

# IEEE 802.16 WirelessMAN<sup>®</sup> Standard for Broadband Wireless Access

*ITU Regional Seminar on Broadband Wireless Access for  
Rural and Remote Areas for the Asia-Pacific Region  
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Chair

IEEE 802.16 Working Group on  
Broadband Wireless Access



## Outline

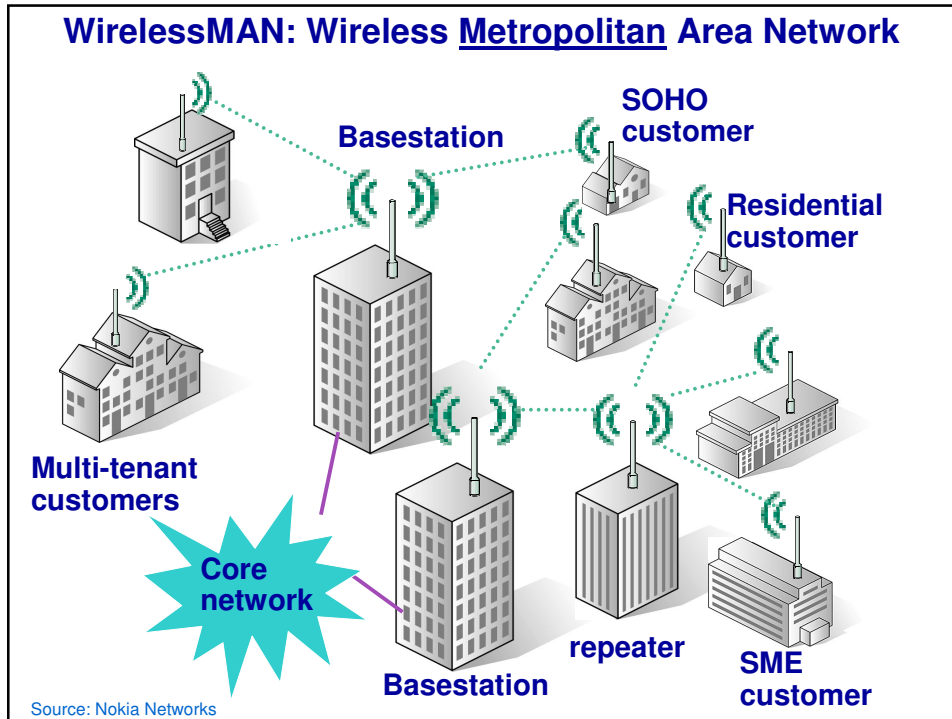
- Wireless Metropolitan Area Networks
  - Broadband Wireless Access
- IEEE Standards and IEEE 802
- IEEE 802.16 Working Group
- IEEE 802.16 Air Interface Standard
  - MAC and PHY, to 66 GHz
    - Revised: June 2004
  - Interoperability documentation in development
  - WiMAX Forum: interoperability testing
  - P802.16e: Mobile Enhancement
  - Other developments

## Broadband Access

- The “last mile” (or the “first few kilometers”)
  - Fast local connection to network
- Business and individual customers demand it
  - Data, Voice, Two-way Video, Gaming, etc.
- Network operators demand it
- Many users are fixed (static)
  - High-capacity cable/fiber to every user is expensive
  - Construction costs do not follow Moore’s Law
  - Most countries lack widespread fixed broadband access
- Many users wish to be mobile

## Universal Access

- Most of the world’s population has no access to broadband.
- Access to even telephone service is far from universal.
- Rather than create parallel telephone and broadband networks, a broadband network supporting voice may be more economical to deploy.



- ## Critical Issues for Broadband Wireless Access
- Access to spectrum on a technology-neutral basis
  - Global industry developing technical standards to meet global needs

## Centimeter-Wave Bands

### *Non-Line-of-Sight*

International

3.5 GHz; 10.5 GHz; etc.

Korea

2.3 GHz

U.S.: Broadband Radio Service

~2.5-2.7 GHz

## License-Exempt Bands

5-6 GHz

2.4 GHz

59-64 GHz

## 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"

## Why IEEE 802®?

### Telecom Standardization

- National
- Political

### Datacom Standardization

- Global
- Open
- Industry-Driven
- 802 and IETF set the standards

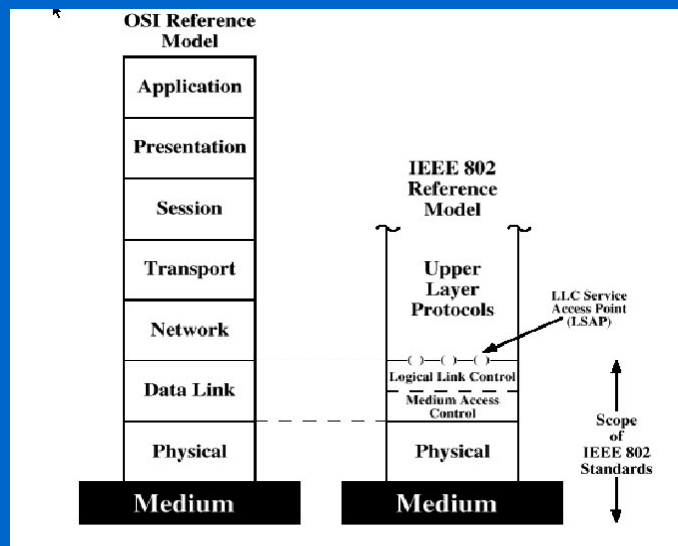
## Who are the Members?

- Telecom Standardization Bodies
  - Governmental Representatives
  - Companies
- IEEE
  - Engineers
  - Currently 342 Members

## Participation in IEEE 802.16

- *Open process and open standards*
- Anyone can participate in meetings
- Anyone can participate outside of meetings
  - Subscribe to mailing lists and read list archives
  - Post to mailing lists
  - Examine documents
  - Contribute and comment on documents
  - Join the Sponsor Ballot Pool
    - Vote and comment on draft standards
    - Must join the IEEE Standards Association to vote
    - Producers and Users must both be in ballot group

## Scope of 802 Standards



## Properties of IEEE Standard 802.16™

- Lower network layers interface with multiple higher layers
- Supports multiple services simultaneously with full QoS
  - Efficiently transport IPv4, IPv6, Ethernet, ATM, etc.
- Broadband
- 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
  - OFDM 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)
- New enhancements underway
  - license-exempt coexistence; multihop relay

## 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 a Wireless LAN AP
  - 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)

## IEEE 802 Process

- Call for Contributions
  - Specific topics for discussion at next meeting
- Receive and post written contributions
- Discuss and debate at meeting
- Create draft by 75% vote
- Working Group Ballot
- IEEE "Sponsor Ballot"
- Ballot Responses:
  - "Approve" (can include comments)
  - "Disapprove": indicate what needs to be changed to bring about an "Approve" vote

## IEEE 802.16 History

#1/Jul'99:	Montreal	Canada	130 people
...			
#29/Jan'04:	Vancouver	Canada	131
#30/Mar'04:	Orlando	USA	222
#31/May'04:	Shenzhen	China	228
#32/Jul'04:	Portland	USA	332
#33/Sep'04:	Seoul	Korea	287
#34/Nov'04:	S. Antonio	USA	367
#35/Jan'05:	Sanya	China	313
#36/Mar'05:	Atlanta	USA	330
#37/May'05:	Sorrento	Italy	218
#38/Jul'05:	San Fran.	USA	341

## The World Wants 802.16 WirelessMAN<sup>®</sup> Standards

- Attendees from Australia, Belgium, Brazil, Canada, China, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Israel, Italy, Japan, Korea, Netherlands, Nigeria, Norway, Pakistan, Romania, Russia, Singapore, Spain, Sweden, Thailand, USA, UK
- Regional coordination
  - Europe, Korea, China
- International coordination with ITU

## 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.”

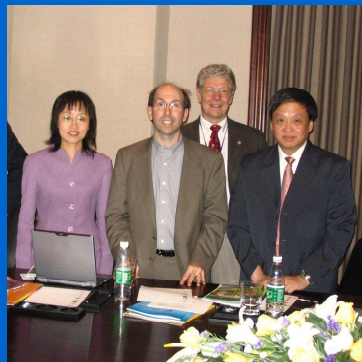
## IEEE 802.16 History in China



- "IEEE 802.16a Broadband Wireless Access (BWA) Standard Development and Internet Application": conference sponsored by BUPT and MII on 24 August 2001 in Beijing (Prof. Liu Yuan An, Chair)

## IEEE Standards & China

- Many positive discussions and links with Ministry of Information Industry and China Communications Standards Association (CCSA)
- IEEE 802.16 has liaison relation with CCSA TC5/WG3
- IEEE offering to open links to China Electronics Standardization Institute (CESI)

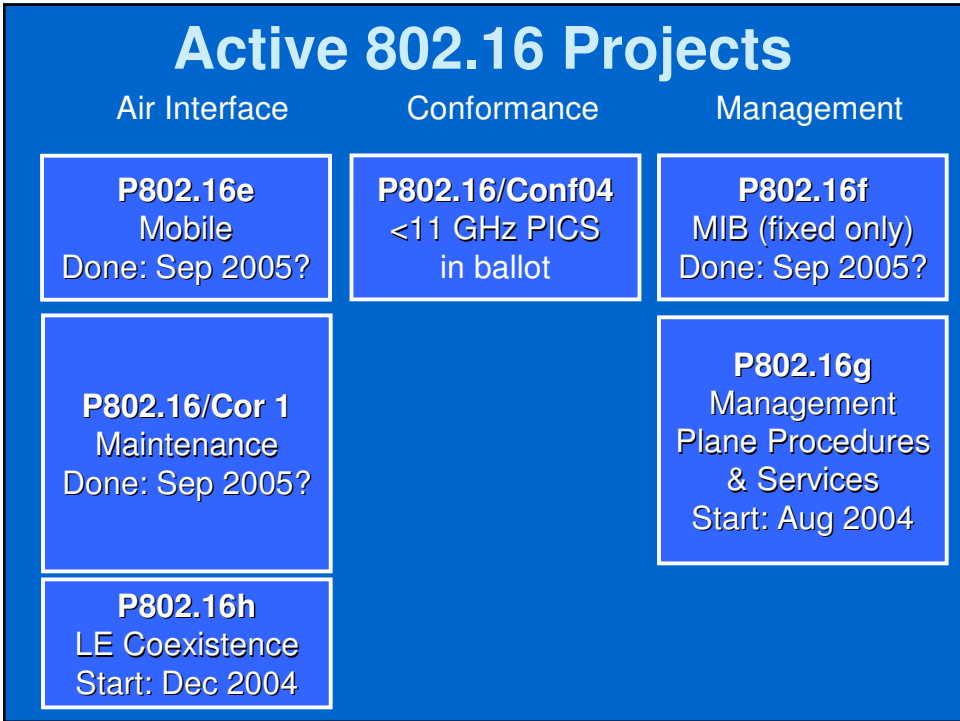
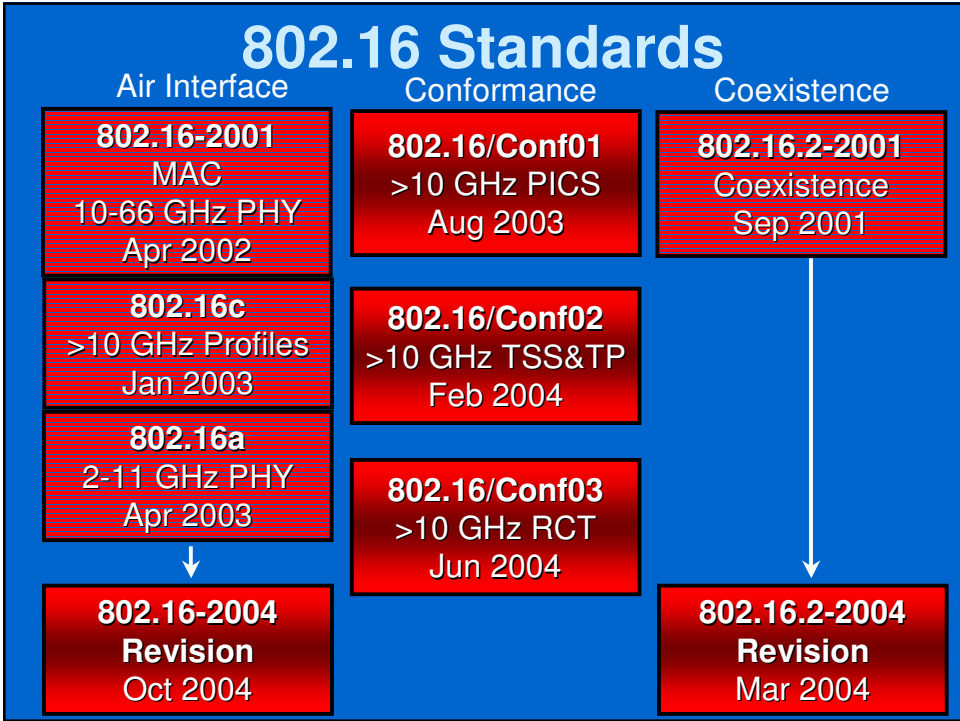


## 802.16 and ITU

- ITU-T:
  - SG15: network access technologies
    - Leadership meeting
    - Liaison letters
  - SG9: cable television networks
    - Leadership visits
    - Liaison letters
    - PDNR underway: broadband wireless extensions
      - 802.16 invited to contribute
- ITU-R:
  - WP 9B: fixed wireless access
    - Liaison exchanges
    - DNR: broadband wireless recommendations
      - Based on 802.16's +ETSI input; approval exp. Sept 2005
  - WP 8A: land mobile radio: initiative underway

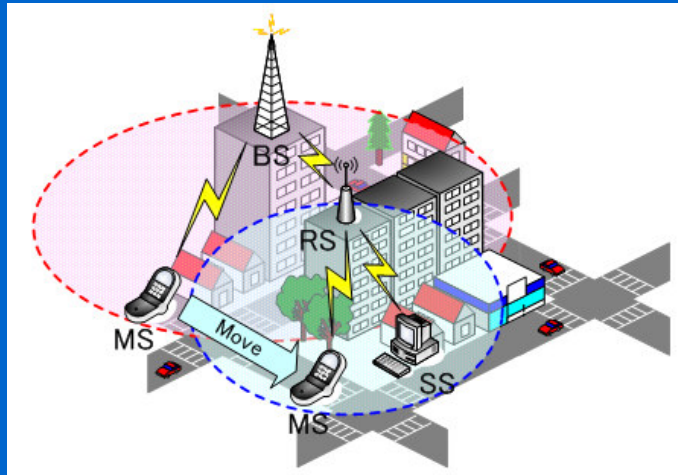
## WiMAX Forum

- WiMAX: Worldwide Interoperability for Microwave Access
- Mission: *To promote deployment of BWA by using a global standard and certifying interoperability of products and technologies.*
- >300 Member companies, and growing
  - Support IEEE 802.16 standard
  - Propose and promote access profiles for IEEE Std 802.16
  - Certify interoperability levels both in network and the cell
  - Achieve global acceptance
  - Promote use of broadband wireless access overall



# Multihop Relay Study Group

- Develop Relay mode for fixed / mobile terminal



\*Reference Presentation (C802.16-005/013) 6

## 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

- 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 802.16-2001, 802.16a, 802.16c
- IEEE Std 802.16.2-2004
- IEEE Std 802.16/Conformance 01 & 02

## IEEE Standard 802.16: Tutorial

*IEEE Communications Magazine*, June 2002  
(available on 802.16 web site)

TOPICS IN BROADBAND ACCESS

### **IEEE Standard 802.16: A Technical Overview of the WirelessMAN™ Air Interface for Broadband Wireless Access**

*Carl Eklund, Nokia Research Center*

*Roger B. Marks, National Institute of Standards and Technology*

*Kenneth L. Stanwood and Stanley Wang, Ensemble Communications Inc.*



## IEEE 802.16 Resources

IEEE 802.16 Working Group on Broadband  
Wireless Access

info, documents, tutorials, email lists, etc:

<http://WirelessMAN.org>

