S-38.042 Seminar on Networking Business

Unlicensed reuse of licensed spectrum: case UWB

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Outline

- Introduction
- Overview of ultrawideband (UWB) systems
  - Motivation for UWB
  - Technical characteristics of UWB
- Current regulation state
  - Regulation in USA
  - Regulation in Europe
- Conclusions

Introduction

- Unlicensed reuse of already licensed spectrum to increase the spectrum efficiency is relevant topic in today's regulation.
- The regulator has interest in this field
  - existing allocated radio systems are not interfered
  - social welfare and increase of spectrum efficiency
- UWB needs some alternative regulatory actions
  - Fundamental differences in system implementation compared to traditional radio systems
- Use of already licensed radio spectrum in an unlicensed manner
  - without a licensing cost or control

Introduction (2)

- Interest of UWB grows rapidly
  - UWB discussion mainly on communication matters
    - also imaging services e.g. short range radar
  - use of radio access is today familiar to users
  - equipment manufacturing costs are low enough
  - Users frustrated of cables running all over the house

> *"In the digital home of the not-too-distant future, people will be sharing photos, music, video, data and voice among networked consumer electronics, PCs and mobile devices throughout the home and even remotely, without the use of any wires."*

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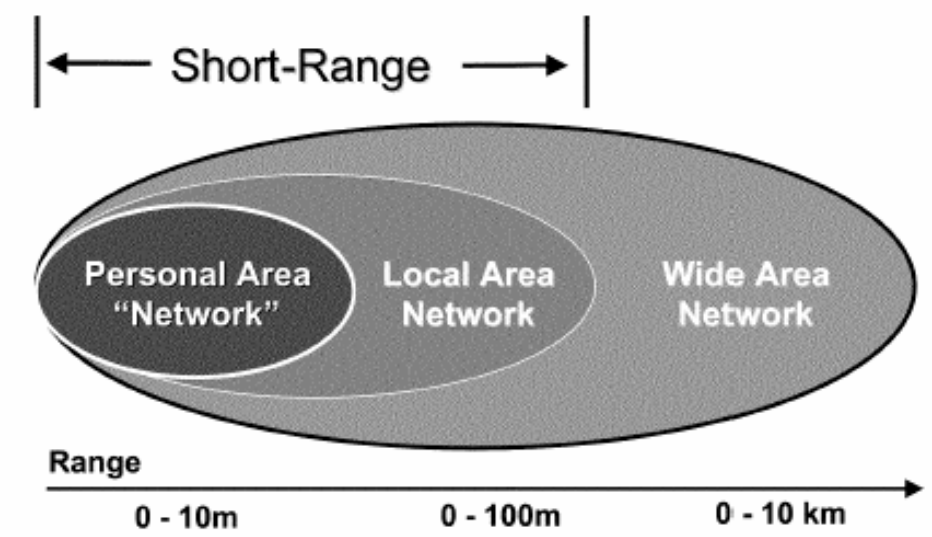
Overview of UWB

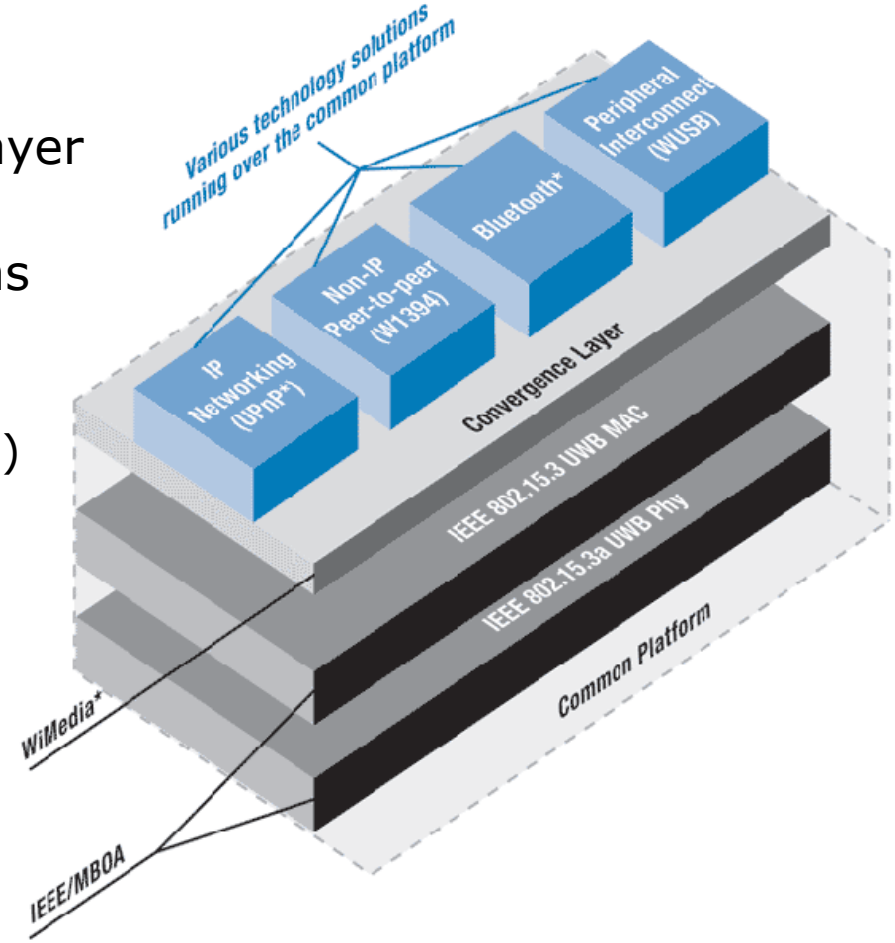
- UWB is a personal area network (PAN)
  - intended for short range radio transmission
  - high-rate connectivity
- UWB definition:
  - bandwidth > 20 % of the center frequency
  - or a bandwidth of at least 500 MHz.



- two physical layer specifications in standardization:
  - -direct sequence spread spectrum (DS-UWB)
  - -multiband orthogonal frequency division multiplexing (OFDM)
- The latter heavily supported by MultiBand OFDM Alliance (MBOA)
  - - inc. above 170 companies (Intel, TI, Nokia, etc.)

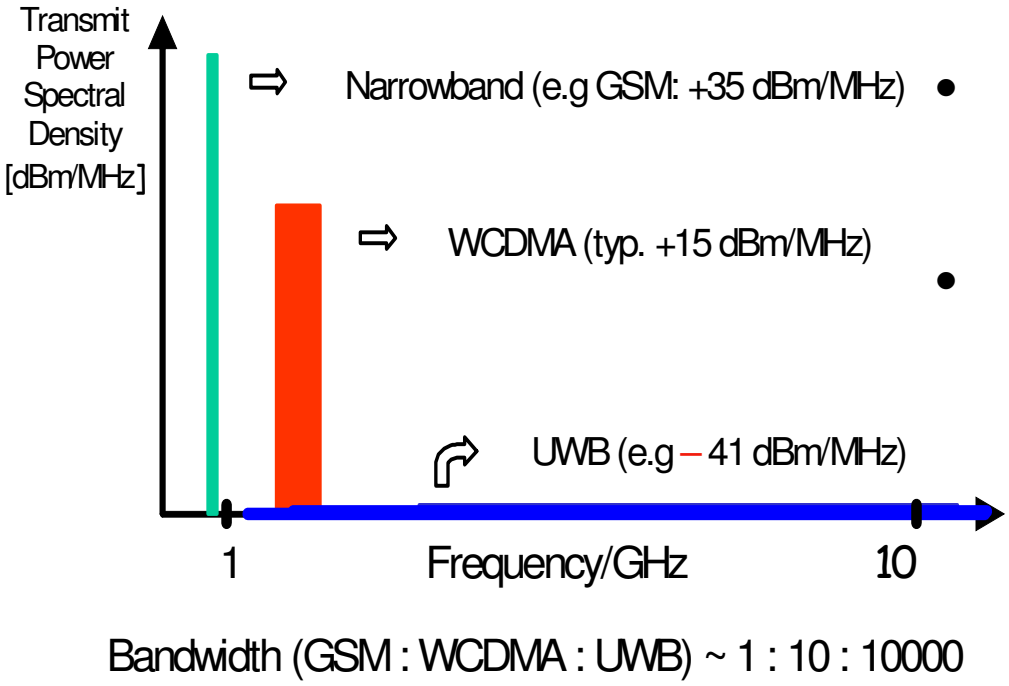
Motivation for UWB

- UWB along with the convergence layer
- becomes the underlying transport mechanism for different applications
  - currently only available in wired networks
  - wireless universal serial bus (WUSB)
  - wireless IEEE 1394 (FireWire)
  - the next generation of Bluetooth
  - Universal Plug and Play (UPnP)



Technical characteristics of UWB

Operates on 3.1-10.6GHz (FCC 2002)

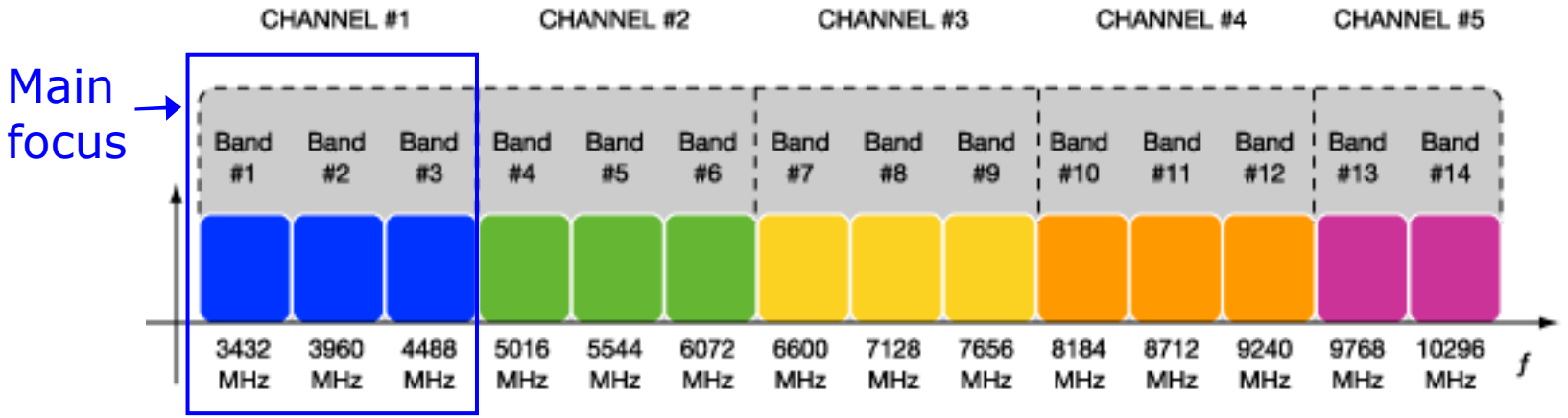


Bandwidth (GSM : WCDMA : UWB) ~ 1 : 10 : 10000

- Physical layer:
  - pulse-based single carrier method or
  - advanced multicarrier techniques
- Pulse-based single carrier systems:
  - transmit signals by phase modulating of a very narrow pulse
  - very simple transmitter design
  - disadvantages
    - signal energy level in multipath environment, switching time, group delay variations, narrowband interference

Technical characteristics of UWB (2)

- Multiband OFDM:
  - transmit data simultaneously over multiple carriers
  - transmitter complexity slightly increased
  - resiliency to RF interference and multipath effects
  - OFDM modulation success in WLAN 802.11a/g and WiMAX 802.16a.
- spectrum divided to 528 MHz bands
  - Dynamic ability to select certain bands and not use other parts



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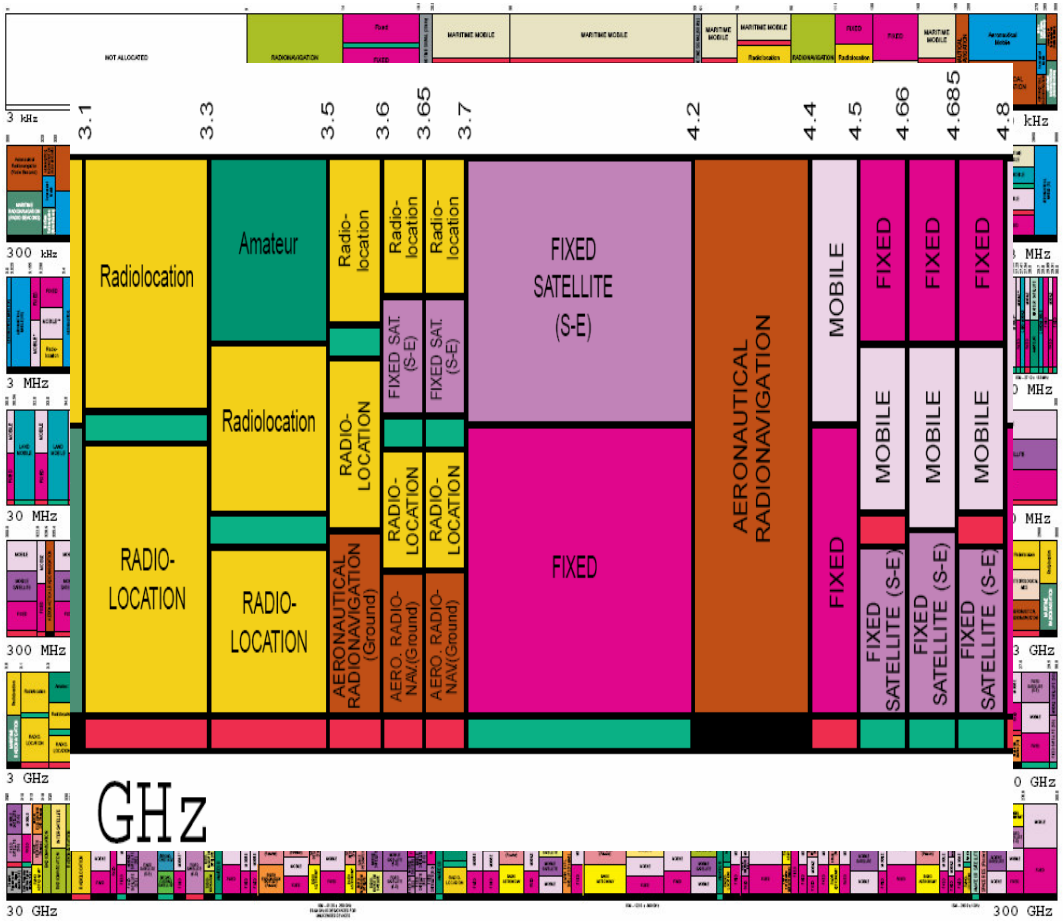
Current regulation state

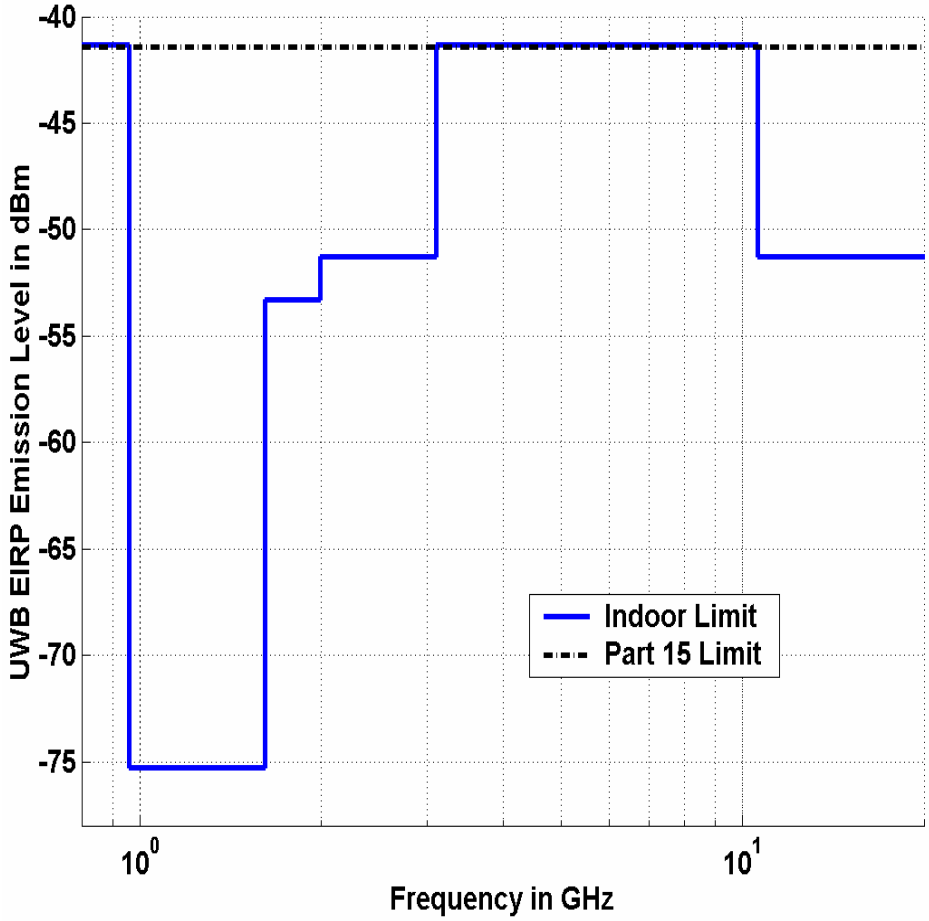
- UWB operates at 3.1-10.6 GHz in 528 MHz bands
- obvious problem for UWB:
  - these frequencies are already in use
    - at least partly in every corner of the world
  - frequency spectrum is limited resource
  - should be efficiently in use
- Existing systems should not be interfered!
  - Regulation impact on development



USA 300kHz-300GHz, 1996

Regulation in USA

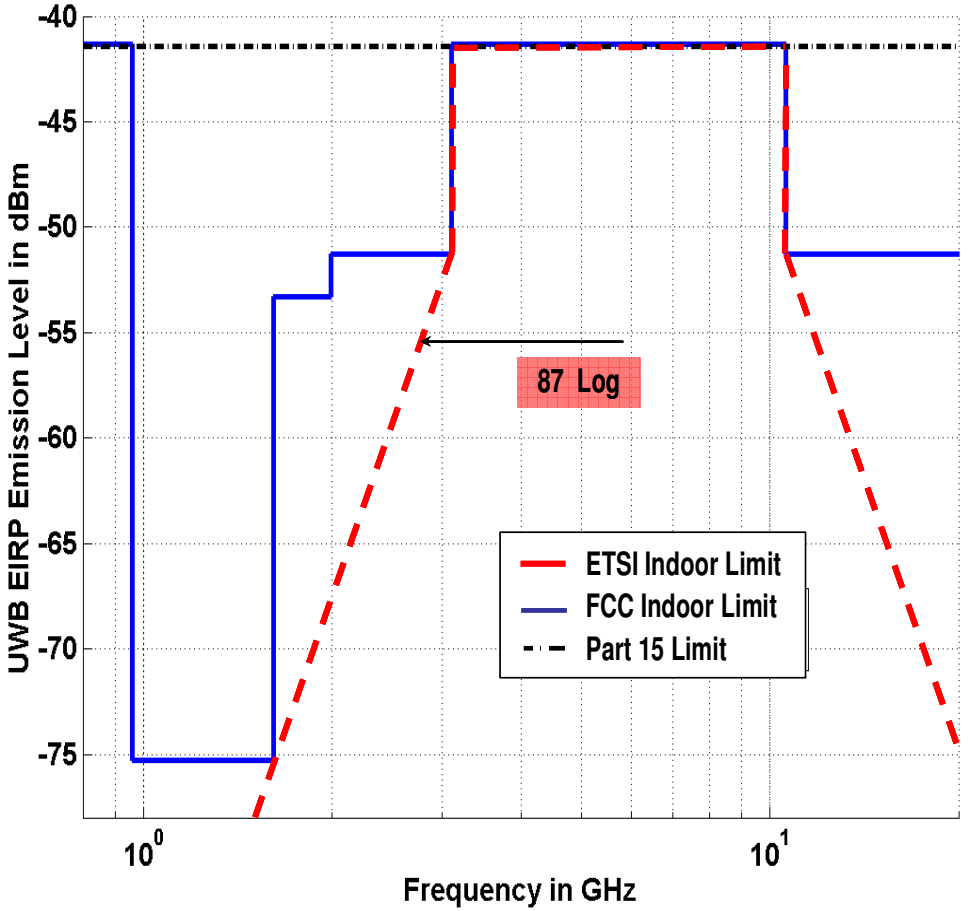
- Strong debate before regulation decision (e.g. GPS)
- The FCC approved UWB on an unlicensed basis in 2002
  - 3.1–10.6 GHz band
  - power spectral density (PSD) limitation:
    - emission level restricted to -41dBm/MHz over a 7.5 GHz bandwidth
    - approximately 0.55 mW average transmit power
  - Additional PSD limits below 2 GHz to protect applications such as GPS
- UWB allowed at a very low transmit power to reduce interference



Regulation in Europe

- Regulation still in progress
  - begun later than in the USA,
- October 2004: Draft of a new Electronic Communication Committee (ECC) Report 64
  - protection requirements of radio communication systems below 10.6 GHz from generic UWB

Power type	Frequency, GHz		
	f < 3.1 dBm/MHz	3.1 < f < 10.6 dBm/MHz	f > 10.6 dBm/MHz
Type I. (Indoor)	–51.3 + 87* log (f/3.1)	–41.3 dBm/ 1 MHz	–51.3 + 87* log (10.6/f)
Type II. (Outdoor)	–61.3 + 87* log (f/3.1)	–41.3 dBm/ 1 MHz	–61.3 + 87* log (10.6/f)



Response of Europe regulation

- Pessimistic response to differences between the FCC and the ETSI mask
  - when the first draft was published in 2002
- from 5 dB to 30 dB more protection at specific frequencies is needed
  - Compared to the FCC in-band limit
- This "European limit" was feared to make UWB useless for consumer and PC applications.
- Single manufacturer in 2002:

> "*UWB may become a US only technology for 3 to 5 years. Afterwards successful deployment in the US, the regulations can be changed in Europe and Japan (Japan may "play it safe" and follow strict European rules)*."

- Later there have been more optimistic approaches
  - manufacturers try to overcome the difficulties

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Conclusions

- Allocation of a large range of spectrum for unlicensed use, as in the case with UWB:
  - Indicates a significant shift away from a traditionally regulatory viewpoint; the licensed spectrum usage philosophy
  - Raised many concerns regarding UWB's ability to coexist with existing radio services
    - such as IEEE 802.11a WLANs, radar systems, etc
  - During the regulation phase, the FCC received a large number of responses from concerned licensed service providers
    - indicating the intense interest that UWB has generate

Conclusions (2)

- However, a wider perspective reveals potential:
  - Achieving more efficient spectrum utilization
  - Licensed bands show a inefficient use of spectrum for significant percentage (averaged over time)
  - The commercial success of WLAN technologies has led to need for increasing globally harmonized allocations of unlicensed spectrum
- It is still worth pointing out:
  - Use of unlicensed spectrum for sure can have its own problems
    - the tragedy of commons
  - Sort of "an etiquette" for sharing of common resources needed
    - e.g. such mechanisms as dynamic spectrum management
- The ability of UWB to fill-in unused/underused spectrum promotes
  - Opportunistic communications can contribute to **both** *greater spectral efficiency* and *aggregate network throughput*
    - Assuming a suitable multiple accessing network architecture for UWB is identified

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Thank you!

Guestions...?