IEEE 802.20: Mobile Broadband Wireless Access
A Technical Overview

June 2006

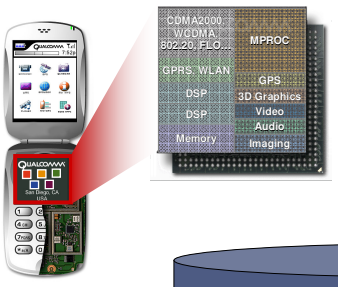
for ITU-BDT Regional Seminar on Mobile and Fixed Wireless Access for Broadband Applications for the ARAB Seminar, June 19-22, 2006, Algiers, Algeria

- 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

Mobile Broadband Vision
3G and Beyond



Best Connected Service:

- Application-specific air interfaces
- New OFDM(A) Physical layers
- Common IP-based core network
- Integrated WAN / LAN services
- Multimode devices

Data rates (vertical) and network coverage (horizontal) are illustrative only. Not drawn to scale.

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

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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

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MBWA 802.20: A Comparison with Mobile WiMAX

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MBWA 802.20 Evaluation Methodology Framework

- To assess performance in MBWA scenarios, IEEE 802.20 standards developed:
  - A comprehensive System Requirements document and a
  - 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 802.20 "The approved version of the Evaluation Criteria Document (ECD)," 802.20-PD-09.
IEEE C802.20-05/88r1 "MBTDD Wideband Mode Performance Report 2"
IEEE C802.20-05/66r1 "MBTDD Wideband Mode Performance Report 1"

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MBWA 802.20 Expected Throughput Performance

	FDD, BW per link		TDD 2:1, total BW	
	10 MHz	20 MHz	10 MHz	20 MHz
Peak Forward Data Rate (1)	140	290	91	190
Peak Reverse Data Rate	34	70	9	20
Forward Average Sector Throughput (2)	21	44	15	32
Reverse Average Sector Throughput (3)	12.5	26	3.4	7.1
Forward Spectral Efficiency (estimate) (2)	~2.2 bps/Hz		~2.3 bps/Hz	
Reverse Spectral Efficiency (estimate)(3)	~1.3 bps/Hz		~1.0 bps/Hz	

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.

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MBWA 802.20 vs. Mobile WiMAX: Performance

FL Spectral Efficiency (for 1Tx, 2Rx Antenna Scenario)	• 802.20 DL Spectral Efficiency is 50% better than Mobile WiMAX – 802.20 can achieve a peak rate over 130 Mbps in 10 MHz DL – 802.20 implements FL precoding, MIMO beamforming & SDMA
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
Latency	• 802.20 offers significantly lower latencies compared to Mobile WiMAX

Note: WiMAX performance may vary due to the large number of options/modes allowed in the 802.16e standard.

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Feature Design	Comparison between 802.20 and Mobile WiMAX
Handoffs	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
Power Control	WiMAX: Slow Message Based Power Control –Reduction in RL margin and throughput 802.20: Uses new innovative distributed fast power control techniques
Battery Power Consumption	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
System Overhead	WiMAX: High System Overhead – Message-based protocols – Based on DOCSIS legacy 802.20: System Overhead is Optimized – Flexible, efficient air interface resource management

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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

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Thank You

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Backup

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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

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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

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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

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802.20 vs. 802.16e: Idle State Duty Cycle Comparison

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

802.16 Paging Cycle (seconds)	802.20 Paging Period (seconds)	802.16 Duty Cycle (%)	802.20 Duty Cycle (%)	802.20 Advantage (%)
0.05	0.0481	30.00	2.2	1363.6
0.39	0.385	3.90	0.28	1391.5
0.77	0.770	1.95	0.14	1391.5
1.54	1.540	0.97	0.069	1411.6
3.08	3.08	0.49	0.035	1391.5

- **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

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