Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Regulatory activities and suggestion for global harmonization
- Overview of Interim Report of MPHPT and ITU-R TG1/8 activities-]

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Re: [ ]

Abstract: [In order to realize the global harmonization and compromise in IEEE 802.15.3a UWB WPAN, the recent Japanese regulatory activities are briefly introduced.]

Purpose: [For realizing High Rate Alternative PHY standard in 802.15TG3a in a timely manner.]

Regulatory activities and suggestion for global harmonization - Overview of Interim Report of MPHPT and ITU-R TG1/8 activities -

Tetsushi IKEGAMI, Tetsuya YASUI, Ryuji KOHNO

National Institute of Information and Communications Technology (NICT)

Outline of presentation

1. Investigations of UWB technology and regulatory issues in the world

2. Japanese regulatory activities on UWB systems, Interim Report of MPHPT UWB Radio Systems Committee

3. Activities in ITU-R TG1/8

4. Concluding remarks

5. Backup materials

1. Investigations of UWB technology and regulatory issues in the world

Investigations in Japan

- Four working groups have been set up to investigate compatibility between UWB and other radio communication systems:
  the Compatibility Model Working Group, the Fixed-Broadcasting systems Working Group,
  the Radar-Aviation and Maritime systems Working Group, the Satellite-Low Power systems Working Group
- Comments were invited on the Draft Interim Report
  22 submissions received in the period 2 – 27 February 2004

UWB investigations overseas

(1) FCC (US Federal Communications Commission)
The FCC began conducting surveys and investigating measurement methods in 1998, based on the basic assumption that UWB should not cause interference or require interference protection. In 2002, the FCC issued tentative provisions.
The provisions for UWB communication applications are:
- Part 15.209 spurious emissions regulations apply to 3.1 – 10.6 GHz
- Emission power restricted below 3.1 GHz and above 10.6 GHz to prevent interference with other radio communications systems.

(2) IEEE (US Institute of Electrical and Electronics Engineers)
The IEEE is studying the feasibility of 802.15TG3a as a WPAN standard.
Candidates for standardization have been narrowed down to Multi-Band OFDM and DS-CDMA, but a final decision has yet to be made.

(3) ITU-R (International Telecommunications Union—Radio Communication Standardization Sector)
In July 2002, ITU-R set up Task Group 1/8 under Study Group 1 (Spectrum management) to investigate UWB technology, regulatory issues and compatibility with other radio systems.

2. Japanese Regulatory Schedule on Commercial UWB Systems

- Sept. 2002: MPHPT organized UWB regulatory committee
- Feb. 2004: MPHPT released an Interim Report of UWB Radio Regulation
- 3rd Q, 2004: MPHPT will partially approve a commercial UWB Regulation

MPHPT : Ministry of Public Managements, Home Affairs, Posts and Telecommunications

MPHPT Telecommunications Council UWB Radio Systems Committee

> Four working groups were set up to investigate compatibility between UWB and other radio communication systems in Nov. 2002:

Group 1: the Compatibility Model Working Group,
Group 2: the Fixed and Broadcasting systems Working Group,
Group 3: the Radar, Aviation and Maritime systems Working Group,
Group 4: the Satellite and Low Power systems Working Group

> Comments were invited on the Draft Interim Report
22 submissions received in the period 2 – 27 February 2004

3. Interim Report Issued by MPHPT Telecommunications Council UWB Radio Systems Committee

Draft Interim Report was issued on 2 Feb. 2004.
Comments were invited.

The Report and Documents are Publicly Available on Web site of MPHPT.

http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol15/Vol15_01/Vol15_01.html#2

Telecommunications Council
Information and Communications Technology Subcouncil
UWB Radio Systems Committee

Interim Report Summary

Wednesday March 24, 2004

Basic principles of compatibility study in Japan

1) Radio spectrum is a finite resource. As such, radio spectrum usage should adhere to international systems of rules and should be carefully designed to avoid future problems.

2) As yet, UWB stations do not belong to any designated services and the UWB format is not based on the Radio Regulations (RR) allocations. As such, it is not considered in compliance with stipulations.

3) The study of compatibility conditions is predicted on radio regulations (RR) Section4.4 concerning interference.

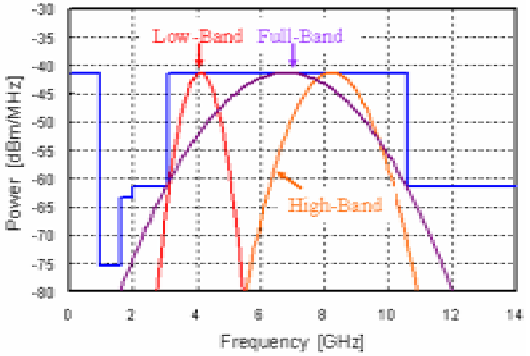
Radio Regulations, Section 4.4

Administrations of the Member State shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.

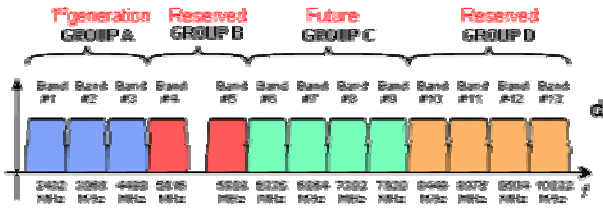
Proposed compatibility models

> Different types of UWB radio systems under consideration

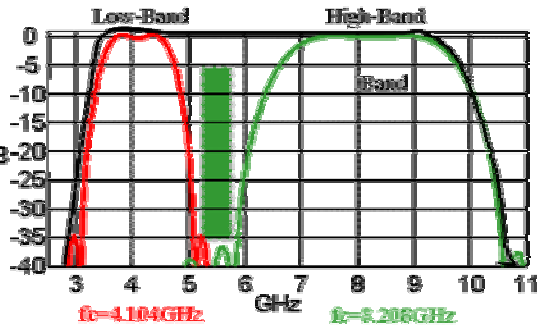
Pulse type



MB-OFDM type



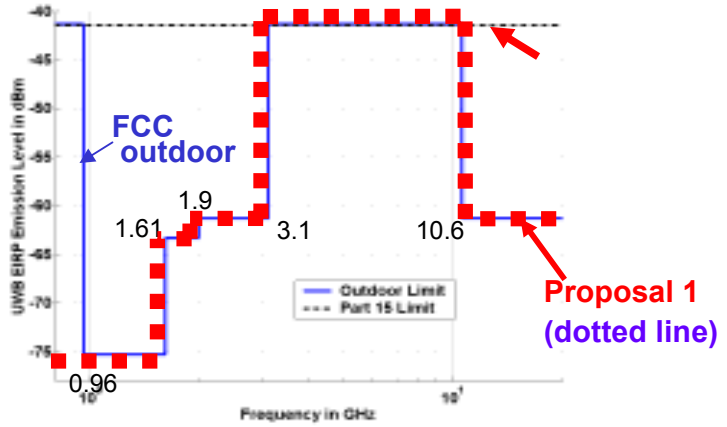
DS-UWB type



> Proposals for emission power mask

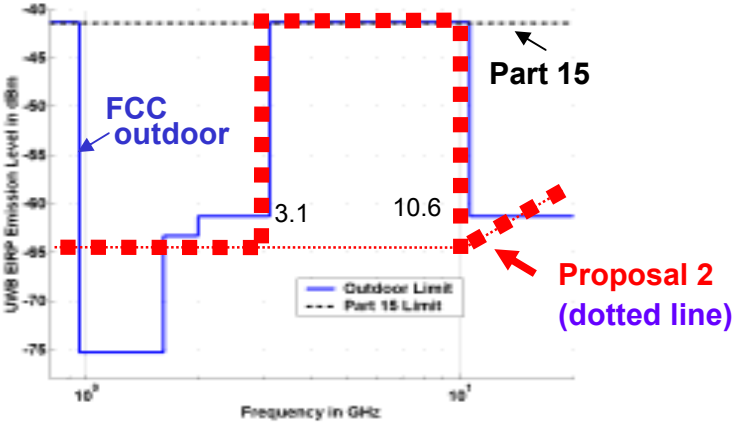
<Proposal 1>

Based on FCC Outdoor specifications



< Proposal 2>

Standards for Extreme Low Power Stations in Japan applied to portion of spectrum outside the range 3.1 – 10.6 GHz



Evaluation of Interference with coexisting radio systems

The proposed compatibility model was subject to interference calculation under the following conditions to assess interference by a single UWB device with other radio communication systems.

- **FCC transmission power mask: -41.3 dBm/MHz at 3.1-10.6GHz**
- **Free space propagation**
- **Wall attenuation: 12 dB (assuming indoor use; outdoor use: four times greater separation)**
- **User density: 3000 devices/km^2 (1/3 of IEEE802 model)**
- **Activity factor: Averaging 1%-5% ON per time basis**
- **Operations onboard aircraft, ships or satellites are prohibited.**
- **Average power evaluation and peak power evaluation**

Some of the evaluation results

- Minimum distance to victim system

Fixed Service: 4GHz, 5GHz, 6GHz, 6.5GHz, 7.5GHz, 11GHz, 12GHz, 15GHz, 18GHz

Criteria:

Allowable Interference Level < kTBF – 20 dB

Based on ITU-R Rec.1094-1

Receiver Sensitivity is decided by

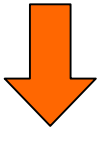
AWGN(kTBF) + Required C/N + Implementation Loss

$k = 6.28 \times 10^{-23}$ [J/K]: Boltzman's Constant

T : System Noise Temperature [K]

B : Receiver Bandwidth [Hz]

F : Noise Figure of Rx



Evaluation Results:

Minimum Separation Distance : 80m to 2.3km

Broadcasting Service: 3.5GHz, 5.9GHz, 6.5GHz, 7GHz, 10.5GHz, 12GHz, 13GHz

Main Usage:

FPU (Field Pick-up Unit)

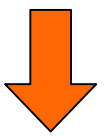
TTL (Transmitter to Transmitter Link)

STL (Studio to Transmitter Link)

SHF band Broadcasting

Criteria:

Allowable Interference Level < kTBF – 20 dB



Evaluation Results:

Minimum Separation Distance 31m to 510m

Radar, Maritime: 1.6GHz, 3GHz, 9GHz

Criteria:

Allowable Interference Level < Rx Sensitivity – 10 dB

Evaluation Results:

Minimum Separation Distance 4m to 188m

It is not allowed to use UWB devices onboard Ship.
However,it cannot be prohibited to bring them into ship.
Evaluation should be based on UWB devices exist onboard.

Weather Radar: 5.3GHz, 5.7GHz

Criteria:

Allowable Interference < Minimum RX Sensitivity – 20 dB
Evaluation based on Peak Power for UWB

Evaluation Results:

Minimum Separation Distance 12km to 38km

Satellite: 1.5GHz, 2GHz, 2.5GHz, 4GHz, 6GHz, 7GHz, 8GHz, 10GHz, 11GHz, 12GHz, 13GHz, 14GHz, 17GHz, 19GHz, 29GHz

Criteria:

From ONE UWB Device

Allowable Interference Level to Down Link < kTBF – 20 dB

Evaluation Results:

Minimum Separation Distance 1m to 925.8m

Earth Observation Satellite (Passive Sensor): 1.4GHz, 2.7GHz, 4.3GHz, 7GHz, 10.7GHz

Frequency	1.4GHz	2.7GHz	4.3GHz	7GHz	10.7GHz
Number of UWB Devices, Outdoor	4642	1174	6	21	2830
Density of UWB,Outdoor	2.3/km^2	0.4/km^2	0.0/km^2	0.0/km^2	2.8/km^2
Number of UWB, Indoor	73578	18604	98	335	44855
Density of UWB, Indoor	36.3/km^2	5.8/km^2	0.1/km^2	0.1/km^2	44.4/km^2

Criteria: Allowable Interference Level Based on ITU-R SA.1029-2

Radio Astronomy: 3260-3267MHz, 3332-3339MHz, 3345.8-3352.5MHz, 4825-4835MHz, 4950-5000MHz, 6650-6675.2MHz, 10.6-10.68GHz, etc.

Criteria: From ONE UWB Device
Allowable Interference Level Based on ITU-R RA.769
Assuming Average Power and Wall Loss

Evaluation Results:

Minimum Separation Distance : 7.7km to 23.6km

When Density of UWB Devices is 3000 devices/km^2,
Allowable Transmitting Power for ONE UWB Device :

–155dBm/MHz !!

Mobile Phone, Base Station: 800MHz, 1.5GHz, 2GHz,1.9GHz, etc.

Criteria:

Allowable Interference Level < kTBF – 20 dB

Evaluation Results:

Minimum Separation 181.7m to 3.92km

Mobile Phone, Terminal: 800MHz, 1.5GHz, 2GHz,1.9GHz, etc.

Criteria:

Allowable Interference Level < kTBF – 10 dB

Evaluation Results:

Minimum Separation 6.4m to 49.5m

Further Study in the MPHPT UWB Committee and Summary of 22 Public Comment Submissions To Draft Interim Report

Further Studies in MPHPT UWB Committee

(1) **Harmonization with international studies** is required, particularly with **ITU-R and IEEE studies**. Similarly, the outcomes of technical studies in Japan should be contributed in recommendations from organizations such as the ITU-R.

(2) Theoretical calculations based on the ITU-R recommendations and the proposed compatibility model incorporating FCC emission power proposals found that long separate distance or limitations on the number of devices would be required **for compatibility between UWB and other radio systems**, necessitating further studies as follows:

> Study of actual effect of UWB based on experimental data and simulations

> Detailed investigation to consider actual deployment of radio systems

> Other strategies for mitigating interference

> Review of emission power proposals

Summary of public comment submissions and future approach

- UWB will be a key technological component used in the construction of **ubiquitous networking systems in the future**. As such, it is important that UWB technology is institutionalize as soon as possible.
- **UWB investigations** should inquire carefully not on condition of introduction but **in consideration of the international investigations**.
- **UWB interference issues** should be considered in terms of a proper understanding of the technology on both sides, as opposed to the traditional approach to interference.
- UWB technology should be institutionalized step-by-step through a combination of **intensive contributions to the ITU-R and usage limitations (such as in-home and regional limitations).**
- Agreement with proposals for the general direction of investigations based on the **need for international harmonization**, **studies of actual effects using experimental data** and **reviews of the emission power mask proposals.**

Personal Comment: Potential Interference Consideration Also Need for Beyond 3G!

4. Activities in ITU-R TG1/8

Japanese Contribution in ITU-R TG1/8

1. Starting: ITU-R established **Task Group 1/8** in the meeting of SG1 in **July 2002**.
Assigned Questions are
> Q.226（**Spectrum management framework related to the introduction of ultra-wideband (UWB) devices**）and
> Q.227（**Compatibility between ultra-wideband (UWB) devices and radiocommunication services**）.

2. Working Plan:Meetings are planned 4 times from 2003 to 04.
Chairman is Mr. Salim Hanna (Canada).

Deliverables:

>ITU-R Recommendation on the characteristics of UWB
>ITU-R Recommendation(s) addressing compatibility between UWB and Radiocommunication services
>ITU-R Recommendation providing guidance to administrations on a spectrum management framework for UWB
>ITU-R Recommendation on measurement techniques for UWB

Working Group 1 (WG 1) – UWB characteristics

Chairman: William Gamble (USA)

Mandate: To collect and document key technical and operational characteristics of UWB;

Working Group 2 (WG 2) - UWB compatibility

Chairman: Yves Ollivier (France).

Mandate: To address compatibility issues

Deliverables:

1 One or more ITU-R Recommendation(s) on **compatibility between UWB devices and Radiocommunication services**.

2 ITU-R Report summarizing the results of technical studies on **compatibility between UWB devices and Radiocommunication services.**

Working Group 3 (WG 3) - UWB spectrum management framework

Chairman: Christoph Wöste (Germany).

Mandate: to prepare a spectrum management framework intended as guidance to administrations considering the introduction of UWB devices.

Working Group 4 (WG4) - UWB measurement techniques

Chairman: Tetsuya Yasui (NICT, Japan)

Mandate: To develop appropriate measurement techniques for UWB emissions

Deliverables:

Develop one or more ITU-R Recommendation providing guidance to administrations how to measure emissions from devices using UWB technology.

ITU-R TG1/8: Summery of 1st meeting

Date and place: Geneva from 21-24 January 2003
Attendees: 85 delegates
representing 17 Administrations,
18 Sector Members including NICT,
Input documents: 44 input documents
Output documents: 23 temporary documents

ITU-R TG1/8: Summery of 2nd meeting

Date and place: Geneva from 27-31 October 2003
Attendees: 118 delegates
representing: 26 Administrations
18 Sector Members including NICT
Input documents: 57 input documents
Output documents: 37 temporary documents

Japanese Contributions on Measurements of UWB Signals for ITU TG1/8

Regulatory Committee for UWB Radio Systems in Ministry:MPHPT

✓ Japanese Regulator (MPHPT) has been investigating **mutual interference** between UWB and victim systems.

✓ Some results on **measurements of UWB signals** have been presented at ITU TG1/8.

✓ This is important for a regulator to **approve type** of UWB systems. Regulators in ITU Region 3 (Korea, China, Singapore etc in Asia) may be mostly same situation.

ITU-R TG1/8: NICT work for 3rd meeting

Date and place: Boston, USA , 9-18 June 2004

Attendees: 150 delegates

representing 21 Administrations,

33 Sector Members including NICT

Input documents: 104 input documents

Output documents: 39 temporary documents

Draft contributions from NICT in Japan:

1 doc for Characteristics (WG1)

7 docs for Measurement (WG4)

8 participants from NICT and UWB consortium

>NICT contribute the activities of ITU-R TG1/8 positively.

>NICT aims that UWB can be introduced to the users soon under the harmonization in the world.

>NICT seeks best way from the point of users' view.

UWB compatibility discussion in ITU-R TG1/8

1. ITU-R TG1/8 is studying compatibility issue between UWB and relative Radio service and system.
2. Following slides are extracts of Temporary documents discussed in the TG1/8 Boston meeting in June 2004.
3. These are not the final conclusion of the discussion.
4. Referring original documents is necessary in order to understand these analyses correctly.
5. The status of ITU-R's discussion seems very severe for UWB devices, equipments and systems.

(An example, see backup materials for more detail)

Radio Astronomy Service (2) (ITU-R TG1/8 1-8/TEMP/77)

1. It can be seen from the initial results that for UWB transmissions a spectrum mask that offers protection to the Radio Astronomy Service is required.

2. It is also noted that the geographic separation distances required to meet with RAS protection criteria are substantial and clearly highlight the sharing difficulties between UWB and radio astronomy.

(An example, see backup materials for more detail)

IMT-2000 (ITU-R TG1/8 1-8/TEMP/47rev1)

UWB PSD values to protect the most sensitive IMT-2000 mobile stations in a typical IMT−2000 deployed network at a reference distance of 36 cm*.

Frequency band	1 710-1 885 MHz	1 885-2 025 MHz	2 110-2 170 MHz	2 500-2 690 MHz
Max UWB PSD (dBm/MHz)	-86.4	-85.9	-85	-83.1

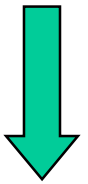
*The maximum UWB PSD value was obtained in the 2 110–2 170 MHz band, the values for the other bands have been extrapolated using free space propagation model.

5. Concluding remarks

1. As for MPHPT Interim Report, merged proposals 1 and 2 both must jointly investigate how to avoid interference to the victim systems. Otherwise we may loose opportunity to promote commercial UWB products at all.

2. ITU-R TG1/8 proposed to organize two more extra meetings in March and June 2005, extended from original schedule that is ended Nov. 2004, in order to complete Regulation agreement in a world. This means that issues for eliminating interference to the victim systems should be resolved as soon as possible before next March. Otherwise we will loose the time to market except USA.

6. Backup materials



6-1 Interim Report, MHPHT Evaluation of Interference with coexisting radio systems

Study of radio systems interference

Interference between a single UWB device and various other radio communication systems was calculated under the following conditions.

- FCC emission power : -41.3 dBm/MHz (3.1 GHz – 10.6 GHz)
- Free space propagation
- Wall attenuation : 12 dB (assuming indoor use. Outdoor use: four times greater separate)
- Average power evaluation

	Main frequencies	Interference study
Fixed microwave systems	4 GHz, 5 GHz, 6 GHz, 6.5 GHz, 7.5 GHz, 11 GHz, 12 GHz, 15 GHz, 18 GHz	Separation of 80 m – 2.3 km is required in order to achieve the allowable interference level of kTBF-20dB as per ITU-R Rec. 1094-1. Minimum reception sensitivity is defined as noise + required C/N + fixed degradation. Composition of fixed degradation component is pre-determined; since UWB interference degradation cannot be included, thermal noise (kTBF) is used as the tolerance standard.
Broadcasting systems	3.5 GHz, 5.9 GHz, 6.5 GHz, 7 GHz, 10.5 GHz, 12 GHz, 13 GHz	Separation of 31 – 50 m required to achieve allowable interference level of kTBF-20db. Single entry separation is calculated for FPU (mobile Field Pick-up Unit used for live transmission on location) and SHF broadcasting (used for fixed household reception) only. For other types of fixed receiver (such as TSL and STL), the fixed microwave systems evaluation results are applied. Systems such as FPU would be used indoors and/or in close proximity to UWB, in situations with little wall attenuation. FPU could be used for (1) non line of sight, (2) wall reflection, or (3) communication between buildings. In terms of actual usage, in most cases a location plan and a frequency plan drawn up to enable prior testing. During actual relay transmission, the UWB device must not generate a signal that interrupts the broadcast. (UWB usage locations are not controlled so the broadcasters are not in a position to do anything about interference.) Some systems would have a bandwidth of under 1 MHz, so this should be tested too.
Amateur radio communication systems	5.6 GHz, 10 GHz	Separation of 29 – 92 m required to achieve a receiver sensitivity at the allowable interference level. Although frequencies are shared with radar and DSRC, the number of radars is relatively low, while DSRC is used in a limited locations. Interference problems would therefore be minimal. UWB, on the other hand, is normally used indoors so the potential for interference would be much greater.

	Main frequencies	Interference study
Radar and marine systems	1.6 GHz, 3 GHz, 9 GHz	Separation of 4 m – 188 km is required in order to achieve the allowable interference level of reception sensitivity –10 dB. In terms of service implications, it is impossible to prohibit on board a ship use of UWB devices. Tests for marine systems should therefore assume that UWB may be present on board. Given that some coastal stations use non-directional antennae, testing is also required in this area.
Aviation and weather radar systems	【Aviation systems】 1 GHz, 4,3 GHz, 9.4 GHz	Regardless of whether UWB is prohibited on board aircraft, further testing is required regarding the effects between external UWB devices (outside the aircraft) and on board radio equipment. In the United States, the RTCA (Radio Technical Commission for Aeronautics) has been studying on board UWB usage since January 2004, with findings due to be released by the end of 2005. Every effort should be made to keep abreast of such developments in international investigations. Testing is still in progress on separation distances for individual systems.
	【 Weather radar systems】 5.3 GHz, 5.7 GHz	In peak power tests, Separation of 12 – 38 km is required in order to achieve the allowable interference level of receiver sensitivity –20 dB (average power tests not carried out). Some weather radar operate with an 0° angle of elevation. An input level greater than the minimum receiver sensitivity would cause a detection error.
Radio astronomy systems	3,260 – 3,267 MHz, 3,332 – 3,339 MHz, 3,345.8 – 3,352.5 MHz, 4,825 – 4,835 MHz, 4,950 – 4,990 MHz, 4,990 – 5,000 MHz, 6,650 – 6.675.2 MHz, 10.6 – 10.68 GHz	For a single UWB device, Separation required to satisfy ITU-R RA.769 at average power is 7.7 km – 23.6 km, taking wall attenuation into consideration. At a density of 3,000 devices per km^2, the emission power limit on each UWB device would need to be around –155 kBm/MHz. Radio astronomy systems observe in low noise level locations, so interference calculation in high noise locations are not considered necessary. Radio astronomy systems involve observation of signal levels below that of thermal noise. It is therefore unlikely that the interference threshold over the 2,000 second calculation period could be lowered below the ITU-R recommended RA.769 level. The ITU-R recommendation P.452 is considered a more realistic for radio astronomy systems compatibility evaluations than the ITU-R recommendation P.1411. A propagation model will need to be chosen at some point in the future. Given that the earth is spherical, the study would need to consider feasibility issues.

<table>
<tr><th></th><th>Main frequencies</th><th>Interference study</th></tr>
<tr><td>Satellite</td><td>• Mobile satellite
• Stationary satellite
• Broadcasting satellite
• Earth exploration satellite (including feeder links)
1.5 GHz, 2. GHz, 2.5 GHz, 4 GHz, 6 GHz, 7 GHz, 8 GHz, 10 GHz, 11 GHz, 12 GHz, 13 GHz, 14 GHz, 17 GHz, 19 GHz, 29 GHz</td><td>Downlink: separation of 1 – 925.8 m required to achieve allowable interference level of kTBF – 20 dB (for single UWB device).
For uplink and downlink, compatibility study required into aggregate interference from all applications including UWB in a footprint (primary applications excluded).
Where UWB is used indoors, it is unlikely to exist in the direction of maximum gain of a terrestrial station antenna. However, UWB may exist in locations very close to this direction, even when the building does not affect transmission.
BS antenna tend to be installed on verandas and at other location that could potentially be in close proximity to UWB. Given the usage environment, the wall attenuation is unlikely to provide much. Receiver could well suffer from UWB interference from neighboring dwellings.
Sea rescue systems use at 1.5 GHz , which is of vital importance with respect to human life. Interference study is already underway.
Some systems use bandwidths under 1 MHz; a study is required into the effect on narrowband carriers using less than 1 MHz.
<table>
<tr><th>Outdoor</th><th>1.4GHz</th><th>2.7GHz</th><th>4.3GHz</th><th>7GHz</th><th>10.7GHz</th></tr>
<tr><td>Number of UWB devices</td><td>4,642</td><td>1,174</td><td>6</td><td>21</td><td>2,830</td></tr>
<tr><td>Density (devices per km²)</td><td>2.3</td><td>0.4</td><td>0.0</td><td>0.0</td><td>2.8</td></tr>
</table>
</td></tr>
<tr><td></td><td>【Earth exploration satellites (on-board passive sensors)】</td><td>The table below shows the maximum number of UWB devices and density for an allowable tolerance level as per the ITU-R recommendation SA.1029-2 for EESS (passive).
<table>
<tr><th>Indoor</th><th>1.4GHz</th><th>2.7GHz</th><th>4.3GHz</th><th>7GHz</th><th>10.7GHz</th></tr>
<tr><td>Number of UWB devices</td><td>73,578</td><td>18,604</td><td>98</td><td>335</td><td>44,855</td></tr>
<tr><td>Density (devices per km²)</td><td>36.3</td><td>5.8</td><td>0.1</td><td>0.1</td><td>44.4</td></tr>
</table>
</td></tr>
<tr><td></td><td>【GPS】
1.5 GHz</td><td>Separation of 0.5 – 7.3 m required to achieve the allowable interference level of kTBF – 6dB.
The accuracy of GPS in mobile telephones and other devices that perform measurements indoors and in close proximity to UWB would be affected.
At the second meeting of ITU-R TG 1/8, Qualcomm submitted a proposal on allowable transmission power with a separation distance of 1 m. Investigations are continuing.</td></tr>
</table>

	Main frequencies	Interference study
DSRC	5.8 GHz	Separation of 0.5 – 11 m is required when the allowable interference level is the reception sensitivity. If the inside of a vehicle is assumed to be indoors, UWB devices can be brought inside. Moving vehicles with UWB devices can potentially impact on a wide range of other radio communication systems. As with aircraft, usage within vehicles will need to be restricted. The types of UWB devices that are build in vehicles can be restricted, but it is more difficult to prevent UWB devices being taken into vehicles. Further investigation is required.
Mobile telephones	800 MHz, 1.5 GHz, 2 GHz, 1.9 GHz (PHS)	Separation is 181.7 m – 3.92 km for base stations (allowable interference level = kTBF – 20dB) and 6.4 – 49.5 m for mobile stations (allowable interference level = kTBF –10dB). While separation for mobile stations may appear short, it is envisaged that UWB devices and mobile phones would be used in the same personal area, with the potential for mobile stations to approach UWB devices to within one meter in an indoor setting. Some form of effective interference mitigation strategy for compatibility. Interference from neighboring cells can be controlled where identical systems are involved, but not when the systems differ from one another. For this reason, kTBF should be used as the base standard for compatibility with mobile phones. Since PDC and PHS use channel bandwidth of less than 1 MHz, an investigation into emission power mask regulations under 1 MHz is required. An ITU-R working document describes IMT-2000 (using the Monte Carlo method) and UWB compatibility test results, suggesting that the FCC mask should be reduced by a further 10 dB in the 2 GHz band. In the near future, systems included in frequency allocation plans should be incorporated into testing and experimental programs so as to prevent any problems with 4G mobile communication systems and ubiquitous networking devices.
Radio access	5 GHz	Separation of 15.6– 61.9 m required to achieve allowable interference level of kTBF – 10dB. In order to prevent reception errors in wireless LAN systems, it may be necessary to impose limits such that the maximum UWB transmission peak power does not result in a received signal level above the wireless LAN CS threshold: 1. Separation between UWB and wireless LAN to ensure that the UWB peak power level received by a wireless LAN does not exceed the CS threshold for the LAN 2. Compatibility with wireless LAN systems requires collision avoidance using CS to be built into UWB (as with 11a).

Comments were invited on the Draft Interim Report, 22 Submissions Received in the Period 2-27 Feb. 2004

Affirmative Comments

- Manufacturer : 8

Negative or Prudent Comments

- Broadcasting Organization : 6
- Mobile Phone Operator : 1
- Independent : 2
- Astronomy Observatory : 1
- Electric Power Organization : 1
- ITS Organization : 1
- Radio Amateur : 2

6-2 UWB compatibility discussion in ITU-R TG1/8

1. ITU-R TG1/8 is studying compatibility issue between UWB and relative Radio service and system.
2. Following slides are extracts of Temporary documents discussed in the TG1/8 Boston meeting in June 2004.
3. These are not the final conclusion of the discussion.
4. Referring original documents is necessary in order to understand these analyses correctly.
5. The status of ITU-R's discussion seems very severe for UWB devices, equipments and systems.

Earth Exploration Service (1) (ITU-R TG1/8 1-8/TEMP/75)

1. SAR: synthetic aperture radar. Spaceborne SARs remote sensing technology make it possible to acquire global-scale data sets that provide unique information about the Earth's continually changing surface characteristics.
2. The current EESS (active) allocation at 5 GHz is from 5 250 MHz to 5 460 MHz (210 MHz bandwidth).
3. The SAR interference threshold is –115.3 dBm per MHz.
4. In the following Table, two cases are considered: indoor use and outdoor use. For the case of indoor use, an average building attenuation of 17 dB towards EESS (active) instruments is used in the aggregate model only.

Earth Exploration Service (2) (ITU-R TG1/8 1-8/TEMP/75)

Compatibility analysis between UWB and EESS (active: SAR) at 5 GHz

Parameter	Value achieved for the limit: modified FCC and slope mask
Maximum e.i.r.p. (power spectral density) of a single UWB device	–41.3 dBm/MHz (**indoor** and **outdoor**)
Distance UWB – Satellite receiver in km (satellite nadir angle of 32.5°)	474
Space attenuation in dB	160.4
Satellite antenna gain in dBi	42.7
Received power at the satellite receiver in 1 MHz bandwidth in dBm	–159

Earth Exploration Service (3) (ITU-R TG1/8 1-8/TEMP/75)

Compatibility analysis between UWB and EESS (active: SAR) at 5 GHz (Cont.)

Threshold in dBm/MHz	–115.3
Margin with a single UWB device in dB	43.7
Gating effect for the aggregate case in dB	3
Size of the satellite footprint in km	8.4
Maximum UWB density per km^2 corresponding to the above SAR footprint	for **outdoor** usage $10^{4.67} / \pi 8.4^2 = 211$ for **indoor** usage with building attenuation of 17 dB $10^{6.37} / \pi 8.4^2 = 10580$

Radio Astronomy Service (1) (ITU-R TG1/8 1-8/TEMP/77)

Estimates of separation distances for a single UWB device, for different spectrum masks (for continuum measurements)

RAS frequency Bands (MHz)	Required MCL (dB) slope mask (Outdoor)	Required MCL (dB) FCC mask (Outdoor)	Resulting separation distance (km) slope mask (Outdoor)	Resulting separation distance (km) FCC mask (Outdoor)
608 - 614	58	138	-	-
1400.0 - 1427.0	98	114	1.37 km	9.6 km
1660.0 - 1670.0	102	124	1.86 km	27 km
2690.0 - 2700.0	120	126	10 km	21 km
4990.0 - 5000.0	144	145	86 km	96 km

Radio Astronomy Service (2) (ITU-R TG1/8 1-8/TEMP/77)

1. It can be seen from the initial results that for UWB transmissions a spectrum mask that offers protection to the Radio Astronomy Service is required.

2. It is also noted that the geographic separation distances required to meet with RAS protection criteria are substantial and clearly highlight the sharing difficulties between UWB and radio astronomy.

Fixed Service (1) (ITU-R TG1/8 1-8/TEMP/69)

Tentative limits for FS [coexistence] with UWB applications

Application	INDOOR	INDOOR	OUTDOOR	OUTDOOR
	e.i.r.p.-density r.m.s.	e.i.r.p.-density peak	e.i.r.p.-density r.m.s.	e.i.r.p.-density peak
[Any indoor in bands up to ~ 5 GHz]	[–100 dBW/MHz (–70 dBm/MHz)]	[–58 dBW/50MHz (–28 dBm/50MHz)]	--	--
High density generic applications (commercial/ consumer)	≤ – 90 dBW/MHz (≤ – 60 dBm/MHz)	≤ –48 dBW/50MHz (≤ –18 dBm/50MHz)	≤ –105 dBW/MHz (≤ –75 dBm/MHz)	≤ –63 dBW/50MHz (≤ –33 dBm/50MHz)

Fixed Service (2) (ITU-R TG1/8 1-8/TEMP/69)

Tentative limits for FS [coexistence] with UWB applications

	INDOOR	APPLICATIONS	OUTDOOR	APPLICATIONS
Application	e.i.r.p.-density r.m.s.	e.i.r.p.-density peak	e.i.r.p.-density r.m.s.	e.i.r.p.-density peak
[High density WPANs communication devices described in Appendix 3]	[≤ – 78.5/73.5 dBW/MHz] [(≤ – 48.5/43.5 dBm/MHz)]	[≤ –36.6/31.5 dBW/50MHz] [(≤ –6.5/1.5 dBm/50MHz)]	--	--

PCS Land mobile service (ITU-R TG1/8 1-8/TEMP/55)

Maximum permissible UWB PSD in DCS1800 band

A	**Received GSM1800 signal level at test handset (dBm/200 kHz)**	**–80**	**–90**	**–100**
B	Required C/I protection ratio	10	10	10
C	Maximum UWB signal power at victim receiver (dBm/200 kHz) = (A) – (B)	–90	–100	–110
D	Maximum UWB PSD at victim receiver (dBm/MHz) = C + 10 log (1 MHz/200 kHz)	–83	–93	–103
E	Receiver antenna gain (Typical) in dBi	–3	–3	–3
F	Path loss over 0.3 m at 1.8 GHz *Free-space path loss is assumed.*	27	27	27
G	**Max. UWB EIRP PSD (dBm/MHz) = (D) – (E) + (F)**	**–53**	**–63**	**–73**

Mobile Satellite Service – Inmarsat (1.5GHz) (2)

Type-2 MES terminal (ITU-R TG1/8 1-8/TEMP/73)

PRF (MHz)	BWCF (dB)	Max permitted UWB EIRP @ 20 m	Delta reference level (dB) wrt FCC limit	Delta reference level (dB) wrt CEPT limit	Distance (m) where permitted UWB EIRP equals FCC limit		Distance (m) where permitted UWB EIRP equals slope mask limit	
Dithered signals – Average – UWB terminal height = 2 m								
0.001 to 500	–12.22	–86.17	–10.87	1.53	70*		17*	
Dithered signals – Peak – UWB terminal height = 2 m								
0.001	12.55	–110.94	–35.64	–23.24	1 211 *	217 **	291*	106**
0.01	2.55	–100.94	–25.64	–13.24	383*	122**	92*	65**
0.1	–7.45	–90.94	–15.64	–3.24	121*	69**	29*	
1 to 500	–12.22	–86.17	–10.87	1.53	70*		17*	

Mobile Satellite Service – Inmarsat (1.5GHz) (1)

Type-2 MES terminal (ITU-R TG1/8 1-8/TEMP/73)

PRF (MHz)	BWCF (dB)	Max permitted UWB EIRP @ 20 m	Delta reference level (dB) wrt FCC limit	Delta reference level (dB) wrt CEPT limit	Distance (m) where permitted UWB EIRP equals FCC limit		Distance (m) where permitted UWB EIRP equals slope mask limit	
Non dithered signals – Average – UWB terminal height = 2 m								
0.001 to 0.01	–12.22	–86.17	–10.87	1.53	70*		17*	
0.1	–10.00	–88.39	–13.09	-0.69	90*		22*	
1 to 500	0.00	–98.39	–23.09	-10.69	286*		69*	
Non dithered signals – Peak – UWB terminal height = 2 m								
0.001	12.55	–110.94	–35.64	–23.24	1 211*	217 **	291*	106**
0.01	2.55	–100.94	–25.64	–13.24	383*	122**	92*	65**
0.1	–7.45	–90.94	–15.64	–3.24	121*	69**	29*	
1 to 500	0.00	–98.39	–23.09	–10.69	286*		69*	

Mobile Satellite Service – Inmarsat (1.5GHz) (3) (ITU-R TG1/8 1-8/TEMP/73)

Separation distances varying from;

i. 14 meters to 132 meters are required for non-dithered average UWB signals,
ii. 32 meters to 1 860 meters are required for non-dithered peak UWB signals in non-urban areas,
iii. 74 meters to 269 meters are required for non-dithered peak UWB signals in urban areas,
iv. 14 meters to 59 meters are required for dithered average UWB signals,
v. 32 meters to 1 860 meters are required for dithered peak UWB signals in non-urban areas, and
vi. 74 meters to 269 meters are required for dithered peak UWB signals in urban areas.

IMT-2000 (ITU-R TG1/8 1-8/TEMP/47rev1)

UWB PSD values to protect the most sensitive IMT-2000 mobile stations in a typical IMT–2000 deployed network at a reference distance of 36 cm*.

Frequency band	1 710-1 885 MHz	1 885-2 025 MHz	2 110-2 170 MHz	2 500-2 690 MHz
Max UWB PSD (dBm/MHz)	-86.4	-85.9	-85	-83.1

*The maximum UWB PSD value was obtained in the 2 110–2 170 MHz band, the values for the other bands have been extrapolated using free space propagation model.

5GHz RLAN (ITU-R TG1/8 1-8/TEMP/61)

1. The interference distances are,
   for Free space indoor: with Maximum Usable Sensitivity (MUS) '3.6 - 6.0 m' and with MUS +10 dB '1.1 – 2 m'; for ITU-R P.1238 indoor: with MUS '2.3 - 3.2 m' and with MUS +10 dB '1.1 - 1.5 m'.

2. Thus, when an active UWB device is within a distance of 6.0 m we can expect RLAN receiver desensitising and fallback in data rate.

3. The interference susceptibility for HIPERLAN/2 equipment is slightly poorer than for IEEE 802.11a depending on the used mode.

DVB-Terrestrial system (1) (ITU-R TG1/8 1-8/TEMP/41)

1. A large number of interference scenarios have been simulated to assess the compatibility between the DVB-T and UWB systems, in the VHF/UHF bands.
2. For each of the considered scenarios, the protection distance (dmin) from the DVB-T receiver to the UWB transmitter has been calculated by using alternatively, as UWB radiated power density level, the FCC UWB emission limits in force and the UWB slope emission masks.
3. The obtained distances have been compared with two threshold values =0.5 m and =3 m, which are respectively the protection distances required to ensure a high protection to the DVB-T system in indoor and outdoor environments, for fixed and portable reception.

DVB-Terrestrial system (2) (ITU-R TG1/8 1-8/TEMP/41)

1. The analyses of the results clearly show that the FCC UWB emission limits do not guaranty the protection of the DVB-T system in the presence of UWB emissions (85 m ≤ dmin ≤ 1284 m), while the UWB slope emission masks reduce significantly the interference probability (dmin < 0.5 m).
2. Consequently, the UWB slope emission mask concept should be considered at international levels to protect the DVB-T system in the presence of UWB emissions, in the VHF/UHF bands.

Broadcasting Satellite Service (ITU-R TG1/8 1-8/TEMP/51)

It is believed that, in order to protect the SDARS (satellite digital audio radio service) operating frequency bands from harmful emission interference from the aforementioned UWB devices and to assure high quality of satellite radio service, the FCC should amend the UWB 1 900 - 3 100 MHz emission band limits as follows:

Indoor communication UWB systems

UWB emission limit from 1 452 to 1 492 and from 2 320 to 2 345 MHz from –51.3 dBm/MHz to –76.3 dBm/MHz.

Hand-held UWB systems

UWB emission limit from 1 452 to 1 492 and from 2 320 to 2 345 MHz from –61.3 dBm/MHz to –79.3 dBm/MHz.

Peak power emissions from UWB systems could result in higher interference to SDARS systems depending on the UWB device's specific pulse repetition frequency.

Fixed Satellite Service (ITU-R TG1/8 1-8/TEMP/60)

[Studies to calculate the downlink interference into FSS earth station receivers have been carried out using the above methodology that are given in Report.

The provisional results of these studies show that the aggregate interference from the UWB devices, based on the assumed UWB emission levels, activity factors and density levels indicate that the 1% FSS protection criteria would be exceeded. Further studies are needed to find ways to reduce the effects of UWB interference to meet the 1% criteria.]