<table>
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<th>Project</th>
<th>IEEE 802.20 Working Group on Mobile Broadband Wireless Access <a href="http://grouper.ieee.org/groups/802/20/">http://grouper.ieee.org/groups/802/20/</a></th>
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<tr>
<td>Title</td>
<td>Evaluation Methodology for MBWA</td>
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<tr>
<td>Date Submitted</td>
<td>2003-05-05</td>
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| Re:          | MBWA Call for Contributions – Session # 2, May 12, 2003                                         |
| Abstract     | This contribution presents a methodology for evaluating MBWA systems.                           |
| Purpose      | Review and Adopt                                                                                  |
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Evaluation Methodology for 802.20 MBWA

Farooq Khan

IEEE 802.20 MBWA
May 12-15, 2003
Evaluation Methodology

• A general Framework based on common set of definitions and assumptions:
  – Traffic models, channel models and link budget etc.

• Detailed description of the MBWA proposals
  – Including details of scheduling algorithms and predictors etc.
  – Allow people to simulate proposals independently

• A set of output metrics
  – Allow comparing technology components and/or Framework MBWA proposals.
Protocol Modeling

- End to End protocol Modeling in order to accurately assess the performance for Internet applications
- Simplified modeling for the higher layer protocols and the backhaul network between the base station and the host server.
- Detailed modeling of the Air-interface (MAC/PHY) protocols.
System simulations

- Dynamic multi-cell system simulations to assess system capacity:
  - Include shadow fading, Rayleigh and Rician fading and evolve in discrete steps (e.g. slot duration).

- Cell/sector layout
  - Site-to-site distance, shadow fading, correlation between cell sites, antenna pattern and cell layout/Wrap around etc.

- Link error methodology to model FER in system simulations, 2 options:
  - Use actual link level curves (require separate curves for each channel condition, decoder type and transmission frame duration etc.)
  - Define a methodology that can, for example, use AWGN curves.
Traffic Models

- A common set of traffic models used in the evaluation
- Non-Real time traffic types
  - HTTP, FTP, Email
- Real time traffic
  - VoIP, and video etc.
- Streaming Traffic
  - Audio and video streaming
- Interactive Traffic
  - Wireless Mobile Gaming etc.
- Simulations performed with different traffic mix scenarios.
Higher Layer Protocol Modeling

• TCP modeling
  - Flow control modeling
    • Slow start and
    • Congestion avoidance
  - Timeouts and Exponential back-off etc.
    • TCP loss due to air interface FER (residual FER after MAC ARQ)

• HTTP modeling
  - HTTP page requests and response

• Models for other protocols such as RTSP and RTP etc. as applicable.
Round Trip Time Model

• Total round trip time can be divided into four delay components
  - $RTT = t_{UL} + t_{N1} + t_{N2} + t_{DL}$
  - $t_{UL}$ Air interface delay between the mobile terminal and the base station router.
  - $t_{N1}$ Network delay between the base station router and the host server.
  - $t_{N2}$ Network delay between the host server and the base station router.
  - $t_{DL}$ Air interface delay between the base station router and the mobile terminal.

• $t_{UL}$ and $t_{DL}$ determined in the simulations by air-interface transmission and queuing delays etc.

• Approximate models used for $t_{N1}$ and $t_{N2}$.
TCP 3-way handshake modeling is important in assessing the System performance with short packets and performance sensitivity to round trip delays.
HTTP Model

- Session arrivals and departures need not be modeled
  - A fixed number of “always active” HTTP users (sessions) can be simulated in each run.
- HTTP/1.0 and HTTP/1.1 page requests and response procedures are modeled.
Channel Models

- Channel models for single-antenna simulations
  - ITU Pedestrian A, Pedestrian B and Vehicular A models etc.
- Channel models for multiple antenna techniques
  - For example, spatial Channel Model (SCM) for MIMO channels [2].
- Simulations performed for various Channel mix scenarios
Control overhead modeling

- Both UL and DL control overhead modeled dynamically
  - Control channels are actually simulated along with the data traffic.
- Examples of control signaling are scheduling grants transmission, channel quality feedback, and ARQ ACK/NACK Feedback etc.
- MAC states and signaling to enable state transitions modeled explicitly in the system simulations.
- Control channel signaling errors are also modeled.
Output Metrics

- **VoIP and video application:**
  - Maximum number of voice/video users that the system can support within a sector with certain maximum outage probability

- **HTTP, FTP and Email etc.**
  - Number of users supported, data throughput per sector, Average packet call throughput, packet call throughput CDF and packet delay etc.

- **Audio/Video streaming**
  - Number of users supported, packet delay and loss.

- **Wireless Gaming**
  - Number of users supported, packet delay and loss.
Fairness criteria

- Guarantee minimal level of throughput to all users.
- The normalized throughput CDF should lie to the right of the Fairness criteria curve.

<table>
<thead>
<tr>
<th>Normalized throughput w.r.t average user throughput</th>
<th>CDF</th>
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<tbody>
<tr>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
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Normalized throughput for user $k = \frac{\text{Throughput}(k)}{(\text{Average throughput across all users})}$
References
