~~UWB~~ (High-rate WPAN) Opportunities and Issues

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April, 2006

Introduction

"Never fall in love with a technology, but rather it's the applications that matter…"

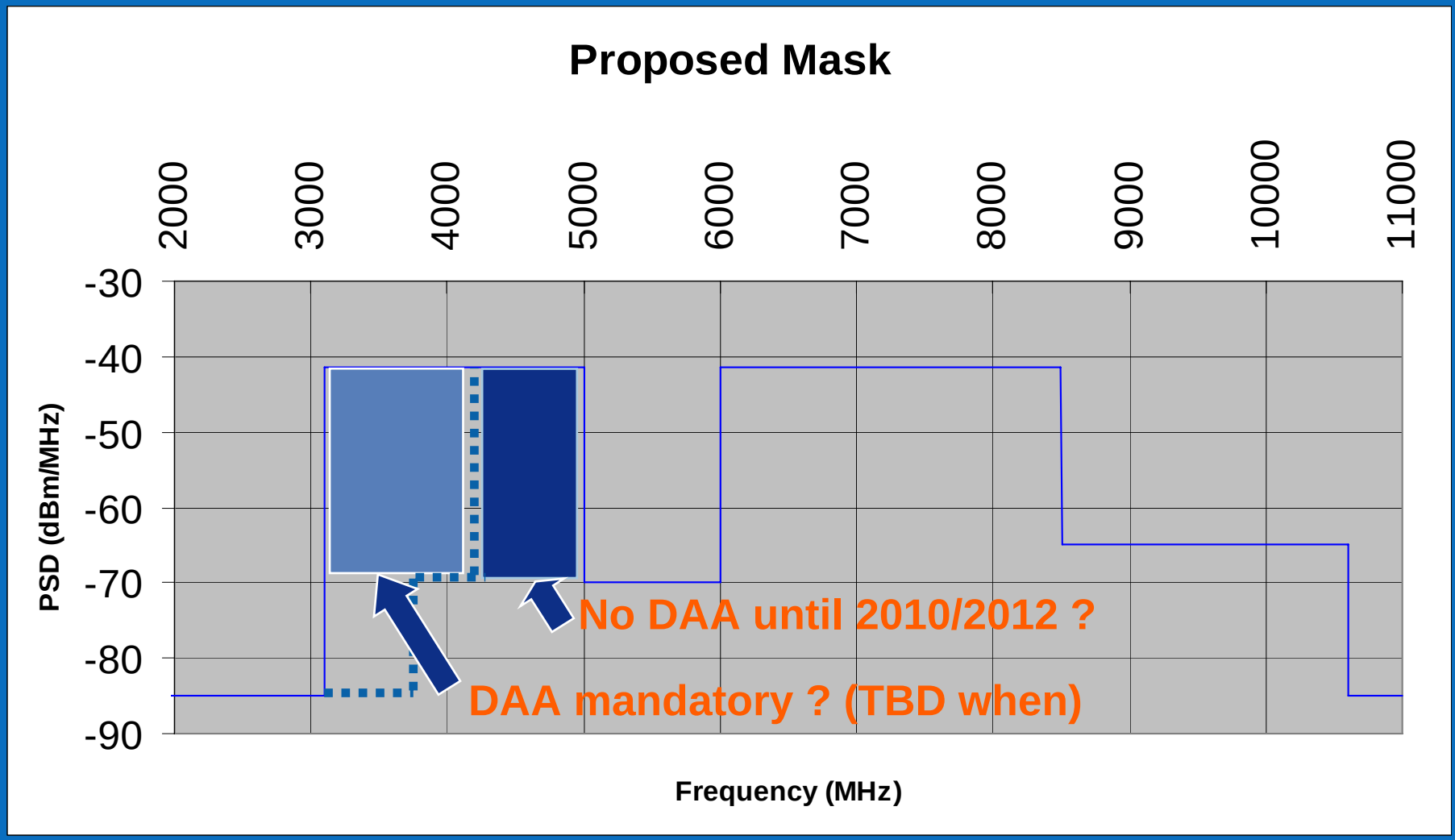
- Former colleague

- High-rate, short-range WPAN is the application
  - Includes cable replacement, rapid file transfer
  - Must be simple to use and setup
    - Robust to different environments, locations, channels
    - Automatically adjusts to changes in the environment (channel, interference, separation distance, etc.)
  - As reliable as the cable (especially for video streaming)
  - Must provide acceptable wait times when exchanging files (10s of seconds)

WPAN Status and Issues

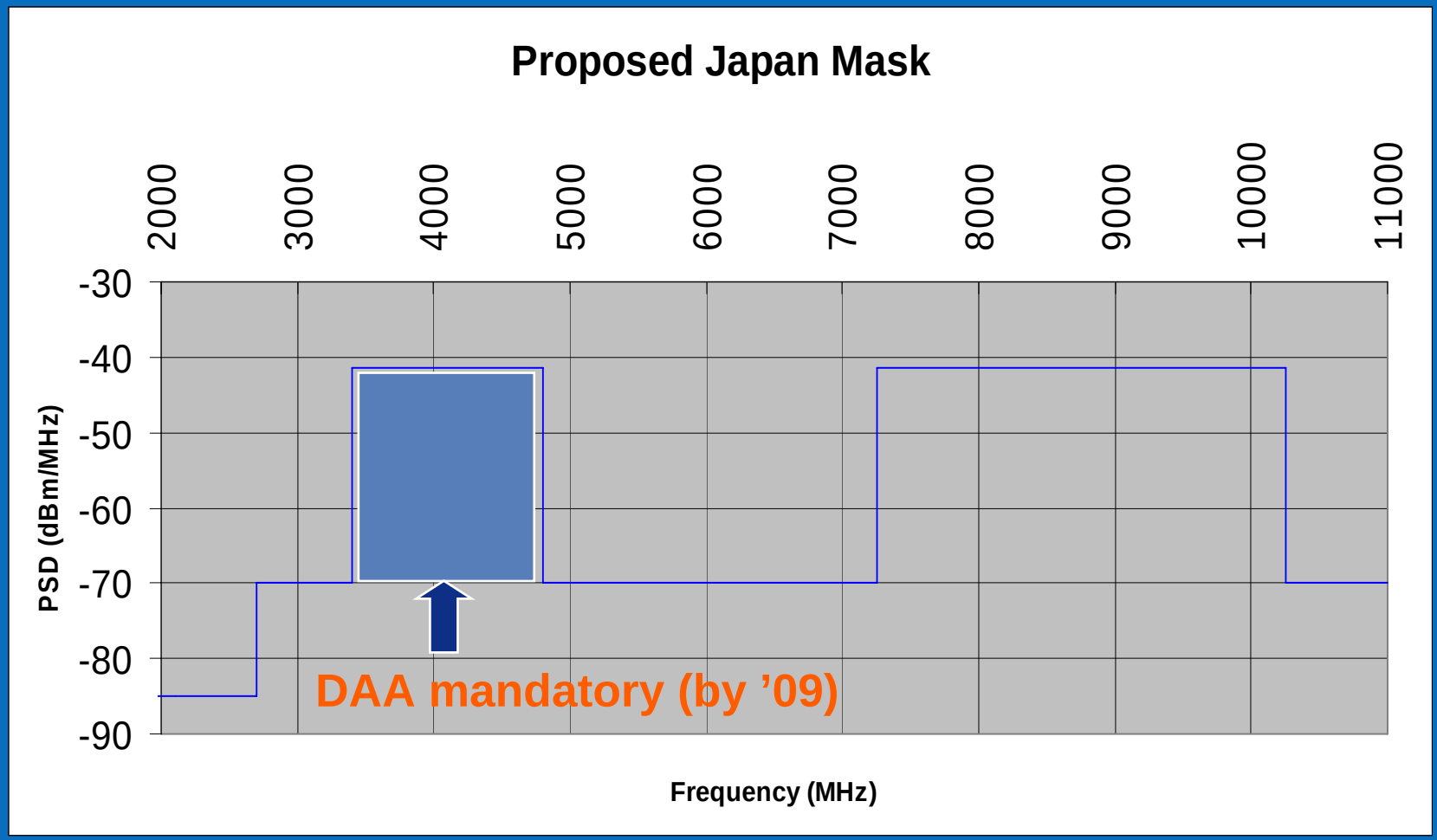
- WiMedia PHY/MAC Specification completed (UWB based)
  - Standardized in ECMA and ETSI (IEEE task group terminated)
  - First gen capable of 480 Mbps at the PHY (2nd gen targeting 1.5-2 Gbps)
  - Adopted by W-USB and Bluetooth (above 6 GHz) SIGs
  - Enables large file transfers, streaming compressed HD video content, simple association and configuration
  - Products expected end of this year and next
- Issues / Challenges for using UWB for WPAN
  - No world-wide harmonized spectrum regulations
    - Available spectrum outside US much less than 7.5 GHz allocated in US
    - Requires 'detect-and-avoid' mechanisms in some cases (adds complexity)
  - Need Gbps to hit next application space (wireless uncompressed / minimally compressed video)
  - Low PSD increases risk of reliability and range concerns for HD video content distribution (especially at higher frequencies)

Recent proposed EU Mask



*** Other restrictions also apply**

Recent proposed Japanese Mask



Why 'Detect and Avoid' (DAA)?

FCC limits are not sufficient to protect a near-by device sharing the same spectrum (3.1-10.6 GHz)

- WiMax has spectrum allocations outside of the US in the 3.4-3.8 GHz band
- Most services are not likely to be operating in close proximity

DAA allows for the re-use of the lower spectrum

- Will be mandatory in some geos for WiMax and future 4G systems

Technical and political issues remain

- Uplink vs. downlink detection
- How to deal with receive only modes (network entry) ?
- TDD vs. FDD (keeping flexibility in UL/DL locations)

Current approach

- Focus on uplink detection (high detection threshold makes detection simple)
- Create 'silent' periods to provide consistent guaranteed 'interference free' times
- Multiple devices running detection circuits provides diversity
- Ensure sufficient detection opportunities for reliable detection in different traffic / operational modes

Next Gen WPAN Opportunities

- Opportunities for UWB research
  - Methods for increasing peak throughput (target 2+ Gbps) and robustness to NLOS
    - Wider transmission bandwidth (2-4 GHz)
    - Advanced FEC (running at Gbps rates)
    - Multiple antennas (spatial multiplexing, range extension, interference mitigation)
  - Integration challenges
    - Multi-radio integration (WiFi and W-USB in same chip and/or on same platform, multi-band antennas / RF FEs, coexistence / sharing protocols)
  - Regulatory challenges
    - 'Detect and avoid' architectures and algorithms to enable dynamic sharing of spectrum
  - Low complexity compression, joint source/channel coding
- What's driving next gen short-range connectivity
  - Replacing the video cable (uncompressed or 'minimally' compressed with close to lossless performance)
    - Wireless HDMI
    - Wireless UDI
  - Movie downloads (850 GbB movie files; Movie kiosks; hot-spots with local content)

CE Display Resolutions

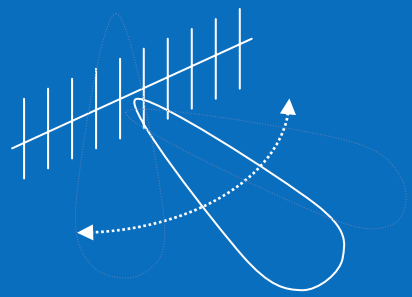
Spatial Resolution	Video Type	Resolution	Ratio	Pixels	Applications	Video bit rate	HDMI BW with 8b10b
480i60	SDTV/NTSC	720x480	4:3, 16:9	.346M	SD Broadcast	249 Mbps	375 Mbps
480p60	EDTV	720x480	4:3, 16:9	.346M	Progressive DVD	500 Mbps	700 Mbps
720p60	HDTV	1280x720	16:9	1M	Fox/ABC/ESPN Broadcast	1.45 Gbps	2.3 Gbps
1080i60 8bit	HDTV	1920x1080	16:9	2M	CBS/NBC/WB/HBO/SHO/TNT/HDNET Broadcast	1.45 Gbps	2.3 Gbps
1080p60 8bit	HDTV	1920x1080	16:9	2M	**CE Target**	3.0 Gbps	4.6 Gbps
1080p60 12bit	HDTV	1920x1080	16:9	2M	**Future Goal**	4.5 Gbps	6.9 Gbps

PC Display Resolutions

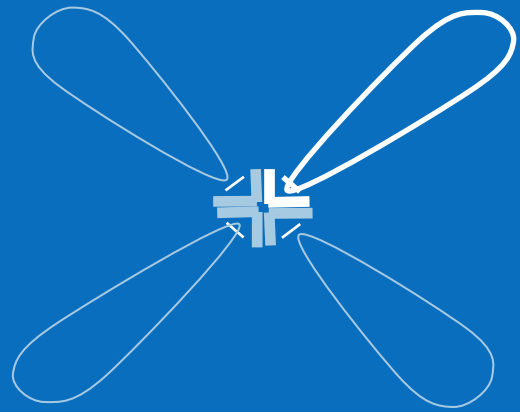
PC Standard	Resolution	Ratio	Pixels	Bits/Pixel	(Gbps) @ 60Hz	(Gbps) @ 85hz
QXGA	2048x1536	4:3	3.1M	24	4.5	6.3
WQXGA	2560x1600	16:10	4.1M	24	5.9	8.4
QSXGA	2560x2048	5:4	5.2M	24	7.5	10.6
WQSXGA	3200x2048	25:16	6.6M	24	9.5	13.5
QUXGA	3200x2400	4:3	7.7M	24	11.1	15.7
WQUXGA	3840x2400	16:10	9.2M	24	13.2	18.8
HXGA	4096x3072	4.3	12.6M	24	18.1	25.7

What about 60 GHz ?

- Why 60 GHz?
  - 7 GHz of unlicensed spectrum in many parts of world
  - Similar concept as UWB…
- Lots of challenges remain at 60 GHz
  - OFDM or single-carrier ?
  - RF front end architectures and antenna designs for beam-steering
  - CMOS integration (little headroom from Ft)
  - Poor RF propagation for NLOS operation
  - High throughput baseband circuitry (Gbps processing required)
  - Silicon integration for high-yield manufacturing (temp variations)
  - Efficient MAC supporting directional antennas



Broad Side
Electronically Steerable Array



Sector Selection

Conclusions

- UWB remains excellent fit for high-rate WPAN / W-USB and compressed video transmission
  - Regulations still a thorn…focus moving to above 6 GHz outside US
  - Peak throughputs / range limited by reduced bandwidth available world-wide, but still sufficient to meet many application needs
  - Next gen UWB should target 1.5-2+ Gbps (larger file downloads, uncompressed/minimally compressed video for low-end displays)
  - Research to improve throughput, robustness, multi-radio integration, DAA will be useful
- Future opportunities
  - Leverage 7 GHz of unlicensed spectrum at 60 GHz (same concept as UWB)
    - Consider UWB + 60 GHz integrated designs
  - Opportunities for uncompressed video transmission or ‘lite’ compression algorithms with close to ‘lossless’ performance
    - PC display compression opportunities