# IEEE 802.20 Working Group on Mobile Broadband Wireless Access

*<http://grouper.ieee.org/groups/802/20/>*

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<table>
<thead>
<tr>
<th>Project</th>
<th>IEEE 802.20 Working Group on Mobile Broadband Wireless Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>MBTDD 625k-MC Mode (BEST-WINE) Performance Report 2 Presentation</td>
</tr>
<tr>
<td>Date Submitted</td>
<td>2006-JAN-13</td>
</tr>
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</tr>
<tr>
<td>Re:</td>
<td>MBWA Call for Proposal</td>
</tr>
<tr>
<td>Abstract</td>
<td>This document presents the Technology Performance and Evaluation Criteria Report 2 of the Technology Proposal MBTDD 625k-MC for IEEE 802.20 MBWA</td>
</tr>
<tr>
<td>Purpose</td>
<td>To discuss and Adopt MBTDD 625kHz MC Mode for Draft Specifications of IEEE802.20 MBWA</td>
</tr>
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<td>Notice</td>
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**Notice:**

To discus and Adopt MBTDD 625kHz MC Mode for Draft Specifications of IEEE802.20 MBWA

**Purpose:**

To discuss and Adopt MBTDD 625kHz MC Mode for Draft Specifications of IEEE802.20 MBWA

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**Patent Policy:**

MBTDD 625k-MC Mode
(BEST-WINE: Broadband Mobile ESpaTial Wireless InterNet AccEss)
Performance Report 2 Presentation

IEEE 802.20 Plenary Meeting
Hawaii
January 16-19, 2006
Outline of Presentation

- System Model
- Link level Simulation
- System Level Simulation
- Traffic
  - Traffic Calibration
  - Traffic Mix and Channel Mix
  - Traffic Mix and Channel Mix
- Mobility-Handover Performance
- Overhead Channels
- Practical System results
System Model
PHY and MAC Layer information

- Channel Configuration

<table>
<thead>
<tr>
<th>Items</th>
<th>Symbol rate</th>
<th>Frame Length</th>
<th>Carrier space</th>
<th>Multiple Access</th>
<th>Duplexing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500 ksps</td>
<td></td>
<td>625 kHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Uplink Time Slots
  - Length: 545 us
  - Payload: 182 symbols

- Downlink Time Slots
  - Length: 1090 us
  - Payload: 494 symbols

- Frequency Configuration
  - 625 kHz
  - 2.5 MHz
Link Level simulation

- Modulation Coding Class

<table>
<thead>
<tr>
<th>ModClass</th>
<th>Modulation Method</th>
<th>Down Link(Kbps)</th>
<th>Up Link(Kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Data Rate /Slot</td>
<td>Data Rate /Carrier</td>
</tr>
<tr>
<td>0</td>
<td>BPSK</td>
<td>35</td>
<td>106</td>
</tr>
<tr>
<td>1</td>
<td>BPSK</td>
<td>50</td>
<td>149</td>
</tr>
<tr>
<td>2</td>
<td>QPSK</td>
<td>82</td>
<td>245</td>
</tr>
<tr>
<td>3</td>
<td>QPSK</td>
<td>126</td>
<td>379</td>
</tr>
<tr>
<td>4</td>
<td>8PSK</td>
<td>162</td>
<td>485</td>
</tr>
<tr>
<td>5</td>
<td>8PSK</td>
<td>198</td>
<td>595</td>
</tr>
<tr>
<td>6</td>
<td>12QAM</td>
<td>262</td>
<td>787</td>
</tr>
<tr>
<td>7</td>
<td>16QAM</td>
<td>307</td>
<td>922</td>
</tr>
<tr>
<td>8</td>
<td>24QAM</td>
<td>354</td>
<td>1061</td>
</tr>
<tr>
<td>9</td>
<td>32QAM</td>
<td>378</td>
<td>1133</td>
</tr>
<tr>
<td>10</td>
<td>64QAM</td>
<td>498</td>
<td>1493</td>
</tr>
</tbody>
</table>
Basic PHY layer (link level) information

- Link Level simulation Parameters
  - TDD /TDMA system with 3 timeslot structure
  - BS antenna number 12 antennae
  - UT antenna numbers
    - Antennas used for transmission : 1
    - Antennas used of receiving: 4
  - Adaptive Array Antenna Algorithm : MMSE
Pedestrian A – 3km/hr (Uplink)
Pedestrian A – 3km/hr (Uplink)

![Graph showing throughput vs. SINR for different modulation schemes at 3km/hr]](image-url)
Pedestrian A – 3km/hr (Downlink)
Pedestrian A – 3km/hr (Downlink)
Vehicular B – 120km/hr (Uplink)
Vehicular B – 120km/hr (Uplink)
Vehicular B – 120km/hr (Downlink)
Vehicular B – 120km/hr (Downlink)

![Graph showing Throughput vs SINR for various modulations at 120km/hr](image)

- **Throughput [kbps]**
- **SINR [dB]**

- **120km/h mod10**
- **120km/h mod9**
- **120km/h mod8**
- **120km/h mod7**
- **120km/h mod6**
- **120km/h mod5**
- **120km/h mod4**
- **120km/h mod3**
- **120km/h mod2**
- **120km/h mod1**
- **120km/h mod0**
Vehicular B – 250km/hr (Uplink)
Vehicular B – 250km/hr (Uplink)

![Graph showing throughput vs. SINR for different modulation schemes at 250km/hr](image-url)
Vehicular B – 250km/hr (Downlink)
Vehicular B – 250km/hr (Downlink)
System Level Simulations
Traffic Performance in System Level Simulation
Traffic Model Calibration - HTTP

Main File Object Size

Embedded Object Size

Size (bytes)

Size (bytes)
Traffic Model Calibration - HTTP

**Embedded objects per page**

- CDF of embedded objects per page as a function of the number of embedded objects.

**Reading time**

- CDF of reading time as a function of time in seconds.
Traffic Model Calibration - FTP

**File size**

**Reading time**

![File size CDF](chart1.png)

![Reading time CDF](chart2.png)
Traffic Model Calibration - NRTV

File size

Interarrival time

Packet size (bytes)

Time (msec)
Traffic Model Calibration - NRTV

Domestic Network delay

International Network delay
Traffic Model Calibration - HTTP

**Main File Object Size**

![CDF plot for Main File Object Size]

**Embedded Object Size**

![CDF plot for Embedded Object Size]
Traffic Model Calibration - HTTP

**Embedded objects per page**

![CDF plot for embedded objects per page](image1)

**Reading time**

![CDF plot for reading time](image2)

- **X-axis**: Number of embedded objects
- **Y-axis**: CDF

- **X-axis**: Time (seconds)
- **Y-axis**: CDF
Traffic Model Calibration - FTP

File size

Reading time

Size (bytes)

File size

Reading time

Time (seconds)
Traffic Model Calibration - NRTV

File size

Packet size (bytes)

Interarrival time

Time (msec)
Traffic Model Calibration - NRTV

Domestic Network delay

International Network delay
VoIP Performance – Delay vs. R-value

![Graph showing Delay vs. R Value]

- **Uplink**
- **Downlink**
FTP Performance

FTP Traffic Scenario (3 traffic spatial channels per conventional channel)

![Graph showing FTP performance with number of users vs. total downlink throughput in kbps.]
FTP-HTTP Performance

Mixed Traffic (FTP and HTTP) Scenario – (3 traffic spatial channels per conventional channel)
TCP-HTTP Uplink Performance

HTTP scenario—(3 traffic spatial channels per conventional channel)
TCP-HTTP Downlink Performance

HTTP scenario—(3 traffic spatial channels per conventional channel)
VoIP Performance – R-value vs. Packet loss

Packet loss vs. R Value

Packet loss [%] vs. R Value

- Uplink
- Downlink
HTTP and VoIP users

Data rate of HTTP users

![Graph showing cumulative probability of data rate for HTTP users]
HTTP and VoIP users

Voice quality with varying HTTP users

Uplink R values as a function of number of HTTP users
(24 voice users)

Downlink R values as a function of number of HTTP users
(24 voice users)
## Traffic Mix

<table>
<thead>
<tr>
<th>Traffic Category</th>
<th>Application</th>
<th>Percentage ( % )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Effort</td>
<td>FTP</td>
<td>30</td>
</tr>
<tr>
<td>Interactive</td>
<td>Web browsing</td>
<td>30</td>
</tr>
<tr>
<td>Streaming</td>
<td>Video streaming</td>
<td>30</td>
</tr>
<tr>
<td>Real-time</td>
<td>VoIP</td>
<td>10</td>
</tr>
</tbody>
</table>
### System Level Simulation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BS antenna</strong></td>
<td></td>
</tr>
<tr>
<td>Number of antennas</td>
<td>12</td>
</tr>
<tr>
<td>Antenna separation</td>
<td>0.5 $\lambda$</td>
</tr>
<tr>
<td><strong>UT antenna</strong></td>
<td></td>
</tr>
<tr>
<td>Number of antennas</td>
<td>4</td>
</tr>
<tr>
<td>Antenna separation</td>
<td>0.5 $\lambda$</td>
</tr>
<tr>
<td><strong>Layout</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19BS with 3sector each</td>
</tr>
<tr>
<td><strong>max Tx power at BS</strong></td>
<td>39dBm/12ant</td>
</tr>
<tr>
<td><strong>max Tx power at UT</strong></td>
<td>27dBm</td>
</tr>
<tr>
<td><strong>BS antenna gain</strong></td>
<td>17dBi</td>
</tr>
<tr>
<td><strong>UT antenna gain</strong></td>
<td>0dBi</td>
</tr>
<tr>
<td><strong>BS NF</strong></td>
<td>5dB</td>
</tr>
<tr>
<td><strong>UT NF</strong></td>
<td>10dB</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>15°C</td>
</tr>
<tr>
<td><strong>BS cable loss</strong></td>
<td>3dB</td>
</tr>
<tr>
<td><strong>UT body loss</strong></td>
<td>3dB</td>
</tr>
<tr>
<td><strong>Simulation bandwidth</strong></td>
<td>2.5MHz (4 carriers) (1 carrier= 625kHz)</td>
</tr>
</tbody>
</table>
# Channel Mix

## Suburban macro channel mix

<table>
<thead>
<tr>
<th>Channel PDP Models</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>User speed (km/h)</td>
<td>3</td>
<td>30</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Probability</td>
<td>0.20</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

## Urban micro channel mix

<table>
<thead>
<tr>
<th>Channel PDP Models</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>User speed (km/h)</td>
<td>3</td>
<td>30</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Probability</td>
<td>0.29</td>
<td>0.14</td>
<td>0.14</td>
<td>0.29</td>
</tr>
</tbody>
</table>
Mobility Model - Handoff performance

- One mobile moving in a straight line from a location close to one BS to a location close to destination BS
Handoff distance and Handoff delay
Overhead channels-Paging Channel

![Diagram showing Paging Channel with Implied Burst and Diversity Burst]
Overhead channels - Paging Channel

Detection statistics for PCH (Desired burst present – 0Hz fading channel)

Detection statistics for PCH (Desired burst, 0Hz fading channel, 2 slot diversity)
Appendix

Practical System Results
Total Throughput : 21.011Mbps
Users : 21
Average data rate : 1Mbps/user
Practical System Results - Yokohama
Practical System Results - Yokohama

Handover Test

48Km/h

1Mbps
Practical System Results - Yokohama

Traffic Mix

- Carrier: 4 (with 3 spatial channels)
- BS: 1 (2.5MHz)
- UT: 34
  - FTP: 10 users
  - Video Streaming: 10 users
  - HTTP: 10 users
  - VoIP: 4 users

- Ftp: Data of 100Mbyte was continuously downloaded.
- Video: 5 mins of content requiring a data rate more than 450kbps was repeated viewed using real player.
- HTTP: 22 pages were viewed repeatedly. Each page was viewed for 6secs after being displayed.
Practical System Results - Yokohama

Traffic Mix

Throughput [bytes/sec]

FTP
Video Stream
Web Browsing
VoIP Stream

Traffic Mix

Throughput [bytes/sec]

FTP
Video Stream
Web Browsing
VoIP Stream