The following is a technical overview of the IEEE 802.20 (FDD & TDD) proposed specification and how it compares to IEEE 802.16e (mobile WiMAX).

The presentation does not cover the IEEE Working Group processes relating to standardization.

I will not be making any comments today on the IEEE 802.20 standardization process or its current status.
Introduction

- The 802.20 standard is being developed by the IEEE for highly efficient Mobile Broadband Wireless Access (MBWA)
  - Spectral efficiencies, sustained user data rates and numbers of active users that are significantly higher than other emerging mobile systems
  - Efficient packet based air interface optimized for IP-data transport, including real time services

- Technology developed to target worldwide deployment of affordable, ubiquitous, always-on networks
  - To meet the needs of business and residential end user markets

- 802.20 provides a specification for physical and medium access control layers for interoperable mobile wireless access systems
  - Operations for licensed bands below 3.5 GHz
  - Supports mobility classes up to 250 Km/h
MBWA 802.20 Overview

- System designed for robust Mobile Broadband Wireless Access
  - Standardized in IEEE 802.20 for both FDD and TDD Modes
- Scalable design with fine bandwidth granularity within 5 - 20MHz
  - In licensed spectrum below 3.5 GHz
- Advanced support for spatial processing techniques
  - Beamforming, MIMO and SDMA
- System designed from ground up for mobile broadband
  - Flexible airlink resource management with efficient, low-overhead signaling
  - Advanced interference management
    - Distributed power control
    - Fractional frequency re-use for cell edge performance
  - Fast sector selection using uplink CDMA control channels
- Designed for Low Latency Applications

MBWA 802.20 Technology Deployment Options

- Operator’s Option for 3G Overlay Deployments
  - MIMO optimized high efficiency mobile broadband solution
    - Peak spectral efficiency up to 13 bps/Hz and higher user capacity
  - Deployment in either paired or unpaired spectrum
  - Multimode terminals to provide tight integration with 3G systems
  - Superior FL Traffic Capacity in handling variety of data applications (HTTP, FTP, NRTV, VoIP etc.)
    - User peak rates over 260 Mbps (DL) and 60 Mbps (UL) in 20 MHz (FDD)
  - Hot-zone overlay in dense areas as supplement to ubiquitous 3G system
- Long Term Operators Option for WAN Deployments
  - Deliver most advanced technology evolution path beyond 3G
  - Leverage 3G’s high volume cost curves

MBWA 802.20 OFDMA technology is ideal for high spectral efficient deployments in both FDD & TDD spectrum
MBWA 802.20: A Comparison with Mobile WiMAX

MBWA 802.20 Evaluation Methodology Framework

- To assess performance in MBWA scenarios, IEEE 802.20 standards developed:
  - A comprehensive System Requirements document
  - A advanced evaluation methodology framework
- 802.20 evaluation methodology is advanced for following reasons:
  - Based on 3GPP2, 3GPP methodologies and tailored for mobile broadband applications
  - Decided upon after extensive input, review and discussions
- 802.20 evaluation methodology uses mixed traffic models simulation to realistically determine actual system performance for a broadband wireless network
- 802.20 evaluation methodology is designed to evaluate latency-sensitive traffic performance (e.g., VoIP, gaming, video conferencing)
- WiMAX does not have any evaluation methodology
  - Entire standard created without any system-level simulations being presented

Key References: [www.ieee802.org/20/contributions]
IEEE C802.20-05/86r1 "MBTDD Wideband Mode Performance Report 2"
IEEE C802.20-05/66r1 "MBTDD Wideband Mode Performance Report 1"
### MBWA 802.20 Expected Throughput Performance

<table>
<thead>
<tr>
<th></th>
<th>FDD, BW per link</th>
<th>TDD 2:1, total BW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 MHz</td>
<td>20 MHz</td>
</tr>
<tr>
<td><strong>Peak Forward Data Rate (1)</strong></td>
<td>140</td>
<td>290</td>
</tr>
<tr>
<td><strong>Peak Reverse Data Rate</strong></td>
<td>34</td>
<td>70</td>
</tr>
<tr>
<td><strong>Forward Average Sector Throughput (2)</strong></td>
<td>21</td>
<td>44</td>
</tr>
<tr>
<td><strong>Reverse Average Sector Throughput (3)</strong></td>
<td>12.5</td>
<td>26</td>
</tr>
<tr>
<td><strong>Forward Spectral Efficiency (estimate) (2)</strong></td>
<td>~2.2 bps/Hz</td>
<td>~2.3 bps/Hz</td>
</tr>
<tr>
<td><strong>Reverse Spectral Efficiency (estimate) (3)</strong></td>
<td>~1.3 bps/Hz</td>
<td>~1.0 bps/Hz</td>
</tr>
</tbody>
</table>

All data rates in Mbps, except where indicated

1 FL peak data rates based on 4x4 MIMO
2 FL throughput and Spec Efficiency is estimated based on 4x4 MIMO at vehicular speed 120 km/h, TDD DL/UL partitioning assumed to be 2:1.
3 RL throughput and Spec Efficiency is based on 4 Rx BS antennas at vehicular speed 120 km/h, TDD DL/UL partitioning assumed to be 2:1.

### MBWA 802.20 vs. Mobile WiMAX: Performance

- **Latency**: 802.20 offers significantly lower latencies compared to Mobile WiMAX
- **FL Traffic Mix Capacity**: 802.20 can support ~3 times the number of users compared to Mobile WiMAX
  - 30% Download, 30% HTTP, 30% NRTV and 10% Voice
- **VoIP Capacity**: 802.20 VoIP capacity is ~3 times greater than Mobile WiMAX
- **RL Spectral Efficiency (for 1Tx, 2Rx Antenna Scenario)**: 802.20 RL Spectral Efficiency is at least 50% better but expected to be >100% better than Mobile WiMAX
  - 802.20 implements efficient interference management techniques
- **Coverage**: 802.20 Link Budget is estimated to offer ~4dB advantage over Mobile WiMAX

Note: WiMAX performance may vary due to the large number of options/modes allowed in the 802.16e standard.
WiMAX: High System Overhead
- Message-based protocols
- Based on DOCSIS legacy

802.20: System Overhead is Optimized
- Flexible, efficient air interface resource management

WiMAX: Inefficient message based sleep mode operation
- Idle State Duty Cycle of WiMAX is 9-14 times higher than 802.20

802.20: Fast and efficient bit based sleep mode mechanism

WiMAX: Slow Message Based Power Control
- Reduction in RL margin and throughput

802.20: Uses new innovative distributed fast power control techniques

WiMAX: Mobility not an inherent part of initial design
- Weak & Unreliable handoff design

802.20: Better Mobility and Handoff design with fast cell switching
- Designed for minimum Handoff latency

Conclusions
- IEEE 802.20 OFDMA based technology is highly optimized for packet-based air interface for Mobile broadband wireless access
- Incorporating advanced communication system techniques, 802.20 offers to provide a strong basis for long term evolution beyond 3G technologies both in 3GPP and 3GPP2
- Ongoing 3G evolution ensures a long term competitive advantage for 3G operators by enabling ubiquitous mobile broadband service with massive economies of scale
- 802.20 complements 3G as a compelling overlay to address hot-zone and dense MWAN areas using large spectrum allocations and supports tight integration with 3G technologies
- Large technical advantages in coverage and capacity make 802.20 far more cost effective than WiMAX in all scenarios
Mobile Broadband Vision
Combining the Strengths of CDMA and OFDMA

CDMA
- Performance in weak signal conditions (e.g., cell edge)
- Intersector interference management
- Mobile maturity (handoff, power efficiency, QoS, etc.)

OFDMA
- Performance in strong signal conditions (e.g., picocells, non-busy hours)
- Multipath/intrasector interference immunity
- Low complexity for wide radio channels and MIMO

OFDM(A) Application Examples

| Broadcast                  | Digital Audio Broadcasting (DAB) |
|                           | Digital Video Broadcasting (DVB) |
|                           | FLO, DO Platinum                |
| WLAN / PAN                | 802.11a, g                      |
|                           | 802.11n                         |
|                           | Ultrawideband (UWB)             |
| Fixed Wireless            | 802.16-2004 (fixed WiMAX)       |
|                           | Various Proprietary PMP Systems |
| Mobile MAN                | 802.20, 802.16e                 |
|                           | 3GPP2 Phase 2, 3GPP LTE         |
|                           | Flash-OFDM                      |

- CDMA and OFDMA spectral efficiency is comparable
- MBWA 802.20 technology combines the mature mobility management algorithms of 3G with the complexity/performance benefits of OFDMA

Adaptive Multiple Antenna Techniques in MBWA 802.20

- Increased spectral efficiency and coverage accrue with additional antennas
- Spatial Division Multiple Access (SDMA)
  - Form of adaptive sectorization
  - Transmit to multiple users simultaneously when users can be separated spatially
- Spatial Multiplexing MIMO
  - Very high data rate transmissions to a single user experiencing high SINR channel
  - Exploits highly scattered environments allowing for spatial separation of multiple data streams
  - Especially suitable for hot zone deployments and partially loaded networks
- MIMO Beamforming
  - Transmit beamforming for low SINR and slow varying channels
  - Beamforming combined with MIMO to provide gains at both high and low SINR

MBWA 802.20 fully exploits MIMO techniques to achieve high performance
802.20 Performance: Latency Metrics

- Request latency
  Minimum latency around 5.5ms, average latency around 11ms
- Access latency
  Within 23ms for 90% attempts, within 30ms for 99% attempts
- Handoff delay
  Average handoff delay, excluding backhaul delay, within 8ms
- Power control rate
  Minimum interval around 5.5ms
  Flexible tradeoff between rate and number of active users
- Paging interval
  Ranging from ~46 ms up to ~3sec
  Corresponding duty cycle from ~2.3% down to ~0.036%

MBWA 802.20 is custom designed for Broadband Wireless Internet

802.20 vs. 802.16e: Idle State Duty Cycle Comparison

- 10 MHz TDD systems compared
- Frame size for 802.16: 5 ms

<table>
<thead>
<tr>
<th>802.16 Paging Cycle (seconds)</th>
<th>802.20 Paging Period (seconds)</th>
<th>802.16 Duty Cycle (%)</th>
<th>802.20 Duty Cycle (%)</th>
<th>802.20 Advantage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.0481</td>
<td>30.00</td>
<td>2.2</td>
<td>1363.6</td>
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<tr>
<td>0.39</td>
<td>0.385</td>
<td>3.90</td>
<td>0.28</td>
<td>1391.5</td>
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<tr>
<td>0.77</td>
<td>0.770</td>
<td>1.95</td>
<td>0.14</td>
<td>1391.5</td>
</tr>
<tr>
<td>1.54</td>
<td>1.540</td>
<td>0.97</td>
<td>0.069</td>
<td>1411.6</td>
</tr>
<tr>
<td>3.08</td>
<td>3.08</td>
<td>0.49</td>
<td>0.035</td>
<td>1391.5</td>
</tr>
</tbody>
</table>

- Conversion of the duty cycle advantage into battery consumption advantage requires the consideration of device manufacturer-dependent factors

802.20 has ~14x advantage in idle state duty cycle