

# IEEE 802.16 WirelessMAN™ Standard for Wireless Metropolitan Area Networks



<http://WirelessMAN.org>

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VP for Technology, WiMAX Forum

Chair, IEEE 802.16 Working Group

# Outline

- **IEEE 802.16 Working Group**
- **IEEE Project 802.16m**
- **IEEE 802.16 IMT-Advanced Proposal**
- **IEEE 802.16 Future Plans**

# **IEEE 802.16 Working Group on Broadband Wireless Access**

# IEEE 802.16 Working Group

- **Initiated in 1998**
- **Formalized in 1999 (11 years old)**
- **Holds at least six sessions a year**
  - Session duration: Four days
- **Open process**
  - Anyone can participate
- **Members are people**
  - Membership earned by participation
  - 3300 individuals have attended a session
  - Currently: 300Members, from around the world

# IEEE 802.16 WG/TG Leadership

- **802.16 Working Group**
  - Chair: Roger Marks, WiMAX Forum
  - Vice Chair: Jose Puthenkulam, Intel
  - Secretary: Scott Probasco, Nokia
  - Treasurer: Scott Migaldi, Motorola
- **802.16m Task Group**
  - Chair: Brian Kiernan, InterDigital
  - Vice Chair: Phillip Barber, Huawei
  - Vice Chair: JK Fwu, Intel
- **Maintenance Task Group**
  - Chair: Jonathan Labs, Wavesat
- **GRIDMAN Study Group**
  - Chair: Tim Godfrey, Electric Power Research Inst.

# Addresses of 802.16 Members

- CANADA (7)
- CHINA (26)
- EGYPT (2)
- FINLAND (3)
- FRANCE (5)
- GERMANY (4)
- INDIA (6)
- ISRAEL (11)
- JAPAN (13)
- KOREA (75)
- RUSSIA (3)
- SINGAPORE (3)
- SWEDEN (3)
- TAIWAN (49)
- UK (9)
- USA (81)

# Major 802.16 Interactions

7

- **Key Liaisons:**
  - ITU-R, CCSA, ETSI BRAN, ARIB, TTA, IEEE WGs
- **ITU-R, especially WP 5D and WP 5A**
- **WiMAX Forum**
  - WiMAX Forum certifies products based on IEEE 802.16
  - Active liaison cooperation in many areas
  - Cooperatively support IEEE 802.16 radio interface in IMT-2000
- **ETSI:**
  - Harmonized standards in ETSI BRAN
- **TTA (Korea)**
  - Proponent of IEEE 802.16 technology in IMT-Advanced
- **Japan**
  - Proponent of IEEE 802.16 technology in IMT-Advanced
  - Cooperation with ARIB

## 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)



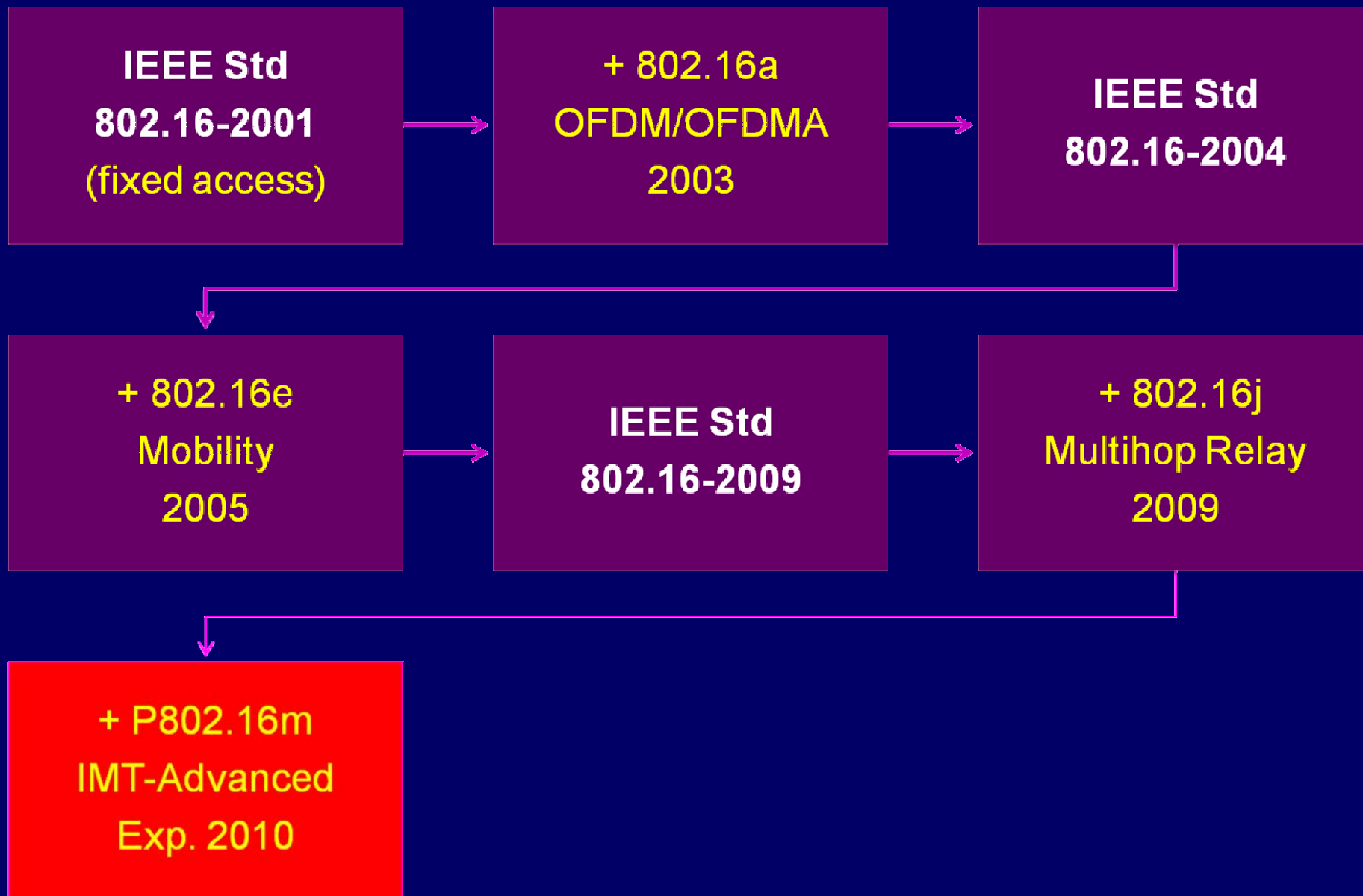


# IEEE 802.16 Session Attendance (excluding IEEE 802 Plenary)

|     |     |      |        |     |
|-----|-----|------|--------|-----|
| #31 | May | 2004 | China  | 228 |
| #33 | Sep | 2004 | Korea  | 287 |
| #35 | Jan | 2005 | China  | 313 |
| #37 | May | 2005 | Italy  | 218 |
| #39 | Sep | 2005 | Taiwan | 225 |
| #41 | Jan | 2006 | India  | 111 |
| #43 | May | 2006 | Israel | 122 |
| #45 | Sep | 2006 | Canada | 191 |
| #47 | Jan | 2007 | UK     | 274 |

|     |     |      |         |     |
|-----|-----|------|---------|-----|
| #49 | May | 2007 | USA     | 307 |
| #51 | Sep | 2007 | Spain   | 288 |
| #53 | Jan | 2008 | Finland | 303 |
| #55 | May | 2008 | China   | 402 |
| #57 | Sep | 2008 | Japan   | 415 |
| #59 | Jan | 2009 | USA     | 310 |
| #61 | May | 2009 | Egypt   | 210 |
| #63 | Sep | 2009 | Korea   | 257 |
| #65 | Jan | 2010 | USA     | 216 |
| #67 | May | 2010 | India   |     |

# IEEE 802.16: Key Evolution Steps



# Progress of 802.16e as an Global <sup>11</sup> Open Standard

- **Adopted by WiMAX Forum as the basis of its “Mobile WiMAX” technology and certification**
- **Widely deployed as a mobile broadband network technology, in countries including::**
  - **Australia, India, Ireland, Japan, Korea, Malaysia, Russia, Taiwan, USA...**
- **Adopted into ITU-R as an “IMT-2000” technology**
  - **Jointly supported by IEEE and WiMAX Forum**
  - **Joined IMT-2000 in Oct 2007**
  - **Has since been updated and revised**

**IEEE Project 802.16m**

# IEEE Project 802.16m

- **Amendment project, initiated 2006**
- **“WirelessMAN-Advanced” Air Interface**
  - **Amend IEEE 802.16 WirelessMAN-OFDMA specification to provide an advanced air interface**
  - **Meet the cellular layer requirements of IMT-Advanced next generation mobile networks**
  - **Support for legacy WirelessMAN-OFDMA equipment (i.e., backward compatibility)**
  - **Provide performance improvements to support future advanced services and applications**

# **Participation in IEEE 802.16m**

## **Development**

14

- **Since 802.16m project began, 802.16 WG participation includes:**
  - **Over 1200 individuals**
    - **From over 250 organizations**
    - **From 23 countries**
- **Contributed documents to 802.16m Task Group**
  - **2007: >300 documents**
  - **2008: >1600 documents**
  - **2009: > 2200 documents**
  - **2010: ~700 documents**

# IEEE 802.16m Key Features

- **New Subframe-based Frame Structure**
- **New Subchannelization Schemes and More Efficient Pilot Structures**
- **New and Improved Control Channel Structures**
- **Extended and Improved MIMO Modes**
- **Increased VoIP Capacity**
- **Multi-Hop Relay**
- **FemtoBS**
- **Self-organization**
- **Multi-carrier Operation**
- **Interference Mitigation**
- **Multi-BS MIMO**
- **Improved Intra-RAT and Inter-RAT Handover**
- **Multi-Radio Coexistence**
- **Location Based Services**
- **Enhanced Multicast and Broadcast Service**

# IEEE 802.16m Doc Progress

- **Background documents:**

- **Evaluation Methodology Document (EMD)**

- Defines link-level and system-level simulation models and associated parameters for evaluation and comparison of technologies for IEEE 802.16m

- **System Requirements Document (SRD)**

- Stage 1
    - Includes advanced features beyond IMT-Advanced requirements

- **System Description Document (SDD)**

- Stage 2
    - System level description of IEEE 802.16m

- **IEEE 802.16m Draft Standard:**

- **Began Working Group Letter Ballot in July 2009**

- **Current version: D5**

- **Expected completion in 2010**

- **Note: WiMAX Forum set to introduce “Release 2” certification in 2011**



# IEEE 802.16 IMT-Advanced Proposal

- **IEEE: Sector Member of ITU-R**
  - “Regional and other International Organizations”
- **ITU-R:**
  - ITU-R Rec. F.1763 recommends the use of IEEE 802.16-2004 for broadband wireless access systems in the fixed service
  - ITU-R Rec. M.1801 recommends the use of IEEE Std 802.16 (inc 802.16e) in the mobile service
  - ITU-R Rec. M.1457 incorporates IEEE Std 802.16 (inc 802.16e) as an IMT-2000 standard
  - IEEE 802.16 is active in IMT-Advanced (“beyond IMT-2000”)

# IEEE 802.16 IMT-Advanced Activities

- **Jan 2007: IEEE notified ITU-R that 802.16m project is intended for future contributions on IMT-Advanced.**
- **2007-2008: IEEE 802.16 WG developed many contributions to ITU-R Working Party 5D on IMT-Advanced process and technical requirements.**
- **Feb/May 2009: IEEE provided specific notice of intention to submit IMT-Advanced proposal, with additional details**
- **October 2009 : IEEE Submitted Candidate IMT-Advanced technology**

# **Development of IEEE 802.16 IMT- Advanced Proposal**

- **Solicited input material towards development of candidate RIT:**
  - Call for comments and contributions
  - Liaison activities with external organizations (e.g. WiMAX Forum, ARIB, TTA, and ITU-R WP 5D)
- **Contributions received containing calibration/simulation results as well as texts for description templates and other elements of the submission from authors affiliated with:**
  - Alcatel Shanghai Bell, Clearwire, ETRI, Fujitsu, Hitachi, Intel, ITRI, KDDI, LG Electronics, MediaTek, Mitsubishi Electric, Motorola, NEC, Samsung Electronics, Toshiba, UQ Comm., WiMAX Forum, etc.

# International support for IEEE 802.16 <sup>21</sup>

## IMT-Advanced Proposal

- IEEE cooperating with national standards bodies
- 3 IMT-Advanced candidate submissions on IEEE technology were submitted to WP 5D at deadline of October 2009:
  - *IMT-ADV/4 - from IEEE*
  - *IMT-ADV/5 - from Japan*
  - *IMT-ADV/7 - from Korea's TTA*
- Proposal documented to meet or exceed requirements in all four “test environments”
- IEEE submission supported by contribution by 50 companies
- IEEE technology (“WirelessMAN-Advanced”) was one of two candidate technologies proposed
  - The other was 3GPP’s “LTE-Advanced”

# IMT-Advanced Requirements

- IEEE has proposed a single RIT (inclusive of TDD and FDD) to meet or exceed all IMT-Advanced requirements in all test environments

| Test Environment / Deployment Scenario | Proposal Meets IMT-Advanced Requirements |
|--|--|
| Indoor Hotspot (InH)                   | ✓  |
| Urban Microcell (UMi)                  | ✓  |
| Urban Macrocell (UMa)                  | ✓  |
| Rural Macrocell (RMa)                  | ✓  |

# Performance: Cell Spectral Efficiency

## DL cell spectral efficiency in bit/s/Hz/cell for TDD

|                          | InH  | UMi  | UMa  | RMa  |
|--------------------------|------|------|------|------|
| Cell spectral efficiency | 6.93 | 3.22 | 2.41 | 3.23 |
| ITU-R requirement        | 3.0  | 2.6  | 2.2  | 1.1  |

## DL cell spectral efficiency in bit/s/Hz/cell for FDD

|                          | InH  | UMi  | UMa  | RMa  |
|--------------------------|------|------|------|------|
| Cell spectral efficiency | 6.87 | 3.27 | 2.41 | 3.15 |
| ITU-R requirement        | 3.0  | 2.6  | 2.2  | 1.1  |

## UL cell spectral efficiency in bit/s/Hz/cell for TDD

|                          | InH  | UMi  | UMa  | RMa  |
|--------------------------|------|------|------|------|
| Cell spectral efficiency | 5.99 | 2.58 | 2.57 | 2.66 |
| ITU-R requirement        | 2.25 | 1.8  | 1.4  | 0.7  |

## UL cell spectral efficiency in bit/s/Hz/cell for FDD

|                          | InH  | UMi  | UMa  | RMa  |
|--------------------------|------|------|------|------|
| Cell spectral efficiency | 6.23 | 2.72 | 2.69 | 2.77 |
| ITU-R requirement        | 2.25 | 1.8  | 1.4  | 0.7  |

# Performance: VoIP Capacity

## VoIP capacity (users/sector/MHz) for TDD

|     | DL  | UL  | Minimum {DL,<br>UL} | ITU-R required |
|-----|-----|-----|---------------------|----------------|
| InH | 140 | 165 | 140                 | 50             |
| UMi | 82  | 104 | 82                  | 40             |
| UMa | 74  | 95  | 74                  | 40             |
| RMa | 89  | 103 | 89                  | 30             |

## VoIP capacity (users/sector/MHz) for FDD

|     | DL  | UL  | Minimum {DL,<br>UL} | ITU-R required |
|-----|-----|-----|---------------------|----------------|
| InH | 139 | 166 | 139                 | 50             |
| UMi | 77  | 102 | 77                  | 40             |
| UMa | 72  | 95  | 72                  | 40             |
| RMa | 90  | 101 | 90                  | 30             |



# **IEEE 802.16 IMT-Advanced Activities and Status**

25

- **14 “Independent Evaluation Groups” are evaluating the two candidate technologies**
  - **Positive initial reports in Feb 2010**
  - **Final reports due to June 2010 meeting in Vietnam**
- **IEEE 802.16 hosted First IEEE 802.16 IMT-Advanced Evaluation Group Coordination Meeting (13 Jan 2010)**
- **IEEE 802.16 hosting Second IEEE 802.16 IMT-Advanced Evaluation Group Coordination Meeting (17 May 2010, Beijing)**

# Conclusion

- The IEEE 802.16 WirelessMAN standard has been evolving for 11 years to bring the latest technology to the marketplace
- IEEE follows an open, worldwide development process
- IEEE has submitted a complete IMT-Advanced candidate RIT, based on IEEE Project 802.16, including documentation demonstrating that it meets the IMT-Advanced requirements in all four test environments
- IEEE 802.16 WirelessMAN standard is still evolving to enhance performance and network capacity

# Resources

- IEEE 802.16 web site
  - <http://WirelessMAN.org>
  - Standards available for download
- IEEE 802.16 IMT-Advanced web page
  - <http://WirelessMAN.org/imt-adv>