RFI — Protecting the terrestrial broadcasting services from new interference sources

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Over the last few years, new wireless applications have been multiplying and appearing quickly on the market. Despite the CE product-marking scheme, framed by the EMC and R&TTE Directives, it appears that some of these new devices do not respect the principle of using the spectrum without causing radio-frequency interference (RFI) to existing on-air services.

This article provides a brief overview of the new and most threatening sources of interference to terrestrial radio and television services.

New wireless applications

Most of the new wireless applications belong to the Short Range Devices (SRDs) class, which comprises low-power transmitters (less than 500 mW). This class is subdivided into several groups according to the primary function, as described in **ERC Recommendation 70-03**.

Among these groups, the following applications have been identified as potential sources of interference to the broadcasting services:

- low-power FM modulators;
- Railway applications.

In addition, ***ultra-wideband (UWB)*** devices tend to disturb the terrestrial reception of TV and radio programmes – as part of their energy falls within the useful bandwidth of broadcast receivers. To make this point clearer, it must be underlined that, by definition, UWB is a combined modulation technique and multiple-access method, and is not dedicated to a specific application. Thus, some SRDs are based on UWB technology … but all UWB applications do not belong to the SRD class!

The risk of interference is not the same for all these applications, as it strongly depends not only on the RF transmission parameters, but also on the *context of use*. For instance, some of the quoted applications are licence-free mass-market products, whereas others are restricted to professional use or to a very limited area.

Audio applications

Low-power FM modulators are designed to be connected to the jack plug of an audio source to retrieve the signal and transmit it over an FM broadcasting channel. This signal is then captured and demodulated by the FM receiver as with any other on-air FM programme. Basically, the idea is to use the existing receiver facilities, namely the amplification unit and the speakers, to play the music or the sound tracks from a device that is usually used with just ear-phones. Typically, this licence-free device is dedicated to listening to an mp3 player through a car radio, yet it can also be used with a home audio system or a portable radio.

Figure 1
Examples of FM low-power transmitters *(Source: audiax.fr)*

The user can manually choose the FM frequency that is apparently free at its current geographical location. If an FM programme is broadcast on the chosen frequency, then the signal transmitted from the SRD is expected to be so disturbed at the receiver that it will be impossible to demodulate it. Conversely, the *FM broadcast programme is also likely to be disturbed*. However, experimentations conducted in France have shown that in urban environments, where FM programmes are mostly received at a level close to the sensitivity of the car receiver, SRDs were able to ensure good reception on FM channels used by local radio stations. Moreover, even with an equivalent radiated power (ERP) of *only 50 nW* (where 1 nW = 1/1 000 000 000 Watt), this equipment can still cause interference to FM reception in neighbouring cars. For instance, in a downtown area at peak hours or during traffic jams, *from 4 to 10 vehicles* can be affected around a car equipped with such a low-power FM modulator.

In the USA, the maximum ERP authorised by the Federal Communications Commission (FCC) is still lower than 50 nW, but many of the models sold exceed this limits. As millions of low-power FM modulators are currently used in the USA, existing *FM programmes are jammed on a large scale* at some locations. This situation has worsened by the proliferation of new *"wired" FM modulators*, which are devices dedicated to re-modulate received XM satellite radio programmes in the FM band in such a way that they can be listened to through a standard car radio. Despite being directly connected to the car receiver, a part of the FM-modulated signal is radiated on-air *through the car antenna*, generally because of a *faulty installation*, and consequently it disturbs the reception in other cars of on-air broadcast FM programmes. Due to the numerous reported complaints, National Public Radio (NPR) has requested the FCC to order recalls of millions of FM modulators. However as these devices are unlicensed, it is not possible to ensure that faulty ones are recalled.

Railway applications (Euroloop System)

Euroloop is a transmission system to communicate control information at railway stations to passing trains through a "leaky cable" in the rail base, running *from a few 100 meters to 1 km* along the station. By using inductive coupling, the electrical signal transmitted by the station modulator is received by the train when passing over the cable without needing to stop or to slow down. The transmission is *occasional*, since the system operates only in the presence of a train.

Figure 2
Principle of the Euroloop application *(Source: Siemens)*

Unfortunately, the signal is modulated using high frequencies in the range 11.1 - 16 MHz which covers certain broadcasting bands. Since the *cable behaves like a large antenna* by radiating most of the energy, this may lead to a field strength level between 0 and 9 dBµA/m at 10 m. With such a high level, the railway application can disturb reception of *AM and DRM* programmes in the short-wave bands over a large area of up to 2 km^2 around train stops and railway stations. To a certain extent, this case of interference is very similar to that generated by Power-Line Telecommunication (PLT) technology: the same frequency band is affected, and it relies on the same kind of transmission medium that turns into a radiating source.

Fortunately though, Euroloop is a fixed application. Therefore, in cases of interference, it is possible to identify the source of the disturbances and to ask the regulatory body for a conservative action. A report on the compatibility of Euroloop with other systems below 30 MHz is currently under development within the CEPT.

Ultra wideband applications

From the very beginning, the basic idea of UWB was to *spread the transmitted signal energy* over an ultra-wide bandwidth by using an impulse modulation in the time domain. The shorter the impulses are, the wider the spectrum is.

Consequently, as depicted in *Fig. 3*:

- the bandwidth of a UWB signal can range from *several hundreds of MHz to a few GHz*;
- the mean-power *spectrum density* is relatively low, depending on the impulse level and time duration.

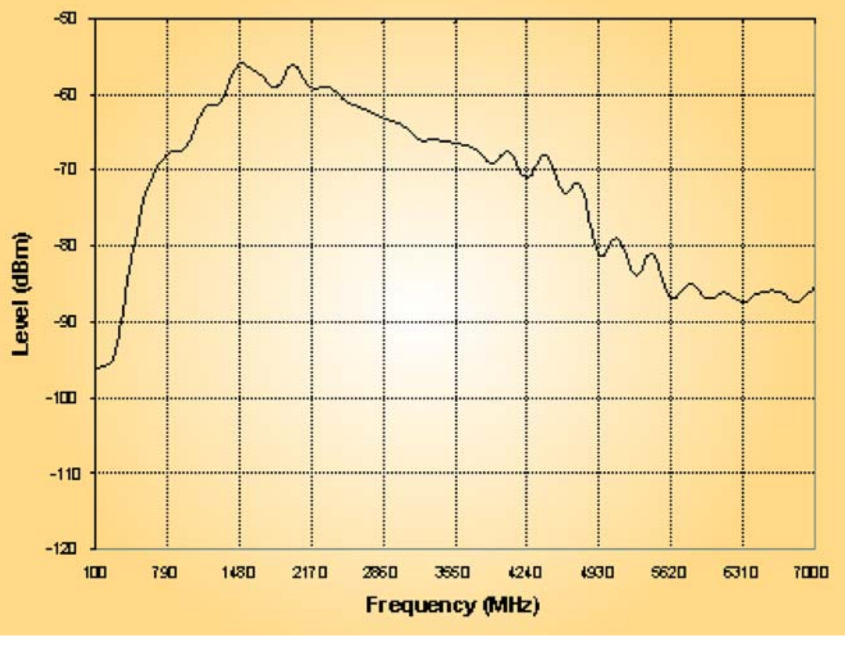

Figure 3
Power Spectrum Density of a UWB signal

Currently, not only impulse modulation but also OFDM is used in UWB technologies. In particular, most of the UWB communication applications use OFDM. Among others, here are the most popular UWB applications, either impulse- or OFDM-modulated:

- Medical applications;
- Consumer communications applications;
- Automotive applications;
- Consumer and industrial construction applications;
- Ground/Wall probing radar (GPR/WPR) systems;
- Industrial liquid level gauges;
- Data communications systems;
- Wireless high-speed networking.

ECC Decision “ECC/DEC/(06)04” addresses the harmonised conditions for devices using UWB technology in bands below 10.6 GHz. This decision covers most consumer communications applications. The UWB emission levels in the broadcasting bands, as defined in this decision, provide *adequate protection* to existing terrestrial broadcasting services.

Abbreviations

AM	Amplitude Modulation
CE	*Commission Européenne* (European Commission)
CEPT	*Conférence Européenne des Postes et Télécommunications* (European Conference of Postal and Telecommunications Administrations)
DRM	Digital Radio Mondiale http://www.drm.org/
DVI	Digital Visual/Video Interface
EC	European Commission
EMC	Electromagnetic Compatibility
ERC	European Radiocommunications Committee of the CEPT
ERP	Effective Radiated Power
FCC	Federal Communications Commission (USA)
FM	Frequency Modulation
GPR	Ground-Probing Radar
ITU	International Telecommunication Union http://www.itu.int
ITU-R	ITU - Radiocommunication Sector http://www.itu.int/ITU-R/publications/rec/index.asp
IWAN	Intelligent Wireless Area Network
NPR	National Public Radio (USA)
OFDM	Orthogonal Frequency Division Multiplex
OPPN	Outdoor Peer-to-Peer Network
PLT	Power-Line Transmission/Telecommunication, also written PLC, BPL ...
R&TTE	Radio and Telecommunications Terminal Equipment (a European Directive) http://www.rtte.org/
RF	Radio-Frequency
RFI	Radio-Frequency Interference
SPIN	Sensor, Positioning and Identification Network
SRD	Short Range Device
UWB	Ultra WideBand
WPAN	Wireless Personal Area Network
WPR	Wall-Probing Radar

Most currently-known impulse UWB applications are oriented towards imaging which includes wall-probing radar, through-wall radar, ground-probing radar, building-material analysis, object classification, etc. UWB imaging systems are expected to operate in any part of the radio spectrum and consequently the transmitted UWB signal may cover both radio and TV broadcast bands. This can result into an *increase of the overall noise level*, since the UWB signal can be considered as white noise from a receiver point-of-view. Eventually, this equivalent noise will *degrade the quality of broadcast reception*, if there is no margin on the received field strength level of the wanted TV or radio signal.

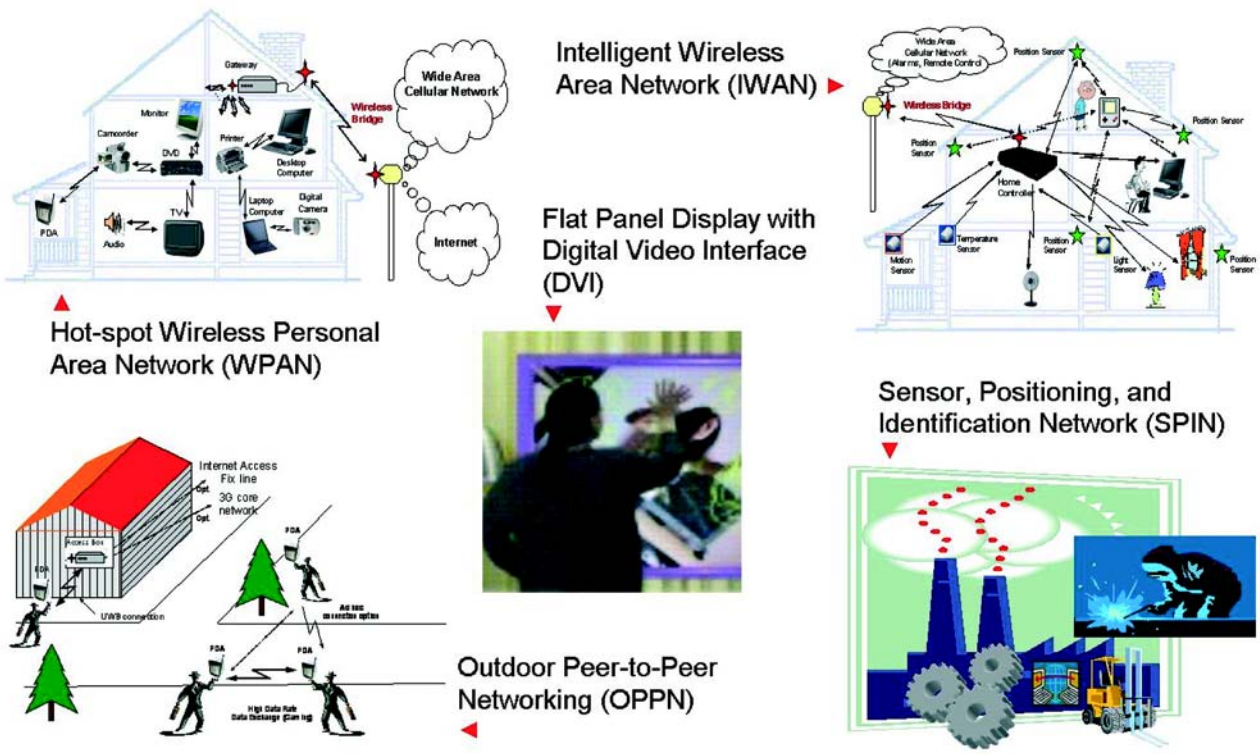

Figure 4
New UWB applications

Figure 5
Typical Ground-Probing Radars

Figure 6
Wall probing radar
(Source : http://www.cambridgeconsultants.com)

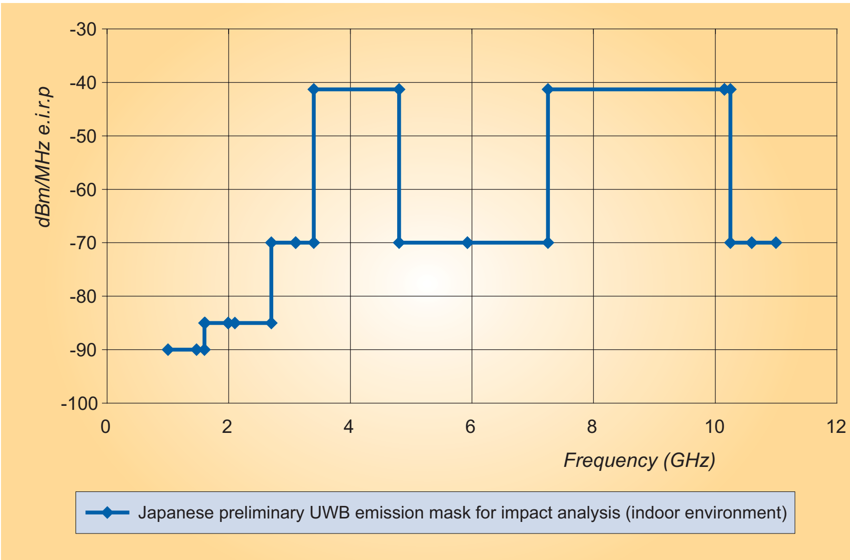

Figure 7
Recommended limits on UWB emissions

As imaging devices are generally dedicated to professional use, they are usually restricted to a given area and generally for a limited duration. Consequently, they will often be subject to a licence authorisation. However, more and more UWB-imaging applications are becoming *mass market products* (intrusion detection, collision avoidance, geolocation, RFID…). The number of UWB equipments is likely to increase in the coming years, thereby increasing the overall noise level in many bands, among them broadcast bands.

Therefore, it is of utmost importance to define limits on the spectrum density radiated by UWB equipment to protect radio services. This process is currently under development both at a European level within the CEPT and at an international level within the ITU-R. Globally, broadcast operators have aligned their position to the limits proposed by the Japanese administration, as depicted in *Fig. 7*.

With such limits, terrestrial TV and radio services should not be significantly affected, statistically speaking, by UWB equipments.

Project Group B/EIC

The EBU has always been actively involved in the protection of broadcasting services, through standardization activities or by lobbying the regulatory bodies as well as the EC. Nowadays, as *rules are tending to change* because of the multiplication of licence-free radio equipment and the flexible approaches to spectrum use, it becomes more important that all broadcast operators contribute to and support the EBU positions. *Common positions* related to standards, or to EC public enquiries as well as other actions, are discussed and defined within EBU project group B/EIC (the “B” stands for Broadcast and “EIC” for Electromagnetic Interference and Compatibility). Besides participating in this group, broadcast operators should try to get closer to their respective national

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regulatory body and/or national standardization organization to make the EBU's point-of-view known.

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