Report Summary From UWB Radio Systems Committee, Information and Communications Technology Sub-Council, Telecommunications Council

March 27, 2006

UWB Radio Systems Committee

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I. Overview of UWB Radio Systems

UWB (Ultra-wideband) Radio Systems

UWB radio systems draw attention as systems that can be used for high-speed information transmission (from tens of Mbps to hundreds of Mbps) over short distances (up to around 10 m) between personal computers and AV equipment. Their communication frequencies occupy an ultra-wide bandwidth (for which UWB stands) of approximately 500 MHz or more.

UWB radio system features

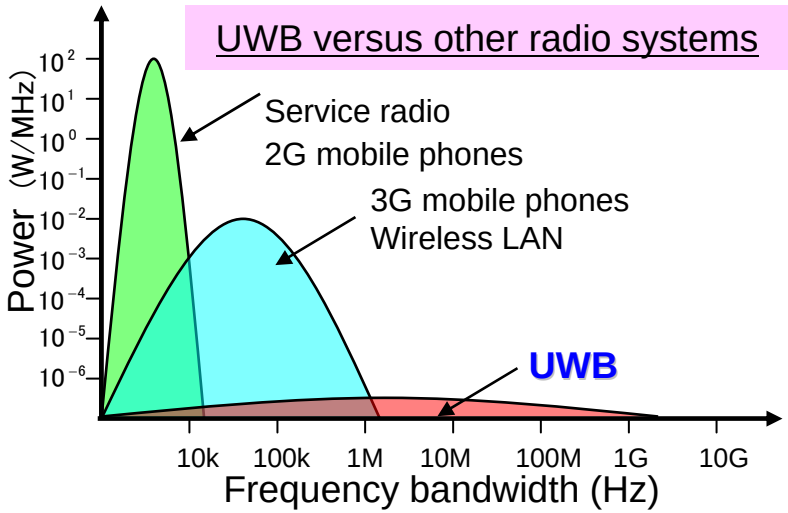
- Occupy frequencies in an ultra-wideband
  Normally, they have a bandwidth of 500 MHz or more.

- Emit radio waves in frequency bands that overlap those used by existing radio systems
  Due to this fact, they must be considered for compatibility with a multitude of other radio systems

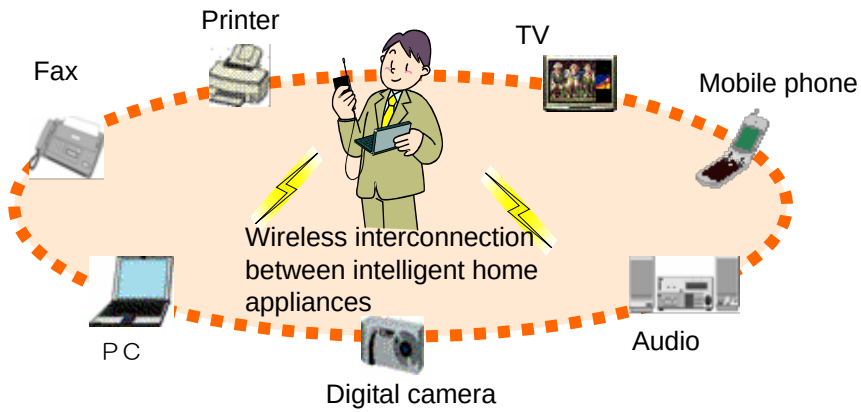
- Have very low transmission power per bandwidth (but higher than that of Extremely Low Power Radio Stations in Japan)
  FCC rule: -41.3 dBm/MHz = 75 nW/MHz, i.e., 0.5 mW in the 7 GHz band (NB: Intensity of Extremely Low Power Radio Stations ≈ 0.37 nW at 322 MHz - 10 GHz)

- Have transmission distances of up to around 10 m (radio field intensity based on FCC standards)

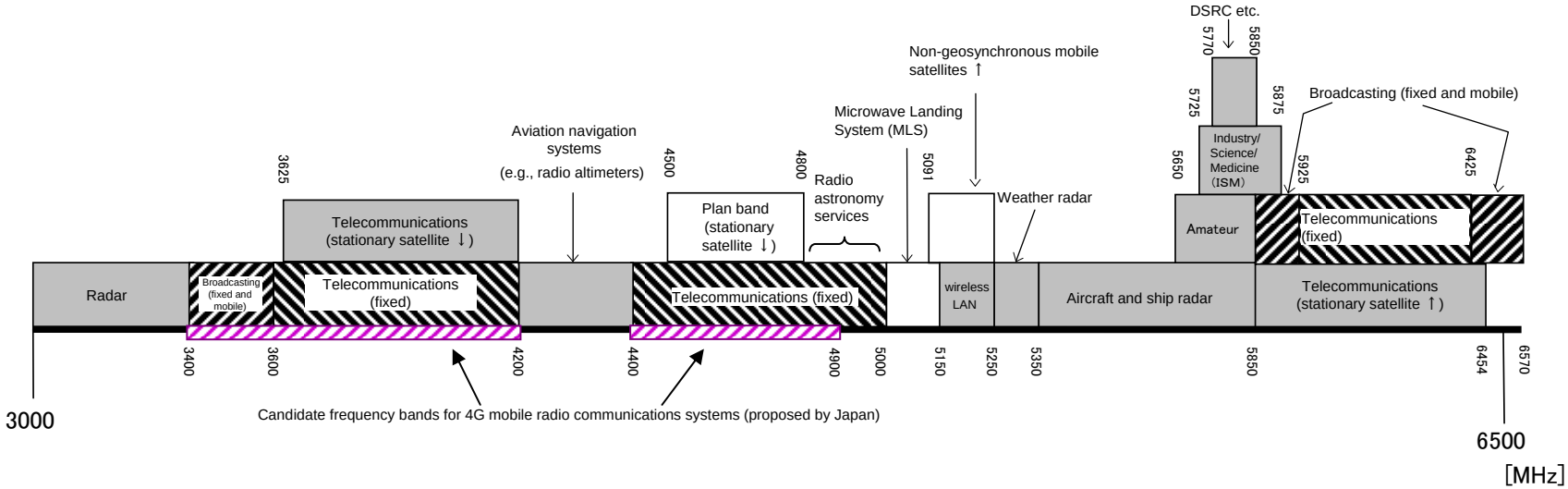
UWB versus other radio systems

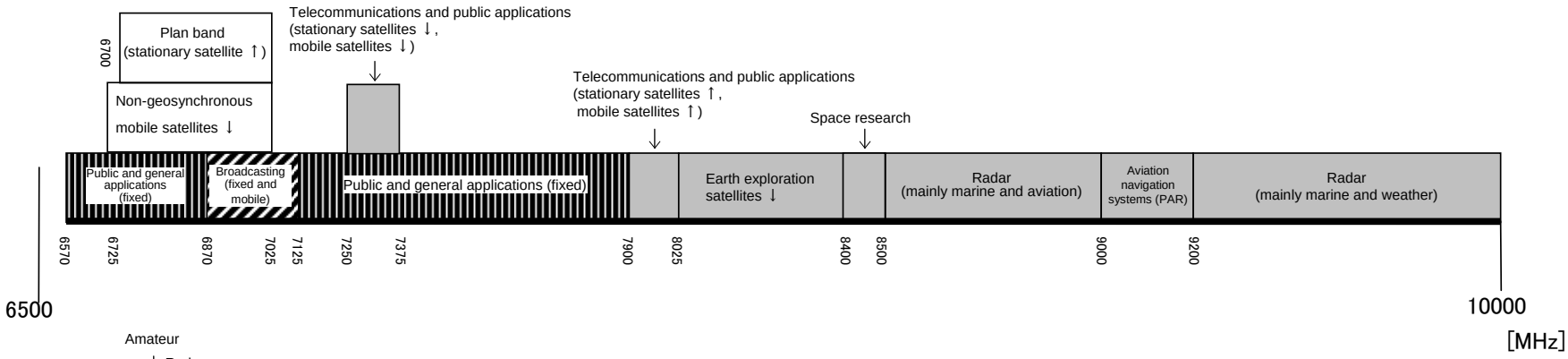


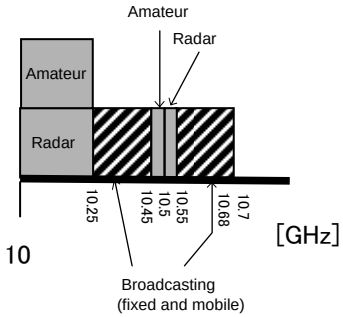
Envisioned UWB applications



Current allocation of 3.1 - 10.6 GHz spectrum







Telecommunications (fixed and mobile)

Public and general applications (fixed and mobile)

Broadcasting (fixed and mobile)

Ⅱ. Report Summary from UWB Radio Systems Committee

1 Background of This Council Report

UWB radio systems draw attention as systems that utilize extremely wide bandwidths and can be used for high-speed data transmission (up to hundreds of Mbps) over short distances (up to around 10 m) between personal computers and AV equipment.

○ Tasks

As UWB radio systems emit radio waves in frequency bands that overlap those used by existing radio systems, they must be compatible with many other radio systems.

○ International trends

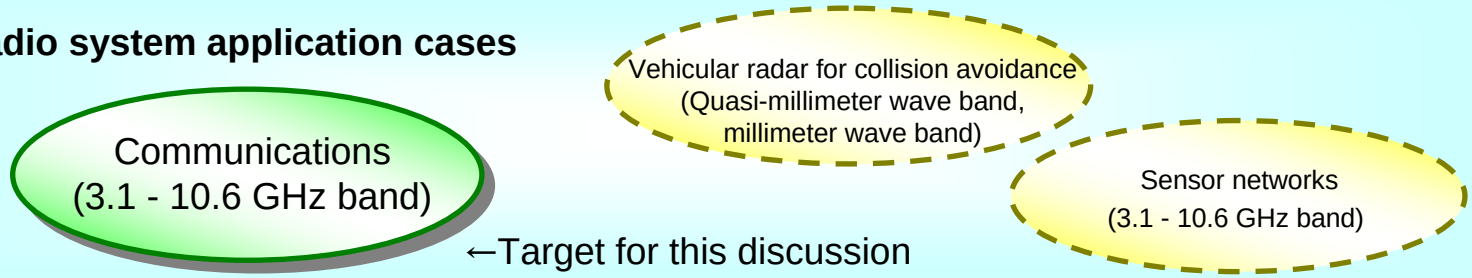
- US: Institutionalized UWB radio systems in February 2002
- IEEE (Institute of Electrical and Electronics Engineers): Started studying standardization for them in January 2002
- ITU-R (International Telecommunications Union — Radio Communication Sector)
  : Started consideration towards developing recommendations by setting up Task Group 1/8 in July 2002

○ UWB radio systems are expected to be a technology for the multiplex use of radio spectrum

○ Needs of users

UWB Radio Systems Committee, Information and Communications Technology Sub-Council, Telecommunications Council started discussing UWB radio systems in September 2002.

UWB radio system application cases



2 Discussion Process

September 2002	UWB Radio Systems Committee, Telecommunications Council started discussing UWB radio systems
March 2004	The Committee announced the interim report concluding that UWB radio systems must be further considered and studied because they may interfere with other existing radio communication systems.
October 2004	ITU decided to extend the discussion period by one year. - To continue to discuss UWB radio systems based on trends of international consideration and their like - To identify the characteristics of UWB radio systems by conducting tests such as demonstration experiments
September 2005	A tentative power reference value (tentative power mask) per frequency was assessed.
October 2005	The Committee proposed the tentative power mask to Task Group 1/8 of Study Group 1 of ITU-R, and the proposal was included in an annex to one of ITU-R's recommendations as reference information in conjunction with those of the US and the European Union.

<Study framework>

A total of five Working Groups were set up to facilitate the discussion of UWB radio systems under the UWB Radio Systems Committee. In addition, a systems group was set up to discuss the details of each existing radio system.

- Committee: Held seven meetings
- Working groups: Held a total of 20 meetings

3 Concept of UWB Radio Systems

(1) Basic concept

UWB radio systems are radio systems that diffuse electric power over extremely wide bandwidths. They attract attention as a new technology that attempts to be compatible with other radio systems by suppressing electric power and using frequencies in an overlapping manner. The name of "Ultra-wideband" comes from the characteristic of their emitting radio waves over extremely wide bandwidths.

(2) Definition

Based on an ITU recommendation, a UWB radio system must be a system that has a bandwidth of 500 MHz or more (*) or whose bandwidth ratio (μ*-10*) is 0.2 or higher, derived by dividing its bandwidth by the center frequency (*fc*).

(*) The bandwidth (*B-10*) is the difference (*fH* - *fL*) between a higher frequency (*fH*) and a lower frequency (*fL*) that have lower radiation power than that of the maximum radiated frequency (*fM*) by 10 dB.

$$B_{-10} = f_H - f_L$$
$$\mu_{-10} = B_{-10} / f_C$$
$$f_C = (f_H + f_L) / 2$$

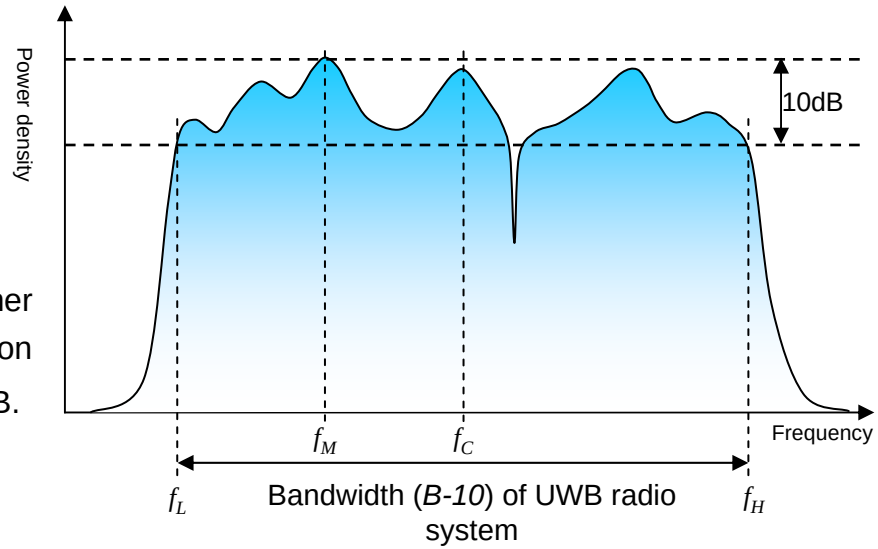


Figure: Radio waves radiated from a UWB radio system

4 Envisioned Applications

Envisioned applications for the purpose of communications which the Committee is studying at this time include the following. In addition, UWB radio systems are expected to be used in various fields such as "sensor networks" using their position detection function and “vehicular radar for collision avoidance" to improve the driving safety.

A UWB radio system installed in a peripheral device works as a client. When the relationship between the host and its clients has been established, communications between them will be started. This means that any UWB radio system installed in a peripheral device does not communicate with the UWB radio system that works as the host until it is started.

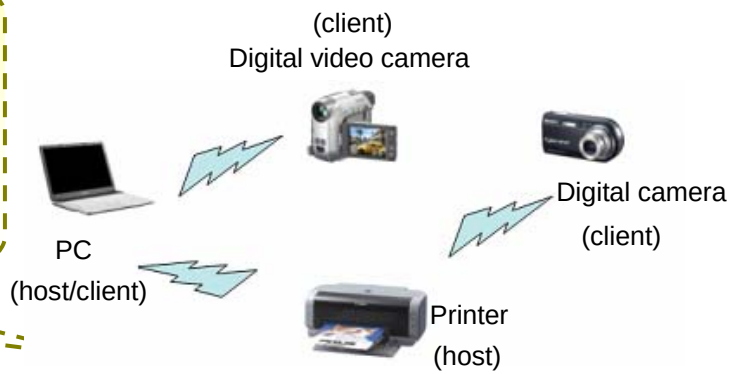


Figure 1: High-speed file transfer application

(1) High-speed file transfer (See Figure 1 on the right.)

As UWB radio systems can provide high-speed transmission at hundreds of Mbps although their transmission distances are short, they can achieve a large volume of data transmission between peripheral devices and a personal computer in a short time, which no existing radio systems can provide.

(2) Streaming transmission (See Figure 2 on the right.)

By leveraging the feature of UWB radio systems that can transmit data of several hundred Mbps over a wide bandwidth with low power consumption, the following application can be provided: A home server transmits voices to a wireless speaker while transmitting moving images to a wall-hanging TV display.

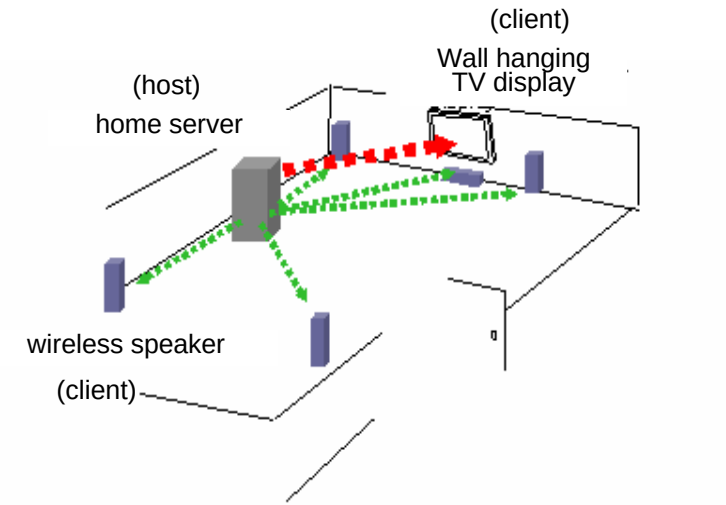


Figure 2: Streaming transmission application

5 Approaches Taken by Other Countries (1)

ITU (International Telecommunication Union)

Note : Information on this sheet was updated as of end of June 2006.

July 2002	Set up Task Group 1/8 (TG1/8) and four Working Groups (WGs) in TG1/8 to start studying UWB radio systems
October 2004	Extended the study period by one year
October 2005	The results of discussion at each WG were consolidated into four Draft New Recommendations (DNRs). They were input to SG1 from TG1/8 and an agreement was reached on submitting them for the adoption and approval procedure through postal voting.
June 2006	Four new recommendations were approved.

<Summary of four Recommendations>

(1) Recommendation on UWB characteristics

Consolidated the definitions of terms, the characteristics of UWB signals, and the like

(2) Recommendation on effects from UWB

Summarized the UWB power levels that prevent UWB radio systems from interfering with other radio systems

(3) Recommendation on the framework for regulating UWB

States that jurisdictional regulatory authorities must be able to develop UWB regulations based on their own authority by referring to these Recommendations, including this one

(4) Recommendation on how to measure UWB

Summarizes the measurement methods.

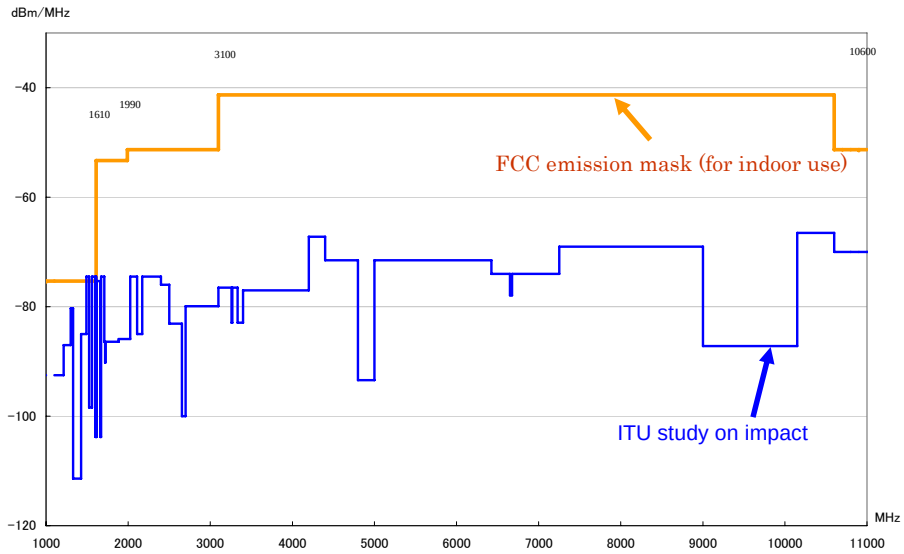


Figure: Comparison between ITU effect assessment values and US power mask

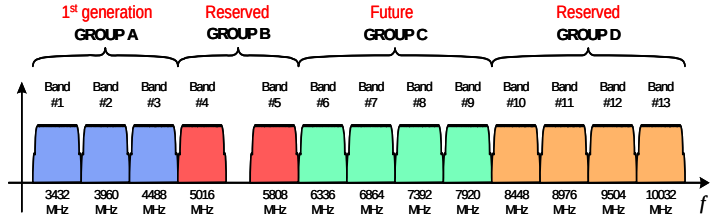
5 Approaches Taken by Other Countries (2)

Institute of Electrical and Electronic Engineers (IEEE)

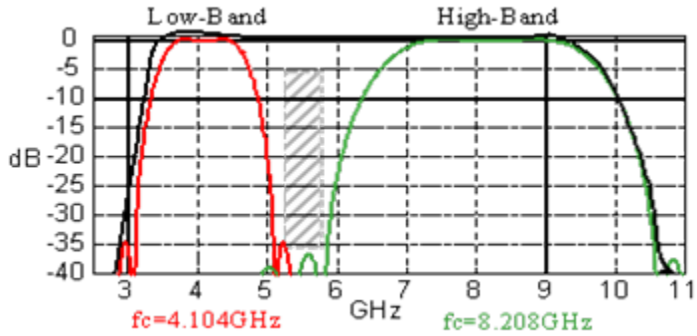
Note : Information on this sheet was updated as of end of June 2006.

January 2002	Started discussing the standardization methods of UWB.
December 2002	Invited public proposals on the standardization methods.
	The repeated adoption process boiled down the candidate standardization methods to two methods: MB-OFDM and DS-UWB.
	(Voting was repeated on the two methods.)
January 2006	As conflicting opinions could not be resolved, a proposal disbanding the working groups was adopted.

MB-OFDM



DS-UWB



Europe

- Europe announced its tentative power mask, similar to that of Japan regarding the basic structure, in September 2005.
- It plans to consolidate its discussions into a European finalized report by July 2006.

Korea and China

- Korea published the draft UWB emission mask at April 2006.
- China has not yet arrived at the point where they discuss a specific power mask for UWB.

6 Requirements

Although UWB radio systems have shorter transmission distances than those of wireless LAN, they have a transmission rate of 50 Mbps or more and can provide high-speed data transmission of several hundred Mbps when the transmission distances are short. In addition, since their transmission power is much lower than those of wireless LAN, they are expected to be radio systems that can be made smaller and have lower power consumption.
The UWB radio systems on which the Committee gives consideration this time are required to meet the following requirements as high-speed transmission systems for communication use with the highest users' needs.

(1) Transmission rate

	Transmission rate	Distance	Comments
High-speed file transfer	480Mbps	Approximately 2m	-Supports wireless USB 2.0
Streaming Transmission	50～100Mbps	Up to approximately 10m	-Supports high-definition video images and a dramatic increase in the volume of video data
	500Mbps	Up to approximately 2m	

(2) Usage environment

When considering envisioned applications for UWB radio systems, they should be able to be used regardless of whether they are outdoors or indoors. As they are more likely to interfere with other radio systems when they are used outdoors, it is required that they must be first considered for indoor usage only, which has higher user needs.
In addition, UWB radio systems are not to be used within aircraft, ships, and satellites that limit the usage of electronic equipment and devices that emit radio waves so that human lives may not be threatened.

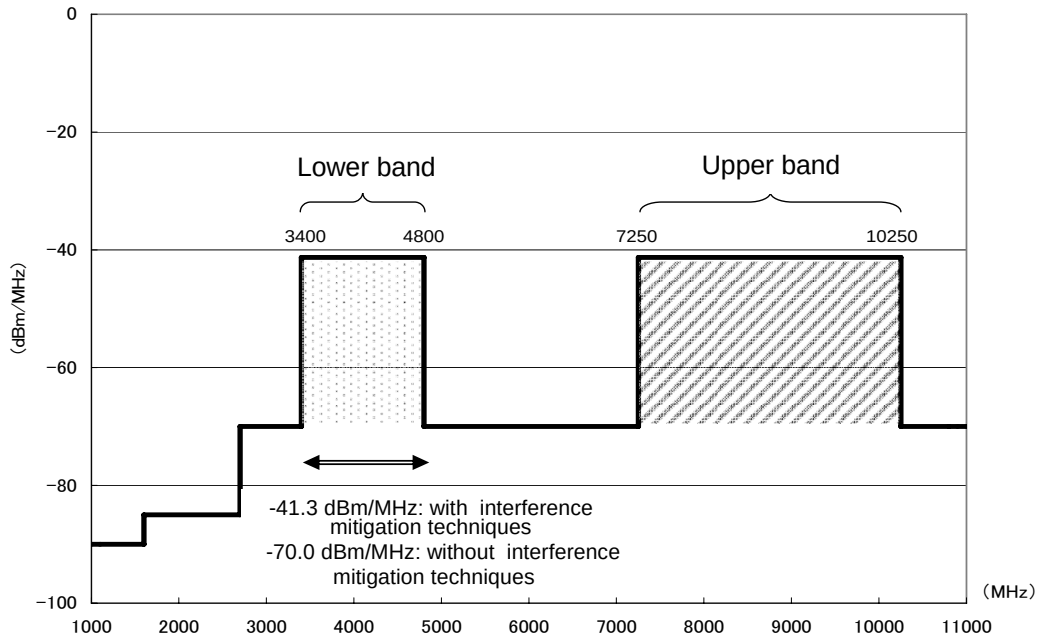
(3) International harmonization

From the viewpoint of ensuring users' convenience or lowering the cost of UWB radio systems by expanding international markets, the requirements must be set up so that as much international harmonization as possible can be ensured.

7 Presuppositions under which Compatibility with Other Radio Systems Are Studied (1)

To study conditions under which UWB radio systems can be compatible with other radio systems within the same frequency band or radio systems with close frequencies, those conditions were studied based on the following presuppositions:

(1) Usage environment	- Indoor use only
	- Prohibited for use within aircraft, ships, and satellites
(2) Attenuation value due to walls	12dB
(3) Operation rate	5%
(4) Tentative power masks	(After comprehensive consideration of the requirements for UWB radio systems, the possible interference with other radio systems, the trends of international studies and the like, a power mask with a shape as flat as possible was created.)



7 Presuppositions under which Compatibility with Other Radio Systems Are Studied (2)

Presuppositions for calculating the estimated number of diffused systems

(1) It is assumed that the number of diffused UWB radio systems follows the logistic curve and demand for replacements and repeat purchase is included.
(2) It is assumed that the ratio of the onboard to the entire number of UWB radio systems increases each year, and they will be installed in most of the target products by around 2014.
(3) Factors due to competition with other radio communication technologies that affect and will affect the diffusion of UWB radio systems are included.
(4) Replacement cycles due to the life spans of other products are considered.

Trend

(1) In lower bands, radio equipment that does not load any interference mitigation techniques will have spread by around 2008.
(2) After that, UWB radio systems that load standardized interference mitigation techniques will diffuse.
(3) Radio equipment developed for upper band will begin to fully diffuse from about 2009.

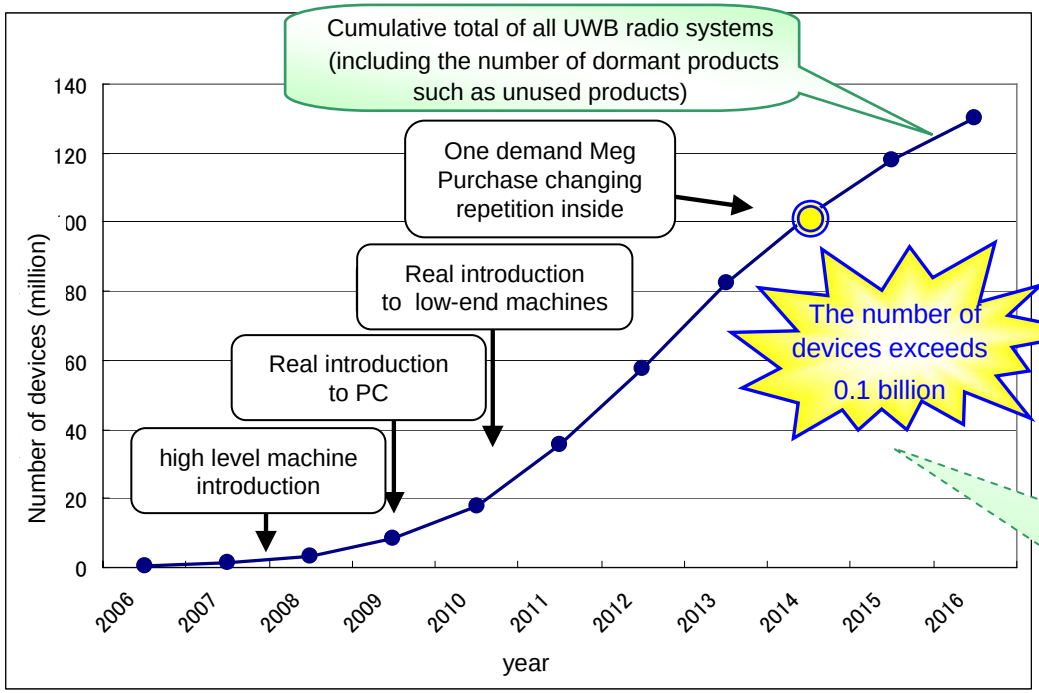


Figure: Estimated number of diffused UWB radio systems

◆ Usage density

The usage density per region in Japan is assumed based on the estimated diffusion of UWB radio systems.

100, 500, 1000 devices/km2

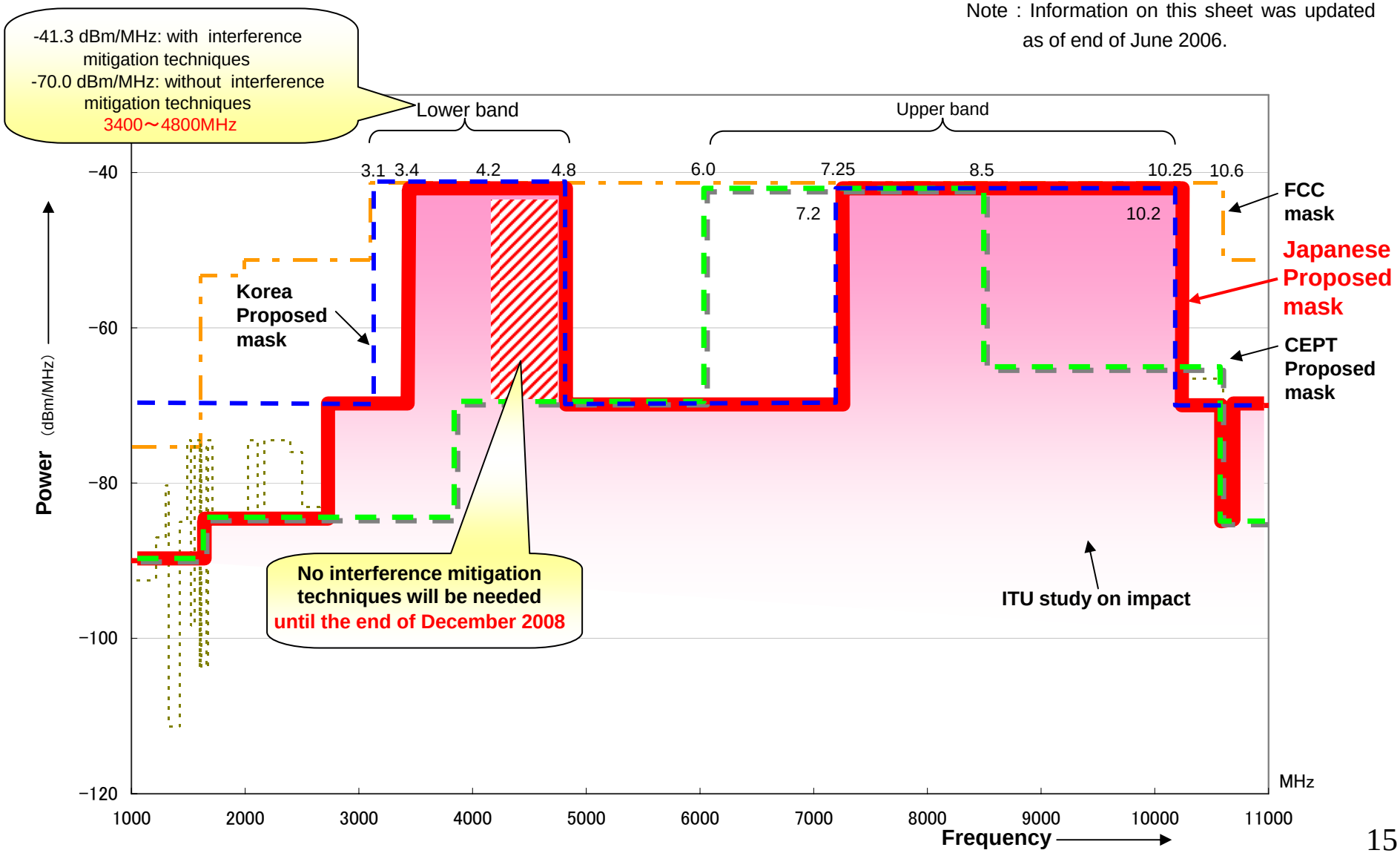
- In big cities, it will reach 1000 devices/km2 in five years
- In local cities, it will reach as few as 100 devices/km2, even in 10 years

As the number of devices powered by UWB radio systems that must be replaced or reach their life span will increase each year, the number of devices that will actually be in service is expected to be less than the calculated number of diffused devices.

8. Major Technical Conditions (1)

In light of the results of studying compatibility with other radio systems, the technical conditions are summarized as follows. The following figure, however, shows the UWB power level in Japan as well as those in US and Europe on top of those conditions.

Note : Information on this sheet was updated as of end of June 2006.



8. Major Technical Conditions (2)

(1) Time-limited actions for 4200 - 4800 MHz band

In light of the results of studying interference with other radio systems that are and will be in service with the same frequency band(s) as those of UWB radio systems, it is concluded that the 3400 - 4200 MHz band must be provided with an interference mitigation techniques. From the viewpoint of the effective use of radio spectrum and the early deployment and diffusion of UWB radio systems, however, it is concluded that the 4200 - 4800 MHz band can appropriately be used by UWB radio systems for the time being without any interference mitigation techniques.

Japan: The end of December 2008 or the day when an interference reduction technology is established, whichever comes first	**Europe: June 30th, 2010**
Comprehensively considers the predicted diffusion of UWB radio systems, the estimated number of remaining devices powered by UWB radio systems after the period of time-limited actions has elapsed, schedules on standardizing interference mitigation techniques at international forums regarding UWB, development time periods by manufactures, and other matters.	Envisions that 4G mobile communications systems will be introduced after 2010

(2) Conditions for compatibility with other radio systems

	Common compatibility conditions	Other compatibility conditions
Fixed microwave systems Broadcasting systems Maritime radar systems Aviation and weather radar systems Satellites DSRC Amateur radio communication systems Radio astronomy systems Mobile telephones Radio access	(1) Limited to indoor usage and need assurance. (2) Prohibited from being used within aircrafts, ships, and satellites and being applied to toys. (3) The technical conditions must be reviewed when the usage density, application cases, operation rate, the real situation of UWB radio systems and the like have changed. (4) The effectiveness of interference mitigation techniques must be determined with tests such as demonstration experiments based on agreements among those concerned. (5) Effect assessment must be continued in production environments, and if a UWB radio system causes harmful radio interference to any other radio system, the technical conditions must be promptly reviewed and the manufacturers, etc. of such UWB radio systems must take immediate actions to eliminate radio interference.	- Prohibited from being used at venues of large-scale events - When using a UWB radio system around radio astronomy systems, a warning must be given. - As for UWB radio systems without interference mitigation techniques in the 4.2 –4.8 GHz band, actions must be taken to reduce the number of remaining such UWB radio devices after 2009.

8. Major Technical Conditions (3)

<table>
<tr><th>Item</th><th>Technical conditions (plan)</th></tr>
<tr><td>1. Used frequency and antenna power</td><td>
<table>
<tr><th>Frequency band (MHz)</th><th>Average power</th><th>Peak power</th></tr>
<tr><td>3400～4800 (*)</td><td>-41.3 dBm/MHz or less</td><td>0 dBm/50 MHz or less</td></tr>
<tr><td>7250～10250</td><td>-41.3 dBm/MHz or less</td><td>0dBm/50MHz or less</td></tr>
</table>
(*) For devices that are not equipped with any interference mitigation techniques, the average power shall be -70 dBm/MHz and the peak power shall be -64 dBm/MHz. Over any frequency band from 4200 to 4800 MHz, devices are allowed to be used without any interference mitigation techniques until the end of December 2008.
</td></tr>
<tr><td>2. Allowable values for the intensity of unwanted emission</td><td>
<table>
<tr><th>Frequency (MHz)</th><th>Average power</th><th>Peak power</th></tr>
<tr><td>Less than 1600</td><td>-90.0 dBm/MHz or less</td><td>-84.0 dBm/MHz or less</td></tr>
<tr><td>1600 to 2700</td><td>-85.0 dBm/MHz or less</td><td>-79.0 dBm/MHz or less</td></tr>
<tr><td>2700 or more</td><td>-70.0 dBm/MHz or less</td><td>-64.0 dBm/MHz or less</td></tr>
<tr><td>10600 to 10700
11700 to 12750</td><td>-85.0 dBm/MHz or less</td><td>-79.0 dBm/MHz or less</td></tr>
</table>
</td></tr>
<tr><td>3. Antenna gain</td><td>If the effective isotropically radiated power is less than or equal to the value derived from adding an antenna power in a used frequency band to an antenna with a gain of 0 dBi, however, the decrease must be able to be covered with the gain of the antenna.</td></tr>
<tr><td>4. Modulation method</td><td>Not specified.</td></tr>
<tr><td>5. Crosstalk prevention function</td><td>The equipment must have the functionality for automatically sending and/or receiving identification signals and be able to be operated in a manner that will not give any interference to the operation of other radio stations.</td></tr>
<tr><td>6. Limited operation</td><td>Indoor use only.</td></tr>
</table>

● Future review of the technical conditions

Consideration must continue to be given to effect assessment on other radio systems in production environments, and the technical conditions must be reviewed in about three years in light of the situation of diffusion of UWB radio systems, the results of effect assessment, and international trends.

9. Future Considerations

Continued considerations

(1) Outdoor usage

From here on, Japan continues to consider UWB radio systems that are to be used outside, such as inside vehicles, for sharing frequencies with other radio systems in light of the situation of diffusion of products powered by UWB radio systems, international trends, and the like.

(2) Interference mitigation techniques

Effective interference mitigation techniques for radio systems that exist now or will be deployed in the future over any frequency band in the range of 3400 to 4800 MHz must continue to be studied, for example, by validating them with tests such as demonstration experiments based on agreements among those concerned.

New applications

New applications using UWB radio systems are under research and development in various fields on a global basis, and Japan shall continue to study them based on the results of comprehensive consideration on international study trends, domestic user needs, and other things. For example, the following lists some of new applications that are now expected to be introduced on a global basis:

(1) Sensor networks
(2) Vehicular radar for collision prevention in quasi-millimeter and millimeter wave bands