



From research to products in 10 years:

FCC NOI (1998)

Worldwide pervasive consumer applications (2008)

Roberto Aiello, Ph.D.

Staccato Communications
San Diego, CA

UWB: Low Transmit Power, Large Bandwidth



Table 15—Transmit Power Levels

Maximum output power	Geographic location	Compliance document
1000 mW	USA	FCC 15.247
100 mW (EIRP)	Europe	ETS 300-328
10 mW/MHz	Japan	MPT ordinance for Regulating Radio Equipment, Article 49-20

802.11b specs

Table 89—Transmit Power Levels for the USA

Frequency Band	Maximum Output Power with up to 6 dBi antenna gain
5.15 - 5.25 GHz	40 mW (2.5 mW/MHz)
5.25 - 5.35 GHz	200 mW (12.5 mW/MHz)
5.725 - 5.825 GHz	800 mW (50 mW/MHz)

802.11a specs

Table 8 Average Emission Limits Applicable to UWB Operation

Frequency Band (MHz)	Imaging below 960 MHz	Imaging, Mid-Frequency	Imaging, High frequency	Indoor applications	Hand held, including outdoor	Vehicular radar
0.009-960	§15.209	§15.209	§15.209	§15.209	§15.209	§15.209
960-1610	-65.3	-53.3	-65.3	-75.3	-75.3	-75.3
1610-1990	-53.3	-51.3	-53.3	-53.3	-63.3	-61.3
1990-3100	-51.3	-41.3	-51.3	-51.3	-61.3	-61.3
3100-10600	-51.3	-41.3	-41.3	-41.3	-41.3	-61.3
10600-22000	-51.3	-51.3	-51.3	-51.3	-61.3	-61.3
22000-29000	-51.3	-51.3	-51.3	-51.3	-61.3	-41.3
Above 29000	-51.3	-51.3	-51.3	-51.3	-61.3	-51.3

FCC R&O



UWB Spectrum's characteristics consequences



$$C = W \cdot \log\left(1 + \frac{S}{N}\right)$$

C = capacity
W = bandwidth
S/N = signal-to-noise ratio

$$d \propto \sqrt{\frac{P_t}{P_r}}$$

d = distance
 P_t = transmit power
 P_r = receive power

Large bandwidth makes high bit rate easier: to increase bit rate by a factor of 2

Increase bandwidth by a factor of 2 or increase power by a factor of 10

Low transmit power makes long range difficult: to increase distance by a factor of 2

Increase bandwidth or power by a factor of 4

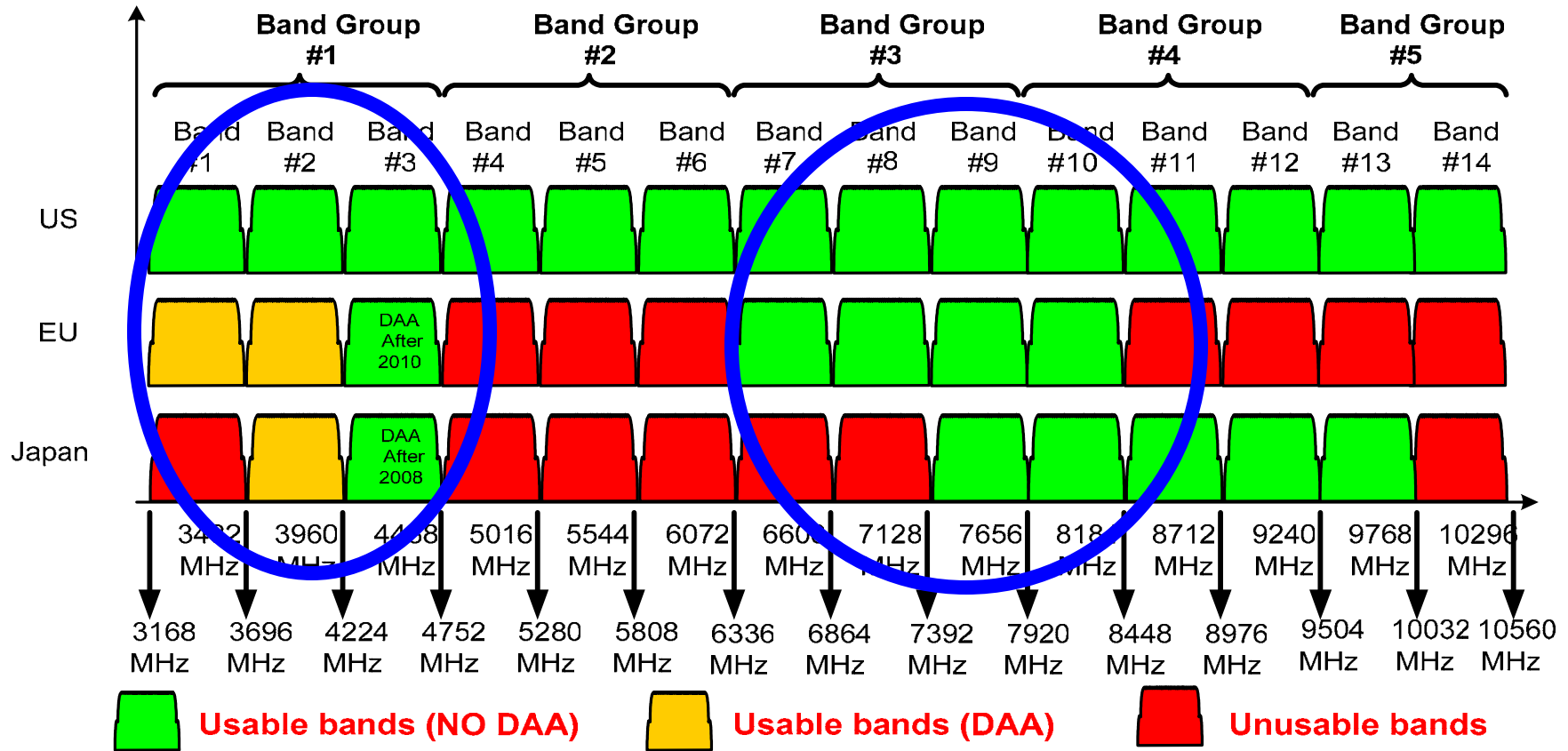


Worldwide Regulatory Status



Low bands

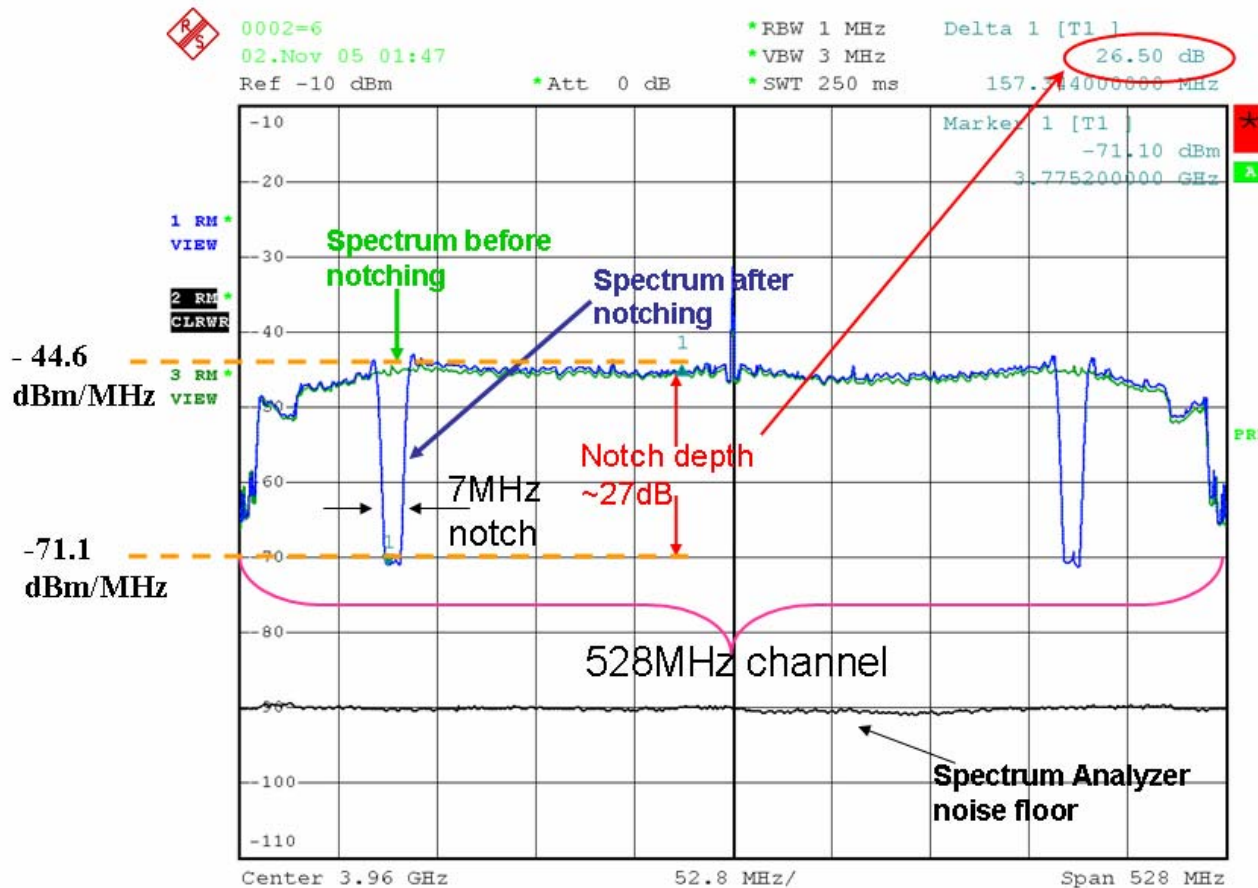
High bands



DAA = Detect and Avoidance



Notch implementation – MB-OFDM radio



- Total 5 tones used for notch
- Analyzer settings
 - Res BW = 1MHz
 - Video BW = 3MHz
 - Span = 528MHz
 - Ctr Freq = 3.96GHz

Date: 2.NOV.2005 01:47:15

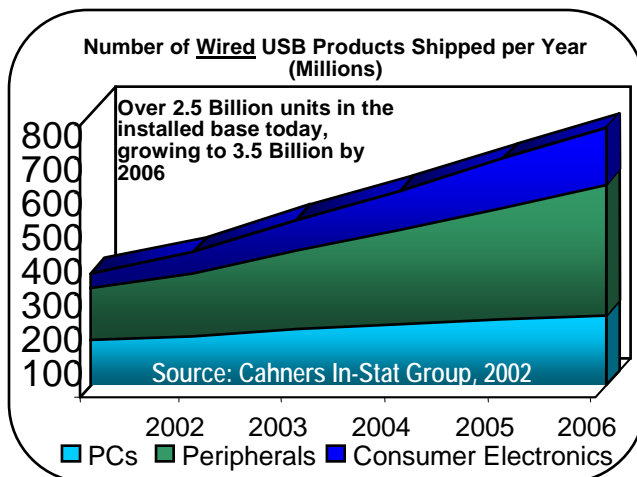


IEEE 802.15-05-648r0, MB-OFDM proposal update, Nov' 2005

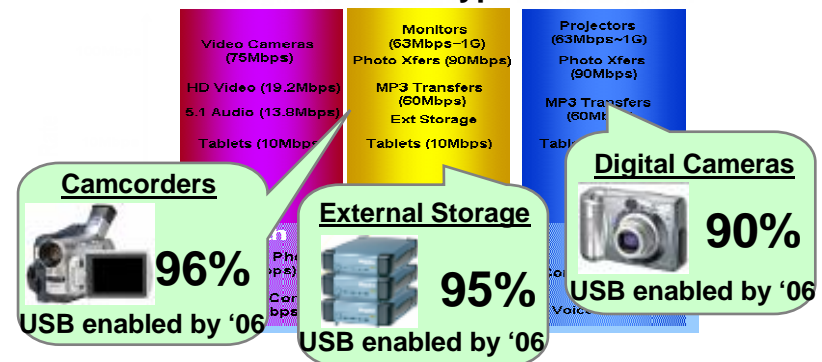
First Major Market for UWB: USB



- Most widely used PC peripheral interface in history
- Installed base of over 2.5 billion units will be joined by another 1+ billion units over the next 12 months
- Wired USB introduced revolutionary ease-of-use, true plug-and-play capability
- Adoption virtually 100% in most PC and peripheral categories
- Rapidly penetrating Mobile and CE markets



Wired USB Attach Rates for Key Peripheral Device Types



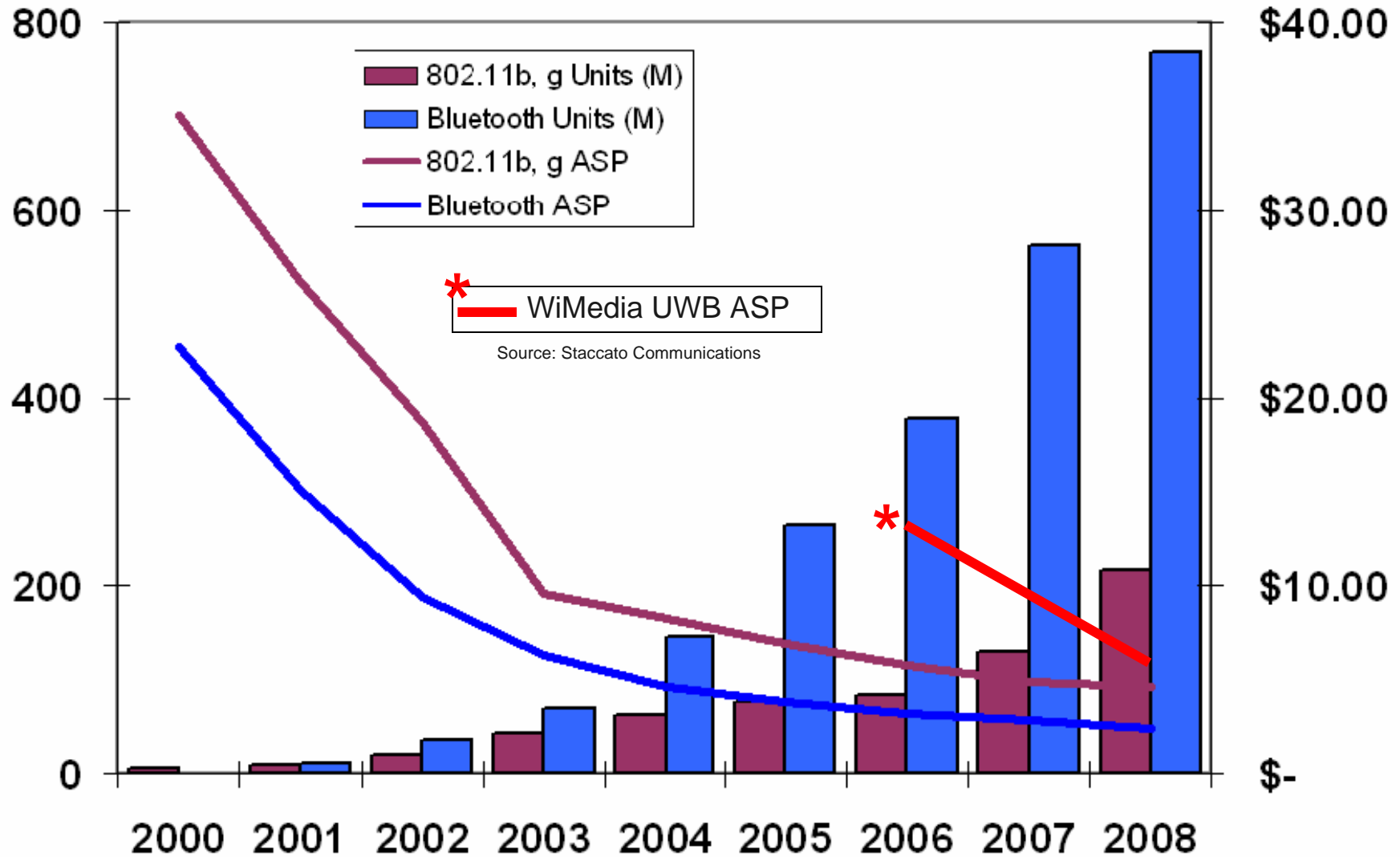
Source: In-Stat/MDR Group, 2004

“USB is the most successful interface in the history of the PC”

Source: Brian O'Rourke/Instat-MDR



Bluetooth & WiFi Uptake Driven by Single-Chip CMOS STACCATO

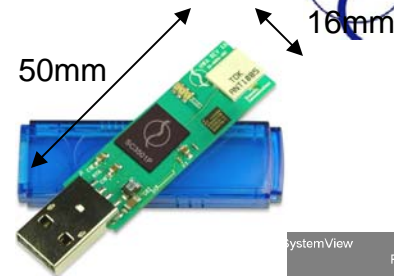


Source: Staccato Communications

Source: In-Stat, 11/04



Challenges



- Low cost, CMOS, high level of integration
- Low power (both active and standby)
- Very high bit rate (for low duty cycle bursty transfer)
- One worldwide product (low and high bands)
- Spectrum flexibility (DAA)
- Good rejection to interference (to and from)

