# OFDMA Broadband Mobile Wireless Access System (WiMAX™ applied in Japan)

# ARIB STANDARD

## ARIB STD-T94 Version 2.0


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Association of Radio Industries and Businesses

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# Preface

## INTRODUCTION

Association of Radio Industries and Businesses (hereinafter ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of “technical standard (ARIB STD)”. These standards are being developed with the participation of, and through discussions amongst various radio equipment manufacturers, operators and users.

ARIB standards include “government technical standards” (mandatory standards) that are set for the purpose of encouraging effective use of frequency resources and preventing interference, and “private technical standards” (voluntary standards) that are defined in order to guarantee compatibility between radio facilities, to secure adequate transmission quality as well as to offer greater convenience to radio equipment manufacturers and users, etc.

An ARIB STANDARD herein is published as "OFDMA Broadband Mobile Wireless Access System (WiMAX™ applied in Japan)". In order to ensure fairness and transparency in the defining stage, the standard was set by consensus of the standard council with participation of interested parties including radio equipment manufacturers, telecommunication operators, broadcasters, testing organizations, general users, etc. with impartiality.

ARIB sincerely hopes that this standard be utilized actively by radio equipment manufacturers, telecommunications operators, and users, etc.

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# Chapter 1 General Descriptions

## 1.1 Outline

This standard specifies requirements of the radio equipment of radio stations stipulated in the Ministry of Internal Affair and Communications (MIC) Ordinance Regulating Radio Equipment, Article 49.28 (this refers to the radio equipment of radio stations of OFDMA Broadband Mobile Wireless Access System) using 2.5 GHz band with 5 ms of transmission burst repetition period. It also specifies the radio communication for OFDMA Broadband Mobile Wireless Access System using 2.5 GHz band with 5 ms of transmission burst repetition period (hereinafter referred to as "Mobile WiMAX™ System") defined as the technology for personal wireless broadband services based on all-IP core network.

The standard shall be in accordance with MIC Ordinance Regulating Radio Equipment, Article 49.28 (including related notifications) when the Mobile WiMAX facilities are used in Japan. The system shall also conform to the WiMAX™ mobile System Profile and the WiMAX End-to-End Network Systems Architecture specified by WiMAX Forum®. It should be noted that the mobile System Profile refers to IEEE802.16 for the specifications of physical layer and MAC layer.

## 1.2 Scope of the Standard

The Mobile WiMAX network consists of Mobile Station (MS), Access Service Network (ASN) and Connectivity Service Network (CSN), and the scope of the standard is shown in Figure 1-1.

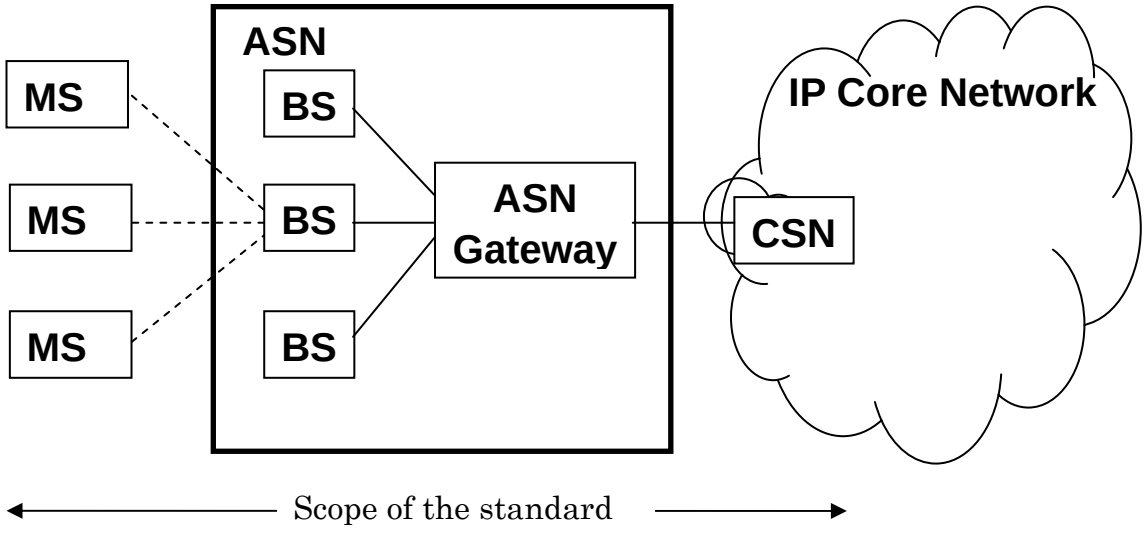


**Figure 1-1 Configuration of Mobile WiMAX Network**

MS is used by the end users to access the network. ASN comprises Base Stations (BS) and ASN gateways. BS is responsible for providing the air interface to the MS, while ASN gateway typically acts as layer 2 traffic aggregation within an ASN. CSN provides IP connectivity and all IP core network functions.

This standard defines the minimum level of specifications required for connection and services for the Mobile WiMAX system. This consists of three different specifications, i.e., Japanese regulatory specifications applied for radio systems, Physical and MAC layers specifications and Upper layers specifications. The Japanese regulatory specifications are developed by national regulatory administration, i.e. MIC. The physical and MAC layers specifications and the Upper layers specifications are developed by international standardization organization, i.e. IEEE802.16 Working Group and WiMAX Forum, respectively.

This standard is intended to combine the national regulations and the international specifications, however in case of inconsistency between them, the national regulations shall prevail. The national regulations are the mandatory requirements for operation of the Mobile WiMAX in Japan.

The physical layer and MAC layer specifications are produced by IEEE802.16 Working Group in two documents, IEEE802.16-2004 and IEEE802.16e-2005. These documents offer a variety of fundamentally different design options in the physical layer and the MAC layer. For practical reasons of interoperability, WiMAX Forum defined a limited number of system profiles from these documents as summarized in the WiMAX mobile system profile.

Since IEEE802.16-2004 and IEEE802.16e-2005 specifications do not define the end-to-end WiMAX network, WiMAX Forum has developed a network reference model called End-to-End Network Systems Architecture as the architecture framework for WiMAX deployment and to insure interoperability among various WiMAX equipment and operators.

## 1.3 Reference Regulations

The acronyms of the referenced regulations used in this standard are as follows;

ORE : Ordinance Regulating Radio Equipment

NT: Notification of the Ministry of Posts and Telecommunications if issued in 2000 or earlier, and a Notification of the Ministry of Internal Affairs and Communications if issued in 2001 or later

## 1.4 Reference Documents

- WiMAX Forum Mobile System Profile
- WiMAX End-to-End Network Systems Architecture

# Chapter 2 System overview

The IEEE802.16 Working Group develops and supports the IEEE802.16 air interface standard for Broadband Wireless Access systems. The amendment IEEE Std 802.16e-2005 along with the base IEEE Std 802.16-2004 provides the basis for the Mobile WiMAX air interface for combined fixed and mobile broadband wireless access.

IEEE Std 802.16 offers a flexible set of parameters and features to meet a range of global requirements. Due to this flexibility, interoperability with respect to the required features needs to be ensured. Interoperability testing is a key function of the WiMAX Forum. Therefore, the WiMAX Forum has developed profiles specifying particular features and parameter sets based on IEEE 802.16 in order to ensure interoperability.

The Mobile WiMAX RTT (Radio Transmission Technology) is consistent with the WiMAX Forum Mobile System Profile being commercialized by members of WiMAX Forum under the name “Mobile WiMAX ™”. The WiMAX Forum Mobile System Profile as illustrated in Figure 2-1 is derived from the mandatory and optional feature sets described in IEEE Std 802.16. This profile is used for air interface certification to foster global interoperability. WiMAX Forum Mobile profiles include recommended 5 and 10 MHz bandwidth, aligned with Mobile WiMAX proposal, for global deployment.

The WiMAX Form Mobile System Profile Release 1.0 was first issued with the basic functionalities to meet the global deployment. Since then WiMAX Forum has been developing additional features to the Release 1.0 over time.

The WiMAX Forum Mobile System Profile Release 1.5 was issued with additional functions, such as FDD mode of operation and the enhancement of the system performance.

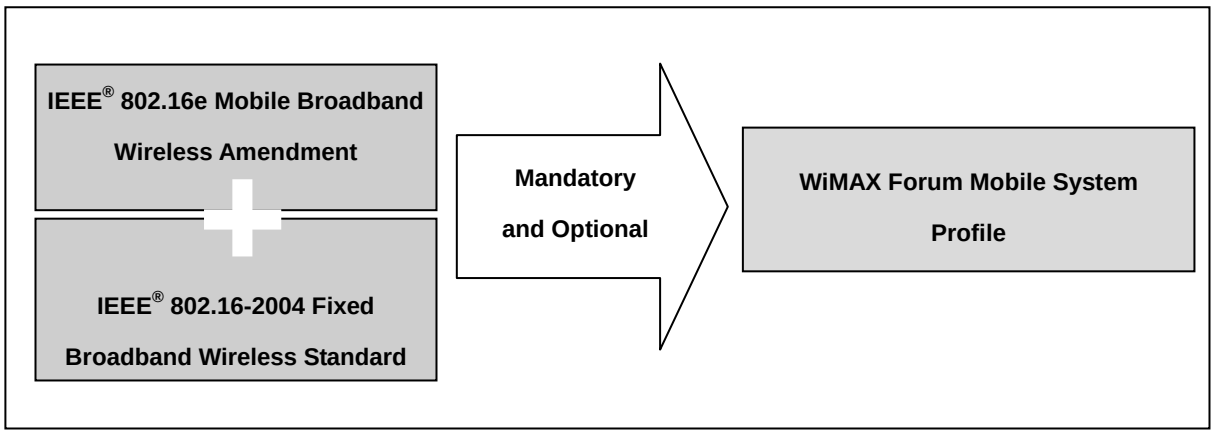


Figure 2-1 WiMAX Forum Mobile System Profile

The WiMAX Mobile System Profile supports the deployment of fully interoperable systems compatible with Mobile WiMAX. The profile includes optional Base Station features providing flexibility for various deployment scenarios and regional requirements to enable optimization for capacity, coverage, etc.[1]

## 2.1 Mobile WiMAX Network Architecture

The Mobile WiMAX radio interface is suitable for use in an all-IP (Internet Protocol) architecture, with support for IP-based packet services. This allows for scalability and rapid deployment since the networking functionality is primarily based on software services.

In order to deploy successful and operational commercial systems, there is need for support beyond the IEEE802.16 air interface specifications, which only address layers 1 and 2 (PHY (Physical) and MAC (Media Access Control) layers). The WiMAX Forum specifies the Mobile WiMAX Network Architecture describing the upper layer of the Radio Access Network and Core Network. Furthermore, the systems can also operate with core network of other IMT-2000 systems.

### 2.1.1 Architecture Principles

The following basic principles have guided the Mobile WiMAX Network Architecture development.

1. The architecture is based on a packet-switched framework, including native procedures based on IEEE Std 802.16, appropriate IETF (Internet Engineering Task Force) RFCs

[1] Mobile WiMAX – Part I: A Technical Overview and Performance Evaluation. http://www.wimaxforum.org/technology/downloads/Mobile_WiMAX_Part1_Overview_and_Performance.pdf

(Request For Comments) and Ethernet standards.

2. The architecture permits decoupling of access architecture (and supported topologies) from connectivity IP service. Network elements of the connectivity system are independent of the IEEE802.16 radio specifics.
3. The architecture allows modularity and flexibility to accommodate a broad range of deployment options such as:
   - Small-scale to large-scale (sparse to dense radio coverage and capacity) networks
   - Urban, suburban, and rural radio propagation environments
   - Licensed and/or license-exempt frequency bands
   - Hierarchical, flat, or mesh topologies, and their variants
   - Co-existence of fixed, nomadic, portable and mobile usage models

Support for Services and Applications: The End-to-End Mobile WiMAX Network Architecture includes a) Support of voice, multimedia services and other mandated regulatory services such as emergency services and lawful interception, b) Access to a variety of independent ASP (Application Service Provider) networks in an neutral manner, c) Mobile telephony communications using VoIP, d) Support interfacing with various interworking and media gateways permitting delivery of incumbent/legacy services translated over IP (for example, SMS (Short Message Service) over IP, MMS (Multimedia Message Service) , WAP (Wireless Application Protocol) ) to WiMAX access networks and e) Support delivery of IP Broadcast and Multicast services over WiMAX access networks.

Interworking and Roaming is another key strength of the End-to-End Mobile WiMAX Network Architecture with support for a number of deployment scenarios. In particular, there will be support of a) Loosely-coupled interworking with existing wireless networks such as those specified in 3GPP (3G Partnership Project) and 3GPP2 (3G Partnership Project 2) or existing wireline networks such as DSL (Digital Subscriber Line) and MSO (Multi Service Operator), with the interworking interface(s) based on a standard IETF suite of protocols, b) Global roaming across WiMAX operator networks, including support for credential reuse, consistent use of AAA (Authentication, Authorization, Accounting) for accounting and billing, and consolidated/common billing and settlement, c) A variety of user authentication credential formats such as subscriber identify modules (SIM/USIM (Subscriber Identity Module/Universal Subscriber Identity Module), R-UIM (Removable User Identity Module)), username/password, digital certificates.

## 2.2 WiMAX Network Reference Model

IEEE Std 802.16 specifies a radio interface but not the network in which it is to be used, instead leaving an open interface to higher network layers. The WiMAX Forum specifies the NRM (Network Reference Model) to describe a practical and functional network making use of the Mobile WiMAX air interface. This NRM is described here because it serves as a framework for evaluating the performance of the Mobile WiMAX radio interface.

The NRM is a logical representation of the network architecture. The NRM identifies functional entities and reference points over which interoperability is achieved between functional entities. The architecture has been developed with the objective of providing unified support of functionality needed in a range of network deployment models and usage scenarios (ranging from nomadicity to full mobility).

Figure 2-2 illustrates the NRM, consisting of the logical entities MS, ASN, and CSN, as well as clearly identified reference points for interconnection of the logical entities. The figure depicts the key normative reference points R1-R5. Each of the entities, MS, ASN and CSN, represents a grouping of functional entities. Each of these functional entities may be realized in a single physical device or may be distributed over multiple physical devices according to allocation defined by ASN profiles[2].

The intent of the NRM is to allow multiple implementation options for a given functional entity, and yet achieve interoperability among different realizations of functional entities. Interoperability is based on the definition of communication protocols and data plane treatment between functional entities to achieve an overall end-to-end function, for example, security or mobility management. Thus, the functional entities on either side of a reference point represent a collection of control and bearer plane end-points.

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[2] An ASN profile represents an allocation of functional entities (e.g. authenticator, radio resource manager, etc.) to the various elements belonging to the access network.

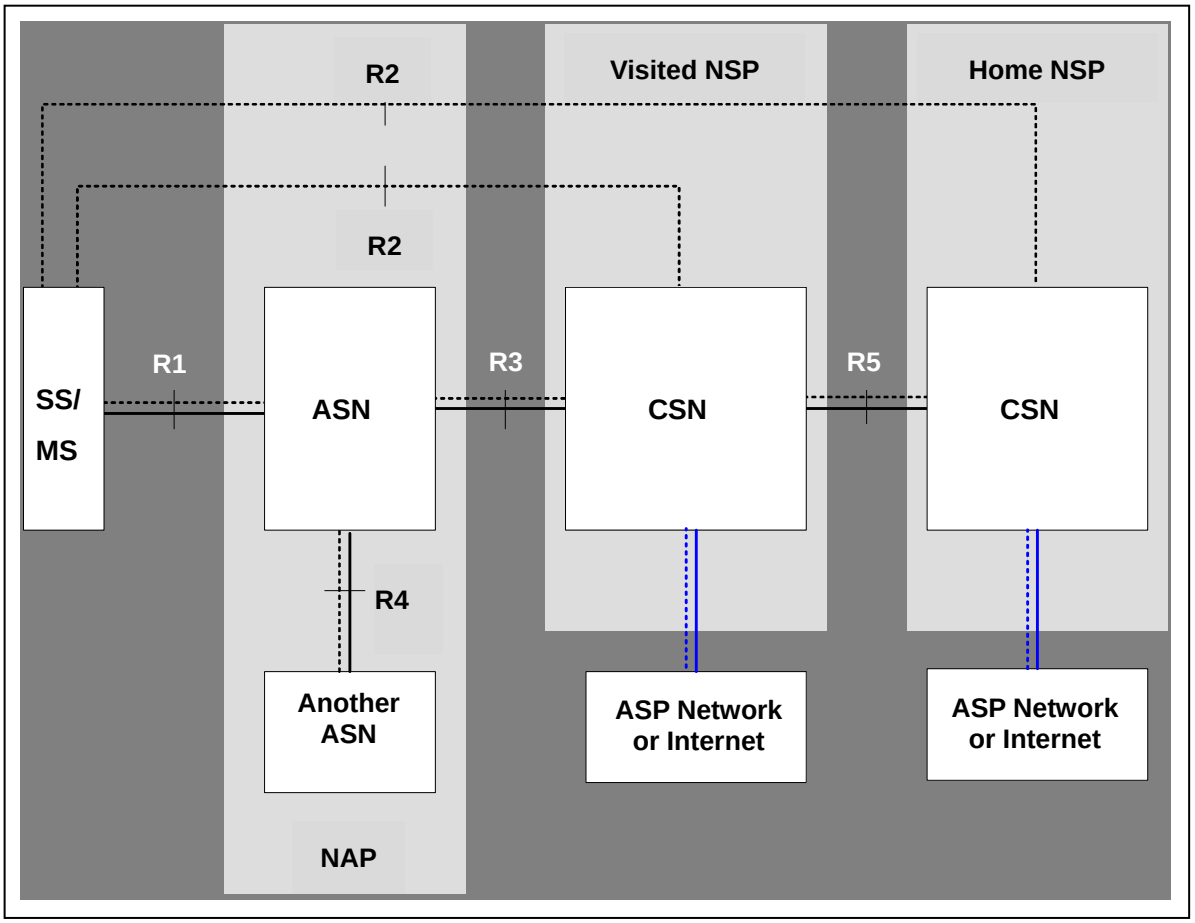


**Figure 2-2 WiMAX Network Reference Model**

The ASN defines a logical boundary and represents a convenient way to describe aggregation of functional entities and corresponding message flows associated with the access services. The ASN represents a boundary for functional interoperability with WiMAX clients, connectivity service functions, and aggregation of functions embodied by different vendors. Mapping of functional entities to logical entities within ASNs as depicted in the NRM may be performed in different ways. The CSN (Connectivity Service Network) is defined as a set of network functions that provide IP connectivity services to the subscriber stations. A CSN may comprise network elements such as routers, AAA proxy/servers, user databases and Interworking gateway devices. Figure 2-3 provides a more basic view of the many entities within the functional groupings of ASN and CSN.

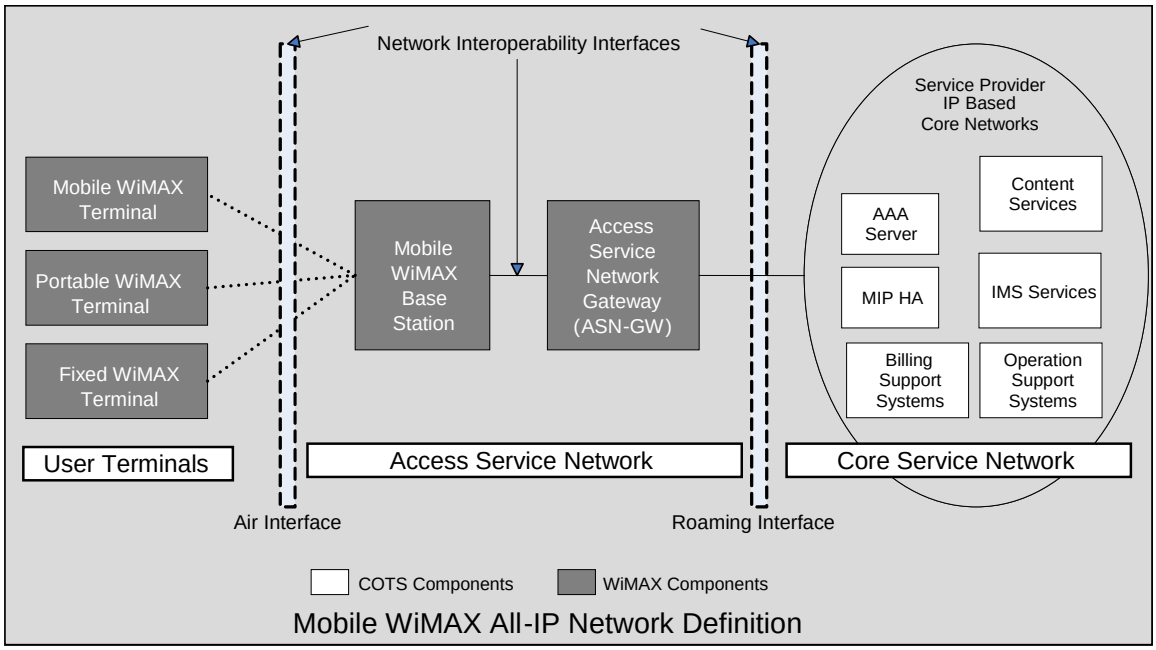


**Figure 2-3 ASN and CSN Entities**

Some general tenets have guided the development of the Network Architecture and include the following: a) Logical separation of IP addressing, routing and connectivity management procedures and protocols, to enable use of the access architecture primitives in standalone and interworking deployment scenarios, b) Support for sharing of ASN(s) of a NAP (Network Access Provider) among multiple NSPs, c) Support of a single NSP (Network Service Provider) providing service over multiple ASN(s) – managed by one or more NAPs, d) Support for the discovery and selection of accessible NSPs by an MS, e) Support of NAPs that employ one or more ASN topologies, f) Support of access to incumbent operator services through internetworking functions as needed, g) Specification of open and well-defined reference points between various groups of network functional entities (within an ASN, between ASNs, between an ASN and a CSN, and between CSNs), and in particular between an MS, ASN and CSN to enable multi-vendor interoperability, h) Support for evolution paths between the various usage models subject to reasonable technical assumptions and constraints, i) Enabling different vendor implementations based on different combinations of functional entities on physical network entities, as long as these implementations comply with the normative protocols and procedures across applicable reference points, as defined in the network specifications and j) Support for the most basic scenario of a single operator deploying an ASN together with a limited set of CSN functions, so that the operator can offer basic Internet access service without consideration for roaming or interworking.

The Mobile WiMAX architecture also supports IP services, in a standard mobile IP compliant network. The flexibility and interoperability supported by this network architecture provides operators with the opportunity for a multi-vendor implementation of a network even with a mixed deployment of distributed and centralized ASNs in the network. The Mobile WiMAX network architecture has the following major features:

Security

The End-to-End Network Architecture is based upon a security framework that is independent of the ASN topology and applies consistently across both new and internetworking deployment models and various usage scenarios. In particular, it supports: a) Strong mutual device authentication between an MS and the network, based on the IEEE802.16 security framework, b) All commonly deployed authentication mechanisms and authentication in home and visited operator network scenarios based on a consistent and extensible authentication framework, c) Data integrity, replay protection, confidentiality and non-repudiation using applicable key lengths, d) Use of MS initiated/terminated security mechanisms such as VPNs (Virtual Private Networks), and e) Standard secure IP address management mechanisms between the MS and its home or visited NSP.

Mobility and Handovers

The End-to-End Network Architecture has extensive capabilities to support mobility and handovers. It a) supports IPv4 or IPv6 based mobility management. Within this framework, and as applicable, the architecture accommodates MS equipment with multiple IP addresses and simultaneous IPv4 and IPv6 connections, b) supports roaming between NSPs, c) utilizes mechanisms to support seamless handovers at up to vehicular speeds— satisfying well-defined bounds of service disruption. Some of the additional capabilities for mobility include the support of: i) dynamic and static home address configurations, ii) dynamic assignment of the Home Agent in the service provider network as a form of route optimization, as well as in the home IP network as a form of load balancing and iii) dynamic assignment of the Home Agent based on policies.

Scalability, Extensibility, Coverage and Operator Selection

The End-to-End Network Architecture has extensive support for scalable, extensible operation and flexibility in operator selection. In particular, it a) enables a user to manually or automatically select from available NAPs and NSPs, b) enables ASN and CSN system designs that easily scale upward and downward – in terms of coverage, range or capacity, c)

accommodates a variety of ASN topologies - including hub-and-spoke, hierarchical, and/or multi-hop interconnects, d) accommodates a variety of backhaul links, both wireline and wireless with different latency and throughput characteristics, e) supports incremental infrastructure deployment, f) supports phased introduction of IP services that in turn scale with increasing number of active users and concurrent IP services per user, g) supports the integration of BSs of varying coverage and capacity - for example, pico, micro, and macro BSs and e) supports flexible decomposition and integration of ASN functions in ASN deployments in order to enable use of load balancing schemes for efficient use of radio spectrum and network resources.

Additional features pertaining to manageability and performance of the Network Architecture include: a) Support for a variety of online and offline client provisioning, enrollment, and management schemes based on open, broadly deployable, IP-based, industry standards, b) Accommodation of OTA (Over-The-Air) services for MS terminal provisioning and software upgrades, and c) Accommodation of the use of header compression/suppression and/or payload compression for efficient use of the radio resources.

Multi-Vendor Interoperability

Another key aspect of the Network Architecture is the support of interoperability between equipment from different manufacturers within an ASN and across ASNs. This includes interoperability between: a) BS and backhaul equipment within an ASN, and b) Various ASN elements (possibly from different vendors) and CSN, with minimal or no degradation in functionality or capability of the ASN.

Quality of Service

The Network Architecture has provisions for support of the QoS (Quality Of Service) mechanisms defined in IEEE Std 802.16. In particular, it enables flexible support of simultaneous use of a diverse set of IP services. The architecture supports: a) differentiated levels of QoS, coarse-grained (per user/terminal) and/or fine-grained (per service flow), b) admission control, c) bandwidth management and d) implementation of policies as defined by various operators for QoS based on their SLAs (Service Level Agreement) (including policy enforcement per user and user group as well as factors such as location, time of day, etc.). Extensive use is made of standard IETF mechanisms for managing policy definition and policy enforcement between operators.

Interworking with Other Networks

The Network Architecture supports loosely coupled interworking with existing wireless or

wireline core networks such as GSM/GPRS (Global System for Mobile Communications/General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), HSDPA (High Speed Downlink Packet Access), CDMA2000 (Code Division Multiple Access 2000), RLAN (Remote Local Area Network), DSL, and cable modem operator networks on the basis of the IP/IETF suite of protocols.

## 2.3 Physical Layer Description

### 2.3.1 OFDMA Basics

OFDM (Orthogonal Frequency Division Multiplexing) is a multiplexing technique that subdivides the bandwidth into multiple frequency sub-carriers as shown in Figure 2-4. In an OFDM system, the input data stream is divided into several parallel sub-streams of reduced data rate (thus increased symbol duration) and each sub-stream is modulated and transmitted on a separate orthogonal sub-carrier. The increased symbol duration improves the robustness of OFDM to delay spread. Furthermore, the introduction of the CP (cyclic prefix) can completely eliminate ISI (Inter-Symbol Interference) as long as the CP duration is longer than the channel delay spread. The CP is typically a repetition of the last samples of data portion of the block that is appended to the beginning of the data payload as shown in Figure 2-5. The CP prevents inter-block interference and makes the channel appear circular and permits low-complexity frequency domain equalization. A perceived drawback of CP is that it introduces overhead, which effectively reduces bandwidth efficiency. While the CP does reduce bandwidth efficiency somewhat, the impact of the CP is similar to the “roll-off factor” in raised-cosine filtered single-carrier systems. Since OFDM signal power spectrum has a very sharp fall of at the edge of channel, a larger fraction of the allocated channel bandwidth can be utilized for data transmission, which helps to moderate the loss in efficiency due to the cyclic prefix.

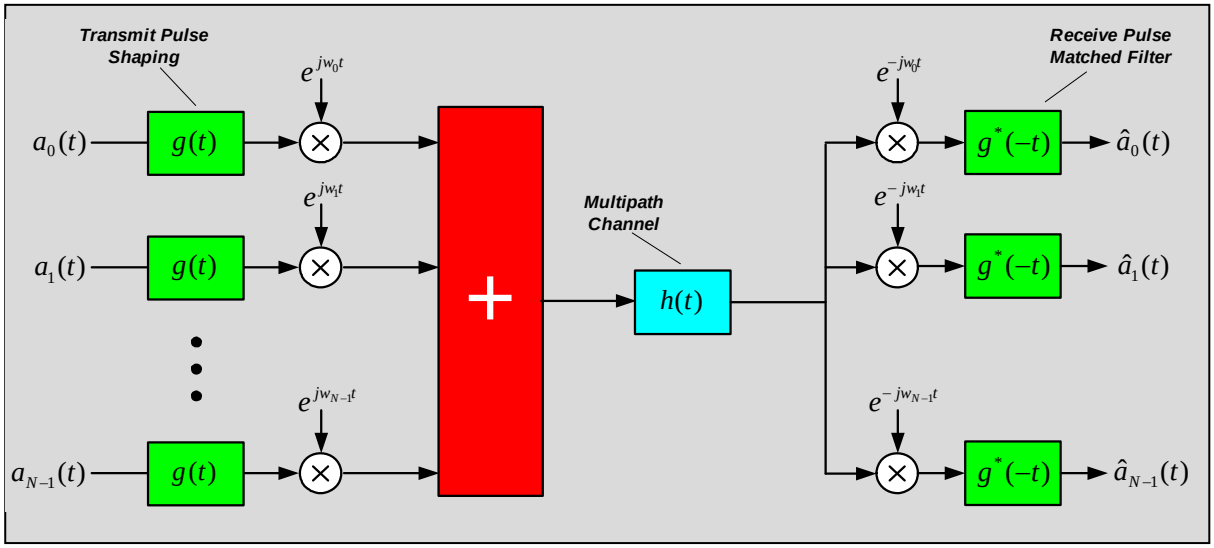


**Figure 2-4 Basic Architecture of an OFDM System**

OFDM exploits the frequency diversity of the multipath channel by coding and interleaving the information across the sub-carriers prior to transmissions. OFDM modulation can be realized with efficient IFFT (Inverse Fast Fourier Transform), which enables a large number of sub-carriers with low complexity. In an OFDM system, resources are available in the time domain by means of OFDM symbols and in the frequency domain by means of sub-carriers. The time and frequency resources can be organized into subchannels for allocation to individual users. OFDMA (Orthogonal Frequency Division Multiple Access) is a multiple-access/multiplexing scheme that provides multiplexing operation of data streams corresponding to multiple users onto the downlink subchannels. It also supports multiple access of various users by means of uplink subchannels.

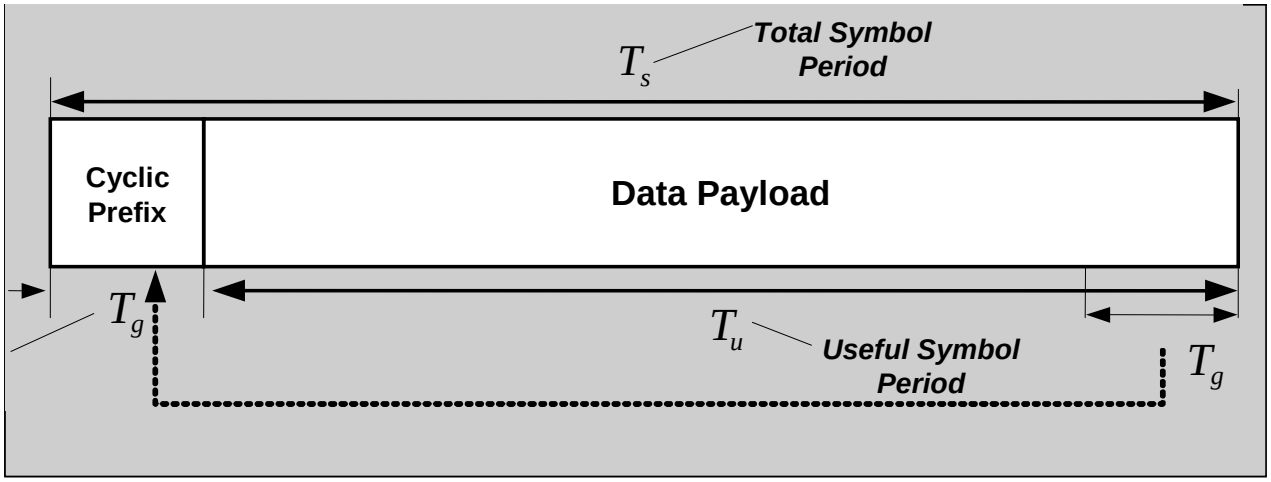


Figure 2-5 Insertion of Cyclic Prefix (CP)

### 2.3.2 OFDMA Symbol Structure and Subchannelization

The OFDMA symbol structure consists of three types of sub-carriers as shown in Figure 2- 6.

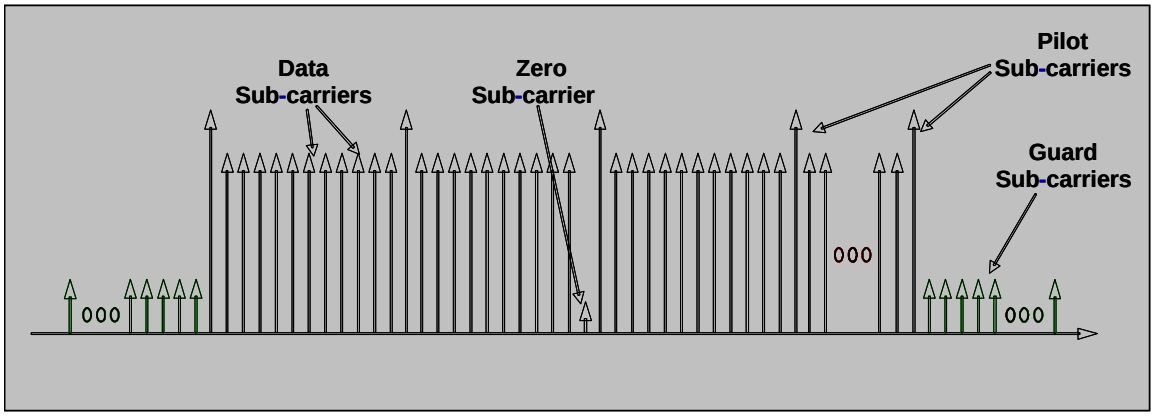


Figure 2-6 OFDMA Sub-Carrier Structure

- Data sub-carriers for data transmission.
- Pilot sub-carriers for estimation and synchronization purposes.
- Null sub-carriers for no transmission; used for guard band and zero Hertz sub-carriers.

Active (data and pilot) sub-carriers are grouped into subsets of sub-carriers called subchannels. The Mobile WiMAX PHY supports subchannelization in both DL (Down Link) and UL (Up Link). The minimum frequency-time resource unit of subchannelization is one slot, which is equal to 48 data tones (sub-carriers).

There are two types of sub-carrier permutations for subchannelization; diversity and

contiguous. The diversity permutation draws sub-carriers pseudo-randomly to form a subchannel. It provides frequency diversity and inter-cell interference averaging. The diversity permutations include DL FUSC (Fully Used Subchanelozation), DL PUSC (Partially Used Subchannelization) and UL PUSC and additional optional permutations. With DL PUSC, for each pair of OFDM symbols, the available or usable sub-carriers are grouped into clusters containing 14 contiguous sub-carriers per symbol, with pilot and data allocations in each cluster in the even and odd symbols as shown in Figure 2- 7.

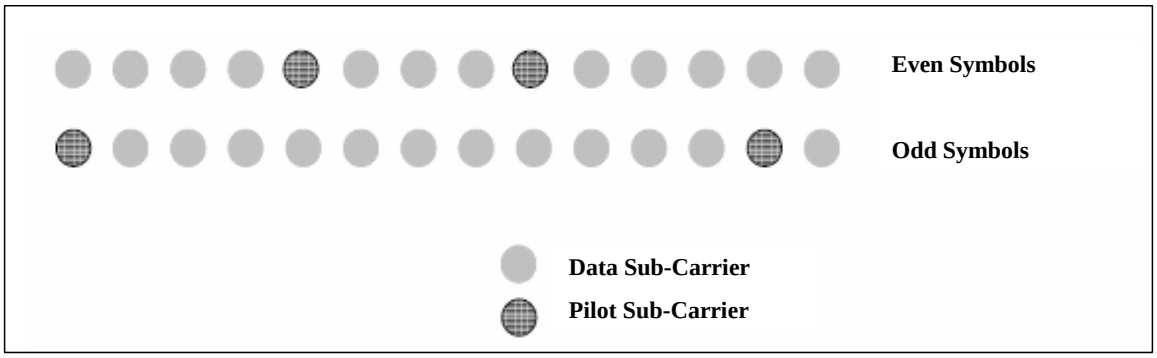


**Figure 2-7 DL Frequency Diverse Subchannel**

A re-arranging scheme is used to form groups of clusters such that each group is made up of clusters that are distributed throughout the sub-carrier space. A subchannel in a group contains two (2) clusters and is comprised of 48 data sub-carriers and eight (8) pilot sub-carriers. The data subcarriers in each group are further permuted to generate subchannels in the group. Therefore, only the pilot positions in the cluster as shown in Figure 2- 7. The data subcarriers in the cluster are distributed to multiple subchannels.

Analogous to the cluster structure for DL, a tile structure is defined for the UL PUSC whose format is shown in Figure 2-8.

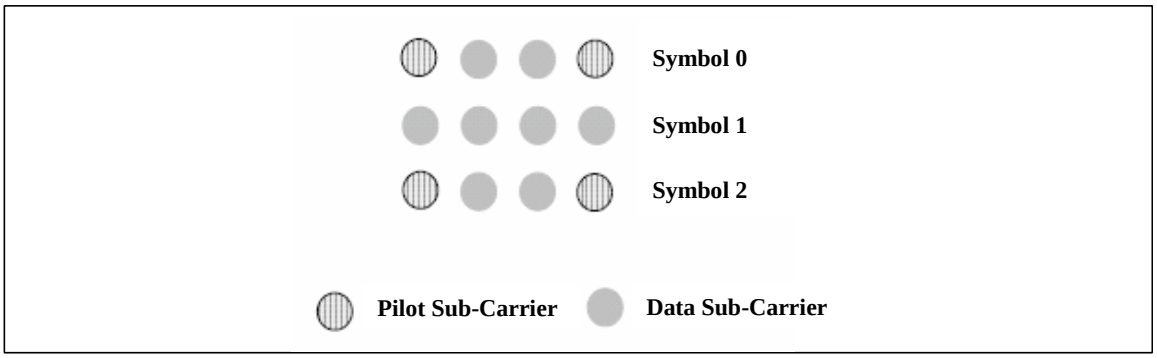


**Figure 2-8 Tile Structure for UL PUSC**

The available sub-carrier space is split into tiles and six (6) tiles, chosen from across the entire spectrum by means of a re-arranging/permutation scheme, are grouped together to form a slot. The slot is comprised of 48 data sub-carriers and 24 pilot sub-carriers in 3 OFDM symbols.

The contiguous permutation groups a block of contiguous sub-carriers to form a subchannel. The contiguous permutations include DL AMC (Adaptive Modulation and Coding) and UL AMC, and have the same structure. A bin consists of 9 contiguous sub-carriers in a symbol, with 8 assigned for data and one assigned for a pilot. A slot in AMC is defined as a collection of bins of the type (N x M = 6), where N is the number of contiguous bins and M is the number of contiguous symbols. Thus the allowed combinations are (6 bins, 1 symbol), (3 bins, 2 symbols), (2 bins, 3 symbols) or (1 bin, 6 symbols). AMC permutation enables multi-user diversity by choosing the subchannel with the best frequency response.

In general, diversity sub-carrier permutations perform well in mobile applications while contiguous sub-carrier permutations are well suited for fixed, nomadic, or low mobility environments. These options enable the system designer to trade-off mobility for throughput.

Following figure demonstrates the physical and Logical subchannel allocation in a OFDMA frame.

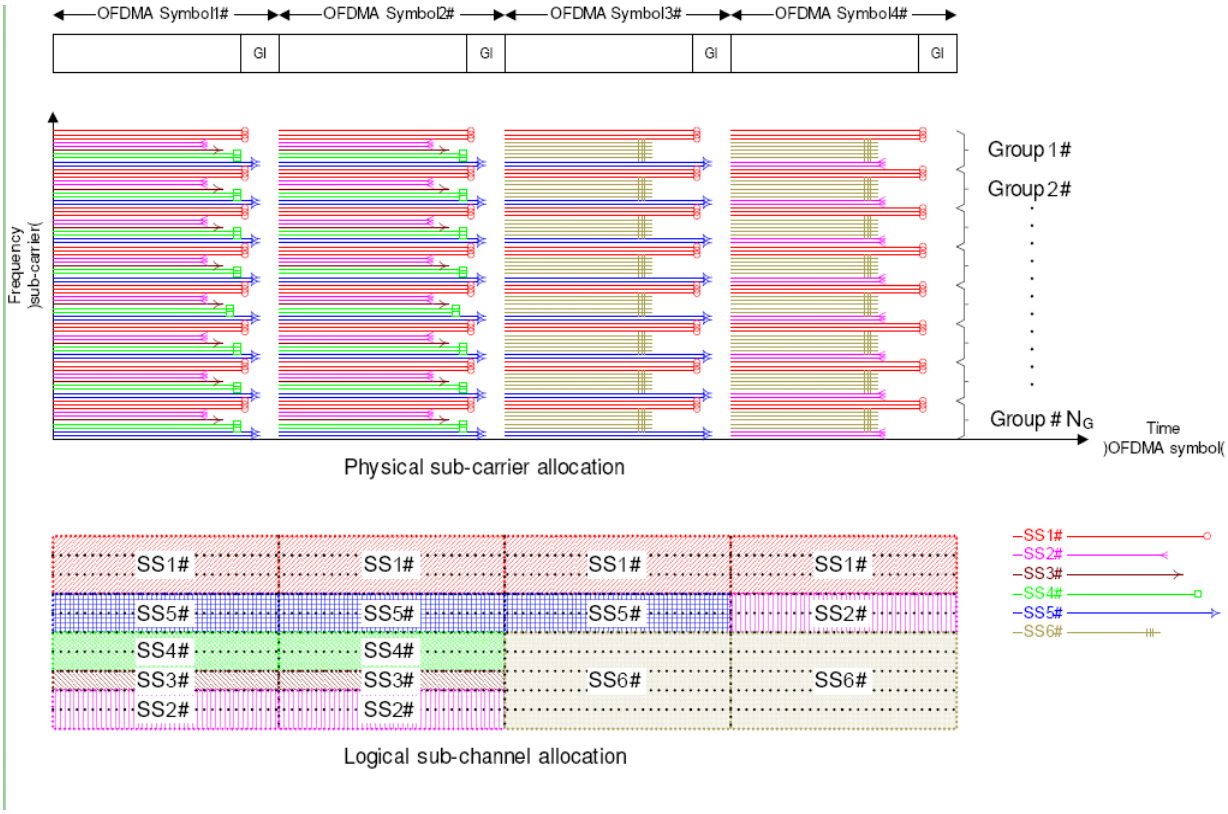


**Figure 2-9 Physical and Logical Subchannel Allocation**

### 2.3.3 Scalable OFDMA

Mobile WiMAX mode is based upon the concept of Scalable OFDMA. The scalability is supported by adjusting the FFT (Fast Fourier Transform) size while fixing the sub-carrier frequency spacing at 10.94 kHz. Since the resource unit sub-carrier bandwidth and symbol duration is fixed, the impact to higher layers is minimal when scaling the bandwidth. The Mobile WiMAX parameters are listed in Table 2-1.

**Table 2-1 OFDMA Scalability Parameters**

| Parameters | Values | |
|---|---|---|
| System Channel Bandwidth (MHz) | 5 | 10 |
| Sampling Frequency ($F_p$ in MHz) | 5.6 | 11.2 |
| FFT Size ($N_{FFT}$) | 512 | 1024 |
| Number of Subchannels | 8 | 16 |
| Sub-Carrier Frequency Spacing | 10.94 kHz | |
| Useful Symbol Time ($T_b = 1/f$) | 91.4 μs | |
| Guard Time ($T_g = T_b/8$) | 11.4 μs | |
| OFDMA Symbol Duration ($T_s = T_b + T_g$) | 102.9 μs | |
| Number of OFDMA Symbols (5 ms Frame) | 48 (including ~1.6 symbols for TTG/RTG) | |

### 2.3.4 TDD Frame Structure

The Mobile WiMAX PHY makes use of TDD (Time Division Duplexing). To counter interference issues, TDD does require system-wide synchronization; nevertheless, TDD has numerous advantages:

- TDD enables adjustment of the downlink/uplink ratio to efficiently support asymmetric downlink/uplink traffic, while with FDD (Frequency Division Duplexing), downlink and uplink always have fixed and, generally, equal DL and UL bandwidths. As shown in Table 2-2, recommended number of UL/DL OFDM symbols can flexibly realize a range of asymmetric downlink/uplink traffic ratio.

**Table 2-2 Number of OFDM Symbols in DL and UL**

| Description | Base Station Values |
|---|---|
| Number of OFDM Symbols in DL and UL for 5 and 10 MHz BW | (35: 12), (34: 13), (33: 14), (32: 15), (31: 16), (30: 17), (29: 18), (28: 19), (27: 20), (26: 21) |

- TDD assures channel reciprocity for better support of link adaptation, MIMO and other closed loop advanced antenna technologies. Also, TDD is the preferred mode of operation with respect to the beamforming systems using phased array antennas.
- Unlike FDD, which requires a pair of channels, TDD only requires a single channel for both downlink and uplink, providing greater flexibility for adaptation to varied global spectrum allocations.
- Transceiver designs for TDD implementations are less complex.

Figure 2-10 illustrates the OFDM frame structure for a TDD implementation. Each frame is divided into DL and UL sub-frames, separated by Transmit/Receive and Receive/Transmit Transition Gaps (TTG and RTG, respectively) to prevent DL and UL transmission collisions. In a frame, the following control information is used:

- Preamble: The preamble, used for synchronization, is the first OFDM symbol of the frame.
- FCH (Frame Control Header): The FCH follows the preamble. It provides the frame configuration information, such as MAP message length, coding scheme, and usable subchannels.
- DL-MAP (Down Link Map) and UL-MAP (Up Link Map): The DL-MAP and UL-MAP provide subchannel allocation and other control information for the DL and UL sub-frames respectively.
- UL Ranging: The UL ranging subchannel is allocated for MSs to perform closed-loop time, frequency, and power adjustment as well as bandwidth requests. Four types of ranging are defined. The different types of ranging are identified by a code and a 2D region in the UL subframe.
    - Initial Ranging- when MS enters (or re-enters) the network,
    - Periodic Ranging once the connection is set up between the MS and the BS,
    - Hand Over Ranging (in case of Hard HO in drop situations), and
    - Bandwidth Request.

- UL CQICH (Up Link Channel Quality Indication Channel): The UL CQICH channel is allocated for the MS to feedback channel-state information.
- UL ACK (Up Link Acknowledge): The UL ACK is allocated for the MS to feedback DL HARQ (Hybrid Automatic Repeat Request) acknowledgement.

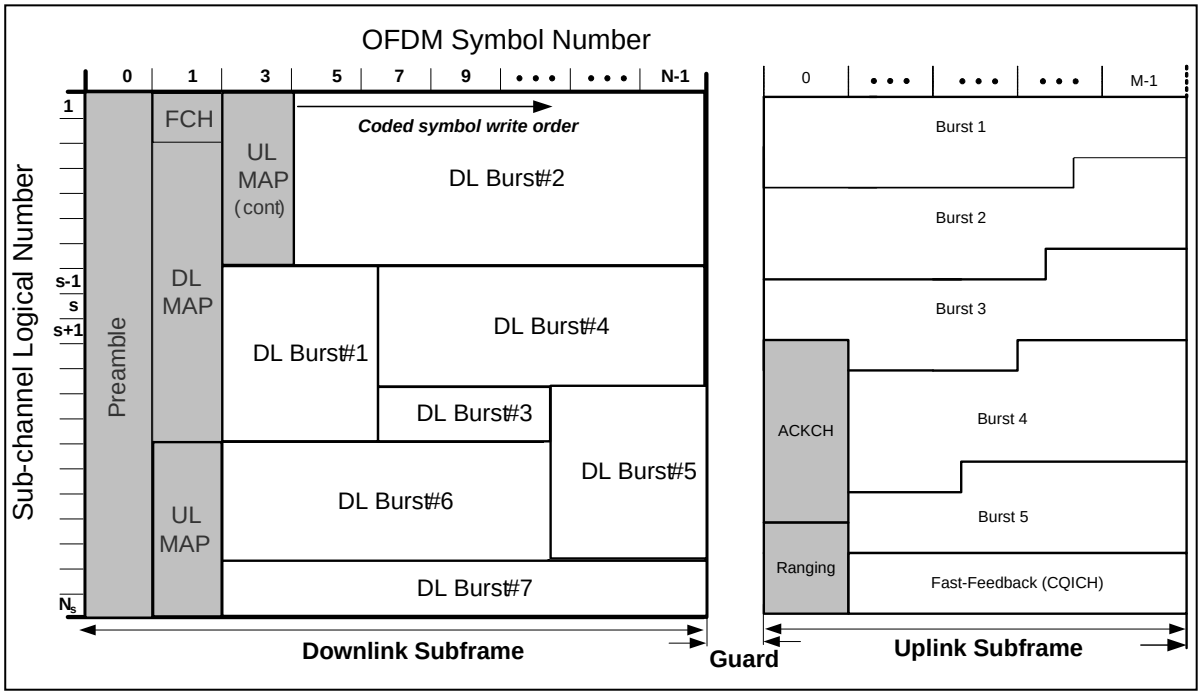


**Figure 2-10 Mobile WiMAX Frame Structure**

### 2.3.5 Other Advanced PHY Layer Features

Adaptive modulation and coding, HARQ, CQICH, and multiple antenna technologies provide enhanced coverage and capacity in mobile applications.

Support for QPSK (Quadrature Phase Shift Keying), 16QAM (Quadrature Amplitude Modulation) and 64QAM are mandatory in the DL. In the UL, 64QAM is optional. Both CC (Convolutional Code) and CTC (Convolutional Turbo Code), with variable code rate and repetition coding, are supported. Table 2-3 summarizes the coding and modulation schemes supported in Mobile WiMAX.

**Table 2-3 Supported Coding and Modulation Schemes**

| | | DL | UL |
|---|---|---|---|
| Modulation | | QPSK, 16QAM, 64QAM | QPSK,16QAM, (64QAM optional) |
| Rate | CC | 1/2, 2/3, 3/4, 5/6 | 1/2, 2/3, (5/6 optional) |
| | CTC | 1/2, 2/3, 3/4, 5/6 | 1/2, 2/3, (5/6 optional) |
| | Repetition | x2, x4, x6 | x2, x4, x6 |

The numerology of WiMAX PHY with the system bandwidth of 5 MHz and 10 MHz is shown in Table 2-4. Table 2-5 assumes PUSC subchannels with frame duration of 5 milliseconds. Each frame has 48 OFDM symbols, with 44 OFDM symbols available for data transmission. The highlighted values indicate data rates for optional 64QAM in the UL.

**Table 2-4 Mobile WiMAX PHY Numerology**

| Parameter | Downlink | Uplink | Downlink | Uplink |
|---|---|---|---|---|
| System Bandwidth | 5 MHz | | 10 MHz | |
| FFT Size | 512 | | 1024 | |
| Null Sub-Carriers | 92 | 104 | 184 | 184 |
| Pilot Sub-Carriers | 60 | 136 | 120 | 280 |
| Data Sub-Carriers | 360 | 272 | 720 | 560 |
| Subchannels | 15 | 17 | 30 | 35 |
| Symbol Period, $T_S$ | 102.9 μs | | | |
| Frame Duration | 5 ms | | | |
| OFDM Symbols/Frame | 48 (including ~1.6 symbols for TTG/RTG) | | | |
| Data OFDM Symbols | 44 | | | |

**Table 2-5 Mobile WiMAX PHY Data Rates with PUSC Subchannel**[3]

| Modulation | Code Rate | 5 MHz Channel | | 10 MHz Channel | |
|---|---|---|---|---|---|
| | | Downlink Rate, Mbit/s | Uplink Rate, Mbit/s | Downlink Rate, Mbit/s | Uplink Rate, Mbit/s |
| QPSK | 1/2 CTC, 6x | 0.53 | 0.38 | 1.06 | 0.78 |
| | 1/2 CTC, 4x | 0.79 | 0.57 | 1.58 | 1.18 |
| | 1/2 CTC, 2x | 1.58 | 1.14 | 3.17 | 2.35 |
| | 1/2 CTC, 1x | 3.17 | 2.28 | 6.34 | 4.70 |
| | 3/4 CTC | 4.75 | 3.43 | 9.50 | 7.06 |
| 16QAM | 1/2 CTC | 6.34 | 4.57 | 12.07 | 9.41 |
| | 3/4 CTC | 9.50 | 6.85 | 19.01 | 14.11 |
| 64QAM | 1/2 CTC | 9.50 | 6.85 | 19.01 | 14.11 |
| | 2/3 CTC | 12.67 | 9.14 | 26.34 | 18.82 |
| | 3/4 CTC | 14.26 | 10.28 | 28.51 | 21.17 |
| | 5/6 CTC | 15.84 | 11.42 | 31.68 | 23.52 |

The BS scheduler determines the appropriate data rate (or burst profile) for each burst allocation based on the buffer size, channel propagation conditions at the receiver, etc. A CQI (Channel Quality Indicator) channel is utilized to provide channel-state information from the user terminals to the BS scheduler. Relevant channel-state information can be fed back by the CQICH including: Physical CINR (Carrier to Interference + Noise Ratio), Effective CINR, MIMO (Multiple Input Multiple Output) mode selection and frequency selective subchannel selection. Because the implementation is TDD, link adaptation can also take advantage of channel reciprocity to provide a more accurate measure of the channel condition (such as sounding).

HARQ is enabled using N channel “Stop and Wait” protocol, which provides fast response to packet errors and improves cell edge coverage. Chase Combining and, optionally, Incremental Redundancy are supported to further improve the reliability of the retransmission. A dedicated ACK channel is provided in the uplink for HARQ ACK/NACK signaling. Multi-channel HARQ

[3] PHY Data Rate=(Data sub-carriers/Symbol period)x(information bits per symbol).

operation is supported. Multi-channel stop-and-wait ARQ with a small number of channels is an efficient, simple protocol that minimizes the memory required for HARQ and stalling. Mobile WiMAX provides signaling to allow fully asynchronous operation. The asynchronous operation allows variable delay between retransmissions, which gives more flexibility to the scheduler at the cost of additional overhead for each retransmission allocation. HARQ combined together with CQICH and adaptive modulation and coding provides robust link adaptation in mobile environments at vehicular speeds in excess of 120 km/hr.

Multiple antenna technologies typically involve complex vector or matrix operations on signals due to the presence of multiple antenna links between the transmitter and receiver. OFDMA allows multiple antenna operations to be performed on a per-subcarrier basis, where the vector-channels are flat fading. This fact makes the multiple antenna signal processing manageable at both transmitter and receiver side since complex transmitter architectures and receiver equalizers are not required to compensate for frequency selective fading. Thus, OFDMA is very well-suited to support multiple antenna technologies. Mobile WiMAX supports a full range of multiple antenna technologies to enhance system performance. The supported multiple antenna technologies include:

- Beamforming (BF) for both the uplink and the downlink: With BF, the system uses multiple-antennas to both receive and transmit signals to improve the coverage and capacity of the system and reduce the outage probability. The BS is usually equipped with two or more antennas, with a typical number being four antennas, and determines so-called antenna weights for both uplink reception and downlink transmission, while the MS is usually equipped with one or two antennas for downlink reception and one antenna for uplink transmission. Note that different BF techniques can be applied in Mobile WiMAX since there is no limitation imposed either to the distance among the antenna elements of the BS or the algorithm employed at the BS transceiver; the possibility of beamforming the pilot subcarriers during downlink transmission (feature of dedicated pilots in the mobile WiMAX system profiles) makes the application of specific BF algorithms transparent to the MS receiver.
- Space-Time Coding (STC) for the downlink: Two-antenna transmit diversity is enabled in Mobile WiMAX through the use of a space-time block coding code widely known as the Alamouti code. STC is a powerful technique for implementing open-loop transmit diversity, while its performance is further increased in Mobile WiMAX since a second antenna is mandated to be present at the MS receiver. Further, STC offers favorable performance in all propagation environments, i.e., it is not constrained by the MIMO channel quality usually represented by the spread of the MIMO channel eigenvalues. As in the BF case where one

spatial stream is transmitted over one OFDMA symbol per subcarrier, STC cannot lead to link throughput increase because it transmits two spatial streams over two OFDMA symbols per subcarrier.

- Spatial Multiplexing (SM) for the downlink: Spatial multiplexing is supported to apply higher peak rates and increased throughput whenever this is possible. With spatial multiplexing, two data streams are transmitted over one OFDMA symbol per subcarrier. Since the MS receiver is also equipped with two receive antennas, it can separate the two data streams to achieve higher throughput compared to single antenna, BF, and STC systems. In Mobile WiMAX, with 2x2 MIMO SM increases the peak data rate two-fold by transmitting two data streams.
- Collaborative Spatial Multiplexing (CSM), also referred to as virtual spatial multiplexing, for the uplink: In the uplink, each MS is equipped with a single transmit antenna. To increase the uplink performance, two users can transmit collaboratively in the same frequency and time allocation as if two streams were spatially multiplexed from two antennas of the same user. The advantage of the uplink CSM compared to the downlink SM is related to the fact that the transmitted spatial streams are uncorrelated since they originate from spatially displaced MSs. By additionally considering that the channel correlation factor at the BS can be kept at lower values than that at the MS receiver (space limitations at the MS usually apply leading to smaller inter-antenna distances and, thus, higher correlation values, especially if cross-polarized antennas are not employed), an improved performance of the spatial stream demultiplexing is expected in the uplink compared to the downlink.

Regarding the MIMO operation in the downlink (use of the STC and SM modes), Mobile WiMAX supports adaptive switching between STC and SM to maximize the benefit of MIMO depending on the channel conditions. For instance, SM improves peak throughput. However, when channel conditions are poor, e.g., when the signal-to-interference ratio is low or the channel correlation factor is relatively high, the PER (packet error rate) can be high and thus the coverage area where the target PER is met may be limited. STC on the other hand provides large coverage regardless of the channel condition but does not improve the peak data rate. Mobile WiMAX supports adaptive switching between multiple MIMO modes to maximize spectral efficiency without compromising on the coverage area.

## 2.4 MAC Layer Description

Mobile WiMAX supports the delivery of broadband services, including voice, data, and video. The MAC layer can support bursty data traffic with high peak rate demand while

simultaneously supporting streaming video and latency-sensitive voice traffic over the same channel. The resource allocated to one terminal by the MAC scheduler can vary from a single time slot to the entire frame, thus providing a very large dynamic range of throughput to a specific user terminal at any given time. Furthermore, since the resource allocation information is conveyed in the MAP messages at the beginning of each frame, the scheduler can effectively change the resource allocation on a frame-by-frame basis to adapt to the bursty nature of the traffic.

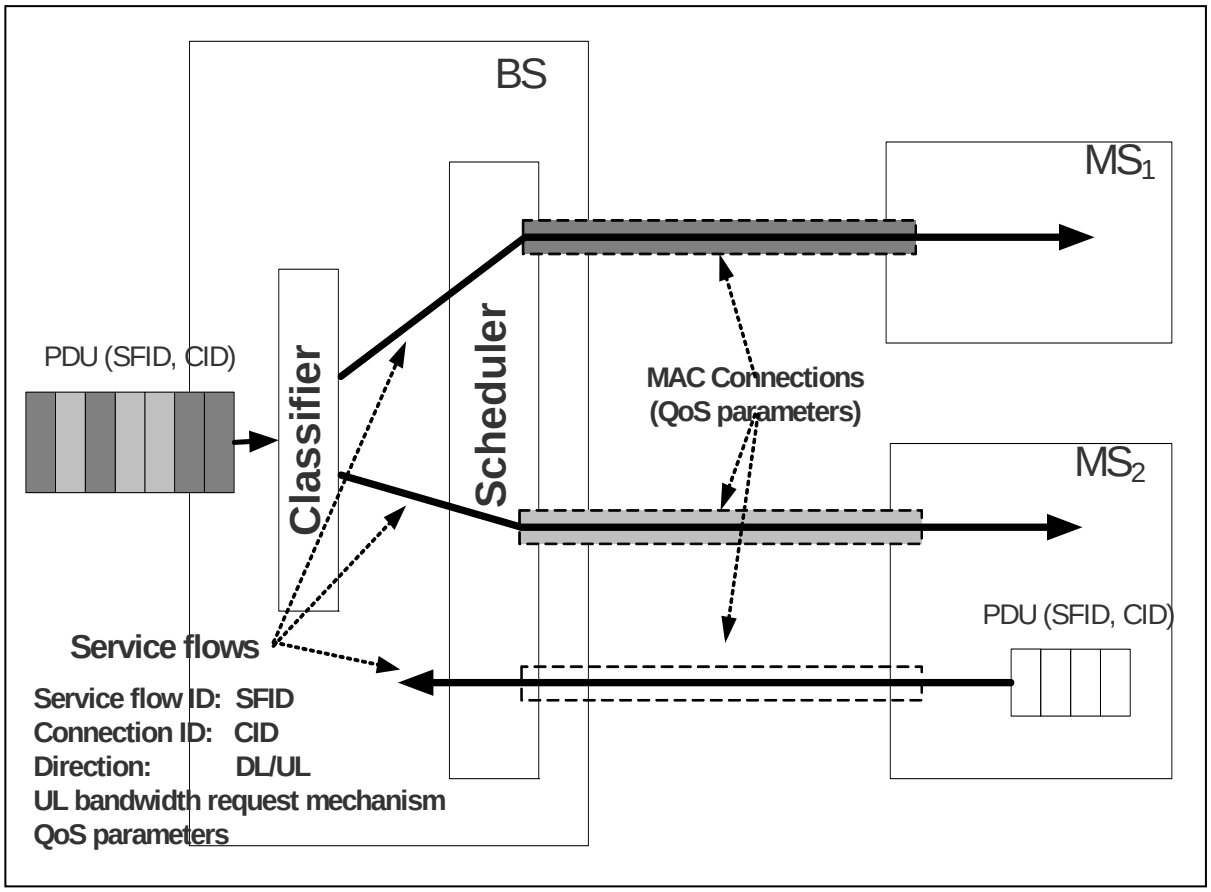


**Figure 2-11 Mobile WiMAX QoS Support**

### 2.4.1 Quality of Service (QoS) Support

With fast air link, symmetric downlink/uplink capacity, fine resource granularity and a flexible resource allocation mechanism, Mobile WiMAX can meet QoS requirements for a wide range of data services and applications.

In the Mobile WiMAX MAC layer, QoS is provided via service flows as illustrated in Figure 2-11. A service flow is a unidirectional flow of packets provided with a particular set of QoS

parameters. Before providing a certain type of data service, the BS and MS first establish a unidirectional logical link between the peer MACs, called a connection. The outbound MAC then associates packets traversing the MAC interface into a service flow to be delivered over the connection. The QoS parameters associated with the service flow define the transmission ordering and scheduling on the air interface. The connection-oriented MAC can therefore provide accurate QoS control over the air interface. Since the air interface is usually the bottleneck, the connection-oriented MAC can effectively enable end-to-end QoS control. The service flow parameters can be dynamically managed through MAC messages to accommodate the dynamic service demand. The service flow based QoS mechanism applies to both DL and UL to provide improved QoS in both directions. Mobile WiMAX supports a wide range of data services and applications with varied QoS requirements. These are summarized in Table 2-6.

**Table 2-6 Mobile WiMAX Applications and Quality of Service**

| QoS Category | Applications | QoS Specifications |
|---|---|---|
| UGS: Unsolicited Grant Service | VoIP | Maximum Sustained Rate<br>Maximum Latency Tolerance<br>Jitter Tolerance |
| rtPS: Real-Time Packet Service | Streaming Audio or Video | Minimum Reserved Rate<br>Maximum Sustained Rate<br>Maximum Latency Tolerance<br>Traffic Priority |
| ErtPS: Extended Real-Time Packet Service | Voice with Activity Detection (VoIP) | Minimum Reserved Rate<br>Maximum Sustained Rate<br>Maximum Latency Tolerance<br>Jitter Tolerance<br>Traffic Priority |
| nrtPS: Non-Real-Time Packet Service | File Transfer Protocol (FTP) | Minimum Reserved Rate<br>Maximum Sustained Rate<br>Traffic Priority |
| BE: Best-Effort Service | Data Transfer, Web Browsing, etc. | Maximum Sustained Rate<br>Traffic Priority |

### 2.4.2 MAC Scheduling Service

The Mobile WiMAX MAC scheduling service is designed to efficiently deliver time-sensitive broadband data services including voice, data, and video over time-varying broadband wireless channel. The MAC scheduling service has the following properties that enable this real-time broadband data service:

- Fast Data Scheduler: The MAC scheduler must efficiently allocate available resources in response to bursty data traffic and time-varying channel conditions. The scheduler is located at each BS to enable rapid response to traffic requirements and channel conditions. The data packets are associated to service flows with well defined QoS parameters in the MAC layer so that the scheduler can correctly determine the packet transmission ordering over the air interface. The CQICH channel provides fast channel information feedback to enable the scheduler to choose the appropriate coding and modulation for each allocation. The adaptive modulation/coding combined with HARQ provide robust transmission over the time-varying channel.
- Scheduling for both DL and UL: The scheduling service is provided for both DL and UL traffic. In order for the MAC scheduler to make an efficient resource allocation and provide the desired QoS in the UL, the UL must feedback accurate and timely information as to the traffic conditions and QoS requirements. Multiple uplink bandwidth request mechanisms (such as bandwidth request through ranging channel, piggyback request, and polling) are specified. The UL service flow defines the feedback mechanism for each uplink connection to ensure predictable UL scheduler behavior. Furthermore, with orthogonal UL subchannels, there is no intra-cell interference. UL scheduling can allocate resource more efficiently and better enforce QoS.
- Dynamic Resource Allocation: The MAC supports frequency-time resource allocation in both DL and UL on a per-frame basis. The resource allocation is delivered in MAP messages at the beginning of each frame. Therefore, the resource allocation can be changed on frame-by-frame in response to traffic and channel conditions. Additionally, the amount of resource in each allocation can range from one slot to the entire frame. The fast and fine granular resource allocation allows superior QoS for data traffic.
- UL and DL QoS: The MAC scheduler handles data transport on a connection-by-connection basis. Each connection is associated with a single data service with a set of QoS parameters that quantify the aspects of its behavior. With the ability to dynamically allocate resources in both DL and UL, the scheduler can provide QoS for both DL and UL traffic.
- Frequency Selective Scheduling: The scheduler can operate on different types of subchannels. For frequency-diverse subchannels such as PUSC permutation, where sub-carriers in the subchannels are pseudo-randomly distributed across the bandwidth, subchannels are of similar quality. Frequency-diversity scheduling can support a QoS with fine granularity and flexible time-frequency resource scheduling. With contiguous permutation such as AMC permutation, the subchannels may experience different attenuation. The frequency-selective scheduling can allocate mobile users to their

corresponding strongest subchannel. The frequency-selective scheduling can enhance system capacity with a moderate increase in CQI overhead in the UL.

- Admission Control: Admission Control admits service flows based on resource availability. That is, a service flow is either admitted or rejected during service flow creation transaction. Admission Control is implemented on the various network elements: Server, BS and MS.
- Policing: A service flow is prohibited from injecting data traffic that exceeds its Maximum Sustained Traffic Rate. Policing enforces this restriction.

### 2.4.3 Power control and boosting

Mobile WiMAX defines two modes of power control.

- Closed Loop Power Control, in which the BSs regularly adjusts the transmission level of each terminals based on the measurements done on received data from this terminal.
- Open Loop Power Control, in which the terminal adjusts its transmission level based on the signal strength measured on the received preamble from the serving BS. The serving BS is furthermore allowed to correct this transmission level, based on received signal strength. This correction is normally performed at very low frequency rate, enough to meet the requirement of the BS.

Furthermore, power boosting on data is a mechanism that can be used by the BS in order to extend its coverage. It is particularly convenient in an OFDMA scheme, where some subchannels can be boosted and some others attenuated, on the same OFDM symbol(s). The BS is hence able to use such boosting for further increasing the granularity of its link adaptation and the network load balancing.

### 2.4.4 Mobility Management

Battery life and handover are two critical issues for mobile applications. Mobile WiMAX supports Sleep Mode and Idle Mode to enable power-efficient MS operation. Mobile WiMAX also supports seamless handover to enable the MS to switch from one BS to another at vehicular speeds without interrupting the connection.

### 2.4.5 Power Management

Mobile WiMAX supports two modes for power efficient operation – Sleep Mode and Idle Mode. Sleep Mode is a state in which the MS conducts pre-negotiated periods of absence from the Serving BS air interface. These periods are characterized by the unavailability of the MS, as

observed from the Serving BS, to DL or UL traffic. Sleep Mode is intended to minimize MS power usage and minimize the usage of the Serving BS air interface resources. The Sleep Mode also provides flexibility for the MS to scan other BSs to collect information to assist handover during the Sleep Mode.

Idle Mode provides a mechanism for the MS to become periodically available for DL broadcast traffic messaging without registration at a specific BS as the MS traverses an air link environment populated by multiple BSs. Idle Mode benefits the MS by removing the requirement for handover and other normal operations and benefits the network and BS by eliminating air interface and network handover traffic from essentially inactive MSs while still providing a simple and timely method (paging) for alerting the MS about pending DL traffic.

### 2.4.6 Handover

There are three handover methods supported within the IEEE 802.16 standard – Hard Handover, Fast BS Switching, and Macro Diversity Handover. Of these, the HHO is mandatory.

WiMAX Forum Mobile System Profile specifies a set of techniques for optimizing handover within the framework of the IEEE 802.16. These improvements have been developed with the goal of keeping Layer 2 handover delays to less than 50 milliseconds.

When FBSS (Fast Base Station Switching) is supported, the MS and BS maintain a list of BSs that are involved in FBSS with the MS. This set is called an Active Set. In FBSS, the MS continuously monitors the BSs in the Active Set. Among the BSs in the Active Set, an Anchor BS is defined. When operating in FBSS, the MS communicates only with the Anchor BS for uplink and downlink messages, including management and traffic connections. Transition from one Anchor BS to another (i.e. BS switching) is performed without invocation of explicit HO signaling messages. Anchor update procedures are enabled by communicating signal strength of the serving BS via the CQICH. A FBSS handover begins with a decision by an MS to receive or transmit data from the Anchor BS that may change within the active set. The MS scans the neighbor BSs and selects those that are suitable to be included in the active set. The MS reports the selected BSs and the active set update procedure is performed by the BS and MS. The MS continuously monitors the signal strength of the BSs that are in the active set and selects one BS from the set to be the Anchor BS. The MS reports the selected Anchor BS on CQICH or MS initiated HO request message. An important requirement of FBSS is that the data is simultaneously transmitted to all members of an active set of BSs that are able to serve the MS.

### 2.4.7 Security

Mobile WiMAX supports mutual device/user authentication, flexible key management

protocol, strong traffic encryption, control and management plane message protection, and security protocol optimizations for fast handovers.

The usage aspects of the security features are:

- Key Management Protocol: Privacy and Key Management Protocol Version 2 is the basis of Mobile WiMAX security as defined in the IEEE 802.16. This protocol manages the MAC security using PKM (Public Key Management)-REQ/RSP (Request/Response) messages. PKM EAP (Extensible Authentication Protocol) authentication, Traffic Encryption Control, Handover Key Exchange, and Multicast/Broadcast security messages all are based on this protocol.
- Device/User Authentication: Mobile WiMAX supports Device and User Authentication using the IETF EAP protocol, providing support for credentials that are based on a SIM, USIM, Digital Certificate, or User Name/Password. Corresponding EAP-SIM, EAP-AKA (Extensible Authentication Protocol-Authentication and Key Agreement), EAP-TLS (Extensible Authentication Protocol-Transport Layer Security), or EAP-MSCHAPv2 (Extensible Authentication Protocol-Microsoft Challenge Handshake Authentication Protocol Version 2) authentication methods are supported through the EAP protocol. Key deriving methods are the only EAP methods supported.
- Traffic Encryption: AES-CCM (Advanced Encryption Standard-Counter with Cipher-block chaining Message authentication code) is the cipher used for protecting all the user data over the Mobile WiMAX MAC interface. The keys used for driving the cipher are generated from the EAP authentication. A Traffic Encryption state machine with a periodic key refresh mechanism enables sustained transition of keys to further improve protection.
- Control Message Protection: Control data is protected using AES based CMAC (block Cipher-based Message Authentication Code) or MD5-based HMAC schemes.
- Fast Handover Support: A 3-way handshake scheme is supported by Mobile WiMAX to optimize the re-authentication mechanisms for supporting fast handovers. This mechanism is also useful to prevent man-in-the-middle-attacks.

## 2.5 Enhancements in the WiMAX Forum System Profile Release 1.5

- FDD mode of operation: The WiMAX deployment in paired spectrum by extending the TDD based system profile is enabled.
- Advanced services: Location based service and improved multicast/broadcast services are added.
- MAC layer efficiency: MAP overhead is lowered especially for VoIP traffic and reduction of latencies

- Closed-loop MIMO: Closed-loop MIMO is included to improve coverage and capacity.

## 2.6 Low Power Repeater

### 2.6.1 Outline

The Low Power Repeaters for Mobile WiMAX are operated in the frequency band of 2.5GHz which are assigned for BWA system in Regenerative and Non-regenerative relay manner. The requirements are compliant to the paragraphs 3.3, Regulation Article 49.28 of the ORE and other related Regulation Articles.

### 2.6.2 Configuration

The Mobile WiMAX repeater consists of Toward Base Station Node and Toward Mobile Station Node and antennas in both uplink and downlink directions. The scope of this standard is shown in Figure 2-12. This standard specifies the minimum radio-frequency performance requirements of the Mobile WiMAX repeater to be deployed under the blanket license in Japan.

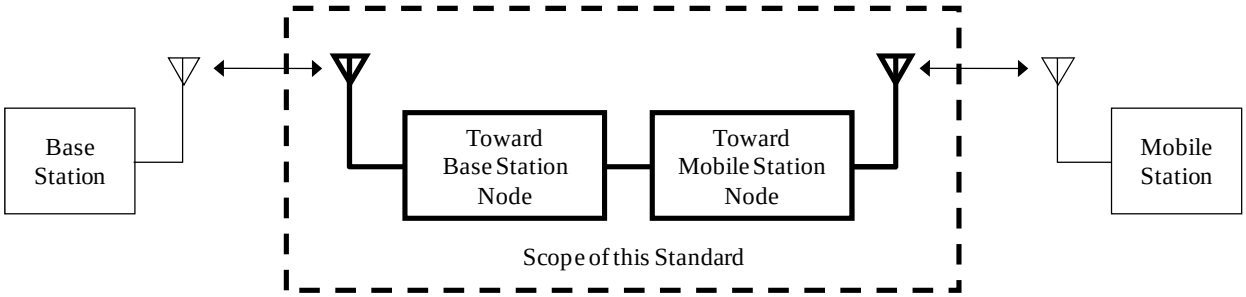


**Figure 2-12 Repeater Configuration**

# Chapter 3 Technical Requirements for WiMAX Systems

For the mobile communications system of a WiMAX system using the 2.5 GHz band, the following prerequisites shall be satisfied.

This chapter is translated into English from the original regulations contained in MIC Ordinances and related Notifications. The original in Japanese shall prevail if any ambiguity exists between the following requirements and the original in Japanese.

## 3.1 Overview

It is assumed that the types of radio equipment are as follows:

<1> Mobile station

<2> Base station

<3> Repeater station (radio station that relays a signal when direct broadband mobile radio communications between a BS and a MS is not possible. The technical prerequisites for MSs shall apply to the upstream links, while those for the BS shall apply to the downstream links.)

## 3.2 General condition

(1) Communications system

Time Division Duplex (TDD) system

(2) Frequency (ORE, Article 49.28)

2545MHz – 2625MHz

(3) Multiplexing system

a Mobile station (upstream link)

Orthogonal Frequency Division Multiple Access (OFDMA) system

b Base station (downstream link)

Composite system using an Orthogonal Frequency Division Multiplexing (OFDM) system and a Time Division Multiplexing (TDM) system

(4) Modulation system (ORE, Article 49.28)

a Mobile station (upstream link)

QPSK or 16QAM

b Base station (downstream link)

BPSK, QPSK, 16QAM, or 64QAM

(5) Transmission synchronization

a Transmission burst repetition period

5 ms

b The transmission burst lengths for Base stations and Mobile stations in Table 3-1 (NT No.651,2007)

**Table 3-1 Maximum Permissible Transmission Burst Length**

| Maximum permissible transmission burst length [ms] | |
|---|---|
| Base station | Mobile station |
| 3.65 | 1.35 |
| 3.55 | 1.45 |
| 3.45 | 1.55 |
| 3.35 | 1.65 |
| 3.25 | 1.75 |
| 3.15 | 1.85 |
| 3.05 | 1.95 |
| 2.95 | 2.05 |
| 2.85 | 2.15 |
| 2.75 | 2.25 |

Transmission Burst Lengths Tolerance

Base Station: +10μs or less, -90μs or over

Mobile Station: +10μs or less, -130μs or over

(6) Authentication, secrecy, and information security

The assignment of numbers specific to mobile station equipment so as to prevent unauthorized use, the application of authentication procedures, the use of secrecy functions for communications information, and other appropriate measures shall be implemented.

(7) Electromagnetic measures

Sufficient consideration shall be given to the mutual electromagnetic interference between Mobile stations and automotive electronic devices and medical electronic devices.

(8) Conformance to the radio radiation protection guidelines

Mobile stations, as well as devices using radio waves shall conform to Regulations for Enforcement of the Radio Law, Article 21.3 and Ordinance Regulating Radio Equipment, Article 14.2.

(9) Mobile station identification numbers

It is preferable for the procedures for assigning and subsequently sending identification numbers to Mobile stations be established with sufficient consideration given to the selection of networks by users, roaming, the assurance of communications security, the supervision of radio stations, and so on.

(10) Stopping emission of radio waves in the event of a fault in a Mobile station's transmission equipment

The functions below shall be executed at the same time, but independently of each other.

a Function whereby, if a Base station detects an error in a Mobile station, the Base station issues a request to that Mobile station to stop transmission.

b Function whereby, if a Mobile station itself detects an internal error, the Mobile station stops transmission upon the timeout of the error detection timer.

(11) Structure of transmitter

The main part of the transmit device (RF and Modem devices, except Antenna device) shall not be opened easily.

(12) Functions to ensure Model-1 Mobile station to be used only indoor coverage

As a general rule, input power source for Model-1 Mobile station shall be AC (alternate current). However, for Mobile station that require DC power source shall not start its operation before it receives operation starting signal from the parent device. ( PC etc.)

(13) Definitions of the Models for Fixed Wireless Access system with antenna gain for Mobile station more than 2dBi.

In case of the Mobile station communicating with the Base station whose antenna gain is 17dBi or less;

- Model-1 Mobile station: Radio equipment with more than 2dBi and 10dBi or less antenna gain.
- Model-2 Mobile station: Radio equipment with more than 10dBi antenna gain.

In case of the Mobile station communicating with the Base station whose antenna gain is more than 17dBi.

Model-3 Mobile station: Radio equipment with more than 17dBi and 25dBi or less antenna gain.

(14) Restrictions on FWA system deployment (NT No.651, 2007)

a Restrictions for Base stations

Note 1: Following Base stations shall be limited for use in depopulated areas, mountain villages, isolated island areas or the areas authorized by Minister of Internal Affairs and Communications.

- The Base station that communicates with the Mobile station with 2dBi or greater antenna gain or repeater station.
- The Base station whose antenna gain is greater than 17dBi.

Note 2: The Base station whose antenna gain is greater than 17dBi shall only communicate with only a single radio station.

b Restrictions for Mobile stations

In case of Mobile station that communicates with the Base station with the antenna gain of 17dBi or less.

Note 1: Mobile station with the antenna gain of greater than 2dBi but not exceeding 10dBi shall be limited for use in a closed environment or equivalent place.

Note 2: Mobile station whose antenna gain is more than 2dBi shall be limited for use in depopulated areas, mountain villages, isolated islands or the areas authorized by Minister of Internal Affairs and Communications.

Note 3: Mobile station whose antenna gain is greater than 2dBi shall not start its operation under any Base station that is installed in places other than those specified in Note 2. At least one of the functions below should be implemented for this purpose.

- Function to enable the Mobile station with high gain antenna to determine, by using WiMAX broadcast message, whether the area is authorized or not.

- Function to enable terminal authentication on the network side to deny the network entry by the high gain antenna Mobile stations within the unauthorized area, if it is agreed upon between WiMAX operators.

- Other functions which have been agreed upon between the WiMAX operators.

In case of Mobile station that communicates with the Base station whose antenna gain is greater than 17dBi

Note 1: Mobile station shall be limited for use in depopulated areas, mountain villages, isolated islands or the areas authorized by Minister of Internal Affairs and Communications.

Note 2: Mobile station shall not start operation under any Base station that is installed in places other than those specified in Note 1. At least one of the functions below should be implemented for this purpose.

- Function to enable the Mobile station to determine, by using WiMAX broadcast message, whether the area is authorized or not.

- Function to enable terminal authentication on the network side to deny the network entry by the Mobile stations within the unauthorized area, if it is agreed upon between WiMAX operators.

- Other functions which have been agreed upon between the WiMAX operators.

### 3.2.1 Transmitter requirement for Mobile WiMAX equipment

#### 3.2.1.1 Frequency tolerance (ORE, Article 5,Table 1)

Mobile station: Within 2 x $10^{-6}$

Base station: Within 2 x $10^{-6}$

#### 3.2.1.2 Occupied band width (ORE, Article 6,Table 2)

5 MHz system: 4.9 MHz or less

10 MHz system: 9.9 MHz or less

#### 3.2.1.3 Output power (ORE, Article 49.28)

Mobile station: 200 mW or less

Base station: 20 W or less

#### 3.2.1.4 Output power tolerance (ORE, Article 14)

Mobile station: ±50%

Base station: ±50%

#### 3.2.1.5 Adjacent channel leakage power (NT No.651,2007)

(1) Mobile station

(i) 5MHz system

Channel space: 5MHz

Occupied bandwidth: 4.8MHz

Permissible adjacent channel leakage power: 2dBm or less

(ii) 10MHz system

Channel space: 10MHz

Occupied bandwidth : 9.5MHz

Permissible adjacent channel leakage power: 0dBm or less

(2) Base station

(i) 5MHz system

Channel space: 5MHz

Occupied bandwidth: 4.8MHz

Permissible adjacent channel leakage power: 7dBm or less

(ii) 10MHz system

Channel space: 10MHz

Occupied bandwidth: 9.5MHz

Permissible adjacent channel leakage power: 3dBm or less

3.2.1.6 Spectrum mask (NT No.651, 2007)

(1) Mobile station

(i) 5MHz system

| offset frequency: Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 8MHz, | less than -20-2.28x(Δf-7.5) dBm/MHz |
| 8MHz or more and less than 17.5MHz, | less than -21-1.68x(Δf-8) dBm/MHz |
| 17.5MHz or more and less than 22.5MHz, | less than -37dBm/MHz |

(ii) 10MHz system

| offset frequency: Δf | Permissible level |
|---|---|
| 15MHz or more and less than 20MHz, | less than -21-32/19x(Δf-10.5) dBm/MHz |
| 20MHz or more and less than 25MHz, | less than -37dBm/MHz |

(2) Base station

(i) 5MHz system

| offset frequency: Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 12.25MHz, | less than -15-1.4x(Δf-7.5) dBm/MHz |
| 12.25MHz or more and less than 22.5MHz, | less than -22dBm/MHz |

(ii) 10MHz system

| offset frequency: Δf | Permissible level |
|---|---|
| 15MHz or more and less than 25MHz, | less than -22dBm/MHz |

### 3.2.1.7 Spurious emission (NT No.651,2007)

(1) Mobile station

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | less than -13dBm/kHz |
| 150kHz or more and less than 30MHz, | less than -13dBm/10kHz |
| 30MHz or more and less than 1000MHz, | less than -13dBm/100kHz |
| 1000MHz or more and less than 2505MHz, | less than -13dBm/MHz |
| 2505MHz or more and less than 2530MHz, | less than -37dBm/MHz |
| 2530MHz or more and less than 2535MHz, | less than 1.7f-4338 dBm/MHz |
| 2535MHz or more and less than 2630MHz, | less than -18dBm/MHz |
| 2630MHz or more and less than 2630.5MHz, | less than -13-8/3.5x(f-2627) dBm/MHz |
| 2630.5MHz or more and less than 2640MHz, | less than -21-16/9.5x(f-2630.5) dBm/MHz |
| 2640MHz or more and less than 2655MHz, | less than -37dBm/MHz |
| 2655MHz or more, | less than -13dBm/MHz |

Permissible level for 2535MHz or more and less than 2630MHz should be applied to the frequency range where a frequency offset from the center frequency of a carrier is equal to or more than 2.5 times of the system frequency bandwidth.

(2) Base station

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | less than -13dBm/kHz |
| 150kHz or more and less than 30MHz, | less than -13dBm/10kHz |
| 30MHz or more and less than 1000MHz, | less than -13dBm/100kHz |
| 1000MHz or more and less than 2505MHz, | less than -13dBm/MHz |
| 2505MHz or more and less than 2535MHz, | less than -42dBm/MHz |
| 2535MHz or more and less than 2630MHz, | less than -13dBm/MHz |
| 2630MHz or more and less than 2634.75MHz, | less than -15-7/5x(f-2629.75) dBm/MHz |
| 2634.75MHz or more and less than 2655MHz, | less than -22dBm/MHz |
| 2655MHz or more, | less than -13dBm/MHz |

Permissible level for 2535MHz or more and less than 2630MHz should be applied to the frequency range where a frequency offset from the center frequency of a carrier is equal to or more than 2.5 times of the system frequency bandwidth.

#### 3.2.1.8 Intermodulation (NT No.651, 2007)

(1) 5 MHz System

Intermodulation emission generated by mixing a desirable emission within regulated power and disturbing waves at ±5MHz offset and at ±10 MHz offset from the desired emission with powers of 30dB less than that of desirable emission should be less than permissible level of the spurious emission and adjacent channel leakage power.

(2) 10 MHz system

Intermodulation emission generated by mixing a desirable emission within regulated power and disturbing waves at ±10MHz offset and at ±20 MHz offset from the desired emission with powers of 30dB less than that of desirable emission should be less than permissible level of the spurious emission and adjacent channel leakage power.

#### 3.2.1.9 Standby output power (ORE, Article 49.28)

Mobile station: -30dBm or less

Base station: -30dBm or less

#### 3.2.1.10 Antenna gain (ORE, Article 49.28)

Mobile station: 2dBi or less

Base station: 17dBi or less

#### 3.2.1.11 Cabinet radiation

Cabinet radiation in EIRP shall be 4nW/MHz or less or the value obtained by adding 0dBi to the permissible spurious emission* in the spurious region measured at the antenna input terminal.

(* Refer to subclause 3.2.1.7 for the spurious emission.)

### 3.2.2 Receiver requirement for Mobile WiMAX equipment

#### 3.2.2.1 Reception sensitivity

(1) Definition

The reception sensitivity shall be defined by the minimum receiver input level (dBm) which yields a bit error rate (BER) of 1x10-6 for the QPSK case under AWGN channel. This is the definition for the specified reception sensitivity as well.

(2) Specification

5MHz bandwidth system

Mobile station: -91.3dBm or less

Base station: -91.3dBm or less

10MHz bandwidth system

Mobile station: -88.3dBm or less

Base station: -88.3dBm or less

#### 3.2.2.2 Spurious response rejection ratio

(1) Definition

The spurious response rejection ratio shall be defined as the level ratio of the interfering signal to the desired signal, specified by the following statement:

The level of desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The level of interfering signal shall be the one yielding a bit error rate of 1x10-6 on the desired signal for the QPSK case. The interfering signal shall not be modulated.

(* Refer to subclause 3.2.2.1 for the specified reception sensitivity.)

(2) Specification

Mobile station: The spurious response rejection ratio shall be 11dB or more.

Base station: The spurious response rejection ratio shall be 11dB or more.

#### 3.2.2.3 Adjacent signal selectivity

(1) Definition

The adjacent signal selectivity shall be defined as the level ratio of the interfering signal to the desired signal, specified by the following statement:

The level of desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The level of interfering signal shall be the one yielding a bit error rate of 1x10-6 on the desired signal for 16QAM. The interfering signal shall be 16QAM and tuned on the first adjacent channel.

(* Refer to Section 3.2.2.1 for the specified reception sensitivity)

(2) Specification

Mobile stations: The adjacent signal selectivity shall be 11dB or more.

Base station: The adjacent signal selectivity shall be 11dB or more.

#### 3.2.2.4 Intermodulation performance

(1) Definition

The intermodulation performance shall be defined as the level of the interfering signal, specified by the following statement:

The level of desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The level of each one of two interfering signals shall be the one yielding a bit error rate of 1x10-6 on the desired signal. The interfering signals shall be tuned on the first and second adjacent channel.

(* Refer to Section 3.2.2.1 for the specified reception sensitivity)

(2) Specification

Mobile stations:

The non-modulated interfering signal on the first adjacent channel shall be -55dBm.

The modulated interfering signal on the second adjacent channel shall be -55dBm.

Base station:

The non-modulated interfering signal on the first adjacent channel shall be -45dBm.

The modulated interfering signal on the second adjacent channel shall be -45dBm.

#### 3.2.2.5 Conducted Spurious (ORE, Article 24)

| | |
|---|---|
| Less than 1GHz: | 4nW or less |
| 1GHz or more: | 20nW or less |

### 3.2.3 Transmitter requirement for FWA equipment

#### 3.2.3.1 Frequency tolerance (ORE, Article 5,Table 1)

| | |
|---|---|
| Land mobile station: | Within 2 x $10^{-6}$ |
| Base station: | Within 2 x $10^{-6}$ |

#### 3.2.3.2 Occupied band width (ORE, Article 6,Table 2)

| | |
|---|---|
| 5 MHz system: | 4.9 MHz or less |
| 10 MHz system: | 9.9 MHz or less |

3.2.3.3 Output power (ORE, Article 49.28)

Land mobile station

Model-1: 200mW or less

Model-2:

Antenna gain

20dBi or less: 200mW or less

More than 20dBi and 23dBi or less: 100mW or less

More than 23dBi and 25dBi or less: 63mW or less

Model-3 :

Antenna gain

23dBi or less: 200mW or less

More than 23dBi and 25dBi or less: 126mW or less

Base station

Antenna gain

17dBi or less: 20W or less

However that only for Model-3, output power is specified as follows.

More than 17dBi and 20dBi or less: 10W or less

More than 20dBi and 23dBi or less: 5W or less

More than 23dBi and 25dBi or less: 3.2W or less

3.2.3.4 Output power tolerance (ORE, Article 14)

Land mobile station: ±50%

Base station: ±50%

3.2.3.5 Adjacent channel leakage power (NT No.651, 2007)

(1) Mobile station

(i) 5MHz system

Channel space: 5MHz

Occupied bandwidth: 4.8MHz
Permissible adjacent channel leakage power: 2dBm or less
(ii) 10MHz system
Channel space: 10MHz
Occupied bandwidth: 9.5MHz
Permissible adjacent channel leakage power: 0dBm or less

(2) Base station
(i) 5MHz system
Channel space: 5MHz
Occupied bandwidth: 4.8MHz
Permissible adjacent channel leakage power: 7dBm or less
(ii) 10MHz system
Channel space: 10MHz
Occupied bandwidth: 9.5MHz
Permissible adjacent channel leakage power: 3dBm or less

3.2.3.6 Spectrum mask (NT No.651,2007)

(1) Mobile station
(i) 5MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 8MHz, | less than -20-2.28x(Δf-7.5) dBm/MHz |
| 8MHz or more and less than 17.5MHz, | less than -21-1.68x(Δf-8) dBm/MHz |
| 17.5MHz or more and less than 22.5MHz, | less than -37dBm/MHz |

(ii) 10MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 15MHz or more and less than 20MHz, | less than -21-32/19x(Δf-10.5) dBm/MHz |
| 20MHz or more and less than 25MHz, | less than -37dBm/MHz |

(2) Base station
(i) 5MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 12.25MHz, | less than -15-1.4x(Δf-7.5) dBm/MHz |
| 12.25MHz or more and less than 22.5MHz, | less than -22dBm/MHz |

(ii) 10MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 15MHz or more and less than 25MHz, | less than -22dBm/MHz |

3.2.3.7 Spurious emission (NT No.651, 2007)

(1) Mobile terminal

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | less than -13dBm/kHz |
| 150kHz or more and less than 30MHz, | less than -13dBm/10kHz |
| 30MHz or more and less than 1000MHz, | less than -13dBm/100kHz |
| 1000MHz or more and less than 2505MHz, | less than -13dBm/MHz |
| 2505MHz or more and less than 2535MHz, | |
| For model-1 | less than -70dBm/MHz |
| For model-2 | less than -68dBm/MHz |
| For model-3 | less than -61dBm/MHz |
| 2535MHz or more and less than 2630MHz, | less than -18dBm/MHz |
| 2630MHz or more and less than 2630.5MHz, | less than -13-8/3.5x(f-2627) dBm/MHz |
| 2630.5MHz or more and less than 2640MHz, | less than -21-16/9.5x(f-2630.5) dBm/MHz |
| 2640MHz or more and less than 2655MHz, | less than -37dBm/MHz |
| 2655MHz or more, | less than -13dBm/MHz |

Permissible level for 2535MHz or more and less than 2630MHz should be applied to the frequency range where a frequency offset from the center frequency of a carrier is equal to or more than 2.5 times of the system frequency bandwidth.

(2) Base station

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | less than -13dBm/kHz |
| 150kHz or more and less than 30MHz, | less than -13dBm/10kHz |
| 30MHz or more and less than 1000MHz, | less than -13dBm/100kHz |
| 1000MHz or more and less than 2505MHz, | less than -13dBm/MHz |
| 2505MHz or more and less than 2535MHz, | less than -42dBm/MHz |
| 2535MHz or more and less than 2630MHz, | less than -13dBm/MHz |
| 2630MHz or more and less than 2634.75MHz, | less than -15-7/5x(f-2629.75) dBm/MHz |

2634.75MHz or more and less than 2655MHz, less than -22dBm/MHz
2655MHz or more, less than -13dBm/MHz

Permissible level for 2535MHz or more and less than 2630MHz should be applied to the frequency range where a frequency offset from the center frequency of a carrier is equal to or more than 2.5 times of the system frequency bandwidth.

3.2.3.8 Intermodulation (NT No.651,2007)

(1) 5 MHz System

Intermodulation emission generated by mixing a desirable emission within regulated power and disturbing waves at ±5MHz offset and at ±10 MHz offset from the desired emission with powers of 30dB less than that of desirable emission should be less than permissible level of the spurious emission and adjacent channel leakage power.

(2) 10 MHz system

Intermodulation emission generated by mixing a desirable emission within regulated power and disturbing waves at ±10MHz offset and at ±20 MHz offset from the desired emission with powers of 30dB less than that of desirable emission should be less than permissible level of the spurious emission and adjacent channel leakage power.

3.2.3.9 Standby output power (ORE, Article 49.28)

Mobile station: -30dBm or less
Base station: -30dBm or less

3.2.3.10 Antenna gain (ORE, Article 49.28)

Mobile station:
Model-1: 10dBi or less
Model-2: 25dBi or less
Model-3: 25dBi or less
Base station:
17dBi or less. However that only for Model-3, it shall 25dBi or less.

3.2.3.11 Cabinet radiation

During idle mode cabinet radiation shall not greater than following level.

| Spectrum band | Permissible level |
|---|---|
| 1000MHz or less: | -54dBm/MHz |
| More than 1000MHz and less than 2505MHz: | -47dBm/MHz |
| 2505MHz or more and 2535MHz or less: | |
| Model-1 | -62dBm/MHz |
| Model-2 | -50dBm/MHz |
| Model-3 | -47dBm/MHz |

### 3.2.4 Receiver requirement for FWA equipment

#### 3.2.4.1 Reception sensitivity

(1) Definition

The reception sensitivity shall be defined by the minimum receiver input level (dBm) which yields a bit error rate (BER) of 1x10-6 for QPSK under AWGN channel.
This is the definition for the specified reception sensitivity as well.

(2) Specification

5MHz bandwidth system

Mobile station : -91.3dBm or less
Base station: -91.3dBm or less

10MHz bandwidth system

Mobile station : -88.3dBm or less
Base station: -88.3dBm or less

#### 3.2.4.2 Conducted Spurious (ORE, Article 24)

During reception mode, output power level at the antenna port shall not greater than following level.

Mobile station

| Spectrum band | Permissible level |
|---|---|
| 9kHz or more and less than 150kHz | -54dBm/kHz |
| 150kHz or more and less than 30MHz | -54dBm/10kHz |
| 30MHz or more and less than 1000MHz | -54dBm/100kHz |
| 1000MHz or more and less than 2505MHz | -47dBm/MHz |
| 2505MHz or more and 2535MHz or less; | |

| | |
|---|---|
| Model-1 | -70dBm/MHz |
| Model-2 | -68dBm/MHz |
| Model-3 | -61dBm/MHz |
| More than 2535MHz | -47dBm/MHz |

Base station

(i) Antenna gain is 17dBi or less

| Spectrum band | Permissible level |
|---|---|
| 1GHz or less | 4nW |
| More than 1GHz | 20nW |

(ii) Antenna gain is more than 17dBi

| Spectrum band | Permissible level |
|---|---|
| 9kHz or more and less than 150kHz | -54dBm/kHz |
| 150kHz or more and less than 30MHz | -54dBm/10kHz |
| 30MHz or more and less than 1000MHz | -54dBm/100kHz |
| 1000MHz or more and less than 2505MHz | -47dBm/MHz |
| 2505MHz or more and 2535MHz or less | -61dBm/MHz |
| More than 2535MHz | -47dBm/MHz |

## 3.3 Low Power Repeater

This section applies only to the Mobile WiMAX repeaters, which complies with the requirements for the blanket license in Japan. The Mobile WiMAX repeaters are utilized to improve the radio access environments.
Unless otherwise stated, all requirements in this standard apply to both the uplink and downlink directions.

### 3.3.1 General Condition

(1) Frequency and channel spacing

The operating frequency bands shall be 2.5GHz bands assigned for the BWA system excluding the 20MHz system and the FWA system. The channel spacing shall be 5MHz or 10MHz.

(2) Type of Repeating

The repeater shall be of Non-regenerative and Generative repeating type.

**Table 3-2 Type of Repeating**

| Type of Repeating | Non-regenerative repeating | | Generative repeating | |
|---|---|---|---|---|
| Relay frequency | Same frequency | Different frequency | Same frequency | Different frequency |
| Number of channels | 3 channels (max) | | 3 channels (max) | |
| Configuration | Integrated or separated type | | Integrated or separated type | |

(3) Communications system

Time Division Duplex (TDD) system

(4) Multiplexing system

a. Toward Base station (upstream link)

Orthogonal Frequency Division Multiple Access (OFDMA) system

b. Toward Mobile station (downstream link)

Composite system using an Orthogonal Frequency Division Multiplexing (OFDM) system and a Time Division Multiplexing (TDM) system

(5) Modulation system (ORE, Article 49.28)

a. Toward Base station (upstream link)

QPSK or 16QAM

b. Toward Mobile station (downstream link)

BPSK, QPSK, 16QAM or 64QAM

(6) Transmission synchronization

a. Transmission burst repetition period

5 ms±10μs or less

b. The transmission burst lengths for Mobile stations and Base stations in Table 3-3 (NT No.651,2007)

**Table 3-3 Maximum Permissible Transmission Burst Length**

| Maximum permissible transmission burst length [ms] | |
|---|---|
| Toward Mobile station | Toward Base station |
| 3.65 | 1.35 |
| 3.55 | 1.45 |
| 3.45 | 1.55 |
| 3.35 | 1.65 |
| 3.25 | 1.75 |
| 3.15 | 1.85 |
| 3.05 | 1.95 |
| 2.95 | 2.05 |
| 2.85 | 2.15 |
| 2.75 | 2.25 |

3.3.1.1 System condition

(1) Maximum number of repeaters (in case of Non-regenerative repeating type)

Maximum number of repeaters per Base station shall be 100.

(2) Compliance with the radio protection guidelines

The repeater shall conform to the Regulations for Enforcement of the Radio Law, Article 21.3 and Ordinance Regulating Radio Equipment, Article 14.2.

3.3.2 Transmitter Requirement for Low Power Repeater

3.3.2.1 Frequency tolerance (ORE, Article 5, Table1)

Downstream link (Toward Mobile station): Within $2x10^{-6}$

Upstream link (Toward Base station): Within $2x10^{-6}$

3.3.2.2 Occupied band width (ORE, Article 6,Table 2)

5 MHz system: 4.9 MHz or less

10 MHz system: 9.9 MHz or less

3.3.2.3 Output power (ORE, Article 49.28)

(1) Non-regenerative repeating

Downstream link (Toward Mobile station): 200mW or less*

Upstream link (Toward Base station): 200mW or less*

*Total power is the aggregate of the output power of the downstream and upstream links. And the maximum number of the transmission channel is 3,when operated simultaneously.

(2) Regenerative repeating

Downstream link (Toward Mobile station): Less than 200mW*

Upstream link (Toward Base station): Less than 200mW*

*Total power is the aggregate of the output power of the downstream and upstream links. And the maximum number of transmission channel is 3, when operated simultaneously.

3.3.2.4 Output power tolerance (ORE, Article 14)

Downstream link (Toward Mobile station): ±50%

Upstream link (Toward Base station): ±50%

3.3.2.5 Adjacent channel leakage power (NT No.651, 2007)

(1) Downstream link (Toward Mobile station)

(i) 5MHz system

Channel space: 5MHz

Occupied bandwidth : 4.8MHz

Permissible adjacent channel leakage power: 2dBm or less

(ii) 10MHz system

Channel space: 10MHz

Occupied bandwidth : 9.5MHz

Permissible adjacent channel leakage power: 0dBm or less

(2) Upstream link (Toward Base station)

(i) 5MHz system

Channel space: 5MHz

Occupied bandwidth : 4.8MHz

Permissible adjacent channel leakage power: 2dBm or less

(ii) 10MHz system

Channel space: 10MHz

Occupied bandwidth : 9.5MHz

Permissible adjacent channel leakage power: 0dBm or less

3.3.2.6 Spectrum mask (NT No.651, 2007)

(1) Downstream link (Toward Mobile station)

(i) 5MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 8MHz, | -20-2.28x(Δf-7.5) dBm/MHz or less |
| 8MHz or more and less than 17.5MHz, | -21-1.68x(Δf-8) dBm/MHz or less |
| 17.5MHz or more and less than 22.5MHz, | -37 dBm/MHz or less |

(ii)10MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 15MHz or more and less than 20MHz, | -21-32/19x(Δf-10.5) dBm/MHz or less |
| 20MHz or more and less than 25MHz, | -37 dBm/MHz or less |

(2) Upstream link (Toward Base station)

(i) 5MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 7.5MHz or more and less than 8MHz, | -20-2.28x(Δf-7.5) dBm/MHz or less |
| 8MHz or more and less than 17.5MHz, | -21-1.68x(Δf-8) dBm/MHz or less |
| 17.5MHz or more and less than 22.5MHz, | -37 dBm/MHz or less |

(ii)10MHz system

| offset frequency : Δf | Permissible level |
|---|---|
| 15MHz or more and less than 20MHz, | -21-32/19x(Δf-10.5) dBm/MHz or less |
| 20MHz or more and less than 25MHz, | -37 dBm/MHz or less |

3.3.2.7 Spurious emission (NT No.651, 2007)

(1) Downstream link (Toward Mobile station)

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | -13dBm/kHz or less |
| 150kHz or more and less than 30MHz, | -13dBm/10kHz or less |
| 30MHz or more and less than 1000MHz, | -13dBm/100kHz or less |
| 1000MHz or more and less than 2505MHz, | -13dBm/MHz or less |
| 2505MHz or more and less than 2530MHz, | -37dBm/MHz or less |
| 2530MHz or more and less than 2535MHz, | 1.7f-4338 dBm/MHz or less |
| 2535MHz or more and less than 2630MHz, | -18dBm/MHz or less * |

| | |
|---|---|
| 2630MHz or more and less than 2630.5MHz, | -13-8/3.5x(f-2627) dBm/MHz or less |
| 2630.5MHz or more and less than 2640MHz, | -21-16/9.5x(f-2630.5) dBm/MHz or less |
| 2640MHz or more and less than 2655MHz, | -37 dBm/MHz or less |
| 2655MHz or more, | -13 dBm/MHz or less |

*Permissible level for 2535MHz or above and below 2630MHz should be applied to the frequency range where the frequency offset from the center frequency of a carrier is equal to or larger than 2.5 times of the system frequency bandwidth

(2) Upstream link (Toward Base station)

| Frequency band | Permissible Level |
|---|---|
| 9kHz or more and less than 150kHz, | -13dBm/kHz or less |
| 150kHz or more and less than 30MHz, | -13dBm/10kHz or less |
| 30MHz or more and less than 1000MHz, | -13dBm/100kHz or less |
| 1000MHz or more and less than 2505MHz, | -13dBm/MHz or less |
| 2505MHz or more and less than 2530MHz, | -37dBm/MHz or less |
| 2530MHz or more and less than 2535MHz, | 1.7f-4338 dBm/MHz or less |
| 2535MHz or more and less than 2630MHz, | -18dBm/MHz or less * |
| 2630MHz or more and less than 2630.5MHz, | -13-8/3.5x(f-2627) dBm/MHz or less |
| 2630.5MHz or more and less than 2640MHz, | -21-16/9.5x(f-2630.5) dBm/MHz or less |
| 2640MHz or more and less than 2655MHz, | -37 dBm/MHz or less |
| 2655MHz or more, | -13 dBm/MHz or less |

*Permissible level for 2535MHz or above and below 2630MHz should be applied to the frequency range where the frequency offset from the center frequency of a carrier is equal to or more than 2.5 times of the system frequency bandwidth

3.3.2.8 Standby output power (ORE,Article 49.28)

Downstream link (Toward Mobile station): -30dBm or less

Upstream link (Toward Base station): -30dBm or less

3.3.2.9 Antenna gain (ORE,Article 49.28)

Downstream link (Toward Mobile station): 2dBi or less

Upstream link (Toward Base station): 2dBi or less

#### 3.3.2.10 Cabinet radiation

Cabinet radiation in EIRP shall be 4nW/MHz or less or the value obtained by adding 0dBi to the permissible spurious emission* in the spurious region measured at the antenna input terminal.

(* Refer to subclause 3.3.2.7 for the spurious emission.)

#### 3.3.2.11 Out of band gain (ORE Article 49.28)

In case of Non-regenerative repeating, out of band gain refers to the gain of the repeater outside the pass band. The gain outside the pass band shall not exceed the maximum level specified in the Table 3-4.

**Table 3-4 Out of band gain limits**

| Frequency Offset from the Edge Frequency, f_offset | Maximum Gain |
|---|---|
| 5MHz | 35dB |
| 10MHz | 20dB |
| 40MHz | 0dB |

#### 3.3.2.12 Intermodulation (NT No.651, 2007)

(1) 5 MHz System

Intermodulation emission generated by mixing the desirable emission within the regulated power limit and the disturbing waves at the ±5MHz offset and at the ±10 MHz offset from the desired emission with powers of 30dB less than that of the desirable emission should be less than the permissible level of the spurious emission and adjacent channel leakage power.

(2) 10 MHz system

Intermodulation emission generated by mixing the desirable emission within the regulated power limit and the disturbing waves at the ±10MHz offset and at the ±20 MHz offset from the desired emission with powers of 30dB less than that of the desirable emission should be less than the permissible level of the spurious emission and adjacent channel leakage power.

### 3.3.3 Receiver Requirement for Low Power Repeaters

#### 3.3.3.1 Reception sensitivity (in case of Regenerative repeating type)

The reception sensitivity shall be defined by the minimum receiver input level (dBm) which yields the bit error rate (BER) of 1x10-6 for QPSK under AWGN channel.

This is the definition for the specified reception sensitivity as well.

(1) Downstream link (Toward Mobile station)
5MHz system: -91.3dBm or less
10MHz system: -88.3dBm or less
(2) Upstream link (Toward Base station)
5MHz system: -91.3dBm or less
10MHz system: -88.3dBm or less

#### 3.3.3.2 Spurious response rejection ratio

The spurious response rejection ratio shall be defined as the level ratio of the interfering signal to the desired signal, specified by the following statement:
The level of the desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The level of the interfering signal shall be the one yielding the bit error rate of 1x10-6 on the desired signal for QPSK. The interfering signal shall not be modulated.
(* Refer to subclause 2.3.2.1 for the specified reception sensitivity.)

(1) Downstream link (Toward Mobile station)
The spurious response rejection ratio shall be 11dB or more.
(2) Upstream link (Toward Base station)
The spurious response rejection ratio shall be 11dB or more.

#### 3.3.3.3 Adjacent signal selectivity

The adjacent signal selectivity shall be defined as the level ratio of the interfering signal to the desired signal, specified by the following statement:
The level of the desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The level of the interfering signal shall be the one yielding the bit error rate of 1x10-6 on the desired signal for 16QAM . The interfering signal shall be 16QAM and tuned on the first adjacent channel.
(* Refer to Section 2.3.2.1 for the specified reception sensitivity)

(1) Downstream link (Toward Mobile station)
The adjacent signal selectivity shall be 11dB or more.

(2) Upstream link (Toward Base station)

The adjacent signal selectivity shall be 11dB or more.

#### 3.3.3.4 Intermodulation performance

The intermodulation performance shall be defined as the level of the interfering signal, specified by the following statement:

The level of the desired signal shall be set to +3 dB higher than the level of the specified reception sensitivity*. The respective level of the two interfering signals shall be the one yielding the bit error rate of 1x10-6 on the desired signal. The interfering signals shall be tuned on the first and second adjacent channel.

(* Refer to Section 3.3.3.1 for the specified reception sensitivity)

(1) Downstream link (Toward Mobile station)

The non-modulated interfering signal on the first adjacent channel shall be -55dBm.

The modulated interfering signal on the second adjacent channel shall be -55dBm.

(2) Upstreamlink (Toward Base station)

The non-modulated interfering signal on the first adjacent channel shall be -55dBm.

The modulated interfeing signal on the second adjacent channel shall be -55dBm.

#### 3.3.3.5 Conducted Spurious (ORE, Article 24)

| | |
|---|---|
| Less than 1GHz: | 4nW or less |
| 1GHz or more: | 20nW or less |

#### 3.3.3.6 Requirements for Blanket License Application

The repeater shall be equipped with operation interruption function which is to stop repeating except the data signal is received from the Base stations or the Mobile stations of the BWA operator.

#### 3.3.3.7 Requirements for Interference Avoidance to Other Radio Stations

The repeater shall be equipped with the runaway oscillation avoidance function which is to stop repeating in case the repeater emits distorted radio wave due to runaway oscillation.

# Chapter 4 System Profile

The system profile of the 2.5 GHz Mobile WiMAX is defined in "WiMAX Forum™ Mobile System Profile" provided by WiMAX Forum as shown in Attachment 3 which is linked to the following electrical document.

## 4.1 Release 1.0

Attachment 3-1 wimax_forum_mobile_system_profile_release 1.0 v1.40.pdf

## 4.2 Release 1.5

Attachment 3-2-1 WiMAX Forum™ Mobile System Profile Release 1.5 Common Part.pdf

Attachment 3-2-2 WiMAX Forum™ Mobile System Profile Release 1.5 TDD Part.pdf

# Chapter 5 Network Architecture

The End-to-End Network Systems Architecture of the 2.5 GHz Mobile WiMAX is defined in "WiMAX forum network architecture Stage 2-3" provided by WiMAX Forum as shown in Attachment 4 which is linked to the following electrical documents.

## 5.1 Release 1.0

Attachment 4-1-1 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-Abbreviations.pdf

Attachment 4-1-2 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-Part 0.pdf

Attachment 4-1-3 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-Part 1.pdf

Attachment 4-1-4 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-Part 2.pdf

Attachment 4-1-5 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-Part 3.pdf

Attachment 4-1-6 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-WiMAX Interworking with DSL.pdf

Attachment 4-1-7 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-3GPP - WiMAX Interworking.pdf

Attachment 4-1-8 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-2-3GPP2 - WiMAX Interworking.pdf

Attachment 4-1-9 End-to-End Network Systems Architecture Stage 2 R1.1.0-Stage-3.pdf

Attachment 4-1-10 End-to-End Network Systems Architecture Stage 2

R1.1.0-Stage-3-Annex- 3GPP-Interworking.pdf

Attachment 4-1-11 End-to-End Network Systems Architecture Stage 2
R1.1.0-Stage-3-Annex- 3GPP2-Interworking.pdf

Attachment 4-1-12 End-to-End Network Systems Architecture Stage 2
R1.1.0-Stage-3-Annex- Prepaid-Accounting.pdf

Attachment 4-1-13 End-to-End Network Systems Architecture Stage 2
R1.1.0-Stage-3-Annex- R6-R8-ASN-Anchored-Mobility-Scenarios.pdf

## 5.2 Release 1.5

Attachment 4-2-1 WiMAX Forum® Network Architecture Detailed Protocols and Procedures Base Specification WMF-T33-001-R015v01.pdf

Attachment 4-2-2 WiMAX Forum® Network Architecture Detailed Protocols and Procedures [Informative Annex: Hooks and Principles for Evolution] WMF-T33-004-R015v01.pdf

Attachment 4-2-3 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures IP Multimedia Subsystem (IMS) Interworking WMF-T33-101-R015v01.pdf

Attachment 4-2-4 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures Emergency Services Support WMF-T33-102-R015v02.pdf

Attachment 4-2-5 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures WiMAX Over-The-Air General Provisioning System Specification WMF-T33-103-R015v02.pdf

Attachment 4-2-6 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures WiMAX Over-The-Air Provisioning & Activation Protocol based on OMA DM Specifications WMF-T33-104-R015v02.pdf

Attachment 4-2-7 WiMAX Forum® Network Architecture Architecture, detailed Protocols

and Procedures Over-The-Air Provisioning & Activation Protocol based on TR-069 Specification WMF-T33-105-R015v01.pdf

Attachment 4-2-8 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures WIMAX Lawful Intercept - NORTH AMERICAN REGION WMF-T33-107-R015v01.pdf

Attachment 4-2-9 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures Robust Header Compression (RoHC) Support WMF-T33-108-R015v01.pdf

Attachment 4-2-10 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures Policy and Charging Control WMF-T33-109-R015v01.pdf

Attachment 4-2-11 WiMAX Forum® Network Architecture Protocols and Procedures for Location Based Services WMF-T33-110-R015v01.pdf

Attachment 4-2-12 WiMAX Forum® Network Architecture System Requirements, Network Protocols and Architecture for Multi-cast Broad-cast Services (MCBCS Subteams Common Sections) WMF-T33-111-R015v01.pdf

Attachment 4-2-13 WiMAX Forum® Network Architecture System Requirements, Network Protocols and Architecture for Multi-cast Broad-cast Services Dynamic Service Flow Based (MCBCS – DSx) WMF-T33-112-R015v01.pdf

Attachment 4-2-14 WiMAX Forum® Network Architecture System Requirements, Network Protocols and Architecture for Multi-cast Broad-cast Services (MCBCS Application Layer Approach) WMF-T33-113-R015v01.pdf

Attachment 4-2-15 WiMAX Forum® Network Architecture Architecture, detailed Protocols and Procedures WiMAX-SIM Application on UICC WMF-T33-114-R015v01.pdf

Attachment 4-2-16 WiMAX Forum® Network Architecture Universal Services Interface (USI) An Architecture for Internet+ Service Model WMF-T33-115-R015v01.pdf

# Chapter 6 Measurement Method

As for the items stipulated in Ordinance Concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment Appendix Table No.1 item 1(3), measurement methods are specified by MIC Notification (Note) or a method that surpasses or is equal to the method.

Note: This Notification refers to MIC Notification No.88 “The Testing Method for the Characteristics Examination”(January 26, 2004) as of the date of the revision of this standard version 1.0 (issued in December, 2007). Thereafter, the latest version of Notification would be applied if this Notification or contents of this Notification would be revised.

Attachment 1　List of Essential Industrial Property Rights　(selection of option 1)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./ APPLICATION NO.<br>〔Applied in Japan 〕 | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| (N/A) | (N/A) | (N/A) | (N/A) |

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./ APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NOKIA Corporation *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |
| NTT DoCoMo Inc. *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |
| Motorola, Inc. *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |
| Qualcomm Inc. *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |
| FUJITSU LIMITED *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |
| KDDI CORPORATION *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NEC Corporation *10 | (1) 可変変調通信方法 | 特許第2776094号 | |
| | (2) 多方向多重通信システムの送信出力電力制御方法 | 特許第2982724号 | |
| | (3) 直交周波数分割多重変復調回路 | 特許第3786129号 | |
| | (4) 送信電力制御方法、送信電力制御装置、移動局、基地局及び制御局 | 特許第3358565号 | |
| | (5) 移動通信システム及び通信制御方法並びにそれに用いる基地局、移動局 | 特許第3675433号 | |
| | (6) 位置登録方法および位置登録方式 | 特許第2748871号 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NTT DoCoMo Inc. *11 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.1 | | |

*11: This patent is applied to the revised part of ARIB STD-T94 Ver.1.1.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Motorola, Inc. *10 | パケット構造フィールドを有する通信システム | 特表平3-501079 | WO, AT, AU, BE, CH, DE, FR, GB, IT, KR, LU, NL, NO, SE,US |
| | 電話通信システムにおける加入者の真正証明および保護のための方法 | 特表平5-503816 | WO, AT, AU, BE, CA, CH, DE, DK, ES, FR,U, NL, SE |
| | 時間領域パイロット成分を有する通信信号 | 特表平5-501189 | WO, AT, AU, BE, BR, CA, CH, DE, DK, ES, FR, GB, GR, IT, KR, LU, NL, SE, US |
| | 電気通信システムにおける加入者の真正証明及び保護のための方法 | 特表平5-508274 | WO, CA, US |
| | QAM通信システムにおけるピーク対平均電力比の軽減方法 | 特表平6-504175 | WO, AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE, US |
| | 時間領域パイロット成分を有する通信信号 | 特表平6-504176 | WO, AU, BR, CA, GB, KR |
| | 通信システムにおいてデータ・ストリームの暗号化保護を提供する方法および装置 | 特表平8-503113 | WO, CA, FI, KR, AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, US |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Motorola, Inc. *10 | ターボコード構造を使用する適応ハイブリッドARQ | 特表2003-515268 | WO, BR, CA, KR, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR, US |
| | マルチチャネル・ストップ・アンド・ウェイトARQ通信のための方法および装置 | 特表2003-514486 | WO, BR, CA, KR, AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR, US |
| | 通信システムにおいて別個の順方向専用チャネル及び共用制御チャネルを与える装置及び方法 | 特表2003-531534 | WO, AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Motorola, Inc. *10 | 広帯域の通信システム内で狭帯域の信号を送信および受信するための方法および装置 | 特表2007-525930 | WO, AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW |
| | Multi-mode hybrid ARQ scheme | WO2006055171A1 | WO, AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NOKIA CORPORATION *10 | 多重アクセス通信システム及び多重アクセス通信方法、並びにその通信装置 | 特許第 3090300 号 | |
| | 無線電話システム、及び無線電話ネットワーク内でのデータ送信方法、無線電話器並びに固定局 | 特許第 3842805 号 | |
| | 無線電話ＴＤＭＡシステムにおいてパケットデータを伝送するシステム | 特許第 3880642 号 | |
| | ＴＤＭＡシステムにおける無線容量の動的割り振り方法 | 特許第 3155010 号 | |
| | ハンドオーバ方法及びセルラ無線システム | 特許第 3825049 号 | |
| | 情報の暗号化方法およびデータ通信システム | 特開 2006-262531 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NOKIA CORPORATION *10 | アイドルタイムを割り振る方法、移動及びネットワーク | 特許第 3943253 号 | |
| | データ伝送を暗号処理する方法とその方法を利用するセルラ無線システム | 特開 2006-271010 | |
| | 無線資源制御方法 | 特許第 3542705 号 | |
| | 移動通信システムにおいてある複数プロトコルに従ってある複数層でデータを処理するための方法と装置 | 特許第 3445577 号 | |
| | 複数アンテナ送信用の非ゼロ複素重み付けした空間－時間符号 | 特表 2005-503045 | |
| | 移動局の内部タイミングエラーを補償する方法及び回路 | 特許第 3923571 号 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| KDDI株式会社 *10<br>株式会社KDDI研究所 *10<br>京セラ株式会社 *10 | (1) OFDM信号復調装置 | 特願平11-159320 | |
| | (2) OFDM信号復調用シンボルタイミング検出回路 | 特願2000-022459 | |
| | (3) OFDM受信装置の周波数及び位相誤差補正装置 | 特願2000-070186 | |
| | (4) OFDM信号復調用シンボルタイミング検出方法及び装置 | 特願2000-246978 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| KDDI株式会社 *10 | (5) 無線パケット通信システム及び基地局 | 特願2000-368610<br>特許3731469<br>米国特許7012910 | US |
| | (6) 多ビームセルラ無線基地局、移動機及びスペクトル拡散信号送信方法 | 特願2001-115422 | |
| | (7) 無線基地局 | 特願2001-190109 | |
| | (8) フレーム同期回路 | 特願2002-037926<br>特許3826810 | |
| | (9) 直交周波数分割多重方式の受信装置及び受信方法 | 特願2002-114677<br>特許3846356 | |
| | (10) OFDM信号の周波数誤差を補正する受信装置 | 特願2002-135473<br>特許3885657 | |
| | (11) 伝搬路推定を行うOFDM受信装置 | 特願2002-229887<br>特許3791473 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| KDDI株式会社 *10<br>小林英雄 *10 | (12) 伝送路特性推定装置および伝送路特性推定方法、無線復調装置、コンピュータプログラム | 特願2002-373986 | |
| | (13) 伝送路特性推定装置および伝送路特性推定方法、無線復調装置、コンピュータプログラム | 特願2003-025910 | |
| | (14) CNR推定装置、CNR推定方法、CNR推定プログラム、適応伝送無線システム、無線装置 | 特願2003-067938 | |
| KDDI株式会社 *10 | (15) 伝送路特性推定装置、コンピュータプログラム<br>受信装置及び受信方法 | 特願2003-204611 | |
| | (16) 伝達関数推定装置及び、伝達関数推定方法 | 特願2006-082414 | |
| | (17) 受信装置、送信装置 | 特願2006-094340 | |
| | (18) 無線フレーム制御装置、無線通信装置及び無線フレーム制御方法 | 特願2006-192128 | |
| | (19) 無線フレーム制御装置、無線フレーム制御方法、および無線通信装置 | 特願2007-93760 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| 三菱電機株式会社 *10 | データ伝送方法、データ受信方法、データ伝送システム、送信機及び受信機 | 特許第 3,895,745 号 | EP(DE,FR,IT,PT,GB), US, CA, AU |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./ APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| 株式会社　日立コミュニケーションテクノロジー *10 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.1.0 | | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| QUALCOMM Incorporated *10 | Method and apparatus for measuring channel state information | JP2003-530010 | US, AU, BR, CA, EP, HK, ID, IL, IN, JP, KR, MX, NO, WO, RU, SG, TW, UA |
| | Multiplexing of real time services and non-real time services for OFDM systems | JP2004-503181 | US, BR, CN, EP, HK, KR, TW, WO |
| | Method and apparatus for utilizing channel state information in a wireless communication system | JP2005-502223 | US 6,771,706, US 20040165558, BE, BR, CN, DE, EP, ES, FI, FR, GB, HK, IE, IT, JP, KR, LU, NL, SE, TW, WO |
| | Rate selection for an OFDM system | JP2005-533402 | US 7,012,883, US 20060087972, BR, CN, EP, HK, KR, TW, WO |
| | Diversity Transmission Modes for MIMO OFDM Communication Systems | JP2005-531219 | US 7,095,709, US 20060193268, AU, BR, CA, CN, EP, HK, ID, IL, IN, KR, MX, NO, RU, SG, TW, UA, WO |
| | Random Access for Wireless Multiple-Access Communication Systems | JP2006-504338 | US, AU, BR, CA, CN, EP, HK, ID, IL, IN, KR, MX, RU, TW, UA, WO |
| | Reverse Link Automatic Repeat Request | JP2006504337 | US, AU, BR, CA, CN, EP, HK, ID, IL, IN, KR, MX, RU, TW, UA, WO |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| QUALCOMM Incorporated *10 | MIMO System with Multiple Spatial Multiplexing Modes | JP2006-504339 | US 20040136349, US 12/115,522, US 12/115,523, AU, BR, CA, CN, EP, HK, ID, IL, IN, KR, MX, RU, TW, UA, WO |
| | Transmit Diversity Processing for a Multi-Antenna Communication System | JP2006-504366 | US 7,002,900, US 20060039275, AU, BR, CA, CN, EP, HK, ID, IL, IN, KR, MX, RU, TW, UA, WO |
| | A method and apparatus of using a single channel to provide acknowledgement and assignment messages | JP2007-520169 | US, AU, CN, HK, IN, KR, WO |
| | Shared signaling channel for a communication system | JP2008-507896 | US, CA, CL, CN, EP, HK, IN, KR, MY, TW, WO |
| | Apparatus and Method for Reducing Message Collision Between Mobile Stations Simultaneously Accessing a Base Station in a CDMA Cellular Communications System | JP3152353 | US 5,544,196, US 6,615,050, AT, AU, BE, BR, BG, CA, CH, DE, DK, KP, EP, ES, FI, FR, GB, GR, HK, HU, IE, IL, IT, KR, MX, NL, WO, CN, PT, RU, ZA, SE, SK |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>(出願国名)<br>REMARKS |
|---|---|---|---|
| QUALCOMM Incorporated *10 | Method and apparatus for performing mobile assisted hard handoff between communications Systems | JP2001-508625 | US, AM, AU, AZ, BR, BY, CA, CL, IL, DE, EPC, EP, ES, FI, FR, GB, HK, ID, IE, IN, IT, KG, KR, KZ, MD, MX, NL, NZ, WO, CN, TW, RU, ZA, SE, SG, TJ, TM, UA |
| | Method and Apparatus for High Rate Packet Data Transmission | JP2001522211 | US 7,079,550, US 20060280160, US 20070066320, US 20070019567, US 20070025267, AR, AT, AU, BE, BR, CA, CH, CL, CN, CY, CZ, EP, HK, NZ, DE, DK, ES, FI, FR, GB, GR, HU, ID, IE, IL, IN, IT, JP, KR, LU, MY, MC, MX, NL, NO, WO, PL, PT, RO, RU, ZA, SE, SG, UA, VN |
| | Method and Apparatus for Coordinating Transmission of Short Messages with Hard Handoff Searches in a Wireless Communications System | JP2002-514844 | AU, BR, US 20060120490, US 20070153941, CA, DE, EP, FI, FR, GB, HK, IL, IT, JP, KR, MX, NO, WO, CN, TW, SE, SG |
| | Reservation Multiple Access | JP2002-528017 | US, CN, EP, HK, KR, WO |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Panasonic Corporation *10 | 直交周波数分割多重信号の伝送方法ならびにその送信装置および受信装置<br><br>受信装置、送信装置及び送信方法 | 特許第3539522号<br><br>特許第 3836019 号 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Approved by the 74th Standard Assembly

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| 株式会社　日立コミュニケーションテクノロジー*10 | (1)　無線通信装置 | 特開2005-160035 | CN, KR, US |
| | (2)　同期配信方法 | 特開2007-019960 | CN, EP, US |
| | (3)　基地局 | 特開2007-312435 | CN, KR, US |
| | (4)　無線端末 | 特開 2007-312436 | CN, KR, US |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>(出願国名)<br>REMARKS |
|---|---|---|---|
| Panasonic<br>Corporation *10 | (1) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3008651 号<br>US09/677421<br>USRE40134<br>USRE40779 | JP<br>US<br>US<br>US |
| | (2) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3061053 号 | JP |
| | (3) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3061054 号 | JP |
| | (4) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3109522 号<br>US6256357<br>US7302007<br>EP1039682<br><br>EP1330090 | JP<br>US<br>US<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL,LI<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |
| | (5) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3114727 号 | JP |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>(出願国名)<br>REMARKS |
|---|---|---|---|
| Panasonic Corporation *10 | (6) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154704 号<br>EP1039675<br><br>EP1330089 | JP<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL,LI<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |
| | (7) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154705 号<br>EP1049284<br><br>EP1330088 | JP<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL,LI<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE |
| | (8) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154706 号<br>EP1045541<br><br>EP01118510.5 | JP<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL,LI<br>EP |
| | (9) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154707 号<br>EP1039680 | JP<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |
| | (10) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154708 号<br>US7146092 | JP<br>US |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. /<br>APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Panasonic Corporation *10 | (11) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3154709 号<br>US7280806 | JP<br>US |
| | (12) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3231035 号 | JP |
| | (13) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3231036 号<br>US6728467<br>EP1035693<br><br>EP1439678 | JP<br>US<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |
| | (14) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3233625 号<br>US6724976<br>EP1035695<br><br>EP1439679 | JP<br>US<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL,LI<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |
| | (15) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3233626 号<br>EP1257104 | JP<br>EP,IT,AT,BE,CH,DK,ES,GR,IE,PT,SE,FR,DE,GE,NL |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Panasonic Corporation *10 | (16) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3248807 号 | JP |
| | (17) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3327914 号<br>US09/740068 | JP<br>US |
| | (18) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3327915 号 | JP |
| | (19) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3327916 号<br>US10/301737 | JP<br>US |
| | (20) 受信装置、受信方法 | 特許第 3359327 号 | JP |
| | (21) 送信装置、受信装置、伝送装置、送信方法、受信方法 | 特許第 3410085 号 | JP |
| | (22) 受信装置、受信方法 | 特許第 3588460 号 | JP |
| | (23) 受信装置、受信方法 | 特許第 3643834 号 | JP |
| | (24) 受信装置、受信方法 | 特許第 3643835 号 | JP |
| | (25) 送信装置、受信装置、送信方法、受信方法 | 特許第 3829141 号 | JP |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| NEC Corporation *10 | 移動無線通信におけるデータ伝送方式 | 特許第 2503888 号 | JP, US |
| | 移動通信システムのハンドオフ方法及び移動端末 | 特許第 3120809 号 | JP |
| | 移動通信システムにおける基地局及び交換局 | 特許第 3214500 号 | JP |
| | 移動通信システムの送信電力制御方式 | 特許第 2823034 号 | JP |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Approved by the 76th Standard Assembly

Attachment 2　List of Essential Industrial Property Rights　(selection of option 2)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./ APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| QUALCOMM Incorporated *20 | A comprehensive confirmation form has been submitted with regard to ARIB STD-T94 Ver.2.0 | | |

*20: This patent is applied to the part defined by ARIB STD-T94 Ver. 2.0.

Reference (Not applied in Japan)

| 特許出願人<br>PATENT HOLDER | 発明の名称<br>NAME OF PATENT | 出願番号等<br>REGISTRATION NO./<br>APPLICATION NO. | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Motorola, Inc. *10 | Multiple user communication system, device and method with overlapping uplink carrier spectra | US5828660A | |
| | Synchronous coherent orthogonal frequency division multiplexing system, method, software and device | US5867478A | |
| | Multicarrier reverse link timing synchronization system, device and method | US5802044A | |
| | Communication system having a packet structure field | US4860003A | |
| | Method and apparatus for providing cryptographic protection of a data stream in a communication system | US5319712A | |
| | Wideband signal synchronization | US5272724A | |
| | Communication signal having a time domain pilot component | US5519730A | |
| | Dynamic control of a data channel in a TDM wireless communication system | US5598417A | |
| | Method for authentication and protection of subscribers in telecommunications systems | US5572193A | |
| | Communication unit and method for performing neighbor site measurements in a communication system | US6249678B1 | |
| | Variable rate spread spectrum communication method and apparatus | US6275488B1 | |
| | Apparatus and method for providing separate forward dedicated and shared control channels in a communications system | US6934275B1 | |
| | Multi-mode hybrid ARQ scheme | US7096401B2 | |
| | Adaptive hybrid ARQ using turbo code structure | US6308294B1 | |
| | Method and apparatus for transmission and reception of narrowband signals within a wideband communication system | US7047006B2 | |
| | Multi channel stop and wait ARQ communication method and apparatus | US7065068B2 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Reference (Not applied in Japan)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| QUALCOMM Incorporated *10 | Mobile Station Assisted Soft Handoff in a CDMA Cellular Communications System | US5,640,414 | US 5,267,261 |
| | Method and Apparatus for Utilizing Channel State Information in a Wireless Communication System | US 7,006,848 | |
| | Remote Transmitter Power Control in a Contention Based Multiple Access System | US 5,604,730 | |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

Reference (Not applied in Japan)

| 特許出願人<br>(PATENT HOLDER) | 発明の名称<br>(NAME OF PATENT) | 出願番号等<br>(REGISTRATION NO. / APPLICATION NO.) | 備考<br>（出願国名）<br>REMARKS |
|---|---|---|---|
| Panasonic Corporation *10 | (26) Method of transmitting orthogonal frequency division multiplex signal, and transmitter and receiver employed therefor | US5682376<br>EP95119990 | US<br>EP |
| | (27) Transmitting apparatus, receiving apparatus, transmission method, and reception method | US7328389 | US |

*10: These patents are applied to the part defined by ARIB STD-T94 Ver. 1.0.

# Change History

| Version | Date | History |
|---|---|---|
| Ver. 1.0 | December 12, 2007 | Enacted by the 68th ARIB Standard Assembly |
| Ver. 1.1 | March 19, 2008 | Approved by the 69th ARIB Standard Assembly |
| Ver. 1.2 | June 6, 2008 | Approved by the 70th ARIB Standard Assembly |
| Ver. 1.3 | September 25, 2008 | Approved by the 71st ARIB Standard Assembly |
| Ver. 1.4 | March 18, 2009 | Approved by the 73rd ARIB Standard Assembly |
| Ver. 1.5 | July 29, 2009 | Approved by the 74th ARIB Standard Assembly |
| Ver. 2.0 | April 26, 2010 | Approved by the 76th ARIB Standard Assembly |

Change History List of Standards Ver.1.1

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Chapter 3.2 | (14), b, Note 3 and Note 2 (greater than 17dBi) | 31,32, 32a | Addition of function on usage restriction for high gain antenna mobile station |
| 2 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-4～ AT2-7 | Addition of IPR list |

Change History List of Standards Ver.1.2

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-8,9 | Addition of IPR list |

Change History List of Standards Ver.1.3

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-10～ 13 | Addition of IPR list |
| 2 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-1～3 AT2-5～9 | Correction of footnote |

Change History List of Standards Ver.1.4

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-14～ 18 | Addition of IPR list |

Change History List of Standards Ver.1.5

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Attach-ment 2 | Industrial Property Rights for Ver1.0 | AT2-19~ 25 | Addition of IPR list |

Change History List of Standards Ver.2.0

| No. | Item No. | Title | Page | Change Summary |
|---|---|---|---|---|
| 1 | Chapter 2.5 | Enhancements in the WiMAX Forum System Profile Release 1.5 | 28 | Addition of description regarding enhancements in the WiMAX Forum System Profile Release 1.5 |
| 2 | Chapter 2.6 | Low Power Repeater | 29 | Addition of outline and configuration of Low Power Repeater |
| 3 | Chapter 3.3 | Low Power Repeater | 46 | Addition of technical requirements for Low Power Repeater |
| 4 | Chapter 4.2 | Release 1.5 | 55 | Addition of Attachment 3-2-1”WiMAX Forum™ Mobile System Profile Release 1.5 Common Part” and Attachment 3-2-2 |

| | | | | |
|---|---|---|---|---|
| | | | | "WiMAX Forum™ Mobile System Profile Release 1.5 TDD Part" |
| 5 | Chapter5.2 | Release 1.5 | 57 | Addition of Attachment 4-2-1 through 4-2-16 "WiMAX Forum™ Network Architecture" |
| 6 | Attachment 2 | Industrial Property Rights for Ver2.0 | AT2-24 | Addition of IPR list |
| 7 | Reference | List of Essential IPRs, Reference | REF 1~3 | Separation of References (Not applied in Japan) from Attachment 2 |

OFDMA Broadband Mobile Wireless Access System
(WiMAX™ applied in Japan)

ARIB STD-T94 Version 2.0

| | | | |
|---|---|---|---|
| Version 1.0 | December | 12th | 2007 |
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| Version 1.2 | June | 6th | 2008 |
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