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TECHNICAL REPORT

System Reference document (SRdoc);
Low Frequency MicroWave Security Scanners (MWSSc)
within the frequency range from 3,6 GHz to 12,4 GHz

Reference
DTR/ERM-593

Keywords
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ETSI

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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

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Introduction

The present document includes necessary information to support the co-operation under the MoU between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

The present document covers the request for harmonised spectrum for security scanner and imaging applications using UWB technology within the frequency range of 3,6 GHz to 12,4 GHz. Communications applications or hybrid applications as a combination of sensor and communications applications are not treated within the scope of the present document.

The intention of the production of the present document is to create a basis for the industry to facilitate the market launch of new innovative and useful security scanners while avoiding any harmful interference with other radio services and equipment.

The present document has been created by TC ERM TGUWB.

1 Scope

The present document provides information on the intended applications, the technical parameters, the relation to the existing spectrum regulation and additional new radio spectrum requirements for MicroWave Security Scanners (MWSScs) operating in the band from 3,6 GHz to 12,4 GHz. MWSScs are surveillance imaging radars expected to comply with limits in the order of those in ECC/DEC(06)/08.

The present document also describes the difference to scanners from the SRdoc ETSI TR 103 664 [i.8] and those applications and use cases. They are similar to those described in SRdoc ETSI TR 103 664 [i.8] (security scanner 60 GHz to 90 GHz) but operate at a much lower frequency range with low power and have a dedicated application in security screening; e.g. to detect objects concealed in or underneath a person's clothing and to display the location of the objects on a human avatar.

The presented application is not intended for communication usage.

The present document includes in particular:

- market information;
- technical information;
- regulatory issues.

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 are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 066-1 (V1.2.1) (2008-02): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground- and Wall- Probing Radar applications (GPR/WPR) imaging systems; Part 1: Technical characteristics and test methods".

[i.2] CEPT ECC/DEC/(06)08 of 01 December 2006, updated on 26 October 2018: "The conditions for use of radio spectrum by Ground- and Wall- Probing Radar (GPR/WPR) imaging system".

[i.3] ECC Report 120 (March 2008): "ECC Report on Technical requirements for UWB DAA (Detect and avoid) devices to ensure the protection of radiolocation in the bands 3.1 - 3.4 GHz and 8.5 - 9 GHz and BWA terminals in the band 3.4 - 4.2 GHz".

[i.4] ECC Report 64: "The protection requirements of radio communications systems below 10,6 GHz from generic UWB applications", Helsinki, February 2005.

[i.5] ECC Report 251: "The impact of UWB applications on board aircraft in the band 6-8.5 GHz on FS links used around airports and on EESS earth stations", 2016.

[i.6] ECC Report 175: "Co-existence study considering UWB applications inside aircraft and existing radio services in 3.1 -4.8 GHz/6.0 - 8.5 GHz", 2012.

[i.7] FCC 47 CFR § 15.511: "Technical requirements for surveillance systems".

[i.8] 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.9] Recommendation ITU-R SM.1755-0 (2006): "Characteristics of ultra-wideband technology".

[i.10] ETSI EN 303 883 (V1.1.1) (07-2016): "Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".

[i.11] "Electronic Microwave Imaging with Planar Multistatic Arrays", PhD Thesis, Sherif Ahmed, 2013.

[i.12] ECC/DEC/(07)01: "ECC Decision of 30 March 2007 on the harmonised use, exemption from individual licensing and free circulation of Material Sensing Devices using Ultra-Wideband (UWB) technology, amended on 26 June 2009, corrected on 18 November 2016 and amended on 8 March 2019".

[i.13] ECC Report 170: "Specific UWB applications in the bands 3.4 - 4.8 GHz and 6 - 8.5 GHz LAES, LT2 and LTA", 2011.

[i.14] ECC Report 234: "Analyses of LDC UWB mitigation techniques with respect to incumbent radiocommunication services within the band 3.1 to 3.4 GHz", 2015.

[i.15] CEPT Report 45: "Report from CEPT to the European Commission in response to the Fifth Mandate to CEPT on ultra-wideband technology to clarify the technical parameters in view of a potential update of Commission Decision 2007/131/EC".

[i.16] ECC Report 94: "Technical requirements for UWB LDC devices to ensure the protection of FWA Systems".

[i.17] ECC Report 123: "The impact of Object Discrimination and Characterization (ODC) applications Using UltraWideband (UWB) technology on radio services".

[i.18] ITU-R Report SM.2057: "Studies on the impact of devices using UWB technology on radiocommunication services".

[i.19] CEPT Report 34: "Report B from CEPT to European Commission in response to the Mandate 4 on Ultra-Wideband (UWB)". Final Report on 30 October 2009 by the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT).

[i.20] ETSI EN 303 883-1 (V1.2.1): "Short Range Devices (SRD) and Ultra Wide Band (UWB); Part 1: Measurement techniques for transmitter requirements".

[i.21] ETSI EN 302 065-1 (V2.1.1) (11-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Requirements for Generic UWB applications".

[i.22] ETSI EN 302 065-2 (V2.1.1) (11-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: Requirements for UWB location tracking".

[i.23] ETSI EN 302 065-3 (V2.1.1) (11-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 3: Requirements for UWB devices for ground based vehicular applications".

[i.24] ETSI EN 302 065-4 (V1.1.1) (11-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 4: Material Sensing devices using UWB technology below 10,6 GHz".

[i.25] ETSI EN 302 372: "Short Range Devices (SRD); Tank Level Probing Radar (TLPR) equipment operating in the frequency ranges 4,5 GHz to 7 GHz, 8,5 GHz to 10,6 GHz, 24,05 GHz to 27 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 303 883 [i.10] and the following apply:

Automatic Threat Recognition (ATR): algorithm detecting suspicious objects on the scanned person

calibration: timing correction for transmitter and receiver channels

image reconstruction: algorithm to reconstruct microwave images out of reflected waves by the scanned person

operator interface: interface where the results of the ATR are displayed to the operator(s)

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI EN 303 883 [i.10] and the following apply:

$\delta_{x,y}$	Image resolution in cross-range
δ_z	Image resolution in range
L	physical antenna array
Z	the target distance from the antenna array

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 303 883 [i.10] and the following apply:

ATR	Automatic Threat Recognition
BWA	Broadband Wireless Access
CFR	Code of Federal Regulations
DAA	Detect And Avoid
EC	European Communities
EESS	Earth Exploration Satellite Service
EIRP	Equivalent Isotropic Radiated Power
FCC	Federal Communications Commission
FS	Fixed Service
FWA	Fixed Wireless Access
GPR/WPR	Ground probing and Wall Probing Radar
GPS	Global Positioning System
ITU-R	International Telecommunication Union, Radiocommunication Sector
LAES	Location tracking Applications for Emergency Services
LBT	Listen Before Talk
LDC	Low Duty Cycle
LTA	Location Tracking and sensor Applications for automotive and transportation environments
MIMO	Multiple Input Multiple Output
MWSSc	MicroWave Security Scanner
ODC	Object Discrimination and Characterization
OJEU	Official Journal of the European Union
PAX	Person to be checked by the SSc/MWSSc
QPS	Quick Personal Security Scanner
RF	Radio Frequency
RNSS	RadioNavigation Sattelite Service
SRD	Short Range Devices
SSc	Security Scanner
TC	Technical Committee
TGUWB	Task Group Ultra Wideband
TLPR	Tank Level Probing Radar
UWB	Ultra Wide Band

4 Comments on the System Reference Document

4.1 Statements by ETSI Members

No statements or comments have been issued by ETSI members.

5 Presentation of the system and technology

5.1 Introduction

A Security Scanner (SSc) is a device that detects objects on a person's body without the need of physical contact.

SScs have seen use in security screening at airports for several years now. Their success is based on the non-ionizing nature of microwaves as well as their strong interaction with potentially dangerous materials. Combined with microwave imaging techniques, SScs have proven their fitness to provide security for both known and previously unknown threats.

Besides the established airport security application, SScs have seen an increased demand also in non-aviation markets such as loss prevention or securing soft targets (i.e. public events). These new applications are related to the existing ones but differ in some critical aspects. As a consequence, new technical approached are required. MWSScs provide the performance to address those requirements.

In contrast to the SScs described in SRdoc ETSI TR 103 664 [i.8], MWSScs work at a much lower frequency. This allows them to perform better in rough environments. At the same time MWSScs are also required to detect and locate objects on the human body. In order to differentiate between benign and dangerous/target objects a focussed microwave image in range and cross-range is required. High absolute and fractional bandwidths combined with large antenna arrays are the consequences.

Another advantage is the "walk through" feature. During operation, people can walk through the scanner in a normal manner without standing still or taking any special pose. This speeds up the scanning process and throughput of PAX/hour.

Differences between MWSScs and SScs are described in detail in clause 5.3.

Figure 1: R&S®QPS Walk2000 System (left) and exemplary measurement result with suspected threats marked in orange (right)

5.2 Basic operation principle of a MWSSc

MWSScs use a large number of transmitters and receivers to create an as large as possible physical antenna aperture. More than 100 of each transmitters and receivers might be employed to meet a specific applications requirement. This is because cross-range and range resolution of these types of systems depend significantly on the size of the aperture.

The workflow of an MWSScs can be summarized as follows:

1) Activate transmitters and receivers in a controlled and synchronized manner.
2) Collect the reflected signals for each transmitter with each receiver.
3) Apply a calibration to the reflected signals.
4) Reconstruct the microwave image.
5) Search for threats on the microwave image via an ATR.
6) Display the ATR's result to an operator.
7) Depending on the result, let PAX pass the check point or take appropriate measures to resolve suspected threats.

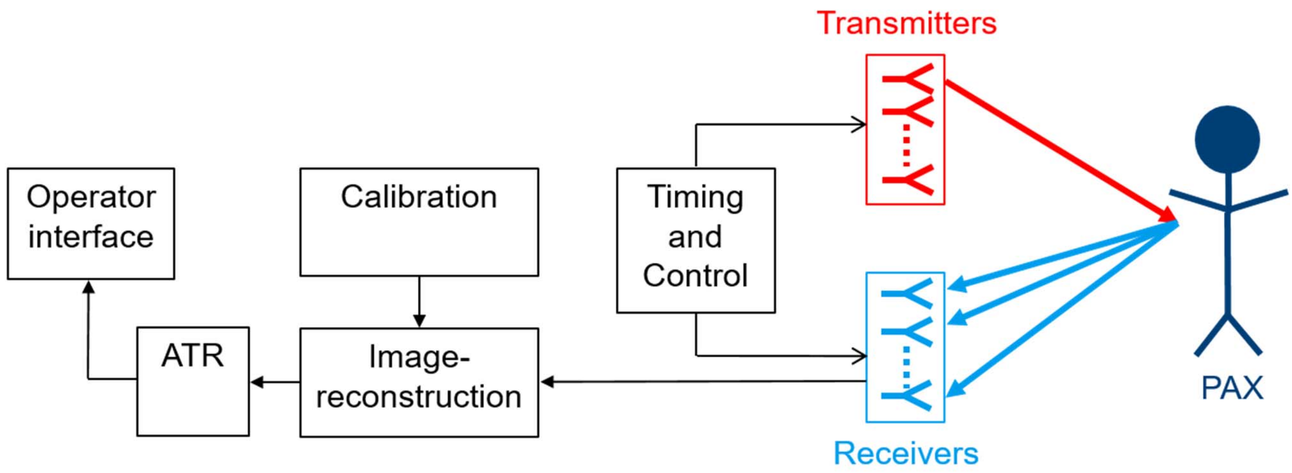

Figure 2: Basic block diagram of an MWSSc

5.3 Comparison between MWSScs and SScs from ETSI TR 103 664

MWSScs and SScs are very similar in their operational principal as well as their fields of use and consequently many general descriptions from ETSI TR 103 664 [i.8] also apply to the devices presented here. See ETSI TR 103 664 [i.8] in particular clauses 5.2 and 5.3.

Still some differences exist which allow each device to excel in different settings of applications. The most important ones are the following:

SScs:

- Very high image resolution and highest detection accuracy
- Single pose scan, PAX needs to stand still for a few seconds
- Achieves highest security standards in controlled environments (i.e. airport security checks)

MWSScs:

- High image resolution and high detection accuracy
- Real-time operation possible and very high throughput (PAX/h)
- Maintains high levels of security even under rough conditions, i.e. heavy clothes, wet clothes, etc.

While SScs are mainly used at security checkpoints to screen persons, MWSScs can also be used at for example stadiums where high throughput and security is of importance. There is no need to stop the persons to be checked during screening while using MWSScs. In addition, those persons also do not need to hold or keep a special pose, empty their pockets or prepare for inspection stop. That reduces time for security screening a lot while keeping a high level of security.

This is a huge benefit in addition to the SScs that are already available.

6 Market information

MWSScs enhance security in areas where potential threat by persons can occur. These are areas where a certain protection level is required and many people appear. Therefore a walk-through feature is required to maintain a high level of throughput.
The potential market is diverse, with a large variety of potential sites, such as:

1) Airports
2) Public events
3) Loss prevention for factories, data centres, authorities, etc.
4) Military facilities
5) Prisons
6) Government offices and courts
7) Public transportation
8) Shopping malls
9) Education facilities

For selected application, the tasks are described in more detail in the following list:

- Airports:
  - Prevent entrance of dangerous items to the terminal areas where persons are screened even before they enter security areas where they are screened by high resolution SScs.
  - Major well-known incidents in the past (9/11, Attack on Brussels Airport 03/2016).
  - SScs are already widely deployed in security checks before boarding the plane.
- Public events:
  - Prevent dangerous items from entering stadiums/concert halls/etc.
  - Large crowds of people at public events have been targets for attacks in the past.
  - Besides security needs also commercial needs of the organizer can be addressed by SScs. SScs can prevent people from bringing beverages and food into the event.

- Public transportation:
  - Prevent prohibited items to be carried into public transportation hubs.
  - Public transportation has seen many attacks in the past.
- Shopping malls:
  - Prevent dangerous items to be carried into shopping malls.
  - Currently many countries see the need to employ security measures on shopping mall entrances.
- Loss prevention for factories, data centres, authorities, etc.:
  - Prevent items from being smuggled in and out of facilities.
  - Examples - Prevent smuggling of:
    - Data storage devices in and out of data centres.
    - Data storage devices out of research and development facilities.
    - Unreleased items out of factories.
    - Valuable goods out of factories.
    - Confidential information/items out of authority buildings.

7 Technical information

7.1 Example specifications of the MWSSc

7.1.1 Summary specifications of the MWSSc

As an example the RF specifications of an MWSSc from Rohde & Schwarz are given.

Table 1: RF specifications of R&S®QPS Walk2000

Number of transmitting antennas per panel	224
Number of transmitting antennas per panel - H polarization	112
Number of transmitting antennas per panel - V polarization	112
Number of receiving antennas per panel	448
Number of receiving antennas per panel - H polarization	224
Number of receiving antennas per panel - V polarization	224
Number of antenna tiles per SSc	28
Number of transmitting antennas per tile	8
Number of receiving antennas per tile	16
Physical aperture size	~6,4 m²
Beam width of an antenna (horizontal and vertical)	~40°
Pulse width	~130 ps
Pulse centre frequency	7,7 GHz
Pulse repetition frequency	12 MHz
Polarization	0° (H polarization) and 90° (V polarization)

7.1.2 Emissions of the MWSSc

7.1.2.1 Transmitter (wanted) emissions within the operating frequency band

Measurements according to the draft standard ETSI EN 303 883-1 (V1.2.1) [i.20].

The maximum mean e.i.r.p. spectral density (over 1 ms) is below -41,3 dBm/MHz for up to 10,6 GHz and below -55 dBm/MHz for frequencies above 10,6 GHz.

The peak e.i.r.p spectral density is below -5 dBm/50 MHz up to 10,6 GHz and below -15 dBm/50 MHz up to 12,4 GHz.

7.1.2.2 Transmitter (unwanted) emissions

The transmitter-unwanted emissions are emissions from the MWSSc originating from the transmitter but outside the operating frequency range. It is the average power per unit bandwidth (centred on that frequency) radiated in the direction of main radiation (main lobe of the antenna).

7.1.2.3 Other emissions

MWSScs emit very low power radio signals, comparable with the power of spurious emissions from digital and analogue circuitry. If it can be clearly demonstrated that an emission from the SSc is not a transmitter emission (e.g. by disabling the SSc's transmitter) or it can clearly be demonstrated that it is impossible to differentiate between other emissions and the transmitter (unwanted) emissions, that emission or aggregated emissions should be considered against the other emission limits.

7.1.2.4 Receiver spurious emissions

The device cannot operate in receiver only mode and thus receiver spurious emissions are not relevant (collocated receiver and transmitter).

7.1.2.5 Technical wanted performance criteria

MWSScs should be able to detect an object and perform the threat assessment. UWB devices for surveillance applications are, among other things, intended to detect a person entering which requires continuous operation. To address the technical wanted performance criteria a test will be specified.

7.2 Status of technical parameters

7.2.1 Current ITU and European Common Allocations

7.2.2 Sharing and compatibility studies already available

In the scope of the UWB regulatory process a set of coexistence studies have been generated and published for the frequency range below 10,6 GHz as ECC and CEPT reports:

- ECC Report 120 [i.3].
- ECC Report 64 [i.4].
- ECC Report 251 [i.5].
- ECC Report 175 [i.6].
- ITU-R Report SM.2057 [i.18].
- CEPT Report 34 [i.19].
- ECC Report 170 [i.13].

- ECC Report 234 [i.14].
- CEPT Report 45 [i.15].
- ECC Report 94 [i.16].
- ECC Report 123 [i.17].

7.2.3 Sharing and compatibility studies still to be considered

Many conclusions could be drawn from the many available studies in the bands 3,1 GHz to 4,8 GHz and 6 GHz to 9 GHz. New studies may be needed to assess the impact of the SSCs on radio services outside these bands. A discussion of the coexistence situation is further discussed in clause 8.

7.3 Information on relevant standards

Table 2: Information on relevant standards

Type	Application	Frequency Ranges [GHz]	ETSI Standard	Status	Remark	Responsible ETSI TC ERM
SRD	GPR/WPR	30 MHz to 12,4 GHz	ETSI EN 302 066-1 [i.1]			TGUWB
Generic	Generic	3,1 GHz to 10,6 GHz	ETSI EN 302 065 [i.21] to [i.24]			TGUWB
SRD	Tank Level Probing radar (TLPR)	4,5 GHz to 7 GHz, 8,5 GHz to 10,6 GHz, 24,05 GHz to 27 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz	ETSI EN 302 372 [i.25]	Cited in the OJEU	RED compliant	TGUWB

8 Radio spectrum request and justification

8.1 Proposal

The future use cases of SSCs considered in the scope of the present document can be rated as fixed radio determination applications.

The proposed limits, bandwidth and frequency range for fixed installed indoor and outdoor usage are given in table 3.

Table 3: Proposed radio spectrum

Frequency	Maximum mean e.i.r.p spectral density averaged over 1 ms (note 1)	Peak e.i.r.p spectral density (note 2)	Comment
3,6 GHz to 10,6 GHz	-41,3 dBm/MHz	0 dBm/50 MHz	
10,6 GHz to 12,4 GHz	-51,3 dBm/MHz	-10 dBm/50 MHz	
NOTE 1: Measured according to ETSI EN 303 883-1 (V1.2.1) [i.20], clause 5.3.2.3. NOTE 2: Measured according to ETSI EN 303 883-1 (V1.2.1) [i.20], clause 5.3.4.2.			

The number of these professionally operated and serviced Security Scanners is limited. Therefore the total radiation and probability of interference with other radio users is assumed to be very low.

Security scanners will typically be used indoor. Coexistence with existing radio users with these indoor SSCs should be possible with the limits in table 3 without any additional mitigations, since most of the radiocommunication services are used outdoor and the interference probability is assumed to be very low.

However, SSC applications should also be allowed to be used at entrances, where there might be a grey zone between indoor and outdoor or in pure outdoor locations. For such outdoor use addition mitigations could be applied. Some possible examples are given below:

- For outdoor SSC use optionally the passive band 10,68 GHz to 10,7 GHz could also be protected by limiting the radiation in the direction > 40° elevation above the horizontal plane by 20 dB.
- Protection areas could be drawn around critical radio systems, for example 3 km to 5 km circularly around a radio astronomy station. One option here would be to operate the outdoor SSC with an integrated GPS receiver that help to detect the position and operate the device only if this is not in a protection area.
- A (light) licensing regime or a registration procedure could be introduced for outdoor SSCs.
- Outdoor SSC could use mitigation techniques like Listen Before Talk (LBT) or Detect and Avoid (DAA) to automatically avoid interference to radio users.
- Antenna height of outdoor SSCs could be restricted (e.g. only up to 4 m above ground).

8.2 Reason for extended frequency range for MWSScs

MWSScs make use of high resolution and high dynamic range microwave images in order to identify threats on the human body. The upper frequency f_H is of key importance for all aspects of the microwave image and thus influences the MWSSc's performance significantly. The influence of the upper frequency should be discussed for the most important image properties in the following clauses.

The key properties to be discussed are:

- Image resolution in cross-range ($\delta_{x,y}$)
- Image resolution in range (δ_z)
- Image dynamic range

Cross-range resolution

MWSScs inherently operate in near-field conditions. This fact makes it so that common approximation of a radar's cross-range resolution is not directly applicable. An approximation for the cross-range resolution of planar MIMO radars operating in the near-field can be found in [i.11], formula (1):

$$\delta_{x,y} \approx \frac{c}{2Lf_c}\sqrt{\left(\frac{L}{2}\right)^2 + Z^2} \qquad (1)$$

$$with \quad f_c = \frac{f_H + f_L}{2} \qquad (2)$$

Besides the size of the physical antenna array L and the target distance from the antenna array Z, the cross-range resolution depends strongly on the center frequency f_c. The higher the center frequency the higher the cross-range resolution. Increasing both the upper and the lower frequency of the UWB signal is desirable.

A maximum improvement in cross-range resolution from 7 mm down to 6 mm can be achieved by increasing the upper frequency from 10,6 GHz to 12,4 GHz. This is especially important for the detection of granular objects as found in certain type of explosives or drugs. Even besides specific threats, improved resolution of often roughly shaped objects in contrast to the smooth human body gives a general improvement in reliability and consequently acceptance of MWSScs by authorities and the public.

Range resolution

The range resolution for MIMO radars, formula (3), operating in near-field is given approximately by [i.11]:

$$\delta_z \approx \frac{\frac{c}{2}}{f_H - f_L \frac{1}{\sqrt{1+\frac{1}{2}\left(\frac{L}{Z}\right)^2}}} \qquad (3)$$

Similar to the cross-range resolution, the range resolution also depends on the size of the physical antenna array L and the target distance from the antenna array Z. Regarding the frequencies of the UWB signal, it is desirable to increase f_H as much as possible while retaining a high bandwidth by keeping f_L as low as possible.

A maximum improvement in range resolution from 21,4 mm down to 17,0 mm can be achieved by increasing the upper frequency from 10,6 GHz to 12,4 GHz. A lower range resolution improves an MWSSc's ability to find objects close to body as well as dielectric threats like explosives.

Dynamic range

The dynamic range of the microwave image is given by the amount of transmitter and receivers used in the MWSSc and their distribution within the physical antenna array. Since the minimum antenna spacing that is necessary to prevent aliasing effects is inversely proportional to f_H, a system with a higher f_H will have a higher amount of transmitters and receivers. Consequently, more channels contribute to the image reconstruction of a particular target and increase its intensity with respect to the noise level.

A 37 % increase in image dynamic range can be achieved by increasing the upper frequency from 10,6 GHz to 12,4 GHz. A higher dynamic range improves the MWSScs ability to detect non-metallic objects with low permittivity. This is relevant to a wide range of threats, in particular to certain types of explosives and weapons.

9 Regulations

9.1 Current regulations

9.1.1 CEPT/ETSI

The existing regulation framework for UWB in Europe already covers a broad range of possible application areas.

Originally, it was planned to have only a generic regulation for all UWB applications. Due to the multitude of different applications and related mitigation factors this approach was only partly efficient. In recent years several specific application related regulations have emerged to cover these specifics.

ITU references "Surveillance" as a core application of UWB in Recommendation ITU-R SM.1755-0 [i.9]. The provided key features of said application by ITU fit well to MWSScs. Currently there is no dedicated adoption of this in a regulation or a harmonized standard by CEPT and ETSI respectively.

From a purely technical viewpoint the closest available regulation is Commission Decision ECC/DEC/(06)08 [i.2] for GPR/WPR.

ETSI EN 302 066-1 (V1.2.1) [i.1]:

- Maximum mean e.i.r.p (Annex F - Calculation of the Mean Power Density)

Table 4: Maximum mean e.i.r.p. of any emission emanating from GPR/WPR imaging systems according to [i.1] and [i.2]

Frequency range (MHz)	Maximum mean e.i.r.p. density (dBm/MHz)
< 230	-65
230 to 1 000	-60
1 000 to 1 600	(see note)
1 600 to 3 400	-51,3
3 400 to 5 000	-41,3
5 000 to 6 000	-51,3
> 6 000	-65
NOTE: *"In addition to the maximum mean e.i.r.p. density given above, a maximum mean e.i.r.p. density of -75 dBm/kHz applies in the RNSS bands 1 164 MHz to 1 215 MHz and 1 559 MHz to 1 610 MHz in case of spectral lines in these bands. Peak power shall be measured according to clause 6.5.6 of" [i.1] "and mean power density shall be determined from formula (F.1) or (F.2)"* from *[i.1].*	

- Peak power limit values for emissions (clause 4.3.4 from ETSI EN 302 066-1 [i.1] - Exterior Limits)

Table 5: Maximum peak power according to [i.1] and [i.2]

Frequency range (MHz)	Maximum peak power
30 to 230	-44,5 dBm/120kHz (e.r.p.)
> 230 to 1 000	-37,5 dBm/120kHz (e.r.p.)
> 1 000 to 18 000	-30 dBm/MHz (e.i.r.p.)

9.1.2 FCC

FCC adoption of ITU's proposed Surveillance application of UWB technology exists in FCC 47 CFR § 15.511 [i.7] "Surveillance Systems". From the point of available regulation, this is currently the best fitting for the needs of MWSScs.

Excerpt from "FCC 47 CFR § 15.511" [i.7]:

"***I*** *The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:*

Frequency in MHz	*EIRP in dBm*
960 to 1610	*-53.3 dBm/MHz*
1610 to 1990	*-51.3 dBm/MHz*
1990 - 10600	*-41.3 dBm/MHz*
Above 10600	*-51.3 dBm/MHz*

(d) *In addition to the radiated emission limits specified in the table in paragraph I of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:*

Frequency in MHz	*EIRP in dBm*
1164 - 1240	*-63.3*
1559 - 1610	*-63.3*

I *There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, fM. That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in § 15.521."*

9.2 Proposed regulations

ECC/DEC(07)01 [i.12] should be amended by a new Annex for security scanners with following content:

- Only quasi fixed installations
- Stationary use
- Limits from Table 5

Table 6: Maximum peak power according

Frequency	Maximum mean e.i.r.p. spectral density averaged over 1 ms, (note 1)	Peak e.i.r.p. spectral density, (note 2)	Comment
3,6 GHz to 10,6 GHz	-41,3 dBm/MHz	0 dBm/50 MHz	
10,6 GHz to 12,4 GHz	-51,3 dBm/MHz	-10 dBm/50 MHz	
NOTE 1: Measured according to ETSI EN 303 883-1 (V1.2.1) [i.20], clause 5.3.2.3 "Mean e.i.r.p Spectral Density, averaged over 1 ms". NOTE 2: Measured according to ETSI EN 303 883-1 (V1.2.1) [i.20], clause 5.3.4.2 "Peak e.i.r.p Spectral Density, General Method".			

The need to implement further mitigations should be further studied. Examples of mitigations are provided in clause 8.

Annex A: Bibliography

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- CEPT ECC Report 139: "Impact of Level Probing Radars Using Ultra-Wideband Technology on Radio communications Services", Rottach-Egern, February 2010.
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- ICNIRP: "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)", Published in: Health Physics 74 (4): 494-522; 1998.
- ETSI TS 103 361 (V1.1.1) (03-2016): "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Receiver technical requirements, parameters and measurement procedures to fulfil the requirements of the Directive 2014/53/EU".
- CISPR 16-1-1 (2014): "Specification for radio disturbance and immunity measuring apparatus and methods: Radio disturbance and immunity measuring apparatus".
- CISPR 16-1-4 (2014): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements".
- CISPR 16-1-5 (2014): "Specification for radio disturbance and immunity measuring apparatus and methods; Antenna calibration sites and reference test sites for 5 MHz to 18 GHz".
- Commission Decision 2007/131/EC of 21 February 2007 on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community (notified under document number C(2007) 522).

History

Document history		
V1.1.1	January 2021	Publication