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Re:	This document represents a collaborative effort by the 802.16.3 Functional Requirements Task Group that started from a contribution by George Fishel (based on the 802.16.1 Functional Requirements [IEEE 802.16s-99/00r1]) and was further revised by the Task Group by a formal comment/resolution process. The version you are reading has been accepted by the Task Group. Please confirm that you are reading the most recent published version of this document (802.16.3-00/02rx where x is the version number) which can be found at: http://ieee802.org/16/sub11/docs/802163-00_02.html This document is output from 802.16 Session #9 (12-15 September, 2000). It contains edits that have been reviewed and resolved by the 802.16.3 Task Group at Session #9.
Abstract	This document provides functional requirements that are guidelines for developing an interoperable 802.16.3 air interface. The 802.16.3 committee desired to reach an understanding and consensus for functional requirements before proceeding with developing standards for 802.16.3 MAC and PHY protocols and thus formed a Functional Requirements Task Group to produce this document.
Purpose	The 802.16.3 task group uses this document to help qualify MAC and PHY protocol proposals.
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Functional Requirements for the 802.16.3 Interoperability Standard

Brian Petry (editor)

Table of Contents

1 Introduction

This document provides functional requirements that are guidelines for developing an interoperable 802.16.3 air interface for the licensed microwave frequency bands between 2 and 11 GHz enabling Point to Multipoint (P-MP) Broadband Wireless Access (BWA). The BWA system provides packet-based transport capabilities that can support a wide range of services (e.g., data, voice and video) to residential, Small and Medium Enterprises (SME) and Small Office/Home Office (SOHO) locations. The 802.16.3 committee desired to reach an understanding and consensus for functional requirements before proceeding with developing standards for 802.16.3 MAC and PHY protocols and thus formed a System Requirements Task Group to produce this document.

For convenience, requirements are itemized in Appendix A.

The Functional Requirements will not be published or sold by the IEEE. The requirements, with possible future amendments, are binding to the future development of 802.16.3 air interface protocols. This means that the forthcoming air interface standard MUST comply with the functional requirements.

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

“MUST” or “SHALL” These words or the adjective "REQUIRED" means that the item is an absolute requirement.

“MUST NOT” This phrase means that the item is an absolute prohibition.

“SHOULD” This word or the adjective “RECOMMENDED” means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.

“SHOULD NOT” This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.

“MAY” This word or the adjective “OPTIONAL” means that this item is truly optional. One implementation may include the item because the target marketplace requires it or because it enhances the product, for example; another implementation may omit the same item.

1.1 Scope

For the purposes of this document, a “system” constitutes an 802.16.3 MAC and PHY implementation in which at least one subscriber station communicates with a base station via a point-to-multipoint (P-MP) radio air interface, the interfaces to external networks, and services supported by the MAC and PHY protocol layers. So, “functional requirements” describes the functions of typical systems in terms of how they affect requirements of interoperable 802.16.3 MAC and PHY protocols. The functional requirements describe 802.16.3 systems and requirements in broad terms: what the required functions are but not how these functions work. The *how* part is left to the forthcoming 802.16.3 interoperability standard [1] which will describe in detail the interfaces, functions and procedures of the MAC and PHY protocols.

This document focuses on the service capabilities that an 802.16.3 system is required to support. These service capabilities have a direct impact on the requirements of the 802.16.3 MAC and PHY protocols. When the 802.16 working group produces an interoperable air interface

standard that meets these functional requirements, resulting 802.16.3-based implementations will provide the services required to interface into many conceivable BWA systems.

Other goals of this document are to formulate reference models and terminology for both network topology and protocol stacks that help the 802.16 working group to discuss and develop the MAC and PHY protocols. As far as possible, these SHOULD be common across 802.16 systems.

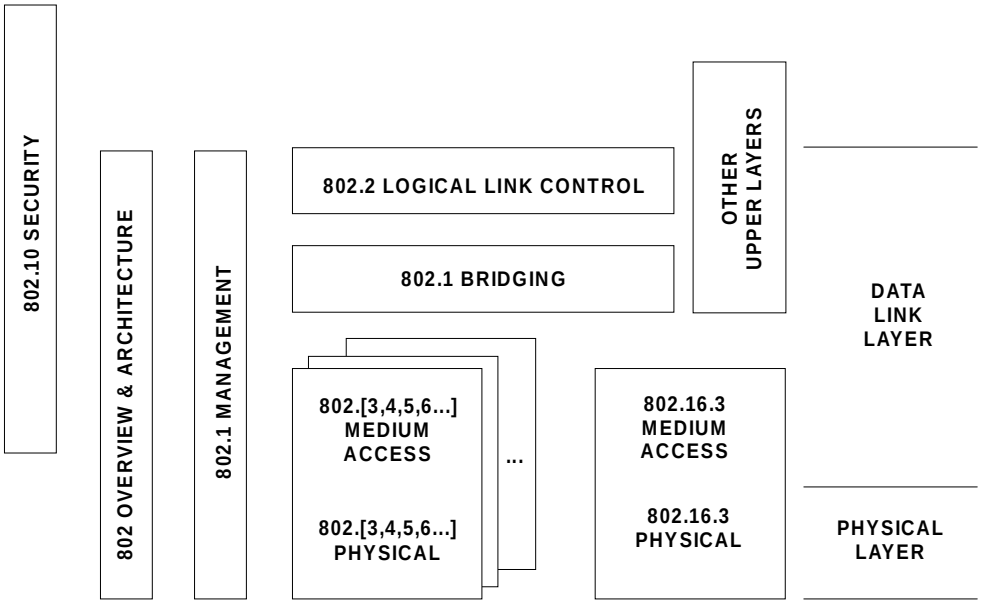

Figure 1-1: Relationship between 802.16.3 and other Protocol Standards (the numbers in the figure refer to IEEE standard numbers)

The 802.16.3 air interface interoperability standard SHALL be part of a family of standards for local, metropolitan and wide area networks. The 802.16.3 protocols relate to other 802 standards and to the OSI model as shown in Figure 1-1.

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection Basic Reference Model (ISO 7498: 1984). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other physical layers and medium access types are under investigation.

The standards that define the services noted in the above diagram are as follows:

IEEE Std 802: Overview and Architecture. This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the 802.1 scope of work.

ANSI/IEEE Std 802.1B [ISO/IEC 15802-2]: LAN/MAN Management. Defines an Open Systems Interconnection (OSI) management-compatible architecture, environment for performing remote management.

ANSI/IEEE Std 802.1D [ISO/IEC 10038]: MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.

ANSI/IEEE Std 802.1E [ISO/IEC 15802-4]: System Load Protocol. Specifies a set of services and protocols for those aspects of management concerned with the loading of systems on IEEE 802 LANs.

ANSI/IEEE Std 802.2 [ISO/IEC 8802-2]: Logical Link Control.

ANSI/IEEE Std 802.3 [ISO/IEC 8802-3]: CSMA/CD Access Method and Physical Layer Specifications.

ANSI/IEEE Std 802.4 [ISO/IEC 8802-4]: Token Bus Access Method and Physical Layer Specifications.

IEEE Std 802.10: Interoperable LAN/MAN Security, Secure Data Exchange (SDE).

1.2 Target Markets

The target markets described in this section are not an exhaustive set, but serve as guidelines and examples that suffice for meeting the broad applicability goals set forth by the air interface "Five Criteria" as described in the IEEE 802.16.3 Project Authorization Request (PAR) and "Five Criteria" [1, 2].

A broadband wireless access (BWA) system based on 802.16.3 protocols is expected to address markets similar to those of certain wired access technologies such as:

- Copper digital subscriber line (xDSL) technologies
- Digital cable TV hybrid fiber/coax (HFC) networks
- Fiber Access Networks
- Integrated Services Digital Network (ISDN)
- The services that such legacy systems carry: data, voice and audio/video

The critical parameters for serving these markets using wireless access technology is the combination of coverage / capacity factors that affects access cost per user, the deployability, maintainability and product costs associated with the customer premise installation, and the spectrum efficiency / reuse for economically serving the required number of customer locations with a minimum number of base station locations and backhaul routes.

The target markets to be addressed by the 802.16.3 protocols in BWA networks are single family residential, SOHO, small businesses and multi-tenant dwellings.

In accordance with ITU-R [3] definitions, Fixed Wireless Access (FWA) (and hence BWA) provides access to one or more (public and private) core networks, rather than forming an end-to-end communication system. 802.16.3 systems serve fixed location customers, but who might be geographically fixed, re-locatable or nomadic (but not mobile).

2 802.16.3 System Model

This section presents a high level description of a system model to be used as a framework for developing 802.16.3 standards. The model identifies of the main features of an 802.16.3 system, and the terminology to be used by the 802.16-working group in the creation of the standards.

As mentioned in section 1.1, an 802.16.3 "system" constitutes an 802.16.3 MAC and PHY implementation in which at least one subscriber station communicates with a base station via a point-to-multipoint (P-MP) radio air interface, and services supported by the MAC and PHY protocol layers. Specific applications of the 802.16.3 point-to-multipoint (P-MP) radios are

generally applicable to the range 2 to 11 GHz. Radio communications in the above range may be possible in near- and non-line-of-sight situations between a base station and subscriber station. Operation may include partial blockage by foliage which contributes to signal attenuation and multipath effects. Figure 2-1 shows an example deployment configuration including the optional use of a repeater. 802.16.3 systems SHALL be deployable in multiple-cell frequency reuse systems and single cell (super cell) frequency reuse systems. The range of 802.16.3 radios varies with transmit power, channel characteristics, availability requirement, local regulations and atmospheric conditions.

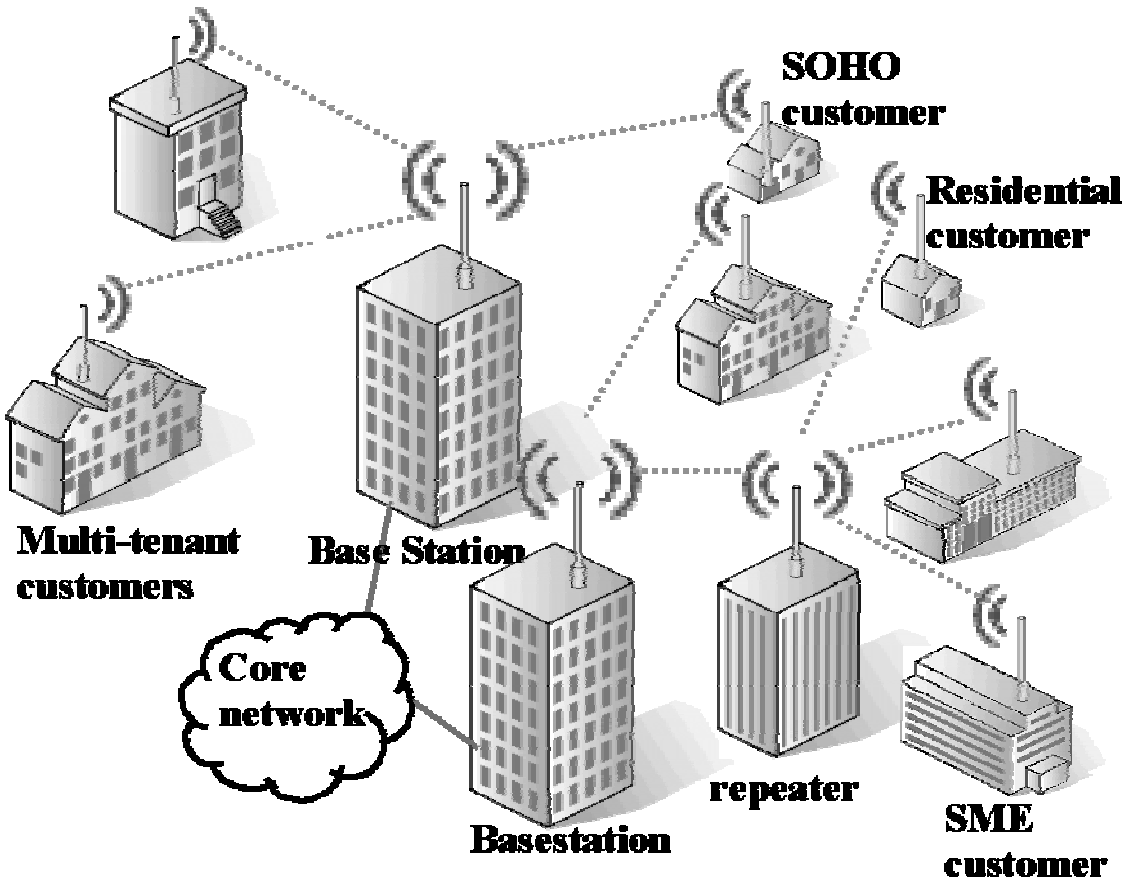

Figure 2-1: Example Deployment Configuration

To facilitate description, an 802.16.3 *system* consists of one base station radio and one or more subscriber stations. Thus, an 802.16.3 system also defines 802.16.3 base station and subscriber station radios that communicate using the 802.16.3 MAC and PHY protocols. The base station radio SHALL be P-MP, radiating its *downstream* signal with a shaped sector or adaptive array (spatial reuse) antenna achieving broad azimuthal beam width to "cover" a prospective number of subscribers.

Furthermore, the 802.16.3 system does not define radio communications between base stations. Since the base station radios might be "sector oriented," multiple base station radios will likely, in practice, be co-located (subject to frequency re-use requirements), and might share physical hardware.

The frequency bands used by 802.16.3 systems vary among governed geographies [4].

2.1 Wireless Access Reference Model

Figure 2-2 shows the 802.16.3 wireless access reference model. The model depicts the relevant points between subscriber networks and "core" networks (the networks that MAY be accessed via 802.16.3 air interface). A greater system encompassing user terminals, base station interconnection networks, network management facilities, etc. may be envisaged but the 802.16.3 protocol focuses on the air interface shown in the model. The Core Network Interface (CNI) and the User Network Interface (UNI) are also shown.

A single SS MAY support multiple customer premises networks that transport data, voice and video through one or more UNIs. Base stations MAY support multiple core networks through one or more CNIs. For the purposes of 802.16.3, the UNI and CNI are abstract concepts. The details of these interfaces are beyond the scope of this document. The standard SHALL specify MAC layer protocols and PHY transmission techniques suitable for providing access between one or more subscriber stations and base stations to support UNI and CNI requirements.

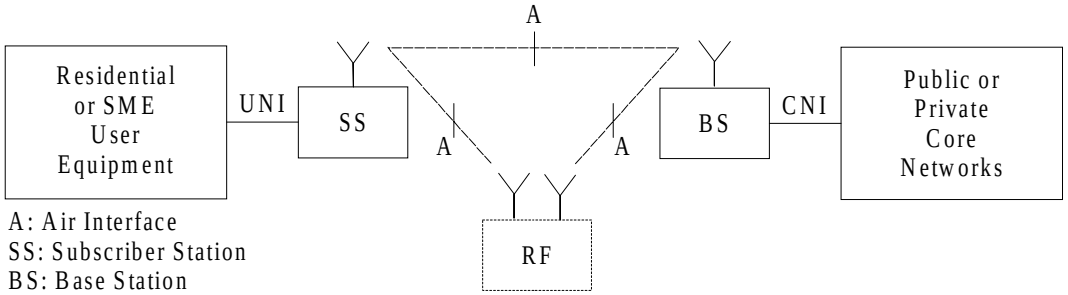

Figure 2-2: Wireless Access Reference Model

2.2 Optional Repeater Function

The 802.16.3 protocols SHALL support the optional deployment of repeater functions. The repeater function SHALL NOT affect the MAC protocol other than the delay which the repeater might introduce into the system. The repeater function SHOULD NOT affect the end-to-end operation of 802.16.3 protocols between BS and SS.

2.3 Topology

Since all data traffic in a single cell of an 802.16.3 network MUST go through the base station, that station SHALL serve as a radio resource supervisor [5].

In the downstream direction, the multiplexed traffic is transmitted by the base station. In the upstream direction, 802.16.3 protocols MUST provide the means to multiplex traffic from multiple subscriber stations, resolve contention, and allocate capacity.

3 Supported Service Capabilities

This section describes typical service capabilities supported by an 802.16.3 air interface.

The MAC and PHY protocols will not have explicit support for each and every service, due to the fact that generic data streams SHALL be used for transport. The MAC and PHY protocols SHALL provide for QoS service specific support, resulting in appropriate BER for data services, limited delay for real time services, etc.

3.1 Voice Transport Service Capabilities

802.16.3 systems SHALL support voice communications for subscribers in a way that eases the migration of legacy voice communications equipment and public switched telephone network (PSTN) access technologies to 802.16.3 systems. The 802.16.3 voice access transport SHALL be packet based (as opposed to circuit-switched based).

3.2 Data Transport Service Capabilities – Internet

The 802.16.3 system MUST directly transport variable-length IP datagrams efficiently. Both IP versions 4 and 6 MUST be supported. For efficient transport of IPv6, TCP/IP header compression over the air interface SHOULD be supported. The 802.16.3 IP service MUST provide support for real-time and non-real-time service capabilities. It SHOULD be possible to support the emerging IP Quality of Service (QoS) efforts: Differentiated Services [6, 7] and Integrated Services [8].

3.3 Bridged LAN Service Capabilities

The 802.16.3 protocols SHOULD support bridged LAN service capabilities, whether directly or indirectly, including always on, ad hoc and on-demand communication in either or both directions.

3.4 Other Services

Other services that for instance require QoS-based delivery of the MAC services may be added. These services SHALL NOT place any additional requirements on 802.16.3 systems (MAC and PHY protocols) not already covered in the above sections.

4 802.16.3 Protocols

The 802.16.3 protocols determine the interoperability of multiple vendors' equipment. Protocol interoperability occurs at each level in the protocol “stack” [9]. In this section, *services* refer to the services provided by the protocols that can appear in the layer sitting directly over the MAC layer. IEEE 802 protocols reside at layer 1 and 2 and consist primarily of Logical Link Control (802.2) [10] and the various MAC and PHY layers for each LAN or MAN standard. The IEEE Std 802-1990 *Overview and Architecture* [11] describes these layers.

The 802.16.3 protocol stack reference diagram is shown in Figure 4-1. In addition to the LLC, MAC and PHY layers suggested by the generic 802 architectures [11] [12] [13], 802.16.3 protocols support other categories of “upper protocols” that correspond to the requirements of the service capabilities described in section 3.

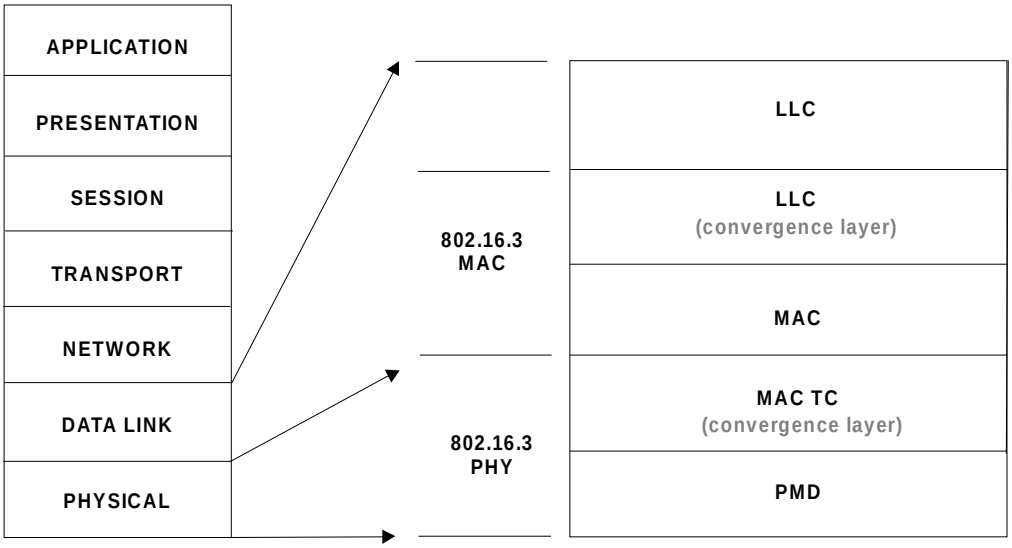

Figure 4-1: Protocol Stack Reference Model

This protocol stack reference model is intended to help develop terminology, and possibly protocol architecture. Each of the protocols above the PHY and MAC support "convergence sub-layers." The convergence sub-layers [14] [15] may be necessary to:

- Encapsulate PDU framing of upper layers into the native 802.16.3 MAC/PHY PDUs [15]
- Map an upper layer's addresses into 802.16.3 addresses
- Translate upper layer CoS/QoS parameters into native 802.16.3 MAC constructs
- Adapt the asynchronous, synchronous or isochronous data pattern of the upper layer into the equivalent MAC service
- Reduce the need for complex inter-working functions (IWFs) [15]

Other convergence sub-layers may be required by additional higher layer service requirements.

The IEEE 802.16.3 MAC and PHY protocol stacks SHALL be the same for all the supported services. The central purpose of the MAC protocol layer in 802.16.3 is sharing of radio channel resources. The MAC protocol defines how and when a base station or subscriber station may initiate transmission on the channel. Since key layers above the MAC require service guarantees, the MAC protocol MUST define interfaces and procedures to provide guaranteed service to the upper layers. Since customer units will contend for capacity to/from one or more base stations, the MAC protocol MUST efficiently resolve contention and resource allocation. Note that the function of the MAC protocols SHOULD include error correction by retransmission, or Automatic Repeat Request (ARQ), whereas, in the 802 model, those functions if necessary, are provided by the LLC layer.

The PHY layer is similarly subdivided between a convergence layer and a physical medium-dependent (PMD) layer. The PMD is the "main" part of the PHY. Like the MAC convergence layers, the PHY convergence layers adapt/map the "special" needs of the MAC services to generic PMD services. Further details, and finalization of the protocol reference model, SHALL be worked out by the 802.16.3 MAC and PHY task groups while developing the air interface interoperability standard.

5 Performance and Capacity

This section addresses some issues regarding 802.16.3 system performance and capacity. Specifying protocols that can maintain specified/mandatory performance levels in the face of fluctuating and diverse channel characteristics (e.g., due to multipath and atmospheric conditions) is a problem that the 802.16.3 work group has to consider. This section specifies the target performance levels. This section also outlines some of the issues for 802.16.3 capacity planning.

Note that ITU-R has presented several questions regarding the need for performance objectives for fixed wireless access radio systems, in particular, the activities being carried out within the Joint Rapporteur Group (JRG) 8A/9B (Questions ITU-R 140/9, ITU-R 215/8, ITU-R 220/9).

5.1 Scalability

The 802.16.3 protocols SHOULD allow for different “scales” of capacity and performance for 802.16.3 system instances.

5.2 Peak Data Rate

802.16.3 protocols SHALL be optimized to support the peak data rate in either or both directions to a subscriber station within the specified distance from the base station. The 802.16.3 MAC protocol SHOULD allow the peak data rate to scale beyond 10 Mbps.

5.3 Propagation Delay

The large cell radius, up to 50km, will produce a large propagation delay difference between near and far CPE units. This difference can be as large as 150us. The PHY and MAC protocol SHOULD provide for far CPEs’ propagation delay compensation.

5.4 Spectral Efficiency

The spectral efficiency is an important performance parameter of a wireless access system.

A.1.1 Per-Subscriber Rate Adaptation

802.16.3 systems can use different modulation and/or coding options for far and near subscriber stations. In this way the data rate to/from relatively near subscribers can be higher, increasing the overall system capacity. Additionally, far subscribers can experience different interference profiles and so would benefit from rate adaptation. The PHY and MAC protocols SHALL provide for multirate support.

5.5 Flexible Asymmetry

802.16.3 protocols SHOULD allow for flexibility between delivered upstream and downstream capacity and CoS/QoS. Some target markets utilize naturally asymmetrical capacity, such as for generic Internet access where most of the capacity is consumed in the downstream direction. Some markets utilize asymmetrical capacity, using more in the upstream direction, such as a video multicast from a corporate or distance-learning source. Other markets and applications require symmetrical capacity, such as telephony and video conferencing [15].

A high degree of flexibility may be achieved by utilizing the MAC protocol to arbitrate channel capacity in either direction, upstream or downstream.

5.6 Radio Link Availability

An 802.16.3 system SHOULD be available to transport all services at better than their required maximum error rates (see section 5.7) from about 99.9 to 99.99% of the time [14, 16], assuming that the system and radios receive adequate mains power 100% of the time and not counting equipment availability. The 802.16.3 specifications SHALL NOT preclude the ability of the radio link to be engineered for different link availabilities, based on the preference of the system operator.

A period of unavailable time begins at the onset of ten consecutive SES events based on the following definitions [17].

- Severely Errored Second (SES) is defined as a one-second period which contains 30% errored blocks.
- Errored Block (EB): A block is defined as a set of consecutive bits associated with the path. Consecutive bits may not be contiguous in time. A block is typified as data block containing an error detection code for service performance monitoring. An errored block is a block in which one or more bits are in error.

It is expected that the highest contributor to 802.16.3 system outage will be excessive attenuation and multipath due to varying path impediments such as reflections and foliage. In a multicell environment, intercell interference can not be neglected as an outage increasing factor. 802.16.3 MAC and PHY protocols MUST accommodate these conditions, perhaps consuming more radio bandwidth and/or requiring smaller radio propagation distance (radius) to meet the availability requirements. Since statistical atmospheric and path conditions vary widely in geography, the 802.16.3 protocols MUST be flexible in consumed radio bandwidth (spectral efficiency), cell radius, and transmit power. Bandwidth and cell radius are critical components of system/cell capacity planning (also see section 5.9).

802.16.3 MAC and PHY protocols SHOULD specify functions and procedures to adjust transmitter power, modulation, or other parameters to accommodate rapid changes in channel characteristics.

5.7 Radio Link Error Performance

The error rate, after application of the appropriate error correction mechanism (e.g., FEC), delivered by the PHY layer to the MAC layer SHALL meet IEEE 802 functional requirements with the following exception: the radio link bit error ratio (BER) SHALL be $10E^{-6}$ (in accordance with ITU FWA recommendations [18] or better. Note that this BER of the recovered payload applies to a BWA system which is only one component of a network's end-to-end BER. Note that the size of the data block is TBD.

5.8 Delay

Delay and variation of delay, or jitter, are important factors to consider. For example, a high variation of delay can severely impact telephony services. However, generic Internet access can tolerate a high degree of delay variation.

The end-to-end delay depends on an entire application-specific network encompassing all 7 layers of the OSI model.

Please refer to section 7, descriptions of QoS parameters.

5.9 Capacity

802.16.3 base station capacity requirement is defined as the product of the number of subscribers, their peak bandwidth requirements and load factor based on quality of service guarantees. The standard SHALL support careful planning to ensure that subscribers' quality of service guarantees and minimum error rates are met.

The delivered base station capacity can vary depending on attenuation due to atmospheric conditions, LOS blockage, transmit power, etc., and SHALL be calculated as the aggregate capacity of all sectors supported by a base station. Sector capacity is defined as the product of two factors: the "modulation factor" and the "sector-bandwidth factor" based on quality of service guarantees. The "modulation factor" is defined as the sector's aggregate bit rate divided by the bandwidth. The "sector-bandwidth factor" is defined as the total frequency band available for the BWA service, adjusted by the appropriate frequency re-use factors. This reflects mainly the factor of frequency reallocation and the ability to optimize frequency usage.

Given the propagation characteristics in a given frequency band and geographic area, and the development of a link budget [16], the following parameters of an 802.16.3 system SHOULD be addressed by the MAC and PHY protocols:

- Radio range (up to 50 Km)
- Upstream/downstream channels' data rates
- Allocation of prospective subscriber data rate to channels. Note: the MAC and PHY standards MAY allow subscribers to hop between channels
- Types of modulation

The MAC and PHY protocols MUST accommodate channel capacity issues and changes in channel capacity to meet contracted service levels with customers. For example, flexible modulation types, power level adjustment, and bandwidth reservation schemes MAY be employed. Also, as subscribers are added to 802.16.3 systems, the protocols MUST accommodate them in an automated fashion.

The time-variant impairments (multi-path interference) is expected to be the most significant contributor to channel impairments and complexity in cell capacity planning [16,17, 19-26].

6 Wireless Media Characteristics

6.1 Duplex Modes

This standard SHALL permit two duplex modes of operation: Frequency Division Duplex (FDD) and Time Division Duplex (TDD). The PHY and MAC protocols MUST provide for duplex (i.e. bi-directional) operation, while preserving the QoS, BER and spectral efficiency requirements for data and voice traffic. The MAC and PHY protocols MUST provide means to resolve applicable collocation and interference problems.

6.2 Channelization

The MAC and PHY protocols MUST permit the operation with channel spacing of 1.75, 3.5 and 7MHz when using ETSI masks and 1.5 to 25MHz when using other masks. The typical value for performance analysis SHOULD be 3.5MHz for the ETSI mask and 3MHz for the MDS mask.

7 Class of Service and Quality of Service

This section describes the classes of service and quality of service for 802.16.3 systems. Terminology is borrowed from the Internet Engineering Task Force (IETF).

802.16.3 protocols MUST support classes of service (CoS) with various quality of service (QoS) guarantees to support the services that an 802.16.3 system MUST transport. Thus, 802.16.3 protocol standards MUST define interfaces and procedures that accommodate the needs of the services with respect to allocation and prioritization of resources. Additionally, 802.16.3 protocols MUST provide the means to enforce QoS contracts and Service Level Agreements. Table 1 provides a summary of the QoS requirements that the PHY and MAC SHALL provide. Note that parameters in the table are measured between the MAC input at the upper layer at the transmit station and the MAC output at the upper layer of the receiving station for information transmission. For example, delay does not include setup time, link acquisition, voice codecs, etc.

For QoS-based, connectionless services, the 802.16.3 protocols MUST support resource negotiation “on-demand”. For instance, the MAC protocol MAY allocate bursts of PDUs to services that require changes in resource allocation. Such allocation, for connectionless services, is thus performed in a semi-stateless manner.

A connection-oriented service may require “state” information to be maintained for the life of a connection. However, the 802.16.3 MAC layer interface MAY provide a connection-less service interface that requires a higher-layer “adaptation” to maintain the “state” of a connection and periodically allocate resources. For instance, the MAC may need to maintain “state” information about a QoS data flow only for the duration of an allocation.

Table 1: Services and QoS Requirements

Service	Maximum Ratio	Maximum Access Delay (One way)
Full Quality Telephony (Vocoder MOS ≥ 4.0)	BER10^{-6}	20 ms
Standard Quality Telephony (Vocoder MOS < 4.0)	BER10^{-4}	40 ms
Time Critical Packet Services	BER 10^{-6}	20 ms
Non- Time Critical Services:	BER 10^{-9}	not applicable

7.1 Types and Classes of Service

The fundamental direction for the QoS model that will be exported to the BWA endpoints will be IP based and conform to IETF DiffServ QoS model in conjunction with other IP based protocols. The DiffServ QoS model defines traffic for all services as follows:

- Expedited forwarding (EF) EF requires a constant, periodic access to “bandwidth”. The “bandwidth” requirements vary over time, within a specified range, but delay and delay variance limits are specified. Examples that fall into this category are voice-over-IP (VoIP), videoconferencing, video on demand (VoD), and other “multimedia” applications.
- Assured Forwarding (AF): In AF the “bandwidth” varies within a specified range, but has loose delay and delay variance requirements. Applications, which are limited in their “bandwidth” usage, may fall into this category. In one example, corporate database transactions could be relegated to this category. 'Assured Forwarding' service allows the traffic to be divided into different classes. Using this service, an ISP can offer an “Olympic” service model, which provides three tiers of services: gold, silver and bronze with decreasing quality (i.e., the gold level of service receives a higher share of resources than silver during times of congestion). This service model would support, for example, the ability to provide preferential treatment to subscribers willing to pay a “premium” price for better service. Or it would support more granular priorities such as giving preference to VoIP traffic over other traffic e.g., HTTP).
- Best Effort Service (BES). The “bandwidth” varies within a wide range, and is allowed to burst up to the maximum link “bandwidth” when EF and AF traffic are not using “bandwidth.” The “bandwidth” and delay requirements may or may not be specified. Higher variations of delay may be tolerable since applications that fall into this category allow for priority traffic to preempt their “bandwidth” consumption. “Bandwidth” is delivered on a “best effort” basis. Current Internet service is an example of this type of operation.

7.2 Parameters

802.16.3 protocols SHALL define a set of parameters that preserve the intent of QoS parameters for IP-based services.

7.3 Service QoS Mappings

The classes of service and QoS parameters of services SHALL be translated into a common set of parameters defined by 802.16.3. A QoS-based IP network may employ the Resource Reservation Protocol (RSVP) [27] to “signal” the allocation of resources along a routed IP path. If 802.16.3 is to be a “link” in the IP network, an IWF MUST interface with 802.16.3 to negotiate resource allocation.

The basic mechanism available within 802.16.3 systems for supporting QoS requirements is to allocate bandwidth to various services. 802.16.3 protocols SHOULD include a mechanism that can support dynamically-variable-bandwidth channels and paths (such as those defined for IP environments).

8 Management

As outlined in IEEE Std 802-1990 [11], The LLC Sublayer, MAC Sublayer and Physical Layer standards also include a management component that specifies managed objects and aspects of the protocol machine that provide the management view of managed resources. The aspect of management considered are (FCAPS):

- Fault management
- Configuration management

- Accounting management
- Performance management (see also section 5)
- Security (see also section 9)

The 802 standards define a framework for LAN/MAN management in ISO/IEC 15802-2: 1995(E) [28]. The framework contains guidelines for managed objects, management protocol, and the relationship to ITU management protocols. 802.16.3 protocols SHOULD comply with the above-mentioned standards and guidelines.

8.1 Service Level Agreements

The 802.16.3 protocols MUST permit operators to enforce service level agreements (SLAs) with subscribers by restricting access to the air link, discarding data, dynamically controlling bandwidth available to a user or other appropriate means [29]. The 802.16.3 protocols MUST also permit subscribers to monitor performance service levels of the 802.16.3 services being provided at the delivery point.

8.2 Malfunctioning Subscriber Station or Base Station

The operator MUST have means to shut down and reactivate a subscriber station if necessary, remote from the subscriber station, in the face of a malfunction. The operator also SHOULD have the means to securely shut down and reactivate a base station remotely. When such capabilities are available, the 802.16.3 protocols SHALL support a secure function. The 802.16.3 protocols SHOULD support functions that automatically shuts down transmission from a subscriber station or base station in case of malfunction (e.g., power limits exceeded).

8.3 Accounting and Auditing

The 802.16.3 system management framework, architecture, protocols and managed objects MUST allow for operators to effectively administer accounting and auditing. An operator MUST be able to account for resource utilization and various service features for each subscriber service separately.

Also recall from section 2 that a single subscriber station can interface to multiple subscribers that an operator could bill separately.

9 Security

The 802.16.3 system SHALL enforce security procedures described in this section.

The security system chosen by 802.16.3 SHALL be added to the protocol stack and reference points to include security protocols, and “database” servers for authentication, authorization, key management, service suspend/resume, relocation, anti-cloning, etc. [30, 31].

9.1 Authentication

There are two types of authentication for an 802.16.3 system. In the first type, a subscriber station MUST authenticate itself with the network every time it registers with the network. This authentication MUST prevent unauthorized subscriber station from entering the network or an unauthorized base station from emulating an authorized base station. This type of authentication MUST be supported by the 802.16.3 MAC layer.

The second type of authentication is between the subscriber and the BWA system. This may or may not be the responsibility of the 802.16.3 protocols. It MAY be handled by higher layer protocols.

An additional level of authentication may exist between the other two. This additional layer is the authentication of the subscriber with the subscriber station. This is beyond the scope of the 802.16.3 protocols.

The authentication mechanisms MUST be secure so that an "enemy" subscriber station is not able to gain access to an 802.16.3 system, or to the core network beyond. Passwords and secrets MUST NOT be passed "in the clear" through the air interface.

9.2 Authorization

Authorization is a security process that determines what services an authenticated subscriber is permitted to invoke. Each subscriber has a set of credentials that describe what the subscriber is "allowed" to do. The 802.16.3 standard SHALL identify a standard set of credentials and allow for vendors to extend the defined credentials with non-standard credentials. Some possible credentials are:

- Permission to access the 802.16.3 system
- Permission to access certain services (IP, Remote Bridging, Digital Audio/Video, etc.)
- Permission to request specific service features, and/or QoS parameters, based on the SLA (resources, delay, etc.).

For each service offered, the 802.16.3 protocols MUST be capable of securely supporting authorization requests and responses.

9.3 Privacy

Privacy is a security concept that protects transmitted data from being intercepted and understood by third parties (e.g., an "enemy" subscriber station, base station or passively "listening" radio). Wire-equivalent privacy (WEP) [5] and shared private key [5] privacy have been suggested as minimum required privacy levels for 802.16.3 systems.

802.16.3 standards SHOULD allow a suitable cryptographic algorithm to be employed that is internationally applicable. Facilities SHOULD also be defined in the protocol for the use of alternate cryptographic algorithms that can be used in certain localities and that can replace algorithms as they are obsoleted or "legalized" for international use.

10 802 Conformance

802.16.3 SHOULD strive to fit into the 802 system model. Some particulars with the 802 model (see *IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture* (IEEE Std 802-1990) [11]) are:

- The 802.16.3 MAC supports 802 “universal” 48 bit addresses.
- An 802.16.3 system supports MAC multicast. Note that 802.16.3 protocols support multicast in the downstream direction only, not upstream.
- The 802.16.3 protocols support 802.1 bridging services and protocols, including support of the 802.1q virtual LAN tag and 802.1D priority ID [32-34].
- The 802.16.3 protocols support encapsulation of 802.2 (LLC) [10] by the MAC protocol.
- Conform to the 802 conventions and structures for “interface primitives:” logical structures that are passed between protocol layers to invoke processes and transact data.
- Address the 802 system management guidelines (see section 8) [35].
- Provide a MAC service interface that complies to 802 conventions [12].

Appendix

A Requirements Summary (Informative)

This section contains tabular summaries or requirements found in the text of this document. Requirements are separated into three categories: required, recommended and optional.

Each requirement is numbered for easy reference. Future revisions of this document will keep the requirement reference numbers intact such that the number for a requirement will not change from revision to revision.

To better discern the meaning and intent of a requirement, please refer to the text.

A.1 Mandatory

It is mandatory that the 802.16.3 standard support or specify the items in Table 2.

Table 2: Mandatory Requirements

#	Section	Requirement
M1	1	The forthcoming air interface standard MUST comply with the system requirements.
M2	1.1	The 802.16.3 air interface interoperability standard SHALL be part of a family of standards for local, metropolitan and wide area networks.
M3	2	802.16.3 systems SHALL be deployable in multiple-cell frequency reuse systems and single cell (super cell) frequency reuse systems.
M4	2.3	Since all data traffic in a single cell of an 802.16.3 network MUST go through the base station, that station SHALL serve as a radio resource supervisor.
M5	2	The base station radio SHALL be P-MP, radiating its *downstream* signal with a shaped sector or adaptive array (spatial reuse) antenna achieving broad azimuthal beam width to “cover” a prospective number of subscribers.
M6	2.1	The standard SHALL specify MAC layer protocols and PHY transmission techniques suitable for providing access between one or more subscriber stations and base stations to support UNI and CNI requirements.
M7	2.2	The 802.16.3 protocols SHALL support the optional deployment of repeater functions.
M8	2.2	The repeater function SHALL NOT affect the MAC protocol other than the delay which the repeater might introduce into the system.
M9	2.3	In the upstream direction, 802.16.3 protocols MUST provide the means to multiplex traffic from multiple subscriber stations, resolve contention, and allocate capacity.
M10	3	The MAC and PHY protocols will not have explicit support for each and every service, due to the fact that generic data streams SHALL be used for transport.
M11	3	The MAC and PHY protocols SHALL provide for QoS service specific support, resulting in appropriate BER for data services, limited delay for real

		time services, etc.
M12	3.1	802.16.3 systems SHALL support voice communications for subscribers in a way that eases the migration of legacy voice communications equipment and public switched telephone network (PSTN) access technologies to 802.16.3 systems.
M13	3.1	The 802.16.3 voice access transport SHALL be packet based (as opposed to circuit-switched based).
M14	3.2	The 802.16.3 system MUST directly transport variable-length IP datagrams efficiently.
M15	3.2	Both IP versions 4 and 6 MUST be supported.
M16	3.2	The 802.16.3 IP service MUST provide support for real-time and non-real-time service capabilities.
M17	3.4	These services SHALL NOT place any additional requirements on 802.16.3 systems (MAC and PHY protocols) not already covered in the above sections.
M18	4	The IEEE 802.16.3 MAC and PHY protocol stacks SHALL be the same for all the supported services.
M19	4	Further details, and finalization of the protocol reference model, SHALL be worked out by the 802.16.3 MAC and PHY task groups while developing the air interface interoperability standard.
M20	4	Since key layers above the MAC require service guarantees, the MAC protocol MUST define interfaces and procedures to provide guaranteed service to the upper layers.
M21	4	Since customer units will contend for capacity to/from one or more base stations, the MAC protocol MUST efficiently resolve contention and resource allocation.
M22	5.2	802.16.3 protocols SHALL be optimized to support the peak data rate in either or both directions to a subscriber station within the specified distance from the base station.
M23	5.4	The PHY and MAC protocols SHALL provide for multirate support.
M24	5.6	The 802.16.3 specifications SHALL NOT preclude the ability of the radio link to be engineered for different link availabilities, based on the preference of the system operator.
M25	5.6	802.16.3 MAC and PHY protocols MUST accommodate these conditions, perhaps consuming more radio bandwidth and/or requiring smaller radio propagation distance (radius) to meet the availability requirements.
M26	5.6	Since statistical atmospheric and path conditions vary widely in geography, the 802.16.3 protocols MUST be flexible in consumed radio bandwidth (spectral efficiency), cell radius, and transmit power.
M27	5.7	The error rate, after application of the appropriate error correction mechanism (e.g., FEC), delivered by the PHY layer to the MAC layer SHALL meet IEEE 802 functional requirements with the following exception: the radio link bit error ratio (BER) SHALL be $10E^{-6}$ (in accordance with ITU FWA

		recommendations or better.
M28	5.9	The standard SHALL support careful planning to ensure that subscribers' quality of service guarantees and minimum error rates are met.
M29	5.9	The delivered base station capacity can vary depending on attenuation due to atmospheric conditions, LOS blockage, transmit power, etc., and SHALL be calculated as the aggregate capacity of all sectors supported by a base station.
M30	5.9	The MAC and PHY protocols MUST accommodate channel capacity issues and changes in channel capacity to meet contracted service levels with customers.
M31	5.9	As subscribers are added to 802.16.3 systems, the protocols MUST accommodate them in an automated fashion.
M32	6.1	This standard SHALL permit two duplex modes of operation: Frequency Division Duplex (FDD) and Time Division Duplex (TDD).
M33	6.1	The PHY and MAC protocols MUST provide for duplex (i.e. bi-directional) operation, while preserving the QoS, BER and spectral efficiency requirements for data and voice traffic.
M34	6.1	The MAC and PHY protocols MUST provide means to resolve applicable collocation and interference problems.
M35	6.2	The MAC and PHY protocols MUST permit the operation with channel spacing of 1.75, 3.5 and 7MHz when using ETSI masks and 1.5 to 25MHz when using other masks.
M36	7	Table 1 provides a summary of the QoS requirements that the PHY and MAC SHALL provide.
M37	7	802.16.3 protocols MUST support classes of service (CoS) with various quality of service (QoS) guarantees to support the services that an 802.16.3 system MUST transport.
M38	7	Thus, 802.16.3 protocol standards MUST define interfaces and procedures that accommodate the needs of the services with respect to allocation and prioritization of resources.
M39	7	802.16.3 protocols MUST provide the means to enforce QoS contracts and Service Level Agreements.
M40	7	For QoS-based, connectionless services, the 802.16.3 protocols MUST support resource negotiation "on-demand".
M41	7	If 802.16.3 is to be a "link" in the IP network, an IWF MUST interface with 802.16.3 to negotiate resource allocation.
M42	7.2	802.16.3 protocols SHALL define a set of parameters that preserve the intent of QoS parameters for IP-based services.
M43	7.3	The classes of service and QoS parameters of services SHALL be translated into a common set of parameters defined by 802.16.3.
M44	8.1	The 802.16.3 protocols MUST permit operators to enforce service level agreements (SLAs) with subscribers by restricting access to the air link, discarding data, dynamically controlling bandwidth available to a user or other

		appropriate means.
M45	8.1	The 802.16.3 protocols MUST also permit subscribers to monitor performance service levels of the 802.16.3 services being provided at the delivery point.
M46	8.2	When such capabilities are available, the 802.16.3 protocols SHALL support a secure function.
M47	8.2	The operator MUST have means to shut down and reactivate a subscriber station if necessary, remote from the subscriber station, in the face of a malfunction.8.2
M48	8.3	The 802.16.3 system management framework, architecture, protocols and managed objects MUST allow for operators to effectively administer accounting and auditing.
M49	8.3	An operator MUST be able to account for resource utilization and various service features for each subscriber service separately.
M50	9	The 802.16.3 system SHALL enforce security procedures described in this section.
M51	9	The security system chosen by 802.16.3 SHALL be added to the protocol stack and reference points to include security protocols, and “database” servers for authentication, authorization, key management, service suspend/resume, relocation, anti-cloning, etc.
M52	9.1	There are two types of authentication for an 802.16.3 system. In the first type, a subscriber station MUST authenticate itself with the network every time it registers with the network. This authentication MUST prevent unauthorized subscriber station from entering the network or an unauthorized base station from emulating an authorized base station. This type of authentication MUST be supported by the 802.16.3 MAC layer.
M53	9.1	The authentication mechanisms MUST be secure so that an “enemy” subscriber station is not able to gain access to an 802.16.3 system, or to the core network beyond.
M54	9.1	Passwords and secrets MUST NOT be passed “in the clear” through the air interface.
M55	9.2	The 802.16.3 standard SHALL identify a standard set of credentials and allow for vendors to extend the defined credentials with non-standard credentials.
M56	9.2	For each service offered, the 802.16.3 protocols MUST be capable of securely supporting authorization requests and responses.

A.2 Recommended (R)

It is recommended that the 802.16.3 standard support or specify the items in Table 3 “Recommended” means that there may exist valid reasons in particular circumstances to ignore an item, but the full implications should be understood and the case carefully weighed before choosing a different course.

Table 3: Recommended Requirements

#	Section	Requirement
R1	1.1	Other goals of this document are to formulate reference models and terminology for both network topology and protocol stacks that help the 802.16 working group to discuss and develop the MAC and PHY protocols. As far as possible, these SHOULD be common across 802.16 systems.
R2	2.2	The repeater function SHOULD NOT affect the end-to-end operation of 802.16.3 protocols between BS and SS.
R3	3.2	For efficient transport of IPv6, TCP/IP header compression over the air interface SHOULD be supported.
R4	3.2	It SHOULD be possible to support the emerging IP Quality of Service (QoS) efforts: Differentiated Services and Integrated Services.
R5	3.3	The 802.16.3 protocols SHOULD support bridged LAN service capabilities, whether directly or indirectly, including always on, ad hoc and on-demand communication in either or both directions.
R6	4	Note that the function of the MAC protocols SHOULD include error correction by retransmission, or Automatic Repeat Request (ARQ), whereas, in the 802 model, those functions if necessary, are provided by the LLC layer.
R7	5.1	The 802.16.3 protocols SHOULD allow for different “scales” of capacity and performance for 802.16.3 system instances.
R8	5.2	The 802.16.3 MAC protocol SHOULD allow the peak data rate to scale beyond 10 Mbps.
R9	5.3	The PHY and MAC protocol SHOULD provide for far CPEs’ propagation delay compensation.
R10	5.5	802.16.3 protocols SHOULD allow for flexibility between delivered upstream and downstream capacity and CoS/QoS.
R11	5.6	An 802.16.3 system SHOULD be available to transport all services at better than their required maximum error rates (see section 5.7) from about 99.9 to 99.99% of the time, assuming that the system and radios receive adequate mains power 100% of the time and not counting equipment availability.
R12	5.6	802.16.3 MAC and PHY protocols SHOULD specify functions and procedures to adjust transmitter power, modulation, or other parameters to accommodate rapid changes in channel characteristics.
R13	5.9	Given the propagation characteristics in a given frequency band and geographic area, and the development of a link budget, the following parameters of an 802.16.3 system SHOULD be addressed by the MAC and PHY protocols: • Radio range (up to 50 Km) • Upstream/downstream channels’ data rates • Allocation of prospective subscriber data rate to channels. Note: the MAC and PHY standards MAY allow subscribers to hop between channels • Types of modulation

R14	6.2	The typical value [channel spacing] for performance analysis SHOULD be 3.5MHz for the ETSI mask and 3MHz for the MDS mask.
R15	7.3	802.16.3 protocols SHOULD include a mechanism that can support dynamically-variable-bandwidth channels and paths (such as those defined for IP environments).
R16	8	The 802 standards define a framework for LAN/MAN management in ISO/IEC 15802-2: 1995(E). The framework contains guidelines for managed objects, management protocol, and the relationship to ITU management protocols. 802.16.3 protocols SHOULD comply with the above-mentioned standards and guidelines.
R17	8.2	The operator also SHOULD have the means to securely shut down and reactivate a base station remotely.
R18	8.2	The 802.16.3 protocols SHOULD support functions that automatically shuts down transmission from a subscriber station or base station in case of malfunction (e.g., power limits exceeded).
R19	9.3	802.16.3 standards SHOULD allow a suitable cryptographic algorithm to be employed that is internationally applicable.
R20	9.3	Facilities SHOULD also be defined in the protocol for the use of alternate cryptographic algorithms that can be used in certain localities and that can replace algorithms as they are obsoleted or “legalized” for international use.
R21	10	802.16.3 SHOULD strive to fit into the 802 system model.

A.3 Optional (O)

It is optional that the 802.16.3 standard support or specify the items in Table 4.

Table 4: Optional Requirements

#	Section	Requirement
O1	2.1	The model [Figure 2-2: Wireless Access Reference Model] depicts the relevant points between subscriber networks and "core" networks (the networks that MAY be accessed via 802.16.3 air interface).
O2	2.1	A single SS MAY support multiple customer premises networks that transport data, voice and video through one or more UNIs.
O3	2.1	Base stations MAY support multiple core networks through one or more CNIs.
O4	5.9	The MAC and PHY standards MAY allow subscribers to hop between channels.
O5	5.9	Flexible modulation types, power level adjustment, and bandwidth reservation schemes MAY be employed [which affect how the MAC and PHY protocols meet contracted service levels with customers].
O6	7	[To support on-demand resource allocation,] The MAC protocol MAY allocate bursts of PDUs to services that require changes in resource allocation.
O7	7	The 802.16.3 MAC layer interface MAY provide a connection-less service interface that requires a higher-layer "adaptation" to maintain the "state" of a connection and periodically allocate resources.
O8	9.1	The second type of authentication is between the subscriber and the BWA system. This may or may not be the responsibility of the 802.16.3 protocols. It MAY be handled by higher layer protocols.

B Vocabulary of Terms (Normative)

Editor's Note: Some definitions below are as yet undefined. And a few other are as yet incomplete or in-progress. The 802.16.3 task group should provide updates for these definitions and release a new version of this document. The in-progress definitions are *in italics.*

Term	Definition	Reference
Access	End-user connection(s) to core networks NOTE 1 - Core networks include, for example, PSTN, ISDN, PLMN, PSDN, Internet, WAN/LAN, CATV, etc. NOTE 2 - The end-user may be a single user or a user accessing the services on behalf of multiple users.	Based on Rec. ITU-R F.1399
Accounting	A function which apportions the revenue obtained by the service providers to network operators in line with commercial arrangements.	Rec. ITU-R M.1224
Ad hoc communication	Use of the wireless access system without reservation or QoS guarantees at sporadic times, by activating the link when needed.	
Air interface	The common boundary between the subscriber station and the radio equipment in the network, defined by functional characteristics, common radio (physical) interconnection characteristics, and other characteristics, as appropriate. NOTE 1 – An interface standard specifies the bi-directional interconnection between both sides of the interface at once. The specification includes the type, quantity and function of the interconnecting means and the type, form and sequencing order of the signals to be interchanged by those means.	Based on Rec. ITU-R M.1224
Always on communication	Use of the wireless access system at any time by having the link continuously available.	
Authentication	The process of verifying the identity of a user, terminal, or service provider.	Rec. ITU-R M.1224
Authorization	A property by which the rights to resources are established and enforced.	Rec. ITU-R M.1224
Backhaul service	Transport of aggregate communication signals from base stations to the core network.	IEEE 802.16
Bandwidth; communication channel bandwidth	The information payload capacity of a communication channel available to a user for services (expressed in bit/s or multiples thereof).	

Bandwidth; RF channel bandwidth	The frequency extent of a specified portion of the RF spectrum capable of carrying information over the radio interface (expressed in Hz or multiples thereof).	
Bandwidth; transmission channel bandwidth	The frequency extent required for the transmission of a specified signal (expressed in Hz or multiples thereof).	
Base station	The common name for all the radio equipment located at one and the same place used for serving one or several cells. (See also “station”).	ITU-R Rec. M.1224
Bearer service	A type of telecommunication service that provides the capability for the transmission of signals between user-network interfaces.	ITU-T Rec. I.112
Broadband wireless access	wireless access in which the connection(s) capabilities are higher than the primary rate.	Rec. ITU-R F.1399
Cell	The radio coverage area of a base station, or of a subsystem (e.g. sector antenna) of that base station corresponding to a specific logical identification on the radio path, whichever is smaller.	Based on Rec. ITU-R M.1224
Cell	A block of fixed length which is identified by a label at the asynchronous transfer mode layer of the B-ISDN protocol reference model.	ITU-T Rec. I.113
Cell delay variation	A component of cell transfer delay, induced by buffering and cell scheduling.	ATM Forum
	The proportion of lost cells over the total number of transmitted cells for a connection.	ATM Forum
Channel; communication channel	A specific portion of the information payload capacity, available to the user for services.	ITU-T Rec. I.113
Channel; radio-frequency (RF) channel	A specified portion of the RF spectrum with a defined bandwidth and a carrier frequency and is capable of carrying information over the radio interface.	Rec. ITU-R M.1224
Channel; transmission channel	A means of unidirectional transmission of signals between two points.	ITU-T Rec. I.112
Class of Service	This is either a Customer Class of Service, a Trunk Class of Service, or a Private-Facility Class of Service. It may refer to either originating or terminating accesses.	ITU-T Rec. Q.1290 (95), 2
Core network	Core networks include, for example, PSTN, ISDN, PLMN, PSDN, Internet, WAN/LAN, CATV, etc.	Based on Rec. ITU-R F.1399
Customer premises	The equipment/network administered by the user.	Based on ITU-T Rec.

equipment/network		H.310
Downstream	The direction from base station to subscriber station(s).	IEEE 802.16
Dynamically variable bandwidth	A capability of a system to be able to change the bandwidth of the information payload capacity of a communication channel available to a user for services according to negotiated user requirements.	
External Network	Any network that is physically located past the base station or the subscriber station.	
Fixed wireless access	Wireless access application in which the base station and the subscriber station are fixed.	Based on Rec. ITU-R F.1399
Frequency Division Duplex	Separation of upstream and downstream transmission in the frequency domain at the same time.	IEEE 802.16
Internet protocol	Networking protocol defined by IETF standards.	IETF
Interoperability	The ability of multiple entities in different networks or systems to operate together without the need for additional conversion or mapping of states and protocols.	Rec. ITU-R M.1124
Inter-working	The means of supporting communications interactions between entities in different networks or systems.	Rec. ITU-R M.1124
Inter-working function	Mechanism which masks the differences in physical, link, and network technologies by converting or mapping states and protocols into consistent network and user services.	Rec. ITU-R M.1124
Link Budget	The allocation of power within a link. Link budget consists of the difference between Tx power and receiver sensitivity.	
Line-of-sight (LOS)	*A radio communication link for which 60% or greater of the first Fresnel zone is unobstructed.* *(i.e., the geographical region where the rules of free space propagation applies).* *Two points for which the signal suffers temporal fading of less than 10 dB 99% of the time.* *Note: This definition does not imply that a direct optical line of sight exists.*	
Modulation Factor	The sector's aggregate payload bit rate divided by the bandwidth.	
Multi-tenant	A primarily non-commercial building designed to	

dwelling	contain more than two residential units.	
Near LOS	*A radio communication link for which 40% or greater of the first Fresnel zone is obstructed.* *Two points for which the signal suffers temporal fading greater than or equal to 10 dB exceeding 1% of the time and an average delay spread of less than 10 microseconds.*	
Non LOS	*A radio communication link that is obstructed.* *Two points for which the signal suffers an average delay spread of greater than or equal to 10 microseconds.*	
Network	A set of nodes and links that provides connections between two or more defined points to facilitate telecommunication between them.	Rec. ITU-R M.1224
Nomadic wireless access	Wireless access application in which the subscriber station may be in different places but must be stationary while in use.	Based on ITU-R Rec. F.1399
On demand communication	Use of the wireless access system for services based on negotiated QoS.	
Peak Data Rate	The maximum bit rate available to a user for communications.	
plesiochronous mode	A mode where the essential characteristic of time scales or signals such that their corresponding significant instants occur at nominally the same rate, any variation in rate being constrained within specified limits.	ITU-T Rec. G.810 (96), 4.3.5
Point-to-multipoint system	a system that establishes connections between a single specified point and more than one other specified points.	ITU-R Rec. F.1399
Privacy	The provision of capabilities to prevent access of information by unauthorized parties.	ANSI T1.702-1995
Quality of service	The collective effect of service performance which determine the degree of satisfaction of a user of the service. NOTE 1 - The quality of service is characterized by the combined aspects of service support performance, service operability performance, serviceability performance, service security performance and other factors specific to each service. NOTE 2 - The term "quality of service" is not used to express a degree of excellence in a comparative sense nor is it used in a quantitative sense for	ITU-T Rec. E.800 (94), 2101

	technical evaluations. In these cases a qualifying adjective (modifier) should be used.	
Radio interface	See air interface	Rec. ITU-R M.1224
Real-Time (adjective)	Pertaining to the processing or transmission of data according to defined time requirements .	Based on ITU-T Rec. Q.9 (88), 6103
Re-use Factor; Frequency re-use factor	As yet undefined	
Sector	As yet undefined	
Sector Bandwidth Factor	As yet undefined	
Security	The protection of information availability, integrity and confidentiality, as well as authentication and authorization.	Based on Rec. ITU-R M.1224
Semi-stateless	As yet undefined	Sect 7
Service	A set of functions offered to a user by an organization.	Recs. ITU-R M.1224, M.1308
Service Capability	Defines possible service arrangements with respect to the number and type of channels that can be supported by the equipment. In this way a subscriber station access capability is the set of possible channel configurations supported by the equipment. Similarly, the base station access capability may be considered to be a super-set with respect to the subscriber station.	Based on ITU-T Rec. Q.1063 (88), 2.4
Single Residential	A non-commercial building intended to be inhabited by an individual.	
Small Business	As yet undefined	
Small Office/Home Office	As yet undefined	
Spectrum (Spectral) Efficiency	Measures of the accuracy and completeness of system tasks relative to the spectral resources used to achieve the specific system tasks	Based on ITU-T Rec. F.901 (93), 2
Standard	A document established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guideline or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.	ISO/IEC Guide 2, 1996
Station	the common name for all the radio equipment at one and the same place. NOTE - The term "station" may refer to any end-	Rec. ITU-R M.1224

	user radio equipment (“subscriber station”) or network radio equipment (“base station”).	
Subscriber	A person or other entity that has a contractual relationship with a service provider on behalf of one or more users. (A subscriber is responsible for the payment of charges due to that service provider.)	Rec. ITU-R M.1224
Subscriber station	the common name for all the radio equipment at one and the same place serving one or more users. (See also “station”).	Based on Rec. ITU-R M.1224
Supplementary service	A service which modifies or supplements a basic telecommunication service. Consequently, it can not be offered to a customer as a standalone service, rather, it must be offered together with or in association with a basic telecommunication service. The same supplementary service may be common to a number of telecommunication services.	Rec. ITU-R M.1224
Synchronous transfer mode	A transfer mode which offers periodically to each connection a fixed-length block.	Based on ITU-T Rec. I.113
System	A regularly interacting or interdependent group of items forming a unified whole technology.	Recs. ITU-R M.1224, M.1308
Telecommuter	As yet undefined	
Time Division Duplex	Separation of upstream and downstream transmission in the time domain using the same frequency.	IEEE 802.16
Upstream	The direction from subscriber station(s) to base station.	IEEE 802.16
User	Any entity external to the network which utilizes connections through the network for communication.	ITU-T Rec. E.600
Virtual point-to-point connections	Providing a point-to-point connection to a subscriber using a point to multipoint system.	IEEE 802.16
Wireless access	end-user radio connection(s) to core networks. NOTE 1 - Core networks include, for example, PSTN, ISDN, PLMN, PSDN, Internet, WAN/LAN, CATV, etc. NOTE 2 - The end-user may be a single user or a user accessing the services on behalf of multiple users.	Rec. ITU-R F.1399

B.1 Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AF	Assured Forwarding
ANSI	American National Standards Institute
ARQ	Automatic repeat Request
BER	Bit Error Ratio
BES	Best Effort Service
BS	Base Station
BWA	Broadband Wireless Access
CNI	Core Network Interface
CoS	Class of Service
CSMA/CD	Carrier Sense multiple Access with Collision Detection
DFM	Dispersive Fade Margin
DSL	Digital Subscriber Line
EF	Expedited Forwarding
ER	Errored Block
ETSI	European Telecommunications Standard Institute
FCAPS	Fault, Configuration, Accounting, Performance, Security Management
FDD	Frequency Division Duplex
FEC	Forward Error Correction
FWA	Fixed Wireless Access
HFC	Hybrid fiber coax
HTTP	Hypertext Transfer Protocol
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IP	Internet protocol
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU-R	International Telecommunications Union- Radiocommunications Sector
IWF	Inter-working function
JRG	Joint Rapporteur group
LAN	Local area network
LLC	Logical link control
LOS	Line of Sight
MAC	Medium Access Control
MAN	Metropolitan area network
MGMT	Management
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PHY	Physical layer
PMD	Physical Medium Dependent
P-MP	Point-to-multipoint
PSTN	Public Switched Telephone Network
QoS	Quality of service
RF	Repeater Function
SDE	Secure Data Exchange
SEC	Security
SES	Severely Errored Second
SLA	Service Level Agreement
SME	Small and Medium Enterprises
SNMP	Simple Network Management Protocol
SOHO	Small Office/Home Office
SS	Subscriber Station
TC	Transmission convergence
TCP/IP	Transmission Control Protocol/Internet Protocol

TDD	Time Division Duplex
UNI	User Network interface
VoIP	Voice over IP
WEP	Wire-Equivalent Privacy

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