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WiMAX™ – HRPD Interworking: Air Interface Specification

Revision 0

No Text.

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FOREWORD

(This foreword is not part of this Standard)

This Standard was prepared by Technical Specification Group C of the Third Generation Partnership Project 2 (3GPP2). This Standard contains the air interface requirements for facilitating High Rate Packet Data (HRPD) interworking with the World Interoperability for Microwave Access (WiMAX™[1]). This specification applies to High Rate Packet Data Revision A compliant access terminals and access networks which are enhanced to support the WiMAX and HRPD interworking.

This is a supplementary specification to HRPD air interface specifications.

This Standard consists of the following sections:

1. **General.** This section defines the acronyms and terms used in this document.
2. **cdma2000®[2] HRPD interworking with WiMAX.** This section specifies the required HRPD procedures and messages for HRPD interworking with WiMAX.

[1] "WiMAX" is a trademark of the WiMAX Forum.

[2] "cdma2000® is the trademark for the technical nomenclature for certain specifications and standards of the Organizational Partners (OPs) of 3GPP2. Geographically (and as of the date of publication), cdma2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA) in the United States."

REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[1] 3GPP2 C.S0024-A v3.0: cdma2000 High Rate Packet Data Air Interface Specification.

[2] 3GPP2 C.R1001: Administration of Parameter Value Assignments for cdma2000 Spread Spectrum Standards. (Informative Reference)

[3] 3GPP2 X.S0058-0 v1.0: WiMAX-HRPD Interworking: Core Network Aspects.

[4] 3GPP2 A.S0023-0 v1.0: WiMAX and HRPD Interworking Interoperability Specification: (WiMAX – HRPD IIOS).

[5] 3GPP2 C.S0087-0 v1.0: E-UTRAN – HRPD and cdma2000 1x Connectivity and Interworking: Air Interface Specification.

[6] 3GPP2 C.S0002, Physical Layer Standard for cdma2000 Spread Spectrum Systems.

[7] 3GPP2 X.S0011-D: cdma2000 Wireless IP Network Standard.

[8] WiMAX Forum®[3]Network Architecture Release 1 Version 1.6.0 Annex: WiMAX - 3GPP2 Interworking Single Radio Transmitter/Dual Receiver. (Informative Reference)

[3] "WiMAX Forum," the WiMAX Forum logo and the WiMAX Forum Certified logo are registered trademarks of the WiMAX Forum.

1 OVERVIEW

1.1 Introduction

These technical requirements form a compatibility standard for facilitating cdma2000 High Rate Packet Data (HRPD) interworking with the World Interoperability for Microwave Access (WiMAX™[4]).

This is a supplementary specification built on top of the existing cdma2000 High Rate Packet Data [HRPD] air interface specifications. All requirements of the existing C.S0024-A v3.0 [1] are included and assumed by this specification, unless explicitly excluded or modified herein. In addition this specification also reuses requirements from E-UTRAN-HRPD Interworking [5] which are referenced in subsequent sections.

1.2 Scope of This Document

This specification applies to High Rate Packet Data Release A compliant access terminals which are enhanced to support the HRPD interworking with WiMAX using a single transmitter/dual receiver and access networks which are enhanced to support the HRPD interworking with WiMAX.

These requirements ensure that a compliant access terminal can obtain interworking service through any access network conforming to this standard. These requirements do not address the quality or reliability of that service, nor do they cover equipment performance or measurement procedures.

This specification is primarily oriented toward requirements necessary for the design and implementation of access terminals. As a result, detailed procedures are specified for access terminals to ensure a uniform response to all access networks. Access network procedures, however, are specified only to the extent necessary for compatibility with those specified for the access terminal.

This specification includes provisions for future service additions and expansion of system capabilities. The architecture defined by this specification permits such expansion without the loss of backward compatibility to older access terminals.

1.3 Requirement Language

Compatibility, as used in connection with this standard, is understood to mean: Any access terminal can obtain service through any access network conforming to this standard. Conversely, all access networks conforming to this standard can service access terminals.

"Shall" and "shall not" identify requirements to be followed strictly to conform to the standard and from which no deviation is permitted. "Should" and "should not" indicate that one of several possibilities is recommended as particularly suitable, without mentioning or excluding

[4] "WiMAX" is a trademark of the WiMAX Forum.

others, that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is discouraged but not prohibited. “May” and “need not” indicate a course of action permissible within the limits of the standard. “Can” and “cannot” are used for statements of possibility and capability, whether material, physical, or causal.

1.4 Architecture Reference Model

The cdma2000 (HRPD) interworking with WiMAX architecture reference model, is presented in Figure 1.4-1-1. The reference model consists of the following functional units: the cdma2000 mode of the dual mode access terminals, the cdma2000 access network and the X1 Tunnel Interface.

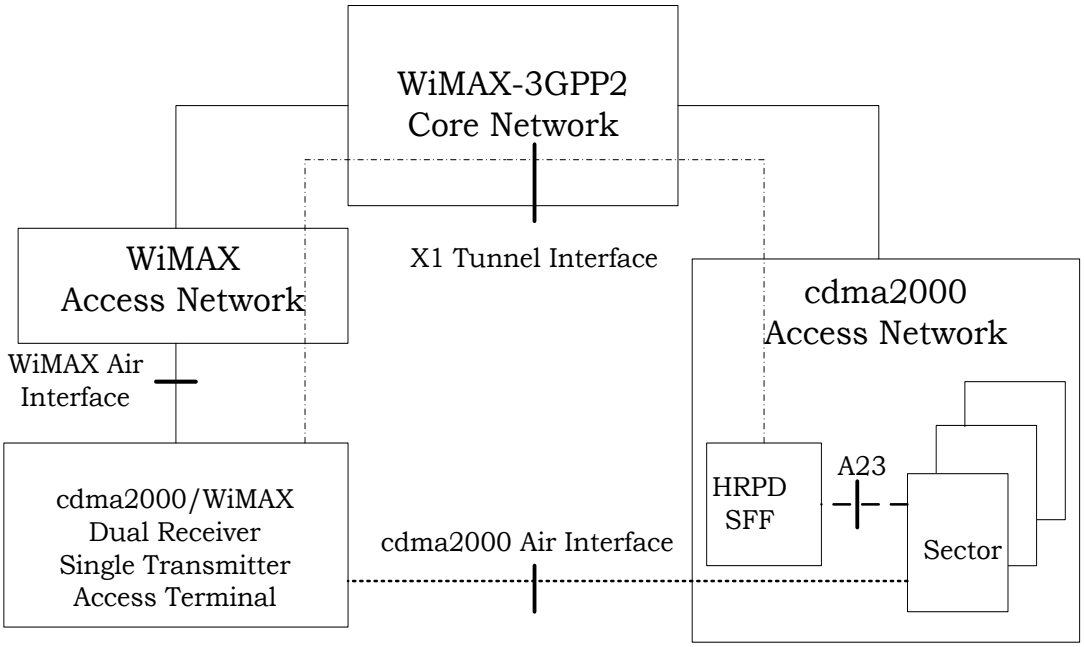

Figure 1.4-1-1 WiMAX-HRPD Interworking Architecture Reference Model

The X1 Tunnel Interface involves the WiMAX mode of the dual mode access terminal, the WiMAX air interface, the WiMAX access network, and the Common IP core network [7]. The elements related to the Tunnel Interface shown in Figure 1.4-1-1 are specified in [3] and [4].

The cdma2000 inter-radio-access-technology interworking protocols used over the X1 Tunnel Interfaces and the cdma2000 air interface are defined in this document.

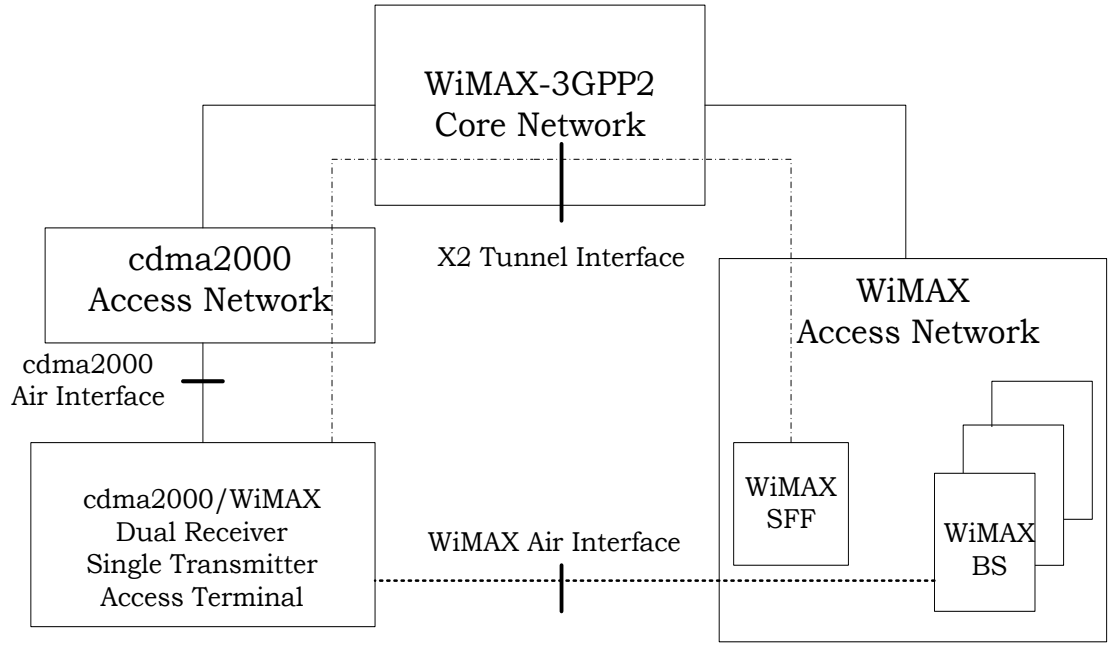

Figure 1.4-1-2 HRPD-WiMAX Interworking Architecture Reference Model

Note: Figure 1.4-2 HRPD-WiMAX Interworking Architecture Reference Model is included only for information.

The X2 Tunnel Interface involves the cdma2000 mode of the dual mode access terminal, the cdma2000 air interface, the cdma2000 access network and the Common IP core network [7]. The elements related to the Tunnel Interface shown in Figure 1.4-1-2 are specified in [8].

The cdma2000 air interface changes to support inter-radio-access-technology interworking are defined in this document.

1.5 Terms

Access Network. (AN). The network equipment providing data connectivity between a packet switched data network (typically the Internet) and the access terminals. An access network is equivalent to a base station in [6].

Access Terminal. (AT). A device providing data connectivity to a user. An access terminal may be connected to a computing device such as a laptop personal computer or it may be a self-contained data device such as a personal digital assistant. An access terminal is equivalent to a mobile station in [6].

cdma2000 Mode of Dual Mode Access Terminal. An operation mode of a dual mode access terminal which provides the connectivity over the cdma2000 HRPD air interface. A dual mode access terminal may operate in the cdma2000 mode or the mode of another radio access technology such as WiMAX.

Code Division Multiple Access (CDMA). A technique for spread-spectrum multiple-access digital communications that creates channels through the use of unique code sequences.

WiMAX. World Interoperability for Microwave Access.

MAC Layer. The MAC Layer defines the procedures used to receive and to transmit over the Physical Layer. The MAC Layer is defined in Chapter 10 of [1].

Primary Radio Access Technology. The Radio Access Technology on which the access terminal can transmit at the present time.

Reverse Traffic Channel. The portion of the Reverse Channel that carries information from a specific access terminal to the access network. The Reverse Traffic Channel can be used as either a Dedicated Resource or a non-Dedicated Resource. Prior to successful access terminal authentication, the Reverse Traffic Channel serves as a non-Dedicated Resource. Only after successful access terminal authentication can the Reverse Traffic Channel be used as a Dedicated Resource for the specific access terminal.

WiMAX Mode of Dual Mode Access Terminal. An operation mode of a dual mode access terminal which provides the connectivity over the WiMAX air interface. A dual mode access terminal may operate in the WiMAX mode or the mode of another radio access technology such as cdma2000 HRPD.

1.6 Notation

A[i]	The i^{th} element of array A. The first element of the array is A[0].
<e_1, e_2, …, e_n>	A *structure* with elements 'e_1', 'e_2', …, 'e_n'. Two structures E = <e_1, e_2, …, e_n> and F = <f_1, f_2, …, f_m> are equal if and only if 'm' is equal to 'n' and e_i is equal to f_i for i=1, …n. Given E = <e_1, e_2, …, e_n> and F = <f_1, f_2, …, f_m>, the assignment "E = F" denotes the following set of assignments: $e_i = f_i$, for i=1, …n.
S.e	The member of the structure 'S' that is identified by 'e'.
M[i:j]	Bits i^{th} through j^{th} inclusive ($i \geq j$) of the binary representation of variable M. M[0:0] denotes the least significant bit of M.
|	Concatenation operator. (A | B) denotes variable A concatenated with variable B.
×	Indicates multiplication.
$\lfloor x \rfloor$	Indicates the largest integer less than or equal to x: $\lfloor 1.1 \rfloor = 1, \lfloor 1.0 \rfloor = 1$.
$\lceil x \rceil$	Indicates the smallest integer greater or equal to x: $\lceil 1.1 \rceil = 2, \lceil 2.0 \rceil = 2$.
$\|x\|$	Indicates the absolute value of x: $\|-17\|=17$, $\|17\|=17$.

$\oplus$	Indicates exclusive OR (modulo-2 addition).
$\otimes$	Indicates bitwise logical AND operator.
min (x, y)	Indicates the minimum of x and y.
max (x, y)	Indicates the maximum of x and y.
x mod y	Indicates the remainder after dividing x by y: x mod y = x – (y × $\lfloor$x/y$\rfloor$).
x^y	Indicates the result of x raised to the power y, also denoted as x^y.
x^y	Indicates the result of x raised to the power y, also denoted as x^y.

Unless otherwise specified, the format of field values is unsigned binary.

Unless indicated otherwise, this standard presents numbers in decimal form. Binary numbers are distinguished in the text by the use of single quotation marks. Hexadecimal numbers are distinguished by the prefix ‘0x’.

Unless specified otherwise, each field of a packet shall be transmitted in sequence such that the most significant bit (MSB) is transmitted first and the least significant bit (LSB) is transmitted last. The MSB is the left-most bit in the figures in this document. If there are multiple rows in a table, the top-most row is transmitted first. If a table is used to show the sub-fields of a particular field or variable, the top-most row consists of the MSBs of the field. Within a row in a table, the left-most bit is transmitted first. Notations of the form “repetition factor of N” or “repeated N times” mean that a total of N versions of the item are used.

No Text.

2 ACCESS TERMINAL SPECIFIC PROCEDURES

The procedures defined in this section describe general requirements to which access terminals and access networks shall comply with, in order to enable WiMAX – HRPD interworking.

2.1 Access Terminal Bootup procedure

When the HRPD protocol stack is created, if the primary radio-access-technology is WiMAX, then the access terminal shall create an InUse instance of each of the protocol types listed in Table 2.1-1, using the respective protocol subtype, the access terminal shall create the InUse instance of Inter-RAT Signaling Adaptation Protocol first, and then create the InUse instances of other protocols. For protocols types not listed in Table 2.1-1, the access terminal shall create the InUse protocol instance using the default protocol subtypes.

Table 2.1-1. Bootup Protocol Type and Protocol Subtype in WiMAX

Protocol Type		Protocol Subtype	
Name	ID	Name	ID
Route Update	0x0e	Inter-RAT Route Update	0x0002
Signaling Adaptation	0x1d	Inter-RAT Signaling Adaptation	0x0001
Reverse Traffic ChannelMAC	0x04	Subtype 3 Reverse Traffic ChannelMAC	0x0003
Idle State	0x0c	Inter-RAT Idle State	0x0003

2.2 WiMAX to HRPD Idle Handoff Procedure

Upon the access terminal performing an WiMAX to HRPD idle handoff, if the protocol subtype of the InUse instance of the Signaling Adaptation protocol is equal to 0x0000 [2] or if there is no InUse instance of the Signaling Adaptation protocol, then the access terminal shall issue an *AirLinkManagement.OpenConnection* command. Otherwise, the access terminal shall issue a *SignalingAdaptation.IdleHandoffRequest* command and then an *AirLinkManagement.OpenConnection* command.

2.3 HRPD to WiMAX Handoff Procedure

Upon the access terminal deciding to perform an HRPD to WiMAX handoff, the access terminal shall issue an *AirLinkManagement.CloseConnection* command if in connected mode.

No Text.

3 SESSION LAYER

3.1 Default Session Management Protocol

3.1.1 HRPD to WiMAX Idle Handoff Procedure and HRPD Prior Session Handling

This is a new section under 7.2 of [1].

If the access terminal has an HRPD session and the primary radio-access-technology is WiMAX, the access terminal shall:

- If the HRPD session has at least one personality with the Signaling Adaptation Protocol subtype not equal to 0x0000, the access terminal may try to restore the HRPD session over the tunnel.
- Otherwise, the access terminal shall purge the HRPD session and follow the Access Terminal Bootup Procedure from 2.1.

No Text.

4 CONNECTION LAYER

4.1 Inter-RAT Signaling Adaptation Protocol

Requirements as specified in "Inter-RAT Signaling Adaptation Protocol" of [5] applies here.

4.2 Inter-RAT Route Update Protocol

Requirements as specified in "Inter-RAT Route Update Protocol" of [5] applies here.

4.3 Inter-RAT Idle State Protocol

4.3.1 Command Processing

4.3.1.1 Activate

This section supersedes 5.3.6.1.1.1 of [5].

When the protocol receives an *Activate* command in the Inactive State and either TunnelModeEnabled public data of Signaling Adaptation Protocol equal to '0' or the primary RAT is WiMAX:

- The access terminal shall transition to the Monitor State.
- The access network shall transition to the Sleep State[5].

When the protocol receives an *Activate* command in the Inactive State and TunnelModeEnabled public data of Signaling Adaptation Protocol is equal to '1':

- The access terminal shall transition to the Tunnel State.
- The access network shall transition to the Sleep State [5].

If the protocol receives this command in any other state it shall be ignored.

4.3.2 Access Terminal Procedures for Sending a ConnectionRequest Message

This section supersedes 5.3.6.1.2 of [5].

When procedures in this section are invoked, the access terminal shall perform the following:

Send a ConnectionRequest message,

If the message is transmitted successfully, e.g. an *AccessChannelMAC.TransmissionSuccessful* indication is received, it shall transition to the Connection Setup State,

If the message failed to be sent, e.g. an *AccessChannelMAC.TransmissionFailed* indication is received, it shall return a *ConnectionFailed* indication.

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[5] Since the transitions happen asynchronously, this requirement guarantees that the access network will not transmit unicast packets to the access terminal over the Control Channel when the access terminal is not monitoring the channel.

4.3.3 Monitor State

4.3.3.1 Access Terminal Requirements

This section supersedes 5.3.6.1.6 of [5].

Upon entering the Monitor State, the access terminal shall issue the following commands:

- *OverheadMessages.Activate*
- *ControlChannelMAC.Activate*

The access terminal shall comply with the following requirements when in the Monitor State:

- If the access terminal has queued an *OverheadMessages.Updated* indication or upon receiving an *OverheadMessages.Updated* indication, the access terminal shall tune to the CDMA Channel selected as specified in 4.3.3.1.1.
- If the access terminal entered Monitor State to receive the synchronous capsule, it shall monitor the overhead messages as specified in the Overhead Messages Protocol (see 8.9.6.1.6 of [1]).
- If the access terminal receives a Page message, it shall perform the procedures in 8.5.6.1.2 of [1] for sending a ConnectionRequest message.
- If the access terminal requires opening a connection, it shall perform the procedures in 8.5.6.1.2 of [1] for sending a ConnectionRequest message.
- If the access terminal receives a *RouteUpdate.ConnectionInitiated* indication it shall transition to the Connection Setup State[6].
- Access terminal may transition to the Sleep State if the requirements specified in 4.3.3.1.2 are satisfied.
- If the access terminal receives a *SignalingAdaptation.ConnectionOpened* indication in this state, then the access terminal shall issue a *ConnectionOpened* indication.
- If the access terminal receives a *SignalingAdaptation.ConnectionFailed* indication in this state, then the access terminal shall issue a *ConnectionFailed* indication.

4.3.3.1.1 CDMA Channel Selection

The access terminal shall select a CDMA Channel from the list of channels or extended channels in the SectorParameters message. If no channels or extended channels are listed, the access terminal shall use the channel it is currently monitoring. If one or more channels are available, the access terminal shall use a hash function (see 14.4 of [1]) to compute an index into the subset of a subset of advertised CDMA Channels according to the following procedures.

The access terminal shall create a combined channel list as follows:

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[6] This requirement provides Fast Connect on the access terminal side.

- If the extended channel list is included in the SectorParameters message, the access terminal shall create a combined channel list by appending each CDMA Channel in the extended channel list (in order) to the set of CDMA Channels in the channel list (in order). Otherwise, the access terminal shall set the combined channel list to the set of CDMA Channels in the channel list.
- If the SupportedCDMAChannels public data of the Route Update Protocol lists any channels, then the access terminal shall remove from the combined channel list all CDMA Channels that are not supported by the access terminal as indicated by the SupportedCDMAChannels public data of the Route Update Protocol.

The set, *S*, of CDMA Channels is determined as follows:

- If the AccessHashingChannelMaskIncluded field in the SectorParameters message is not included or is included and set to '0', the access terminal shall set *S* to the subset of CDMA Channels in the combined channel list.
- If the AccessHashingChannelMaskIncluded field in the SectorParameters message is included and is set to '1', the access terminal shall set *S* to the subset of CDMA Channels in the combined channel list for which:
  - Ni is equal to Nmax, where i is the index of the CDMA Channel in the combined channel list,

    where Nj = bitcount(AccessHashingClassMask [AccessHashingMaskLength:0] ⊗ Mj), where Mj is the AccessHashingChannelMask field in the SectorParameters message corresponding to the jth CDMA Channel in the combined channel list;

    Nmax is the maximum value of Nk for all k , where k is the index of the CDMA Channel in the combined channel list; and

    bitcount(x) is the number of '1' bits in the binary representation of x.

The CDMA Channels supported by the access terminal are public data of the Route Update Protocol. The access terminal shall use the following hash function parameters to obtain the index into set *S*:

- Key = SessionSeed
- Decorrelate = 0
- N = Number of CDMA Channels in set *S*

where SessionSeed is provided as public data by the Address Management Protocol.

4.3.3.1.2 Transition to Sleep State

The access terminal may transition to the Sleep State if all of the following requirements are met:

- One of the following requirements is met:

– The access terminal entered the Monitor State to receive the synchronous capsule and has received a Control Channel synchronous Sleep State capsule in the current Control Channel Cycle and has determined that the SectorParameters message is up to date (see 8.9.6.1.6 of [1]). The current Control Channel Cycle is defined to be the Control Channel Cycle that started at slot $\lfloor T/256 \rfloor$, where T is the current CDMA System Time in slots.

– The access terminal entered the Monitor State to receive a sub-synchronous capsule, and has received the sub-synchronous capsule, or did not receive the sub-synchronous capsule in the expected slots.

- Access terminal received an *AccessChannelMAC.TxEnded* indication for every *AccessChannelMAC.TxStarted* indication it received since entering the Monitor State.[7]
- Access terminal has not advertised a suspend period that is current (see 8.6.6.1.2.1.1 of [1]). The suspend period is current if the time advertised in the associated ConnectionClose message is greater than the current CDMA System Time[8].

4.3.4 Sleep State

This section supersedes 5.3.6.1.5 of [5].

When the access terminal is in the Sleep State it may stop monitoring the Control Channel by issuing the following commands:

- *OverheadMessages.Deactivate*
- *ControlChannelMAC.Deactivate*

The access terminal may shut down processing resources to reduce power consumption.

In order to transmit on the Access Channel in this state, the access terminal shall first transition from the Sleep State to the Monitor State. If the access terminal requires opening a connection, it shall transition to the Monitor state and perform the procedures in 4.3.2 for sending a ConnectionRequest message.

In order to transmit on the WiMAX in this state, the access terminal shall first transition from the Sleep State to the Monitor State. If the access terminal requires opening a connection, it shall transition to the Monitor state and perform the procedures for sending a AlternateLinkOpenReq message.

When the access network is in the Sleep State, it is prohibited from sending unicast packets to the access terminal.

If the access network receives a ConnectionRequest message, it shall transition to the Connection Setup State.

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[7] This pairing ensures that the access terminal does not have any outstanding messages waiting for an answer.

[8] The access terminal monitors the Control Channel continuously during a suspend period thus avoiding the delay in opening access network initiated connections due to the sleep period.

If the access terminal advertised a suspend period that is current, the access network may transition to the Monitor State.

The access network and the access terminal shall transition from the Sleep State to the Monitor State in time to send and receive, respectively, the sub-synchronous capsule or the synchronous capsule sent at time T satisfying the following condition:

$$[T+256\times R] \bmod \text{Period} = \text{Offset},$$

where T is the CDMA System Time in slots, and Offset is public data of the Control Channel MAC protocol.

R shall be obtained as follows:

- If PreferredControlChannelCycleEnabled is equal to '0', then *R* is the result of applying the hash function (see section 14.4 of [1]) using the following parameters:
  - Key = SessionSeed
  - Decorrelate = 6 × SessionSeed[11:0]
  - N = Max(Period3/256, 1)
  - where SessionSeed is given as public data of the Address Management Protocol.
- If PreferredControlChannelCycleEnabled is equal to '1', then *R* is set to PreferredControlChannelCycle.

Period shall be computed as follows:

$$\text{Period} = \begin{cases} \text{Period1}, & \text{CDMA System Time in slots} < T_{12} \\ \text{Period2}, & T_{12} \le \text{CDMA System Time in slots} < T_{23}. \\ \text{Period3}, & \text{Otherwise} \end{cases}$$

The access network and the access terminal shall compute Period*i* according to Table 4.3.3.1.2-1.

Table 4.3.3.1.2-1. Computation of Period*i* from SlotCycle*i*

SlotCycle*i*	Period*i*
0x00 to 0x06	$2^{\text{SlotCycle}i} \times 4$ slots
0x07 to 0x1c	$2^{(\text{SlotCycle}i - 0x7)} \times 768$ slots

If the access network receives a *SignalingAdaptation.ConnectionOpened* indication in this state, then the access network shall issue a *ConnectionOpened* indication.

If the access network receives a *SignalingAdaptation.ConnectionFailed* indication in this state, then the access network shall issue a *ConnectionFailed* indication.

4.4 Default Signaling Adaptation Protocol

Requirements as specified in "Default Signaling Adaptation Protocol" of [5] applies here.

4.5 Default Air-Link Management Protocol

Requirements as specified in “Default Air-Link Management Protocol” of [5] applies here.

4.6 Default Connected State Protocol

Requirements as specified in “Default Connected State Protocol” of [5] applies here.

4.7 Default Packet Consolidation Protocol

Requirements as specified in “Default Packet Consolidation Protocol” of [5] applies here.

5 INITIAL MEAN OUTPUT POWER REQUIREMENT FOR ACTIVE INTER-RAT HANDOFF

5.1 Access Terminal Subtype 3 RTCMAC Protocol Requirement

Requirements as specified in “Access Terminal Subtype 3 RTCMAC Protocol Requirement” of [5] applies here.

5.2 Estimated Open-Loop Output Power

Requirements as specified in “Estimated Open-Loop Output Power” of [5] applies here.

No text.

6 ANNEX A – INFORMATIVE

6.1 E-UTRAN-WiMAX CALL FLOW EXAMPLES

6.1.1 Access Terminal Call Flow – UATI Assignment, Session Configuration over X1

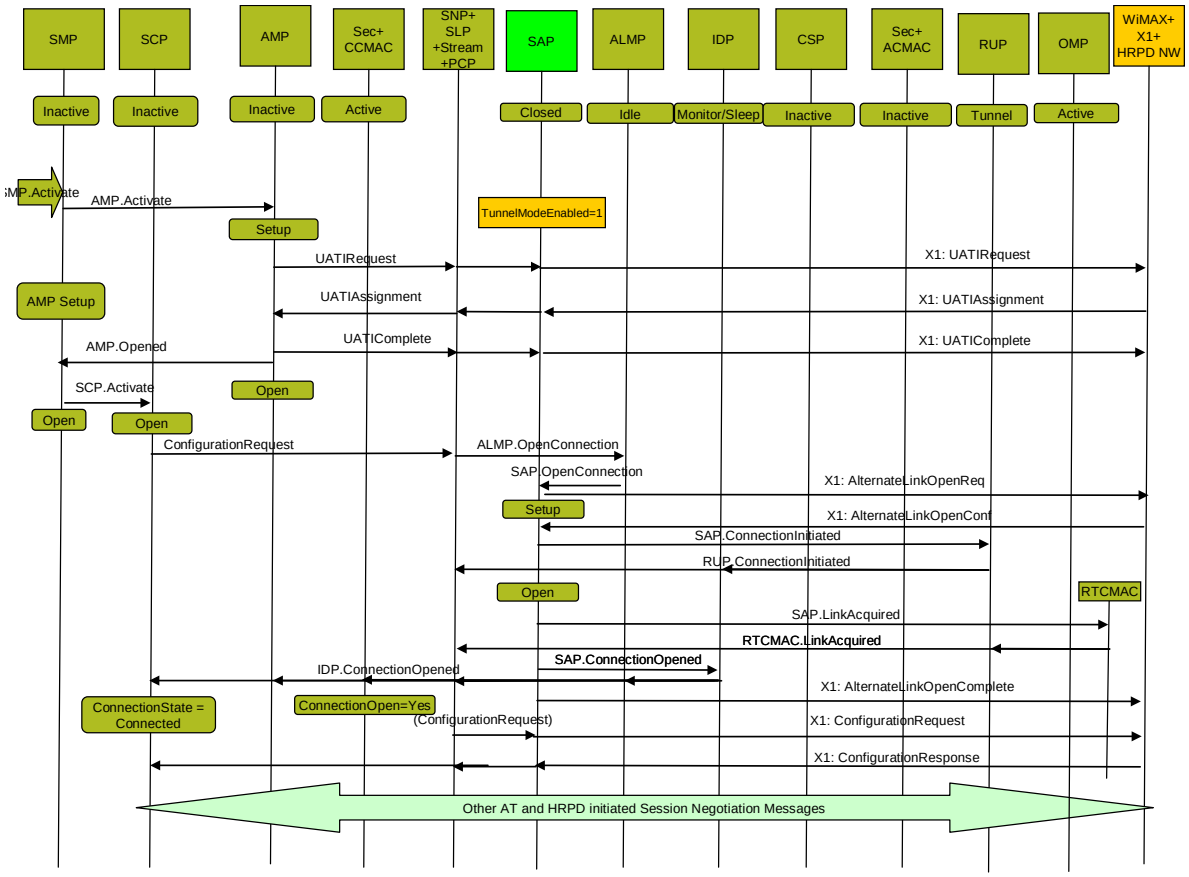

Figure 6-1 Access Terminal, UATI Assignment and Session Configuration over X1

6.1.2 Access Network Call Flow – UATI Assignment, Session Configuration over A23

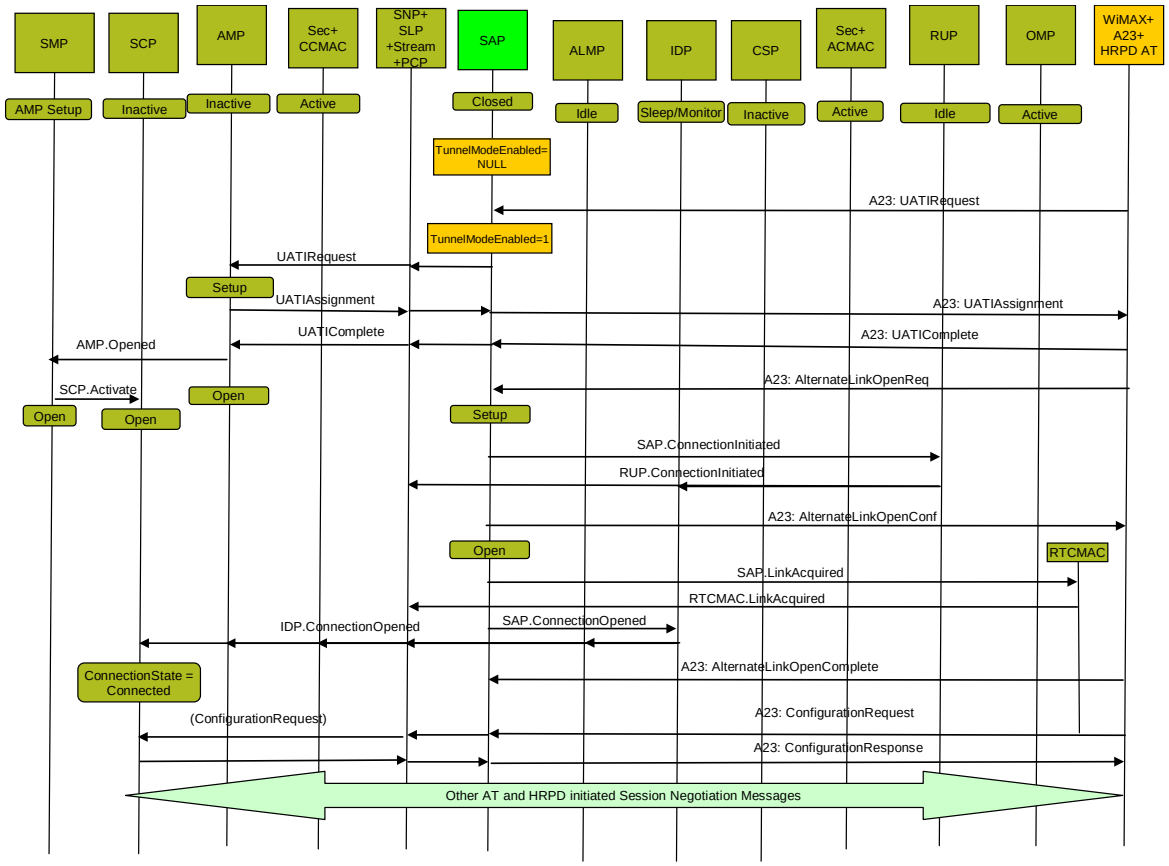

Figure 6-2 Access Network, UATI Assignment and Session Configuration over A23

6.1.3 Access Terminal Call Flow – Idle Handoff from WiMAX to HRPD

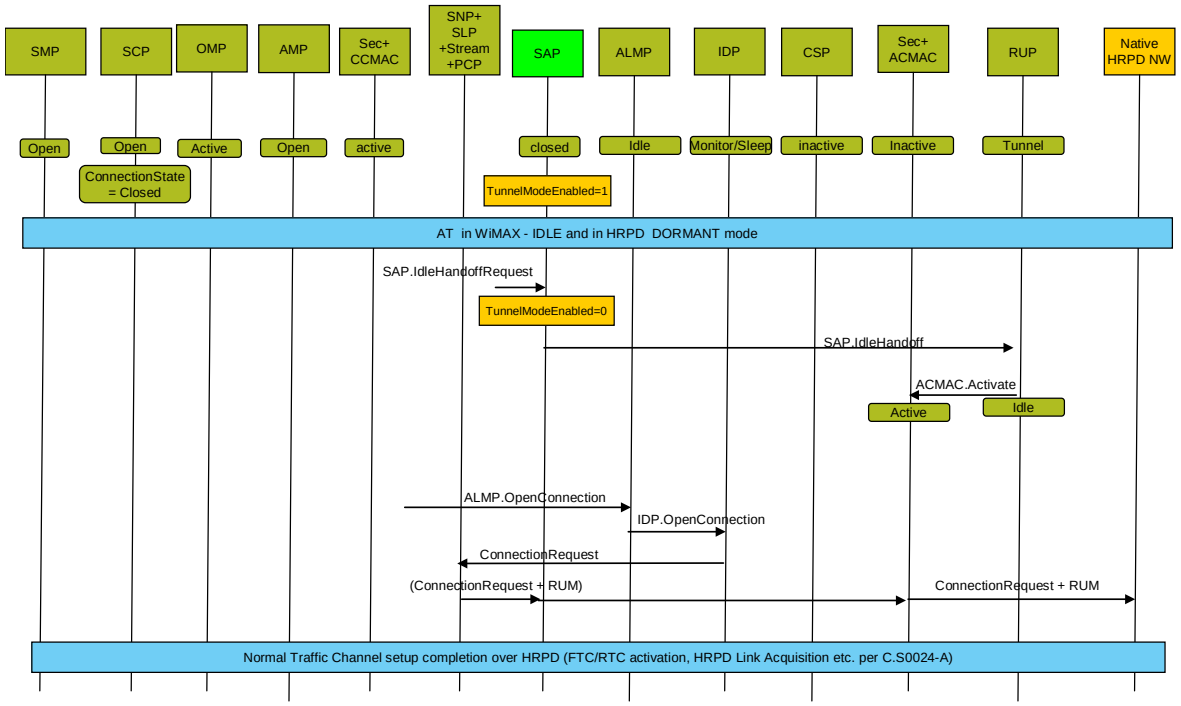

Figure 6-3 Access Terminal, Idle Handoff from WiMAX to HRPD

6.1.4 Access Network Call Flow – Idle Handoff from WiMAX to HRPD

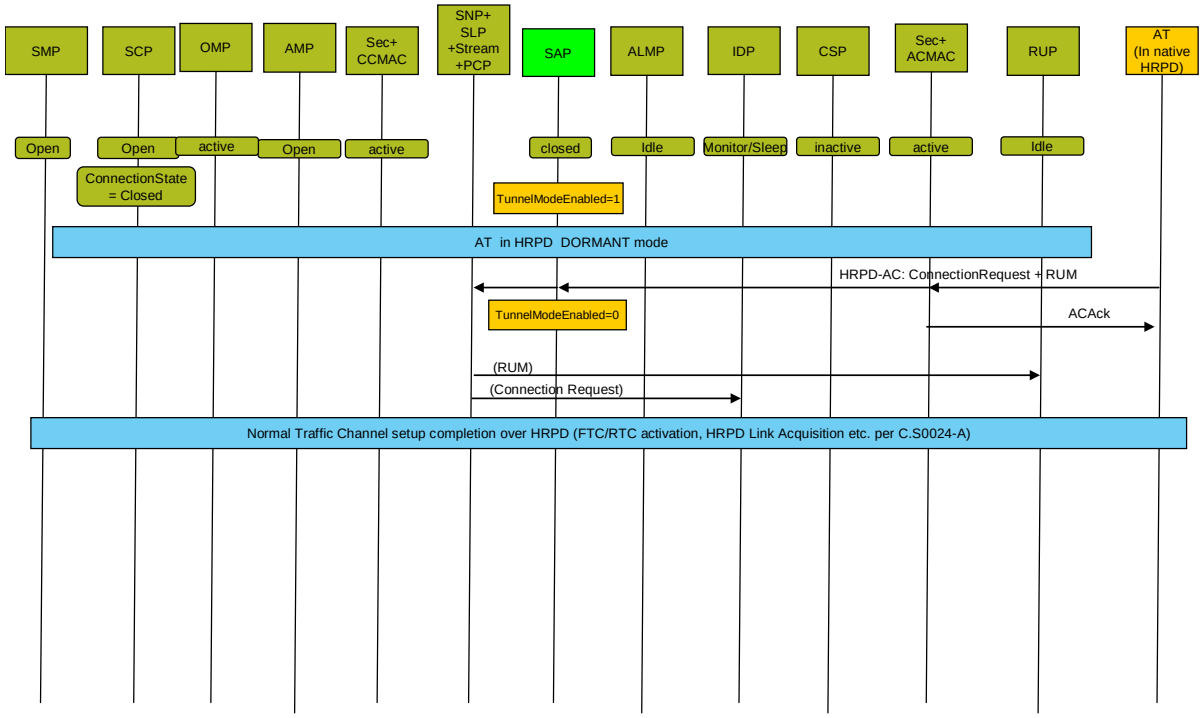

Figure 6-4 Access Network, Idle Handoff from WiMAX to HRPD

6.1.5 Access Terminal Call Flow – Active Handoff from WiMAX to HRPD

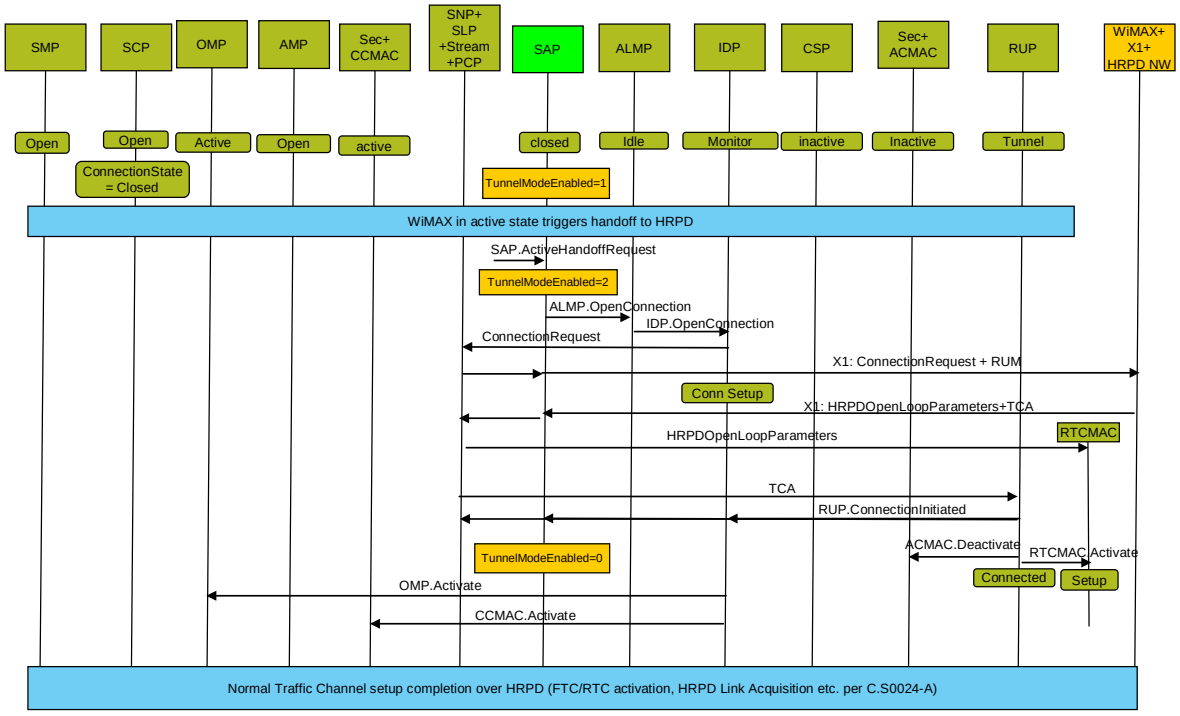

Figure 6-5 Access Terminal, Active Handoff from WiMAX to HRPD

6.1.6 Access Network Call Flow – Active Handoff from WiMAX to HRPD

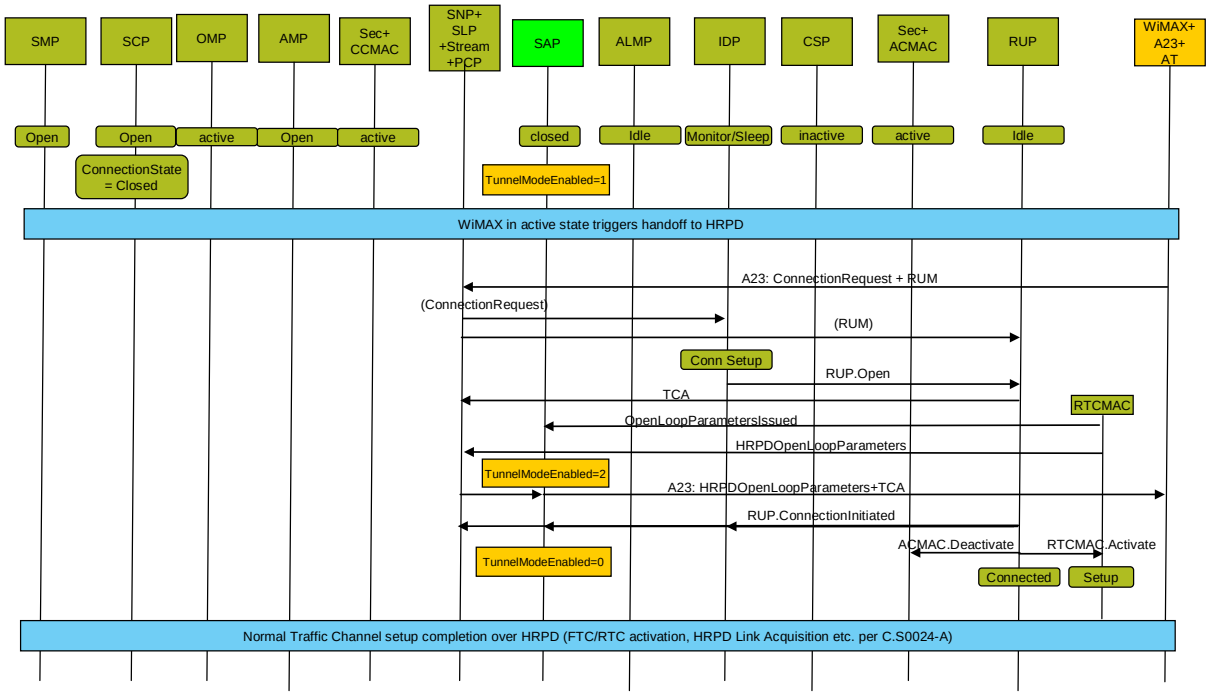

Figure 6-6 Access Network, Active Handoff from WiMAX to HRPD