<table>
<thead>
<tr>
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<th>IEEE 802.20 Working Group on Mobile Broadband Wireless Access</th>
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</thead>
<tbody>
<tr>
<td>Title</td>
<td>Desired Characteristics for an MBWA Air Interface</td>
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</tbody>
</table>
| Source(s) | John L. Fan  
135 Route 202/206 South  
Bedminster, NJ 07921 | Voice: 908-997-2000  
Fax: 908-947-7090  
Email: j.fan@flarion.com |
| Re: | IEEE 802.20 Session#1 Call for Contributions |  |
| Abstract | This accompanying presentation discuss desired characteristics for an MBWA Air Interface |  |
| Purpose | For informational use only |  |
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Desired Characteristics for an MBWA Air Interface

John L. Fan

IEEE 802.20 MBWA
March 10-13, 2003
Outline

• Overview
• Existing characteristics
• PHY-related characteristics
• MAC-related characteristics
High-level Characteristics of MBWA

- Wireless Data Links for Mobile Devices
- Operating in Licensed Cellular Spectrum
- Designed for IP-based Data Services
Wireless Data Links for Mobile Devices

Handheld and portable data devices
• Laptop computers (via PC Card)
• Personal Digital Assistants
• Digital Cameras
• Data Enhancement for Mobile Phones
• Mobile Gaming Devices

Characteristics
• Provides the user with “always on” connectivity
• Supports robust performance over vehicular wireless channel
• Enables low power, low cost and small form factor
• Inter-technology roaming, open interfaces, QoS support
Operating in Licensed Cellular Spectrum

• Use deployment parameters typical of cellular systems
  – Coexistence with existing wireless systems
  – Leverage existing infrastructure (e.g., cell towers)
  – Benefit from mass market RF components and equipment

• Characteristics
  – Spectrum (< 3.5 GHz)
  – Channel bandwidth (e.g., 1.25 MHz)
  – Cell size
  – Sectorization
  – Frequency Reuse
Designed for IP-based Data Services

• Take advantage of vast content on the Internet and the ubiquity of IP-based applications
  – World Wide Web
  – Electronic mail
  – File download and uploads
  – Video and audio streaming
  – Voice over IP (VoIP)
  – Virtual Private Network (VPN)
  – Financial transactions
  – Online multiplayer gaming
  – Instant messaging

• Provide robustness and throughput equivalent to a wireline link

• Characteristics
  – High throughputs for DL and UL (peak, sustained)
  – Low latency link (fast ACK)
  – User states based on IP data traffic models
# MBWA Characteristics (from PAR)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.25 MHz paired FDD</td>
</tr>
<tr>
<td></td>
<td>2.5 MHz unpaired TDD</td>
</tr>
<tr>
<td>Spectrum</td>
<td>&lt; 3.5 GHz</td>
</tr>
<tr>
<td>Peak user data rate (DL)</td>
<td>&gt; 1 Mbps</td>
</tr>
<tr>
<td>Peak user data rate (UL)</td>
<td>&gt; 300 Kbps</td>
</tr>
<tr>
<td>Peak aggregate DL data rate per cell</td>
<td>&gt; 4 Mbps</td>
</tr>
<tr>
<td>Peak aggregate UL data rate per cell</td>
<td>&gt; 800 Kbps</td>
</tr>
<tr>
<td>Mobility</td>
<td>Up to 250 km/h</td>
</tr>
<tr>
<td>Spectral efficiency (sustained)</td>
<td>&gt; 1 b/s/Hz/cell</td>
</tr>
<tr>
<td>Airlink MAC frame RTT (ARQ loop time)</td>
<td>&lt; 10 ms</td>
</tr>
</tbody>
</table>

These values are directly dependent on the channel bandwidth.
Outline

• Overview
• Existing characteristics
• PHY-related characteristics
• MAC-related characteristics
Cellular Wireless Characteristics

• **Cell Size**: Typical of macro-cellular operation.
• **Channel Bandwidth**: For full performance evaluation of FDD systems, use paired 1.25 MHz spectrum.
• **Carrier Frequency**: For full performance evaluation, use 1.9 GHz. For informational evaluation, consider 800 MHz.
• **Sectorized Operation**: System should support 6 or more sectors per cell (with typical deployment of 3 sectors/cell).
• **Universal Frequency Reuse**: System should allow same frequencies to be reused in all cells and sectors (frequency reuse factor =1 or less).
Robustness on Wireless Channel

- **Doppler Tolerance**: Support Doppler spread of more than 400 Hz, with graceful degradation of data rates and performance for higher Doppler.

- **Delay Spread Tolerance**: Based on channel models, the system should tolerate 10 microseconds of delay spread, with graceful degradation for longer multipath.

- **Advanced coding**: The forward error correction (FEC) should achieve state-of-the-art performance in terms of coding gain. For a rate ½ code, the required SNR for $10^{-2}$ FER should be within 1.5 dB of theoretical limit on a binary-input AWGN channel (which is $E_b/N_0=0.2$ dB). Thus the required $E_b/N_0$ is 1.7 dB.
### Summary of PHY Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Bandwidth</td>
<td>1.25 MHz paired spectrum for FDD</td>
</tr>
<tr>
<td>Carrier Frequency</td>
<td>1.9 GHz for full evaluation; 800 MHz for informational evaluation</td>
</tr>
<tr>
<td>Sectorized Operation</td>
<td>Supports 6 or more sectors/cell (typical deployment 3 sectors)</td>
</tr>
<tr>
<td>Doppler Tolerance</td>
<td>&gt; 400 Hz</td>
</tr>
<tr>
<td>Delay Spread Tolerance</td>
<td>&gt; 10 us</td>
</tr>
<tr>
<td>FEC Gap from Capacity at rate $\frac{1}{2}$ for FER=10^{-2}</td>
<td>&lt; 1.5 dB</td>
</tr>
</tbody>
</table>
Outline

- Overview
- Existing characteristics
- PHY-related characteristics
- MAC-related characteristics
MAC states

- Corresponding to user states based on the data traffic models, there should be MAC states for efficient use of system resources.

- **MAC States:**
  - **“On” state** - user is actively using system resources to transmit and receive data.
  - **“Hold” state** - for conserving air-link resource usage when users are temporarily not using the system.
  - **“Sleep” state**, where the mobile is inactive.

- **Number of users:** Should support more than 100 active users per sector/cell.

- **State transitions:** Should be fast and dynamic.
Transitions

- **State transitions**: Fast transitions between states improve system capacity while maintaining user experience (e.g., good TCP/IP performance).
  - From “On” to “Hold” in < 100 ms.
  - From “Hold” to “On” in < 50 ms.
  - From “Hold” to “Sleep” in < 100 ms.
  - From “Sleep” to “On” in < 200 ms.

- **Paging**: For users that conserving power in Sleep state, the paging mechanism wakes users up and bring them into an active state.
  - Frequent paging supports applications such as voice, push-to-talk and instant messaging.
  - Should support the ability to send paging signals at least once every 100 ms
  - To save mobile power and increase standby time, paging duty cycle should be < 1%, so paging duration should be < 1 ms.
Others

- **Resource allocation**: Should support fast resource assignment and release on the uplink and downlink
  - Fine scheduling granularity tailored for data traffic
  - Adaptive coding and modulation per codeword
  - Minimum scheduling interval should be < 2 ms.
  - The duration between opportunities for mobile requests for UL resource allocation should be < 10 ms.

- **Handoff**: Should support robust inter-sector and inter-cell handoffs at vehicular speeds
  - Mobile-controlled handoffs
  - Minimize packet loss and latency for robust and seamless IP packet transmission
  - Time required for handoff-related signaling and access should be < 200 ms, comparable with state transitions
## Summary of MAC parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Active Users per Sector/Cell</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Transition from On to Hold state</td>
<td>&lt; 100 ms</td>
</tr>
<tr>
<td>Transition from Hold to On state</td>
<td>&lt; 50 ms</td>
</tr>
<tr>
<td>Transition from Hold to Sleep state</td>
<td>&lt; 100 ms</td>
</tr>
<tr>
<td>Access Time from Sleep to On state</td>
<td>&lt; 200 ms</td>
</tr>
<tr>
<td>Paging Signal Periodicity</td>
<td>&lt; 100 ms</td>
</tr>
<tr>
<td>Paging Signal Duration</td>
<td>&lt; 1 ms</td>
</tr>
<tr>
<td>Minimum Scheduling Interval</td>
<td>&lt; 2 ms</td>
</tr>
<tr>
<td>UL Request Time</td>
<td>&lt; 10 ms</td>
</tr>
<tr>
<td>Inter-Sector/Cell Handoff Time</td>
<td>&lt; 200 ms</td>
</tr>
</tbody>
</table>
Summary of MBWA Characteristics

- Leverage cellular wireless deployments in licensed spectrum
- Based on data and channel models, obtain numerical guidelines for the MBWA air interface
- Provide robust performance on mobile wireless channel
- Support IP data transport efficiently through MAC states with fast transitions and paging
- Support fine granularity scheduling, fast UL requests and fast mobile-controlled handoffs