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Consultation Paper on the Introduction of Wireless Systems Using Ultra-wideband Technology

Canada

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Industry Canada

Radiocommunication Act

Notice No. SMSE-002-05 — Consultation Paper on the Introduction of Wireless Systems Using Ultra-wideband Technology

Introduction

The purpose of this Notice is to invite public comment on the document entitled *Consultation Paper on the Introduction of Wireless Systems Using Ultra-wideband Technology* announced through this Notice.

Background

Over the years, the Department has designated specific spectrum to support a wide range of licence-exempt products and devices to benefit consumers and businesses. Similarly, technical provisions have been established on an ongoing basis to enable low-power products and devices to coexist with licensed radiocommunication systems in an increasing number of frequency bands.

It has been the Canadian experience that consumers and business have a strong interest in adopting new wireless products and in having access to the latest technology and applications, so as to increase productivity and improve the standard of living.

As information and communication technologies propel the adaptation to the information economy, it is important that Canada maintains its leadership in providing access to its citizens to the best wireless services and products in both licensed and licence-exempt radiocommunication. Ultra-wideband is a new wireless technology, which could provide many benefits to consumers, businesses and industries. The introduction of such new technology requires the development of appropriate radio equipment standard specifications and certification requirements. In this case, however, concerns have been raised regarding the potential interference to radiocommunication services. In view of this, the Department hereby initiates a comprehensive consultation with the public, consumer groups, businesses, and users of the spectrum on the introduction and use of ultra-wideband systems in Canada.

Submitting Comments

Interested parties should submit their comments no later than May 6, 2005. Shortly after the close of the comment period, all comments received will be posted on Industry Canada's [Spectrum Management and Telecommunications Web site](http://strategis.gc.ca/spectrum) at: <http://strategis.gc.ca/spectrum>.

Respondents are requested to provide their [comments](#) in electronic format (WordPerfect, Microsoft Word, Adobe PDF or ASCII TXT) to the following e-mail address, dgse-uw@ic.gc.ca, along with a note specifying the software, version number and operating system used.

Written submissions should be addressed to the Director General, Spectrum Engineering Branch, Industry Canada, 300 Slater Street, Ottawa, Ontario, K1A 0C8.

All submissions should cite the *Canada Gazette*, Part I, the publication date, the title, and the notice reference number (SMSE-002-05).

Obtaining Copies

Copies of this notice and documents referred to are available electronically on the Spectrum Management and Telecommunications Web site at: <http://strategis.gc.ca/spectrum>.

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January 28, 2005

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1. Intent

The intent of this consultation, announced in Gazette Notice SMSE-002-05, is to identify public interest and issues regarding the introduction and use of low-power systems using ultra-wideband (UWB) technology in Canada. A key objective of the Department is to draw a good balance between facilitating the introduction of new technologies such as UWB and protecting radiocommunication services from harmful interference.

It has been the Canadian experience that consumers and businesses have a strong interest in adopting new wireless products to improve their standard of living and increase productivity.

Over the years, the Department has allowed the use of an increasing number of wireless devices that operate without a licence (i.e. licence-exempt). Some of these licence-exempt devices operate in special frequency bands or can be underlaid in bands used by licensed radiocommunication services provided these devices meet low-power emission limits and other specific requirements. The introduction of licence-exempt devices requires the development of certification requirements and appropriate radio equipment standard specifications. In the case of systems that use UWB technology, concerns have been raised about the proliferation of these systems and the potential interference to certain radio services. In view of this, the Department wishes to engage the public, consumer groups, and the industry in this consultation process.

The Gazette Notice provides the guidelines, addresses, and deadlines for submitting public comments. Public comments on this consultation paper will provide important inputs for the development of specific spectrum policy provisions and radio equipment standards for the introduction and use of ultra-wideband systems in Canada.

2. Background

2.1 What is Ultra-wideband (UWB)

Ultra-wideband is a wireless technology that can operate at very low-power density to communicate at high data rates over short distances. UWB was initially developed for military applications and has started moving into civilian use. UWB devices generally operate using very narrow pulses thus occupying very large emission bandwidths.

UWB can be integrated into a wide variety of applications including vehicular radar, radar imaging systems such as ground penetrating radar (GPR), and short-range wireless radiocommunication systems such as wireless personal area networks (WPANs). UWB technology could replace in part the need to connect different equipment with cables for the transmission of high data rate information. Some UWB applications are already available in the market such as ground penetrating radar systems and through-wall image detection systems. Other applications are at an advanced design and development stage.

The use of UWB for WPANs is expected to be a key application. The UWB industry is currently developing, through the Institute of Electrical and Electronics Engineers (IEEE), standards for UWB wireless networks. The availability of industry standards for UWB systems will facilitate the development of regulations and rules, and will facilitate the introduction of UWB devices into the market.

2.2 General Features of UWB

UWB technology possesses some features that are attractive:

- **Low susceptibility to multipath fading:** Multipath fading can degrade the performance of conventional (non-UWB) communication systems. In the case of UWB communications, the transmitted signal has a large bandwidth (very fine time resolution) and due to the narrow observation window at the receiver, multiple reflections with sub-nanosecond delays can be resolved and added constructively to provide gain compared to a single, direct path.
- **Immunity to interference:** An important feature of UWB systems is their large processing gain, a measure of a system's robustness against interference.
- **Secure communications:** UWB signals are more covert and potentially harder to detect than conventional radiocommunication signals. This is because UWB signals occupy large bandwidth, can be made noise-like, can communicate at a power spectral density level well below the noise floor of conventional radiocommunication receivers, and can communicate with a unique timing code at millions of bits per second. These features result in secure transmissions with low probability of detection (LPD) and low probability of interception (LPI).
- **Relative system simplicity:** In wireless communication systems that use UWB technology, the baseband information can be directly modulated using short pulses rather than modulating a sinusoidal wave. In this form of implementation, the UWB transceiver will have no phase-locked loop synthesizer, voltage-controlled oscillator, mixer, or power amplifier. This translates to a relative architectural simplicity compared to the super-heterodyne transceiver, and may lead to lower equipment costs.
- **Penetration properties:** UWB emissions have good ability to penetrate walls and obstacles and provide high accuracy location determination. These properties would also be useful in applications such as medical imagery.

2.3 UWB and Alternate Technologies for Wireless Networking

UWB technology has the potential to support low-power, short-range wireless networks such as WPANs. Other wireless access technologies such as WiFi and Bluetooth could serve similar purposes. Table 1 shows a comparison between UWB and other wireless technologies.

Table 1 - Technical Comparison between UWB and Other Wireless Technologies

Technology	Data Rate	Range (m)	Frequency Band	Power (e.i.r.p.) ¹	Modulation	Use	Specification
UWB	>100 Mbits/s	~ 15	3.1–10.6 GHz	≤ - 41.3 dBm/MHz	PPM, etc.	WPAN	IEEE 802.15.3a ² High data rate PANs
UWB	> 500 kbits/s	~ 10	3.1–10.6 GHz	≤ - 41.3 dBm/MHz	PPM, etc.	WPAN	IEEE 802.15.4a ²
Bluetooth	700 kbits/s	~ 15	ISM 2.4 GHz	Class-1: 20 dBm Class-2: 0 dBm	GMSK	WPAN	IEEE 802.15.1
WiFi	Up to 54 Mbits/s	~ 50	5 GHz ³	Max: 200 mW up to 1W	BPSK, 16-QAM, QPSK, 64-QAM	RLAN	IEEE 802.11a Rec. ITU-R M.1450
	Up to 11 Mbits/s	~100	ISM 2.4 GHz	Max. 100 mW up to 2W	CCK (8 Complex Chip Spreading)	RLAN	IEEE 802.11b Rec. ITU-R M.1450 ETSI EN 300 328
	Up to 54 Mbits/s	~100	ISM 2.4 GHz	Max. 100 mW up to 2W	BPSK, 16-QAM, QPSK, 64-QAM	RLAN	IEEE 802.11g ETSI EN 300 328

3. Ultra-Wideband Developments

3.1 Potential benefits

UWB technology can potentially be integrated into many applications that could benefit the Canadian public, consumers, businesses, and industries. Examples of current and potential UWB applications include:

- Applications for improved public safety through the use of vehicular radar systems for collision avoidance, airbag activation, road sensors, etc.

¹ The power limits for UWB applications are defined in terms of power spectral density (dBm/MHz).

² The IEEE is developing standards for UWB wireless personal area networks (WPANs) and other UWB applications.

³ The 5 GHz band consists of several sub-bands (5 150-5 350 MHz, 5 470-5 725 MHz and 5 725-5 875 MHz), which are used in part, or in their entirety, for radio LANs (RLANs) depending on national or regional arrangements. There may be additional restrictions imposed (e.g. on the power level) depending on the sub-band used.

- Applications to detect location and movement of objects. Such applications can be used by law enforcement, rescue and fire organizations to detect persons hidden behind walls or under debris in situations such as hostage rescues, fires, collapsed buildings, and avalanches. UWB can also be used at hospitals and clinics for variety of medical applications to obtain images of organs, etc. within the body of a person or an animal.
- Inexpensive short-range wireless networks. UWB is a candidate technology for dedicated short-range wireless networks (IEEE 802.15.3a standard for personal area networks at data rates greater than 100 Mbits/s, and IEEE 802.15.4a standard for *ad hoc* networks at data rates up to 1 Mbits/s). For example, UWB wireless personal area networks could be established at home allowing televisions, VCRs, stereo-systems, and computers to communicate with each other without using cable connections. Similarly in a typical office environment, UWB wireless links could replace wired connections to the computer, monitor, keyboard, mouse, speakers, and printers. Some UWB chipsets are being developed to operate at data rates between 400 and 700 Mbits/s.
- Reliable low probability of intercept and detection wireless communication systems. UWB is advantageous for secure radiocommunications. In addition, UWB devices can operate at very low power levels, function extremely well in cluttered environments (e.g. factory, indoors, etc.), and can support multiple users at high data rates.
- Applications to locate objects such as mineral deposits, non-metallic pipes, plastic land mines, and flaws in bridges and highways using ground penetrating radar (GPR) systems. GPRs can also be used to measure the ice thickness of frozen lakes, runway conditions at airports, as well as in forensic and archaeological studies.
- Various other applications such as tagging systems, liquid level detectors and sensors, surveillance systems, location determination systems, and as replacement to wired high data rate connections over short distances.

3.2 Potential concerns

Some of the concerns associated with the introduction of UWB radiocommunication systems include:

- (1) Finding appropriate spectrum: UWB emissions spread over a very large frequency bandwidth. Among the challenges is finding a suitable spectrum and a way to introduce UWB applications without causing harmful interference to authorized radiocommunication systems.
 - (a) The UWB industry wishes to operate low-power UWB systems on a licence-exempt basis across numerous frequency bands allocated to several radiocommunication services. On the one hand, this could improve spectrum utilization; on the other hand, there are concerns about potential harmful interference to radiocommunication systems operating in these bands.
 - (b) The licensees and users of spectrum in these bands would prefer to see licence-exempt equipment operate in specific frequency bands as do industrial, scientific, and medical (ISM) devices.

- (2) **Aggregate impact:** Though most UWB systems would operate at very low power, the many potential UWB applications could result in high-density use in certain environments such as office and business cores and on highways. There are concerns about the potential proliferation of UWB systems and their aggregate impact on the radio-frequency (RF) noise floor and consequently on radiocommunication services (e.g. passive services and services that operate close to the RF noise floor).
- (3) **UWB peak power:** There are concerns about potential peak power interference from UWB systems into authorized radiocommunication systems.
- (4) **UWB susceptibility to interference:** UWB systems operate at very low power levels and have broad front-end filters. The relatively high-power emissions of conventional radiocommunication systems could render the operation of some UWB applications impossible.

3.3 Application Developments

Wireless systems being developed by UWB manufacturers around the world fit broadly into three categories:

- (1) **Radar imaging systems:** This category includes ground penetrating radar, wall and through-wall imaging, medical imaging, construction and home repair imaging, mining imaging, and surveillance systems. The UWB signal can penetrate the ground or a wall to sense what's inside or behind it, as well as measure distances precisely. The same principle could apply to the human body. Therefore, the principal users of this category would be law enforcement, search and rescue, construction, mining, geological and medical professionals. Radar imaging systems operate at infrequent intervals and are expected to have low proliferation due to their nature of use. Such devices would have a niche market with limited distribution.
- (2) **Vehicular radar systems:** This category includes collision warning radars, improved airbag activation, and field disturbance sensors, etc. Vehicular radar systems can detect the distance between objects and a vehicle, or can be integrated into the navigation system of the vehicle. Some vehicular radar devices started appearing at car exhibits in luxury cars. Should it become mandatory to install such devices on all vehicles, then a proliferation of vehicular radar systems is expected. Users of this category are mostly mobile and outdoor which could increase the potential of interference to other services.
- (3) **Communication systems:** This category includes short-range communication systems including wireless personal area networks and measurement systems. This category is expected to have the largest proliferation due to potential high-density use of UWB devices in office buildings, meeting and conference rooms, and public places (e.g. airports, shopping malls, etc.).

Examples of the above UWB systems and their operational characteristics are included in Table 2.

Table 2 - Examples UWB Systems and their Operational Characteristics

UWB Application	Operational Characteristics
(1) Radar Imaging Systems	<ul style="list-style-type: none"> – Mostly occasional use by professionals. – Use is usually limited to specific locations or geographic areas.
Ground Penetrating Radar Systems	<ul style="list-style-type: none"> – GPRs do not intend to transmit in air. Their emission is directed towards ground. – Occasional use by professionals at infrequent intervals and specific sites.
Wall Imaging Systems	<ul style="list-style-type: none"> – Occasional use by professionals at infrequent intervals and specific locations. – Emission is directed towards a wall and attenuated by the material of the wall.
Through-wall Imaging Systems	<ul style="list-style-type: none"> – Occasional use by professionals at infrequent intervals and specific locations. – Emission is directed through a wall and attenuated by the material of the wall.
Surveillance Systems	<ul style="list-style-type: none"> – Continuous use at fixed locations.
Medical Systems	<ul style="list-style-type: none"> – Occasional indoor use by medical professionals at specific sites. – Emission is directed towards a body.
(2) Vehicular Radar Systems	<ul style="list-style-type: none"> – Mostly mobile outdoor use on terrestrial transportation (when engine is running). – Emission is directional.
(3) Radiocommunication Systems	<ul style="list-style-type: none"> – Some devices will be used occasionally (e.g. a wireless mouse); others will operate for most of the time such as a wireless personal area network in an office building. – Mostly indoor use or hand-held outdoor peer-to-peer use.

3.4 Regulatory and Standardization Considerations

Considerable worldwide effort is currently underway to study the compatibility of UWB systems and systems operating under various radiocommunication services, as well as to develop standards and regulations for the introduction and use of UWB systems.

3.4.1 UWB Activities in USA

Following public consultation, the Federal Communications Commission (FCC) adopted in February 2002 a *First Report and Order on UWB* that permits marketing and operation of three types of systems that use UWB technology [ref. 1]. The FCC stated that their rules were very conservative. In their opinion, UWB would not harm other radio services and tremendous benefits could be achieved by using this innovative technology.

The FCC order authorizes the operation of UWB devices on a licence-exempt basis (Part 15 of the FCC rules) subject to certain operational and power restrictions. The FCC defined a UWB device as any device having a fractional bandwidth⁴ greater than 20% or occupying 500 MHz or more of spectrum. The three authorized types of UWB systems are:

(a) Radar imaging systems: Operation of UWB radar imaging systems is restricted to specific frequency bands⁵:

- below 960 MHz: GPRs, wall, and through-wall imaging systems;
- 1.99-10.6 GHz: fixed surveillance and through-wall imaging systems; and
- 3.1-10.6 GHz: GPRs, wall imaging, and medical imaging systems.

Operators of this category of devices must be eligible for licensing under Part 90 of FCC rules (e.g. public protection, fire and rescue organizations, medical professionals, scientific research institutes, and construction and mining companies). All devices of this category shall bear a *User Restriction Statement*. The FCC requires that devices of this category be equipped with a manually operated switch that causes the device to cease emission within 10 seconds of being turned off. This switch may also be operated remotely. UWB radar imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination. The users of UWB radar imaging systems shall supply detailed operational areas to the FCC who shall notify the National Telecommunications and Information Administration (NTIA) of this information.⁶ The coordination information shall describe the general areas in which the device is to be operated, so the NTIA can alert the UWB operator(s) of any sensitive government systems in these areas.

(b) Vehicular radar systems: UWB vehicular radar systems and similar field disturbance sensors are restricted to terrestrial transportation in the band 22-29 GHz. The UWB device should operate when the engine of the vehicle is running. Directional antennas must be used. UWB devices of this category are licence-exempt under Part 15 of FCC rules provided that both the centre and maximum frequencies of the emission are greater than 24.075 GHz.

(c) Communication and measurement systems: This category is licence-exempt under Part 15 of FCC rules to operate in the band 3.1-10.6 GHz. UWB communications and measurement devices must be designed for indoor use or outdoor hand-held devices for peer-to-peer operations. Outdoor use systems should have no fixed infrastructure and the use of outdoor mounted antennas is prohibited. In addition, an outdoor transmitter must cease emission within 10 seconds unless it receives acknowledgement from an associated receiver.

⁴ The fractional bandwidth is defined by the FCC as $2(f_H - f_L) \times 100 / (f_H + f_L)$, where f_H and f_L are the upper and lower frequencies of the -10 dB points from the highest radiated emission, respectively.

⁵ In July 2002, the FCC issued a waiver that allows UWB ground penetrating radar and wall imaging systems purchased before 15 July 2002 to also operate in the band 960 – 3 100 MHz.

⁶ The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area(s) of operation, the FCC ID number and other nomenclature of the UWB device.

In February 2003, the FCC reaffirmed its UWB rules and stated that future FCC rules are expected to explore flexible technical standards and to address operations and additional types of UWB systems. In August 2004, the FCC certified a 115 Mbits/s UWB chipset intended for wireless personal area networks and consumer applications.

3.4.2 UWB Activities in Europe

There are no European regulations yet on UWB technology. The European Telecommunications Standards Institute (ETSI) has developed draft emission masks for indoor and outdoor UWB communication systems. These masks have the same maximum power level as the FCC masks but use a slope function instead of a step function for the mask skirts. ETSI is drafting a standard on *Short Range Devices* using UWB technology.

3.4.3 UWB Activities in Other Parts of the World

Many countries around the world are assessing the compatibility of UWB systems with other wireless systems.

In Japan an institute for the development of UWB standards has been established. Japan's regulator⁷ has expressed readiness to issue experimental licences for UWB applications.

Singapore⁸ has expressed readiness to issue trial permits for UWB applications in a specific geographical location (UWB friendly zone) with emission masks relaxed by 6 dB (from 2.2 GHz to 10.6 GHz) relative to the FCC UWB masks. No intentional UWB emissions are allowed below 960 MHz. In addition, UWB applications with unusual emission requirements may be approved on a case-by-case basis. The UWB friendly zone will be available until Singapore formally announces its UWB regulations.

The Australian Communications Authority recently granted an interim licence for an ultra-wideband ground penetrating radar system.

3.4.4 IEEE standards

The IEEE standardization committees are considering ultra-wideband for low-power short-range dedicated wireless networks including wireless personal area networks. The IEEE 802.15 task group 3a (IEEE 802.15.3a) is developing a standard for the physical (PHY) layer of wireless personal area networks at high data rates (> 100 Mbits/s). In addition, the IEEE 802.15.4a task group is considering UWB for short-range wireless applications at data rates from 500 kbits/s and up to a few Mbits/s.

At the time of writing this paper, some proposals to task group 3a are based on multi-band OFDM (Orthogonal Frequency Division Multiplexing) implementation that divides the band 3.1–10.6 GHz into a number of 528 MHz channels. Other proposals are based on a Direct Sequence Spread Spectrum

⁷ The Ministry of Public Management, Home Affairs, Posts and Telecommunications.

⁸ Infocomm Development Authority (IDA) of Singapore.

implementation that divides the band 3.1–10.6 GHz into two channels. The development of a detailed standard could take more than a year from the date of an agreement on a general proposal for a standard.

The development of industry standards for UWB applications will facilitate the introduction of UWB systems (especially wireless personal area networks) into the market.

3.4.5 UWB Developments in the ITU-R

Activities are presently underway within the International Telecommunications Union (ITU-R) to study the various aspects of UWB. In 2002, the ITU-R established Task Group 1/8 to urgently study UWB issues.

ITU-R Task Group 1/8 is tasked with the development of:

- a recommendation on the characteristics of UWB systems;
- recommendation(s) addressing compatibility between UWB and radiocommunication services;
- a recommendation providing guidance to administrations on a spectrum management framework for UWB; and
- a recommendation on measurement techniques for UWB emissions.

ITU-R Task Group 1/8 is progressing its work on the development of recommendations on UWB characteristics, compatibility methodologies, a spectrum management framework, and measurement techniques, as well as on a report on compatibility studies.

3.4.6 UWB Activities in Canada

A number of Canadian companies are developing UWB applications. For example, Canada has the largest manufacturer worldwide of UWB ground penetrating radar systems. Several Canadian companies also intend to market UWB applications. In addition, there are ongoing research and development activities on UWB at Canadian universities and research centres.

Industry Canada is evaluating national UWB developments as well as conducting studies on compatibility between UWB systems and other radiocommunication systems. Industry Canada is keeping the Canadian industry, through the Radio Advisory Board of Canada (RABC) and other interested parties, well informed of the latest UWB developments. Industry Canada is also following the standardization efforts within the IEEE groups, and actively participating in international and regional UWB activities including the activities of the ITU-R and the Inter-American Telecommunication Commission (CITEL).

4. Discussion and Proposals

4.1 Definitions and Terminology

The following set of UWB definitions and terminology is used by the UWB industry. This set is also similar to the UWB definitions and terminology of the FCC and those under development by the ITU-R.

UWB bandwidth: The frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the transmit antenna. The upper and lower -10 dB frequency points are referred to as f_H and f_L , respectively.

UWB centre frequency: The centre frequency, f_C , of an UWB emission is given by,

$$f_C = (f_H + f_L) / 2.$$

UWB fractional bandwidth: The fractional bandwidth of an UWB emission is defined as:

$$FBW(\%) = 2(f_H - f_L) * 100 / (f_H + f_L)$$

UWB device: An intentional radiator or a receiver that operates using UWB technology and has a bandwidth equal to or greater than 0.5 GHz or a fractional bandwidth equal to or greater than 20%.

UWB activity factor: For applications that do not require the devices to operate continuously, this represents the fraction of time during which an UWB device is actively servicing the application.

Pulse transmitter duty cycle: For pulse generated UWB, during the period in which the UWB transmitter is active, this is the ratio of the impulse duration to the time between the start of two adjacent impulses.

UWB system: A wireless system that consists of at least one UWB transmitter and an associated receiver.

The Department proposes the use of the above UWB definitions and terminology.

4.2 Technical Considerations

4.2.1 Emission Limits

In an effort to control the potential interference from UWB systems, emission limits should be established. Industry Canada notes that the Federal Communications Commission (U.S.) and the European Conference of Post and Telecommunications Administrations (CEPT) have adopted or drafted e.i.r.p. density emission masks for UWB systems as listed in Tables 3 and 4, respectively.

Table 3 - FCC Emission Limits (dBm/MHz) for Various UWB Systems

UWB System	GPR, Wall and Through-wall Imaging	Through-wall Imaging, and Fixed Surveillance	GPR, Wall Imaging, and Medical Imaging	Communications and Measurement		Vehicular Radar
				Indoors	Hand-held devices including outdoors	
Frequency Band	UWB bandwidth below 960 MHz	UWB bandwidth in 1.99–10.6 GHz	UWB bandwidth in 3.1–10.6 GHz			Anti-collision radar and other field disturbance sensors
≤ 960 MHz	The radiated emissions at or below 960 MHz shall not exceed the emission levels in Section 15.209 of the FCC Part 15 UWB rules (Radiated emission limits; general requirements).					
960-1 610 MHz	-65.3	-53.3	-65.3	-75.3	-75.3	-75.3
1 610-1 990 MHz	-53.3	-51.3	-53.3	-53.3	-63.3	-61.3
1 990-3 100 MHz	-51.3	-41.3	-51.3	-51.3	-61.3	-61.3
3.1-10.6 GHz	-51.3	-41.3	-41.3	-41.3	-41.3	-61.3
10.6-22.0 GHz	-51.3	-51.3	-51.3	-51.3	-61.3	-61.3
22.0-29.0 GHz	-51.3	-51.3	-51.3	-51.3	-61.3	-41.3
29.0-31.0 GHz	-51.3	-51.3	-51.3	-51.3	-61.3	-51.3
Above 31.0 GHz	-51.3	-51.3	-51.3	-51.3	-61.3	-61.3

Table 4 - CEPT Draft Emission Masks (dBm/MHz) for UWB Radiocommunication Systems

Type of Use	Frequency (f) / Power Density		
	f < 3.1 GHz	3.1 GHz < f < 10.6 GHz	f > 10.6 GHz
Indoor Use	-51.3 + 87 log (f/3.1)	-41.3	-51.3 + 87 log (10.6/f)
Outdoor Use	-61.3 + 87 log (f/3.1)	-41.3	-61.3 + 87 log (10.6/f)

It should be noted that the maximum emission levels of the FCC and draft CEPT masks are identical in the range 3.1–10.6 GHz and have the same value as the licence-exemption level for conventional (non-UWB) wireless systems (RSS-210 [ref. 2]).

4.2.2 Aggregate Interference

Industry Canada has conducted technical studies on compatibility between UWB and radiocommunication devices [ref. 3]. Below is a summary of the results of the studies performed by the Canadian Communications Research Centre (CRC) on aggregate interference from a multitude of UWB sources at 5 GHz.

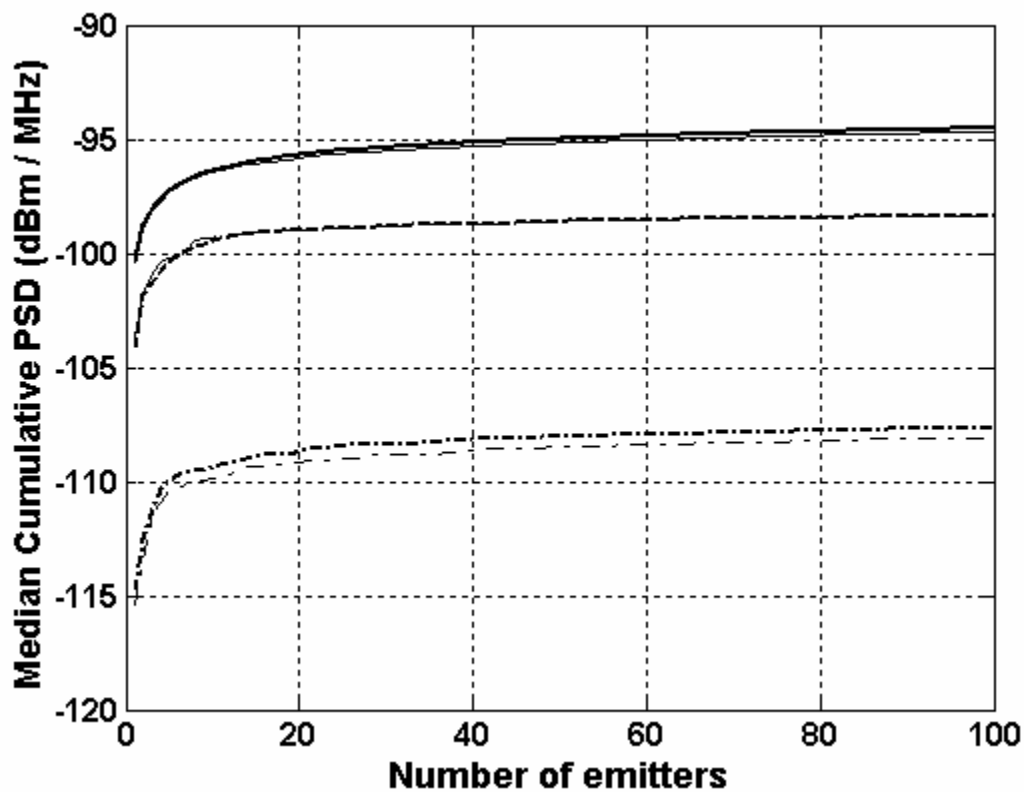
The aggregate interference from randomly distributed UWB emitters was analyzed using five different propagation (free-space, log-normal shadowing, random propagation factor using uniformly distributed random variables for the path loss exponent and the shadowing attenuation level, two-ray, and modified

two-ray) models in an outdoor environment. A uniformly random distribution of UWB devices was used to evaluate the aggregate interference of multiple UWB devices. The victim receiver was located at the centre of this distribution. For each distribution, the UWB emitters were sorted by distance from the victim receiver. The interfering power spectral density (PSD) level was calculated at the input of the antenna of the victim receiver as a function of the number of emitters by distance from the victim receiver. The emission level for each UWB device was at an e.i.r.p. spectral density of -41.3 dBm/MHz.

The simulation results show that the median cumulative power spectral density increases rapidly as a function of the number of UWB emitters up to a certain value beyond which the PSD level increases very slowly with the number of emitters. As shown in Figures 1 and 2, this value varies with the propagation model used in the analysis. In addition, Figures 1 and 2 show that the median cumulative PSD over different numbers of random distributions does not vary with the number of distributions when the number of distributions is sufficiently large.

Figure 1

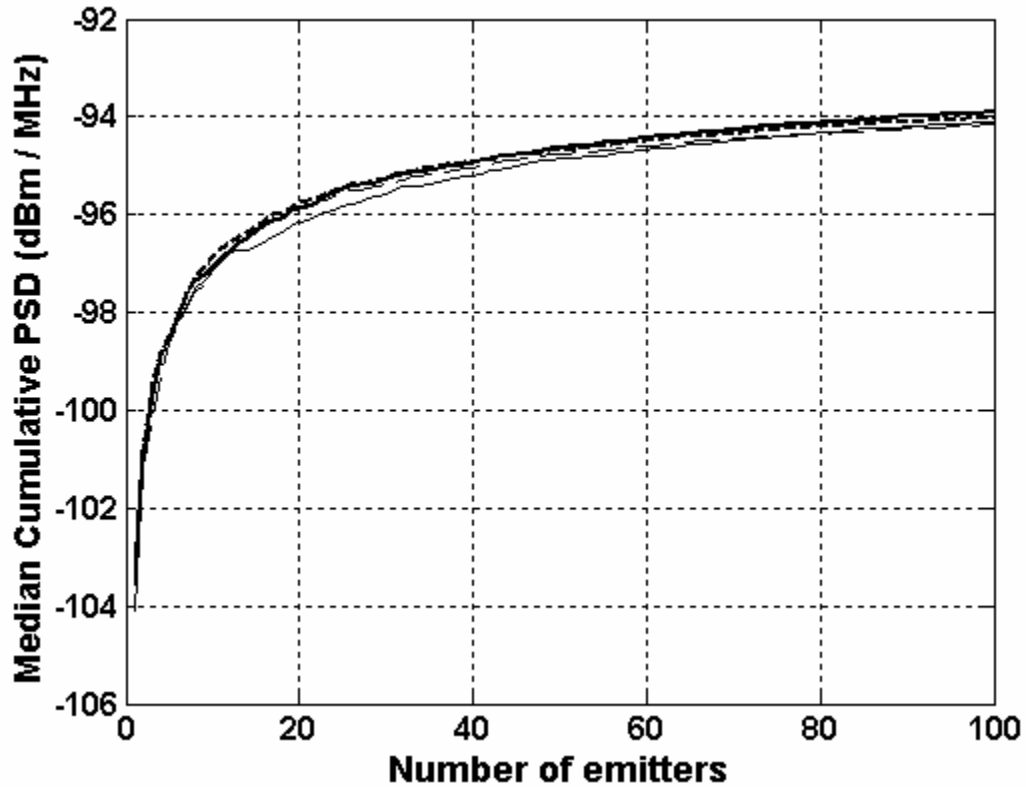
Median Cumulative PSD versus Number Of UWB Emitters in a $100\text{ M} \times 100\text{ M}$ Zone



For each propagation model there are two lines: one for 50 random distributions (i.e. thin lines) and the other for 200 random distributions (i.e. thick lines). The propagation models are free-space (solid lines), log-normal shadowing (dashed lines) and random propagation factor (dash-dot lines).

Figure 2

Median Cumulative PSD versus Number of UWB Emitters in a 100 M × 100 M Zone



For each propagation model there are two lines: one for 80 random distributions (i.e. thin lines) and the other for 200 random distributions (i.e. thick lines). The propagation models are two-ray (solid lines) and modified two-ray (dashed lines).

4.2.3 Measurement of UWB Emissions

One of the key issues for assessing interference levels, determining compatibility, and for certifying equipment is the establishment of appropriate measurement methodologies. Proper methodologies for the measurement and assessment of power and field strength are required for compliance with standards and specifications and may be useful for the purpose of spectrum monitoring. UWB devices can transmit at a low spectral power density to deliver a large amount of data across several GHz of spectrum. UWB devices may have pulsed emissions with fast rise-times. Thus UWB challenges the way radio frequency measurements are made for conventional radiocommunication systems. Appropriate measurement methods are needed for:

- power spectral density;
- peak power level; and

- other measurements (e.g. pulse repetition frequency, etc.).

The Department proposes the following guidelines for measuring UWB emissions:

- The spectrum is to be investigated from the lowest frequency generated in the UWB transmitter, without going below 9 kHz. If the UWB center frequency is less than 10 GHz, then there is no requirement to measure emissions beyond 40 GHz. There is no requirement to measure emissions beyond 100 GHz if the UWB center frequency is at or above 10 GHz and below 30 GHz; or beyond 200 GHz if the UWB center frequency is at or above 30 GHz.
- Radiated UWB emissions are to be made based on power spectral density measurements in terms of e.i.r.p. per one MHz spectral segments. The measurement is to be based on the use of a spectrum analyzer employing a 10 kHz integration bandwidth. If the transmission is in bursts, measurements are to be made over any 100 millisecond period or over the burst duration if the burst is shorter than 100 milliseconds, during which its power value is at its maximum.
- Peak power measurements are to be centered on the frequency at which the highest radiated emission occurs.

4.3 Regulatory and Licensing Considerations

There are three different options that could potentially be used to address the authorization requirements of devices using UWB technology in Canada.

(a) A Licensing Approach

The traditional licensing approach used by Industry Canada has been to process most applications for radio facilities and assign frequencies for a specific location for which a “radio licence” is issued. Another type of radio authorization called a “spectrum licence” is also being used to accommodate the concept of area licensing. Spectrum licences are authorized by geographical area(s) and frequencies or frequency block(s). Both these licensing processes are provided for in the *Radiocommunication Act* [ref. 4] and the *Radiocommunication Regulations* [ref. 5].

UWB is a wireless technology and not a radiocommunication service. However, it can be integrated into various wireless services. In addition, it is envisaged that UWB will be integrated into a variety of applications including consumer devices and vehicular radar. Therefore the traditional approaches of radio and spectrum licensing may not be adequate for some UWB applications.

(b) A Licence-exempt Approach

The *Radiocommunication Act* (section 6(2)) and the *Radiocommunication Regulations* provide a regulatory scheme whereby licence exemptions on the basis of a technical standard for certain radio apparatus may be articulated in appropriate equipment standard specifications. Such radio apparatus are exempt from the requirement to operate under a radio licence, but are instead authorized by way of certification to appropriate Industry Canada Radio Standards Specifications (RSS). Such radio apparatus are operated in accordance with the Department’s policies.

A new RSS could be developed to permit UWB devices to operate on a licence-exempt basis under technical conditions that would provide a level of interference protection for licensed radiocommunication systems. Licence-exemption requirements for UWB devices could also be included into an existing standard such as RSS-210 [ref. 2].

(c) A User-eligibility Based Approach

This option would allow some user groups to operate specific UWB equipment on a licence-exempt basis under certain conditions. The UWB equipment would have to comply with specific radio standards specifications and be certified. UWB devices operated under this option would have to bear a statement specifying the eligible user groups (e.g. law enforcement agencies, scientific research institutes, fire and emergency rescue organizations). Under such an option, the *Radiocommunication Regulations* may have to be amended to allow specific user groups to operate certain UWB systems without the requirement of a licence. A potential consequence of this option is that it may be difficult to find a flexible regulatory framework to address future requirements to include additional user groups and /or additional UWB equipment.

5. Invitation to Comment

Industry Canada wishes to identify public interests and issues relevant to the introduction of various types of UWB devices in Canada. Interested parties are invited to respond to the following questions:

- (Q1) Sections 3.1 and 3.2 of this consultation describe potential benefits and concerns relevant to the introduction of wireless devices using ultra-wideband (UWB) technology. Please provide additional interests and/or concerns that you may have.
- (Q2) The Department proposes to use the set of definitions and terminology in Section 4.1 in reference to UWB technology. Is this set adequate and if not, what would be the appropriate alternative(s)?
- (Q3) The Department is proposing guidelines in Section 4.2.3 for measuring emissions from devices which use UWB technology. Please provide your comments regarding these guidelines.
- (Q4) The Department is of the view that licensing is a valid approach to authorize ground penetrating radar, wall imaging, and through-wall imaging devices that use UWB technology. The Department is considering limiting the use of these devices to specialized user groups (e.g. law enforcement agencies, scientific research institutes, fire and emergency rescue organizations) and of limiting area(s) of operation. Please provide your comments regarding this licensing approach.
- (Q5) UWB will be integrated into various wireless applications including consumer devices (e.g. laptops, home theatre, etc.) and into transportation vehicles (e.g. vehicular radars, road sensors, etc.). These applications will be mass distributed in markets and may be acquired both in Canada and abroad. Consequently the Department is of the view that a licence-exempt approach is a valid regulatory option to authorize these devices. These devices must comply with specific radio standards specifications and be certified. Please provide your comments on the use of an appropriate approach for authorizing UWB consumer devices, UWB communications and measurement devices, UWB vehicular radars, and UWB field disturbance sensors.

- (Q6) Considering the FCC and the proposed CEPT emission masks for UWB systems, what emission masks and what other, if any, measures (operational restrictions, etc.) would protect authorized radiocommunication services from harmful interference and would not impede the development of UWB devices?

Please supply the rationale with technical studies as appropriate with your comments or response to the above questions. Please consider the feasibility of implementing and enforcing various licensing options, as well as their implication on the market and trade. Please show how your proposal is in the public interest and explain the implication on the UWB industry (e.g. cost of producing UWB devices and marketability) and on radiocommunication services (e.g. quality of service and additional costs for radiocommunication services).

6. Next Step

In developing the appropriate regulatory tools for ultra-wideband, the Department will consider the status of ultra-wideband wireless communication applications in the market, standardization developments within the ultra-wideband industry, other regional and international regulatory and technical developments, as well as the results of ongoing compatibility studies. The cost and feasibility of implementing and enforcing various regulatory and licensing options and their implication on trade, the ultra-wideband industry, and on radiocommunication services will also be taken into consideration.

Based on these factors and considering public comments on this consultation, the Department anticipates that it will develop policies, standards, certification and/or licensing requirements to oversee the introduction and use of ultra-wideband technology in Canada. These factors and comments may also provide a basis for further consultations.

7. References

- [1] *First Report and Order on ultra-wideband (UWB) technology*, ET Docket 98-153, Federal Communications Commission, Washington, D.C., USA, April 2002.
- [2] [Radio Standards Specifications 210: Low Power Licence-Exempt Radiocommunication Devices \(All Frequency Bands\)](http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf01320e.html), Industry Canada, Issue 5, November 2001,
<http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf01320e.html>
- [3] *Suitability of some propagation models to analyse interference from ultra wideband transmitters in outdoor environments*, Q. Zeng, Communications Research Centre Canada, IEEE Conference on Ultra Wideband Systems and Technologies, Reston, Virginia, USA, November 2003, pp. 488-492.
- [4] [Radiocommunication Act](http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf01140e.html), Industry Canada, Issue 5, September 1996,
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- [5] [Radiocommunication Regulations](http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwGeneratedInterE/sf01265e.html), Industry Canada, Issue 7, January 2002,
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Annex: Acronyms

BPSK:	Binary Phase Shift Keying
CEPT:	European Conference of Post and Telecommunications Administrations
CITEL:	Inter-American Telecommunication Commission
E.I.R.P. / e.i.r.p.:	Effective isotropic radiated power
ETSI:	European Telecommunications Standards Institute
FCC:	Federal Communications Commission
GPR:	Ground Penetrating Radar
GMSK:	Gaussian Minimum Shift Keying
IEEE:	Institute of Electrical and Electronics Engineers
ISM:	Industrial, Scientific, and Medical
ITU-R:	International Telecommunications Union (Radiocommunications Bureau)
NTIA:	National Telecommunications and Information Administration
OFDM:	Orthogonal Frequency Division Multiplexing
PSD:	Power Spectral Density
PPM:	Pulse Position Modulation
QPSK:	Quadrature Phase Shift Keying
QAM:	Quadrature Amplitude Modulation
RABC:	Radio Advisory Board of Canada
RF:	Radiofrequency
RLAN:	Radio Local Area Network
RSS:	Radio Standards Specifications
UWB:	Ultra-wideband
WPAN:	Wireless Personal Area Network