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Agenda

• Key Messages
• Relationship of WUSB and other WiMedia\MBOA Specifications
• WiMedia/MBOA MAC 1.0 specification overview
  • Details frame formats
  • Details on the use of MAC device address and EUI-64 addresses
  • Details on beacons and synchronization
  • Details on dynamic reservation protocol (DRP)
  • Details on the Use of private reservations
  • Overview on security and the use of encryption offset

• Summary
• Q & A
Key Messages

• The session will teach vendors & manufacturers what they need to know to implement WiMedia/MBOA MAC features into their product.
  • Focus on information that developer of WUSB host, devices, and dual role devices need to understand
  • Provide detailed examination of key features of the recently finalized WiMedia/MBOA MAC 1.0 RC specification
High Level Overview of MAC Capabilities

• Mobility
  • Allows devices to maintain connectivity as they move across network boundaries in which networks merge and split.

• Simultaneous Operating Piconets (SOP) Performance
  • Allows independent Piconet to have distributed coordination to remove the problem of devices in different Piconets interfering with each other.

• Support for isochronous and asynchronous data
  • Prioritized access for both types.
• Decentralized PAN Operations
  • Every device beacons during the beacon period at the begin of the superframe (65ms) and access control is decided by each device
  • Rest of the superframe is for data transfers
  • Beacon slot occupancy info in each beacon to detect hidden node problem
  • Distributed Reservations ensures Quality of Service (QoS) Support
• Combination of Carrier Sense Multiple Access (CSMA) and Time Division Multiple Access (TDMA)
  • Distributed Reservation Protocol (DRP) is used to reserve the medium for isochronous or other traffic and provides the TDMA access
    • Reservations are announced in the beacons
  • For CSMA access Prioritized Contention Access (PCA) based on Enhanced Distributed Channel Access (EDCA), with mapping of 802.1d user priorities to MAC access priorities
    • Uses Ready to Send (RTS) and Clear to Send (CTS)
### WiMedia/MBOA MAC Header

#### Header Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol Version</td>
<td>3 bits</td>
<td>3 bits</td>
</tr>
<tr>
<td>Secure</td>
<td>1 bits</td>
<td>1 bit</td>
</tr>
<tr>
<td>ACK Policy</td>
<td>2 bits</td>
<td>2 bits</td>
</tr>
<tr>
<td>Frame Type</td>
<td>3 bits</td>
<td>3 bits</td>
</tr>
<tr>
<td>Delivery ID/ Frame Subtype</td>
<td>4 bits</td>
<td>4 bits</td>
</tr>
<tr>
<td>Retry</td>
<td>1 bits</td>
<td>1 bit</td>
</tr>
<tr>
<td>Resv.</td>
<td>2 bits</td>
<td>2 bits</td>
</tr>
<tr>
<td>Frame Control</td>
<td>2 bytes</td>
<td>2 bytes</td>
</tr>
<tr>
<td>DstID</td>
<td>2 bytes</td>
<td>2 bytes</td>
</tr>
<tr>
<td>SrcID</td>
<td>2 bytes</td>
<td>2 bytes</td>
</tr>
<tr>
<td>Sequence Ctrl</td>
<td>2 bytes</td>
<td>2 bytes</td>
</tr>
<tr>
<td>Duration/Access Method</td>
<td>2 bytes</td>
<td>2 bytes</td>
</tr>
</tbody>
</table>

#### Frame Payload

- Variable Length: 0 – 4095 bytes
- Frame Payload: 53.3, 80, 106.7, 160, 200, 320, 400, 480 Mb/s

#### Frame Preamble

- PLCP Header: 39.4 Mb/s
- PHY Header
- Tail Bits
- MAC Header
- HCS
- Tail Bits
- Pad Bits
- Frame Payload: 53.3, 80, 106.7, 160, 200, 320, 400, 480 Mb/s
- FCS
- Tail Bits
- Pad Bits
Non-Secure and Secure Frames

- Secure frames provide encryption and integrity checks
- Non-Secure frames are clear text with no integrity checks
• Media Access Slot (MAS) is 256 us
• 256 MAS per Superframe
Beaconing Period (BP)

- **Resv Beacon Expansion Time**
- **Dynamic Beaconing Period**
- **Beacon Slot #**
- **Reserved Beacon Expansion Time**
  - Allows Beacon to dynamically grow and shrink

**Superframe**

- **DBP**
- **DevID1**
- **DevID2**
- **DevID3**
- **DevID4**
- **DevID5**
- **DevID6**
- **DevID7**
- **DevID8**
- **DevID9**
- **EW01**
- **EW02**

**Signaling Slot**

- **DevID7**
- **DevID1**
- **DevID2**
- **DevID5**
- **DevID9**

**Beacon Slot #**

- **0**
- **1**
- **2**
- **3**
- **4**
- **5**
- **6**
- **7**

**Dynamic Beaconing Period Length**

- **Beacon Slot**
Beaconing

• How it works:
  • First, the device scans channels for beacons
    • If no beacons are received…
    • then creates its own BP and sends the first beacon
  • If another beacon is received
    • looks for Extended Window Slots
    • Once a slot is chosen, the beacon uses the same slot until the BP can be compressed or unless a collision is detected
  • All devices, which are not sleeping, send beacons.
Purpose of Beacons

- WiMedia Device Discovery
- Superframe Time synchronization
- Creating, Sharing and Honoring Reservations
- Traffic Indications Map (TIM) Information
- Interference Mitigation
• Distributed Reservation Protocol IE
• Beaconing Period Occupancy Information Element
• Traffic Indication Map (TIM) IE

<table>
<thead>
<tr>
<th>Li</th>
<th>Lm</th>
<th>Ln</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beacon Parameters</td>
<td>Information Element-1</td>
<td>Information Element-2</td>
<td>...</td>
</tr>
</tbody>
</table>

Beacon Frame Body
Superframe Synchronization

Device a: Slower

Ta

Ta

Ta

Ta

Device b: Faster

Tb + dT

dT = 0

Tb + dT

dT = Ta-Tb

Tb + dT

dT = Ta-Tb

Tb + dT

dT = Ta-Tb

Clock Synchronization done using expected Beacon arrive time
MAC Synchronization and MMC

- MAC Synchronization must be done at end of the superframe
- In the Last MMC, the Next MMC field must be adjusted
Beaconing Period Occupancy Information Element (BPOIE)

<table>
<thead>
<tr>
<th>Element ID</th>
<th>1</th>
<th>1</th>
<th>K</th>
<th>2</th>
<th>...</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length = 1 + K + 2*N</td>
<td>BP Length</td>
<td>Beacon Slot Bitmap</td>
<td>DevAddr 1</td>
<td>...</td>
<td>DevAddr N</td>
<td></td>
</tr>
</tbody>
</table>

- BPOIE allows other devices to determine the set of neighbor for a device
- The host can use this information to determine if the device is required to perform directed beaconing
Medium Access Methods

- Distributed Reservation Period (DRP)
  - Beacon Period (BP) Reservations
  - Hard Reservations
  - Private Reservations
  - Soft Reservations
  - PCA Reservations

- Prioritized Contention Access (PCA)
• Reserve the medium for isochronous or other traffic

• Provides QoS Support

DRP time will be variable based on data transfer and buffer size

Time between DRPs will be equal to the minimum latency required
• Reservations are negotiated for multiple Superframes until they are removed

• Hard Reservations
  • Reservations must be explicitly released by Unused DRP Announcement/Unused DRP Response (UDA / UDR)

• Private Reservations
  • Used by WUSB
  • Reservations must be explicitly released by Unused DRP Announcement/Unused DRP Response (UDA / UDR)
DRPs (Cont.)

- Soft Reservations
  - Accessed by PCA method
  - Owner of reservation has Highest priority
  - If they are not used, can be reclaimed by neighbors

- PCA Reservations
  - Accessed by normal PCA method
  - If they are not used, can be reclaimed by others
• The Physical Layer communications channel is a sequence of symbols in a frequency band
The WiMedia MAC defines a repeating superframe over the PHY channel.

Reservations can be established in the WiMedia MAC channel.
WUSB Channel

- WUSB MAC defines a monotonically increasing channel time
- Linked list of MMCs occupy the W-USB channel
- WUSB channel can be mapped onto a set of WiMedia MAC reservations on the same WiMedia PHY channel
- WUSB logo/certification will enforce the mapping
UWB Protocol Relationships

Various technology solutions running over the common platform

This is ‘pure’ WUSB

This is ‘coexistence’ WUSB

Single Radio In Platform

WiMedia UWB PHY

WiMedia UWB MAC

Convergence Layer

WiMedia Common Ultrawideband Radio Platform

Wireless USB

WiMedia UWB PHY

Wireless USB

IP (WiNet)

Bluetooth

Wireless 1394
Conclusions

• WiMedia/MBOA MAC provides the following key Personal Area Networking features
  • Mobility
  • SOP Performance
  • Support for isochronous and asynchronous data
  • Decentralized PAN Operations
• WiMedia/MBOA MAC Specification 1.0 expected to be completed by end of Q2 2005
Additional Information

- Join WiMedia for additional information on the MAC Specification and the workgroup
Acronyms

- PCA – Prioritized Contention Access
- EDCA – Enhanced Distributed Channel Access
- TDMA – Time Division Multiple Access
- CSMA – Carrier Sense Multiple Access
- DRP – Distributed Reservation Protocol
- BP – Beacon Period
- MAS – Media Access Slot
- TIM – Traffic Indication Map
- IE – Informational Element