

Vulnerabilities in Localization with regard to GNSS and Harmful Radio Interference: International and EU Law Aspects

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ABSTRACT Harmful radio interference contravenes many national, regional and international laws. Global Navigation Satellite System (GNSS) services have global coverage, therefore development of international law is necessary. European Union (EU) also requires harmonized law for its Member States. This article focuses on the current state of international and EU laws to tackle GNSS, radio spectrum and radio equipment usage and probable interference with regard to location services and privacy. From a legal point of view, this article seeks to include mitigation of unlawful interference in radio communication in order to ensure a secured location estimation and positioning system.

INDEX TERMS GNSS, Radio Interference, Localization, Radio Communication, Radio Equipment Directive.

I. INTRODUCTION

The radio spectrum as well as Global Navigation Satellite System (GNSS) technology has many uses [1]. The radio spectrum is not only essential in wireless communication such as Wi-Fi and mobile phones; it is also used in vehicles, broadcasting and many other areas [2]. GNSS position services are widely used in mobile phone networks, public safety services, banking systems, electrical grids, airport landings, ship navigation, and in other vehicles [3][4].

In this respect it is important to make clear the relation between the radio spectrum and GNSS. In fact, GNSS operates on the radio frequency spectrum by transmitting navigation, positioning and timing information. Use of radio frequencies should be minimized since those are classed as “limited natural resources” in Article 44 of the International Telecommunication Union (ITU) Constitution, because radio signals are vulnerable to interference from other nearby radio frequency uses [5]. This article discusses GNSS as one of the prime examples in radio communication, particularly with regard to its connection with the radio spectrum and location services. At the same time, EU law related to use of the radio spectrum and radio devices in general which involves mitigating probable interference and securing location are also discussed separately.

The GNSS Market Report of the European GNSS Agency (GSA) estimates that more than 7 billion GNSS devices will be used globally by 2019, which implies one device per

person on average [6]. Location based services (LBS) and road and transportation systems contribute more than 90 percent of the global revenue from GNSS devices and services [6]. Aside from Europe’s Galileo¹, most of the world’s GNSS services are controlled by military authorities, although GNSS is mostly used for civilian purposes (86%) [5]. This article articulates GNSS implying its attachment with localization, radio spectrum and civilian use.

However, with the advent of the Internet of Things (IoT)² and smart devices, radio equipment is used in everyday life [15]. The Electronic Communications Committee (ECC) harmonizes the use of the radio frequency spectrum throughout Europe and provides relevant regulations allocating radio communication frequencies within European Conference of Postal and Telecommunications Administrations (CEPT) countries and conditions on using radio equipment that spreads the spectrum [16]. In addition to regulation of radio spectrum interferences by national governments, there are international and regional regulation measures due to the spread of radio signals across national borders [17].

A. COORDINATION INTERNATIONALLY AND WITHIN EU

Like the Internet, outer space does not have any boundary, thus GNSS and its services are universal in nature. Same as the Internet governance system, GNSS is governed under a

connected over the internet with distinctive identifiers; objects are embedded with sensors and software and become enabled to communicate and transfer data. [13][14]

¹ Galileo is European GNSS [7]

² The Internet of Things (IoT) implies a system or network where computing devices, home appliances, vehicles and other objects are

soft law³ mechanism. National laws regulating GNSS may be hard law⁴, but international laws for GNSS are soft law. The existence of multiple GNSS services in space necessitates secure interoperability among different GNSS providers in order to avoid probable interference. Accuracy is very important in measuring location navigation, positioning and timing. If all the service providers cooperate with each other, the probability of gaining accuracy becomes higher [5].

The International Committee on GNSS (ICG) is a subcommittee of the United Nations (UN) Committee on Peaceful Uses of Outer Space (COPUOS). These and other related organizations monitor the international coordination of GNSS services. ITU is a body that manages and synchronizes the worldwide use of the radio spectrum [17]. The ITU Radio Regulations form part of UN regulation and regulate GNSS and the radio spectrum [5]. The radio regulations and conventions of ITU are internationally applicable and provide provisions regarding harmful interference occurring to or caused by the radio communication system [20].

International standards for GNSS are arranged largely in support of US law. The US has an active role in the coordination processes of UN, ICG, ITU and other related bodies. The most popular GNSS, GPS, is used all over the world, being capable for use with any GNSS receiver, even though the US Department of Defense operates GPS. GPS provides different positioning services for general users and military use. Like GPS, Russia's GNSS service is GLONASS, which is accessible worldwide [5]. EU, China, Japan and India are also researching and examining their projected GNSS.

Europe's Galileo is a new GNSS service compared to GPS or GLONASS. The European Galileo differs from other GNSS services by offering commercial global positioning services under civilian control; in other words, by Galileo Member States focusing on civilian GNSS, that may impose charges on the users and create contractual liability. The necessity for a European Liability Regulation was proposed by Italy in 2006. The French Parliament further emphasized the matter in 2011. In the "Roadmap on a Regulation on EU GNSS third party liability" the European Commission (EC) addressed the necessity of specific regulation in order to "put in place a uniform liability regime which strikes a balance between the interests of the users and third parties, as possible claimants and of all players in the GNSS chain, as possible defendants" in 2011. The GNSS Regulation (EU) No 1285/2013 [55] is currently in force, but that does not provide provisions on liabilities relating to Galileo signals and services. The EC expressed the importance of "appropriate initiatives" which is still not specific and in existent in Europe and also around

the world. In absence of such legal instrument, parties need to follow contractual arrangements [20]. However, on request of some European countries to the International Institute for the Unification of Private Law (UNIDROIT), drafting of a treaty is under discussion in order to receive complaints and determine third party liabilities concerning defects in Galileo service [5].

Although as well-developed as military signals, both governmental and authorized users are targeted by the Public Regulated Service (PRS) of Galileo [1]. As it is not under military control like GPS and GLONASS, different and EU-focused law is required for Galileo. There are several EU decisions in this regard, such as PRS Decision 1104/2011 [22], Galileo Commercial Service Implementing Decision [23], and so on. But as the number of such decisions is many, the need for specific law is apparent.

The EU and the US authorities have drafted the "US-EC Agreement on the promotion, provision and use of GALILEO and GPS satellite-based navigation systems" [24] in order to coordinate and mitigate interference. In 2004, the EU and the US agreed on bilateral coordination of GNSS range [5].

B. INTERFERENCE BY JAMMERS AND SPOOFERS

Interference in GNSS signals and radio communication system may be natural or intentional. While some atmospheric conditions constitute natural interference, in most of the cases intentional and personal use of jammers and spoofers constitute malicious or man-made interference. There may be accidental or unintentional jamming as well, with interference among close signals [18] [5].

Intentional and harmful interference in GNSS signals, including jamming and spoofing, has added new legal challenges for location and positioning security. It is a paradox that although EU law makes it illegal to sell, purchase and use GNSS jammers, it is still legal to own them [8]. Jammers cause deliberate interference in receiving and transmitting radio signals, the signals which are important for the functioning of radio equipment [9]. Spoofers are considered more harmful, since they produce false GNSS signals to deceive receivers into wrongly estimating location and/or time [10]. In response, various jamming resistance measures have been developed using modern technologies and GNSS satellites. Safety from harmful GNSS jamming and spoofing is important to both GNSS users and providers, for the proper use and smooth running of the service, and also for integration of drones in air traffic. The possibility of such harmful attacks has made GNSS less reliable in many cases [5]. Use of GNSS technologies in measuring accuracy of time in geo-location⁵ and synchronizing different zones with each

³ Soft law refers to "co-operation based on instruments that are not legally binding, or whose binding force is somewhat "weaker" than that of traditional law, such as codes of conduct, guidelines, roadmaps, peer reviews." [19]

⁴ Hard law is binding, provides higher legal obligation and enforceability than soft law [21].

⁵ The physical or geographic location of a remote device, such as, Internet-connected computer or mobile phone, and the process of detection of that location is known as geo-location [11][12].

other carry huge business and financial considerations, requiring a safe and reliable GNSS system [10]. In a crisis, the military or government authorities may use “friendly” jammers to jam civilian signals in order to limit the enemy’s tactical options [1].

Jammers are used to interrupt or block signal transmission in satellite navigation. GNSS systems and mobile phones are most affected by such devices. The mobile phone jammers prevent mobile phones from making calls or receiving and sending messages [9]. On the other hand, by producing incorrect time and positioning information through spoofing attacks, it is even theoretically possible to hijack cargo containers or aircrafts and affect the global economy on protected infrastructures [1]. Such attacks may also create risks for other GNSS related services in which satellite signals, navigation and position related services are used in aviation, naval and transport sectors, and also when LBS are offered by online platforms [10].

In the process of computing Position Velocity and Time (PVT) solutions using the GNSS receivers, within a distance of 20000 km with satellite antennas, the received signals become very vulnerable to interference from different sources. Since jamming and spoofing attacks can significantly affect GNSS signals in broad locations, some counter technologies and techniques have been developed to detect and mitigate the probable harm and interference [18].

Location privacy may be under threat because of the use of some GNSS services, applications and GNSS-enabled devices. As a preventive measure, the use of personal privacy devices (PPD) has become popular. However, PPDs are also jammers that cause interference in radio communication systems and their use is illegal [25]. By deliberately transmitting signals at or near radio as well as GNSS frequencies, PPDs overpower GNSS signals, thereby preventing tracking within certain regions and making GNSS unworkable around the PPD [25].

Although the present EU data protection law provides extensive personal data protection measures, unfortunately the above-mentioned duality has not been addressed as to how personal data protection issues should be tackled regarding use of GNSS services in electronic communication systems without causing any harmful interference in radio communication [25].

II. LEGAL INITIATIVES IN EU AGAINST HARMFUL RADIO INTERFERENCE

Although radio equipment is relevant for many safety, health and environment related issues, this section discusses radio

equipment and related laws, suggesting their relevance and impact in measuring accurate location in navigation and radio communication systems.

The regulatory landscape in EU concerning radio equipment and spectrum is governed jointly in cooperation among the European Commission, European Telecommunications Standards Institute (ETSI) and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) [16].

A. LAWFUL USAGE OF RADIO SPECTRUM

The first **Radio Spectrum Policy Programme (RSPP)** was introduced by **Decision 243/2012/EU** [26], which coordinated conditions so that the radio spectrum could be used efficiently and different radio equipment could interoperate effectively for the period 2012-15 [16][27]. The **Radio Spectrum Policy Group (RSPG)** is a supporting body for EC for developing and implementing RSPP [16]. Likewise, **Radio Spectrum Decision (No 676/2002/EC)** [28] supported CEPT in harmonizing technical settings for spectrum usage. This Decision established the **Radio Spectrum Committee**, which exercises its functions through the Comitology decision [29] of EU [16].

Licensing is important for using certain devices. After getting a license, devices get exclusive rights to transmit on a designated frequency at a specified power within a particular geographic location. Unlicensed transmissions are permitted in certain situations using licensed bands, but the power levels must not interfere with licensed users [30]. Many of the familiar transmitters used in everyday life are exempted from licensing, such as Wi-Fi, Bluetooth, remote entry without key, sensors, garage door controls and radio-frequency identification (RFID). In order to cope with the expansion and popularity of the IoT environment, the use of low-power wireless transmitters is increasing day by day [30].

In order to market the products that use radio frequencies and spectrum, manufacturers must comply with EU directives and regulations. Only after fulfilling the legal requirements a product can receive CE Marking⁶ [32]. However, there are different directives for radio devices and non-radio devices. Regarding radio devices, the most relevant law in connection to location security is **Radio Equipment Directive (RED) 2014/53/EU** [33]. **Restriction of Hazardous Substances (RoHS2) Directive 2011/65/EU** [34] is important in restricting the use or marketing of hazardous substances. **Electromagnetic Compatibility (EMC) Directive 2014/30/EU** [35] (for electrical devices), **Low Voltage**

product may be legally placed on the market in their country. 3. CE Marking on a product ensures the free movement of the product within the EFTA & European Union (EU) single market (including totally 30 EEA countries)...” [31].

⁶ “1. CE Marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation, in practice by many of the so-called Product Directives.... 2. CE Marking on a product indicates to governmental officials that the

Directive (LVD) 2014/35/EU [36], and RoHS2 Directive 2011/65/EU are relevant for non-radio devices. LVD 2014/35/EU applies to electrical apparatus for certain ranges of voltage [32].

Discussing RED in isolation will not always be appropriate. There is a series of directives that need to be complied with in order to get CE marking; all of them together constitute the “New Approach” directives. “New Approach” directives take into account health, safety, new technologies, environment and trade in the digital single market of the EU [15][30].

At the same time, the EU harmonized standards prefixed with “EN” imply “presumption of conformity” by the manufacturers. There is a number of such standards for radio spectrum use, EMC and electronic security. However, it is the responsibility of the manufacturers to check the changes in the official journals, because the standards are upgraded with the technological developments in wireless devices [37][30]. The “Blue Guide” on the implementation of EU product rules 2016 [38] provides elaborated processes on CE Marking and different conformity assessment procedures [30]. There are regulatory experts and EMC test labs that can provide guidelines to manufacturers on applicable harmonized standards, radio frequency usage in different bands and other factors [30].

In addition to the “New Approach” directives and related standards for CE Marking, some sector-specific regulations are relevant and applicable: for example, the “E- Mark” may be issued to a device or transmitter integrated into a public vehicle. Similarly, the Marine Equipment Directive 2014/90/EU is mainly applicable for marine applications, but some on-board marine transmitters may also require the CE Mark [30].

The following table summarizes directives for both radio and non-radio devices with relevance to CE Marking, and other complementary legal frameworks for RED:

TABLE I
Summary of Directives

Directives for radio devices	Radio Equipment Directive (RED) 2014/53/EU (R&TTE Directive 1999/5/EC)
	Restriction of Hazardous Substances (RoHS2) Directive 2011/65/EU
Directives for non-radio devices (but inevitably connected to radio directives)	Electromagnetic Compatibility (EMC) Directive 2014/30/EU
	Low Voltage Directive (LVD) 2014/35/EU [37]

	RoHS2 Directive 2011/65/EU
Other legislative frameworks that complement RED	EC M/536 Commission Implementing Decision 2015
	The ETSI standard (ETSI EN 303 413)
	ECC Recommendation (04)01 and ECC Recommendation (03)04
	Guide to the R&TTE Directive 1999/5/EC

B. THE RADIO EQUIPMENT DIRECTIVE AND RELATED INSTRUMENTS

RED 2014/53/EU entered into force on 11 June 2014 and applies from 13 June 2016 with a one-year transition period; revising, aligning and repealing the **Radio and Telecommunications Terminal Equipment (R&TTE) Directive 1999/5/EC** [39] (Arts 48-50 RED). Existing equipment using the radio spectrum get the flexibility until June 13, 2017 to follow the R&TTE Directive 1999/5/EC, but afterwards both the new and existing equipment are bound to follow the RED. Manufacturers received a one-year transition period to comply with the new provisions of RED, which is a good consideration for them [15].

1) PRIME DEVELOPMENTS IN RADIO EQUIPMENT DIRECTIVE

Article 3(2) of the RED states, “Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.” Thus, RED harmonizes the legal requirements to run radio equipment, which is essentially required not to create harmful interference in the radio spectrum. This promotes the efficient use of the radio frequency spectrum. For the smooth usage of the radio spectrum, before placing the products on the market, it is required to meet the legal requirements under RED [16]. The **EC M/536 Commission Implementing Decision [C(2015) 5376 final]** [40] contains the voluntary Harmonized Standards, and by applying those standards the manufacturers can comply with the requirements under RED. The Member States should enforce RED at national level, especially in market surveillance activities [16].

The definitions of “apparatus” and “telecom terminal equipment” provided in the R&TTE Directive have been removed in RED. The definition of “radio equipment” is broadened in Article 2(1) RED:

‘radio equipment’ means an electrical or electronic product, which intentionally emits and/or receives radio

waves for the purpose of radio communication and/or radio determination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radio determination.

Thereby, radio equipment may cover a variety of products, such as web-enabled machines, medical devices to monitor home, devices relating to GNSS and navigation, positioning or tracking systems and smart phones. But radio equipment is particularly relevant in localization. In Annex I of RED, a list of equipment is mentioned that are not covered by RED. Apart from those, RED will be applicable on any device that communicates using the radio spectrum [15]. Other than the exclusions explicitly mentioned in Article 1, RED provides requirements and limitations for running wireless transmitters and receivers. More specifically, RED applies concerning the activities of radio devices ranging from mobile phones with cell base stations to two-way handheld or radio transceivers (walkie-talkies) with their base stations. In addition, it includes microwave backhaul in telecommunications networks, particular marine applications, radio astronomy, emergency beacons, radar and so on [30]. By taking into account the necessity of improved market surveillance, RED provides developed instruments, such as the requirement that certain types of radio equipment should be registered before being sent to market, especially those “affected by a low level of compliance” [Art. 5(1)] [41]. It is good that RED provides clear and explicit provision regarding the use of the radio spectrum considering modern technological developments [15].

RED is a significant improvement over the R&TTE Directive in that RED is only concerned about radio products, excluding provision for the R&TTE equipment- the telecom terminal equipment that is now included in the EMC Directive and LVD. Unlike R&TTE, RED includes broadcast receivers and takes into account the new legislative framework (NLF⁷ [30]) of EU [43]. RED also includes transceivers operating below 9 kHz, and radio-determination devices such as radar and RFID. Radio spectrum has a direct connection with location and positioning with respect to radio communication and radio determination that is specifically included by RED. RED requires Declaration of Conformity (DoC), which must contain information on frequency and maximum power transmission; such a provision was absent in the R&TTE Directive [30]. Also, some new terms have been included, such as “radio determination” (e.g., radar), “manufacturer”, “authorized representative”, “importer” and “distributor” [15].

The RED makes the manufacturers responsible for the construction of radio equipment and use of radio spectrum

⁷ NLF is an initiative to align set of EU regulations that provides standardised conformity processes and conditions within EU for placing products in the Internal Market, improving market

such “that it can be operated in at least one Member State without infringing applicable requirements” [Article 10 (2)]. RED also describes the requirement for documentation where the details of the radio frequency band and power should be included and making it available during 10 years after the product goes to market. Fulfilment of legal requirements should be declared by the manufacturers or importers of the device. As a different option, a notified body may check and confirm the conformity. Thereby a device can gain the CE mark as well as permission to be marketed in the EU [32]. By requiring other relevant details including batch or serial number of the product and contact information of and DoC by the manufacturer, RED tries to make products traceable and forces manufacturers to be more accountable [15].

Importers are also bound to market only products that comply with the provisions of RED, and to ensure adequate information and documentation on products. Distributors are required to apply “due care” about RED, especially concerning CE Marking and documentation [15]. In Annex V of RED, detailed requirements for documentation are described [30]. In case of non-compliance, the manufacturers may have an opportunity to correct the situation. But in case of serious infringements, according to Article 46, “effective, proportionate and dissuasive” penalties could be imposed by the Member States [15]. How much a manufactured product complies with the EU regulations is determined by a process called conformity assessment. Annexes II, III and IV of RED contain options to assess such conformity. However, depending on the products, conformity may vary [30].

After RED is applied, the future steps should be to evaluate receiver performance and spectrum sharing. In order to avoid interference between different radio spectrum and devices, spectrum sharing is encouraged by the directives and standards, especially when transmission power is more than 10 mW. Furthermore, considering the new situation, registration of radios with low level of compliance may be required of manufacturers in 2018. The manufacturers’ action should now be to update DoC and other responsibilities in order to comply with the new changes [30].

2) APPLICABILITY OF RED FOR GNSS DEVICES

It is good that ETSI is going to introduce a harmonized standard for GNSS receivers (**ETSI EN 303 413**) [44] for EU Member States, which is now under observation. The standard will cover GNSS systems and receivers operating within certain band ranges, and enable the receivers to handle interference within a particular range. The proposed standard aims to complement RED. Another improvement this standard may bring is that it could have international application [45].

surveillance and clear responsibilities for the economic operators, was adopted in 2008 [42].

The ETSI standard requires GNSS receivers sold in EU from June 2017 to meet “essential requirements” under Article 3 of RED. In other words, it arranges mandatory testing requirements for the devices reliant on GNSS in order to protect GNSS radio frequencies against radio frequency interference. For testing purposes, this standard recommends the use of specific equipment [46]. However, this standard will provide the main way to meet essential requirements, but considering the circumstances the notified body may acknowledge the fulfilment of essential requirements in other ways as well [45].

ETSI standard will be a complementary part of RED that requires fulfilment of the European conformity and testing for GNSS products within EU for the first time. There are inherent and adjacent frequency spectrum to GNSS system and devices, and the ETSI standard will provide protection against probable radio frequency interference within those spectrum [46]. Such interference is adjacent band interference, which may cause impaired performance in the receiver device, and may also cause jamming and spoofing with misleading information [47].

RED is now the most efficient legal instrument that requires obligatory testing for marketing GNSS-reliant devices in EU. Thus the GNSS device manufacturers are bound to follow RED requirements regarding CE marking and conformity [47].

C. OTHER RELEVANT LAWS

RED is considered a product specific directive. For example, a Wi-Fi router for consumers must comply with the provisions of RED. But for the power supply in the router, separate compliance with the EMC Directive and LVD may be required. According to Article 3(1)(b) of RED, the radio equipment must ensure the safety requirements as stated in EMC Directive 2014/30/EU and the LVD 2014/35/EU irrespective of the voltage limit. Also some provisions of the RoHS directives may appear to be relevant [30].

Both the EMC Directive and LVD entered into force on 18/04/2014 and applied from 20/04/2016, replacing the old EMC Directive (directive 2004/108/EC) and LVD (directive 2006/95/EC) respectively. The new EMC Directive and LVD have not changed the scope of the earlier versions, but with the changed scope of RED the scope of these two directives has been influenced considerably [48]. However, there is some complex time division regarding the applicability of these directives. In short, the new EMC Directive and LVD apply to products covered under the R&TTE Directive, but do not apply to products covered under the RED in order to avoid duplicate provisions (Recital 8 RED) [48].

The R&TTE Directive 1999/5/EC is also relevant in the context of jammers. Jammers are mentioned in the ‘Interpretation of the Directive 1999/5/EC’ [49] as follows:

The legality of jamming, including GSM and GPS jamming, has been discussed on several instances in the context of the R&TTE (1999/5/EC) and the EMC Directives (2004/108/EC). These discussions have made clear that Member States neither permit nor wish to permit radio communications to be disrupted by jamming devices operated by members of the public. It is not possible to construct jammers that comply with R&TTE or the EMC Directives. Such devices cannot therefore be legally placed on the market within the Community for use under these Directives. Therefore, where such products claim compliance with the R&TTE or the EMC Directive, Member States' market surveillance authorities are under an obligation to take them from the market under the provisions of those Directives and to notify such actions to the Commission. For reference see also the Electronic Communication Committee (ECC) recommendation (04/01) with regard to forbidding the placing on the market and use of GSM jammers in the CEPT member countries.

ECC Recommendation (04)01 [50] and **ECC Recommendation (03)04** [51] prohibits the sale and use of jammers in CEPT Member States. Marketing and operating mobile phone jammers is banned in the **Guide to the R&TTE Directive 1999/5/EC** [52] (this is not legally enforceable though) as being unable to “fulfil the essential requirements of the Directive”.

III. CONCLUSION

GNSS services may become more accurate, effective and efficient if possible collisions and interference are avoided or minimized. For that purpose a unified management forum is required. The UN can play such a role, although military involvement in most of the GNSS may make it difficult for UN to exercise full control over GNSS. However, the present international coordination measures are not strong in many respects that need more effort and research.

As there are multiple operating GNSS services in the market, they can interoperate with each other, and in such cases it is difficult to determine the actual interference and the party responsible for the damage. Legal initiatives to secure GNSS services and defeat probable related harms are still not sufficient on the international stage. The need for universally applicable and acceptable specific binding international law is evident. In spite of several initiatives at different times and places, there is still no international binding law to manage GNSS signals and services [20].

With their potential for use in committing crime, jammers and spoofers pose genuine and increasing threats. In order to effectively use the GNSS services, restrict the use and expansion of illegal devices, and reduce harmful radio interference, harmonization and coordination of the related laws both in the EU and at the international level are very important [8].

With regards to EU, the fulfilment of “essential requirements” under RED can be effective in reducing possible interference. Although the terms “jammers” and “spoofers” are not specifically mentioned in many related EU laws, their provisions are relevant and applicable in defining the legal status of those devices. In a nutshell, the marketing and use of any radio, electrical and electronic devices (including jammers and spoofers) in any EU Member State are illegal when they cause excessive radio frequency and electromagnetic interference. At the same time, the CE mark on any devices signifies compliance with EU law [9].

The Telecommunication Conformity Assessment and Market Surveillance Committee (TCAM) arranges regular meetings with the representatives of EU Member States in order to discuss possible RED implementation measures. Member states are required to develop market surveillance with adequate national systems to control improper use of radio equipment [41].

People are not much concerned about radio communication related laws yet, unlike most of the other laws. One reason may be that individuals do not realize the damages caused by deleterious radio equipment, the damage which is operative in a larger context, such as measuring accurate locations by navigation systems may be hampered by such equipment. Therefore, the RED and related laws impose clear obligations upon manufacturers, distributors and importers [54]. What the individual users can do is to check the CE Marking, and whether the devices ensure the RED conformity assessment. They can also examine the documentation which the manufacturers are bound to maintain where individuals will find specifications about the equipment and radio frequency powers. If they find any proof of non-compliance with the RED requirements, they can inform the market surveillance authorities of the Member States, who are competent to take appropriate measures to correct or withdraw the equipment from the market (Article 40 RED). The Commission is also entitled to adopt implementing and delegated acts in certain circumstances.

While international law on GNSS constitutes part of an informal soft law network, the EU directives provide hard law provisions. For radio communication related directives, every EU Member State should have consistent law. Thus, theoretically, there should be some common basic principles that all the EU Member States should maintain. But in practice, the legality of manufacturing, importing and exporting of such devices still varies from nation to nation within the EU [8].

Sometimes it may be challenging for the manufacturers and importers to identify the applicable law and in doing so they should apply due diligence. However, they can obtain detail related information and guidelines from the website of European Union and Europa portal [30]. The European Communications Office (ECO) endeavors to establish harmonized radio spectrum usage in EU Member States and

its website portal Frequency Information System (EFIS) [53] publishes radio spectrum and frequency related information [30]. As a new and recent branch of law, GNSS and radio communication related laws are making progress. RED and its associated laws are set to accelerate that progress efficiently.

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