802.16 WirelessMAN®

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“At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.”

IEEE-SA Standards Board Operation Manual (subclause 5.9.3)
802.16 is...
- Working Group
- Standard

Latest Significant Activity: 16m
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Resources & References
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802.16 is...
An IEEE-SA P802
Working Group (WG)

- IEEE 802.16 Working Group on Broadband Wireless Access
- Develops and maintains a set of standards
802.16 is...
A standard

- IEEE Standard 802.16: Air Interface for Broadband Wireless Access Systems
- The WirelessMAN® standard for Wireless Metropolitan Area Networks
MENU

- 802.16 is...
  - Working Group
  - Standard

- Latest Significant Activity: 16m
- Standard & ITU
- 16m Details
- Resources & References
- WiMAX Forum
- 802.20
- 802.21
The 802.16 Working Group
Overview

- Organized under IEEE
- Initiated in 1998; Formalized in 1999 (over 10 years old)
- Holds at least six sessions a year
  - Session duration: four days
  - 64 Sessions to date
- Open & Transparent process
  - Anyone can participate; become a Member
The 802.16 Working Group Overview (continued)

- Members are individuals; people
- Membership earned by participation
- Currently: 437 Members, from around the world, from dozens of countries
802.16 is...
  - Working Group
  - Standard
Latest Significant Activity: 16m
Standard & ITU
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The 802.16 Standard
Overview

- “Air Interface for Broadband Wireless Access Systems”
- Developed since 1999 by IEEE 802.16 WG
- Evolves by amendments and revision
- Fixed non-line-of-sight OFDMA introduced in 2002
- Mobile-enabled OFDMA introduced in 2005 ("802.16e")
The 802.16 Standard
Key Evolution Steps

IEEE Std 802.16-2001
(fixed access)

+ 802.16a
OFDM/OFDMA
2003

IEEE Std 802.16-2004

+ 802.16e
Mobility
2005

IEEE Std 802.16-2009

+ 802.16j
Multihop Relay
2009

A dozen other Amendments and Corrigenda not shown
802.16 is...
- Working Group
- Standard

Latest Significant Activity: 16m

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The 802.16 Standard
Latest Significant Activity: 16m

- “Advanced Air Interface” 16m Amendment project, initiated 2006
- Amend IEEE 802.16 WirelessMAN-OFDMA specification only
- meet the cellular layer requirements of IMT-Advanced next generation mobile networks
The 802.16 Standard
Latest Significant Activity: 16m (continued)

- support for legacy WirelessMAN-OFDMA equipment (i.e., backward compatibility)
- provide performance improvements to support future advanced services and applications
The 802.16 Standard
Latest Significant Activity: 16m (continued)

- Wide participation and interest
  - Over 1200 professionals
  - From about 240 organizations
  - From 23 countries
  - Contributed > 4400 documents to date since project inception
The 802.16 Standard
Latest Significant Activity: 16m (continued)

- Project Process
  - Evaluation Methodology Document (EMD)
  - System Requirements Document (SRD)
    - Stage 1
  - System Description Document (SDD)
    - Stage 2
  - Draft Amendment to IEEE 802.16-2009
    - Stage 3
The 802.16 Standard
Latest Significant Activity: 16m (continued)

- Draft Amendment to IEEE 802.16-2009
  - Stage 3 Draft Status
  - Four versions before P802.16m/D1
  - Current version P802.16m/D2
  - D3 to be published by Dec 4

- Draft Progress and Completion
  - Likely enter Sponsor Ballot in 2010Q2
  - Likely project completion 2010Q4
802.16 is...
  - Working Group
  - Standard

Latest Significant Activity: 16m

Standard & ITU

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The 802.16 Standard & ITU

- IEEE: ITU-R Sector Member
  - “Regional & other International Organizations”

- Relevant ITU-R Engagement
  - Fixed Wireless Access
    - Rec. F.1763: IEEE 802.16 in the Fixed Service
  - Land Mobile Radio
    - Rec. M.1801: IEEE 802.16 in the Mobile Service
The 802.16 Standard & ITU (continued)

- Relevant ITU-R Engagement (continued)
  - IMT-2000
  - IMT-Advanced
The 802.16 Standard & ITU (continued)

- Relevant ITU-R Engagement (continued)
  - IMT-2000
    - M.1457 Rev. 7 (2007) adds “OFDMA TDD WMAN”
      - Based on IEEE Std 802.16 (including 802.16e)
      - Implementation profile developed by WiMAX Forum
    - M.1457 Rev. 9 (2009) completed by WP 5D
      - Updates reference to IEEE Std 802.16-2009
      - Includes FDD as well as TDD updates
The 802.16 Standard & ITU (continued)

- Relevant ITU-R Engagement (continued)
  - IMT-Advanced
    - Contribution 8F/1083 (Jan 2007) notified ITU-R that 802.16m project is intended for future contributions on IMT-Advanced.
    - IEEE 802.16 Working Group developed many contributions to WP 5D regarding IMT-Advanced process and technical requirements.
Relevant ITU-R Engagement (continued)

- IMT-Advanced (continued)
  - 5D/356 (Feb 2009) and 5D/443 (May 2009) provided specific notice of intention to submit IMT-Advanced proposal, with additional details.
  - 5D/542 (October 2009): Submission of a Candidate IMT-Advanced RIT based on IEEE 802.16m
Relevant ITU-R Engagement (continued)

– IMT-Advanced (continued)

- Presentation at the 3rd Workshop on IMT-Advanced as one of two Technology Proponents (Dresden, 15 Oct 2009)
  - 802.16m for both FDD and TDD; targeting meeting all four ITU IMT-Advanced test environments
    - Indoor Hotspot
    - Urban Microcell
    - Urban Macrocell
    - Rural Macrocell
The 802.16 Standard & ITU
(continued)

- Relevant ITU-R Engagement (continued)
  - IMT-Advanced (continued)
    - Cooperating with national standards bodies in support of 802.16 candidate technology
      - Japan, ARIB; Korea, TTA
    - Large commercial support
      - Endorsement of candidate IMT-Advanced RIT based on IEEE 802.16 from 30 multinationals that participate in ITU-R
802.16 is...
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## The 802.16 Standard

16m Details: SRD Key System Requirements

<table>
<thead>
<tr>
<th>Requirements</th>
<th>IMT-Advanced</th>
<th>802.16m SRD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak spectral efficiency</strong> (b/s/Hz/sector)</td>
<td>DL: 15 (4x4)</td>
<td>DL: 8.0/15.0 (2x2/4x4)</td>
</tr>
<tr>
<td></td>
<td>UL: 6.75 (2x4)</td>
<td>UL: 2.8/6.75 (1x2/2x4)</td>
</tr>
<tr>
<td><strong>Cell spectral efficiency</strong> (b/s/Hz/sector)</td>
<td>DL (4x2) = 2.2</td>
<td>DL (2x2) = 2.6</td>
</tr>
<tr>
<td></td>
<td>UL (2x4) = 1.4</td>
<td>UL (1x2) = 1.3</td>
</tr>
<tr>
<td></td>
<td>(Base coverage urban)</td>
<td>(Mixed Mobility)</td>
</tr>
<tr>
<td><strong>Cell edge user spectral efficiency</strong> (b/s/Hz)</td>
<td>DL (4x2) = 0.06</td>
<td>DL (2x2) = 0.09</td>
</tr>
<tr>
<td></td>
<td>UL (2x4) = 0.03</td>
<td>UL (1x2) = 0.05</td>
</tr>
<tr>
<td></td>
<td>(Base coverage urban)</td>
<td>(Mixed Mobility)</td>
</tr>
<tr>
<td><strong>Latency</strong></td>
<td>C-plane: 100 ms (idle to active)</td>
<td>C-plane: 100 ms (idle to active)</td>
</tr>
<tr>
<td></td>
<td>U-plane: 10 ms</td>
<td>U-plane: 10 ms</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td>0.55 at 120 km/h</td>
<td>Optimal performance up to 10 km/h</td>
</tr>
<tr>
<td></td>
<td>0.25 at 350 km/h</td>
<td>“Graceful degradation” up to 120 km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Connectivity” up to 350 km/h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up to 500 km/h depending on operating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>frequency</td>
</tr>
<tr>
<td><strong>Handover interruption time (ms)</strong></td>
<td>Intra frequency: 27.5</td>
<td>Intra frequency: 27.5</td>
</tr>
<tr>
<td></td>
<td>Inter frequency: 40 (in a band)</td>
<td>Inter frequency: 40 (in a band)</td>
</tr>
<tr>
<td></td>
<td>60 (between bands)</td>
<td>60 (between bands)</td>
</tr>
<tr>
<td><strong>VoIP capacity</strong></td>
<td>40 (4x2 and 2x4)</td>
<td>60 (DL 2x2 and UL 1x2)</td>
</tr>
<tr>
<td></td>
<td>(Base coverage urban)</td>
<td></td>
</tr>
</tbody>
</table>

- **VoIP capacity**
  - 40 (4x2 and 2x4) (Base coverage urban)
The 802.16 Standard
16m Details: SDD Key Features

- Protocol Structure
- Frequency Bands
- Convergence Sublayer
- Medium Access Control Layer
- Physical Layer
- Location Based Services
- Enhanced Multicast Broadcast Service

- Multi-Hop Relay
- FemtoBS
- Self-organization
- Multi-carrier Operation
- Interference Mitigation
- RF Requirements
- Inter-BS Synchronization
The 802.16 Standard
16m Details: Amendment: Protocol Structure
The 802.16 Standard
16m Details: Amendment: Frame Structure

- improved voice capacity and reduced channel response latency
The 802.16 Standard
16m Details: Amendment: Frame Detail

TDD Frame: 5 ms

Type-1 Subframe

Type-2 Subframe

FDD Frame: 5 ms

Idle
The 802.16 Standard
16m Details: Amendment: Preamble

- **Primary (PA-) Preamble**: For initial acquisition, superframe synchronization, etc.
- **Secondary (SA-) Preamble**: For fine synchronization, cell identification, etc.
The 802.16 Standard
16m Details: Amendment: Frame Header

- Superframe Header (SFH)
  - To carry the system configuration information for cell selection and system access

- Advanced MAP (A-MAP): RU Assignment A-MAP; HARQ Feedback A-MAP; Power Control A-MAP
# The 802.16 Standard

**16m Details: Amendment: Numerology**

<table>
<thead>
<tr>
<th>Nominal channel bandwidth (MHz)</th>
<th>5</th>
<th>7</th>
<th>8.75</th>
<th>10</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling factor</td>
<td>28/25</td>
<td>8/7</td>
<td>8/7</td>
<td>28/25</td>
<td>28/25</td>
</tr>
<tr>
<td>Sampling frequency (MHz)</td>
<td>5.6</td>
<td>8</td>
<td>10</td>
<td>11.2</td>
<td>22.4</td>
</tr>
<tr>
<td>FFT size</td>
<td>512</td>
<td>1024</td>
<td>1024</td>
<td>1024</td>
<td>2048</td>
</tr>
<tr>
<td>Subcarrier spacing (kHz)</td>
<td>10.937500</td>
<td>7.812500</td>
<td>9.765625</td>
<td>10.937500</td>
<td>10.937500</td>
</tr>
<tr>
<td>Useful symbol time $T_u$ (µs)</td>
<td>91.429</td>
<td>128</td>
<td>102.4</td>
<td>91.429</td>
<td>91.429</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cyclic prefix (CP) $T_g = 1/8 \ T_u$</th>
<th>Symbol time $T_s$ (µs)</th>
<th>102.857</th>
<th>144</th>
<th>115.2</th>
<th>102.857</th>
<th>102.857</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDD</td>
<td>Number of OFDMA symbols per frame</td>
<td>48</td>
<td>34</td>
<td>43</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Idle time (µs)</td>
<td>62.857</td>
<td>104</td>
<td>46.40</td>
<td>62.857</td>
<td>62.857</td>
</tr>
<tr>
<td>TDD</td>
<td>Number of OFDMA symbols per frame</td>
<td>47</td>
<td>33</td>
<td>42</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>TTG + RTG (µs)</td>
<td>165.714</td>
<td>248</td>
<td>161.6</td>
<td>165.714</td>
<td>165.714</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cyclic prefix (CP) $T_g = 1/16 \ T_u$</th>
<th>Symbol Time $T_s$ (µs)</th>
<th>97.143</th>
<th>136</th>
<th>108.8</th>
<th>97.143</th>
<th>97.143</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDD</td>
<td>Number of OFDMA symbols per frame</td>
<td>51</td>
<td>36</td>
<td>45</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Idle time (µs)</td>
<td>45.71</td>
<td>104</td>
<td>104</td>
<td>45.71</td>
<td>45.71</td>
</tr>
<tr>
<td>TDD</td>
<td>Number of OFDMA symbols per frame</td>
<td>50</td>
<td>35</td>
<td>44</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>TTG + RTG (µs)</td>
<td>142.853</td>
<td>240</td>
<td>212.8</td>
<td>142.853</td>
<td>142.853</td>
</tr>
</tbody>
</table>
IEEE 802.16m RIT provides continuing support for legacy IMT-2000 (OFDMA TDD WMAN) MSs and BSs.

802.16m BS/MS supports a legacy BS/MS at a level of performance equivalent to that of a legacy BS.
The 802.16 Standard
16m Details: Amendment: PHY&MAC Improvements

- Advanced MIMO
- Reduced Overhead Resource Mapping
- Multi-carrier Operation
- Advanced Interference Mitigation
- Multi-RAT service
- Co-located Multi-RAT Coexistence
- Inter-BS Synchronization
- Enhanced MBS
- Multi-Hop Relay
- FemtoBS
- Self-organization
- Enhanced LBS
- Improved Privacy and Security
The 802.16 Standard
16m Details: Amendment: PHY&MAC
Improvements (continued)

- Improved Scalability and Flexibility in QoS
- Improved HARQ Integration
- Improved Control Message Integrity
- Enhanced Power Conservation Operation in All Modes
- Emergency Services and Notification support
The 802.16 Standard
16m Details: Amendment: Performance

<table>
<thead>
<tr>
<th>Designation</th>
<th>Test environment</th>
<th>Deployment scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>InH</td>
<td>Indoor</td>
<td>Indoor Hotspot</td>
</tr>
<tr>
<td>UMi</td>
<td>Microcellular</td>
<td>Urban micro-cell</td>
</tr>
<tr>
<td>UMa</td>
<td>Base coverage urban</td>
<td>Urban macro-cell</td>
</tr>
<tr>
<td>RMa</td>
<td>High speed</td>
<td>Rural macro-cell</td>
</tr>
</tbody>
</table>
### The 802.16 Standard 16m Details: Amendment: Performance

#### Table 7-5: DL cell spectral efficiency in bit/s/Hz/cell for TDD

<table>
<thead>
<tr>
<th>Cell spectral efficiency</th>
<th>InH</th>
<th>UMi</th>
<th>UMa</th>
<th>RMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell spectral efficiency</td>
<td>6.93</td>
<td>3.22</td>
<td>2.41</td>
<td>3.23</td>
</tr>
<tr>
<td>ITU-R requirement</td>
<td>3.0</td>
<td>2.6</td>
<td>2.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>

#### Table 7-7: DL cell spectral efficiency in bit/s/Hz/cell for FDD

<table>
<thead>
<tr>
<th>Cell spectral efficiency</th>
<th>InH</th>
<th>UMi</th>
<th>UMa</th>
<th>RMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell spectral efficiency</td>
<td>6.87</td>
<td>3.27</td>
<td>2.41</td>
<td>3.15</td>
</tr>
<tr>
<td>ITU-R requirement</td>
<td>3.0</td>
<td>2.6</td>
<td>2.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>

#### Table 7-9: UL cell spectral efficiency in bit/s/Hz/cell for TDD

<table>
<thead>
<tr>
<th>Cell spectral efficiency</th>
<th>InH</th>
<th>UMi</th>
<th>UMa</th>
<th>RMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell spectral efficiency</td>
<td>5.99</td>
<td>2.58</td>
<td>2.57</td>
<td>2.66</td>
</tr>
<tr>
<td>ITU-R requirement</td>
<td>2.25</td>
<td>1.8</td>
<td>1.4</td>
<td>0.7</td>
</tr>
</tbody>
</table>

#### Table 7-11: UL cell spectral efficiency in bit/s/Hz/cell for FDD

<table>
<thead>
<tr>
<th>Cell spectral efficiency</th>
<th>InH</th>
<th>UMi</th>
<th>UMa</th>
<th>RMa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell spectral efficiency</td>
<td>6.23</td>
<td>2.72</td>
<td>2.69</td>
<td>2.77</td>
</tr>
<tr>
<td>ITU-R requirement</td>
<td>2.25</td>
<td>1.8</td>
<td>1.4</td>
<td>0.7</td>
</tr>
</tbody>
</table>
### The 802.16 Standard

16m Details: Amendment: Performance

Table 7-13: VoIP capacity (users/sector/MHz) for TDD

<table>
<thead>
<tr>
<th>Test environment</th>
<th>DL</th>
<th>UL</th>
<th>Minimum {DL, UL}</th>
<th>ITU-R required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor (InH)</td>
<td>140</td>
<td>165</td>
<td>140</td>
<td>50</td>
</tr>
<tr>
<td>Microcellular (UMi)</td>
<td>82</td>
<td>104</td>
<td>82</td>
<td>40</td>
</tr>
<tr>
<td>Base coverage urban (UMa)</td>
<td>74</td>
<td>95</td>
<td>74</td>
<td>40</td>
</tr>
<tr>
<td>High speed (RMa)</td>
<td>89</td>
<td>103</td>
<td>89</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 7-14: VoIP capacity (users/sector/MHz) for FDD

<table>
<thead>
<tr>
<th>Test environment</th>
<th>DL</th>
<th>UL</th>
<th>Minimum {DL, UL}</th>
<th>ITU-R required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor (InH)</td>
<td>139</td>
<td>166</td>
<td>139</td>
<td>50</td>
</tr>
<tr>
<td>Microcellular (UMi)</td>
<td>77</td>
<td>102</td>
<td>77</td>
<td>40</td>
</tr>
<tr>
<td>Base coverage urban (UMa)</td>
<td>72</td>
<td>95</td>
<td>72</td>
<td>40</td>
</tr>
<tr>
<td>High speed (RMa)</td>
<td>90</td>
<td>101</td>
<td>90</td>
<td>30</td>
</tr>
</tbody>
</table>
### The 802.16 Standard
16m Details: Amendment: Performance

<table>
<thead>
<tr>
<th></th>
<th>FDD</th>
<th>TDD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RIT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Required</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DL</strong></td>
<td>17.79</td>
<td>16.96</td>
</tr>
<tr>
<td><strong>UL</strong></td>
<td>9.40</td>
<td>9.22</td>
</tr>
<tr>
<td><strong>TDD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UL</strong></td>
<td>6.75</td>
<td>6.75</td>
</tr>
</tbody>
</table>
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- IEEE 802.16 Website
  - http://WirelessMAN.org
- IEEE 802.16 IMT-Advanced web page
  - http://WirelessMAN.org/imt-adv
- IEEE 802.16 Candidate Proposal for IMT-Advanced
  - L802.16-09/0114r4
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WiMAX Forum®...

WiMAX Forum Vision:
Global adoption of WiMAX as the broadband wireless Internet technology of choice anytime, anywhere

WiMAX Forum Seeks to Achieve this Vision By:
• Promoting WiMAX to ensure spectrum availability and a favorable regulatory environment.
• Delivering a trusted certification process to achieve global interoperability.
• Publishing technical specifications based on recognized standards.
• Promoting the brand and technology to establish WiMAX as the worldwide market leader for broadband wireless
WiMAX Forum®

- WiMAX Forum <http://wimaxforum.org> is an international consortium of hundreds of leading companies from around the world
- certifies broadband wireless products based upon IEEE Std 802.16, promoting compatibility and interoperability
- dedicated to the global adoption of WiMAX as the broadband wireless Internet technology of choice anytime, anywhere
- Over 150 WiMAX Forum certified Products
  - from 25 BS vendors and 42 SS vendors
- 518 deployments in 146 countries
  - coverage of more than 430 Million people
WiMAX Forum, IEEE, and IMT

- WiMAX Forum partners with IEEE in supporting IMT-2000 OFDMA TDD WMAN radio interface in ITU-R
  - Approved in 2007
  - Updated to include FDD in 2009 (awaiting adoption)

- Endorses IEEE proposal to include 802.16m in ITU-R’s IMT-Advanced standard
  - Issued supportive announcement
  - Coordinated ecosystem news conference
  - Developed supporting contribution to ITU-R and enlisted 50 companies to co-sign
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802.20 Mobile Broadband Wireless Access (MBWA) Working Group

- Base standard IEEE 802.20-2008
- Two standards in one
  - TDD UMB design substantially based on 3GPP2/TIA FDD UMB
    - 3GPP2 C.S0084-0-000 thru C.S0084-0-009
  - Separate and unrelated 625kiloHertz-spaced MultiCarrier (625k-MC) enhancements to ATIS High Capacity-Spatial Division Multiple Access (HC-SDMA)
    - ATIS-070004.2005
802.20 Mobile Broadband Wireless Access (MBWA) Working Group

- Current projects
  - PICS
  - Minimum Performance Requirements
  - MIB
  - Virtual Bridging
802.20 Mobile Broadband Wireless Access (MBWA) Working Group

- TDD UMB
  - DL OFDMA, UL CDMA/OFDMA based air interface PHY
802.20 MBWA
TDD UMB Layering Architecture

Figure 2 — Unicast Route Layering Architecture
802.20 MBWA
TDD UMB FL Superframe Structure

Figure 82 — TDD44 Forward Link Superframe Structure

Figure 83 — TDD63 Forward Link Superframe Structure
# 802.20 MBWA

## TDD UMB FL Symbol Numerology

Table 154 — Forward Link Orthogonal Frequency Division Multiplexing Symbol Numerology

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FFT Size 512</th>
<th>FFT Size 1024</th>
<th>FFT Size 2048</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chip Rate 1/(T_{CHIP})</td>
<td>4.9152</td>
<td>9.8304</td>
<td>19.6608</td>
<td>Mcps</td>
</tr>
<tr>
<td>Subcarrier Spacing 1/((T_{CHIP}N_{FFT}))</td>
<td>9.6</td>
<td>9.6</td>
<td>9.6</td>
<td>kHz</td>
</tr>
<tr>
<td>Bandwidth of Operation</td>
<td>2.5–5</td>
<td>5–10</td>
<td>10–20</td>
<td>MHz</td>
</tr>
<tr>
<td>Cyclic Prefix Duration (T_{CP})</td>
<td>6.51, 13.02, 19.53, or 26.04</td>
<td>6.51, 13.02, 19.53, or 26.04</td>
<td>6.51, 13.02, 19.53, or 26.04</td>
<td>(\mu s)</td>
</tr>
<tr>
<td>Windowing Guard Interval (T_{WGI})</td>
<td>3.26</td>
<td>3.26</td>
<td>3.26</td>
<td>(\mu s)</td>
</tr>
<tr>
<td>Orthogonal Frequency Division Multiplexing Symbol Duration (T_{S})</td>
<td>113.93, 120.44, 126.95, or 133.46</td>
<td>113.93, 120.44, 126.95, or 133.46</td>
<td>113.93, 120.44, 126.95, or 133.46</td>
<td>(\mu s)</td>
</tr>
</tbody>
</table>
### 802.20 MBWA

#### TDD UMB FL Superframe Numerology

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N_{\text{FRAME}} ) = Number of Orthogonal Frequency Division Multiplexing Symbols in a Forward Link PHY Frame</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Number of FL PHY Frames in a Superframe</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Guard time between a FL PHY Frame and the subsequent RL PHY Frame</td>
<td>78.13</td>
<td>( \mu s )</td>
</tr>
<tr>
<td>( T_{g,\text{TDD,R}} = 3N_{\text{FFT}}T_{\text{CHIP}}/4 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guard time between a RL PHY Frame and the subsequent FL PHY Frame</td>
<td>16.28</td>
<td>( \mu s )</td>
</tr>
<tr>
<td>( T_{g,\text{TDD,R}} = 5N_{\text{FFT}}T_{\text{CHIP}}/32 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superframe Duration (( T_{\text{SUPERFRAME}} )) for ( N_{\text{CP}} = 1, 2, 3, \text{ or } 4 )</td>
<td>23.07, 24.37, 25.67, 26.98</td>
<td>ms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of FL PHY Frames in a Superframe</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Guard time between a FL PHY Frame and the subsequent RL PHY Frame</td>
<td>78.13</td>
<td>( \mu s )</td>
</tr>
<tr>
<td>( T_{g,\text{TDD,R}} = 3N_{\text{FFT}}T_{\text{CHIP}}/4 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guard time between a RL PHY Frame and the subsequent FL PHY Frame</td>
<td>16.28</td>
<td>( \mu s )</td>
</tr>
<tr>
<td>( T_{g,\text{TDD,R}} = 5N_{\text{FFT}}T_{\text{CHIP}}/32 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superframe Duration (( T_{\text{SUPERFRAME}} )) for ( N_{\text{CP}} = 1, 2, 3, \text{ or } 4 )</td>
<td>25.80, 27.26, 28.72 or 30.18</td>
<td>ms</td>
</tr>
</tbody>
</table>
802.20 MBWA
TDD UMB Superframe Preamble

Figure 84 — Superframe Preamble Structure
802.20 Mobile Broadband Wireless Access (MBWA) Working Group

- References
  - [http://grouper.ieee.org/groups/802/20/](http://grouper.ieee.org/groups/802/20/)

- IEEE 802.20-2008
802.16 is...
- Working Group
- Standard

Latest Significant Activity: 16m
Standard & ITU
16m Details
Resources & References
WiMAX Forum
802.20
802.21
802.21 Media Independent Handover (MIH) Working Group

- Base standard IEEE 802.21-2008
- Current projects
  - Security Extensions
  - Handovers for Downlink only Technologies
802.21-2008

- 802.21 ‘Shim’ Layer
  - event service (MIES)
  - command service (MICS)
  - information service (MIIS)

- Provide Inter-RAT services
  - Service continuity
  - Quality of service
  - Network discovery
  - Network selection
  - Power management
  - Handover policy
802.21-2008

- Management and control messaging primitives; enabled technology specific
- L2.5 Protocol defined
802.21-2008
Communication Model

Figure 2—MIHF communication model
802.21-2008
Protocol Reference Model

Figure 4—General MIHF reference model and SAPs
802.21-2008
Protocol Reference Model for 802.3

Media independent handover function (MIHF)

MIH event service
MIH command service
MIH information service

MIH_SAP

MIH users
Layer 3 or higher Mobility Protocol (L3MP)

LSAP

LLC-Logical link control or other MAC client

MAC

PHY
802.21-2008
Protocol Reference Model for 802.11
802.21-2008
Protocol Reference Model for 802.16

Layer 3 or higher Mobility Protocol (L3MP)

CS_SAP
Service-specific convergence sublayer (CS)

MAC_SAP
MAC common part sublayer (MAC CPS)

Security sublayer

PHY_SAP
PHY

MIH_SAP

MIH event service
MIH command service
MIH information service

C_SAP

M_SAP

Management entity

Media independent handover function (MIHF)
802.21-2008
MIHF Relationship Model

Legend

MIH Message Transport

Network or Node Block

MIH Local Interface

Functional Block
802.21 Media Independent Handover (MIH) Working Group

- References
  - [http://grouper.ieee.org/groups/802/21/](http://grouper.ieee.org/groups/802/21/)

- IEEE 802.21-2008