\`Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** **<http://grouper.ieee.org/groups/802/20/>**
Title	**MBTDD 625k-MC[*] MODE Technology Overview**
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Re:	MBWA Call for Proposal
Abstract	This document presents the **Technology Overview** for the MAC and the PHY layer of the of MBTDD 625k-MC mode in MBTDD proposal for IEEE 802. 20 MBWA
Purpose	To discuss MBTDD proposal for Draft Specifications of IEEE802.20 MBWA
Notice	
Release	
Patent Policy	

[*] 625k-MC(625kHz625kiloHertz-spaced MultiCarrier) is Previously known as BEST-WINE: Broadband MobilE SpaTial Wireless InterNet AccEss

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MBTDD 625k-MC* (BEST-WINE)

Technology Overview

* 625k-MC(625kHz625kiloHertz-spaced MultiCarrier) is Previously known as BEST-WINE: Broadband MobilE SpaTial Wireless InterNet AccEss

1 Executive Summary

1.1 Summary Classification Statement

1. Refer to The document IEEE C802.20-06/03.

1.2 Salient Features

The air interface **MBTDD 625k-MC(BEST-WINE) (Enhanced HC-SDMA = Base HC-SDMA + Additional Enhancements)** proposed here is designed to maximally leverage adaptive antenna processing and take advantage of SDMA to achieve or exceed the IEEE 802.20 PAR objectives [2] and System Requirements [3]. MBTDD 625k-MC (BEST-WINE) offer Broadband *Peak Per User* Data Rates, High System Spectral Efficiency, Wide Area Coverage and High System capacity.

- High Spectral Efficiency (Bits/Sec/Hz/Sector) = 13.4 with Four Spatial Channels
- Peak Per User Rates:
  - Maximum User Data rates of 1.493 Mbps (Downlink) and 571Kbps (Uplink) with Single Channel of 625 KHz.
  - Maximum User Data rates of 5.97 Mbps (Downlink) and 2.28 Mbps (Uplink) with TDD Block assignment of 2.5 MHz
- Improved Coverage
- Greater Capacity by handling more than 100 Active sessions per sector
- Reduced Spectrum Requirements and Spectrum Reuse less than 1 with no frequency Planning
- Efficient Handover
  - Radio Layer Handover
    - Mobile Directed using BS Load and Signal Strength indicators
    - Make Before Break For Transparency
  - Network Handover
    - Simple IP – Efficient Micro mobility
    - Mobile IP – For Inter System Mobility
- Security
  - Authentication
  - Encryption
  - AES

1.3 MBTDD 625k-MC(BEST-WINE) Proposal Package Structure

2. Refer to The document IEEE C802.20-06/04

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2 References

[1] ATIS-PP-0700004*-2005, High Capacity-Spatial Division Multiple Access (HC-SDMA)

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b. ***For Electronic Downloads, Paper Copy or CD-ROM please follow the link https://www.atis.org/atis/docstore/doc_display.asp?ID=3617***

[2] IEEE 802.20 PD-2.doc: Mobile Broadband Wireless Access Systems: Approved PAR (02/12/11):

[3] IEEE 802.20 PD-06r1.doc: IEEE 802.20 System Requirement Document (V 1.0)

[4] IEEE_802.20-PD-08.doc: IEEE 802.20 Channel Models (V 1.0)

[5] IEEE_802.20-PD-09.doc: IEEE 802.20 Evaluation Criteria (V 1.0)

[6] IEEE_802.20-PD-10.doc: IEEE 802.20 Technology Selection Process (V 1.0)

[7] X.P0011-001-D on 3gpp2 TSG-X specification

[8] IEEE C802.20-05/75

[9] IEEE C802.20-05/76

[10] IEEE C802.20-05/77

[11] IEEE C802.20-05/78

[12] IEEE C802.20-05/79

[13] IEEE C802.20-06/04

3 Definitions

As defined in the References [1], [2], [3]

4 Abbreviations and acronyms

AA	Access Assignment
AAA	Adaptive Antenna Array
ACLPR	Adjacent Channel Leakage Power Ratio
ACS	Adjacent Channel Selectivity
AM	Acknowledged Mode
API	Application Programming Interface
ARQ	Automatic Repeat Request
BCH	Broadcast Channel
BS	Base Station
BSCC	Base Station Color Code
CA	Certificate Authority
CCH	Configuration Channel
CM	Configuration Message
CoS	Class of Service
CR	Configuration Request
CRC	Cyclic Redundancy Check
EUD	End User Device
FACCH	Fast Associated Control Channel
FEC	Forward Error Control
FER	Frame Error Rate
GPS	Global Positioning System
HC-SDMA	High Capacity Spatial Division Multiple Access
i-HAP	Handshake and Authentication Protocol
IMSI	International Mobile Station Identifier
IPPR	Intermodulation Product Power Ratio
i-SEC	Secure Communications Protocol
i-TAP	Terminal Authentication Protocol
IWAN	Interconnection Wide Area Network
L2	Layer 2
L2TP	Layer 2 Tunneling Protocol
L3	Layer 3
L3 CM	CM L3 Connection Management
L3 MMC	MMC L3 Mobility Management and Control
L3 RM	RM L3 Registration Management
LLC	Logical Link Control
LDAP	Lightweight Directory Access Protocol
LFSR	Linear Feedback Shift Register
LNA	Low Noise Amplifier
LNS	L2TP Network Server
LSB	Least Significant Bit
MAC	Medium Access Control
MBWA	Mobile Broadband Wireless Access
MSB	Most Significant Bit
PA	Power Amplifier
PAR	Project Authorization Requirements
PCH	Paging Channel
PDCL	Packet Data Conversion Layer
PHY	Physical Layer
PID	Paging Identity

PPM	Parts Per Million
PPP	Point to Point Protocol
PPPoE	PPP over Ethernet
PSS	Packet Services Switch
QoS	Quality of Service
RA	Request Access
RACH	Random Access Channel
RSA	Rivest, Shamir, Adleman
RF	Radio Frequency
RLC	Radio Link Control
RM	Registration Management
RMU	RLC Message Unit
RRC	Radio Resource Control or Root Raised Cosine
RSSI	Received Signal Strength Indicator
SDMA	Space Division Multiple Access
SDU	Service Data Unit
SINR	Signal-to-Interference plus Noise Ratio
SN	Slot Number
SNR	Signal to Noise Ratio
TCH	Traffic Channel
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TWAN	Transport Wide Area Network
UM	Unacknowledged Mode
UT	User Terminal

5 Introduction

As a result of merged MBTDD proposal, By this document, Kyocera Team provides a TDD Technology Proposal tilted **MBTDD 625k-MC(BEST-WINE: Broadband MobilE SpaTial Wireless InterNet AccEss),** which is an enhanced Air Interface based on "**ATIS-PP-0700004-2005, High Capacity-Spatial Division Multiple Access (HC-SDMA)** [1]. The technology proposal **MBTDD 625k-MC (BEST-WINE), which incorporates the necessary enhancements to the base HC-SDMA specification,** is a **Complete** and **Fully compliant** Specifications of Physical (PHY) and Media Access Control (MAC) of an air interface for MBWA system in Licensed Frequency Bands below 3.5 GHz.

6 Scope of this Document

This document presents overview of MBTDD 625k-MC(BEST-WINE) mode of MBTDD. MBTDD 625k-MC is an enhanced HC-SDMA [1] and then defines the additional draft MAC/PHY layer specifications supplemental that of HC-SDMA [1] relevant to the scope of MBWA SRD [2] and PAR [3]. The basic (foundation) draft specifications are available as ATIS standard: **ATIS-PP-0700004-2005** and will not be copied in this Document due to Copyrights of ATIS. These additional specifications results in enhanced HC-SDMA, which is named as MBTDD 625k-MC(BEST-WINE), so as to meet system Requirements of MBWA system will presented in this document.

7 Overview

7.1 System Architecture

MBTDD 625k-MC(BEST-WINE) system, which employs Adaptive Antenna Array and SDMA Technologies, transfers IP traffic, including Broadband IP Data, over air interface by using a layered protocol reference model. Physical and data link layers are kept distinct to clarify the operation of the wireless interface. Higher layers then integrate the physical and data link layers into an end-to-end architecture based on VPN (GRE) and PPP, over which the user establishes a session with the desired Internet Service Provider. IP packets are then transported between the end-user-device such as a personal computer and the service provider. *MBTDD 625k-MC(BEST-WINE)* network structure is shown in Figure 7-1.

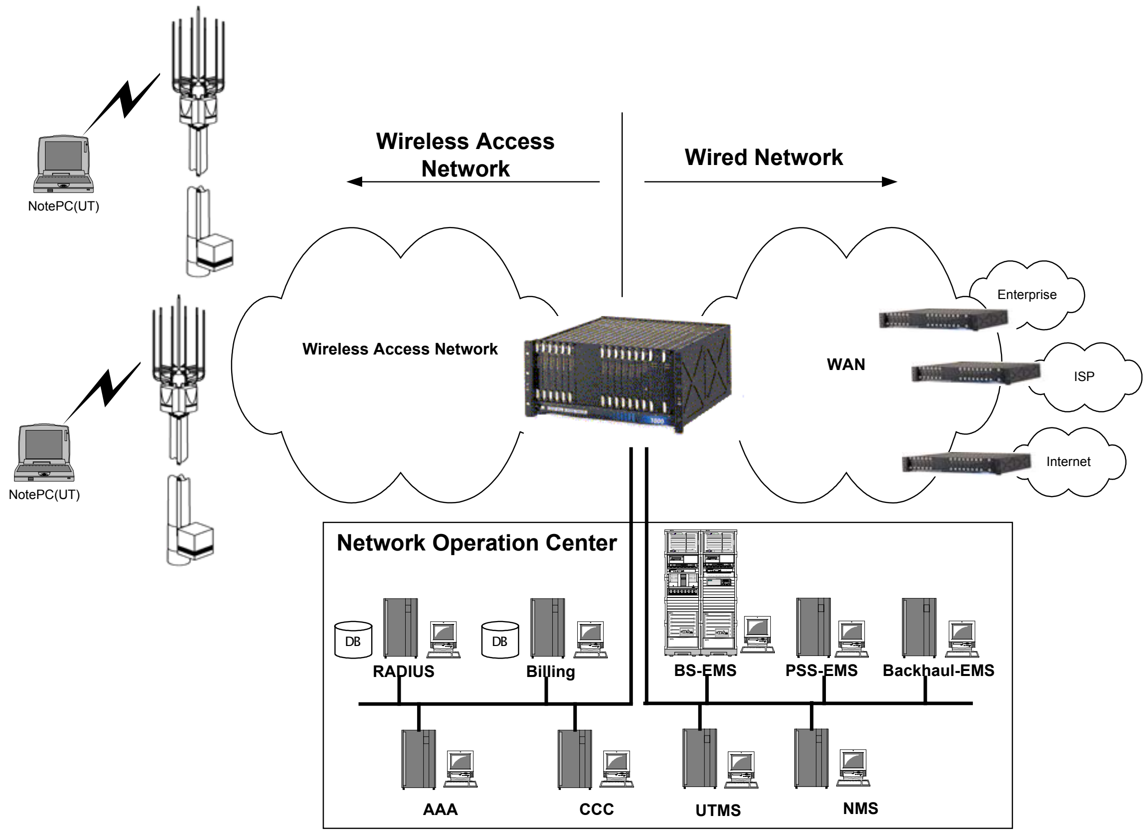


Figure 7-1 MBTDD 625k-MC(BEST-WINE) Network structure

Figure 7-2 show MBTDD 625k-MC(BEST-WINE) network protocol stack. *MBTDD 625k-MC(BEST-WINE)* protocol provides end to end solution for air interface between EUD and PDSN. *MBTDD 625k-MC(BEST-WINE)* network supports not only Simple IP but also MIP (Mobile IP) for mobility functionality on following stack..

Figure 7-3 shows the case of MIP usage.

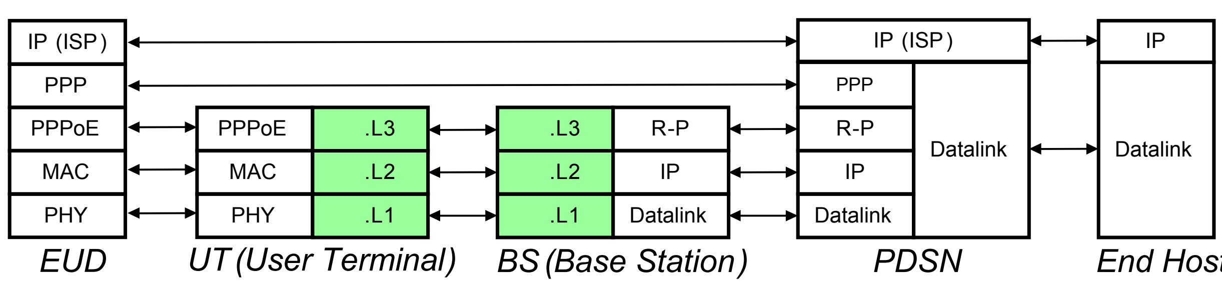


Figure 7-2 MBTDD 625k-MC(BEST-WINE) network (L1/L2/L3) protocol stack

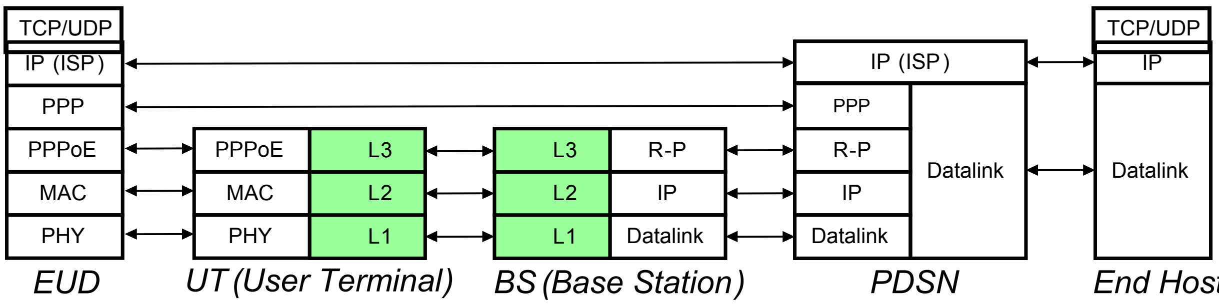


Figure 7-3 MBTDD 625k-MC(BEST-WINE) network (L1/L2/L3) protocol stack on MIP

The proposed air interface MBTDD 625k-MC(BEST-WINE), which is based on HC-SDMA [1], has a TDD/TDMA structure whose physical and logical characteristics have been chosen for the efficient transport of end-user IP data and to extract maximum benefit from adaptive antenna processing. The physical aspects of the protocol are arranged to provide spatial training data, and correlated uplink and downlink interference environments, for logical channels amenable to directive transmission and reception such as traffic channels. Conversely, channels not amenable to directive processing, such as paging and broadcast channels have smaller payloads and receive a greater degree of error protection to balance their links with those of the directively processed channels. Adaptive modulation and channel coding, along with uplink and downlink power control, are incorporated to provide reliable transmission across a wide range of link conditions. Modulation, coding and power control are complemented by a fast ARQ mechanism to provide as reliable link as is possible in a mobile wireless setting. Fast, low-overhead make-before-break inter-cell handover is also supported. Differentiated and tiered services are enabled through a flexible QOS mechanism. Security for the radio access link is provided by mutual authentication of the terminals and access network, and by encryption to ensure data privacy.

7.2 Layered Protocol Architecture

As shown in MBTDD 625k-MC(BEST-WINE) air interface has three layers designated as L1, L2, and L3. Table 7-1describes the air interface functionality embodied in each layer. Each layer's features are briefly described below; more detailed overviews of key aspects are described in subsequent sections of this document.

Layer	Defined Properties
L1 (PHY)	• Radio Performance (transmit and receive) • Modulation and Coding • Performance and Test
L2 (MAC)	• Channel Structure (frame and slot) • Access Management • Data and Control • Flow over logical channels

	• Mapping between logical and physical (transport) channels • Automatic Repeat Request (ARQ)
L3 (DLC/LLC)	• Connection, Registration, Mobility Management (CM, RM, MMC) • Radio Resource Control (RRC) • Authentication and Security (i-HAP, i-TAP, i-SEC) • Packet Segmentation, Slot Aggregation • Power control • Link Adaptation

Table 7-1: Air interface layers

7.2.1 Physical (PHY) Layer: L1

Physical (PHY) Layer: L1 is characterized by a TDD/TDMA structure as shown in Figure 7-4 with 5 ms frame length, each frame containing three uplink and three downlink bursts (timeslots). The air interface's logical channels are all mapped onto this structure. In the interest of providing high spectral efficiency, many aspects of L1 are specifically designed to support the effective use of adaptive antennas. For instance, training sequences for Spatial Division Multiple Access (SDMA) are incorporated in certain burst structures.

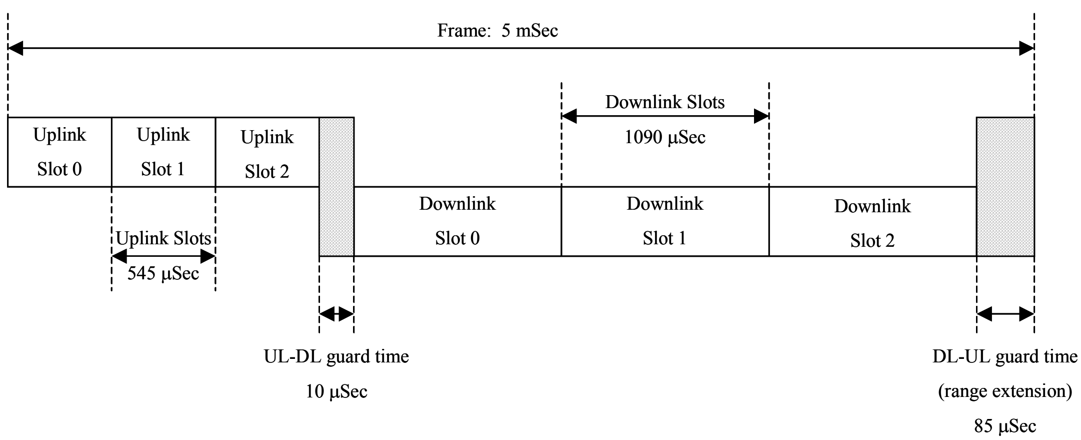


Figure 7-4 MBTDD 625k-MC(BEST-WINE) TDD/TDMA frame structure

7.2.1.1 Frame and Timeslots

This MBTDD 625k-MC(BEST-WINE) TDD/TDMA frame structure is designed for deployment in a narrow frequency channelization (625 kHz) with a constant baud rate (2 µSec/symbol) across the frame. This specification has several advantages.

- Ordering uplink slots prior to downlink slots facilitates the implementation of spatial filters for adaptive antenna arrays in the BS.

- Narrow carrier bandwidth simplifies equalization, channel estimation, and network deployment in the available TDD spectrum.
- Narrow frequency channelization reduces access latency by providing many access channels

The logical channels, defined later in this document, are mapped to physical channels within the frame structure. Figure 7-1. also shows a range extension period of 85 µs, corresponding to a range of 12.7 km, suitable for metropolitan area coverage of MBWA system: MBTDD 625k-MC(BEST-WINE) as described in the 802.20 PAR[2]. If inter-burst guard times in the air interface are exploited, the effective range extension period becomes 100 µs, corresponding to a maximum range in excess of 15 km. The range extension is obtained with less than 2% overhead of the frame period, and its cost is more than offset by the TDD and adaptive antenna benefits that it enables.

All TDD networks require close synchronization among all the BSs in the network. Any time reference with a stability of ±1 symbol period and with network-wide availability can be used for inter-cell synchronization of base stations. For example, the Global Positioning System (GPS) has the required stability and low-cost GPS receivers are available. In contrast, the UTs would derive their timing reference from the BSs. A single carrier and timeslot pair is reserved network-wide for the broadcast super frame structure of . The super frame is synchronized across *all* BSs in the network (i.e., the F burst is transmitted simultaneously from every BS).

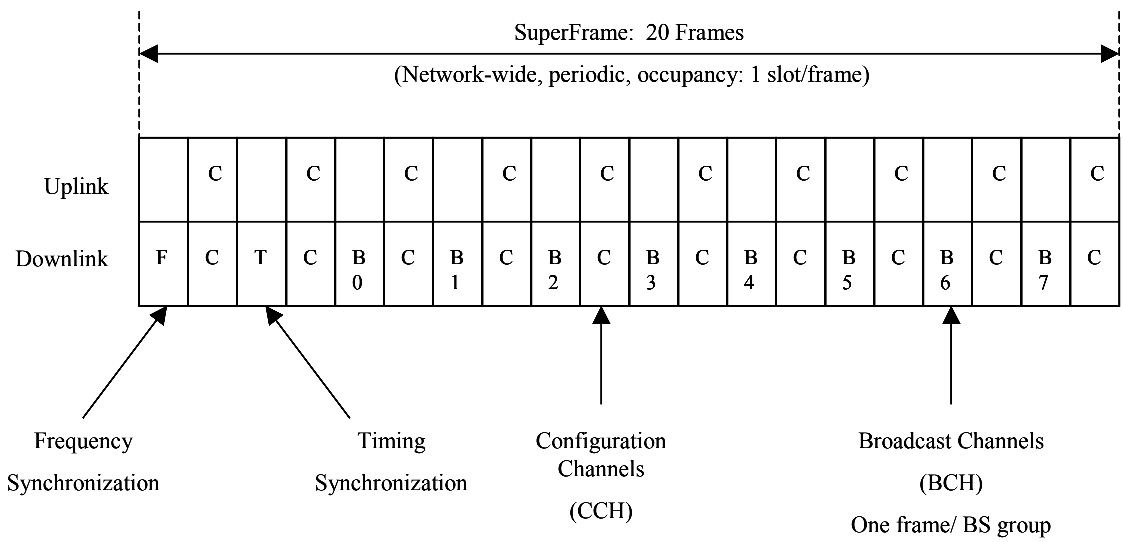


Figure 7-5 Super frame structure

The super frame as shown in Figure 7-5begins with a downlink burst (F-type in) designed to facilitate frequency-offset estimation between the UT local oscillator and the BS frequency reference. Similarly, a T-type burst is dedicated to frame time estimation. The UT can detect all BSs in its vicinity using the same BCH carrier and rank them according to the quality of their channel to the UT. The downlink slots labeled B0 to B7 in are dedicated to each of the pre-assigned *groups* of BSs. For example, only BS belonging to group 5 would send a downlink burst in the position labeled B5. The group-specific downlink slot is the BCH for all BSs in that group. Acquisition of the BCH from within a group of base stations works best if interference from other base stations in the same group is minimized. At least seven base station groups are required to ensure that only one BS from the first tier transmits during its group-assigned slot in the BCH super frame. The MBWA eight base station groups are convenient for deployment as the network evolves. The UT can use these BCH for refined estimates of time- and frequency-offset to the nearest BS. The remaining slots labeled “C” are paired uplink/downlink bursts and serve as the CCH.

Uplink and downlink symbol rates are 500 kSymbols/s in all circumstances and a 25% root-raised cosine filter is employed, which leads to a 625 kHz carrier spacing. Figure 7-6 shows an example of Carrier aggregation with 2.5 MHz Block assignment.

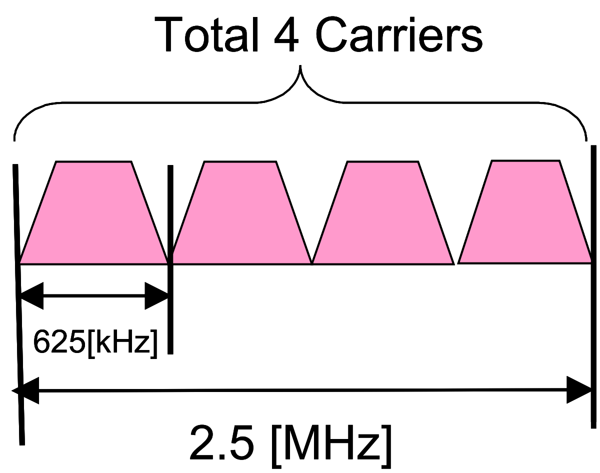


Figure 7-6 Carrier Aggregation in 2.5 MHz Block Assignment

The basic physical resource in the system is a **spatial channel**, which consists of a carrier, an uplink and downlink timeslot pair, and a spatial channel index. Multiple antennas and adaptive antenna processing make it possible to support multiple spatial channels simultaneously on the same conventional channel.

7.2.1.2 Modulation and Coding

While the symbol rate (500 KSymbols/sec) is constant for all slots in the frame definition in Figure 7-4 , the modulation order is adaptable (separately in uplink and downlink) to both the quality of a user’s channel and the current data rate requirements. Seven modulation schemes proposed are shown in Table 7-2.

Modulation Scheme used	Logical channel
π/2-BPSK	Control CHannel (CCH) Random Access CHannel (RACH) Fast Associated Control CHannel (FACCH)
QPSK	Broadcast CHannel (BCH) Paging CHannel (PCH)
π/2-BPSK QPSK	Traffic CHannel (TCH) under control of the higher-layer link-adaptation protocol

8-PSK 12-QAM 16-QAM 24-QAM 32-QAM 64-QAM	

Table 7-2 Modulation Schemes -Logical Channel

A range of modulation and coding combinations (referred to as "ModClasses") are employed to maximize throughput subject to FER and link conditions. Independent uplink and downlink power control and ModClass adaptation are to be performed on a burst-by-burst basis on traffic channels. Channels that have lower spatial processing gain, such as broadcast and paging channels, are to be transmitted generally with more extensive channel coding than traffic channels, balancing the tolerable path loss for all channel types. L1 employs spatial processing, multiple modulation and channel coding formats, and equalization with per-burst training data to manage the RF challenges of a mobile Non-Line-of-Sight (NLOS) environment. L1 is to support per-user data rates in excess of 1 Mbps per carrier on the downlink and in excess of 300 kbps per carrier on the return link as demanded by the MBWA PAR [2]. Carrier aggregation multiplies these per-user data rates by the number of aggregated carriers.

This set of modulation classes is flexible, consisting of both constant-modulus and rectangular constellations. The UT is not required to implement all of the ModClasses. This facilitates low-cost, power efficient devices. Note that most of the logical channels are transmitted using the lowest-order modulation classes. These low-bandwidth channels must be received correctly with high probability. The higher-order modulation classes are primarily intended for use by the traffic channels.

Figure 7-7 illustrates the coded modulation system that achieves rates from approximately 1/2 to 5.5 bits/symbol. Table 7-3 lists modulation classes and signal sets, together with the associated parameters for puncturing, shaping, and block coding.

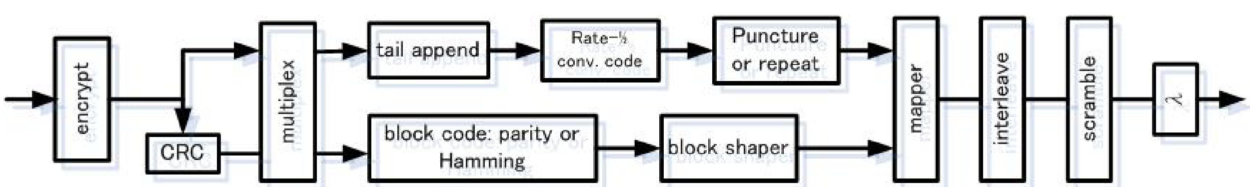


Figure 7-7 Block Diagram of Error control Coding Scheme

Coding for FEC is provided by a rate-1/2 convolutional code with 256 states combined in some cases with a block code. In some ModClasses, periodic puncturing is applied to increase the rate of the convolutional code to 2/3, ¾ or 5/6. Repetition is used in ModClass 0 to construct RA, AA and CM burst but not for CR and TCH bursts, ModClasses 6,7,8 ,9 and 10 employ four-dimensional block shaping to generate 12-,16-,24-, and 64-QAM signal sets, respectively.

ModClass	Bit/Sym	Signal Set	Puncture	Shaper	Block Code
0	0.5	BPSK	Repeat	-	-
1	0.67	BPSK	1 of 4	-	-
2	1.0	QPSK	-	-	-
3	1.5	QPSK	2 of 6	-	-
4	2.0	8-PSK	-	-	(64,57)
5	2.5	8-PSK	-	-	(64,57)
6	3	12-QAM	2 of 6	3/4	(48,47)
7	3.5	16-QAM	2 of 6	4/4	(64,63)
8	4	24-QAM	2 of 6	5/4	(80,79)
9	4.5	32-QAM	2 of 6	5/5	(80,79)
10	5.5	64-QAM	2 of 5	6/6	(80,79)
11-15	RESERVED				

Table 7-3 Modulation and Coding Rates

Information bits should be subject to forward error control coding prior to transmission. The coding rates vary from 0.5 bits/symbol to 5.5 bits/symbol in the downlink and 0.5 bits/symbol to 3.5 bits/symbol in the uplink. The Forward Error Control (FEC) provides for these components.

- CRC-16 across the information portion of the payload.
- Error control codes including
  - Convolutional code
  - Block code
  - Shaping code
- Bit interleaving within a burst
- Scrambling

The choice of codes is a function of the modulation class and includes provisions for puncturing and/or repeating portions of the block as required for rate matching.

The BCH is a heavily coded channel with low order modulation so that the link budget on the BCH matches that on the adaptive antenna enhanced TCH and RACH. The BCH repeatedly transmits the same information within a slot to exploit spatial diversity. Similarly, the PCH is heavily coded with low order modulation..

Table 7-4 shows the maximum per user data rates for each modulation class. This table indicates data rates achievable with single slot and with 3 slots aggregation using single frequency carrier for up link and down link The data rate are calculated as following formula.

ModClass	Modulation Method	Down Link(Kbps)		Up Link(Kbps)	
		Data Rate /Slot	Data Rate /Carrier	Data Rate /Slot	Data Rate /Carrier
0	BPSK	35	106	6	19
1	BPSK	50	149	13	38

2	QPSK	82	245	26	77
3	QPSK	126	379	43	130
4	8PSK	162	485	58	173
5	8PSK	198	595	72	216
6	12QAM	262	787	98	293
7	16QAM	307	922	115	346
8	24QAM	354	1061	133	398
9	32QAM	378	1133	142	427
10	64QAM	498	1493	190	571

Table 7-4 User data rates per Modulation Class

The data rate for four carrier aggregation will be:
Down Link : 1493kbps x 4 Carrier aggregation = 5.97 Mbps
Up Link : 571kbps x 4 Carrier aggregation = 2.28 Mbps

7.2.1.3 Support for adaptive antenna

In a frame of Figure 7-4, uplink slots are stacked together ahead of the downlink slots so that the downlink spatial signature can incorporate the received uplink signature estimate. Each uplink slot is paired with a downlink slot. The duration between any paired uplink and downlink slot is small (e.g. 1-2 ms) to prevent channel conditions from degrading the degree of channel reciprocity existing between the uplink and downlink slots and hence degrading the adaptive antennas' performance. Therefore, the frame duration is also small (5 ms). Carrier bandwidth is relatively narrow (625 KHz) to enable low complexity adaptive antenna algorithms. On a given carrier-timeslot pair, each user is assigned a unique training sequence. Training sequences are designed for appropriately accurate estimation of the propagation channel. Each UT on a conventional channel doing SDMA uses a different training sequence from a selected set with good correlation properties. The cross correlation property between the training sequences is very low. The autocorrelation property for the non-zero lags is also very low.

Generally, Adaptive array performance is determined by number of Antenna Elements.
In MBTDD 625k-MC(BEST-WINE), Base station can have 12 or 9 antenna while User Terminal (UT) can have 1,2,4 antenna elements.

7.2.2 MAC Layer L2

L2 maps control and data messages to physical resources and provides Acknowledged Mode (AM) and Unacknowledged Mode (UM) message delivery. AM data is delivered via a byte-addressable retransmission mechanism similar to that used in TCP, and provides a reliable delivery mechanism for L3 data including the preservation of byte ordering. Retransmission is done directly from the Base Station (BS) or User Terminal (UT) as appropriate to minimize ARQ latency. Traffic bursts are composed of tagged UM, AM, control and user data, allowing multiple messages to be sent in a single air interface burst for efficiency and low latency. L2 also provides bulk encryption to ensure the confidentiality of user and control data.

7.2.2.1 Logical Channels and Burst Types

A UT and a BS exchange information using a small number of logical channels. These logical channels, listed in Table 7-5, are mapped to physical bursts for transmission. There is a Standard Uplink and a Standard Downlink burst type common to the RACH, TCH, CCH in the downlink and FACCH logical channels. The remaining logical channels, namely PCH, BCH, and CCH in the uplink, are transmitted by dedicated burst types.

Burst (Transport Channel) Type	Symbol	Logical Channel
Downlink bursts:		
Frequency Synchronization	F	BCH
Timing Synchronization	T	BCH
Broadcast	B	BCH,CCH (for BCMCS)
Page	P	PCH
Standard Downlink	D	RACH, TCH, CCH, FACCH
Uplink Bursts:		
Configuration Request	C	CCH
Standard Uplink	U	RACH, TCH, FACCH

Table 7-5 Burst types

7.2.2.1.1 BCH

The Broadcast CHannel (BCH) is a downlink-only channel and the first logical channel the UT uses in establishing a connection to the BS and subsequently to the backhaul network. The purpose of the BCH is to allow the UT to gain coarse timing and frequency synchronization and to determine the best BS with which to communicate, both for initial acquisition and for handovers.

The BCH consists of the F, T, and B bursts. The F burst is used to gain coarse frequency synchronization and timing to the network. The T burst is used to calculate receive timing estimates, relative propagation delays, and relative path loss to each BS in the network. The B burst is used to provide more accurate information on the estimates derived from the T burst. Additionally, the B burst contains some information bits to aid in BS selection.

Two major considerations in the design of the BCH are the following.

1. The BCH compensates for the additional spatial processing gain of other channels (namely, CCH, TCH and RACH, to be defined and described later in this section) that have increased range and significantly less network interference due to adaptive antenna processing.
2. The BCH consumes a minimal amount of overhead so that it has a small impact on total base station throughput.

These design considerations lead to a B burst with a small number of information bits. The B burst contains small bit fields to indicate the transmitted power of the burst and the BS load. See Section 6.2 for more information on BS load usage.

7.2.2.1.2 CCH

The Configuration CHannel (CCH) serves two primary purposes.

1. The CCH is used as a fine adjustment mechanism for timing synchronization, e.g., during initial network acquisition and handovers.
2. The CCH is used to inform the UT of key BS and network parameters to enable the UT to continue connecting to a BS via registration

There are only three messages carried by CCH – CR, CM and SMB. On the uplink, the Configuration Request (CR) message has a field indicating the power of the transmitted CR burst. On the downlink, the Configuration Message (CM) needs to inform the UT of several key parameters, including the following.

- A network ID to distinguish between collocated operators in a geographic area
- A protocol version to identify system compatibility
- Information relating to BS channel configuration, such as identifying which conventional channels may be used for registration

Short broadcast message (SMB) is used to transmit broadcast data.

7.2.2.1.3 PCH

The Paging CHannel (PCH) is a downlink-only channel used to tell a UT to access the BS. It can be sent simultaneously with RACH and TCH on a given timeslot/frequency pair. Like BCH, PCH must compensate for the increased range of other channels (namely, TCH and RACH) that results from the adaptive antenna processing. The PCH conveys a small number of information bits. A page identifier (PID) is contained in each paging burst to communicate with a specific UT.

7.2.2.1.4 RACH

The Random Access CHannel (RACH) is used by the UT to gain access to a BS. It can be sent simultaneously with PCH and TCH on a given carrier-timeslot pair. Multiple messages are carried over this channel. The Request Access (RA) message is sent by the UT in the uplink, and contains a registration identifier (RID) that identifies a network session and indicates the transmit power of the burst containing the message. The Access Assignment (AA) message is sent by the base station in response to an RA message. The AA message is used in the downlink to grant a user terminal a TCH stream. The AA message contains several pieces of information, including the following.

- Modulation and coding information for the initial TCH burst(s) that follow
- Conventional channel (i.e., carrier-timeslot pair) assignment of the TCH stream
- Spatial training sequence (see section 6) assignment of the TCH stream
- Timing and power correction parameters

Figure 7-8 shows the Standard Downlink burst used for RACH, TCH, and FACCH. The Standard Uplink burst is shown in Figure 7-9.

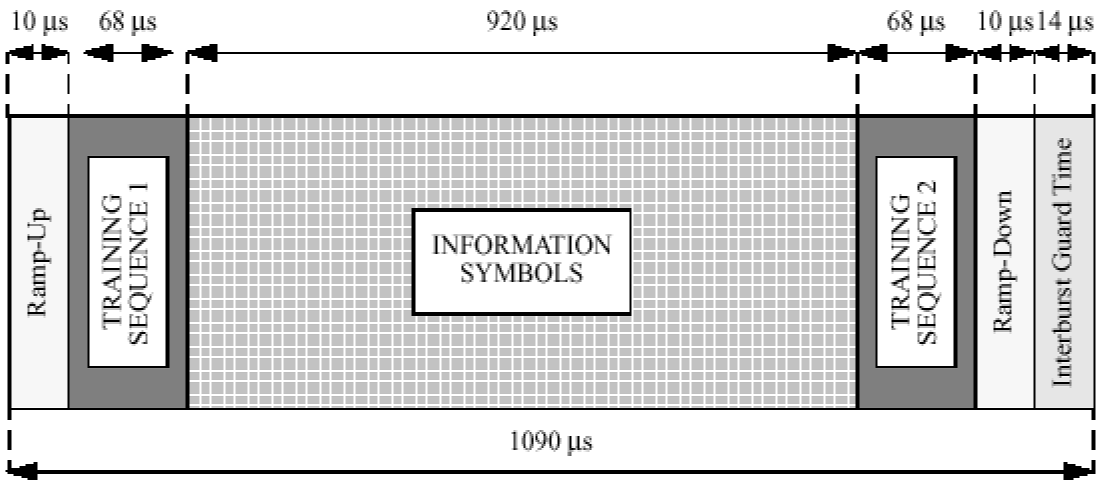


Figure 7-8 Standard Downlink Burst structure

7.2.2.1.5 TCH

The Traffic CHannel (TCH) is used to transport both end-user and control traffic data. The RACH initiates a TCH stream. A TCH stream is a series of TCH frames used by a single user terminal and is the basic mechanism used to convey user and control data. TCH streams are created and closed in response to the bandwidth needs of each UT.

7.2.2.1.6 FACCH

The Fast Associated Control CHannel (FACCH) is a logical channel associated with RACH and TCH. It carries power control and link adaptation information. The FACCH has its own modulation and coding (Walsh-Hadamard) and is recoverable at low SINR. The FACCH enables fast link adaptation since it contains real time updates of the modulation class of the TCH bursts that are being sent.

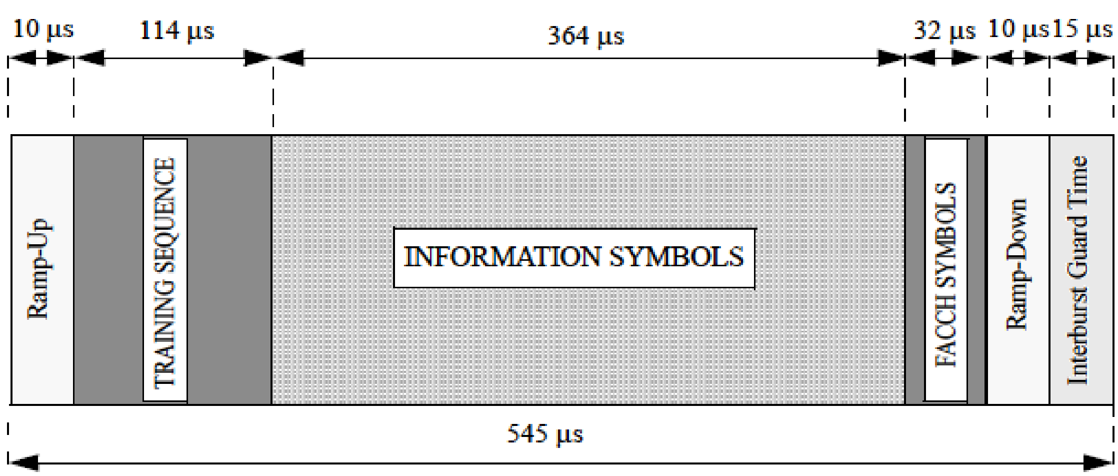


Figure 7-9 Standard Uplink Burst structure

7.2.3 Data Link Control (DLC) /Logical Link Control (LLC) L3

L3 manages access to air interface resources. Once a UT has registered with a BS, no air interface resources are allocated to that UT unless upstream or downstream traffic needs to be exchanged between it and the BS. All resource allocation decisions are made centrally at the BS, governed, in part, by QoS considerations including per-user limits on data rate and priority. Carrier and timeslot aggregation is employed to increase per-user throughputs on traffic channels beyond those supported by a single carrier-timeslot pair. Finally, uplink and downlink spatial processing at the base station results in a highly efficient access mechanism that exploits SDMA rather than conventional techniques such as collision detection/avoidance.

L3 also manages the relationship between the UT and the BS, maintaining the fundamentals of the association between those two entities that permits the exchange of end-user IP data. In addition, L3 employs physical measurements made at L1 to manage mobility and coordinate power control and link adaptation between the UT and the BS. L3 nominally receives end-user PPP or IP data from higher-level protocol entities. It provides for BS authentication so that the UT confirms the identity of the BS and vice versa.
Fig3-1 shows the structure of layer stack.

User and certain control data are transported using TCH streams. TCH streams provide two data delivery mechanisms.

1. Unacknowledged Mode (UM) traffic that is not sent through ARQ.
2. Acknowledged Mode (AM) traffic that is sent through ARQ.

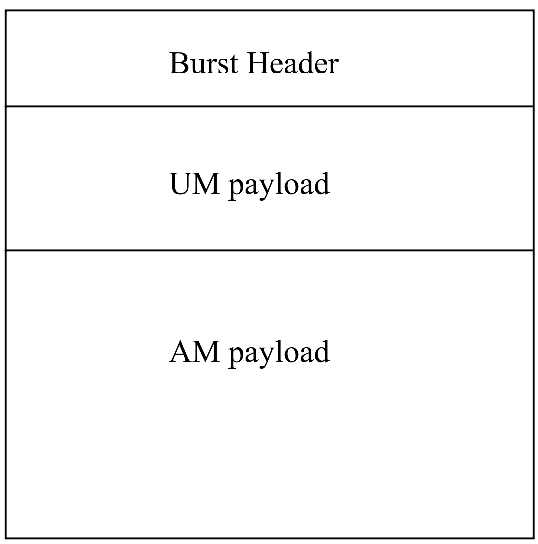


Figure 7-10 Burst Payload Format

UM and AM traffic are multiplexed on a burst-by-burst basis within a TCH stream. In order to multiplex efficiently and flexibly, the UM messages form a prefix code. AM traffic is mostly end-user data, but it may also contain control messages that need to be sent reliably. AM traffic is sent reliably using an ARQ scheme. The following describes the attributes of the ARQ scheme.

1. The endpoints are in the L2 layer of the UT and BS, minimizing the retransmission latency.

2. The ARQ scheme is byte-oriented, which allows for flexible payload sizes that result from adaptive modulation and the AM/UM multiplexing scheme.
3. The acknowledgement scheme is cumulative, i.e., the acknowledgements report the next byte expected for contiguous reception.

In order to facilitate the ordered and reliable delivery of AM traffic over aggregated TCH streams, a set of Packet Data Conversion Layer (PDCL) algorithms is to be applied to the AM traffic flow. The set of PDCL algorithms is extensible. The following list contains the key PDCL algorithms.

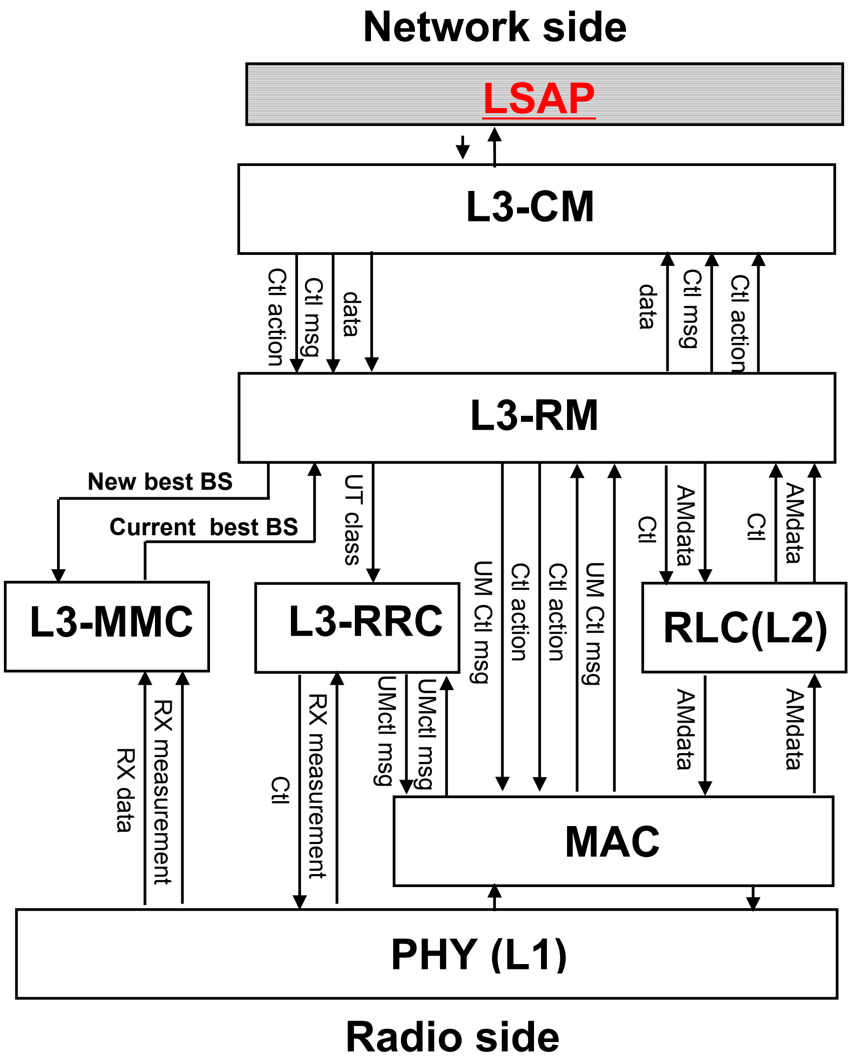
1. L3 packet checksum. This is used to augment the L1 checksum that is applied to each TCH burst.
2. Packet sequencing and reordering. This algorithm allows the receive side to reorder packets that have been sent in parallel by multiple streams.
3. Packet Fragmentation. This algorithm fragments packets into smaller units in order to reduce latency when there are multiple streams open for a connection.

7.2.3.1 Power Control and Link Adaptation

Power control and link adaptation control algorithms are present both in the uplink and downlink. The power control algorithm has open and closed loop controls. Both loops are controlled by the BSs, and hence the BS sends uplink power control and link adaptation commands in the downlink. To support centralized control by the BSs, the UTs need to report downlink signal quality (Signal to Interference plus Noise Ratio - SINR) back to the BSs. The UTs also needs to report the available transmit power (i.e. difference between the maximum available transmit power and the current transmit power) to the BSs in order to enable effective uplink link adaptation.

Power control and link adaptation messages are sent in every slot of every frame. Therefore the system is able to adapt to fast changes in propagation channels and in the interference environment. Power control commands accommodate both fixed step commands to compensate for small changes in SINR (e.g. +/-1 dB) and variable step commands to compensate for large changes in SINR (e.g. 10 dB). These commands are low bandwidth messages. The UT report (feedback on downlink signal quality) is present in every slot of every frame. The report is able to specify small (e.g. 1 dB) as well as large changes in the SINR (e.g. 10 dB). These reports are also low bandwidth messages.

Modulation and coding information is conveyed through FACCH. This channel carries information on the recommended modulation and coding class and the current modulation and coding used to construct the payload. This information is shared between the BS and the UT on a slot-by-slot basis.



L3CM	: Connection management
L3RM	: Registration management
L3RRC	: Radio resource control
L3MMC(UT only)	: Mobility management/control
MAC	:Media Access Control
RLC	:Radio Link Control

Figure 7-11 Protocol relationship among the Air interface Layers L1,L2 and L3

7.2.4 Layer3+

7.2.4.1 QoS

This proposal supports Quality of Service (QoS), with QoS behaviors defined using common traffic engineering modeling elements, such as token buckets, meters, algorithmic droppers, shapers, etc. The proposal supports a standard DiffServ solution. Per-session QoS can be specified to the radio access network using standard DiffServ Code Points (DSCP's). The Per Hop Behaviors (PHB's) are defined by a standard DiffServ API.

The BS scheduler is in charge of enforcing the Quality of Service (QoS) requirements for the aggregate set of network sessions, as configured through the DiffServ API. The air-interface is highly versatile, providing the basic mechanisms used by the BS scheduler.

The scheduler incorporates individual UT RF and baseband capabilities, such as RF carrier and timeslot aggregation capabilities. Using this information and the basic stream mechanisms, the scheduler can enforce basic QoS behaviors, such as individual rate limits, priority, and soft resource partitioning between aggregate classes. The BS may schedule all users together over the complete set of physical resources. Alternately, it can separate individual users into specific registration domains by partitioning the overall set of physical resources, assigning individuals to particular registration domains during or even after registration.

7.2.4.2 Air Interface Handover

The air interface's make-before-break handover scheme is UT-directed. Each UT monitors the broadcast channels from surrounding BSs and ranks candidates based on transmitted and received signal power, delay, and BS load as indicated by the BCH. The UT can perform these measurements as well as register with a candidate new serving BS while exchanging TCH data with its current serving BS. The handover for user data is make-before-break with the TCH data being redirected to the new serving BS after successful registration.

7.2.4.3 Security

The MBTDD 625k-MC (BEST-WINE) air interface provides a robust security infrastructure with air interface confidentiality and authentication. It provides seamless support of IP-centric network, transport and application layer security. The air interface security architecture is designed to overcome known problems in contemporary wireless systems.

7.2.4.3.1 Authentication

Authentication (for both the BS and UT) is be based on using digital certificates signed according to ISO/IEC 9796 standard using the RSA algorithm as the signature primitive. The digital certificates present information about the owner of the certificate and its elliptic curve public key. RSA modulus ranges from a minimum of 1024 bits to a maximum of 2048 bits.

7.2.4.3.2 Shared Secret

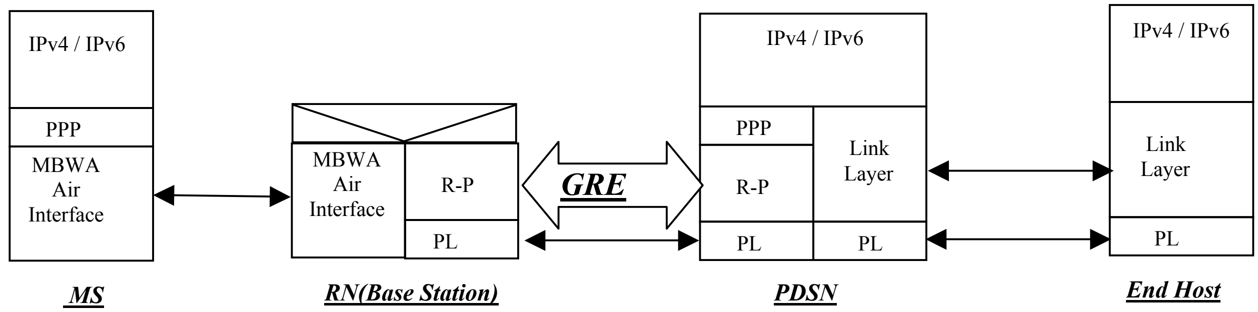
Shared secret and air interface parameter exchange is performed using the public keys of the UT and the BS. The public key infrastructure is based on elliptic curve cryptography (using curves K-163 and K-233 in FIPS-186-2 standard)..
During registration the UT and BS digital certificate transmissions, together with the public key encrypted shared secret and air interface transmissions, are interleaved to optimize air interface utilization.
Shared secret exchange capacity ranges from 163 bits to 466 bits depending on the needs of the bulk encryption algorithm.

7.2.4.3.3 Bulk Encryption

Bulk encryption is performed using a stream cipher such as RC4 initialized by a function of the shared secret and the temporal parameters of a stream to be encrypted (system may also support any block cipher that can operate in output feedback mode (OFB) or in cipher feedback mode (CFB)). The stream cipher supports a variable length shared secret key which is diffused properly prior to each stream start and shared secret refreshment is enforced by both the UT and the BS in order to circumvent errors in UT configuration settings.

7.2.4.4 Supporting IPV4 and IPV6

MBWA Base Station (BS) and User Terminal(UT) supports IPv6 based on 3GPP2[7]. MBWA systems provides transparency interface for User IP layer. MBWA user can make possible to use IPv4 or IPv6 on the expectation. Following diagram is network protocol stack of MBTDD 625k-MC (BEST-WINE) system.



1 ***3GPP2 Base Network Protocol Stack (Simple IPv6)***

7.3 Performance

The proposed MBTDD 625k-MC(BEST-WINE)'s Base systems HC-SDMA [1] has been implemented and tested in some countries. The section illustrates the performance results spatial channels in delivering high spectrum efficiency in Australia.

HC-SDMA [1] implemented spatial channel testing in Nov 7th 2003 at North Sydney (North ride). Base station had 12 dipole antennas on 25m height tower and terminals are of PCMCIA type as shown in Figure 7-12 . Total 5MHz bandwidth (625kHz x 8Carrier) was used for performance testing. The base station performs 8 Carrier communication including BCH and 3 spatial channels simultaneously. User terminal needs to use 625kHz bandwidths for 1Mbps communication. Therefore, Base station delivered the following data rates to a total of24 (3 × 8) User simultaneously.

User terminal data rate without BCH : Uplink 1,061 kbps
Downlink 346 kbps
User terminal data rate with BCH : Uplink 707 kbps
:Downlink 231 kbps

So, Aggregate data rate (1,061 kbps ＋ 346 kbps) × 7 Carrier × 3 Spatial
+ (707 kbps + 231 kbps) × 1 Carrier × 3 Spatial ≅ 32.4 Mbps.

HC-SDMA system could deliver Aggregate data rate ≅ 32.4 Mbps. The corresponding Maximum Spectrum efficiency that is achieved in 5MHz band is 32.4 Mbps / 5 MHz≅ 6.5 bit/sec/Hz/cell

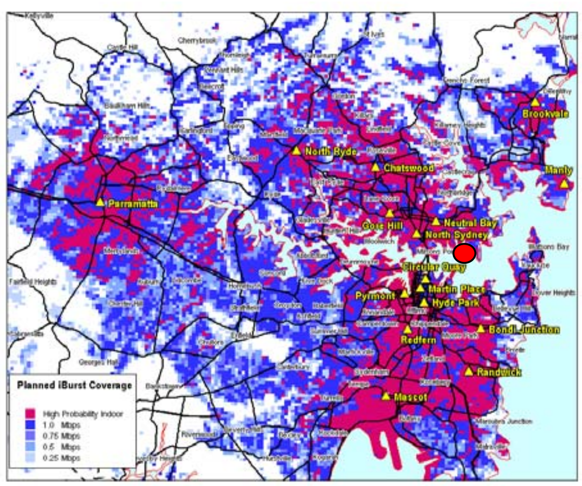


Figure 7-12 25m height Tower, Sydney MAP and **User terminal**

The test result for 24 terminals communication performed total 29.6Mbps.Table 6 show throughput result for downlink performance. The logical maximum data rate is 32.4Mbps as already stated. From this result, Spatial efficiency is computed as 29.6Mbps / 32.4 Mbps ≅ 0.913 91.3%

Furthermore, about the Spectrum efficiency is computed as 29.6 Mbps / 5 MHz ≅ 5.9 bit/sec/Hz/cell

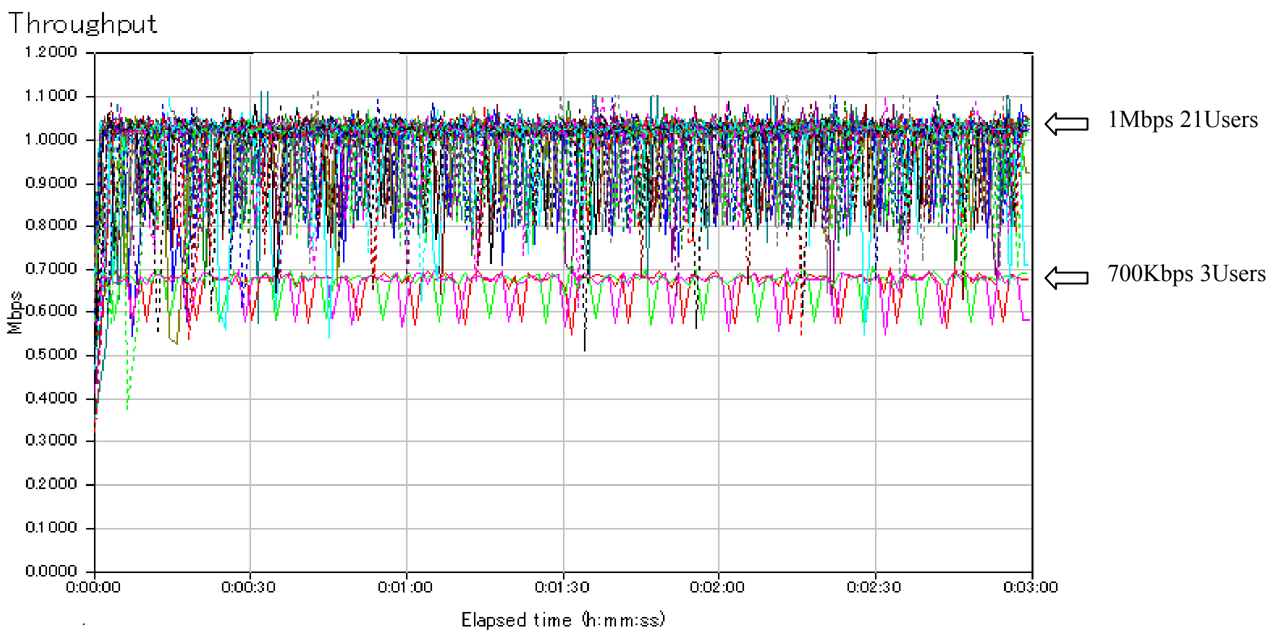


Figure 7-13: Downlink Date Rate Results

Data Flow Direction	Typical/Terminal	Total Data Rates/Base station	Spectrum Efficiency (bit/sec/Hz/sector)
Downlink	**942kbps**	**22.6Mbps**	**6.8**
Uplink	**290kbps**	**7.0Mbps**	**4.2**
Uplink	**1,232kbps**	**29.6Mbps**	**5.9**

Figure 7-14: Date Rate and Spectrum Efficiency Test Results of HC-SDMA in Australia

7.3.1 Low Power Consumption

In Idle mode UT periodically monitors own paging PCH (Refer to 7.3.3 of HC-SDMA [1]) for wake up requirement. When BS needs to deliver data to UT in Idle Mode, BS shall follow the procedure as specified in 9.3.4.1 of HC-SDMA [1]. The frequency of pages from BS shall conform to five discrete levels of paging activity levels (Paging States) transitions from high level to low level: Page every frame, Page every 8th frame, Page every 64th frame, Page every 512th frame and No paging at all, as specified in 9.3.4.1.2 of HC-SDMA [1]. BS and UT shall agree during the registration phase on the length of duration of paging activity before changing to next lower paging activity, thereby allowing the power conservation feature in 625k-MC mode. This feature may be used to plan the hardware resources at UT at powerdown mode.

7.3.2 Radio Network Quality monitor and control

MBTDD 625k-MC(BEST-WINE) network systems provides radio network quality monitor and control functionality. These information are controlled by following strategies.

7.3.2.1 Performance Measurement

MBTDD 625k-MC(BEST-WINE) equipment should be support to inform performance data for network quality maintenance.
Typical statistical data is shown below .
-Signal vs. Noise Ratio measurement (SINR)
-RSSI measurement
-Global positioning and absolute time stamp measurement (GPS)
-Total registration number
-Data rate

These performance data are transported to EMS periodically.

7.3.2.2 Diagnosis, Monitoring and Alarm

MBWA equipments should be supports diagnosis and monitoring devices functions. If a fail status is detected by these functions, *MBTDD 625k-MC(BEST-WINE)* equipments take the appropriate process to keep operation with minimum resource reduction and inform alarm to EMS via SNMP interface on alarm occurrence. Also, the each board on Base Unit and PA Unit also display current status using LED. Alarm severities depend on maintenance urgency.

7.3.2.3 Process statistical data and configuration control

MBTDD 625k-MC(BEST-WINE) element management systems(EMS) extract statistical data and alarm information from *MBTDD 625k-MC(BEST-WINE)* equipments to solve network quality . EMS analyzes interference from statistical data of each equipments. And, EMS controls interference to use equipments configuration parameter .via IP network and air interface.

8 Proposed Draft Specifications of MBTDD 625k-MC(BEST-WINE)

This Section defines the additional draft specification that deliver enhanced performance to meet the SRD [3]and PAR [2]of IEEE-MBWA , which are supplemental to the Draft Specifications of the Pre published ATIS standard HC-SDMA [1]. The Complete Proposed Draft specifications are as listed in Chapters 14-29 of IEEE C802.20-06/04

9 Summary

Table 9-1 summarizes the key elements of the MBTDD 625k-MC(BEST-WINE) a TDD MBWA System

Quantity	Value
Duplex Method	TDD
Multiple Access Method	FDMA/TDMA/SDMA
Access Scheme	Collision avoidance, centrally scheduled
Carrier Spacing	625 kHz
Frame Period	5 ms
User Data Rate Asymmetry	3:1 down/up asymmetry at peak rates
Uplink Time Slots	3
Downlink Time Slots	3
Range	< 15 km
Symbol Rate	500 kbaud/sec
Pulse shaping	Root raised cosine
Excess channel bandwidth	25%
Modulation and coding	- Independent frame-by-frame selection of uplink and downlink constellation + coding. - 11 uplink constellation + coding classes - 11 downlink constellation + coding classes - Constant modulus and rectangular constellations
Power Control	Frame-by frame uplink and downlink open and closed loop
Fast ARQ	Yes
Carrier and timeslot aggregation	Yes
QoS	DiffServ policy specification, supporting rate limiting, priority, partitioning, etc.
Security	Mutual UT and BS authentication, encryption for privacy
Handover	*UT directed, make-before-break*
Resource Allocation	Dynamic, bandwidth on demand

Table 9-1 Summary of the basic elements of the MBWA TDD MBWA air interface