Wireless Universal Serial Bus

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Outline

○ Wired Universal Serial Bus (USB)
○ Overview of Wireless USB (wUSB)
  ● History/Vision
  ● Features
○ How wUSB Works
  ● Design
  ● Security
○ Issues/Limitations
○ Current Implementations
○ Future/Conclusion
Wired USB

- **Overview**
  - Plug/Play standard for peripheral devices
  - Standardized by the USB Implementers Forum

- **Technical Details**
  - Host/Slave Connection
    - PC (host) manages all transfers; peripherals (slave) just responds
    - Supports 127 slaves per host
  - Physical Connection
    - Four wire connection
      - Two wires for power (+5 and GND)
      - Two wires (twisted pair) for synchronous serial data
    - Computer supplies power (up to 500 mA)
Wired USB

- Technical Details (Cont.)
  - Data Rates
    - Low Speed: 1.5 Mbps (Keyboards, mice, etc.)
    - Full Speed: 12 Mbps (USB1.1 max speed)
    - Hi-Speed: 480 Mbps (USB2.0 max speed)
Reasons For Wireless USB

- **Wired Issues**
  - Wires are restrictive
  - Multiple wires can be a hassle
  - Wires slower than wireless solutions

- **Current wireless solutions inadequate**
  - Bluetooth
    - Bandwidth of 3 Mbps not enough for higher demand applications (Video, HDTV, Monitor)
  - WiFi
    - Expensive
    - Too much power usage for mobile devices
Data Rate Comparisons

<table>
<thead>
<tr>
<th>Home Activity</th>
<th>Mbps</th>
<th>Bandwidth Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple, simultaneous VoIP calls</td>
<td>0.1 - 0.2</td>
<td></td>
</tr>
<tr>
<td>Phone Text browsing (WAP)</td>
<td>0.1 - 0.5</td>
<td></td>
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<tr>
<td>Streaming whole-home audio</td>
<td>0.2 - 0.5</td>
<td></td>
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<tr>
<td>Static Web surfing on PC</td>
<td>0.2 - 0.5</td>
<td></td>
</tr>
<tr>
<td>Streaming video onto phone</td>
<td>0.2 - 3</td>
<td></td>
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<tr>
<td>Streaming SD Video onto TV</td>
<td>2 - 3</td>
<td></td>
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<tr>
<td>Streaming Multiple HD Videos on TV’s</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Multiple PC-Based LAN applications **</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Theoretical Maximum</td>
<td></td>
<td>500</td>
</tr>
</tbody>
</table>

* Based on existing applications
** Such as file transfers, storage, background IT applications, etc.

Source: Texas Instruments - Internal Analysis
Wireless USB Overview

- **Overview**
  - Has evolved as companies figured out standards
  - Based on Ultra-Wideband (UWB) RF technology
  - UWB is a technology for transmitting data over a large bandwidth (>500 MHz)

- **History of Ultra-Wideband (UWB)**
  - Late 1800s: Started with Spark Gap radio for transmitting Morse Code
  - 1924: Spark Gap forbidden due to disruptive nature to narrowband carrier radios
  - 1960s – 1999s: Better test equipment promoted research of UWB for radar and communications
Wireless USB Overview

- History of Ultra-Wideband (cont.)
  - April 2002: FCC issued UWB Regulations
    - Permitted marketing and operation of new products
    - Limited power and freq range
  - 2002: Two standards emerge
    - Orthogonal Frequency Division Multiplexing (OFDM) UWB
      - WiMedia Alliance & Intel
    - Direct Sequence (DS) UWB
      - UWB Forum & Freescale
  - 2006: DS-UWB loses support & OFDM-UWB wins
    - Freescale left UWB Forum; became quiet
    - Many companies dropped Freescale chips
    - Freescale trying proprietary “Cable-Free USB”
  - 2007: Products begin to hit the market
Wireless USB Overview

Goals of Intel OFDM-UWB Wireless USB Standard
- Wireless version of USB; same features, speeds
- Interoperable across three major platforms
  - Consumer Electronic devices (digital video/audio)
  - Mobile devices (cellular phones, PDA)
  - Personal Computing (laptop, PC, printer, peripherals)
- High bandwidth to support demanding data transfer (High Definition, Monitors)
- Mobile friendly
  - Low power usage
  - Inexpensive costs
  - Small physical implementation
- High level of security
- Next gen Wireless Personal Area Network (WPAN)
Wireless USB Vision

Figure 1. Home usage scenarios that could be "unwired" with Wireless USB.
Wireless USB Vision

- Camera: Transfer digital photos, MP3s, etc.
- Flash Card Reader: Scan images
- Scanner: Transfer video and digital stills
- Camcorder: Print documents
- Printer: Live video feed

Desktop PC OR Notebook PC

- Back up data and files: HDD, Zip, Mass Storage Devices
- Multimedia presentation: Portable Projector
- Copy data, files, CDs, etc.: CD/RW, DVD-RW
- Surf the Web: Ethernet, HPNA, DSL/Cable Modem
- Transfer music: MP3 Player
- Sync-up with e-mail/calendar: PDA
Wireless USB Physical Design

○ Features of UWB
  • Speed/Range
    ○ Scaleable speeds up over 1 Gbps
    ○ Currently 480 Mbps at 3 m; 110 Mbps at 10 m
  • Frequency: 3.1 GHz to 10.6 GHz
    ○ Divided into 14 bands; 5 groups
      • Each band is 528 MHz wide
      • OFDM symbols are interleaved across all bands
      • Provides protection against multi-path / interference
Wireless USB Physical Design

○ Features of UWB (cont.)
  ▪ Frequency: 3.1 GHz to 10.6 GHz (cont.)
    ○ Band Groups 1 & 2: Longer range apps
    ○ Bands Groups 3 & 4: Shorter range apps
    ○ Bands can be turned off to accommodate for conflicts or for regulations
Wireless USB Physical Design

- Features of UWB (cont.)
  - Power
    - Power is limited due to usage of wide spectrum
    - Low power for mobile devices and minimum interference
    - Max output to -41.3 dBm/MHz

![Graph showing Energy Output vs Frequency Range with SS, NB, UWB labels]
Wireless USB Security Design

- **Overview**
  - Strongly stressed in wUSB specification and outlined in its own requirements document
  - Security needed due to crowded environments
  - Two major components: Association and Encryption

- **Association**
  - **Overview**
    - Device must first associate with the host in a one-time event
    - Accomplished via wired verification or numeric association
Wireless USB Security Design

- Association (cont.)
  - Wired Verification
    - Cable is attached between devices
    - Exchanges a unique 384-bit identifier known as the “connection context”
  - Numeric Association
    - Devices associate wirelessly
    - User must enter a hex code manually
Wireless USB Security Design

- Encryption
  - Data encrypted with the AES 128 algorithm
  - During each session devices derive a session key based on “connection context”
  - Wireless data is encrypted using session key
  - Does not encrypt PHY and MAC headers
Wireless USB Connection Design

○ Host/Slave Connection
  • Similar to wired USB (127 devices; host is PC)
  • Each host forms a cluster
  • Clusters can coexist with minimum interference

○ Power Management
  • Sleep/Listen/Wake used to conserve power
  • Tx/Rx power management
Wireless USB Issues/Problems

- **Interference Issues**
  - Potential conflict to devices on same frequencies
  - “Detect and Avoid”
    - Wisair’s solution to detect other frequencies
    - Switches to frequencies not being used
  - Conflict issues are more of a concern for wireless USB devices being overpowered

- **Competing Standards**
  - Cable-Free USB (Freescale)
  - USB-Implementers Forum (Intel, HP, Microsoft)
Product Comparison

Freescale’s Cable-Free USB lets legacy wired USB devices go wireless using a hub-and-dongle combo implemented in a point-to-point model. In contrast, Certified Wireless USB uses a hub-and-spoke model where a wireless USB hub and devices with integrated wireless USB can communicate with a single host.
Wireless USB Implementations

- **Belkin Cable Free Hub**
  - Released Dec, 2006
  - Dongle attaches to PC
  - Retail price of $199.00
  - Speeds up to 480 Mbps
Wireless USB Implementations

- **GeFen HMDI Extender**
  - Coming soon...
  - Based on WiMedia Alliance specification
  - Retail price of $699.00
  - Range of 20 meters; data rates up to 480 Mbps
  - Frequency band: 3.1 - 4.8 GHz
  - Resolution support: 480i, 480p, 720p, and 1080i
Wireless USB Implementations

- Seagate Wireless USB Hard Drive
  - Coming soon...
  - 2.5 inches wide
  - Speeds up to 480 Mbps
Future of Wireless USB

- **Early 2007**
  - Initial devices being produced

- **Late 2007**
  - Expect wUSB being built into laptops, PCs, multimedia devices

- **2008**
  - Visiongain research firm predicts increase of wUSB by 400 percent

- **2009-2010**
  - Wide scale interoperability?
Concluding Thoughts

- Appears well designed; good support
- Slow start of products
  - Will it really catch on?
  - More products need to be developed
- Promises a lot; will it deliver?
- Security is very important
Questions?