency range 76 GHz to 77 GHz; Harmonised Standard for access to radio spectrum".

  V1.1.1 was published by ETSI in 2024.

8 Radio spectrum request and justification

No change to the spectrum allocations, in terms of frequency bands, power limits, etc., is requested.

The purpose of the present document is to seek clarity and a harmonised position on the applications and use cases of radar equipment in the 76 - 77 GHz band.

In particular, the request is that applications for security and safety are expressly permitted.

At present, most radar equipment in the band is deployed and operated under the heading of Transport and Traffic Telematics (TTT). While many applications are clearly TTT, some applications are wholly or partly for purposes of security and safety. Manufacturers and operators find that some countries permit them anyway and some countries say they are outside the definition of TTT. The situation is further confused by grey area applications where it is difficult, for either manufacturers or administrations, to determine whether they are TTT or not.

The proponents of the present document believe that the solution is to expressly permit additional applications such as security and safety in the 76 - 77 GHz band. Further details of the request are given in clause 9.

It is accepted that an ETSI Systems Reference Document normally presents technology and use cases and that a spectrum allocation is the role of ECC. In this case, however, the 76 - 77 GHz band is already allocated for radar and the equipment under discussion is the same as that already deployed in the band.

The proponents of the present document believe that the additional applications will not cause any compatibility issues. There are various mitigation techniques available including sector blanking, duty cycle, pulse jittering, etc. One compatibility concern is with vehicular radar. This particular concern is solved by geographic separation; the new applications will be away from roads and will not cause any significant increase in illumination of automobiles.

The question at heart here is not so much finding new spectrum for a technology, but to create a harmonised market across CEPT for existing equipment. Such harmonisation is of obvious benefit to manufacturers, users and operators, but will also be of benefit in increasing the security and safety of citizens within CEPT countries.

9 Regulations

9.1 Current regulations

Fixed infrastructure radars are in Annex 5 (TTT) of ERC/REC 70-03 [i.3] with a corresponding usage restriction in the EU Decision [i.4].

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / occupied bandwidth	ECC/ERC Deliverable	Notes
e1	76 - 77 GHz	55 dBm peak e.i.r.p.	(see note)	Not specified	ECC Report 262 [i.2]	50 dBm average power or 23,5 dBm average power for pulse radar only. For ground based vehicle and infrastructure systems only. The frequency band is also included in Annex 4 of ERC/REC 70-03 [i.3].
NOTE: Fixed transportation infrastructure radars have to be of a scanning nature in order to limit the illumination time and ensure a minimum silent time to achieve coexistence with automotive radar systems.						

The 76 - 77 GHz band is included in another entry in ERC/REC 70-03 [i.3] Annex 5 for use on rotorcraft and also in Annex 4 for railway use.

9.2 Proposed regulation and justification

9.2.1 Additional applications

The applications described in clause 5.2 (Fixed Security and Safety Applications) raise an interesting question when FSSA is installed in locations such as airports and harbours. Is the application already harmonised as Transport and Traffic Telematics?

If a radar illuminates a vehicle or a small boat, does the answer depend on whether the occupants are passengers or terrorists - i.e. whether the issue is transport or security? If they are terrorists, does it depend on whether they intend to disrupt transport or to create another type of mayhem?

One of the intentions of the present document is to remove the need for such sophistry. It is requested that the usage restriction on infrastructure radars, which is currently TTT only, be relaxed to include security and safety radiodetermination.

Specifically for ERC/REC 70-03 [i.3], where Annex 4 is for fixed railway applications, Annex 5 is for TTT and Annex 6 for Radiodetermination, the requested change might be achieved by a Note in Annex 5, but better would be a new entry in Annex 6.

The current scope of Annex 6 is:

> *"This annex covers frequency bands and regulatory as well as informative parameters recommended for SRD radiodetermination applications including Equipment for Detecting Movement and Alert. Radiodetermination is defined as the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves. Radiodetermination equipment typically conducts measurements to obtain such characteristics."*

This scope perfectly describes the operation of FSSA. The proposal therefore is to create a new entry in ERC/REC 70-03 [i.3] Annex 6 for 76 - 77 GHz radar equipment, with the same technical parameters as in Annex 5.

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / occupied bandwidth	ECC/ERC Deliverable	Notes
x	76 - 77 GHz	55 dBm peak e.i.r.p.	(see note)	Not specified		50 dBm average power or 23,5 dBm average power for pulse radar only. For fixed radar installations. The frequency band is also included in Annexes 4 and 5.
NOTE: To ensure coexistence with Annexes 4 and 5 applications in this band, for fixed radars one of the following mitigations is required: - Not sited at the roadside. - Having a scanning antenna nature or a Low-Duty Cycle (LDC) to ensure similar silent times.						

A possible definition of "roadside" is discussed below in clause 9.2.3.

9.2.2 Scanning antenna restriction

The reasons for mandating scanning antennas are discussed above in clause 5.2.5.

It is noted that this provision arose purely for the purposes of mitigation towards vehicular radar.

The proposal therefore is that the requirement for antennas of a scanning nature is applied only to roadside installations. One option is to alter Note 1 in ERC/REC 70-03 [i.3] Annex 5.

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / occupied bandwidth	ECC/ERC Deliverable	Notes
e1	76 - 77 GHz	55 dBm peak e.i.r.p.	(see note)	Not specified	ECC Report 262 [i.2]	50 dBm average power or 23,5 dBm average power for pulse radar only. For ground based vehicle and infrastructure systems only. The frequency band is also included in Annexes 4 and 6.
NOTE: Roadside fixed infrastructure radars have to be of a scanning nature or transmit with a low duty cycle in order to limit the illumination time and ensure a minimum silent time to achieve coexistence with vehicular radar systems. This requirement does not apply to non-roadside installations.						

Alternatively, if the proposal in clause 9.2.1 for an entry in ERC/REC 70-03 [i.3] Annex 6 is adopted, this change may not be necessary as the radars described above could operate under that provision.

Note it is also proposed to remove the word "transportation".

9.2.3 Roadside meaning

Inevitably, the above proposals lead to the question of what counts as roadside and non-roadside.

The following ideas are offered for consideration.

Road

A paved way accessible to the public on which motorised traffic routinely exceeds 100 vehicles per hour and which is not subject to a speed limit of 20 km/h or lower.

It is noted that the level of traffic may not be known to the installer/operator, but it is still felt that it is a useful distinction between an active road and one that is hardly used.

Roadside

Sited within 10 m of a road and with all or part of the 3 dB beamwidth of the antenna intersecting the road within 500 m.

Alternatively, a field strength limit could be applied at the road edge, similar to that in ETSI EN 301 091-3 [i.7] for road/rail crossings.

Annex A: Fixed Radar Installations at 76 - 77 GHz

A.1 Existing Installation Examples

A.1.1 Bristol Airport, United Kingdom

Figure A.1: Bristol airport (source: Navtech Radar)

Bristol is the UK's 7th largest airport and uses a security radar to monitor a Critical Point Boundary to detect any movement from an open area used as an overflow carpark into the main airport grounds.

A.1.2 Ostrava Airport, Czechia

Figure A.2: Ostrava airport (source: Navtech Radar)

Ostrava Airport in Czechia has four radars deployed for wide area security sensing to detect vehicles, humans and animals and provide alarms when pre-determined rules are breached. Ostrava airport is Czechia's 3rd largest airport with over 300 000 passengers per year.

A.1.3 Bologna Airport, Italy

Figure A.3: Bologna airport (source: Navtech Radar)

Figure A.4: Bologna airport (source: Navtech Radar)

Bologna Airport in Italy has a number of radars deployed for wide area security sensing to detect any intrusion and track the intruder once inside the airport grounds. Bologna airport is Italy's 7th largest airport with over 8,5 million passengers per year.

A.1.4 Jersey Airport

Figure A.5: Jersey airport (source: Navtech Radar)

The busy Critical Part (CP) at Jersey Airport sits within an unrestricted area of the airport grounds. Unable to protect it with a physical barrier, the airport is using radar with its virtual alarm zones to secure the area.

A.1.5 Other Notable Airport Installation Examples

- Shannon Airport, Ireland

  Shannon airport is the third busiest airport in Ireland and has a number of HDR200 & HDR300 radars deployed for a PID system.

- Istanbul Grand Airport, Türkiye

  Istanbul Grand Airport has approximately 10 of HDR200 & 300 radars for a PID system.

- San Francisco Airport, USA

  San Francisco Airport has a number of HDR300 radars for a PID system.

- East Midlands Airport, United Kingdom

  East Midlands Airport near Nottingham has radar systems installed for aircraft Surface Movement monitoring.

A.1.6 Minas Gerais

A.1.6.1 Stockpile Monitoring

A Ground Based Vehicle installation in a mining environment in Brazil. The radar is integrated into the customer stacker reclaimer vehicle to profile the stockpile close to the bucket wheel to improve efficiency.

Figure A.6: Stockpile monitoring (source: Navtech Radar)

A.2 Maritime & Shoreside Examples

A.2.1 Khalifa Port, Abu Dhabi

Khalifa Port is a state-of-the-art, world-leading, deepwater cargo handling facility, and as such has built a solid reputation. To maintain this status, it was recognized that tighter security measures surrounding Khalifa Port, both on land and sea needed to be implemented.

Due to its complex geographical location, Khalifa Port required a security solution that would provide perimeter detection both over water and on land. This solution needed to accurately and quickly detect approaching vessels, boats, vehicles, and intruders, and to operate effectively 24/7 and in all weather and light conditions, providing 360° perimeter protection. It quickly became evident that Khalifa Port were not only looking for a suitable technology that could effectively operate across both land and sea, but they also required a solution that they could have complete confidence in.

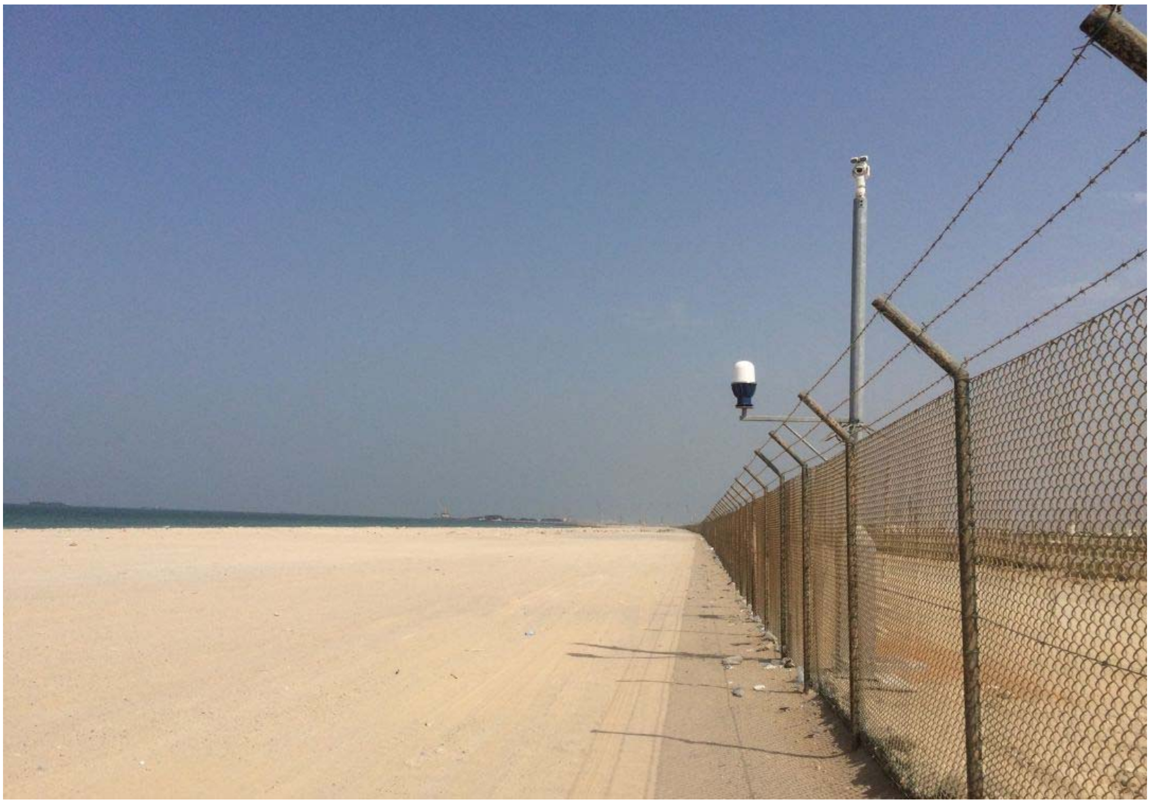

Figure A.7: Khalifa port (source: Navtech Radar)

Figure A.8: Khalifa port (source: Navtech Radar)

A.2.2 Collision Avoidance

Radars used to detect ship infrastructure in order to avoid collisions between loading boom and ship.

Figure A.9: Crane protection (source: Navtech Radar)

A.2.3 Small Target Detection for Inland Marine

The radar detects much smaller objects than traditional X-band radar, such as buoys and kayaks, supporting navigation in congested waterways.

Figure A.10: Inland marine (source: Navtech Radar)

A.2.4 Quayside collision prevention

Vessels manoeuvring too fast and/or on the wrong heading repeatedly cause damage to port infrastructure, piers, sluices, floodgates, fairway limitation/buoy and other ships.

Figure A.11: Vessel and infrastructure (source: Robert Bosch GmbH)

To prevent this, a radar on the infrastructure side could be foreseen as part of an assistance / protection system. Such system integrates highly robust maritime radar sensors that are installed at various points on the maritime infrastructure and is in direct contact with the crew on the ships via various end devices (signal lamps, displays, etc.). The information on local conditions helps the crew to navigate the ship safely even during adverse weather conditions affecting the ship captain's sight (fog, heavy rain, snow, nighttime, etc.) or affecting the ship's manoeuvrability (heavy winds / gusts).

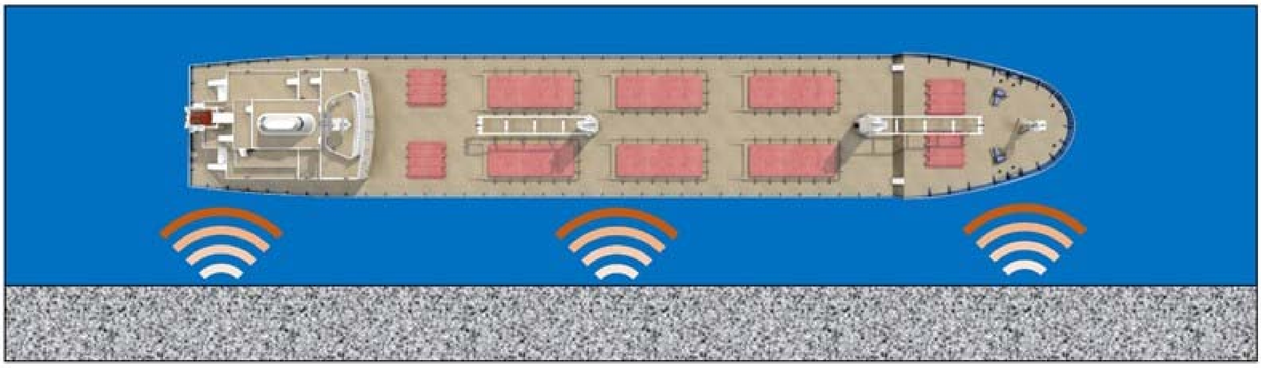

Figure A.12: Vessel and infrastructure (source: Robert Bosch GmbH)

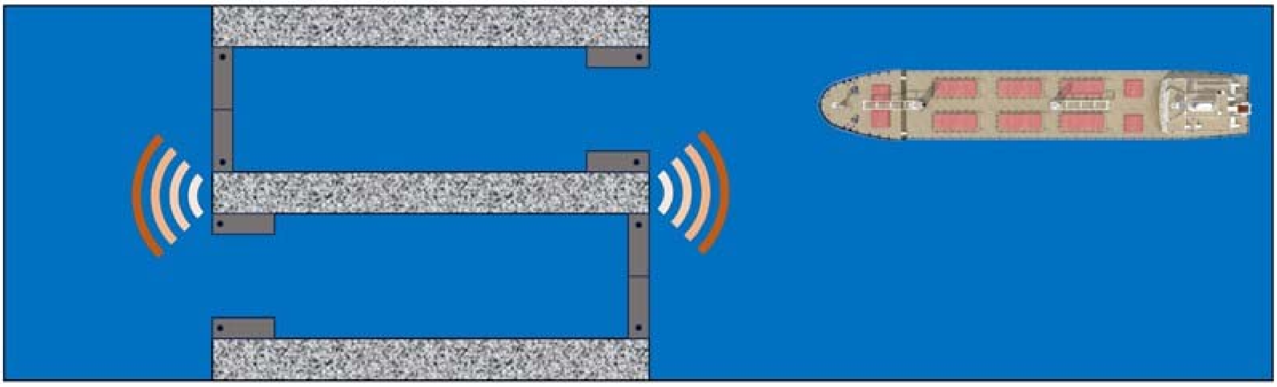

Figure A.13: Vessel and infrastructure (source: Robert Bosch GmbH)

Such a system could be seen as part of TTT infrastructure but the antenna would be fixed not scanning.

A.2.5 Dynamic positioning

High definition radar is especially useful in poor weather or GNSS denied areas/times.

Figure A.14: Marine positioning (source: Navtech Radar)

The radar provides situational awareness, for small object detection and high-resolution imaging of harbour infrastructure for vessels navigating inland waterways, near-shore environments and ports. E.g. autonomous navigation, berthing, tracking and collision avoidance.

Another application is targetless dynamic positioning: to accurately hold position of a vessel when operating around infrastructure in ports and offshore e.g. windfarms, oil rigs, docking of autonomous vessels. "Targetless" means the system is self-contained and does not rely on co-operative devices on the infrastructure.

Many ETSI members believe such an application falls under TTT. Some members, however, have encountered arguments that is it predominantly safety and thus not necessarily TTT.

Annex B:
Change history

Date	Version	Information about changes
3/2/24	V1.1.1_0.0.1	First draft
12/2/24	V1.1.1_0.0.2	For rapporteur meeting 15/2/24
11/3/24	V1.1.1_0.0.3	For TGUWB#67
5/5/24	V1.1.1_0.0.4	For rapporteur meeting 6/5/24
3/6/24	V1.1.1_0.0.5	For TGUWB#68
14/6/24	V1.1.1_0.0.6	Following TGUWB#68
25/8/24	V1.1.1_0.0.7	For rapporteur meeting 27/8/24
31/10/24	V1.1.1_0.0.8	Following TGUWB/TGSRR meeting on GBV 28/11/24
10/11/24	V1.1.1_0.0.9	Following rapporteur meeting 4/11/24
11/11/24	V1.1.1_0.0.10	
18/11/24	V1.1.1_0.0.11	
4/12/24	V1.1.1_0.0.12	Output of TGUWB#70
17/1/25	V1.1.1_0.0.13	Output of TGUWB#70bisD2
29/1/25	V1.1.1_0.0.14	Output of TGUWB#70bisD3
17/2/25	V1.1.1_1.0.0	TG UWB#71 Clean and accepted version
26/03/25	V1.1.1_1.0.1	Editorial corrections after internal quality check

History

Document history		
V1.1.1	June 2025	Publication