Wireless Universal Serial Bus

Kanika Aggarwal
1207192
B.Tech(4th Yr.)
Wireless Universal Serial Bus
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
**Wired USB**

- **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)

- **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

- **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>
</tr>
<tr>
<td>Streaming whole-home audio</td>
<td>0.2 - 0.5</td>
<td></td>
</tr>
<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>
</tr>
<tr>
<td>Streaming SD Video onto TV</td>
<td>2</td>
<td>3</td>
</tr>
<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**
  - Based on Ultra-Wideband (UWB) RF technology
  - UWB is a technology for transmitting data over a large bandwidth (3.1 to 10.6 GHz)

- **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
History of Ultra-Wideband (cont.)

- 2006: DS-UWB loses support & OFDM-UWB wins
  - Free scale left UWB Forum; became quiet
  - Many companies dropped Free scale chips
  - Free scale 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
- Camcorder: Transfer video and digital stills
- Printer: Print documents
- PC Video Conference Camera: Live video feed
- Desktop PC: OR
- Notebook PC: OR
- HDD, Zip, Mass Storage Devices: Back up data and files
- Portable Projector: Multimedia presentation
- CD/RW, DVD-RW: Copy data, files, CDs, etc.
- Ethernet, HPNA, DSL/Cable Modem: Surf the Web
- MP3 Player: Transfer music
- PDA: Sync-up with e-mail/calendar
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
      - Provides protection against multi-path / interference.
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

[Diagram showing Frequency Range with SS = Spread Spectrum, NB = Narrowband, UWB = Ultra-Wideband]
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
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.
Wireless USB Issues/Problems

- **Interference Issues**
  - Potential conflict to devices on same frequencies
  - “Detect and Avoid”
    - Switches to frequencies not being used
  - Conflict issues are more of a concern for wireless USB devices being overpowered.
Product Comparison

**WIRELESS USB APPROACHES**

**Freescale Cable-Free USB**
- Wireless USB dongle
- Printer
- Digital camera

**Certified Wireless USB**
- External hard drive
- Video camera
- Printer
- Digital camera

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
  - Best Resolution support.
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
- Security is very important
Questions?