

Radiocommunication Study Groups



Attachment 5.10 to Document 5D/836
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22 October 2014

English only

Working Party 5D

LIAISON STATEMENT TO EXTERNAL ORGANIZATIONS ARCHITECTURE AND TOPOLOGY OF IMT NETWORKS

Working Party 5D (WP 5D) wishes to inform the relevant External Organizations that it is continuing development of a working document toward a preliminary draft new Report ITUR M. [IMT.ARCH], "Architecture and topology of IMT networks". At its October 2014 meeting, WP 5D developed the attached version of the draft Report.

WP 5D would appreciate receiving contributions from the relevant External Organizations containing material for inclusion in the draft Report. In particular, WP 5D would appreciate input contributions for sections 7, 8, and 9 (addressing configuration and transport requirements).

It would facilitate the work of the meeting to receive proposals for content with specific guidance as to what text is proposed for what section (using tracking changes where appropriate), rather than receiving references to extensive standards publications.

Contributions to the next meeting of WP 5D must be submitted prior to the deadline of 1600 hours UTC on 20 January 2015.

WP 5D looks forward to a close cooperation with the relevant External Organizations in the development of this draft Report on the architecture and topology of IMT networks.

Status: For action

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Attachment: Attachment 5.8 to Document 5D/836 (Att_5.8_5D_836.docx)

Source: Attachment 5.7 to Document 5D/726

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20 October 2014

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Working Party 5D

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[IMT.ARCH]

Architecture and topology of IMT networks

1 Introduction

This document offers an overview of the architecture and topology of IMT networks and a perspective on the dimensioning of the respective transport requirements in these topologies. This document covers different architectural aspects in a general level of detail.

2 Scope

Describes the architecture, topology, and transport requirements of IMT networks

3 Related Documents [or References]

[Editor's Note: Consider adding additional reference to ITU documents (e.g. M.1457)?]

- [1] 3GPP TS 23.401 "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access", Release 11, V11.9.0; March 2014
- [2] 3GPP TS 36.300 "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2", Release 11, V11.9.0, March 2014
- [3] 3GPP TS 25.401 "UTRAN overall description", Release 11, V11.1.0, December 2012
- [4] 3GPP TS 23.060 "General Packet Radio Service (GPRS); Service description; Stage 2", Release 11, V11.9.0, March 2014
- [5] 3GPP TS 23.402 "Architecture Enhancements for Non-3GPP Accesses", Release 11, V11.8.0 December 2013
- [6] 3GPP TS 29.276 "3GPP Evolved Packet System (EPS): Optimized Handover Procedures and Protocols Between E-UTRAN Access and cdma2000 HRPD Access; Stage 3", Release 11, V11.0.0, September 2012
- [7] 3GPP2 A.S0008-D "Interoperability Specification (IOS) for High Rate Packet Data (HRPD) Radio Access Network Interfaces with Session Control in the Access Network", March 2013.
- [8] 3GPP2 A.S0009-D "Interoperability Specification (IOS) for High Rate Packet Data (HRPD) Radio Access Network Interfaces with Session Control in the PDF", March 2013.

- [9] 3GPP2 A.S0011-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 1 Overview”, August 2012.
- [10] 3GPP2 A.S0012-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 2 Transport”, August 2012.
- [11] 3GPP2 A.S0013-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 3 Features”, August 2012.
- [12] 3GPP2 A.S0014-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 4 (A1, A1p, A2, and A5 Interfaces)”, August 2012.
- [13] 3GPP2 A.S0015-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 5 (A3 and A7 Interfaces)”, August 2012.
- [14] 3GPP2 A.S0016-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 6 (A8 and A9 Interfaces)”, August 2012.
- [15] 3GPP2 A.S0017-D “Interoperability Specification (IOS) for cdma2000 Access Network Interfaces - Part 7 (A10 and A11 Interfaces)”, August 2012.
- [16] 3GPP2 C.S0001-F “Introduction to cdma2000 Spread Spectrum Systems”, May 2014.
- [17] 3GPP2 C.S0002-F “Physical Layer Standard for cdma2000 Spread Spectrum Systems”, May 2014.
- [18] 3GPP2 C.S0003-F “Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems”, May 2014.
- [19] 3GPP2 C.S0004-F “Signaling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems”, May 2014.
- [20] 3GPP2 C.S0005-F “Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems”, May 2014.
- [21] 3GPP2 C.S0006-F “Analog Signaling Standard for cdma2000 Spread Spectrum Systems”, May 2014.
- [22] 3GPP2 C.S0023-D “Removable User Identity Module for Spread Spectrum Systems”, December 2013.
- [23] 3GPP2 C.S0024-B “cdma2000 High Rate Packet Data Air Interface Specification”, June 2012.
- [24] 3GPP2 C.S0063-B “cdma2000 High Rate Packet Data Supplemental Services”, May 2010.
- [25] 3GPP2 C.S0065-B “cdma2000 Application on UICC for Spread Spectrum Systems”, January 2014.
- [26] 3GPP2 C.S0087-A “E-UTRAN – cdma2000 HRPD Connectivity and Interworking Air Interface Specification”, January 2014.
- [27] 3GPP2 X.S0004-E “Mobile Application Part (MAP)”, January 2010.
- [28] 3GPP2 X.S0011-E “cdma2000 Wireless IP Network Standard”, November 2009.
- [29] 3GPP2 X.S0014-E “Wireless Radio Telecommunication Intersystem Non-Signaling Data Communication DMH (Data Message Handler)”, August 2006.
- [30] 3GPP2 X.S0042-B “Voice Call Continuity between IMS and Circuit Switched Systems”, December 2013.
- [31] 3GPP2 X.S0057-B “E-UTRAN - eHRPD Connectivity and Interworking: Core Network Aspects”, July 2014.
- [32] NGMN, “Small cell backhaul requirements”, June 2012. (http://www.ngmn.org/uploads/media/NGMN_Whitepaper_Small_Cell_Backhaul_Requirements.pdf)
- [33] 3GPP2 A.S0022-B, “Interoperability Specification (IOS) for Evolved High Rate Packet Data (eHRPD) Radio Access Network Interfaces and Interworking with Enhanced Universal Terrestrial Radio Access Network (E-UTRAN)”, April 2012

- [34] 3GPP TS 29.273, “Evolved Packet System (EPS); 3GPP EPS AAA Interfaces”, Release 11, V11.8.0, December 2013
- [35] 3GPP TS 29.275, “Proxy Mobile IPv6 (PMIPv6) Based Mobility and Tunneling Protocols; Stage 3”, Release 11, V11.8.0, December 2013

4 Basic Elements of an IMT System based on 3GPP Technical Specifications

(The basic network entities of an IMT System are described in this chapter)

Introduction to Evolved Packet System (EPS)

This section describes the basic elements and logical architecture of the Evolved Packet System (EPS) 3GPP TS 23.401 [1].

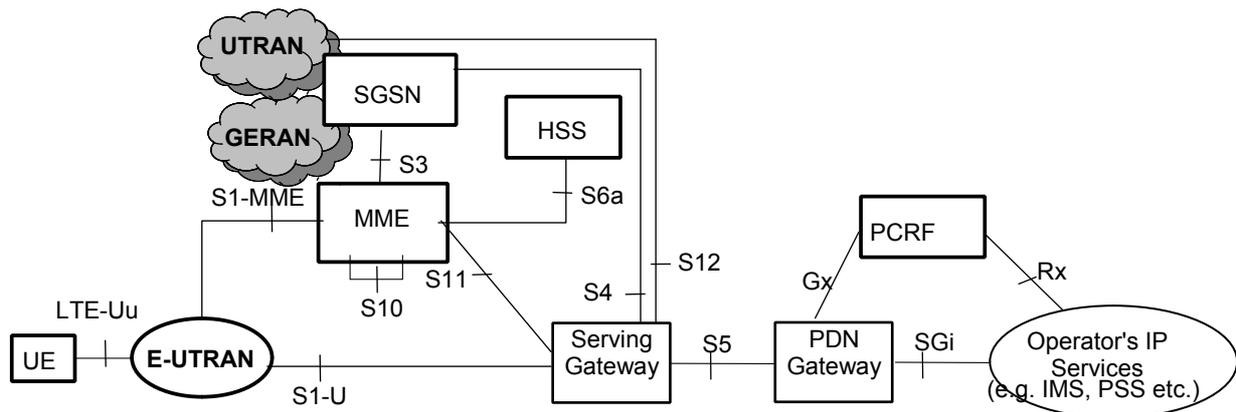
The Evolved 3GPP Packet Switched Domain provides IP connectivity and comprises of the Evolved Packet Core (EPC) and the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) 3GPP TS 36.300 [2].

The Universal Terrestrial Radio Access Network (UTRAN) 3GPP TS 25.401 [3] and details of the possible Core Network topologies for UTRAN can be found in 3GPP TS 23.060 [4] (Figure 2 and Figure 2a).

It must be noted that **3GPP defines a logical architecture of the network** – the physical network topology is not in the scope of 3GPP and may be different in different network deployments.

FIGURE 4-1

Non-roaming architecture for 3GPP accesses



4.1 Core Network - EPC

The Evolved Packet Core (EPC) comprises several network elements which are listed in the following with a brief summary of their functions.

4.1.1 MME

MME functions include:

- NAS signalling;
- NAS signalling security;
- Inter CN node signalling for mobility between 3GPP access networks (terminating S3);
- UE Reachability in ECM-IDLE state (including control and execution of paging retransmission);
- Tracking Area list management;
- Mapping from UE location (e.g. TAI) to time zone, and signalling a UE time zone change associated with mobility;
- PDN GW and Serving GW selection;
- MME selection for handovers with MME change;
- SGSN selection for handovers to 2G or 3G 3GPP access networks;
- Roaming (S6a towards home HSS);
- Authentication;
- Authorization;
- Bearer management functions including dedicated bearer establishment;
- Lawful Interception of signalling traffic;
- Warning message transfer function (including selection of appropriate eNodeB);
- UE Reachability procedures;
- Support Relaying function (RN Attach/Detach).

NOTE: The Serving GW and the MME may be implemented in one physical node or separated physical nodes.

4.1.2 Gateway

4.1.2.1 General

Two logical Gateways exist - the Serving GW (S GW) and the PDN GW (P GW). They may be implemented in one physical node or separated physical nodes.

4.1.2.2 Serving GW

The Serving GW is the gateway which terminates the interface towards E-UTRAN. For each UE associated with the EPS, at a given point of time, there is a single Serving GW.

The functions of the Serving GW, for both the GTP-based and the PMIP-based S5/S8, include:

- the local Mobility Anchor point for inter-eNodeB handover;
- sending of one or more "end marker" to the source eNodeB, source SGSN or source RNC immediately after switching the path during inter-eNodeB and inter-RAT handover, especially to assist the reordering function in eNodeB;
- Mobility anchoring for inter-3GPP mobility (terminating S4 and relaying the traffic between 2G/3G system and PDN GW);
- ECM-IDLE mode downlink packet buffering and initiation of network triggered service request procedure;

- Lawful Interception;
- Packet routing and forwarding;
- Transport level packet marking in the uplink and the downlink, e.g. setting the DiffServ Code Point, based on the QCI of the associated EPS bearer;
- Accounting for inter-operator charging. For GTP-based S5/S8, the Serving GW generates accounting data per UE and bearer;
- Interfacing OFCS according to charging principles and through reference points specified in 3GPP TS 32.240.

Additional Serving GW functions for the PMIP-based S5/S8 are captured in 3GPP TS 23.402 [5].

Connectivity to a GGSN is not supported.

4.1.2.3 PDN GW

The PDN GW is the gateway which terminates the SGi interface towards the PDN. If a UE is accessing multiple PDNs, there may be more than one PDN GW for that UE, however a mix of S5/S8 connectivity and Gn/Gp connectivity is not supported for that UE simultaneously.

PDN GW functions include for both the GTP-based and the PMIP-based S5/S8:

- Per-user based packet filtering (by e.g. deep packet inspection);
- Lawful Interception;
- UE IP address allocation;
- Transport level packet marking in the uplink and downlink, e.g. setting the DiffServ Code Point, based on the QCI of the associated EPS bearer;
- Accounting for inter-operator charging;
- UL and DL service level charging as defined in 3GPP TS 23.203 (e.g. based on SDFs defined by the PCRF, or based on deep packet inspection defined by local policy);
- Interfacing OFCS through according to charging principles and through reference points specified in 3GPP TS 32.240;
- UL and DL service level gating control as defined in 3GPP TS 23.203;
- UL and DL service level rate enforcement as defined in 3GPP TS 23.203 (e.g. by rate policing/shaping per SDF);
- UL and DL rate enforcement based on APN-AMBR (e.g. by rate policing/shaping per aggregate of traffic of all SDFs of the same APN that are associated with Non-GBR QCIs);
- DL rate enforcement based on the accumulated MBRs of the aggregate of SDFs with the same GBR QCI (e.g. by rate policing/shaping);
- DHCPv4 (server and client) and DHCPv6 (client and server) functions;
- The network does not support PPP bearer type in this version of the specification. Pre-Release 8 PPP functionality of a GGSN may be implemented in the PDN GW;
- packet screening.

Additionally the PDN GW includes the following functions for the GTP-based S5/S8:

- UL and DL bearer binding as defined in 3GPP TS 23.203;
- UL bearer binding verification as defined in 3GPP TS 23.203;
- Functionality as defined in IETF RFC 4861;
- Accounting per UE and bearer.

The P GW provides PDN connectivity to both GERAN/UTRAN only UEs and E UTRAN capable UEs using any of E UTRAN, GERAN or UTRAN. The P GW provides PDN connectivity to E UTRAN capable UEs using E UTRAN only over the S5/S8 interface.

4.1.3 SGSN

In addition to the functions described in 3GPP TS 23.060 [4], SGSN functions include:

- Inter EPC node signalling for mobility between 2G/3G and E-UTRAN 3GPP access networks;
- PDN and Serving GW selection: the selection of S GW/P GW by the SGSN is as specified for the MME;
- Handling UE Time Zone as specified for the MME;
- MME selection for handovers to E-UTRAN 3GPP access network.

4.1.4 PCRF

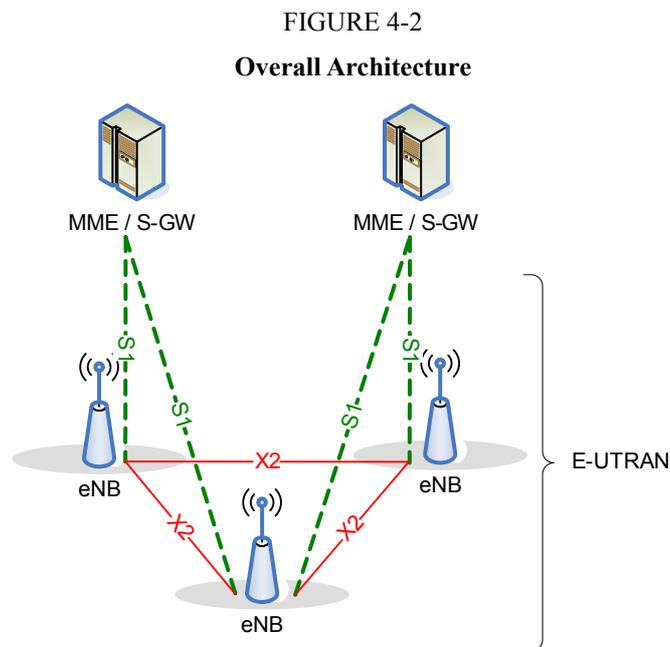
The PCRF is the policy and charging control element. PCRF functions are described in more detail in 3GPP TS 23.203. In non-roaming scenario, there is only a single PCRF in the HPLMN associated with one UE's IP-CAN session. The PCRF terminates the Rx interface and the Gx interface.

4.2 Access Network

4.2.1 Access Network – E-UTRAN

The Evolved Universal Terrestrial Radio Access Network (E-UTRAN) 3GPP TS 36.300 [2] consists of eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of the X2 interface. The eNBs are also connected by means of the S1 interface to the EPC (Evolved Packet Core), more specifically to the MME (Mobility Management Entity) by means of the S1-MME interface and to the Serving Gateway (S-GW) by means of the S1-U interface. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs.

The E-UTRAN architecture is illustrated in Figure 4-2 below.



The eNB hosts the following functions:

- Functions for Radio Resource Management: Radio Bearer Control, Radio Admission Control, Connection Mobility Control, Dynamic allocation of resources to UEs in both uplink and downlink (scheduling);
- IP header compression and encryption of user data stream;
- Selection of an MME at UE attachment when no routing to an MME can be determined from the information provided by the UE;
- Routing of User Plane data towards Serving Gateway;
- Scheduling and transmission of paging messages (originated from the MME);
- Scheduling and transmission of broadcast information (originated from the MME or O&M);
- Measurement and measurement reporting configuration for mobility and scheduling;
- Scheduling and transmission of PWS (which includes ETWS and CMAS) messages (originated from the MME);
- CSG handling;
- Transport level packet marking in the uplink.

A stage-2 level description of the E-UTRAN can be found in 3GPP TS 36.300 [2]

4.2.2 Access Network – UTRAN

The Universal Terrestrial Radio Access Network (UTRAN) 3GPP TS 25.401 [3] consists of a set of Radio Network Subsystems (RNS) connected to the Core Network through the Iu interface. An RNS consists of a Radio Network Controller (RNC) and one or more NodeBs connected to the RNC through the Iub interface.

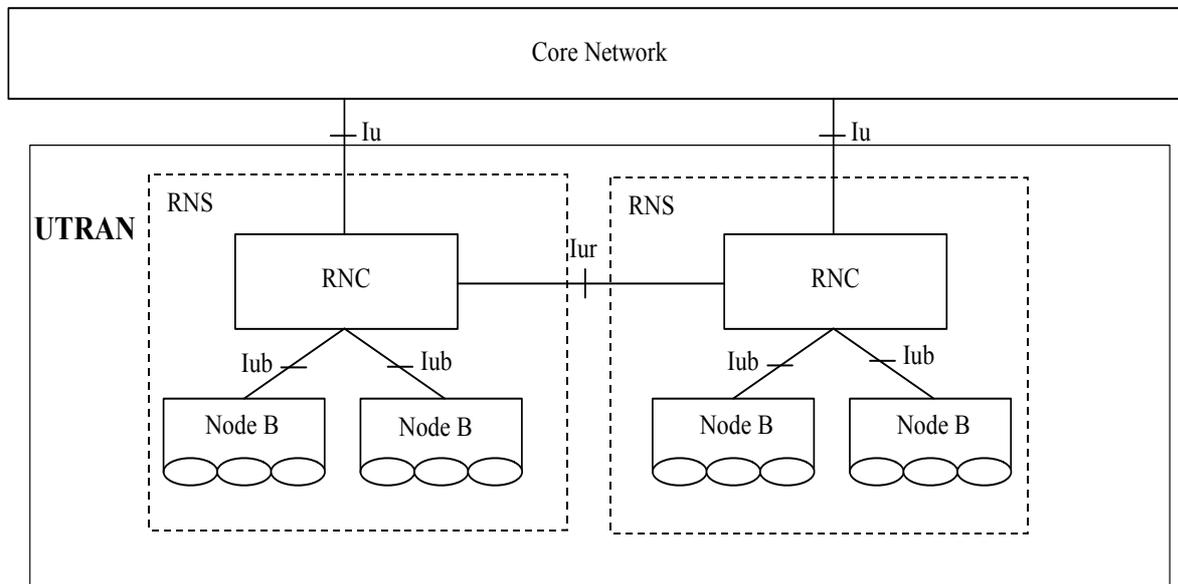
A Node B can support FDD mode, TDD mode or dual-mode operation.

Inside the UTRAN, the RNCs of the Radio Network Subsystems can be interconnected together through the Iur. Iu(s) and Iur are logical interfaces. Iur can be conveyed over direct physical connection between RNCs or virtual networks using any suitable transport network.

The UTRAN architecture is shown in Figure 4-3.

Details of the possible Core Network topologies for UTRAN can be found in 3GPP TS 23.060 [4] (Figure 2 and Figure 2a).

FIGURE 4-3
UTRAN Architecture



4.3 Mobile Station

4.4 User Equipment

5 Basic Elements of an IMT System based on 3GPP2 Technical Specifications

(The basic network entities of an IMT System are described in this chapter)

5.1 Core Network Elements

5.1.1 cdma2000^{®1} Core Network

The following is abstracted from 3GPP2 S.R0005-B v2.0 [xx]

5.1.1.1 Wireless Network Reference Model

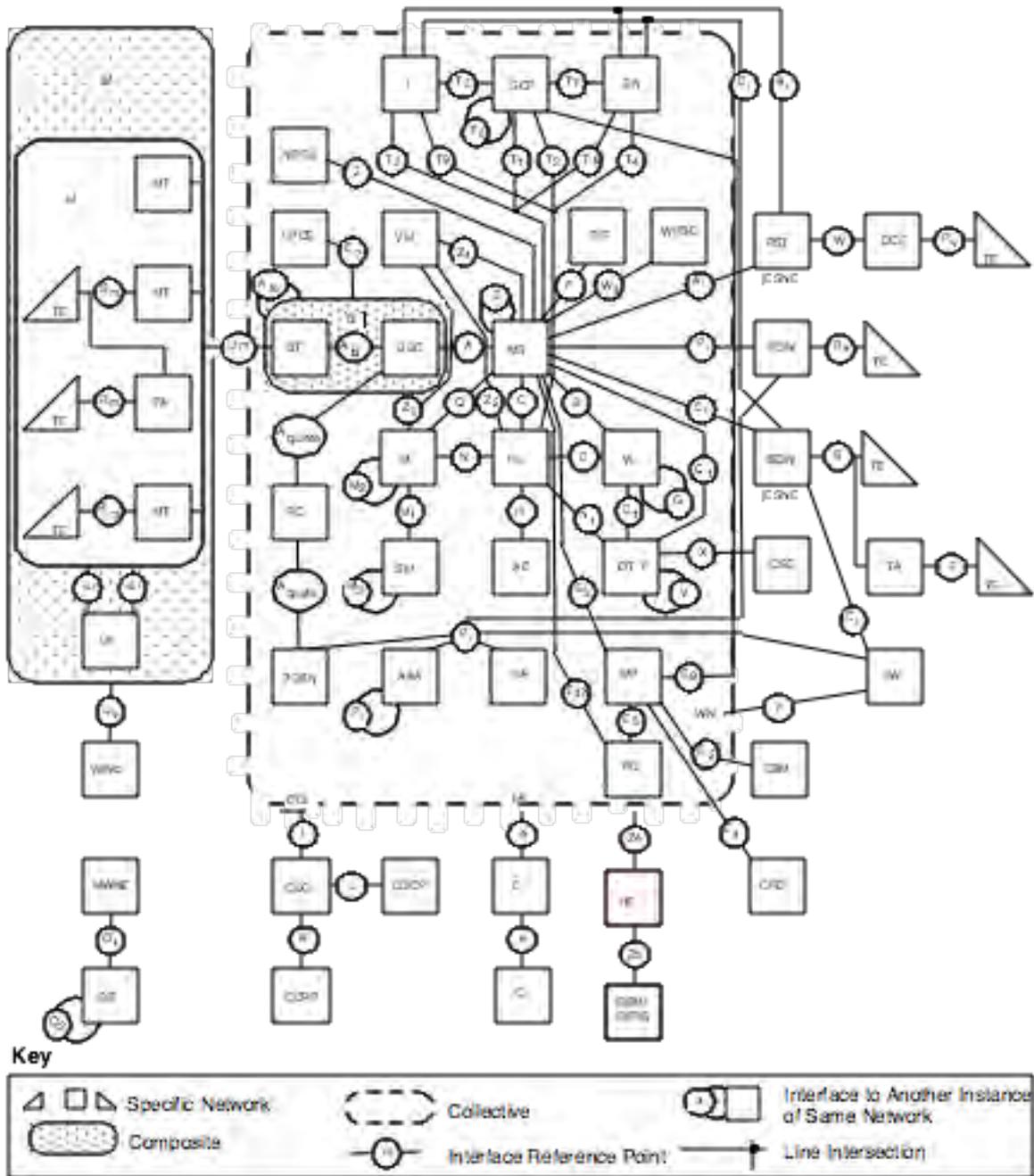
Figure 5.1.1-1 presents the network entities and associated reference points that comprise a wireless network. The network entities are represented by squares, triangles and rounded corner rectangles; the reference points are represented by circles. The network reference model in this document is the compilation of several reference models currently in use in wireless standards.

¹ 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.

Note the following:

- The network reference model is a functional block diagram.
- A network entity represents a group of functions, not a physical device. For example, a Mobile Switching Center (MSC) is a physical device; it comprises frames, shelves, circuit packs, etc. The physical device may comprise a single network entity such as the MSC, or it may comprise some combination such as the MSC, the Visitor Location Register (VLR), the Home Location Register (HLR), and the Authentication Center (AC). The physical realization is an implementation issue; a manufacturer may choose any physical implementation of network entities, either individually or in combination, as long as the implementation meets the functional requirements. Sometimes, for practical reasons, the functional network entity is a physical device. The Mobile Station (MS) is an excellent example.
- A reference point is a conceptual point that divides two groups of functions. It is not necessarily a physical interface. A reference point only becomes a physical interface when the network entities on either side of it are contained in different physical devices.
- A “Collective Entity” contains encompassed network entities that are an instance of the collective.
- A “Composite Entity” contains encompassed network entities that are part of the composite.

FIGURE 5.1.1-1
Wireless Network Reference Model



AAA	Authentication, Authorization and Accounting	MC	Message Center
AC	Authentication Center	ME	Mobile Equipment
BS	Base Station	MPC	Mobile Position Center
BSC	Base Station Controller	MS	Mobile Station
BTS	Base Transceiver System	MSC	Mobile Switching Center
CDC P	Call Data Collection Point	MT	Mobile Terminal
CDG P	Call Data Generation Point	MW NE	Managed Wireless Network Entity
CDIS	Call Data Information Source	NPD B	Number Portability DataBase
CDR P	Call Data Rating Point	OSF	Operations System Function
CF	Collection Function	OTA F	Over-The-Air Service Provisioning Function
CRD B	Coordinate Routing Data Base	PCF	Packet Control Function
CSC	Customer Service Center	PDE	Position Determining Entity
DCE	Data Circuit Equipment	PDN	Packet Data Network
DF	Delivery Function	PDS N	Packet Data Serving Node
EIR	Equipment Identity Register	PST N	Public Switched Telephone Network
ESM E	Emergency Services Message Entity	SCP	Service Control Point
ESN E	Emergency Services Network Entity	SN	Service Node
HA	Home Agent	SME	Short Message Entity
HLR	Home Location Register	TA	Terminal Adapter
IAP	Intercept Access Point	TE	Terminal Equipment
IIF	Interworking and Interoperability Function	UIM	User Identity Module
IP	Intelligent Peripheral	VLR	Visitor Location Register
ISDN	Integrated Services Digital Network	VMS	Voice Message System
IWF	Interworking Function	WNE	Wireless Network Entity
LPD E	Local Position Determining Entity	WPS C	Wireless Priority Service Center
LNS	L2TP Network Server		

5.1.1.2 Network Entities

Each Network Entity may be a physical device, may form part of a physical device, or may be distributed over a number of physical devices. See Section 2.1.2 for the definition of the Reference Points associated with each Network Entity.

Authentication, Authorization and Accounting (AAA)

The AAA is an entity that provides Internet Protocol functionality to support the functions of Authentication, Authorization and Accounting.

Authentication Center (AC)

The AC is an entity that manages the authentication information related to the MS. The AC may, or may not be located within, and be indistinguishable from an HLR. An AC may serve more than one HLR.

Base Station (BS)

A BS is an entity that provides the means for MSs to access network services using radio. It includes a BSC and a BTS.

Base Station Controller (BSC)

The BSC is an entity that provides control and management for one or more BTSs. The BSC exchanges messages with both the BTS and the MSC. Traffic and signaling concerned with call control, mobility management, and MS management may pass transparently through the BSC.

Base Transceiver System (BTS)

The BTS is an entity that provides transmission capabilities across the U_m reference point. The BTS consists of radio devices, antenna and equipment.

Call Data Collection Point (CDCP)

The CDCP is the entity that collects the *Data Message Handler (DMH)* format call detail information as defined in 3GPP2 X.S0014-E [29].

Call Data Generation Point (CDGP)

The CDGP is an entity which provides call detail information to the CDCP in *DMH* format as defined in 3GPP2 X.S0014-E [29]. This may be the entity which converts call detail information from a proprietary format into the *DMH* format. All information from the CDGP to the CDCP should be in *DMH* format.

Call Data Information Source (CDIS)

The CDIS is an entity that can be the source of call detail information as defined in 3GPP2 X.S0014-E [29]. This information may be in proprietary format. It is not required to be in *DMH* format.

Call Data Rating Point (CDRP)

The CDRP is the entity that takes the unrated *DMH* format call detail information as defined in 3GPP2 X.S0014-E [29] and applies the applicable charge and tax related information. The charge and tax information is added using *DMH* format as defined in 3GPP2 X.S0014-E [29].

Collection Function (CF) - [Intercept]

The CF is an entity that is responsible for collecting intercepted communications for a lawfully authorized law enforcement agency.

The CFs typically include:

- the ability to receive and process call contents information for each intercept subject.
- the ability to receive information regarding each intercept subject (e.g., call associated or non-call associated) from the Delivery function and process it.

Coordinate Routing Data Base (CRDB)

The CRDB is an entity which stores information to translate a given position expressed as a latitude and longitude to a string of digits.

Customer Service Center (CSC)

The CSC is an entity where service provider representatives receive telephone calls from customers wishing to subscribe to initial wireless service or request a change in the customer's existing service. The CSC interfaces proprietarily with the OTAF to perform network and MS related changes necessary to complete the service provisioning request.

Data Circuit Equipment (DCE)

A termination that provides a non-ISDN user-network interface.

Delivery Function (DF) - [Intercept]

The DF is an entity that is responsible for delivering intercepted communications to one or more collection functions.

The DFs typically include:

- the ability to accept call contents for each intercept subject over one or more channels from each Access function;
- the ability to deliver call contents for each intercept subject over one or more channels to a Collection function as authorized for each law enforcement agency;
- the ability to accept information over one or more data channels and combine that information into a single data flow for each intercept subject;
- the ability to filter or select information on an intercept subject before delivery to a Collection function as authorized for a particular law enforcement agency;
- the optional ability to detect audio in-band DTMF digits for translation and delivery to a Collection function as authorized for a particular law enforcement agency;
- the ability to duplicate and deliver information on the intercept subject to one or more Collection functions as authorized for each law enforcement agency;
- the ability to provide security to restrict access.

Emergency Service Message Entity (ESME)

The ESME routes and processes the out-of-band messages related to emergency calls. This may be incorporated into selective routers (also known as Routing, Bridging and Transfer switches), public safety answering points, emergency response agencies, and Automatic Location Information (ALI) data base engines. The structure of the Emergency Service Network is beyond the scope of this document.

Emergency Service Network Entity (ESNE)

The ESNE routes and processes the voice band portions of the emergency calls. This is composed of selective routers (also known as Routing, Bridging and Transfer switches), public safety answering points and emergency response agencies.

Equipment Identity Register (EIR)

The EIR is an entity that is the register to which user equipment identity may be assigned for record purposes. The nature, purpose, and utilization of this information is an area for further study.

Global System for Mobile Communications (GSM) Mobile Application Part (MAP)

The network supporting GSM and Wideband CDMA radio systems.

Home Agent (HA)

The HA is an entity that:

- authenticates Mobile IP registrations from the MS.
- redirects packets to the foreign agent component of the PDSN, and optionally receives and routes reverse packets from the foreign agent component of the PDSN.
- may establish, maintain and terminate secure communications to the PDSN.
- receives provisioning information from the AAA Function for users.
- may assign a dynamic home IP address.

Home Location Register (HLR)

The HLR is the location register to which a user identity is assigned for record purposes such as subscriber information (e.g. Electronic Serial Number (ESN), Mobile Directory Number (MDN), Profile Information, Current Location, Authorization Period).

Integrated Services Digital Network (ISDN)

The ISDN is defined in accordance with the appropriate *ANSI* Standards.

Intelligent Peripheral (IP)

The IP is an entity that performs specialized resource functions such as playing announcements, collecting digits, performing speech-to-text or text-to-speech conversion, recording and storing voice messages, facsimile services, data services, etc.

Intercept Access Point (IAP)

The IAP is an entity that provides access to the communications to, or from, the equipment, facilities, or services of an intercept subject.

Interworking and Interoperability Function (IIF)

The network entity that interfaces between a GSM MAP network and a MAP network.

Interworking Function (IWF)

The IWF is an entity that provides information conversion for one or more WNEs. An IWF may have an interface to a single WNE providing conversion services. An IWF may augment an identified interface between two WNEs, providing conversion services to both WNEs.

L2TP Network Server (LNS)

LNS manages secure L2TP tunnels/sessions with the L2TP Access Concentrator and PPP sessions with the MS. It may authenticate the MS and assigns it an IP address.

Local Position Determining Entity (LPDE)

The LPDE facilitates determination of the position or geographical location of a wireless terminal. Each LPDE supports one or more position determining technologies. Multiple LPDEs using the same technology may serve the coverage area of an Mobile Position Center (MPC) and the multiple

LPDEs each using a different technology may serve the same coverage area of an MPC. Local-PDEs (LPDEs) reside at the Base Station (BS).

Managed Wireless Network Entity (MWNE)

A WNE or any specific network entity having Operations System wireless management needs, including another Operations System.

Message Center (MC)

The MC is an entity that stores and forwards short messages. The MC may also provide supplementary services for Short Message Service (SMS).

Mobile Equipment (ME)

A MS without a UIM. The ME is only capable of accessing the network for a locally defined service configuration (e.g., emergency services, service center).

Mobile Position Center (MPC)

The MPC selects a PDE to determine the position of a mobile station. The MPC may restrict access to position information (e.g., require that the MS be engaged in an emergency call or only release position information to authorized network entities).

Mobile Station (MS)

A wireless terminal used by subscribers to access network services over a radio interface. MSs include portable units (e.g., hand-held units), units installed in vehicles, and somewhat paradoxically, fixed location MSs. The MS is the interface equipment used to terminate the radio path at the subscriber. A MS is a ME with a programmed UIM.

Mobile Switching Center (MSC)

The MSC switches circuit mode MS originated or MS terminated traffic. An MSC is usually connected to at least one BS. It may connect to the other public networks (PSTN, ISDN, etc.), other MSCs in the same network, or MSCs in different networks. The MSC may store information to support these capabilities.

Mobile Terminal 0 (MT0)

A self-contained data capable ME termination that does not support an external interface.

Mobile Terminal 1 (MT1)

A ME termination that provides an ISDN user-network interface.

Mobile Terminal 2 (MT2)

A ME termination that provides a non-ISDN user-network interface.

Number Portability DataBase (NPDB)

The NPDB is an entity which provides portability information for portable Directory Numbers.

Operations System Function (OSF)

The OSF is defined by the Telecommunications Management Network (TMN) OSF (see ITU M.3100). OSF functions include Element Management Layer (EML), Network Management Layer (NML), Service Management Layer (SML), and Business Management Layer (BML) functions spanning across all operations systems functions (e.g., Fault Management, Performance Management, Configuration Management, Accounting Management, and Security Management).

Over-The-Air Service Provisioning Function (OTAF)

The OTAF is an entity that interfaces proprietarily to CSCs to support service provisioning activities. The OTAF interfaces with the MSC to send MS orders necessary to complete service provisioning requests.

Packet Control Function (PCF)

The PCF is an entity in the radio access network that manages the relay of packets between the BS and the PDSN.

Packet Data Network (PDN)

A PDN, such as the Internet, provides a packet data transport mechanism between processing network entities capable of using such services.

Packet Data Serving Node (PDSN)

The PDSN routes MS originated or MS terminated packet data traffic. The PDSN establishes, maintains, and terminates link layer sessions to MSs. The PDSN may interface to one or more BSs and may interface to one or more PDNs.

Position Determining Entity (PDE)

The PDE facilitates determination of the position or geographical location of a wireless terminal. Each PDE supports one or more position determining technologies. Multiple PDEs using the same technology may serve the coverage area of an Mobile Position Center (MPC) and the multiple PDEs each using a different technology may serve the same coverage area of an MPC.

Public Switched Telephone Network (PSTN)

The PSTN is defined in accordance with the appropriate *ANSI* Standards.

Service Control Point (SCP)

The SCP is an entity that acts as a real-time database and transaction processing system that provides service control and service data functionality.

Service Node (SN)

The SN is an entity that provides service control, service data, specialized resources and call control functions to support bearer-related services.

Short Message Entity (SME)

The SME is an entity that composes and decomposes short messages. A SME may, or may not be located within, and be indistinguishable from, an HLR, MC, VLR, MS, or MSC.

Terminal Adapter (TA)

An entity that converts signaling and user data between a non-ISDN and an ISDN interface.

Terminal Adapter m (TA_m)

An entity that converts signaling and user data between a non-ISDN and an ISDN interface.

Terminal Equipment 1 (TE1)

A data terminal that provides an ISDN user-network interface.

Terminal Equipment 2 (TE2)

A data terminal that provides a non-ISDN user-network interface.

User Identity Module (UIM)

The UIM contains subscription information such as the NAM (Number Assignment Module) and may contain subscription feature information. The UIM may be integrated into the ME or the UIM may be removable.

Vehicle

The Vehicle is an entity in which the ME may be installed. The Vehicle may provide power, audio, antenna connections to the ME along with a control and user data gateway to vehicle based data networks.

Visitor Location Register (VLR)

The VLR is the location register other than the HLR used by an MSC to retrieve information for handling of calls to or from a visiting subscriber. The VLR may, or may not be located within, and be indistinguishable from an MSC. The VLR may serve more than one MSC.

Voice Message System (VMS)

The VMS stores received voice messages, data messages (e.g., email), or both message types and supports a method to retrieve previously stored messages. A VMS may also support (on a Directory Number basis) notification of the presence of stored messages and notification of a change in the number of voice messages, data messages, or both message types that are waiting retrieval.

Wireless Network Entity (WNE)

A Network Entity in the wireless Collective Entity.

Wireless Priority Service Center (WPSC)

The WPSC is an entity that stores and facilitates the management of the WPS priority level information for the WPS Users. The WPSC authorizes the WPS User and provides the priority level information for a WPS User call origination upon request from an MSC. The WPSC serves multiple MSCs. The WPSC is only applicable to the WPSC-based solution for WPS.

5.1.1.3 Reference Points

The U_m reference point is the only reference point that is by definition a physical interface.

The other reference points are physical interfaces if network entities on either side of them are contained in different physical devices.

An interface exists when two Network Entities are interconnected through exactly one Reference Point.

Reference Point A

Reference Point A is the interface between the BSC and the MSC. See 3GPP2 A.S0011-D v5.0 [9] through 3GPP2 A.S0017-D v5.0 [15].

Reference Point A_i

Reference Point A_i is the interface between the IP and the PSTN, plus the interface between the MSC and the PSTN [ESNE], plus the interface between the SN and the PSTN.

Reference Point A_{bis}

Reference Point A_{bis} is the interface between the BSC and the BTS.

Reference Point A_{quater}

Reference Point A_{quater} is the interface between the PDSN and the PCF. See 3GPP2 A.S0011-D [9] through 3GPP2 A.S0017-D [15].

Reference Point A_{quinter}

Reference Point A_{quinter} is the interface between the BSC and the PCF. See 3GPP2 A.S0011-D [9] through 3GPP2 A.S0017-D [15].

Reference Point A_{ter}

Reference Point A_{ter} is the BS to BS interface. See 3GPP2 A.S0011-D [9] through 3GPP2 A.S0017-D [15].

Reference Point B

Reference Point B is the interface between the MSC and the VLR. See 3GPP2 X.S0004-E [27].

Reference Point C

Reference Point C is the interface between the MSC and the HLR. See 3GPP2 X.S0004-E [27].

Reference Point D

Reference Point D is the interface between the VLR and the HLR. See 3GPP2 X.S0004-E [27].

Reference Point d

Reference Point d is the interface between an IAP and the DF.

Reference Point D

Reference Point D₁ is the interface between the OTAF and the VLR. See 3GPP2 X.S0004-E [27].

Reference Point D_i

Reference Point D_i is the interface between:

- the IP and the ISDN,
- the IWF and the ISDN,
- the MSC and the ISDN [ESNE], plus
- the SN and the ISDN.

Reference Point E

Reference Point E is the interface between the MSC and the MSC. See 3GPP2 X.S0004-E [27].

Reference Point E₂

Reference Point E₂ is the interface between the MPC and the ESME.

Reference Point E₃

Reference Point E₃ is the interface between the MSC and the MPC. .

Reference Point E₅

Reference Point E₅ is the interface between the MPC and the PDE. .

Reference Point E₉

Reference Point E₉ is the interface between the SCP and the MPC. See 3GPP2 X.S0004-E [27].

Reference Point E₁₁

Reference Point E₁₁ is the interface between the CRDB and the MPC.

Reference Point E₁₂

Reference Point E₁₂ is the interface between the MSC and the PDE.

Reference Point E₇

Reference Point E₇ is the interface between the BS and the Local-PDE (LPDE).

Reference Point e

Reference Point e is the interface between the CF and the DF.

Reference Point F

Reference Point F is the interface between the MSC and the EIR.

Reference Point G

Reference Point G is the interface between the VLR and the VLR. See 3GPP2 X.S0004-E [27].

Reference Point H

Reference Point H is the interface between the HLR and the AC. See 3GPP2 X.S0004-E [27].

Reference Point I

Reference Point I is the interface between the CDIS and the CDGP. The operations supported by this interface are described in 3GPP2 X.S0014-E [29].

Reference Point J

Reference Point J is the interface between the CDGP and the CDCP. The operations supported by this interface are described in 3GPP2 X.S0014-E [29].

Reference Point K

Reference Point K is the interface between the CDGP and the CDRP. The operations supported by this interface are described in 3GPP2 X.S0014-E [29].

Reference Point L

Reserved.

Reference Point M₁

Reference Point M₁ is the interface between the SME and the MC. See 3GPP2 X.S0004-E [27].

Reference Point M₂

Reference Point M₂ is the MC to MC interface. See 3GPP2 X.S0004-E [27].

Reference Point M₃

Reference Point M₃ is the SME to SME interface. See 3GPP2 X.S0004-E [27].

Reference Point N

Reference Point N is the interface between the HLR and the MC. See 3GPP2 X.S0004-E [27].

Reference Point N₁

Reference Point N₁ is the interface between the HLR and the OTAF. See 3GPP2 X.S0004-E [27].

Reference Point O₁

Reference Point O₁ is the interface between an MWNE and the OSF.

Reference Point O₂

Reference Point O₂ is the interface between an OSF and an another OSF.

Reference Point P_i

Reference Point P_i is the interface between:

- the AAA and the AAA,
- the AAA and the PDN,
- the IWF and the PDN,
- the MSC and the PDN, plus
- the PDSN and the PDN.

See 3GPP2 X.S0011-E [28].

Reference Point Q

Reference Point Q is the interface between the MC and the MSC. See 3GPP2 X.S0004-E [27].

Reference Point Q₁

Reference Point Q₁ is the interface between the MSC and the OTAF. See 3GPP2 X.S0004-E [27].

Reference Point R

Reference Point R is the interface between the TA and the TE2.

Reference Point R_m

Reference Point R_m is the interface between the TE2 and the TA_m plus the interface between the TE2 and the MT2.

Reference Point R_v

Reference Point R_v is the interface between the DCE and the TE2.

Reference Point R_x

Reference Point R_x is the interface between the PDN and the TE2.

Reference Point S

Reference Point S is the interface between the ISDN and the TE1.

Reference Point S_m

Reference Point S_m is the interface between the TE1 and the MT1 plus the interface between the TE1 and the TAM.

Reference Point T₁

Reference Point T₁ is the interface between the MSC and the SCP. See 3GPP2 X.S0004-E [27].

Reference Point T₂

Reference Point T₂ is the interface between the HLR and the SCP. See 3GPP2 X.S0004-E [27].

Reference Point T₃

Reference Point T₃ is the interface between the IP and the SCP. See 3GPP2 X.S0004-E [27].

Reference Point T₄

Reference Point T₄ is the interface between the HLR and the SN. See 3GPP2 X.S0004-E [27].

Reference Point T₅

Reference Point T₅ is the interface between the IP and the MSC. See 3GPP2 X.S0004-E [27].

Reference Point T₆

Reference Point T₆ is the interface between the MSC and the SN. See 3GPP2 X.S0004-E [27].

Reference Point T₇

Reference Point T₇ is the interface between the SCP and the SN. See 3GPP2 X.S0004-E [27].

Reference Point T₈

Reference Point T_8 is the interface between the SCP and the SCP. See 3GPP2 X.S0004-E [27].

Reference Point T_9

Reference Point T_9 is the interface between the HLR and the IP. See 3GPP2 X.S0004-E [27].

Reference Point U_i

Reference Point U_i is the interface between the integrated UIM and the ME.

Reference Point U_m

Reference Point U_m is the interface between the BS and the MS, which corresponds to the air interface.

Reference Point U_r

Reference Point U_r is the interface between the Removable-UIM and the ME. See *CDMA_UIM* and *TDMA_UIM*. See 3GPP2 C.S0023-D [22] and 3GPP2 C.S0065-B [25].

Reference Point U_v

Reference Point U_v is the interface between a the ME and the Vehicle.

Reference Point V

Reference Point V is the interface between the OTAF and the OTAF. See 3GPP2 X.S0004-E [27]

Reference Point W

Reference Point W is the interface between the DCE and the PSTN.

Reference Point W_1

Reference Point W_1 is the interface between the MSC and the WPSC.

Reference Point X

Reference Point X is the interface between the CSC and the OTAF. See 3GPP2 X.S0004-E [27]

Reference Point Y

Reference Point Y is the interface between a Wireless Network Entity (WNE) and the IWF. See 3GPP2 A.S0011-D v5.0 [9] through 3GPP2 A.S0017-D v5.0 [15].

Reference Point Z

Reference Point Z is the interface between the MSC and the NPDB. See 3GPP2 X.S0004-E [27].

Reference Point Z_1

Reference Point Z_1 is the interface between the MSC and the VMS. See 3GPP2 X.S0004-E [27].

Reference Point Z_2

Reference Point Z_2 is the interface between the HLR and the VMS. See 3GPP2 X.S0004-E [27].

Reference Point Z₃

Reference Point Z₃ is the interface between the MC and the VMS. See 3GPP2 X.S0004-E [27].

Reference Point Z₄

The interface between the MSC, HLR, MC, AAA, PDSN, etc. and the IIF.

Reference Point Z₅

The interface between the GSM/GPRS networks and the IIF .

5.1.2 HRPD IOS Architecture Reference Model

The following is extracted from 3GPP2 A.S0008-D v1.0 [7].

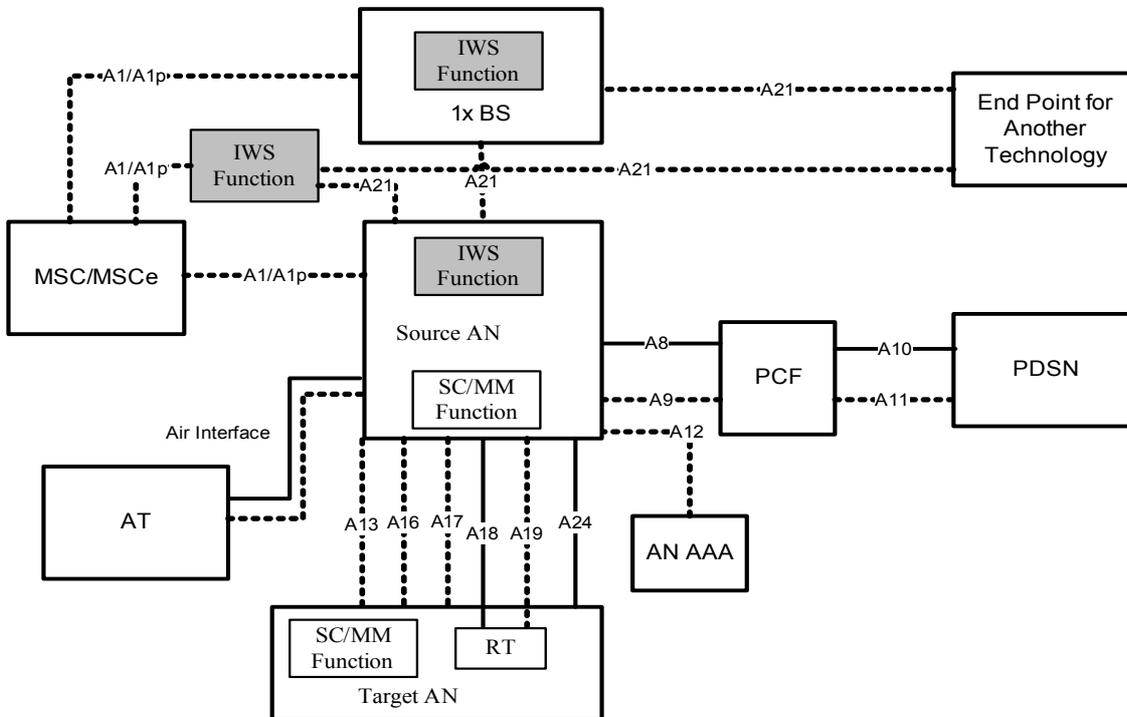
The interfaces defined in this specification are described as follows:

- A1** The A1 interface carries signaling information between the call control and mobility management functions of the circuit-switched MSC and the IWS function.
- A1p** The A1p interface carries signaling information between the call control and mobility management functions of the MSCe and the IWS function. It is recommended that the A1p interface, instead of the A1 interface, be applied for interworking between the 1x and HRPD systems.
- A8** The A8 interface carries user traffic between the Access Network (AN) and the Packet Control Function (PCF).
- A9** The A9 interface carries signaling information between the AN and the PCF.
- A10** The A10 interface carries user traffic between the PCF and the PDSN.
- A11** The A11 interface carries signaling information between the PCF and the PDSN.
- A12** The A12 interface carries signaling information related to access authentication between the SC/MM function in the AN and the AN-AAA (Authentication, Authorization and Accounting entity).
- A13** The A13 interface carries signaling information between the SC/MM function in the source AN and the SC/MM function in the target AN for dormant state session transfer and inter-AN paging when the AT is in idle state
- A16** The A16 interface carries signaling information between the source AN and the target AN for HRPD Inter-AN Connected State Session Transfer (hard handoff or with cross-connectivity support).
- A17** The A17 interface carries signaling information between a source AN and a target AN to manage resources in support of inter-AN cross-connectivity (soft/softer handoff). The A17 interface establishes dedicated endpoints for the A18 and A19 interfaces. Additionally, the A17 interface tunnels air interface forward control channel signaling messages from the source AN to a target AN that has sectors in the AT's Active Set to be transmitted to the AT.

- A18** The A18 interface transports user traffic (i.e., air interface traffic channel data) for an AT between the source AN and a target Radio Transceiver (RT) during cross-connectivity. The A18 interface endpoints are set up using the A17 interface.
- A19** The A19 interface carries RT-specific bearer-related cross-connectivity control messages for an AT between the source AN and a target RT. The A19 interface endpoints are set up using the A17 interface.
- A21** The A21 interface carries signaling information between the HRPD AN and the IWS or between the end point for another technology and the IWS.
- A24** The A24 interface carries buffered user data from the source AN to the target AN for an AT, during A13 session transfer. The target AN interface endpoint is transmitted to the source AN in the A13-Session Information Request message.

The HRPD IOS messaging and call flows are based on the Architecture Reference Model shown in Figure 5.1.2-1. In Figure 5.1.2-1, solid lines indicate signaling and bearer and dashed lines indicate only signaling.

FIGURE 5.1.2-1
HRPD IOS Architecture Reference Model (SC/MM in the AN)



Note: The IWS Function may be collocated at either the 1x BS or may be a standalone entity. When providing support for HRPD interworking, the IWS may be collocated at the HRPD AN. When the IWS function is collocated at the 1x BS, the A21 interface is supported between the 1x BS and the HRPD AN or between the 1x BS and the end point for another technology, and the A1/A1p interface is supported between the MSC and the 1x BS. When the IWS function is part of the HRPD AN, the A1/A1p interface between the MSC and the HRPD AN exists, and the A21 interface is internal to the HRPD AN. When the IWS is a standalone entity, the A1/A1p interface is supported between the MSC and the IWS, and the A21 interface is supported between the IWS and the HRPD AN or between the IWS and the end point for another technology.

5.1.3 cdma2000 Attachment to the 3GPP Enhanced Packet Core (EPC)

The following is abstracted from 3GPP2 X.S0057-B [31].

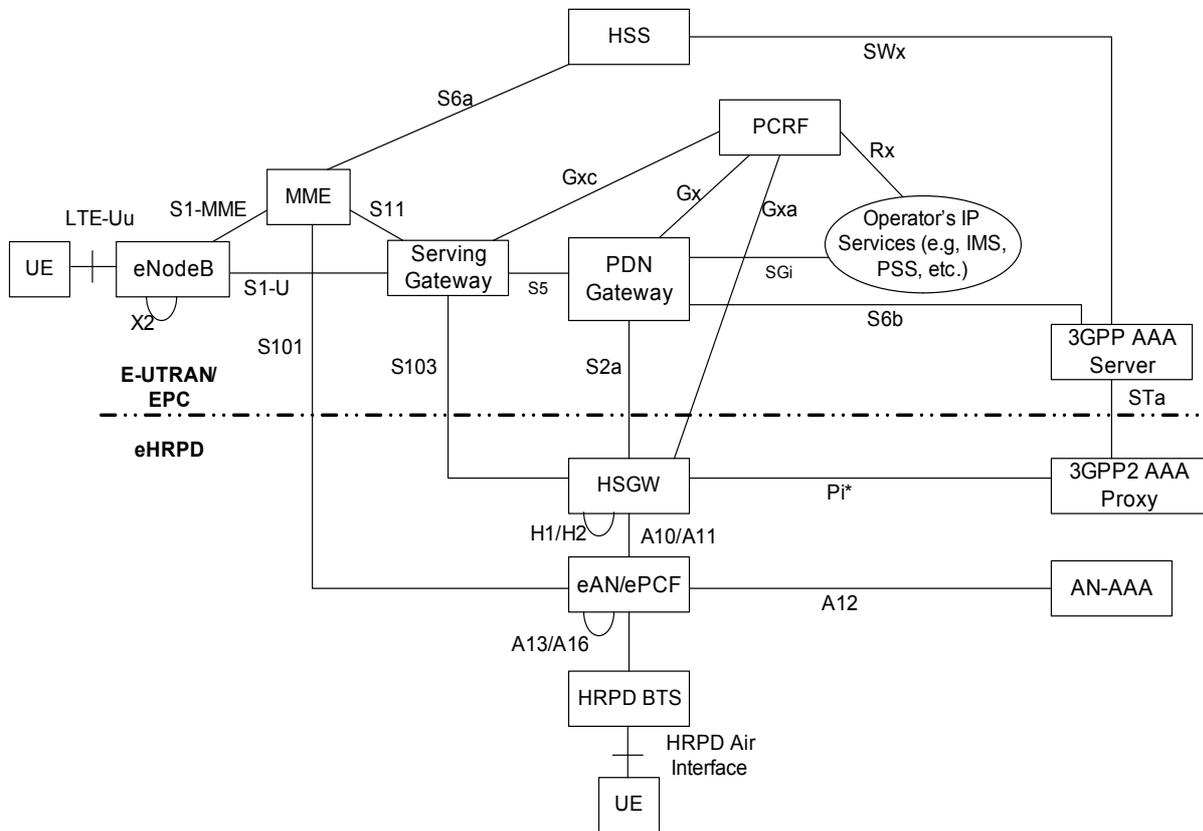
E-UTRAN – eHRPD Interworking Non-Roaming Architecture

Figure 1 shows the architecture for interworking between the 3GPP Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and the 3GPP2 evolved High Rate Packet Data (eHRPD) network. This architecture supports the interworking interfaces defined in 3GPP TS 23.402 [5], including the following interfaces:

- S101: the signaling interface between the EPC Mobility Management Entity (MME) and the evolved HRPD Access Network (eAN/ePCF) (ref. 3GPP TS 29.276 [6]). Note that the eAN/ePCF functions are defined in 3GPP2 A.S0022-B [33],

- S103: the bearer interface between the Evolved Packet Core (EPC) Serving Gateway (S-GW) and the HSGW (ref. 3GPP TS 29.276 [6]).

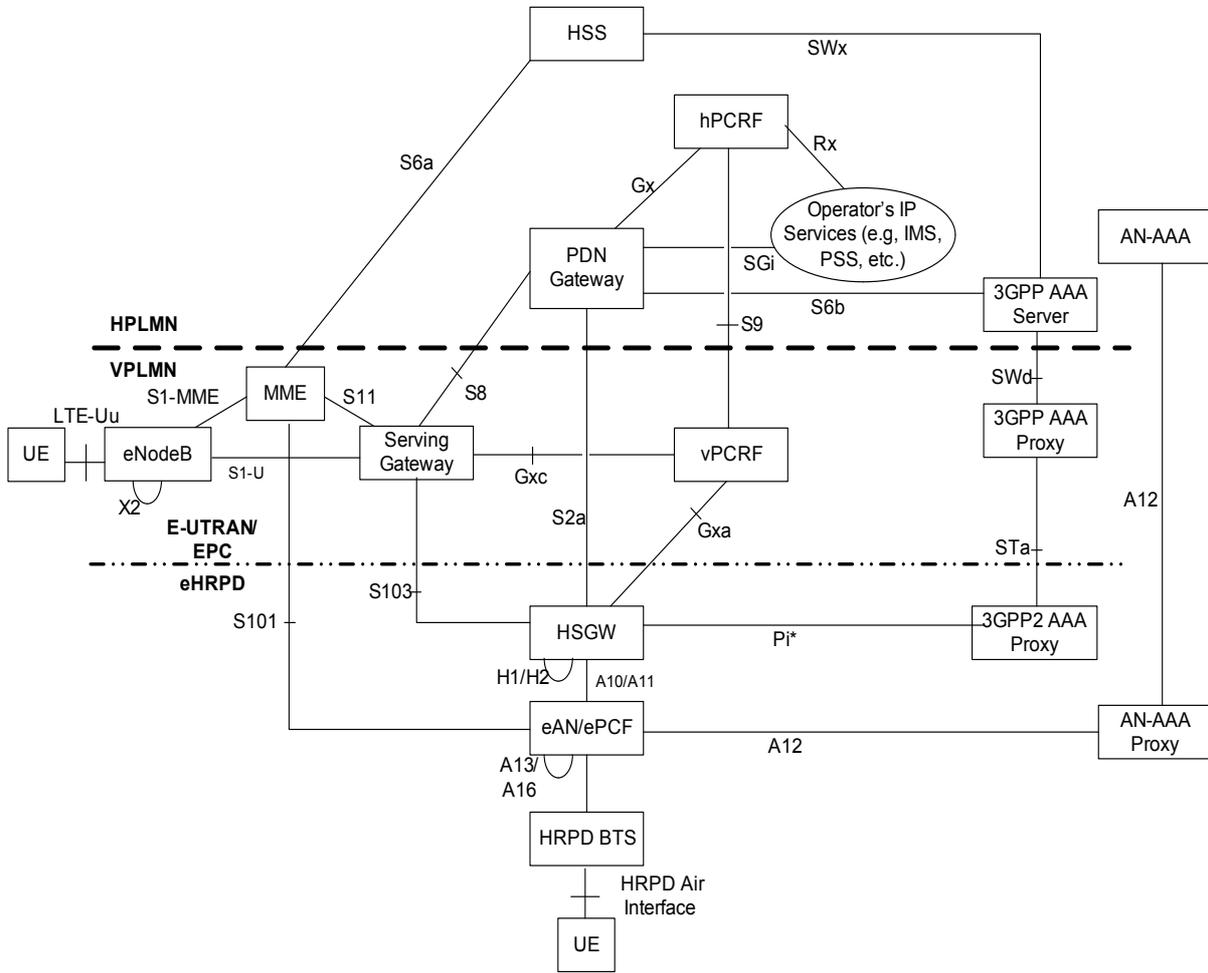
FIGURE 1
E-UTRAN - eHRPD Interworking Non-Roaming Architecture



E-UTRAN – eHRPD Interworking Roaming Architecture (Home-Routed Traffic)

Figure 2 illustrates the E-UTRAN – eHRPD interworking architecture for home-routed traffic. In this case the anchor point (i.e., the PGW) is located in the home network.

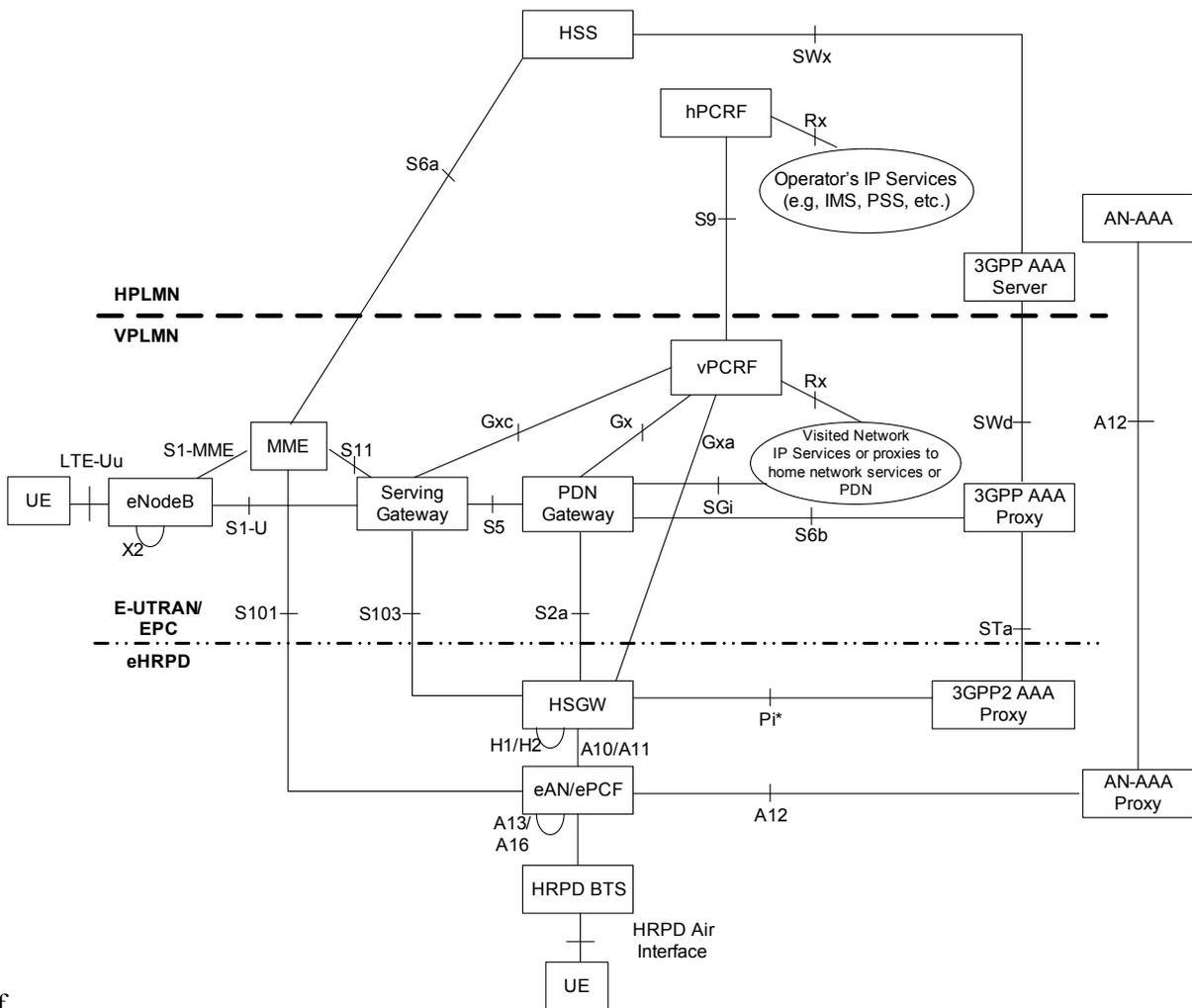
FIGURE 2
E-UTRAN – eHRPD Interworking – Roaming Architecture (Home-Routed Traffic)



E-UTRAN – eHRPD Interworking Roaming Architecture (Local Breakout)

Figure 3 illustrates the E-UTRAN – eHRPD interworking architecture for local breakout traffic. In this case the anchor point (i.e., the PGW) is located in the visited network.

FIGURE 3
E-UTRAN – eHRPD Interworking – Roaming Architecture (Local Breakout)



f

Reference Points

As shown in Figure 1 through Figure 3, for the interworking between E-UTRAN and eHRPD, the following reference points are defined:

H1/H2 Reference Points

The H1 reference point carries signaling information between a source HSGW (S-HSGW) and a target HSGW (T-HSGW) for optimized inter-HSGW handoff.

The H2 reference point carries user traffic, both uplink and downlink, from a source HSGW (S-HSGW) to a target HSGW (T-HSGW) for optimized inter-HSGW handoff.

Gxa Reference Point

The Gxa reference point connects the Policy and Charging Rules Function (PCRF) in the 3GPP EPC to the BBERF in the HSGW in the 3GPP2 eHRPD access network.

Detailed requirements and operation of this interface is defined in 3GPP TS 23.203 [21], 3GPP TS 29.212 [31] and 3GPP TS 29.213 [32].

Pi* Reference Point

The protocol used on the Pi* reference point connects the HSGW to the 3GPP2 AAA Proxy.

The requirements for this interface to support the Pi*3GPP2 Diameter Application are as defined in 3GPP2 X.S0057-B [31]. If the Pi*3GPP2 Diameter Application is not supported, the Pi* reference point is identical to that used on the STa reference point.

S101 Reference Point

The S101 reference point connects the MME in the 3GPP EPS to the eAN/ePCF in the 3GPP2 eHRPD access network per 3GPP2 A.S0022-B [33]. This reference point provides tunneling of signaling and data between the UE and the target access network via the source/serving access network.

The detailed operation of this interface is defined in 3GPP TS 23.402 [5] and 3GPP TS 29.276 [6].

S103 Reference Point

The S103 reference point connects the Serving Gateway (S-GW) in the 3GPP EPC to the HSGW in the 3GPP2 eHRPD network. Its function is to forward downlink data between the S-GW and the HSGW to minimize packet losses in mobility from E-UTRAN to eHRPD.

Detailed requirements and operation of this interface is defined in 3GPP TS 23.402 [5] and 3GPP TS 29.276 [6].

S2a Reference Point

The S2a reference point connects the PDN Gateway in the 3GPP EPC to the HSGW in the 3GPP2 eHRPD network. This reference point provides the user plane with related control and mobility support between eHRPD access and the P-GW.

Detailed requirements and operation of this interface is defined in 3GPP TS 23.402 [5], 3GPP TS 29.275 [35], and Section 5.

STa Reference Point

The STa reference point connects the AAA server/proxy in the 3GPP EPC to the AAA proxy in the 3GPP2 eHRPD network. This reference point is used to authenticate and authorize the UE and carries PMIPv6 mode related Diameter parameters between the 3GPP AAA server/proxy and the 3GPP2 AAA Proxy.

Detailed requirements and operation of this interface is defined in 3GPP TS 23.402 [5] and 3GPP TS 29.273 [34].

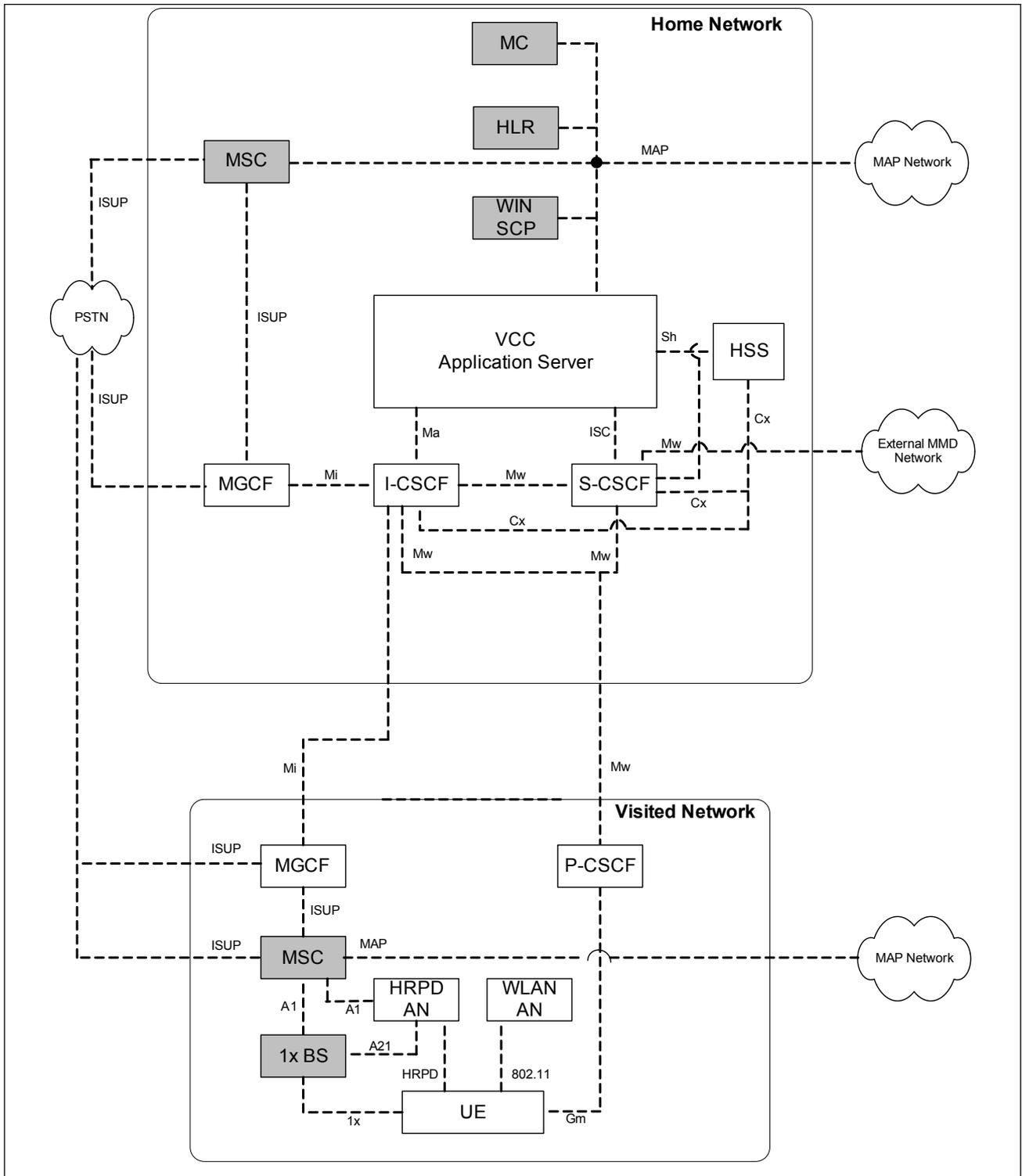
5.1.4 cdma2000 Architecture for Voice Call Continuity (VCC)

The following is abstracted from 3GPP2 X.S0042-B [30].

Architecture Reference Model

The following figure illustrates the architecture reference model to support Voice Call Continuity, including IMS-CS DTs, call origination and call termination. Only those MMD or CS network entities or interfaces supporting VCC are shown.

FIGURE 1
VCC Architecture Reference Model



Voice Call Continuity introduces a new VCC Application Server (VCC AS) functional entity in the MMD network and relevant reference points for communication with the CS and IMS functional entities. The VCC AS makes use of existing CS and IMS functional entities and reference points.

The VCC Application Server comprises two main functions:

- assists in terminating services to a terminal that is 1x CS registered and/or IMS registered
- is involved in voice call setup signaling to facilitate HRPD/WLAN VoIP-to-1x CS voice call DTs and 1x CS voice call to WLAN VoIP DTs

The VCC AS is anchored in the call signaling path of all voice calls originated from, or terminated to, a VCC UE that is IMS registered and tuned to HRPD/WLAN, or 1x CS registered and tuned to 1x. It has the following signaling interfaces:

- VCC AS / S-CSCF (ISC)

The VCC AS serves as a SIP Back-to-Back User Agent (B2BUA) that interfaces to the S-CSCF via an ISC SIP signaling interface.

- VCC AS / I-CSCF (Ma)

The VCC AS interfaces to an I-CSCF via an 'Ma' SIP signaling interface. This interface is used to anchor the VCC AS in the call path by sending SIP request from I-CSCF directly to the VCC AS.

- VCC AS / HLR (MAP)

The VCC AS interfaces to the 1x CS HLR using MAP in order to obtain routing information for terminating voice calls to a UE via the 1x CS network.

- VCC AS / HSS (Sh)

The VCC AS also interfaces to the HSS via an Sh interface [MMD Part-10] using the Diameter protocol to transfer data between the VCC AS and HSS.

- VCC AS / WIN SCP (MAP)

The VCC AS interfaces to the WIN SCP using the MAP protocol in order to provide routing information for 1x voice call originations and terminations and to anchor the VCC AS in these calls. The WIN SCP may be integrated with the VCC AS or may be a standalone network element.

5.2 Access Network Elements

5.2.1 cdma2000 1xRTT and HRPD Access Network Architecture

The following is abstracted from 3GPP2 A.S0011-D [9].

Interface Reference Model

The interfaces defined in this standard are described below.

- A1 The A1 interface carries signaling information between the call control and mobility management functions of the circuit-switched MSC and the call control component of the BS (BSC).

- A1p The A1p interface carries signaling information between the call control and mobility management functions of the MSCe and the call control component of the BS (BSC).
- A2 The A2 interface is used to provide a path for user traffic. The A2 interface carries 64/56 kbps PCM information (for circuit-oriented voice) or 64 kbps Unrestricted Digital Information (UDI, for ISDN) between the Switch component of the circuit-switched MSC and the Selection/Distribution Unit (SDU) function of the BS.
- A2p The A2p interface provides a path for packet-based user traffic sessions. The A2p interface carries voice information via IP packets between the MGW and the BS.
- A3 The A3 interface is used to transport user traffic and signaling for inter-BS soft/softer handoff when a target BS is attached to the frame selection function within the source BS. The A3 interface carries coded user information (voice/data) and signaling information between the source BS SDU function and the channel element component (BTS) of the target BS. This is a logical description of the endpoints of the A3 interface. The physical endpoints are beyond the scope of this specification. The A3 interface is composed of two parts: signaling and user traffic. The signaling information is carried across a separate logical channel from the user traffic channel, and controls the allocation and use of channels for transporting user traffic.
- A5 The A5 interface is used to provide a path for user traffic for circuit-oriented data calls between the source BS and the circuit-switched MSC. The A5 interface carries a full duplex stream of bytes between the switch component of the circuit-switched MSC and the SDU function of the BS.
- A7 The A7 interface carries signaling information between a source BS and a target BS for inter-BS soft/softer handoff.
- A8 The A8 interface carries user traffic between the BS and the PCF.
- A9 The A9 interface carries signaling information between the BS and the PCF.
- A10 The A10 interface carries user traffic between the PCF and the PDSN.
- A11 The A11 interface carries signaling information between the PCF and the PDSN.

This is a logical architecture that does not imply any particular physical implementation. For this standard the IWF for circuit-oriented data calls is assumed to be located at the circuit-switched MSC, and the SDU function is considered to be co-located with the source BSC. Figure 2.21 and Figure 2.22 show the relationship among network components in support of MS originations, MS terminations, and direct BS-to-BS soft/softer handoff operations.

FIGURE 2.2-1
Reference Model for Circuit-Switched cdma2000 Access Network Interfaces

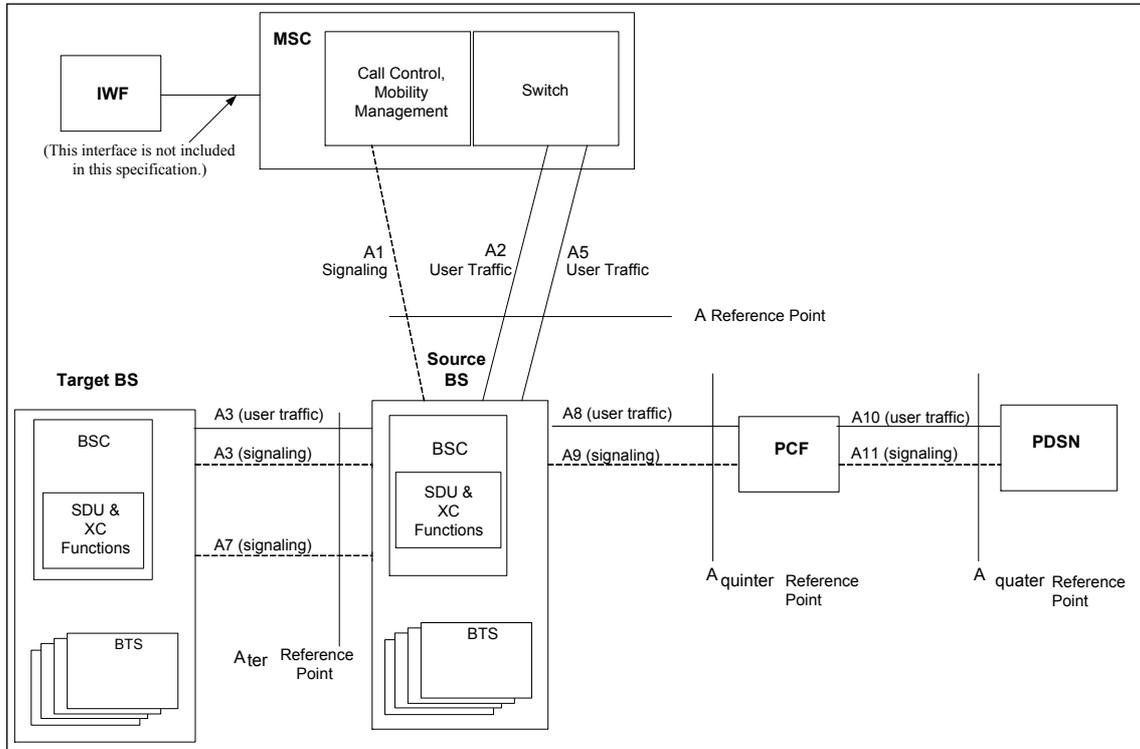
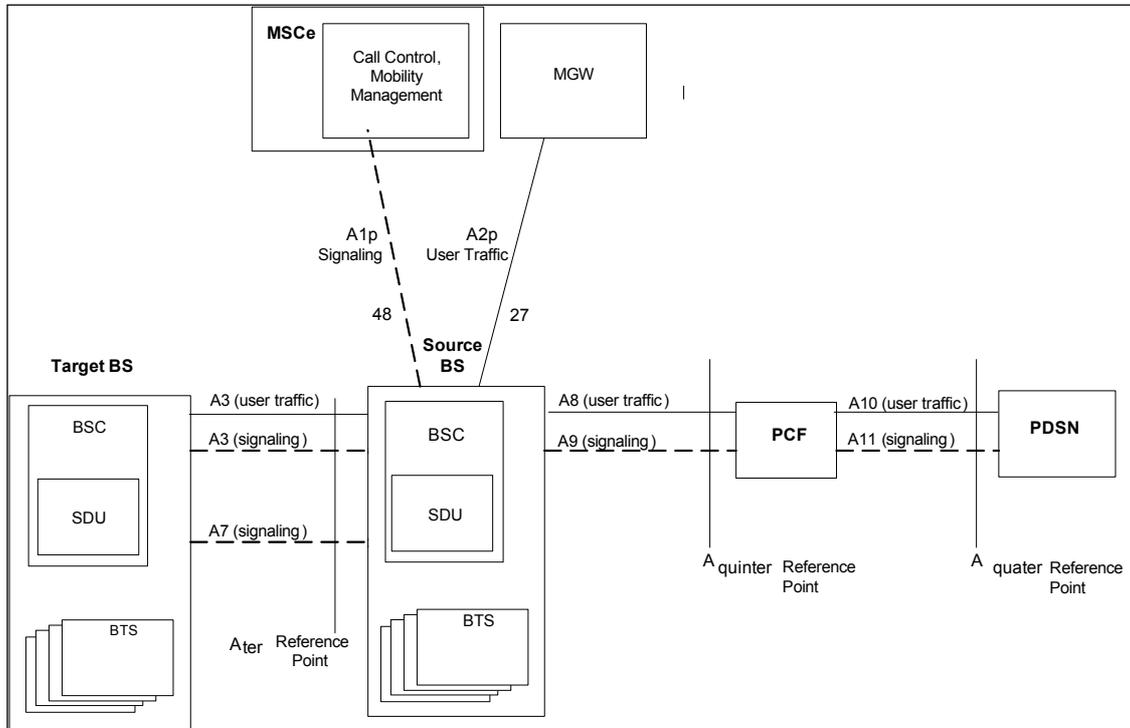


FIGURE 2.2-2
Reference Model for Packet-based cdma2000 Access Network Interfaces



5.2.2 cdma2000 eHRPD Access Network Architecture

The following is abstracted from 3GPP2 A.S0022-B [33].

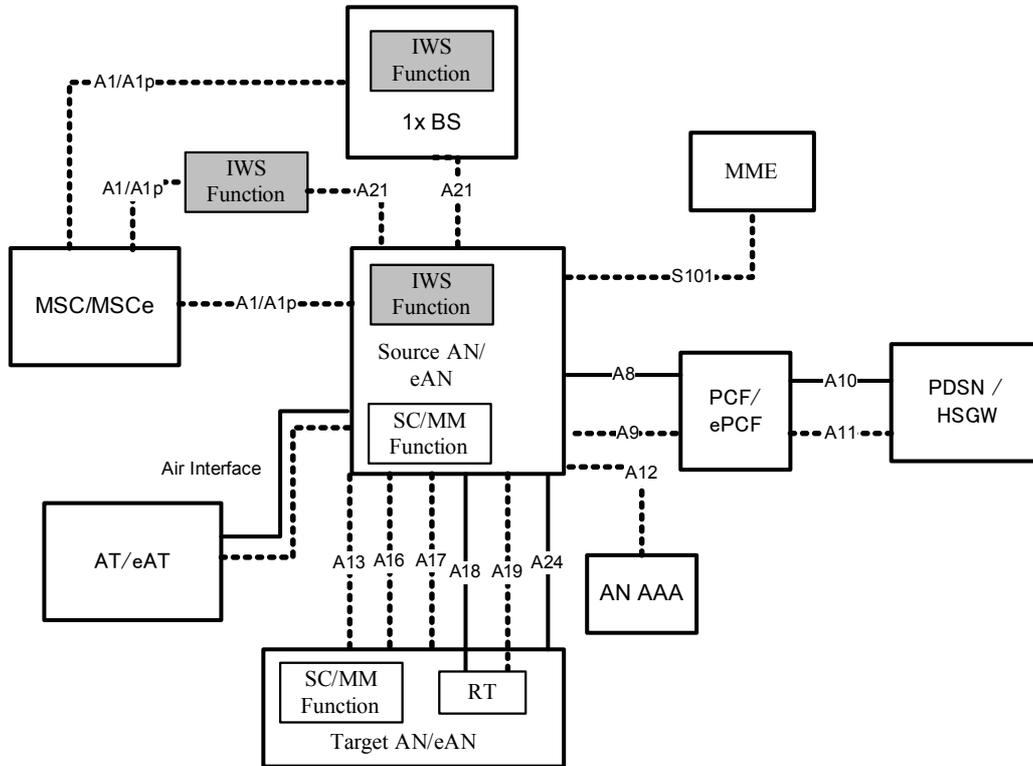
HRPD IOS Architecture Reference Model

The eHRPD IOS messaging and call flows are based on the Architecture Reference Model shown in Figure 1.4-1 (Session Control and Mobility Management in the evolved Access Network) and in Figure 1.4-2 (Session Control and Mobility Management in the evolved Packet Control Function). In the figures, solid lines indicate signaling and bearer and dashed lines indicate only signaling.

The eHRPD call flows include the E-UTRAN and other 3GPP access entities (S-GW, P-GW, HSS and PCRF). Refer to 3GPP TS 23.402 [5] for the architecture model and descriptions of these network entities and associated interfaces.

FIGURE 1.4-1

E-UTRAN - eHRPD IOS Architecture Reference Model (SC/MM in the eAN)

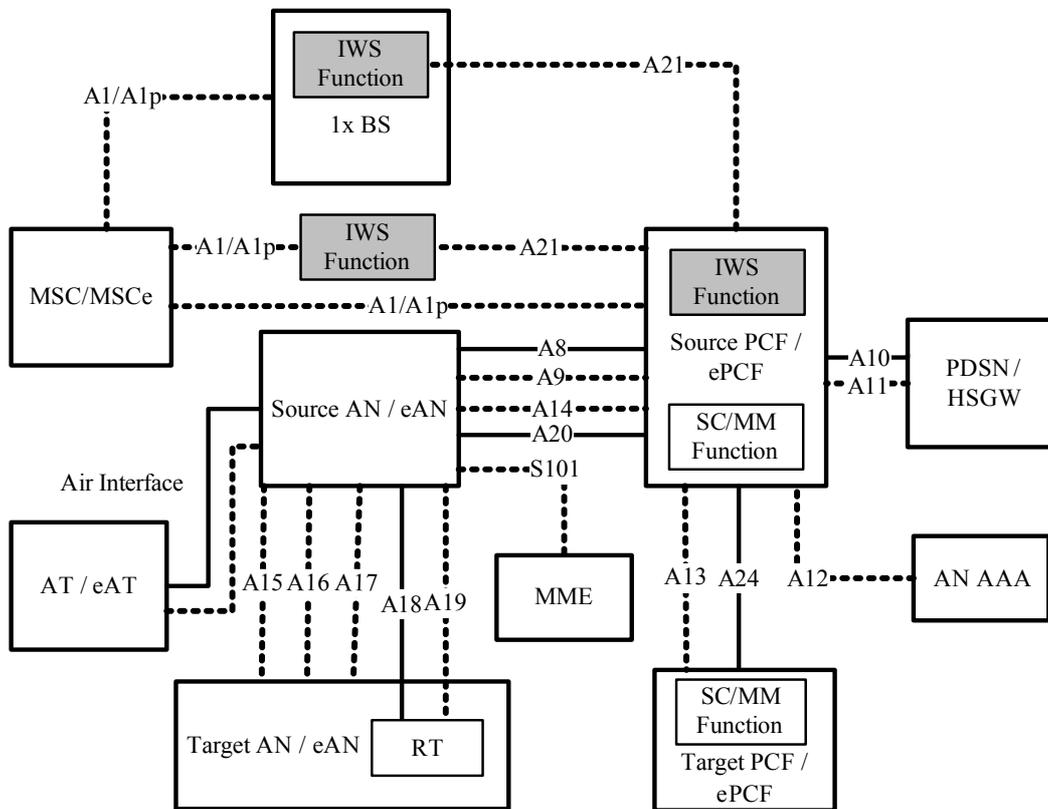


Note: The Interworking Solution (IWS) Function in Figure 1.4-1 may be collocated at either the 1x Base Station (BS) or at the HRPD eAN, or may be a standalone entity. When the IWS function is collocated at the 1x BS, the A21 interface is supported between the 1x BS and the HRPD eAN, and the A1/A1p interface is supported between the Mobile Switching Center (MSC) and the 1x BS. When the IWS function is part of the HRPD eAN, the A1/A1p interface between the MSC and the HRPD eAN exists, and the A21 interface is internal to the HRPD eAN. When the IWS is a standalone entity, the A1/A1p interface is supported between the MSC and the IWS, and the A21 interface is supported between the IWS and the HRPD eAN.

Note: PDSN and HSGW functions may not be in the same physical entity.

FIGURE 1.4-2

E-UTRAN - eHRPD IOS Architecture Reference Model (SC/MM in the ePCF)



Note: The IWS Function in Figure 1.4-2 may be collocated at either the 1x BS or at the HRPD ePCF, or may be a standalone entity. When the IWS function is collocated at the 1x BS, the A21 interface is supported between the 1x BS and the HRPD ePCF, and the A1/A1p interface is supported between the MSC and the 1x BS. When the IWS function is part of the HRPD ePCF, the A1/A1p interface between the MSC and the HRPD ePCF exists, and the A21 interface is internal to the HRPD ePCF. When the IWS is a standalone entity, the A1/A1p interface is supported between the MSC and the IWS, and the A21 interface is supported between the IWS and the HRPD ePCF.

Note: PDSN and HSGW functions may not be in the same physical entity.

eHRPD IOS Interfaces

The interfaces defined in this specification are described as follows.

- A1** The A1 interface carries signaling information between the call control and mobility management functions of the circuit-switched MSC and the IWS function. For A1 descriptions, refer to section 2.1. The A1 interface required for eHRPD is specified in 3GPP2 A.S0008-D [7] and 3GPP2 A.S0009-D [8].
- A1p** The A1p interface carries signaling information between the call control and mobility management functions of the Mobile Switching Center Emulation (MSCe) and the IWS

function. It is recommended that the A1p interface, instead of the A1 interface, be applied for interworking between the 1x and HRPD systems. For A1p descriptions, refer to section 2.1. The A1p interface required for eHRPD is specified in 3GPP2 A.S0008-D [7] and 3GPP2 A.S0009-D [8].

- A8 The A8 interface carries user traffic between the Access Network and the PCF. For A8 descriptions, refer to section 2.2..
- A9 The A9 interface carries signaling information between the AN and the PCF. For A9 descriptions, refer to section 2.2..
- A10 The A10 interface carries user traffic between the PCF and the PDSN/HSGW. For A10 descriptions, refer to section 2.3..
- A11 The A11 interface carries signaling information between the PCF and the PDSN/HSGW. For A11 descriptions, refer to section 2.3..
- A12 The A12 interface carries signaling information related to access/terminal authentication between the SC/MM function and the AN-AAA.
- A13 For A.S0008 architecture, the A13 interface carries signaling information between the SC/MM function in the source AN and the SC/MM function in the target AN for dormant state session transfer and inter-AN paging when the AT is in idle state. For A.S0009 architecture, the A13 interface is between the SC/MM function in the source PCF and the SC/MM function in the target PCF.
- A14 For A.S0009 architecture, the A14 interface carries signaling information between the SC/MM function in the PCF and the AN. The A14 interface is not applicable to A.S0008 architecture..
- A15 For A.S0009 architecture, the A15 interface carries signaling information between ANs when inter-AN paging is used. The A15 interface is not applicable to A.S0008 architecture..
- A16 The A16 interface carries signaling information between the source AN and the target AN for HRPD Inter-AN Connected State Session Transfer (hard handoff or with cross-connectivity support).
- A17 The A17 interface carries signaling information between a source AN and a target AN to manage resources in support of inter-eAN cross-connectivity (soft/softer handoff). The A17 interface establishes dedicated endpoints for the A18 and A19 interfaces. Additionally, the A17 interface tunnels air interface forward control channel signaling messages from the source AN to a target AN that has sectors in the AT's Active Set to be transmitted to the AT..
- A18 The A18 interface transports user traffic (i.e., air interface traffic channel data) for an AT between the source AN and a target RT during cross-connectivity. The A18 interface endpoints are set up using the A17 interface..
- A19 The A19 interface carries RT-specific bearer-related cross-connectivity control messages for an AT between the source AN and a target RT. The A19 interface endpoints are set up using the A17 interface.
- A20 For A.S0009 architecture, the A20 interface carries user traffic between the SC/MM function in the PCF and the AN. The A20 interface is not applicable to A.S0008 architecture.

- A21 The A21 interface carries signaling information between the HRPD AN and the IWS.
- A24 The A24 interface carries buffered user data from the source AN/PCF to the target AN/PCF for an AT, during A13 session transfer. The target AN/PCF interface endpoint is transmitted to the source AN/PCF in the A13-Session Information Request message.
- S101 The S101 interface carries signaling information between the HRPD eAN and the Mobility Management Entity (MME). Refer to 3GPP TS 29.276 [6].

eHRPD IOS Network Entities

- 1x Base Station A 1x Base Station (1x BS) operates on the cdma2000 1x air interface defined by 3GPP2 C.S0001 [16] through 3GPP2 C.S0006 [21] and also supports the 1x IOS specified in 3GPP2 A.S0011 [5] through 3GPP2 A.S0017 [11].
- Access Network A logical entity in the RAN used for radio communications with the AT. An AN contains one or more RTs and is equivalent to a base station in 1x systems. AN in this specification refers to both legacy AN and evolved AN. Refer to the definition of Legacy Access Network and Evolved Access Network.
- Access Terminal A device providing data connectivity to a user. An AT 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 AT is equivalent to a mobile station in 1x systems. The term AT applies to both an Evolved Access Terminal (eAT) and a legacy AT.
- AN-AAA An entity that performs access/terminal authentication functions for the RAN.
- Evolved Access Network Access Network that supports operations for EPS – eHRPD RAN interworking specified in this specification, in addition to legacy access network capabilities.
- Evolved Access Terminal AT that supports both evolved mode (refer to 3GPP2 C.S0087-A [26]) and legacy mode operation (refer to 3GPP2 C.S0024-B [23] and 3GPP2 C.S0063-B [24]). An eAT is referred to as a UE in 3GPP TS 23.402 [5], 3GPP TS 29.276 [6] and 3GPP2 X.S0057-B [31].
- Evolved Packet Control Function
Packet Control Function that supports operations for EPS – eHRPD RAN interworking specified in this specification, in addition to legacy packet control function capabilities.
- HRPD Serving Gateway The HSGW is the HRPD Serving Gateway that connects the evolved HRPD access network with the EPC as a trusted non-3GPP access network.
- IWS Function IWS Function is logically collocated at the 1x BS or the AN, or as a standalone entity. In this standard the term IWS is used without regard to the location of the IWS. When it is necessary to make a distinction with regard to the location of the IWS, that is explicitly stated. IWS provides the following functions:
- Message Translation: This function translates between IOS A1/A1p messages received from/sent to an MSC and 1x air interface signaling messages sent/received over the HRPD air interface.

- 1x Parameters Storage: This function stores 1x radio parameters required for Circuit Services Notification Application (CSNA) support.
- 1x PN Offset and BTS Cell ID Mapping: This function enables to map a pair of 1x PN pilot information and HRPD sector information into BTS Cell ID.
- RAND Generation: This optional function provides the RAND used for 1x authentication. This function may be in the HRPD AN. When several nodes in the RAN have this function, the RAND value provided by the IWS is used.

Legacy Access Network An Access Network that complies to the specifications in 3GPP2 A.S0008-D [7] and/or 3GPP2 A.S0009-D [8] and does not support evolved mode operation in this specification.

Legacy Access Terminal An AT that does not support evolved mode is referred to as a legacy AT.

Legacy Packet Control Function

A Packet Control Function that complies to the specifications in 3GPP2 A.S0008-D [7] and/or 3GPP2 A.S0009-D [8] and does not support evolved mode operation in this specification.

Mobile Station In 1x systems, the Mobile Station (MS) is an entity in the public cellular radio telecommunications service intended to be used while in motion or during halts at unspecified points. In this specification, the term MS may also refer to an AT where text that is applicable to 1x systems has been extended to apply to HRPD and/or eHRPD systems.

Mobile Switching Center The MSC switches MS/AT-originated or MS/AT-terminated traffic. An MSC connects to one or more ANs. It may connect to other public networks (PSTN, ISDN, etc.), other MSCs in the same network, or MSCs in different networks. (It has been referred to as Mobile Telephone Switching Office, MTSO.) It provides the interface for user traffic between the wireless network and other public switched networks, or other MSCs.

In this document, for signaling, the term MSC refers to either a circuit-switched MSC or an MSCe. In situations where a statement applies to either the circuit-switched or packet-based MSC exclusively, the type of MSC is specifically identified (i.e., “circuit-switched MSC” or “MSCe”).

Mobility Management Entity

The MME is defined in 3GPP TS 23.402 [5].

MSC Emulation (MSCe) The MSCe provides processing and control for calls and services. The MSCe provides signaling capabilities equivalent to a circuit-switched MSC on the A1p interface. The MSCe connects to an AN via IP based protocols.

Packet Control Function An entity in the radio access network that manages the relay of packets between the AN and the PDSN/HSGW. PCF in this specification refers to

both legacy PCF and evolved PCF. Refer to the definition of Legacy Packet Control Function and Evolved Packet Control Function.

- Packet Data Serving Node** An entity that routes AT originated or AT terminated packet data traffic. A PDSN establishes, maintains and terminates link layer sessions to ATs. PDSN in this specification refers to legacy PDSN that supports legacy HRPD session with AT or eAT.
- Radio Access Network** The network entities providing data connectivity between the packet switched data network (typically the Internet) and the AT. The RAN may be divided into the following logical entities: ANs, AN-AAAs, and PCFs. The interfaces between these entities, the interfaces between the PCF and the PDSN, and the interfaces between the AN and the MSC are considered parts of the RAN. Refer to section 1.4.
- RT** An RT is a component of an AN comprising a collection of sectors that transmit the same power control command to an AT. An RT is also referred to as a cell on the air interface (refer to 3GPP2 C.S0087-A [26]).
- SC/MM Function:** SC/MM is logically located in the AN for the A.S0008 architecture or the PCF for the A.S0009 architecture and includes the following functions:
- Storage of HRPD session related information: This function keeps HRPD session related information (e.g., Keep Alive timer, MNID, mapping between MNID and UATI, etc.) for idle ATs.
 - Assignment of UATI: This function assigns a new UATI to an AT.
 - Access Authentication for the A.S0008 architecture: This function performs the access authentication procedure. This function judges whether an AT should be authenticated or not when the AT is accessing the HRPD RAN. The SC/MM performs PPP procedures for access authentication.
 - Terminal Authentication for the A.S0009 architecture: This function performs the terminal authentication procedure. This function judges whether an AT should be authenticated or not when the AT is accessing the HRPD RAN. The SC/MM performs Point-to-Point Protocol (PPP) procedures for terminal authentication.
 - Mobility Management: This function manages the location of an AT.

5.3 Mobile Station

5.4 User Equipment

6 Basic Elements of an IMT System based on TDMA-SC Technical Specifications

The IMT-2000 TDMA single-carrier radio interface specifications contain two variations depending on whether a TIA/EIA-41 circuit switched network component or a GSM evolved UMTS circuit switched network component is used. In either case, a common enhanced GSM General Packet Radio Service (GPRS) packet switched network component is used.

Radio interface use with TIA/EIA-41 circuit switched network

The IMT-2000 radio interface specifications for TDMA single-carrier technology utilizing the TIA/EIA-41 circuit switched network component are developed by TIA TR45.3 with input from the Universal Wireless Communications Consortium. This radio interface is called Universal Wireless Communication-136 (UWC136), which is specified by American National Standard TIA/EIA-136. It has been developed with the objective of maximum commonality between TIA/EIA-136 and GSM EDGE GPRS.

This radio interface was designed to provide a TIA/EIA-136 (designated as 136)-based radio transmission technology that meets ITU-R's requirements for IMT-2000. It maintains the TDMA community's philosophy of evolution from 1st to 3rd Generation systems while addressing the specific desires and goals of the TDMA community for a 3rd Generation system.

Radio interface used with GSM evolved UMTS circuit switched network component

This radio interface provides an evolution path for an additional pre-IMT-2000 technology (GSM/GPRS) to IMT-2000 TDMA Single-Carrier. The IMT-2000 radio interface specifications for TDMA Single-Carrier technology utilizing the GSM evolved UMTS circuit switched network component are developed by 3GPP and transposed by ATIS Wireless Technologies and Systems Committee (WTSC). The circuit switched component uses a common 200 kHz carrier as does the GSM EDGE enhanced GPRS phase 2 packet switched component, as used by 136EHS, to provide high speed data (384 kbit/s). In addition a new dual carrier configuration is supported

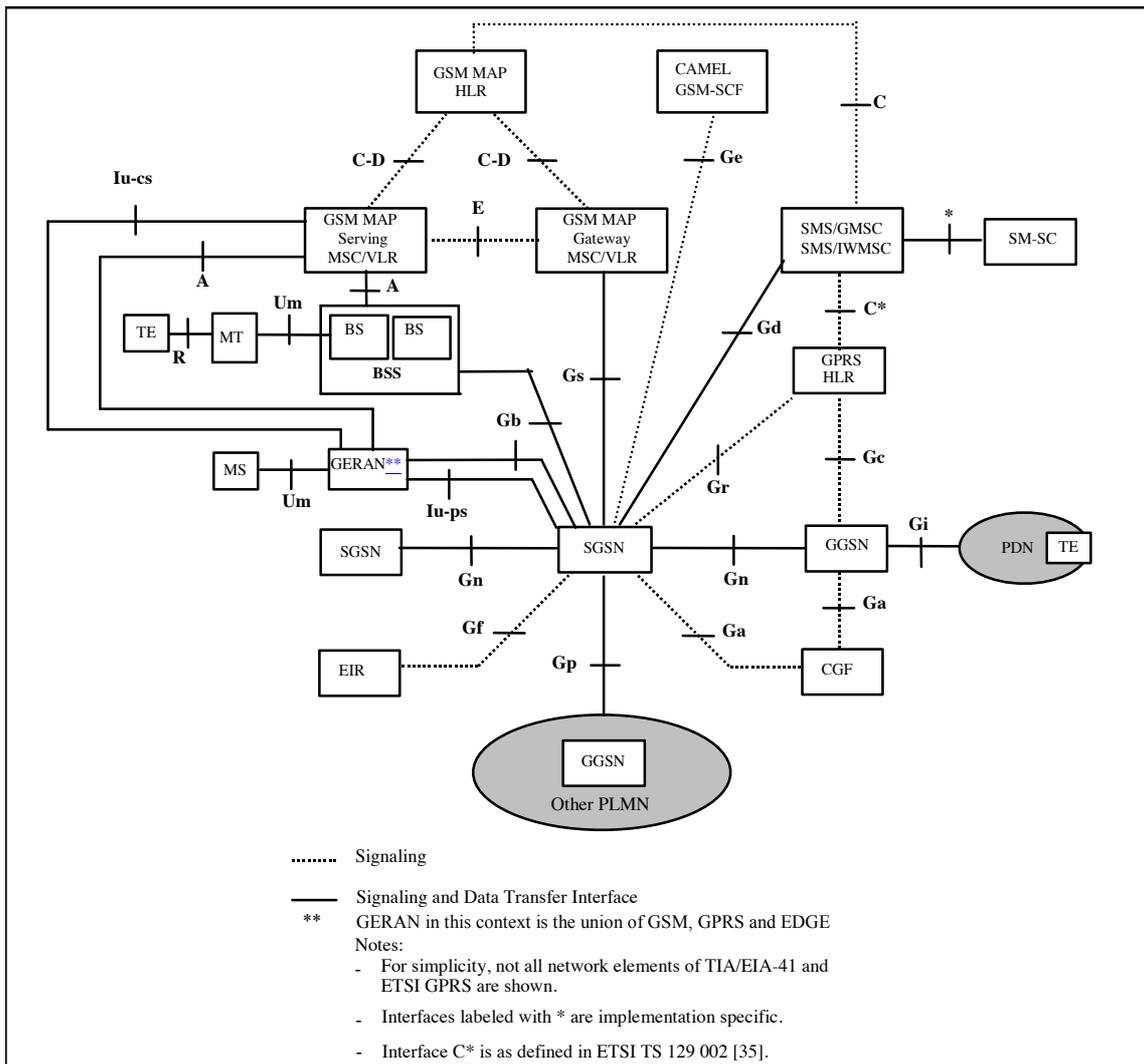
TIA/EIA-41 Circuit Switched Network component

Figure 10 presents the network elements and the associated reference points that comprise a system utilizing the TIA/EIA-41 circuit switched network component. The primary TIA/EIA-41 network node visible to the serving GPRS support node (SGSN) is the gateway mobile switching center (MSC)/visitor location register (VLR). The interface between the TIA/EIA-41 gateway MSC/VLR and the SGSN is the Gs' interface, which allows the tunnelling of TIA/EIA-136 signalling messages between the MS and the gateway MSC/VLR. The tunnelling of these signalling messages is performed transparently through the SGSN. Between the MS and the SGSN, the signalling messages are transported using the tunnelling of messages (TOM) protocol layer. TOM uses the LLC unacknowledged mode procedures to transport the signalling messages. Between the SGSN and the gateway MSC/VLR, the messages are transported using the BSSAP+ protocol.

Upon receiving a TIA/EIA-136 signalling message from a MS via the TOM protocol, the SGSN forwards the message to the appropriate gateway MSC/VLR using the BSSAP+ protocol. Upon receiving a TIA/EIA-136 signalling message from a gateway MSC/VLR via the BSSAP+ protocol, the SGSN forwards the message to the indicated MS using the TOM protocol.

MS supporting both the TIA/EIA-41 circuit switched network component and packet services (Class B136 MS) perform location updates with the circuit system by tunnelling the registration message to the gateway MSC/VLR. When an incoming call arrives for a given MS, the gateway MSC/VLR associated with the latest registration pages the MS through the SGSN. The page can be a hard page (no Layer 3 information included in the message), in which case, the Gs' interface paging procedures are used by the MSC/VLR and the SGSN. If the circuit page is not for a voice call or, if additional parameters are associated with the page, a Layer 3 page message is tunnelled to the MS by the MSC/VLR. Upon receiving a page, the MS pauses the packet data session and leaves the packet data channel for a suitable DCCH. Broadcast information is provided on the packet control channel to assist the MS with a list of candidate DCCHs. Once on a DCCH, the MS sends a

FIGURE 11



7 Configuration of an IMT System

(The basic configurations of an IMT System are described in this chapter)

7.1 Potential future network topology and architecture

[Editor's note] This section describes the future potential topology and architecture, from which we can see the potential backhaul solutions.

8 Transport requirements of IMT networks

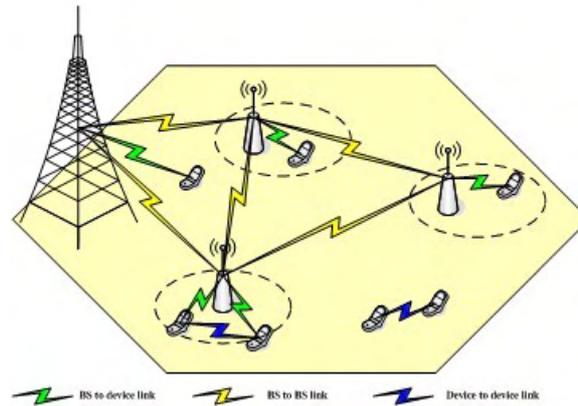
8.1 Key features of transport solutions

[Editor's note] This section describes the key features of the topology and architecture of future network, especially the backhaul, e.g. compatibility, flexibility, rapid deployment, QoS of multiple applications, and higher network energy efficiency which is to meet the gap described in section 2.

For mobile operators, transport might become more complex and more flexibility might be required to provide high quality services with reasonable cost, especially when networks deployment are becoming denser.

It is expected that in the next-generation IMT networks, many different types of base stations/ devices are likely to be deployed, with different transportation requirements and targets. As shown in Fig. 1, the transport in future IMT network would involve base station (BS) to device, device to device, and furthermore, BS to BS (or BS to dedicated relaying node) to transport the data traffic back to/from the core network.

FIGURE 1
Illustration of different transport links in future IMT networks



For the last category, the transport purely relying on optical fibre and microwave transmission may be inefficient and costly to provide the end-to-end transport service in the future dense deployment due to economic and/or propagation condition constraint. Wireless transport in this category would be introduced for its inherent flexibility, low cost, and ease of deployment. It is therefore expected that the hybrid deployment, including optical fibre, microwave, wireless and other medias/ technologies would be the case for BS to BS (or BS to dedicated relaying node) transport.

On the other hand, statistics show that in dense and heterogeneous networks, traffics of different BSs at different locations vary quite a lot, which is due to the un-uniform traffic distribution, and time-varying traffic that results in high peak-to-mean data traffic ratio at a given location (see [32]). It in turn indicates that statistical multiplexing of radio resources become possible. By flexible use and assignment of the radio resources (including spatial-, frequency- and time-domain resources), the hybrid fibre/microwave/wireless deployment for BS to BS transport could meet the multiple requirements on achieving high capacity, while maintaining low cost and ease of deployment. Furthermore, the flexible use of radio resources among BS to device, device to device, and BS to BS transport might show more significant benefit to meet the different transportation requirements and targets with specific traffic distributions and propagation environments. Therefore, new transport solutions must be flexible enough to make sure that the scarce radio resources among the network could be multiplexed statistically to match the required service traffic distribution and the related propagation environments.

The flexibility requirement includes the capability of flexible topology and the capability of flexible resource assignment or sharing. The former refers to the capability of flexible use of spatial-domain resources, i.e., the deployed devices, and flexible configuration of the connection of the network

nodes. The latter refers to the capability of flexible sharing and use of the time- and frequency-domain resources with the flexible configuration of the topology.

Besides, such flexibility needs also to improve other issues, such as reliability, co-existence with other solutions, fast deployment, support of multiple applications with different QoSs, network level energy efficiency, etc. In the following, detailed descriptions on the above key features are presented.

8.1.1 Performance (i.e. Availability levels, Bandwidth, Bit Error Rate, Latency, Throughput, etc.)

8.1.2 Reliability

Reliable communication is the basic requirement of end-to-end data delivery for users. However, in real system, some network equipments such as BSs may break down due to irresistible reasons (e.g., natural disaster, accidents). In this situation, if the transport system is configured statically, communication reliability may thus become hard to achieve, e.g., the transport from one BS to another BS might break down due to one of the BS in accidents, and the topology configuration is static. Therefore, resilience is an important feature for transport systems to maintain high reliability, which can be achieved with flexible topology adaptation through advanced routing algorithms.

8.1.3 Compatibility with existing transport

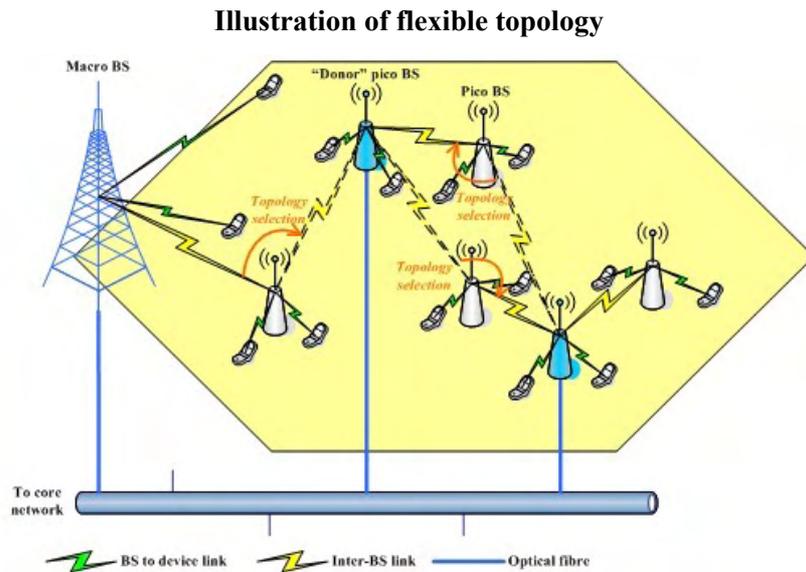
New transport solution should be compatible or could co-exist with the legacy transport, e.g., the legacy BS to device transport. The requirement is on two-fold. On one hand, new transport solution must have no impact on the existing ones, especially for the wireless transport links among BS to devices. On the other hand, multiplexing of different kinds of transport resources, even among new and existing ones, should be considered in order to maximize the efficiency of current transport resources.

8.1.4 Flexibility

[Editor's note] Transport technology provides flexible resource allocation based on timely traffic variation, which will provide higher efficiency and lower cost and shorter deployment period.

The new transport solution needs to be flexible in topology configuration and resource use and sharing. This is especially important for BS to BS (or BS to dedicated relaying node) transport, and in turn has impact on the other two categories of transport. In future IMT systems with dense deployment of BSs having hybrid transport capability to core networks (e.g., some with optical fibre, some with microwave, and some with wireless module only), the flexible configuration of topology and resource assignment is the key to adapt the spatial-, time-, and frequency-domain resource to the traffic variations and distributions. For example, the flexible topology configuration could appropriately switch the connection path of one BS with wireless-only module to an idle “donor” BSs/relays that have fibre or microwave connection to core network, rather than a pre-defined BS/relay which might be in heavy load and could not assign any more resource to the target BS. The flexible resource allocation, on the other hand, would enable the fully resource sharing with different BS to BS transport. And resource sharing may be even among BS to device transport, device to device transport, and BS to BS transport, such that the resource utilization efficiency could be maximized. One example of flexible topology is shown in Fig. 2.

FIGURE 2



8.1.5 Fast deployment

[Editor's note] Transport technology provides fast deployment at emergency cases.

Typical IMT system provides continue coverage for both urban, suburban and rural scenarios. However, in particular cases such as assembly, sports event or even equipment failure, coverage hole or capacity gap may exist. In this situation, it is important to quickly deploy temporary transport resources to recover the network's capability to satisfy users' requirements. Fast transport deployment requires quick installing and configuration, which must be facilitated with advanced self-configure and self-optimization features, and therefore, aggregation adjacent resources and avoiding co-channel interference must be supported.

8.1.6 QoSs of multiple applications

[Editor's note] Transport technology provides QoSs insurance under multiple applications and mobility environment.

Diverse applications and multiple different QoSs should be supported at the same time even for a particular user, as the requirements of end users are becoming more complicated. In traditional IMT system, this could be assured with advanced resource allocation and scheduling in BS to device link (or referred to as access link). However, if the BS to BS (or BS to dedicated relaying node) capability becomes the bottleneck of end-to-end transmission, smarter transport technology is necessary since the efficiency of inter-BS/relaying is equivalently important to that of access. Therefore, different transport links must be scheduled intelligently to match the QoS of end-to-end users, even in mobility environment, which may be possible if joint optimizations of different transport categories are implemented.

8.1.7 Higher network energy efficiency.

[Editor's note] Transport technology improve the higher energy efficiency.

Network energy consumption significantly influences the environment and operators, and is regarded as an important issue in future IMT system especially when the base station density becomes higher. Transport technology is a key factor in network energy efficiency improvement, since it not only impacts the end-to-end transmission performance such as throughput, connection number, but also contributes to the total energy consumption as many network devices are activated for transport communications. Therefore, new transport technology must be able to save huge amount of energy while providing the equivalent quality of service, which can be achieved through dynamic high energy efficient node selection and advanced cell on/off schemes. Besides, new transport architecture where more small cells with low energy consumption and simple functions are deployed to enhance the inter-BS/relaying links should also be considered.

9 Transport requirements

[Editor's note] Based on the discussion above, this section is to conclude on the backhaul requirements of IMT services.

9.1 Amount of traffic we expect

9.2 How it distribute across various transport mechanisms

10 Challenges of future network topology and network

10.1 Characteristics of future network

[Editor's note] This section describes the key characteristics of future network, e.g., the dramatic capacity requirement, un-uniform and fast-varying traffic load but with uniform user experience, and quite diverse applications and QoSs.

Though accurate prediction of future network is difficult, four key features of future network are expected, including denser and more diverse hotspot, non-uniform traffic distribution but uniform user experience, various application services and better support of emergency communications. Since mobile data explosion (e.g., 1000 times traffic improvement in the next 10 years) could happen and the traffic may appear in any possible locations, there will be a large amount of hotspots among the network whose location may vary during time and space domain. However, from the point of view of end-users, same high quality service and experience is expected no matter where and when the communication is triggered. Besides, more and more innovative services are designed and proposed, which make QoS more complicated and diverse. Furthermore, for emergency situation such as natural disaster, quick and reliable basic communication should be provided even some of the network equipments are broken down.

10.2 Future impact of Cloud

Cloud is another significant trend of future network, especially in terms of computing, storage and network service. As the development of cloud technology, network topology would definitely become more diverse. One major example is the decoupling of physical equipments and network functions, which makes ubiquitous service possible. To be specific, network devices may be

flexibly connected with each other and dynamically share own capability to provide high quality service and amazing experience when needed. It is expected that many different kinds of topologies, including star, ring, mesh, and even arbitrary mixtures of them may exist.

Therefore, how to jointly optimize the overall network performance under such complicated topology is an open issue, to all categories of transportations.

10.3 Challenges to reach the future

[Editor's note] This section describes the gap between the existing topology, architecture and backhaul technologies with the future network requirements.

In order to make the future IMT system come true, great effort must be made especially considering the severe challenges. One major concern about future IMT system is the cost, which is composed of two parts, i.e., CAPEX and OPEX. On one hand, excessive traffic improvement needs more and more equipments together with more advanced technologies, which contributes the increase of CAPEX. On the other hand, if network resources cannot be dynamically allocated, huge waste of resources or severe resource conflict may occur, which could obviously worsen the end-to-end performance and leads to higher OPEX to network optimization. Furthermore, if network topology is statically configured, network reliability might be a problem especially when some equipment failure happens.

Flexibility is the key to address the performance achievement requirements while maintaining an affordable network cost. By flexible topology configuration, the network could offload the heavy data traffic with appropriately selected transport paths. By flexible radio resource assignment and sharing, the deployed time- and frequency-domain resource (either for BS-to-device, or for device-to-device, or for BS-to-BS, etc.) could be fully utilized, and waste of resource could be avoided.

11 Conclusion

This section draws the main conclusions on topology and architecture of future network and the backhaul requirements.

12 Terminology, abbreviations

ANNEXES AND APPENDICES...
