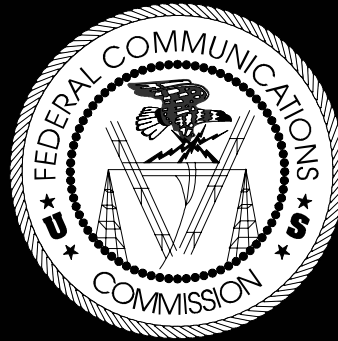


UWB: Fostering Innovation Through a Balanced Regulatory Framework



Ron Chase

Chief, Technical Analysis Branch

Office of Engineering and Technology

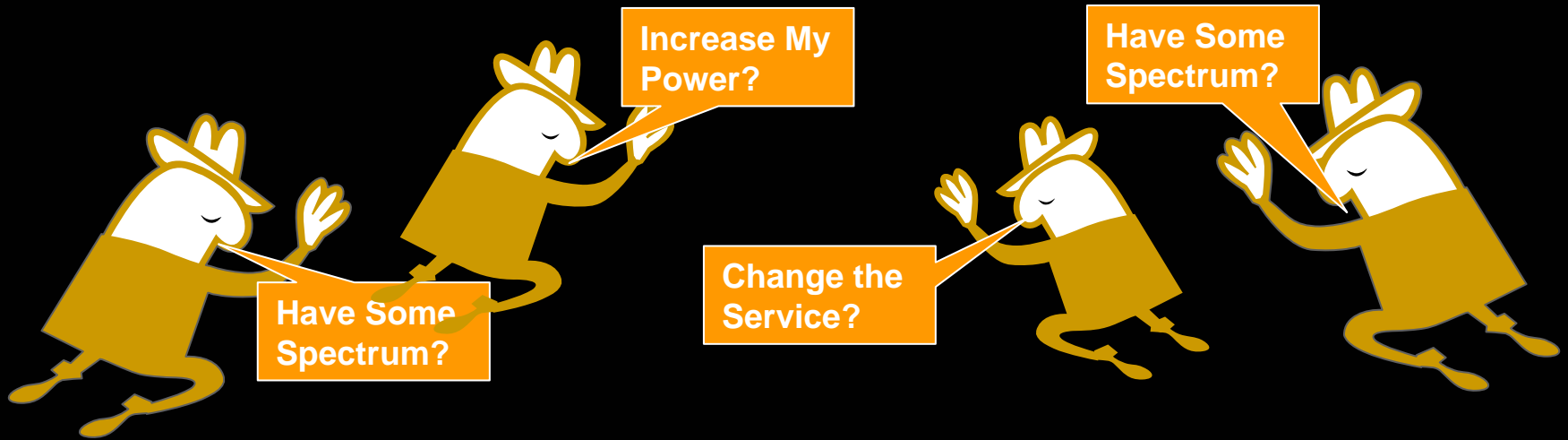
11 April, 2006

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 ...



Public Input - WWW Resources

FCC ECFS Access

FCC Federal Communications Commission

1184 Record(s) Found For Proceeding:98-153

Record 1 through 100 displayed

Proceeding: 98-153 Date Received/Adopted: 08/22/05 Document Type: NOTICE File Number/Community: Filed on Behalf of: Wiley Rein & Fielding LLP Filed By: Wiley Rein & Fielding LLP Attorney/Author Name: Nancy J. Victory Complete Mailing Address: 1776 K Street, NW Washington, DC 20006 OTHER	Type Code: NO Date Released/Denied: Total Pages: 48 DA/FCC Number: Document Date: OTHER
Proceeding: 98-153 Date Received/Adopted: 07/20/05 Document Type: REPLY File Number/Community: Filed on Behalf of: Satellite Industry Association Filed By: Attorney/Author Name: Complete Mailing Address: 1730 M Street, NW Suite 600 Washington, DC 20036	Type Code: RL Date Released/Denied: Total Pages: 18 DA/FCC Number: Document Date:

FCC Federal Communications Commission

Search for Filed Comments

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Retrieve Document List Clear

FCC Rules: <http://www.fcc.gov/mmb/asd/bickel/47CFRule.html>

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

Statutory Language on New Technology

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

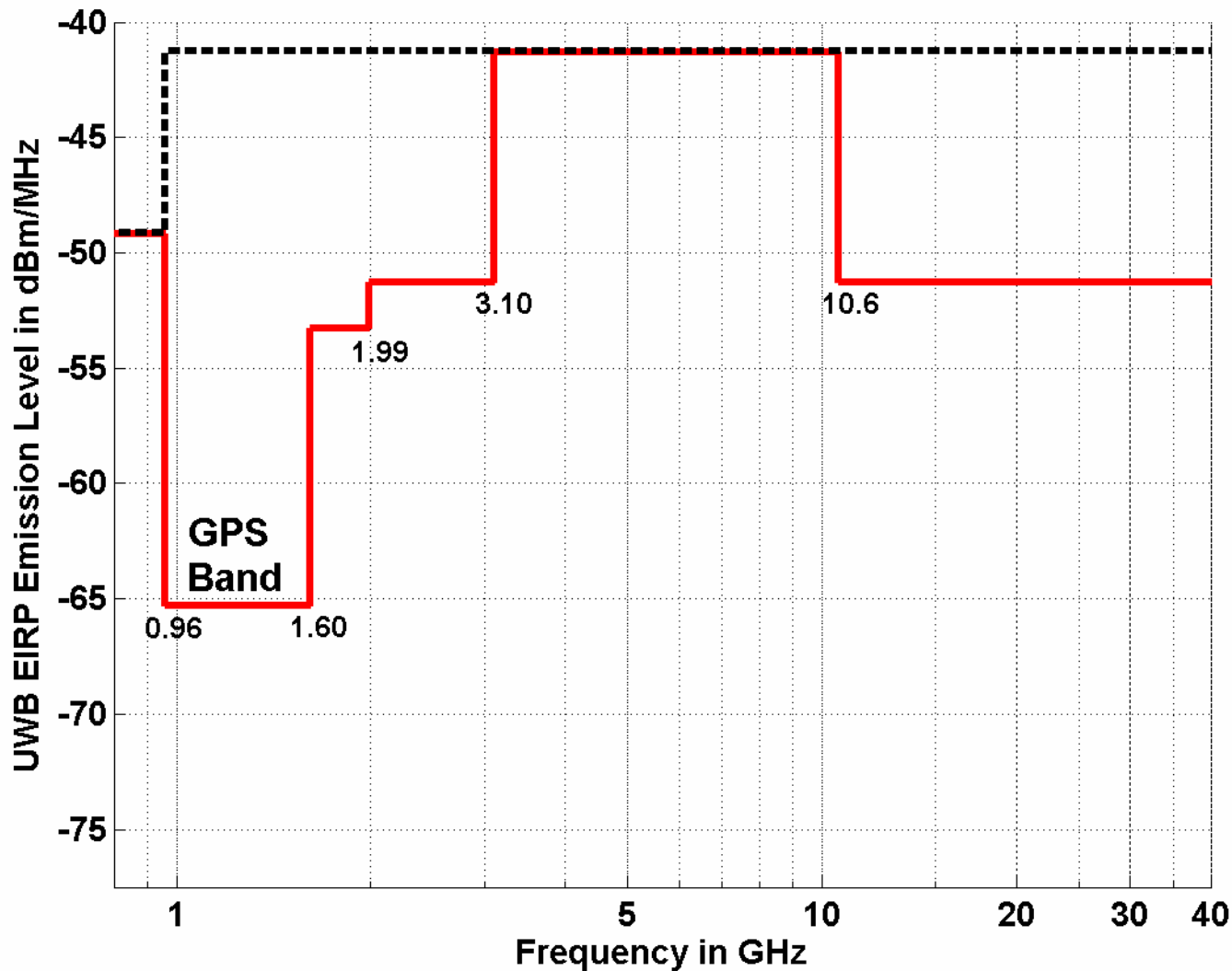
- **February 2003** – Memorandum Opinion and Order (MO&O) and Further Notice of Proposed Rule Making (FNPRM)
 - Affirmation of U.S. regulations and provided greater flexibility
 - Addressed 14 petitions for reconsideration
 - Proposed new rules for low pulse repetition frequency UWB systems
- **December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

	GROUND PENETRATING RADARS (GPR) AND WALL IMAGING SYSTEMS	THROUGH-WALL IMAGING SYSTEMS (1)	THROUGH-WALL IMAGING SYSTEMS (2)	SURVEILLANCE SYSTEMS	MEDICAL IMAGING SYSTEMS	VEHICULAR RADAR SYSTEMS	INDOOR COMM SYSTEMS	OUTDOOR, HAND-HELD COMM SYSTEMS																																																																																						
OPERATING BANDS	OPERATION MUST BE BELOW 10.6 GHz	OPERATION MUST BE BELOW 960 MHz	OPERATION WITH CENTER FREQUENCY, F_C , AND F_M BETWEEN 1990 AND 10600 MHz	OPERATION MUST BE CONTAINED BETWEEN 1990 MHz AND 10600 MHz	OPERATION MUST BE CONTAINED BETWEEN 3100 MHz AND 10600 MHz	OPERATION MUST BE CONTAINED BETWEEN 22 AND 29 GHz. F_C AND F_M MUST BE GREATER THAN 24.075 GHz	OPERATION MUST BE CONTAINED BETWEEN 3100 MHz AND 10600 MHz.	OPERATION MUST BE CONTAINED BETWEEN 3100 MHz AND 10600 MHz.																																																																																						
LIMITATIONS OF SERVICE	Law Enforcement, Fire Fighting, Emergency Rescue, Scientific Research, Commercial Mining, or Construction	Law Enforcement, Emergency Rescue or Firefighting Organizations that are under the authority of a local or state government	Law Enforcement Applications, Emergency Services, and necessary training operations	Law Enforcement, Fire or Emergency Rescue Organizations, or Manufacturer/Petroleum/Power Licensees	Used at the direction of, or under supervision of, a licensed health care practitioner	Operation is limited to UWB field disturbance sensors mounted in terrestrial transportation vehicles. These devices shall operate only when vehicle is running.	Operation is limited to UWB transmitters employed solely for indoor operation.	UWB devices are relatively small and primarily hand-held while being operated, and do not employ a fixed infrastructure.																																																																																						
RADIATED EMISSION LIMITS WITH RESOLUTION BANDWIDTH OF 1 MHz	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-65.3</td></tr> <tr><td>1610-1990</td><td>-53.3</td></tr> <tr><td>1990-3100</td><td>-51.3</td></tr> <tr><td>3100-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-65.3	1610-1990	-53.3	1990-3100	-51.3	3100-10600	-41.3	Above 10600	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-65.3</td></tr> <tr><td>1610-1990</td><td>-53.3</td></tr> <tr><td>Above 1990</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-65.3	1610-1990	-53.3	Above 1990	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-46.3</td></tr> <tr><td>1610-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-46.3	1610-10600	-41.3	Above 10600	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-53.3</td></tr> <tr><td>1610-1990</td><td>-51.3</td></tr> <tr><td>1990-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-53.3	1610-1990	-51.3	1990-10600	-41.3	Above 10600	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-65.3</td></tr> <tr><td>1610-1990</td><td>-53.3</td></tr> <tr><td>1990-3100</td><td>-51.3</td></tr> <tr><td>3100-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-65.3	1610-1990	-53.3	1990-3100	-51.3	3100-10600	-41.3	Above 10600	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-75.3</td></tr> <tr><td>1610-22000</td><td>-61.3</td></tr> <tr><td>22000-29000</td><td>-41.3</td></tr> <tr><td>29000-31000</td><td>-51.3</td></tr> <tr><td>Above 31000</td><td>-61.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-75.3	1610-22000	-61.3	22000-29000	-41.3	29000-31000	-51.3	Above 31000	-61.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-75.3</td></tr> <tr><td>1610-1990</td><td>-53.3</td></tr> <tr><td>1990-3100</td><td>-51.3</td></tr> <tr><td>3100-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-51.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-75.3	1610-1990	-53.3	1990-3100	-51.3	3100-10600	-41.3	Above 10600	-51.3	<table border="1"> <tr><td>Frequency</td><td>e.i.r.p.</td></tr> <tr><td>960-1610</td><td>-75.3</td></tr> <tr><td>1610-1990</td><td>-63.3</td></tr> <tr><td>1990-3100</td><td>-61.3</td></tr> <tr><td>3100-10600</td><td>-41.3</td></tr> <tr><td>Above 10600</td><td>-61.3</td></tr> </table>	Frequency	e.i.r.p.	960-1610	-75.3	1610-1990	-63.3	1990-3100	-61.3	3100-10600	-41.3	Above 10600	-61.3
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UWB Emission Limits

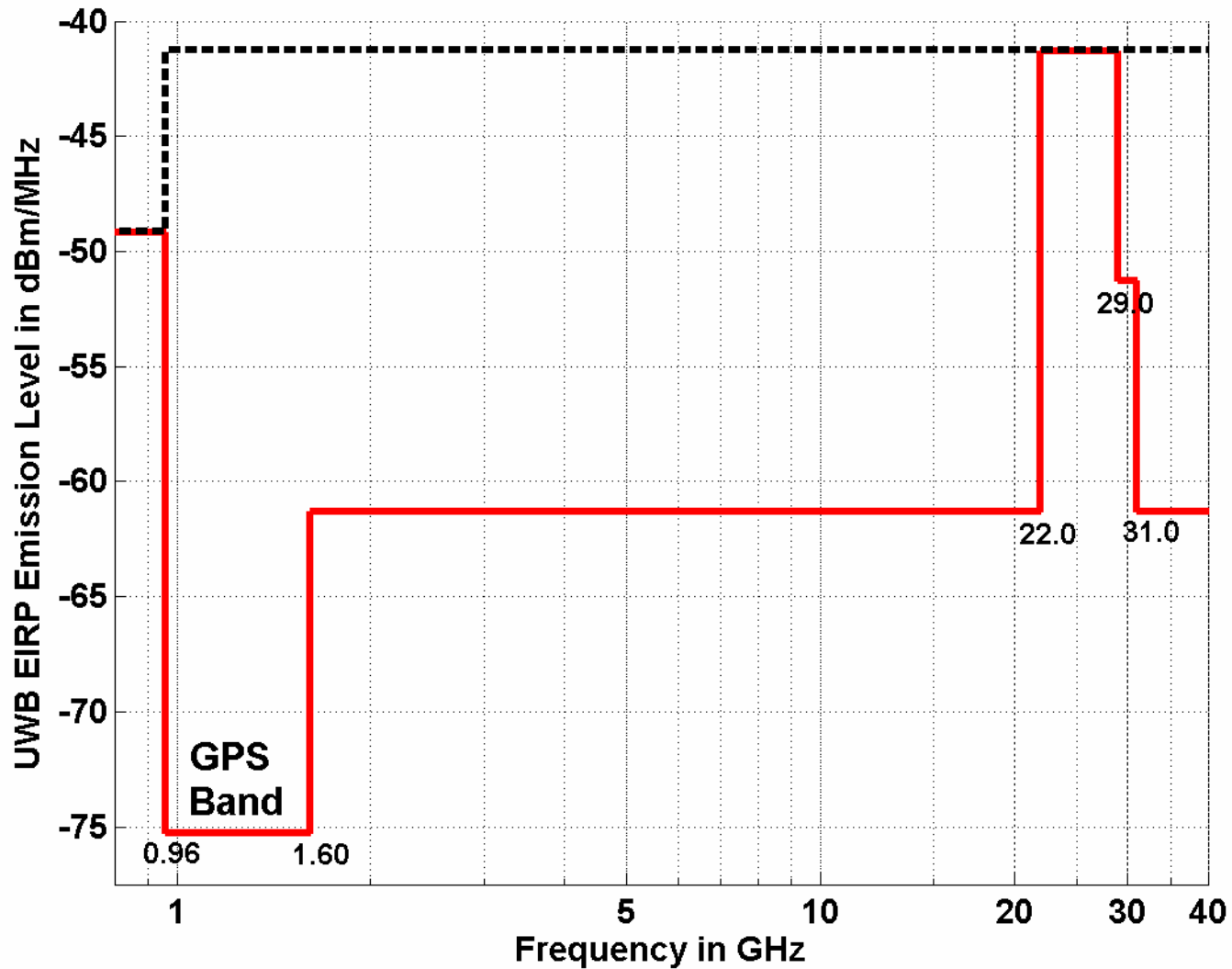
GPRs and Wall Imaging Systems



Operation is limited to law enforcement, fire and rescue organizations, scientific research institutions, commercial mining companies, and construction companies.

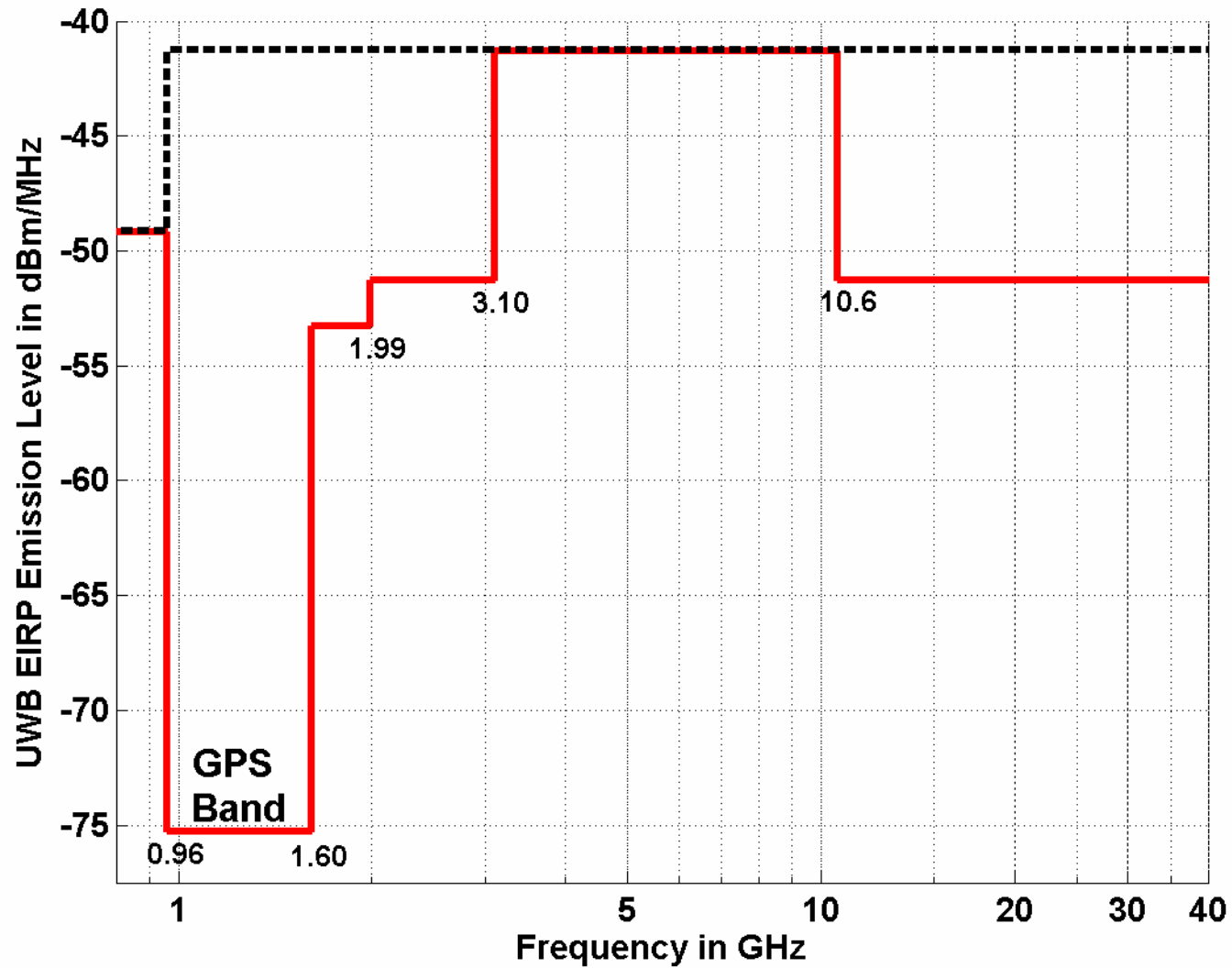
UWB Emission Limits

Vehicular Radar Systems



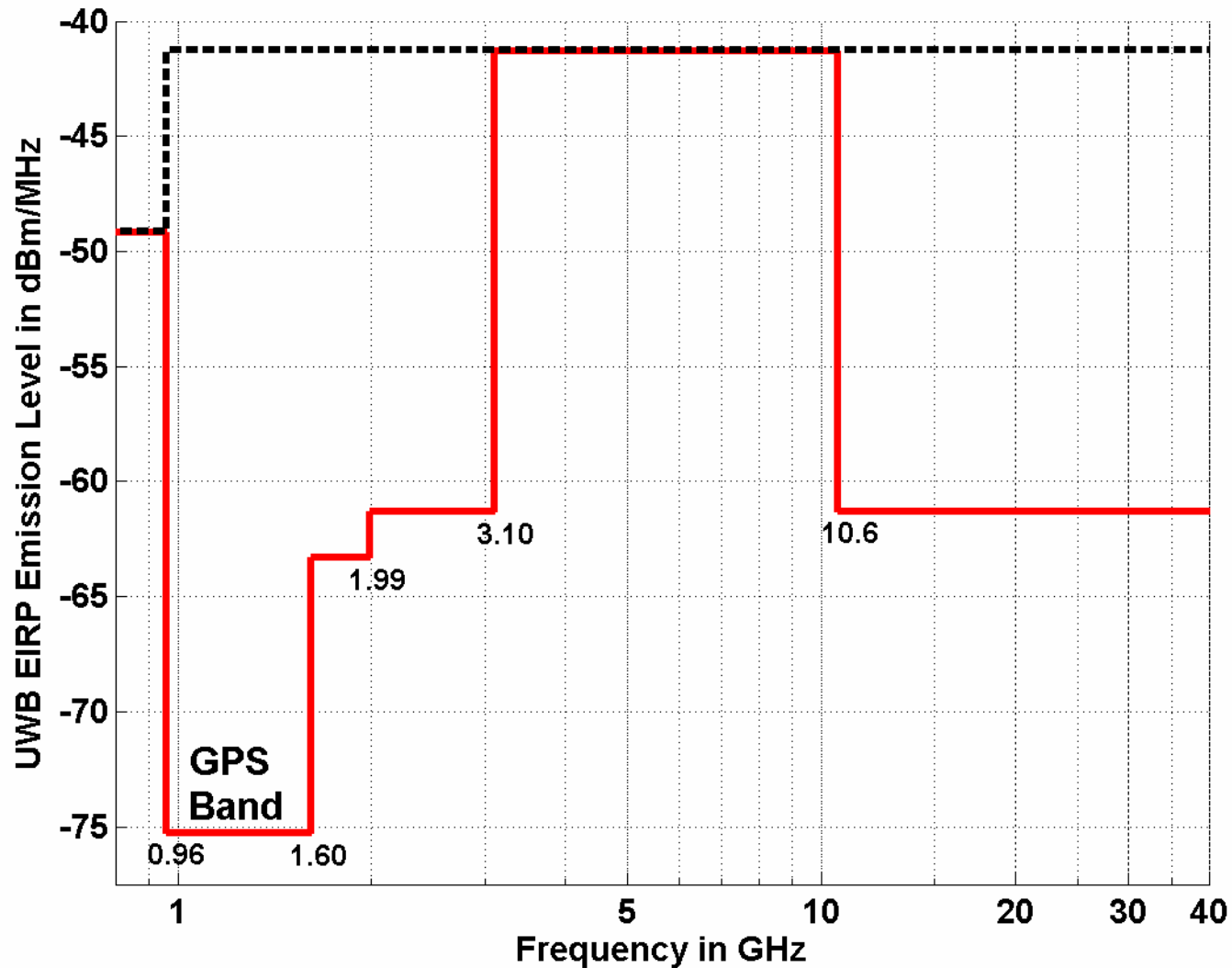
UWB Emission Limits

Indoor Communications Systems



UWB Emission Limits

Outdoor (Handheld) Communication Systems

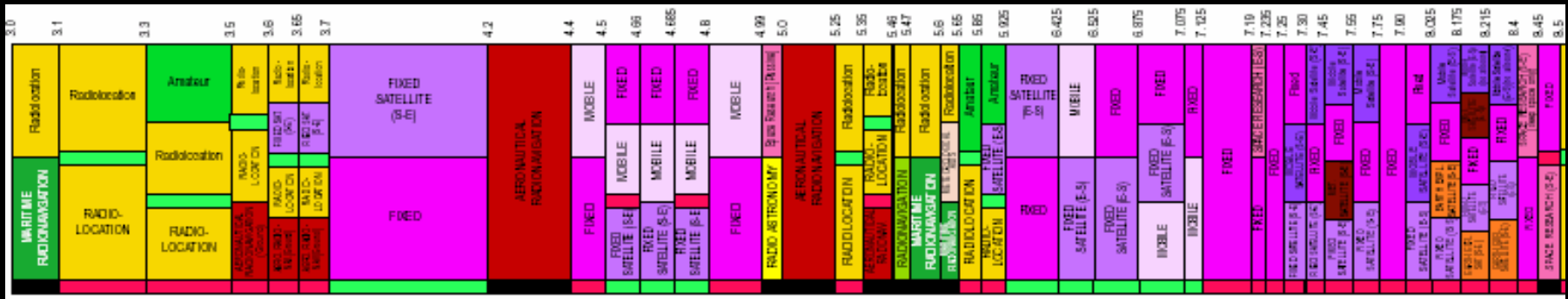


UWB Technology Basics: Spectrum Sharing Issues/Interference Risks

SPECTRUM CROSSOVER	
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



GOVERNMENT EXCLUSIVE
 GOVERNMENT/ NON-GOVERNMENT SHARED

NON-GOVERNMENT EXCLUSIVE

Spectrum Management Policy: The basic issue



Interference
risk to
incumbent
services

Benefits of
new service

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

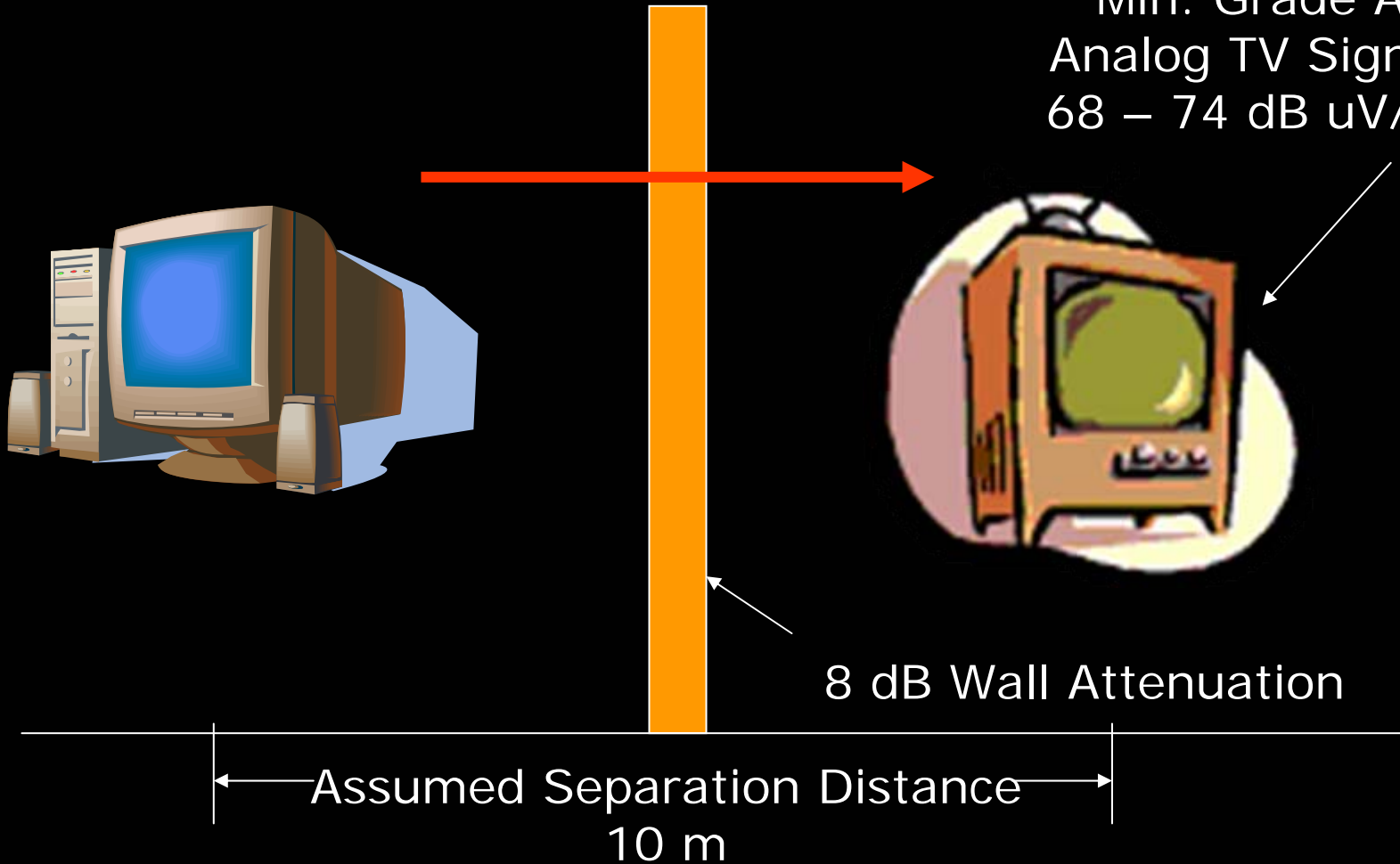
Benchmark Standard - Unlicensed

- Digital device limits established in 1979 establish radiated emissions standards:
 - 100 $\mu\text{V}/\text{m}$ 30 – 88 MHz @ 3 m
 - 150 $\mu\text{V}/\text{m}$ 88 – 216 MHz @ 3 m
 - 200 $\mu\text{V}/\text{m}$ 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 $\mu\text{V}/\text{m}$ above 960 MHz @ 3 m

Basis for Limits

Class B Digital Devices

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

The screenshot shows the homepage of the 2006 International CES website. At the top left is the International CES logo. The main header area contains the text "2006 International CES" and "January 5-8, 2006 Las Vegas, NV". To the right of this is a search bar labeled "Search CESweb.org" with a magnifying glass icon. Below the header is a navigation menu with four items: "ATTENDEES", "EXHIBITOR SERVICES", "PRESS ROOM", and "INTERNATIONAL VISITORS". On the left side, there is a "Register" button with a right-pointing arrow. Below the register button is a box for the Consumer Electronics Association (CEA), which is the producer of CES. The central part of the page is a large collage of images showing various scenes from the CES event, including people interacting with technology, a large crowd, and exhibition booths. At the bottom of the page, there are two columns of text. The left column has a headline "Record breaking 2006 International CES reflects strength of consumer technology industry." followed by a sub-headline "CES attracts 150,000 and serves as global launchpad for 2,500 exhibitors." and a link "Get keynote transcripts, read highlights, purchase". The right column has a headline "CES grabs headlines." followed by a sub-headline "CES generates more than 5,000 stories about its exhibitors and the industry." and two links: "View CES press releases." and "See recent CES media coverage."

International CES

2006 International CES
January 5-8, 2006 Las Vegas, NV

2006 International CES

ATTENDEES EXHIBITOR SERVICES PRESS ROOM INTERNATIONAL VISITORS

Search CESweb.org

Register

CEA
Consumer Electronics Association
Producer of CES

Record breaking 2006 International CES reflects strength of consumer technology industry.

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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
 - 1st International meeting held in Sept 2002
 - 6th 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
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IN SEEKING NEW
LANDSCAPES, BUT IN
HAVING NEW EYES.”**

- MARCEL PROUST -

a French novelist

***ALTHOUGH HE DIDN'T KNOW IT, HE WAS
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TIME.***