UWB: Fostering Innovation Through a Balanced Regulatory Framework

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The views expressed herein are those of the presenter and are not necessarily the views of the Federal Communications Commission or the Commissioners
Outline of Presentation

- Regulatory process
- UWB Operational limits today
- UWB implementation challenges
- Part 15 – Basis for UWB limits
- UWB debate
- Impact / Conclusion / Results
- IEEE 802.15.3a / ITU-R
Oh, FCC May I …

- Have Some Spectrum?
- Increase My Power?
- Change the Service?
- Have Some Spectrum?
Public Input - WWW Resources

FCC ECFS Access

1184 Record(s) Found For Proceeding: 98-153
Record 1 through 100 displayed

Public comments: http://gullfoss2.fcc.gov/cgi-bin/ws.exe/prod/ecfs/comsrch_v2.hts
Spectrum Management in USA: Two Agencies

- National Telecommunications and Information Administration/NTIA is responsible for all Federal Government use - including FCC’s!

- FCC is responsible for all spectrum use by individuals, private companies and state and local government

- Memorandum of Understanding – Joint use Spectrum
47 USC 157. New technologies and services

(a) It shall be the policy of the United States to encourage the provision of new technologies and services to the public. Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest.

(b) The Commission shall determine whether any new technology or service proposed in a petition or application is in the public interest within one year after such petition or application is filed. If the Commission initiates its own proceeding for a new technology or service, such proceeding shall be completed within 12 months after it is initiated.
Government Objectives for UWB

- Enable the introduction of UWB technology
  - Provides numerous benefits to the public
  - Maintains U.S. technical leadership

- Protect against harmful interference
  - Establish interference standards
The Long Regulatory Road for UWB

- **September 1998** – Notice of Inquiry
  - UWB Proposed Commercially

- **June 1999** – Waivers granted for 3 UWB devices
  - Time Domain (through-wall imaging)
  - Zircon (“stud-finder” for rebar in concrete)
  - U.S. Radar (ground penetrating radar)

- **May 2000** – Notice of Proposed Rule Making (NPRM)
  - UWB Regulations Proposed

- **February 2002** – First Report and Order (R&O)
  - Defined UWB regulations for, and authorized three classes of systems:
    - Imaging systems (ground penetrating radar, wall and through-wall, surveillance, and medical systems)
    - Vehicular radar systems
    - Communication and measurement systems
The Long Regulatory Road for UWB

- **February 2003** – Memorandum Opinion and Order (MO&O) and Further Notice of Proposed Rule Making (FNPRM)
  - Affirmation of U.S. regulations and provided greater flexibility
  - Addressed 14 petitions for reconsideration
  - Proposed new rules for low pulse repetition frequency UWB systems

- **December 2004** – Second R&O and Second MO&O
  - U.S rules affirmed again
  - No new rules added for low pulse repetition frequency UWB
  - Two petitions for reconsideration addressed

- **March 2005** – MBOA Waiver
  - Additional flexibility provided for frequency hopping and gated UWB systems
# UWB Technical and Operational Summary Table

<table>
<thead>
<tr>
<th>OPERATING BANDS</th>
<th>GROUND PENETRATING RADARS (GPR) AND WALL IMAGING SYSTEMS</th>
<th>THROUGH-WALL IMAGING SYSTEMS (1)</th>
<th>THROUGH-WALL IMAGING SYSTEMS (2)</th>
<th>SURVEILLANCE SYSTEMS</th>
<th>MEDICAL IMAGING SYSTEMS</th>
<th>VEHICULAR RADAR SYSTEMS</th>
<th>INDOOR COMM SYSTEMS</th>
<th>OUTDOOR, HAND-HELD COMM SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMITATIONS OF SERVICE</td>
<td>Law Enforcement, Fire Fighting, Emergency Rescue, Scientific Research, Commercial Mining, or Construction</td>
<td>Law Enforcement, Emergency Rescue or Firefighting Organizations that are under the authority of a local or state government</td>
<td>Law Enforcement Applications, Emergency Services, and necessary training operations</td>
<td>Law Enforcement, Fire or Emergency Rescue Organizations, or Manufacturer/Petroleum/Power Licensees</td>
<td>Used at the direction of, or under supervision of, a licensed health care practitioner</td>
<td>Operation is limited to UWB field disturbance sensors mounted in terrestrial transportation vehicles. These devices shall operate only when vehicle is running.</td>
<td>Operation is limited to UWB transmitters employed solely for indoor operation.</td>
<td>UWB devices are relatively small and primarily hand-held, while being operated, and do not employ a fixed infrastructure.</td>
</tr>
<tr>
<td>RADIATED EMISSION LIMITS WITH RESOLUTION BANDWIDTH OF 1 MHz</td>
<td>Frequency</td>
<td>e.i.r.p.</td>
<td>Frequency</td>
<td>e.i.r.p.</td>
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<td>-65.3</td>
<td>1610-1990</td>
<td>-53.3</td>
<td>1990-3100</td>
<td>-51.3</td>
<td>3100-10600</td>
<td>-41.3</td>
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<td></td>
<td>1610-1990</td>
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<td>1610-10600</td>
<td>-41.3</td>
<td>Above 10600</td>
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<tr>
<td>LIMITS FOR RESOLUTION BANDWIDTH OF NO LESS THAN 1 kHz</td>
<td>Frequency</td>
<td>e.i.r.p.</td>
<td>Frequency</td>
<td>e.i.r.p.</td>
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<td>Frequency</td>
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Operation is limited to law enforcement, fire and rescue organizations, scientific research institutions, commercial mining companies, and construction companies.
UWB Emission Limits

Vehicular Radar Systems

![Graph showing UWB emission levels in dBm/MHz vs. frequency in GHz.](image)
UWB Emission Limits

Indoor Communications Systems

UWB EIRP Emission Level in dBm/MHz vs. Frequency in GHz

GPS Band

0.96 1.60 3.10 10.6
UWB Emission Limits
Outdoor (Handheld) Communication Systems
UWB Technology Basics: Spectrum Sharing Issues/Interference Risks

<table>
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<th>Spectrum Crossover</th>
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| **FCC Part 15 limit** | -41.25 dBm  
| **WLANs** | 2.45 GHz  
| **Radiolocation** | 3.0 to 3.7 GHz  
| **Upper UWB operating range** | 3.1 to 10.6 GHz  
| **Fixed satellite service (FSS) earth stations** | 3.7 to 4.2 GHz  
| **RF altimeters** | 4.2 to 4.4 GHz  
| **Fixed satellite (S-E)** | 4.5 to 4.8 GHz  
| **WLANs** | 5 GHz  
| **Microwave landing system** | 5.03 to 5.09 GHz  
| **Fixed satellite (E-S)** | 5.85 to 7.075 GHz  
| **Fixed wireless** | 5.9 to 8.6 GHz  
| **Radiolocation** | 9.5 to 10 GHz  

Also GPS and PCS
Portion of the Spectrum Shared by UWB
Spectrum Management Policy:
The basic issue

Can we balance the benefits of a possible new service to the interference risk it creates?
Challenges – Spectrum

• UWB must operate across wide swaths of spectrum used by many services

• What spectrum is appropriate?

• Need to balance:
  – Spectrum requirements for applications
  – Technology performance requirements
  – Interference risk to sensitive radio services
Challenges – Emission Limits

• UWB devices must provide robust performance within realistic cost and fabrication constraints

• What emission limits are appropriate?

• Need to balance:
  – Emission limits for applications
  – Technology performance requirements
  – Interference risk to sensitive radio services
Challenges – Interference

• **Extensive** analyses and tests performed

• Sharp disagreements on interpreting results due to differing assumptions about:
  – Desired signal levels
  – Interference protection levels
  – Required separation distances
  – Operational scenarios
  – Aggregate interference
  – And many other factors!
Unlicensed Devices: Part 15

• Part 15 provides for unlicensed operation of radio frequency devices
  – Unintentional radiators
  – Intentional radiators

• General Operating conditions:
  – May not cause harmful interference
  – Must accept any interference received
Controlling Interference

- **Intentional radiators:**
  - Careful selection of frequency bands
  - Limiting in-band to low power operation
  - Limiting out-of-band and spurious emissions
  - Application Limitations

- **Unintentional radiators:**
  - Radiated emissions limits < 960 MHz
  - Radiated emissions limits > 960 MHz

- **Equipment authorization ensures compliance**
Benchmark Standard - Unlicensed

- Digital device limits established in 1979 establish radiated emissions standards:
  - 100 uV/m 30 – 88 MHz @ 3 m
  - 150 uV/m 88 – 216 MHz @ 3 m
  - 200 uV/m 216 – 960 MHz @ 3 m
- CISPR adopts similar limits in 1980s
- In 1989 adopted as Part 15 general emissions limits & extended above 960 MHz
  - 500 uV/m above 960 MHz @ 3 m
Basis for Limits
Class B Digital Devices

Min. Grade A Analog TV Signal
68 – 74 dB uV/m

8 dB Wall Attenuation

Assumed Separation Distance
10 m
The Results

• Twenty five years of experience

• 100’s of millions of products deployed
  – Increasing clock frequencies
  – Numerous portable devices

• Many new services introduced:
  – Cellular/PCS; GPS; DARs; MSS; DBS, etc.

• Few interference complaints!
UWB Sparks Debate Over Appropriate Assumptions

- “Harmful Interference” based on theoretical performance degradation
- Protect weakest usable signal
- Protect poorest receivers
- Assume close spacing to mobile devices or in main beam for directional antennas
- Account for aggregate interference
- Budget/Apportion interference
Driving Factors

• Interference is not precisely defined

• Auctions & flexibility - Some licensees view as property rights

• Licensees argue radio noise:
  – Increases infrastructure costs; i.e. more cells
  – Reduces performance; i.e. radar range
  – Degrades reliability (margins); errors/outages

• Proliferation of devices and mobility bring devices closer together
Is The UWB Debate Unique?

• Radio services seek to establish stringent protection levels

• *These levels could establish precedents for other devices*

• The UWB debate is continuing internationally in the ITU-R
Potential Impact

• Might a very “conservative” approach to limits affect the viability of devices and services?

• Extreme worst case analyses can lead to:
  – Increased product costs
  – Increased testing costs

• Need to balance benefits vs. costs
Conclusion

• The U.S. believes that our implementation of UWB technology
  – Is a conservative approach
  – Protects existing Radio Services

• U.S. rules offer a stable environment for the development of UWB technology
First UWB Commercial Products Arrive

INNOVATION PLUS at the Sands

17 Companies Demo Products
IEEE UWB Standard Activity

- IEEE 802.15.3a Standards Group was chartered to draft a new standard for WPANs

- The group voted to disband this year w/o a Std.

- Two industry groups emerged from the process but their technology is neither compatible nor interoperable
THE GLOBAL ROAD TO UWB

• ITU-R Task Group 1/8 created in 2002
  – 1\textsuperscript{st} International meeting held in Sept 2002
  – 6\textsuperscript{th} and last meeting held in Oct 2005

• The TG developed one report on Compatibility and four recommendations on:
  – UWB Characteristics
  – UWB Measurements
  – UWB Regulatory Framework
  – UWB Compatibility
THE GLOBAL ROAD TO UWB

• Approval and adoption by Administrations of the TG’s documents is fully expected in May 2006.

• The primary accomplishment of the TG (in my opinion) was to allow Administrations to implement UWB without violating ITU-R rule restrictions.
UWB INTERNATIONAL ACTIVITIES

• U.S. Goals:
  – Present to administrations the U.S. framework for the implementation of UWB technology
  – Demonstrate that our rules for UWB are adequate to introduce this technology while still protecting existing services
  – Persuade administrations to adopt our approach in the implementation of UWB technology

• Partial success with adoption of U.S. UWB operational limit in the recommendations
UWB INTERNATIONAL ACTIVITIES

• UWB compatibility studies strongly reflect the contentious nature of the U.S. Proceeding
  – Apportionment of total interference for sharing
    • Non-service allotment typically 1% of total interference
  – Extreme protection criteria (I/N < - 20 dB)
  – Unrealistic aggregation scenarios
  – Worse case values for each element of the analysis
“THE REAL VOYAGE OF DISCOVERY CONSISTS NOT IN SEEKING NEW LANDSCAPES, BUT IN HAVING NEW EYES.”

- MARCEL PROUST – a French novelist

ALTHOUGH HE DIDN’T KNOW IT, HE WAS TALKING ABOUT UWB A CENTURY BEFORE ITS TIME.