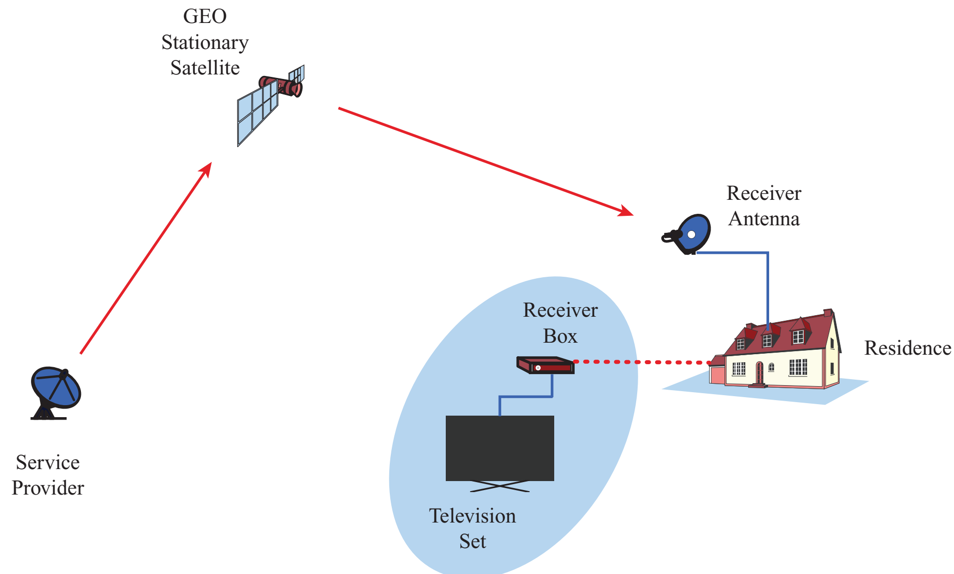


Figure 16.17 Direct Broadcast Satellite

16.4 FIXED BROADBAND WIRELESS ACCESS

Traditionally, the provision of voice and data communications to the end user, over the local loop, or subscriber loop, has been provided by wired systems. As the demand for broadband Internet access has grown, providers of wired local loop service have responded with increasing reliance on optical fiber and coaxial cable.

However, increasing interest is being shown in competing wireless technologies for subscriber access. These approaches are generally referred to as ***wireless local loop (WLL)***, or ***fixed wireless access***. The most prominent **fixed broadband wireless access** (fixed BWA) system is referred to as WiMAX, based on the IEEE 802.16 standard. We examine WiMAX in the next section. In this section, we provide an overview of the concept of fixed BWA.

Figure 16.18 illustrates a simple fixed BWA configuration. A BWA provider services one or more cells. Each cell includes a base station (BS) antenna, mounted on top of a tall building or tower. In earlier systems, subscribers used a fixed antenna mounted on a building or pole that has an unobstructed line of sight to the BS antenna. The technology has evolved so that indoor wireless access points are possible. From the BS, there is a link, which may either be wired or wireless, to a switching center. The switching center is typically a telephone company local office, which provides connections to the local and long-distance telephone networks. An Internet service provider (ISP) may be collocated at the switch or connected to the switch by a high-speed link.

Figure 16.18 shows what amounts to a two-level hierarchy. More complex configurations have also been implemented, in which a BS may serve a number of subordinate BS antennas, each of which supports a number of subscribers.

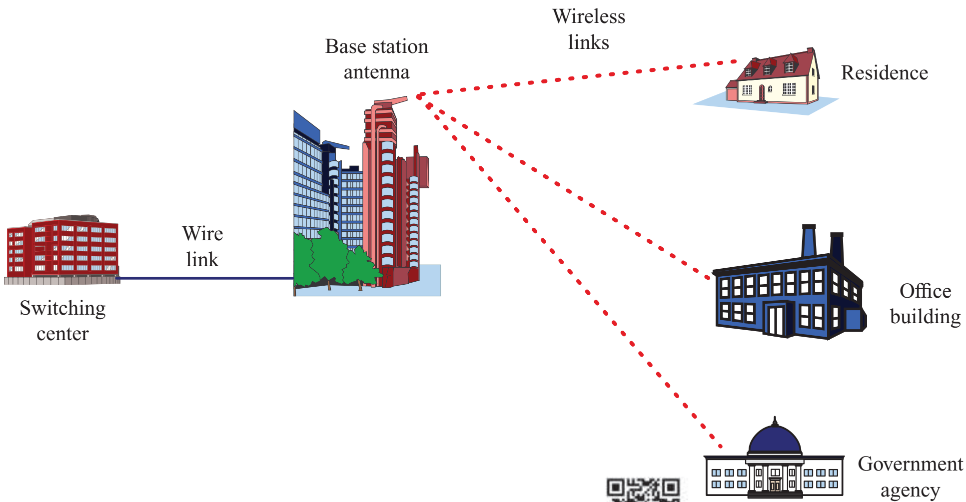


Figure 16.18 Fixed Broadband Wireless Configuration

The fixed BWA has a number of advantages over a wired approach to subscriber loop support:

- **Cost:** Wireless systems are less expensive than wired systems. Although the electronics of the wireless transmitter/receiver may be more expensive than those used for wired communications, with BWA the cost of installing kilometers of cable, either underground or on poles, is avoided, as well as the cost of maintaining the wired infrastructure.
- **Installation time:** BWA systems typically can be installed rapidly. The key stumbling blocks are obtaining permission to use a given frequency band and finding a suitable elevated site for the BS antennas. Once these hurdles are cleared, a BWA system can be installed in a small fraction of the time required for a new wired system.
- **Selective installation:** Radio units are installed only for those subscribers who want the service at a given time. With a wired system, typically cable is laid out in anticipation of serving every subscriber in a local area.

BWA needs to be evaluated with respect to two alternatives:

- **Wired scheme using existing installed cable:** A large fraction of the earth's inhabitants do not have a telephone line. For high-speed applications, many subscribers with telephone lines do not have a line of sufficient quality or are too far from the central office to effectively use Digital Subscriber Line (DSL). Many of these same subscribers also do not have cable TV or their cable provider does not offer two-way data services. Finally, because WLL has become cost-competitive with wired schemes, new installations face a genuine choice between the wired and wireless approaches.
- **Mobile cellular technology:** 4G cellular systems provide broadband support. The primary advantages of a fixed BWA scheme are that the fixed BWA BS can cover a larger area, and that higher data rates can be achieved.

16.5 WIMAX/IEEE 802.16

With the growing interest in BWA services, a need was recognized within the industry to develop standards for this service. In response to this need the IEEE 802 committee set up the 802.16 working group in 1999 to develop broadband wireless standards. The charter for the group was to develop standards that:

- Use wireless links with microwave or millimeter wave radios.
- Use licensed spectrum (typically).
- Are metropolitan in scale.
- Provide public network service to fee-paying customers (typically).
- Use PMP architecture with stationary rooftop or tower-mounted antennas.
- Provide efficient transport of heterogeneous traffic supporting quality of service (QoS).
- Are capable of broadband transmissions (>2 Mbps).

In essence, **IEEE 802.16** standardizes the air interface and related functions associated with BWA. In addition, an industry group, the **WiMAX** (Worldwide Interoperability for Microwave Access) Forum, was formed to promote the 802.16 standards and to develop interoperability specifications. Initially targeted at fixed BWA, IEEE 802.16 and the associated WiMAX specification now deal with both fixed and mobile BWA. In this section, we provide an overview of the 802.16 and WiMAX specifications, with an emphasis on the fixed BWA application. This section is based on the 2012 version of IEEE 802.16.

IEEE 802.16 Architecture

Network Reference Model The WiMAX Forum has developed a logical representation of the architecture of a network that implements WiMAX, called the network reference model [WIMA12]. The model is useful in determining interface points between logical functional entities that can be used as a guide for developing interoperability standards. Figure 16.19 illustrates key elements of this model, which include the following:

- **Access Service Network (ASN):** The set of network functions needed to provide radio access to WiMAX subscribers.
- **Network Access Provider (NAP):** A business entity that provides WiMAX radio access infrastructure to one or more WiMAX Network Service Providers.
- **Connectivity Service Network (CSN):** A set of network functions that provide IP connectivity services to WiMAX subscribers. These functions include Internet access, authentication, and admission control based on user profiles.
- **Network Service Provider (NSP):** A business entity that provides IP connectivity and WiMAX services to WiMAX subscribers.
- **ASN Gateway:** Provides connectivity from an ASN to an NSP. The gateway performs such functions as routing and load balancing.

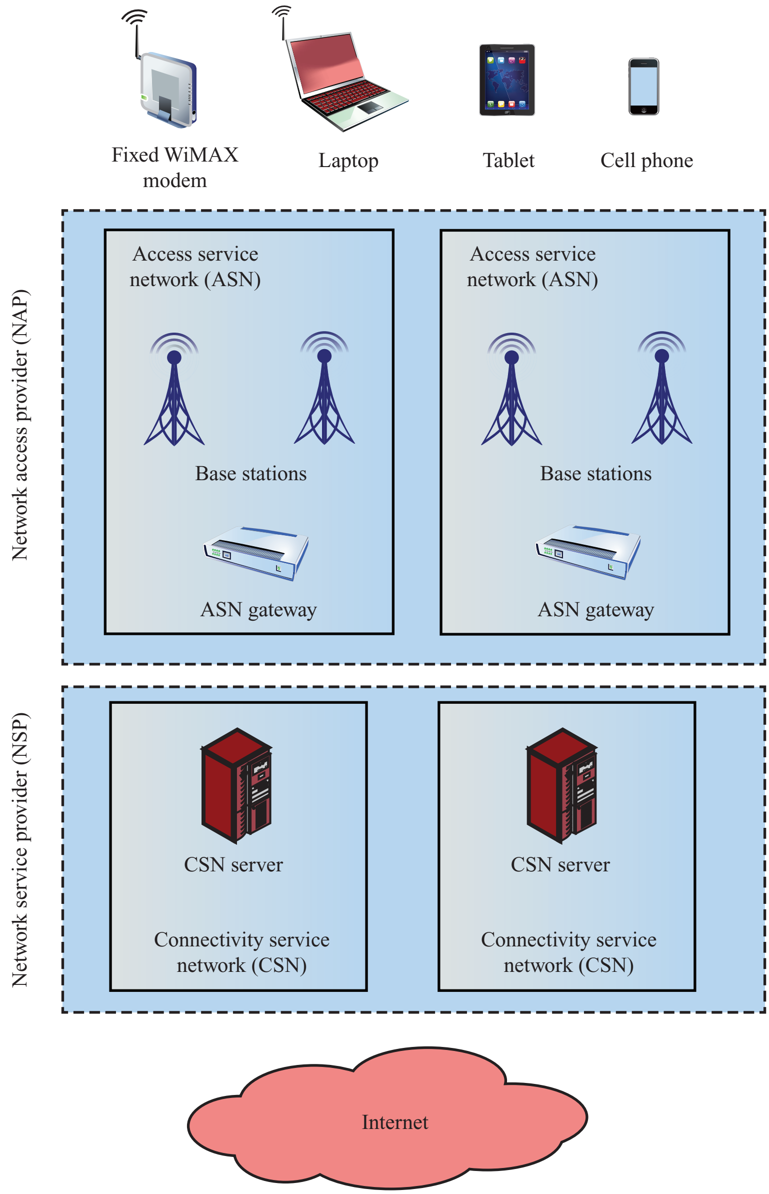


Figure 16.19 Elements of the WiMAX Network Reference Model

The network architecture logically divides into three parts: subscriber stations (SSs), the access service network, and the connectivity service networks. Subscribers may be fixed or mobile. Fixed subscribers are at a fixed geographic location and connect using a fixed WiMAX modem for broadband access. Fixed locations include residential, business, and government entities. An ASN consists of one or more BSs that are interconnected by a core network and connect to an ASN gateway. The gateway connects to one or more CSNs, which provide broadband access to the Internet. IEEE 802.16 standards are concerned with the air interface between the subscriber's transceiver station and the base transceiver station. The standards specify all the details of that interface, as discussed subsequently in this section. The system reference model also shows interfaces between the transceiver stations and the networks behind them. The details of these interfaces are beyond the scope of the 802.16 standards. The reason for showing these interfaces in the system reference model is that the subscriber and core network technologies (such as voice, ATM, etc.) have an impact on the technologies used in the air interface and the services provided by the transceiver stations over the air interface.

Protocol Architecture Figure 16.20 illustrates the IEEE 802.16 protocol reference model. The ***physical layer*** includes the following:

- Encoding/decoding of signals
- Preamble generation/removal (for synchronization)
- Bit transmission/reception
- Frequency band and bandwidth allocation

The medium access control (MAC) layer is divided into three sublayers. The ***security sublayer*** includes authentication, secure key exchange, and encryption. Note that this sublayer is concerned with secure communication between the SS and the ASN base station. Secure communication between the SS and the CSN is handled at a higher layer.

The ***MAC common part sublayer*** includes the basic functions of any MAC layer:

- On transmission, assemble data into a protocol data unit (PDU) with address and error detection fields.
- On reception, disassemble PDU, and perform address recognition and error detection.
- Govern access to the wireless transmission medium.

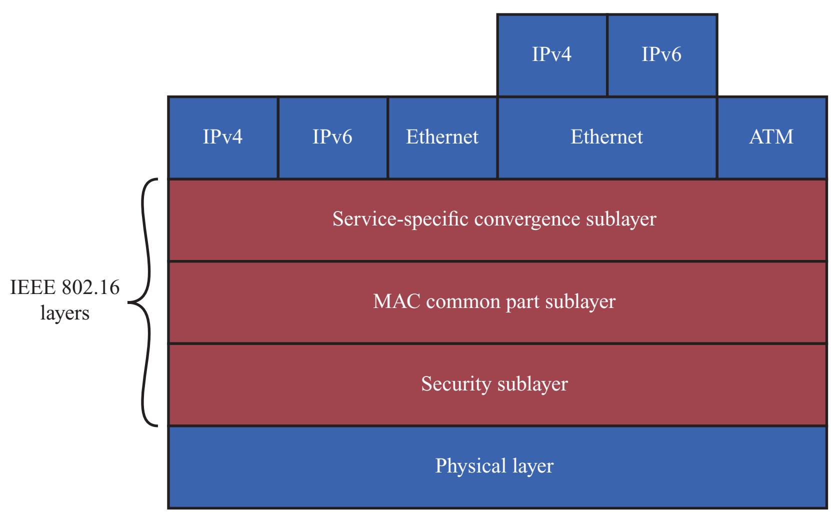


Figure 16.20 IEEE 802.16 Protocol Architecture

This sublayer, between the BS and the SS, is responsible for sharing access to the radio channel. Specifically, the MAC protocol defines how and when a BS or SS may initiate transmission on the channel. Because some of the layers above the MAC layer, such as ATM, require specified service levels (QoS), the MAC protocol must be able to allocate radio channel capacity so as to satisfy service demands. In the downstream direction (BS to SS), there is only one transmitter and the MAC protocol is relatively simple. In the upstream direction, multiple SSs are competing for access, resulting in a more complex MAC protocol.

The service-specific convergence sublayer provides functions specific to the service being provided. A convergence layer protocol may do the following:

- Encapsulate PDU framing of upper layers into the native 802.16 MAC PDUs.
- Map an upper layer's addresses into 802.16 addresses.
- Translate upper layer QoS parameters into native 802.16 MAC format.
- Adapt the time dependencies of the upper layer traffic into the equivalent MAC service.

IEEE 802.16 MAC Layer

Data transmitted over the 802.16 air interface from or to a given subscriber are structured as a sequence of MAC PDUs. The term **MAC PDU** as used in this context refers to the PDU that includes MAC protocol control information and higher-level data. This is not to be confused with a ***TDMA burst***, which consists of a sequence of time slots, each dedicated to a given subscriber. A TDMA time slot may contain exactly one MAC PDU, a fraction of a MAC PDU, or multiple MAC PDUs. The sequence of time slots across multiple TDMA bursts that is dedicated to one subscriber forms a logical channel, and MAC PDUs are transmitted over that logical channel.

Connections and Service Flow The 802.16 MAC protocol is connection oriented. That is, a logical connection is set up between peer entities (MAC users) prior to the exchange of data between those entities. Each MAC PDU includes a connection ID, which is used by the MAC protocol to deliver incoming data to the correct MAC user. In addition, there is a one-to-one correspondence between a connection ID and service flow. The service flow defines the QoS parameters for the PDUs that are exchanged on the connection.

The concept of a service flow on a connection is central to the operation of the MAC protocol. Service flows provide a mechanism for upstream and downstream QoS management. In particular, they are integral to the bandwidth allocation process. The BS allocates both upstream and downstream bandwidth on the basis of the service flow for each active connection. Examples of service flow parameters are latency (maximum acceptable delay), jitter (maximum acceptable delay variation), and throughput (minimum acceptable bit rate).

PDU Format A good way to get a grasp of the MAC protocol is to examine the PDU format (Figure 16.21). The MAC PDU consists of three sections:

- **Header:** Contains protocol control information needed for the functioning of the MAC protocol.

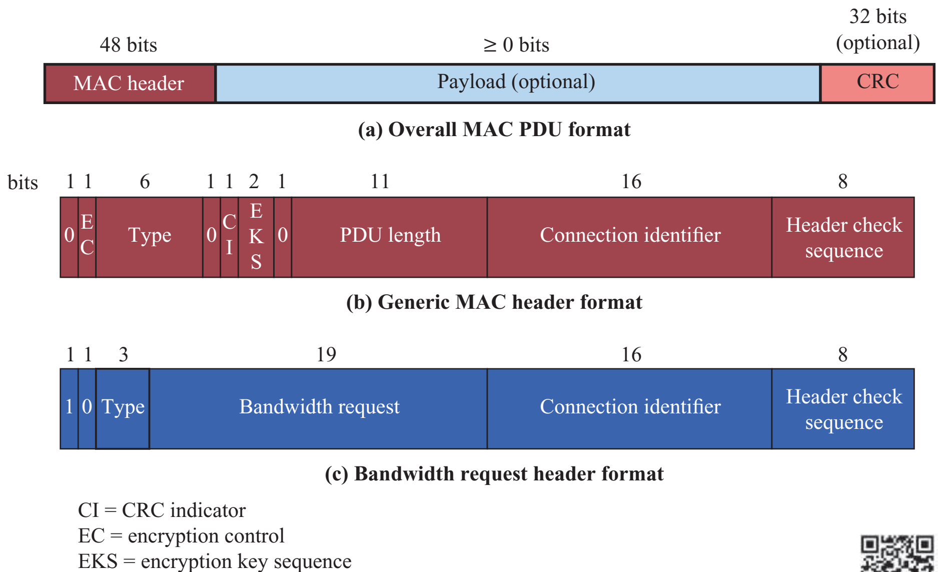


Figure 16.21 IEEE 802.16 MAC PDU Formats

- **Payload:** The payload may be either higher-level data (e.g., an ATM cell, an IP packet, a block of digital speech) or a MAC control message.
- **CRC:** The cyclic redundancy check field contains an error-detecting code. This optional CRC covers both the header and the payload and is applied after the payload is encrypted, if encryption is used.

Two types of headers are defined: the generic MAC header and the bandwidth request header. The ***generic MAC header*** is used in both the downlink (BS to SS) and uplink (SS to BS) directions. A MAC PDU with a generic header contains either MAC management messages or convergence sublayer data. The generic MAC header consists of the following fields:

- **Header type (1 bit):** This bit is set to zero indicating the header type is generic MAC PDU.
- **Encryption control (1 bit):** Indicates whether the payload is encrypted.
- **Type (6 bits):** Indicates the subheaders and special payload types present in the message payload.
- **Reserved (1 bit):** Reserved bit, set to zero.
- **CRC indicator (1 bit):** Indicates whether there is a 32-bit CRC after the payload.
- **Encryption key sequence (2 bits):** An index into a vector of encryption key information, to be used if the payload is encrypted.
- **Reserved (1 bit):** Reserved bit, set to zero.
- **PDU length (11 bits):** Length in bytes of the entire MAC PDU.

- **Connection identifier (16 bits):** A unidirectional, MAC-layer address that identifies a connection to equivalent peers in the subscriber and base station MAC. A CID maps to an SFID, which defines the QoS parameters to the service flow associated with that connection.
- **Header check sequence (8 bits):** An 8-bit CRC used to detect errors in the header.

The type field contains bits that indicate the presence or absence of each of the following subheaders at the beginning of the payload:

- **Fragmentation subheader:** Fragmentation is used to divide a higher-level block of data [called a service data unit (SDU)] into two or more fragments in order to reduce the size of MAC frames. This is done to allow efficient use of available bandwidth relative to the QoS requirements of a connection's service flow. If fragmentation is used, then all of the fragments are assigned the same fragment sequence number (FSN) in the fragmentation subheader. The MAC user at the destination is responsible for reassembling all of the fragments with the same FSN.
- **Packing subheader:** Packing is the process in which multiple MAC SDUs are packed into a single MAC PDU payload. This subheader contains the information needed for the receiving MAC entity to unpack the individual SDUs.
- **Fast feedback allocation subheader:** Only used in the downlink direction. It requests feedback from a SS with an advanced antenna system.
- **Grant management subheader:** Only used in the uplink direction. It conveys various information related to bandwidth management, such as polling request and additional-bandwidth request.

The ***bandwidth request header*** is used by the subscriber to request additional bandwidth. This header is for a MAC frame with no payload. As shown in Figure 16.21, this header includes many of the fields in the generic MAC header. The 19-bit bandwidth request field indicates the number of bytes of capacity requested for uplink transmission. The type field allows the SS to request bandwidth for this connection only or aggregate bandwidth for all connections on this uplink.

Scheduling Service and QOS An IEEE 802.16 network is designed to be able to transfer many different types of traffic simultaneously, including real-time flows such as voice, video, and bursty TCP flows. Although each such traffic flow is handled as a stream of PDUs traveling through a connection, the way in which each data flow is handled by the BS depends on the characteristics of the traffic flow and the requirements of the application. For example, real-time video traffic must be delivered within minimum variation in delay. See Section 3.5 for more discussion on traffic types and QoS requirements.

To accommodate the requirements of different types of traffic, IEEE 802.16 defines a number of different service classes. Each class is defined by certain general characteristics and a particular service flow is defined by assigning values to a set of QoS parameters. The most important of these parameters are the following:

- **Maximum sustained traffic rate:** The peak information rate, in bits per second of the service. The rate pertains to the SDUs at the input to the system. The parameter is 6 bits in length and includes values in the range from 1200 bps to 1.921 Mbps.
- **Minimum reserved traffic rate:** The minimum rate, in bits per second, reserved for this service flow. The BS shall be able to satisfy bandwidth requests for a connection up to its minimum reserved traffic rate. If less bandwidth than its minimum reserved traffic rate is requested for a connection, the BS may reallocate the excess reserved bandwidth for other purposes. Values range from 1200 bps to 1.921 Mbps.
- **Maximum latency:** The maximum interval between the reception of a packet at the convergence sublayer of the BS or the SS and the forwarding of the SDU to its air interface. Values range from 1 ms to 10 s.
- **Tolerated jitter:** The maximum delay variation (jitter) for the connection. Values range from 1 ms to 10 s.
- **Traffic priority:** The priority of the associated service flow. Given two service flows identical in all QoS parameters besides priority, the higher-priority service flow should be given lower delay and higher buffering preference. For otherwise nonidentical service flows, the priority parameter should not take precedence over any conflicting service flow QoS parameter. Eight priority levels are used.

Table 16.4 lists the principal QoS parameters used for each of the five service classes defined in IEEE 802.16. The standard designates separate uplink and downlink services. Corresponding services use the same QoS parameter set. The principal

Table 16.4 IEEE 802.16 Service Classes and QoS Parameters

Scheduling Service (uplink)	Data Delivery Service (downlink)	Applications	QoS Parameters
Unsolicited grant service (UGS)	Unsolicited grant service (UGS)	VoIP	• Minimum reserved traffic rate • Maximum latency • Tolerated jitter
Real-time polling service (rtPS)	Real-time variable-rate (RT-VR) service	Streaming audio or video	• Minimum reserved traffic rate • Maximum sustained traffic rate • Maximum latency • Traffic priority
Non-real-time polling service (nrtPS)	Non-real-time variable-rate (NRT-VR) service	FTP	• Minimum reserved traffic rate • Maximum sustained traffic rate • Traffic priority
Best effort (BE) service	Best effort (BE) service	Data transfer, Web browsing, etc.	• Maximum sustained traffic rate • Traffic priority
Extended rtPS	Extended real-time variable-rate service (ERT-VR)	VoIP (voice with activity detection)	• Minimum reserved traffic rate • Maximum sustained traffic rate • Maximum latency • Tolerted jitter • Traffic priority

difference is that for two of the service classes, polling is involved in the uplink transmission. Downlink transmission from the BS does not use polling, as there is a single transmitter, the BS.

The **unsolicited grant service (UGS)** is intended for real-time applications that generate fixed-rate data. A service flow with a data delivery service of UGS gets uplink resources assigned at uniform periodic intervals without requesting them each time (Figure 16.22). UGS is commonly used for uncompressed audio and video information. On the downlink, the BS generates fixed-rate data as a uniform stream of PDUs. Examples of UGS applications include videoconferencing and distance learning.

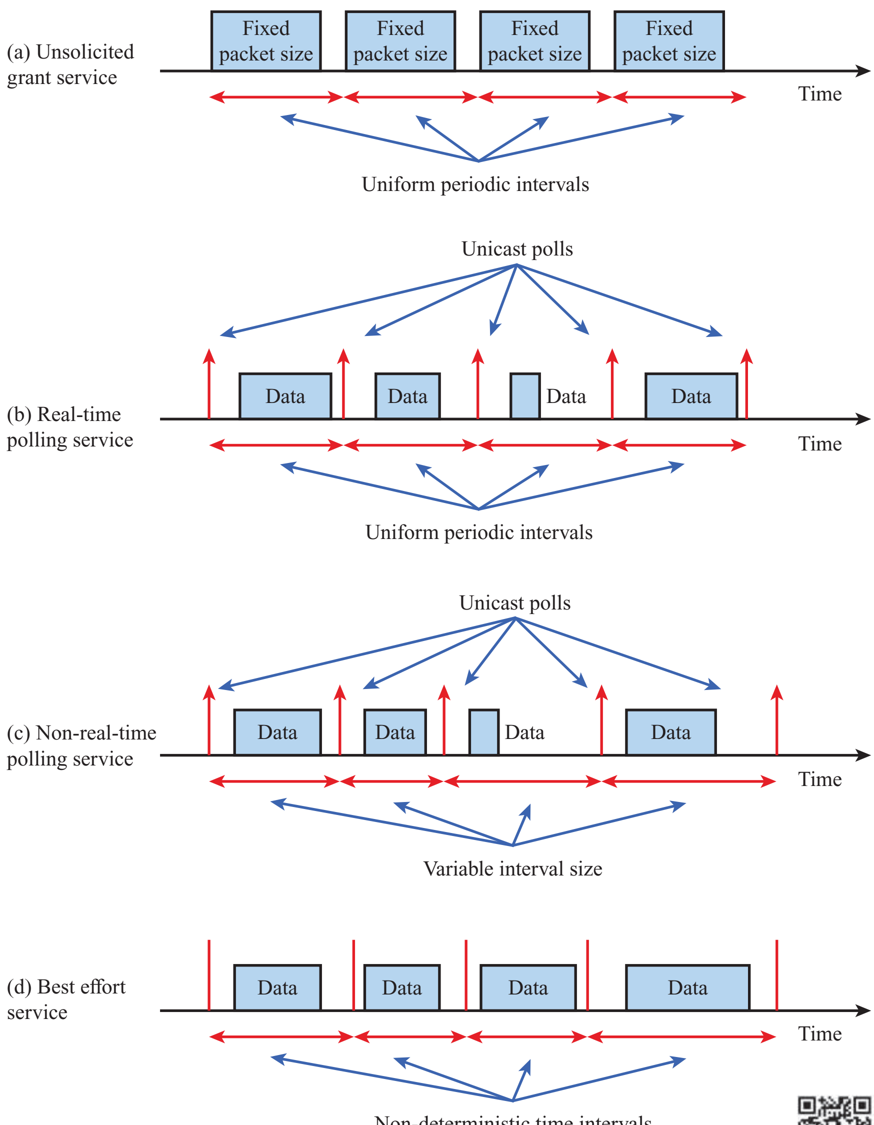


Figure 16.22 IEEE 802.16 Services

The **real-time variable rate (RT-VR)** downlink service is intended for time-sensitive applications, that is, those requiring tightly constrained delay and delay variation. The principal difference between applications appropriate for RT-VR and those appropriate for UGS is that RT-VR applications transmit at a rate that varies with time. For example, the standard approach to video compression results in a sequence of image frames of varying sizes. Because real-time video requires a uniform frame transmission rate, the actual data rate varies. On the downlink, RT-VR is implemented by transmitting the available data at uniform periodic intervals. On the uplink, the service is called **real-time polling service (rtPS)**. The BS issues a unicast poll (poll directed at a SS station) at periodic intervals, enabling the SS to transmit a block of data in each interval (Figure 16.22b). The RT-VR/rtPS service allows the network more flexibility than UGS. The network is able to statistically multiplex a number of connections over the same dedicated capacity and still provide the required service to each connection.

The ***extended real-time variable rate (ERT-VR)*** service is to support real-time applications with variable data rates, which require guaranteed data and delay, for example, VoIP with silence suppression. On the uplink, this service is called ***extended rtPS***. As with UGS, the BS provides unicast grants of bandwidth in an unsolicited manner, thus saving the latency of a bandwidth request. However, in this case the allocations are variable in size, based on the amount of traffic so far carried. On the downlink side, the BS transmits PDUs over the service flow in varying sizes and at varying intervals, to keep up with the service flow QoS.

The **non-real-time variable-rate (NRT-VR)** service is intended for applications that have bursty traffic characteristics, do not have tight constraints on delay and delay variation, but for which it is possible to characterize the expected traffic flow and therefore set QoS parameters. An example is file transfer. On the downlink, the BS transmits data at variable intervals, to satisfy the minimum and maximum data rate requirements of the service flow. On the uplink, the service is called **non-real-time polling service (nrtPS)**. The BS issues polls at varying intervals, depending on how much data has so far been transferred, so as to keep up with the required flow (Figure 16.22c).

At any given time, a certain amount of capacity between the BS and SSs is unused by the four classes of service so far discussed. This capacity is available for the **best effort (BE)** service. This service is suitable for applications that can tolerate variable delays and rates. Most applications running over TCP exhibit such tolerance. On the uplink, the SS sends requests for bandwidth in either random access slots (time slots in which SSs contend for access) or using dedicated transmission opportunities.

IEEE 802.16 Physical Layer

The IEEE 802.16 physical layer set of standards is still evolving, but is sufficiently stable to form the basis of widespread WiMAX implementation and deployment. The 2012 standard devotes almost 600 pages to the physical layer specification. Here we provide a brief overview.

The 802.16 specification defines three principal air interfaces, summarized in Table 16.5. All of these operate in licensed frequency bands. In addition, there are modifications to these specifications for operation in unlicensed bands below 11 GHz.

Table 16.5 IEEE 802.16 Physical Layer Modes

	WirelessMAN-SC	WirelessMAN-OFDM	WirelessMAN-OFDMA
Frequency band	10 to 66 GHz	≤ 11 GHz	≤ 11 GHz
LOS limitation	LOS	NLOS	NLOS
Duplexing technique	TDD, FDD	TDD, FDD	TDD, FDD
Uplink access	TDMA, DAMA	OFDM	OFDMA
Downlink access	TDM, TDMA	OFDM	OFDMA
Downlink modulation	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM, BPSK	QPSK, 16-QAM, 64-QAM, BPSK
Uplink modulation	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM, BPSK	QPSK, 16-QAM, 64-QAM, BPSK
Channel size	20 to 28 MHz	1.75 to 20 MHZ	1.25 to 20 MHZ
Subcarrier spacing	N/A	11.16 kHz	11.16 kHz
Data rate	32 to 134 Mbps	≤ 70 Mbps	≤ 70 Mbps
Downlink FEC	Reed-Solomon	Reed-Solomon	Convolutional
Uplink FEC	Reed-Solomon	Reed-Solomon	Convolutional

WirelessMAN-SC The ***WirelessMAN-SC*** interface is intended for use in the 10–66 GHz bands. In this region, due to the short wavelength, line of sight (LOS) is required and multipath is negligible. This environment is well suited for PMP access serving applications from small office/home office (SOHO) through medium- to large-office applications. Thus, this standard is suited for fixed wireless broadband access but does not support mobile stations.

Uplink transmission, from SSs, is based on a combination of **time-division multiple access (TDMA)** and ***demand-assignment multiple access (DAMA)***. TDMA employs a single, relatively large, uplink frequency band that is used to transmit a sequence of time slots. Repetitive time slots are assigned to an individual subscriber station to form a logical subchannel. When DAMA is employed, the time-slot assignment is changed as needed to respond optimally to demand changes among the multiple stations.

Downlink transmission from the BS is TDM, with the information for each SS multiplexed onto a single stream of data and received by all SSs within the same sector. To support SSs that operate in a half-duplex mode with frequency-division duplex (FDD), the standard makes provision for a TDMA portion of the downlink. With TDMA, the downlink time slots are scheduled to coordinate the interchange with specific SSs.

WirelessMAN-OFDM The ***WirelessMAN-OFDM*** interface operates below 11 GHz. In this region, due to the short wavelength, LOS is not necessary and multipath may be significant. The ability to support near-LOS and non-LOS (NLOS) scenarios requires additional physical-layer functionality, such as the support of advanced power management techniques, interference mitigation/coexistence, and MIMO antennas. Both uplink and downlink transmission use OFDM. Both

Table 16.6 Data Rates Achieved at Various WirelessMAN-OFDM Bandwidths

Modulation	**QPSK**	**QPSK**	**16-QAM**	**16-QAM**	**64-QAM**	**64-QAM**
Code Rate	**1/2**	**3/4**	**1/2**	**3/4**	**2/3**	**3/4**
1.75 MHz	1.04	2.18	2.91	4.36	5.94	6.55
3.5 MHz	2.08	4.37	5.82	8.73	11.88	13.09
7.0 MHz	4.15	8.73	11.64	17.45	23.75	26.18
10.0 MHz	8.31	12.47	16.63	24.94	33.25	37.40
20.0 MHz	16.62	24.94	33.25	49.87	66.49	74.81

WirelessMAN-OFDM and WirelessMAN-OFDMA are suitable for an environment that includes mobile SSs.

WirelessMAN-OFDM supports a range of channel bandwidths. Table 16.6 shows likely data rates achievable for various bandwidths.

WirelessMAN-OFDMA ***WirelessMAN-OFDMA*** is an enhanced version of WirelessMAN-OFDM that provides added flexibility and efficiency by the use of OFDMA. Figure 16.23 is an example of how WirelessMAN-OFDMA operates using time-division duplex (TDD). Transmission is structured as a sequence of frames, each of which includes a downlink (DL) subframe followed by an uplink (UL) subframe. In each frame, a time gap is inserted between the DL and UL subframes and at the end of each frame to allow for transmission turnaround. Each DL subframe begins with a preamble used to synchronize all stations. This is followed by a DL-MAP pattern, which indicates how all of the subchannels are allocated in the DL

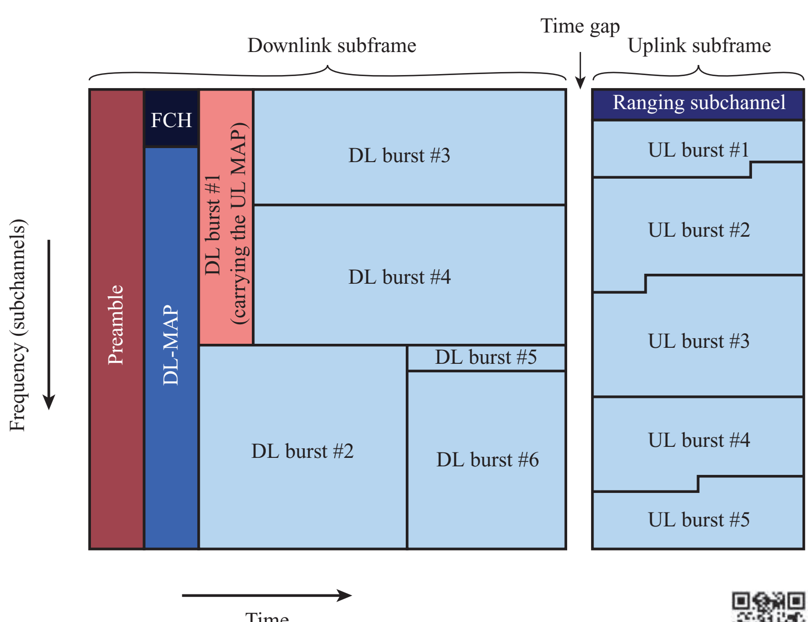
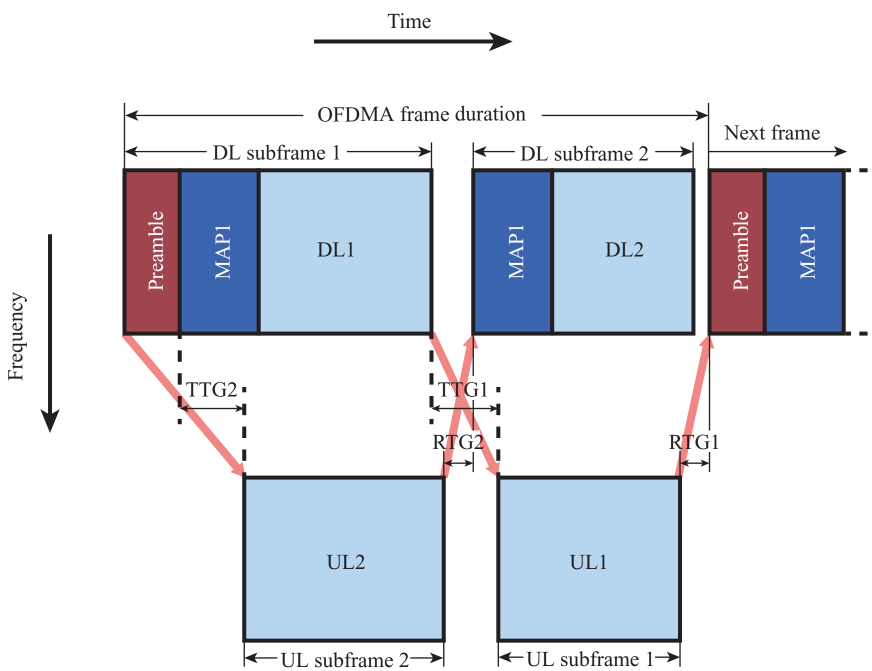


Figure 16.23 IEEE 802.16 OFDMA Frame Structure in TDD Mode

subframe and a frame control header (FCH). The FCH provides frame configuration information, such as the MAP message length, the modulation and coding scheme, and the usable subcarriers. The remainder of the DL subframe is divided into bursts, with each burst occupying a contiguous set of subchannels for a contiguous set of time intervals. One of these bursts is the UL-MAP pattern. The remaining bursts contain data, each burst intended for a specific SS. The UL subframe is similarly divided into bursts. One of these bursts is the ranging subchannel, which is allocated for SSs to perform closed-loop time, frequency, and power adjustment as well as bandwidth requests. The remaining bursts are allocated to SSs for transmission to the BS.

TDD, by its structure, readily supports half-duplex transmission, because UL and DL transmissions must alternate in time. This is not the case with FDD. Figure 16.24 shows how the structure of FDD WirelessMAN-OFDMA supports half-duplex operation. The FDD frame structure supports both full-duplex and half-duplex SS types. The frame structure supports a coordinated transmission arrangement of two groups of half-duplex SSs (Group-1 and Group-2) that share the frame at distinct partitions of the frame. In each frame, one portion of the frequency band is devoted to DL transmission and one portion to UL transmission. The DL transmission consists of two subframes, the first for Group-1 and the second for Group-2. The UL transmission consists of a Group-2 subframe followed by a Group-1 subframe. Time gaps are inserted between subframes to enable both turnaround and half-duplex operation.



TTG = transmitter-to-receiver gap
RTG = receiver-to-transmitter gap

Figure 16.24 IEEE 802.16 OFDMA Frame Structure in FDD Mode