The IEEE 802.16 WirelessMAN® Standard for Broadband Wireless Metropolitan Area Networks

ITU-Anatel Regional Seminar on BWA for Rural and and Remote Areas for the Americas

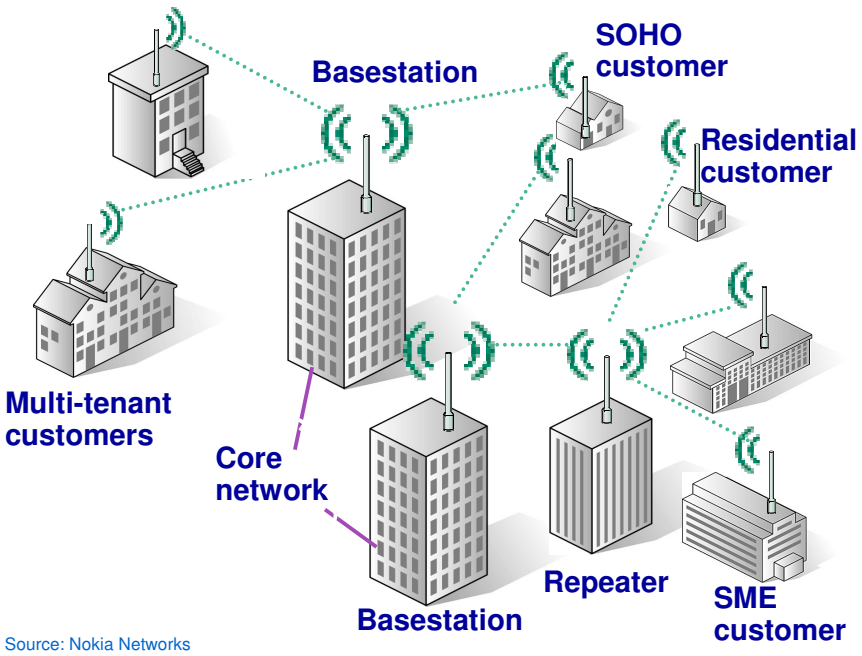
Brasilia, Brazil
23-25 May 2005

Thanks to Roger Marks, chair of IEEE 802.16 for contributing material for this presentation

Agenda

- **Wireless Metropolitan Area Networks**
- **IEEE 802.16 Working Group**
- **Global Standards Harmonization**
- **WiMAX Forum & Interoperability**
- **IEEE 802.16 Air Interface Standard**

WirelessMAN: Wireless Metropolitan Area Network



Source: Nokia Networks

Importance of Global Standards for Broadband Wireless Access Systems

- Reduced costs due to mass production
- Reduced operator risk
- Opportunities for roaming
- Stimulate adoption of technology
- Platform for technical innovation

- Global standards benefit the **users** and the **producers**.

IEEE Standards for Broadband Wireless Access Systems

- Institute of Electrical and Electronics Engineers (IEEE)
  - Global, open process
  - Worldwide participation
  - Producing international standards
- IEEE 802.11™ (short-range: ~100 m):
  - Wireless Local Area Networks
  - Often called "Wi-Fi" for "Wi-Fi Alliance"
- IEEE 802.16 ™ (long-range: ~10 km):
  - Wireless Metropolitan Area Networks
  - Often called "WiMAX" for "WiMAX Forum"
  - or "WiBro" for "Wireless Broadband"

Properties of IEEE Standard 802.16™

- Broadband
  - Up to ~100 Mbit/s (in principle, at PHY, in 28 MHz channel)
- Supports multiple services simultaneously with full QoS
  - Efficiently transport IPv4, IPv6, ATM, Ethernet, etc.
- Bandwidth on demand (frame by frame)
- MAC designed for efficient use of spectrum
- Comprehensive, modern, and extensible security
- Supports multiple frequency allocations up to 66 GHz
  - ODFM and OFDMA for non-line-of-sight applications
- TDD and FDD
- Link adaptation: Adaptive modulation and coding
  - Subscriber by subscriber, burst by burst, uplink and downlink
- Point-to-multipoint topology, with mesh extensions
- Support for adaptive antennas, space-time coding, MIMO
- Extensions to mobility (nearly finished – 802.16e)
- An element of 4G wireless.

802.16 Membership

- 261 Members (individuals)
  - Australia, Belgium, Brazil, Canada, China, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, Pakistan, Russia, Singapore, Spain, Sweden, Taiwan, UK, USA
  - plus >100 "Potential Members"
  - plus 85 official Observers
- Regional coordination
  - Europe (ETSI), Korea (TTA), China (CCSA)
- International coordination with ITU

IEEE 802.16 History

- Project development & acceptance: 1998-1999
- Meet every two months since 1999:

• #1: July 1999	Montreal	Canada	130 people
• ...			
• #29/Jan 2004	Vancouver	Canada	131
• #30/Mar 2004	Orlando	USA	222
• #31/May 2004	Shenzhen	China	228
• #32/Jul 2004	Portland	USA	332
• #33/Sep 2004	Seoul	Korea	287
• #34/Nov 2004	S. Antonio	USA	367
• #35/Jan 2005	Sanya	China	313
• #36/Mar 2005	Atlanta	USA	340
• #37/May 2005	Sorrento	Italy	~250

802.16 and ETSI

- Over 50 liaison letters between 802.16 and ETSI
  - (European Telecom Standards Institute)
- ETSI HIPERMAN
  - Below 11 GHz
  - IEEE began first
  - Healthy cooperation
  - Harmonized with 802.16 OFDM
- Cooperation on conformance tests

802.16 and Korea

- Several liaison letters between 802.16 and TTA (Telecommunication Technology Association)
- Korean Ministry of Information and Communication announced (29 July 2004) that Portable Internet Service (WiBro) using the 2.3 GHz spectrum "must comply with IEEE 802.16-2004 and IEEE 802.16e/Draft3 or later versions."

IEEE-SA, 802.16, & China

- Several meetings with leaders of Ministry of Information Industry and China Communications Standards Association (CCSA)
- 802.16 Liaison contacts with CCSA

802.16 and ITU

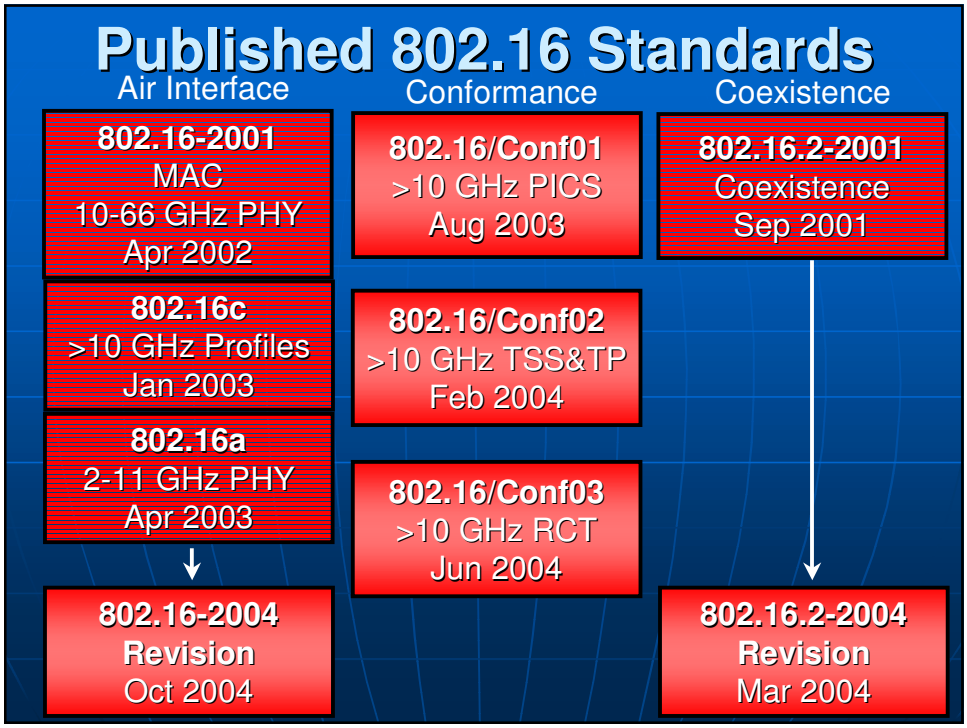
- ITU-T:
  - SG15: network access technologies
    - Liaison letters
  - SG9: cable television networks
    - Liaison letters
    - PDNR underway: broadband wireless extensions
      - 802.16 invited to contribute; 802.16 referenced
- ITU-R:
  - WP 9B: fixed wireless access
    - Liaison exchanges
    - DNR: broadband wireless recommendations
      - Based on 802.16's invited input
      - Approval expected in September 2005
  - WP 8A and 8F: recent activities

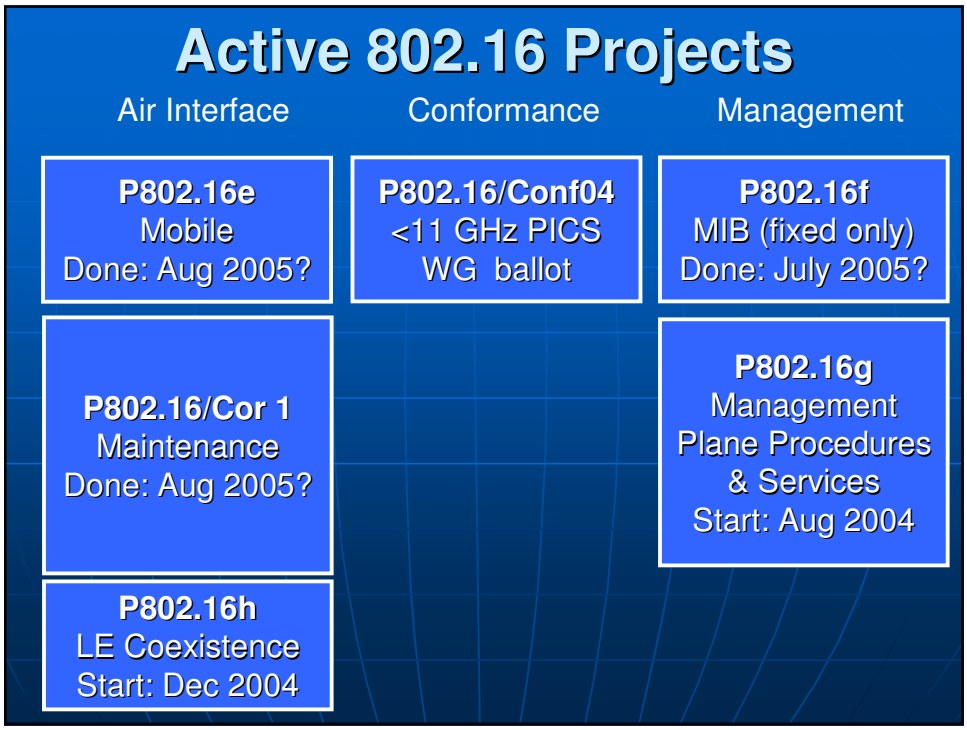
WiMAX Forum

- WiMAX: Worldwide Interoperability for Microwave Access
- Mission: *To promote deployment of BWA by using a global standard and certifying interoperability of products and technologies.*
- ~245 Member companies
  - Support IEEE 802.16 standard
  - Propose and promote access profiles for IEEE 802.16
  - Certify interoperability levels both in network and the cell
  - Achieve global acceptance
  - Promote use of broadband wireless access overall

IEEE Standard 802.16: WirelessMAN™ Air Interface

Technical Overview


Published 802.16 Standards
Air Interface
Conformance
Coexistence
802.16-2001
MAC
10-66 GHz PHY
Apr 2002
802.16/Conf01
>10 GHz PICS
Aug 2003
802.16.2-2001
Coexistence
Sep 2001
802.16c
>10 GHz Profiles
Jan 2003
802.16/Conf02
>10 GHz TSS&TP
Feb 2004
802.16a
2-11 GHz PHY
Apr 2003
802.16/Conf03
>10 GHz RCT
Jun 2004
802.16-2004
Revision
Oct 2004
802.16.2-2004
Revision
Mar 2004


Active 802.16 Projects
Air Interface
Conformance
Management
P802.16e
Mobile
Done: Aug 2005?
P802.16/Conf04
<11 GHz PICS
WG ballot
P802.16f
MIB (fixed only)
Done: July 2005?
P802.16/Cor 1
Maintenance
Done: Aug 2005?
P802.16g
Management
Plane Procedures
& Services
Start: Aug 2004
P802.16h
LE Coexistence
Start: Dec 2004

Point-to-Multipoint Wireless MAN: not a LAN

- Base Station (BS) connected to public networks
- BS serves Subscriber Stations (SSs)
- Provide SS with first-mile access to networks
  - SS can serve a building (business or residence)
  - SS can serve an 802.11 Wireless LAN access point
  - SS can serve a PDA, etc.
- Compared to a Wireless LAN:
  - Multimedia QoS, not only contention-based
  - Many more users
  - Much higher data rates
  - Much longer distances

802.16 MAC: Overview

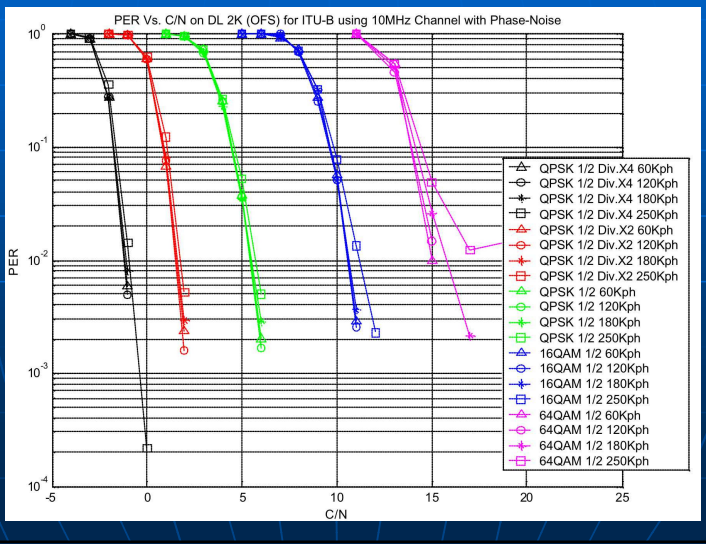
- Point-to-Multipoint Metropolitan Area Network
- Connection-oriented
- Supports difficult user environments
  - High bandwidth, hundreds of users per channel
  - Continuous and burst traffic
  - Very efficient use of spectrum
- Protocol-Independent core (ATM, IP, Ethernet, …)
- Balances between stability of contentionless and efficiency of contention-based operation
- Flexible QoS offerings
  - CBR, rt-VBR, nrt-VBR, BE, with granularity within classes
- Supports multiple 802.16 PHYs (SC, OFDM, OFDMA)
- ARQ/HARQ for link reliability
- Adaptive Antenna System (AAS) and MIMO support
- Dynamic Frequency Selection (DFS) (license-exempt)

Multiple Access and Duplexing

- On DL, SS addressed in TDM stream
- On UL, SS allotted a variable length TDMA slot
- Time-Division Duplex (TDD)
  - DL & UL time-share the same RF channel
  - Dynamic asymmetry
  - SS does not transmit/receive simultaneously (low cost)
- Frequency-Division Duplex (FDD)
  - Downlink & Uplink on separate RF channels
  - Static asymmetry
  - Half-duplex SSs supported
    - SS does not transmit/receive simultaneously (low cost)

PHY in Mobile Application

Source: "Applying scalability for the OFDMA PHY Layer," Contribution IEEE C802.16e-04/47r2((Y. Segal, I. Kitroser, Y. Leiba, Z. Hadad)



802.16 Summary

- The IEEE 802.16 WirelessMAN Air Interface, addresses worldwide needs
- The 802.16 Air Interface provides great opportunities for vendor differentiation, particularly at the base station, without compromising interoperability.
- The air interface is suitable for mobile subscriber stations, and enhancements for mobile use are nearly complete.
- Standardized network management functions will be defined.
- Compliance tests will be defined.

Free IEEE 802 Standards & Info

- Since May 2001, IEEE 802 standards have been available for free download, beginning six months after publication.
- See:

http://WirelessMAN.org

- You will find:
  - IEEE Std 802.16-2004
  - IEEE Std 802.16.2-2004
  - IEEE Std 802.16/Conformance 01, 02, & 03
  - Documents, tutorials, email lists