3GPP2 X.S0011-001-C
Version 2.0
Version Date: July 2005

cdma2000 Wireless IP Network Standard: Introduction

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2 Revision History:

Revision	**Date**	Comments
P.S0001	December 2000	Initial Publication
P.S0001 Rev A	May 2001	Added specification or clarification for the following items: • New mechanism for PDSN/HA pre-shared secret distribution for IKE • Security status is replaced by *IKE Pre-shared Secret Request* attribute • New counters G15 and G16 for Mobile IP signaling • Clarifications with respect to counters G1 and G2 • A new indicator in RADIUS stop message to indicate session still in progress (to avoid release of the IP address) • Removal of RADIUS accounting fields H1, I2, and I3 • New accounting session to be created when F1, F2 accounting fields vary • Non-zero and zero IP address in IP Configuration option in IPCP is treated as Simple IP by PDSN. Mobile IP is supported with null IP address configuration option (i.e., not included). • The Active Time attribute format changed from standard RADIUS encoding to 3GPP2 specific encoding.
P.S0001 Rev B	September 2002	This document has been revised to support the following features: • Simultaneous multiple ~~over-the-air~~ service instances concept introduced. • RTP/UDP/IP Header Reduction Schemes • Differentiated Services QoS Policy • Fast handoff for data call (i.e., tunneled PPP between PDSNs) • Dynamic Home Agent allocation with RADIUS • Optional support for DNS server address auto configuration in MS • Always On support • IP Reachability Service with dynamic DNS update • Simple IPv6 • Remote address based accounting
P.S0001 Rev B v2.0	September, 2004	Bug fixes

Revision	**Date**	Comments
X.S0011-C	August 2003	• New format: the specification is split into 6 chapters identified by X.S0011.xxx-C, where xxx is the chapter number. • Multiple Service Instance support • LLAROHC Header Compression and LLA Header Removal • Enhanced CRTP as an additional compression scheme • Dynamic flow mapping/treatment • PrePaid Packet Data service (phase 1) • PDSN/HA Resource management • Accounting support for 1xEVDV • Packet Data Inactivity Timer • IKE/IPsec clarifications • IP Reachability enhancements • Enhancements to Always On • Enhancements to Simple IPv6
X.S0011-C v2.0	May 2005	Bug fixes imported from P.S0001-B v2.0

1 **Table 1 Revision History**

1 Introduction

This document defines requirements for support of wireless packet data networking capability on a third generation wireless system based on cdma2000®[1]. This document supports the services and architecture in [1].

This document defines the two methods for accessing public networks (Internet) and private networks (intranets): Simple IP and Mobile IP. It describes the required Quality of Service, Security, Mobility Management, and Accounting capabilities needed to support both methods. IETF protocols are widely employed whenever possible to minimize the number of new protocols required and to maximize the utilization of well accepted standards.

This document is organized into a series of related chapters, some of which address capabilities common to both IP access service types: Mobile IP and Simple IP, and others may describe capabilities applicable to a specific IP access service. The chapters included in this series are:

X.S0011-001-C cdma2000 Wireless IP Network Standard: Introduction.

X.S0011-002-C cdma2000 Wireless IP Network Standard: Simple IP and Mobile IP Access Services.

X.S0011-003-C cdma2000 Wireless IP Network Standard: Packet Data Mobility and Resource Management.

X.S0011-004-C cdma2000 Wireless IP Network Standard: Quality of Service and Header Reduction.

X.S0011-005-C cdma2000 Wireless IP Network Standard: Accounting Services and 3GPP2 RADIUS VSAs.

X.S0011-006-C cdma2000 Wireless IP Network Standard: PrePaid Packet Data Service.

A chapter may be referred to by its full designation (e.g., X.S0011-001-C), or by its relative chapter number (e.g., Chapter 1 means X.S0011-001-C, Chapter 2 means X.S0011-002-C, etc.)

Chapter 1	This chapter presents an overview of the document content, and contains the complete glossary and definitions applicable to all the chapters. It describes the network and protocol reference models for the wireless IP Network entities: PDSN, HA and RADIUS server.
Chapter 2	This chapter describes the basic IP access services: Simple IPv4/IPv6 and Mobile IPv4 with Dynamic Home Agent, and Home IP address Assignment. It also addresses the security requirements between the Wireless IP Network nodes: PDSN, HA and RADIUS servers. The chapter includes other capabilities such as Always On, multiple simultaneous Mobile IPv4 and Simple IPv4/IPv6 packet data session and IP Reachability Service.
Chapter 3	This chapter describes packet data intra-PDSN, inter-PDSN handoff as well as inter-PDSN fast handoff capabilities and the RN requirements.

[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.

	The chapter includes mechanisms for PDSN and HA resource management and provisioning of dormancy timers in the RN.
Chapter 4	This chapter describes user Differentiated services capability, multiple service instances, flow mapping and treatment, as well as a detailed description of Link Layer Assisted Robust Header compression and Header Removal treatment to support Voice over IP Service over an auxiliary service instance.
Chapter 5	This chapter describes source IP address and remote IP address based accounting and details procedures required for this series of specifications. It also includes a description of the 3GPP2 RADIUS VSAs required to support this series of specifications.
Chapter 6	This chapter describes the PrePaid Packet Data Service for the Wireless IP Network users and includes the PrePaid service architecture, the detailed procedures and the requirements on the Wireless IP Network elements.

In this specification, several key words are used to signify the requirements. The key words "shall", "shall not", "should", "should not", and "may" are to be interpreted as described in RFC 2119 and the TIA Engineering Style Manual.

2 Glossary and Definition

2.1 *Acronyms*

AAA	Authentication, Authorization, and Accounting
ACCM	Asynchronous Control Character Map
AH	Authentication Header
AVP	Attribute Value Pair
BS	Base Station
CA	Certificate Authority
CCP	Compression Control Protocol
CHAP	Challenge Handshake Authentication Protocol
CoA	Care-of Address
CRL	Certificate Revocation List
CSRC	Contributing Source
D-H	Diffie-Hellman
DN	Distinguished Name
DNS	Domain Name System
DSA	Digital Signature Algorithm
DOI	Domain Of Interpretation
DQ	Duration Quota
DT	Duration Threshold
ESP	Encapsulating Security Payload
FQDN	Fully Qualified Domain Name
FA	Foreign Agent
FAC	Foreign Agent Challenge
GRE	Generic Routing Encapsulation
HA	Home Agent
HAAA	Home AAA
HDLC	High-level Data Link Control
HG	Header Generator
HLR	Home Location Register
HRPD	High Rate Packet Data
HRL	Header Reduction Lower
HRU	Header Reduction Upper
IANA	Internet Assigned Numbers Authority
IETF	Internet Engineering Task Force
IKE	Internet Key Exchange
IMSI	International Mobile Subscriber Identity
IMT-2000	International Mobile Telecommunications - 2000
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IPCP	Internet Protocol Control Protocol
ICMP	Internet Control Message Protocol
IPv6CP	IPv6 Control Protocol
IPSec	IP Security
IR	Initialization and Refresh Packet (RFC 3095)
IRM	International Roaming MIN
IRS	IP Reachability Service
ISAKMP	Internet Security Association and Key Management Protocol
ISP	Internet Service Provider
LAC	Link Access Control
LCP	Link Control Protocol

LLA	Link-Layer Assisted
MAC	Medium Access Control
MEID	Mobile Equipment Identifier
MIN	Mobile Identification Number
MIP	Mobile IP
MS	Mobile Station
MSID	Mobile Station ID
NAI	Network Access Identifier
NAS	Network Access Server
NAT (-PT)	Network Address Translation – Protocol Translation
NHP	No-Header Packet (as defined in RFC3242)
NID	Network ID
NVSE	Normal Vendor Specific Extension
OUI	Vendor's Organizationally Unique Identifier
PAP	Password Authentication Protocol
PCF	Packet Control Function
PDSN	Packet Data Serving Node
PHB	Per Hop Behavior
Pi	PDSN – Internet (Interface)
PL	Physical Layer
P-P	PDSN-PDSN (Interface)
PPAC	PrePaid Accounting Capability
PPAQ	PrePaid Accounting Quota (duration/volume)
PPC	PrePaid Client
PPP	Point-to-Point Protocol
PPS	PrePaid Server
PSI	PCF Session ID
PTS	PrePaid Tariff Switch
PZID	Packet Zone ID
QID	Quota IDentifier
QoS	Quality of Service
RA	Router Advertisement
RADIUS	Remote Authentication Dial In User Service
RC	Radio Configuration
RHP	ROHC Header Packet (as defined in RFC3242)
RLP	Radio Link Protocol
RN	Radio Network
RN-PDIT	Radio Network-Packet Data Inactivity Timer
R-P	RN-PDSN Interface
ROHC	Robust Header Compression
RRP	Mobile IP Registration Reply
RRQ	Mobile IP Registration Request
RS	Router Solicitation
RSA	Rivest-Shamir-Adleman public key algorithm
RTP	Real-time Transport Protocol
SA	Security Association
SDP	Session Description Protocol
SDB	Short Data Burst
SHA	Secure Hash Algorithm
SI	Service instance
SID	System Identification
SIP	Session Initiation Protocol
SO	Service Option
SPI	Security Parameter Index
SR_ID	Service Reference Identifier
SSRC	Synchronization Source

SS7	Signaling System 7
STC	Session Termination Capability
TCP	Transmission Control Protocol
TFT	Traffic Flow Template
TIA	Telecommunication Industry Association
TITSU	Time Interval After Tariff Switch Update
TOS	Type Of Service
TSI	Tariff Switch Interval
TSIG	Transaction Signature
TTL	Time To Live
UDP	User Datagram Protocol
UDR	Usage Data Record
UR	Update Reason
VAAA	Visited AAA
VLR	Visitor Location Register
VoIP	Voice over IP
VQ	Volume Quota
VQO	Volume Quota Overflow
VSA	Vendor Specific Attribute
VSE	Vendor Specific Extension
VT	Volume Threshold
VTO	Volume Threshold Overflow
VUATS	Volume Used After Tariff Switch
VUATSO	Volume Used After Tariff Switch Overflow

2.2 *Definitions*

A Resource Record:

In the DNS, the A resource record type [RFC 1035] is a record specific to the Internet class that stores a single IPv4 address.

AAAA Resource Record:

In the DNS, the AAAA resource record type [RFC 1886] is a record specific to the Internet class that stores a single IPv6 address.

A6 Resource Record:

In the DNS, the A6 resource record type [RFC 2874] is a record specific to the Internet class that stores IPv6 address.

Access Provider Network:

A cdma2000 network that provides access to cdma2000 users.

Always On:

The Always On Service maintains the subscriber's packet data session in the local network (i.e., for Always On service, the PDSN does not initiate release of the subscriber's packet data session, unless the PDSN determines the user is no longer reachable).

Auxiliary Service Instance:

Auxiliary service instance refers to an additional service instance that is initiated on a per need basis, e.g., when a service such as VoIP is invoked. The QoS characteristics of an auxiliary service instance are based on the needs of the application using it, e.g., low delay, maximum bit rate, guaranteed bit rate, etc. The auxiliary service instance(s) only exist for the time that they are needed by the

requesting application. Current HRPD specifications [17] do not support auxiliary service instances.

Broker RADIUS Server:

An intermediate RADIUS server that has security relationships with the Visited RADIUS server and the Home RADIUS server and is used to securely transfer RADIUS messages between the Visited Access Provider Network and the Home IP Network. In some situations, there may be more than one broker RADIUS server in the path between the Visited RADIUS server and the Home RADIUS server.

Broker RADIUS Network:

A collection of administrative domains that contain Broker RADIUS servers.

Default Treatment:

The default treatment is the header and payload compressions that are applied to a packet. The particular compression technique for a given packet is chosen from the set of techniques negotiated during IPCP and CCP.

Fast Handoff:

An inter PDSN based low latency handoff between PCFs. Fast handoff between two PDSNs allows a mobile's PPP session to be maintained via a layer two tunnel passing through a Target PDSN to the Serving PDSN. Note: There is also an intra PDSN fast handoff that is described in [4] that is outside the scope of this specification.

Handoff:

In this document the term "handoff" is defined to mean continuity of IP bindings or PPP link layer state during an interface change from one entity to another. In the absence of any continuity of state whatsoever, this document does not refer to such interface changes as "handoffs".

Home RADIUS:

The RADIUS server that resides in the Home IP Network.

HAAA:

The AAA server that resides in the Home IP Network.

Home Access Provider Network:

A cdma2000 wireless network that is the home for the mobile subscriber.

Home Address:

An MS IP address that remains unchanged regardless of the MS's point of attachment to the network.

Home IP Network:

The home network that provides IP based data services to the user. This network is where the user's NAI is homed. This network may be a private network, publicly accessible ISP network, or a cdma2000 wireless network.

Intra PDSN Handoff:

A handoff that is between PCFs with direct connectivity to the same PDSN.

Inter PDSN Handoff:

A handoff that is between PCFs with connectivity to different PDSNs.

Link Local Address:

An IPv6 address whose scope is local to a link.

Main Service Instance:

An MS initiated service instance of SO 33/59 that carries PPP negotiation, Mobile IP signaling and Flow Mapping signaling. This document allows exactly one main service instance per MS. For any PPP session, the main service instance is established first, before any auxiliary service instances are established.

Packet Data Service:

A general term used for any packet switched data service offered by an access provider network to a user through the user's MS.

Packet Data Service Option:

A number specified in [13] that is used to identify a packet switched data service. A packet data service option may be of type 33 [11], 60/61[16] or 59 [17].

Packet Data Session:

Describes continuous use of packet data service by the user. A packet data session begins when the user invokes packet data service. A packet data session ends when the user or the network terminates packet data service. During a particular Mobile IP packet data session, the user may change its point of attachment while maintaining the same home address.

For Simple IP service, changing points of attachments constitutes a change in packet data session because a new IP address is assigned by the new point of attachment. For Simple IP service, a packet data session and a PPP session are concurrent, where as for Mobile IP service, the packet data session can exist through several changes of the PPP session.

Point of Attachment:

Point of attachment refers to the node where the MS is connected to access the IP network. In the context of this specification, it refers to the PDSN entity.

Pi:

Pi is the interface between the PDSN and the public Internet.

P-P Connection:

A connection between a Serving and a Target PDSN that uses a GRE tunnel to transport user data for a single service instance during fast handoff.

P-P Interface:

The interface between the Target PDSN and the Serving PDSN that is used to support fast handoff.

P-P Session:

The set of all P-P connections for a single MS.

PPP Session:

A PPP session describes the time during which the main service instance is maintained between the MS and the Serving PDSN. The PPP session is maintained while the MS is dormant. If a user hands off from one RN to another RN but is still connected to the same PDSN, the PPP session remains.

PrePaid Packet Data Service:

A function that allows a user to pay in advance for the use of packet data service.

PrePaid Server (PPS):

A function that manages prepaid accounts for the users. It maintains the PrePaid accounts on a per user basis or on a per service type basis for a user. It communicates with the PrePaid client for contol of the PrePaid packet Data Service.

PrePaid Client (PPC):

A function that resides in the wireless IP network and communicates with the PrePaid Server function (PPS) to control the prepaid user's packet data session. It requests PrePaid account authorization for a user and monitors the user's packet data session to determine when the limits of the authorization are reached.

PrePaid User:

A user who paid for the packet data service in advance. The user is charged by either the wireless IP Network Provider or a 3rd Party Packet PrePaid Service Provider.

Private Address:

An IP address conforming to RFC 1918.

Private Network:

An IP Network that is isolated from the global Internet. Generally this type of networks may reside behind a firewall, proxy-servers or a NAT (-PT) and may use private IPv4 addresses.

RADIUS:

The specific AAA server implementation used in cdma2000 networks for AAA functionality. The RADIUS servers may be located in the Home IP Network, the Broker RADIUS Network, or the Visited Access Provider Network.

Radio Network:

The RN is equivalent to the BS and the PCF as defined in the Network Reference Model [14]. In this specification, the terms PCF and RN are used interchangeably when describing handoffs across the R-P interface. The RN is equivalent to the Radio Access Network (RAN) specified in [4].

R-P Connection:

A connection between a PCF and a PDSN that uses a GRE tunnel to transport user data for a single packet data service instance. This is equivalent to the A10 connection specified in [4].

R-P Interface:

The interface between the PCF and PDSN that transports user packet data and signaling messages, as specified in [4].

R-P Network:

An IP network as defined in [4] connecting the RNs with the PDSNs.

R-P Session:

The R-P session is a collection of R-P connections for a single MS and is equivalent to a Packet Data Session as specified in [4].

Service Instance:

A connection between an MS and PDSN used to transport user data for a packet data service. Associated with each service instance is a packet data service option, a service reference identifier (SR_ID), and an R-P connection. This document

defines two categories of service instances, a main service instance and an auxiliary service instance.

Serving PDSN:

A PDSN that supports the PPP session to an MS.

Serving R-P Address:

The R-P network interface IP address of the Serving PDSN or that of the Target PDSN when fast handoff is used.

Serving P-P Address:

The P-P network interface IP address of the Serving PDSN.

SR_ID:

A unique number assigned to each connected service option instance.

Target PDSN:

A PDSN that co-operates with a Target RN over the R-P interface, and co-operates with the Serving PDSN over the P-P interface to provide link layer tunneling between the Serving PDSN and the Target RN in the context of a fast handoff.

Target P-P Address:

The P-P network interface IP address of the Target PDSN.

Traffic Flow Template:

The Traffic Flow Templates (TFT) may include packet filter(s) that identify the IP flow(s) as indicated by the MS. The TFTs are used to map forward traffic to the main or the auxiliary service instances and to indicate if a specific flow treatment (e.g. Header Compression technique) should be applied for the forward packet that matches the packet filter.

User Profile:

The User Profile is an abstraction for the collection of all the parameters applied to the user. The User Profile includes the Subscriber QoS profile (which itself includes the Allowed Differentiated Services Marking and Service Option profile).

Visited Access Provider Network:

The visited service provider provides access services through the establishment of a service agreement with a home service provider.

Visited RADIUS:

The RADIUS server that resides in the Visited Access Provider Network.

3 References

3.1 *Normative 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.

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[18] A.S0007-A v2.0, Inter-Operability Specification (IOS) for High Rate Packet Data (HRPD) Access Network Interfaces – Rev. A, May 2003.

~~3.3~~3.1.3 ITU-T

[E.212] ITU-T Recommendation E.212, The International Identification Plan for Mobile Terminals and Mobile Users.

[X.500] ITU-T recommendation X.509, Public-key and Attribute Certificate Frameworks.

3.2 *Informative*

3.2.1 TIA

[1] P.R0001, cdma2000 Wireless IP Architecture Based on IETF Protocols, August 2000.

[2] N.S0017-B v1.0, International Implementation of Wireless Telecommunication Systems Compliant with TIA/EIA-41, December 2002.

[13] C.R1001-C, Administration of Parameter Value Assignments for cdma2000 Spread Spectrum Standards, Jan. 2002.

[14] S.R0005-B, Network Reference Model (NRM) for cdma2000 Spread Spectrum Systems, Nov. 2000.

4 Protocol Reference Models

This section specifies the protocol architecture between the entities of the Wireless IP Network architecture. Refer to [1] for the description of the Wireless IP Network architecture, its components and message flows. To support fast handoff, an optional interface between PDSN entities is defined in this specification. The architecture in [1] for both Mobile IP and Simple IP has been amended to show the new reference point between two adjacent PDSNs.

4.1 *Network Reference Models*

Figure 1 shows a reference model for Simple IP service with fast handoff.

Figure 2 shows a reference model for Mobile IP service with fast handoff. For Internet access when the MS is in the home network or roaming, the HA resides in a home access provider network. For private network or home ISP access, the HA resides in the respective external network.

The IP Network entity in Figure 1 and Figure 2 represents IP Networks that may reside in the public Internet as well as private IP networks between access provider networks and home IP networks.

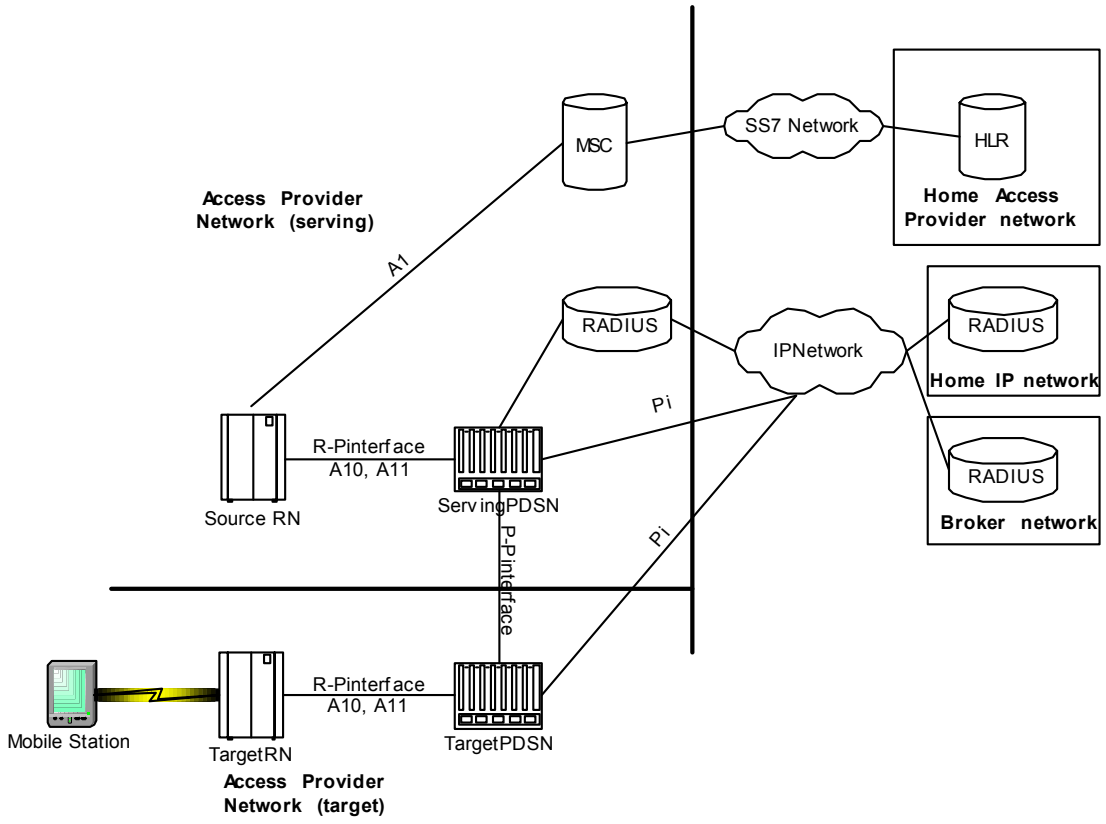

Figure 1 - Reference Model for Simple IP Access with Fast Handoff

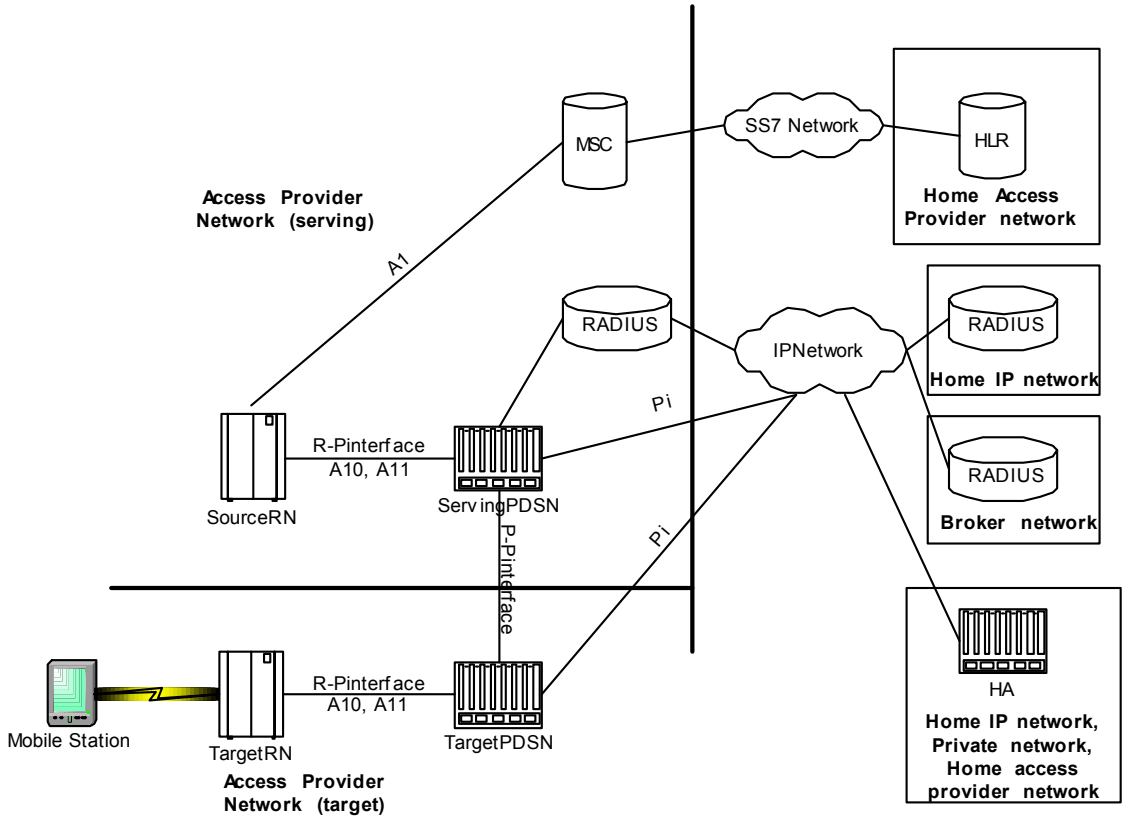

Figure 2 - Reference Model for Mobile IP Access with Fast Handoff

The MS is implemented as a single MT0 type device or as a MT2 and a TE2 pair. See [11] for details.

Although Mobile IP and Simple IP services are represented in different protocol reference models, the network provides both Simple IP and Mobile IP service simultaneously to an MS using the same PPP session for IPv4. For IPv6 MSs, the network provides Simple IP service. The network supports IPv4 and IPv6 MSs simultaneously. The network provides Simple IPv4 and/or Simple IPv6 service for the same MS over the same PPP session. Support of IPv6 MSs in the network is independent of the IP version used for transport in the RN.

4.2 *Simple IP*

Figure 3 shows the protocol reference model for Simple IPv4 or IPv6 service. Figure 4 shows the protocol reference model for Simple IP access during fast handoff.

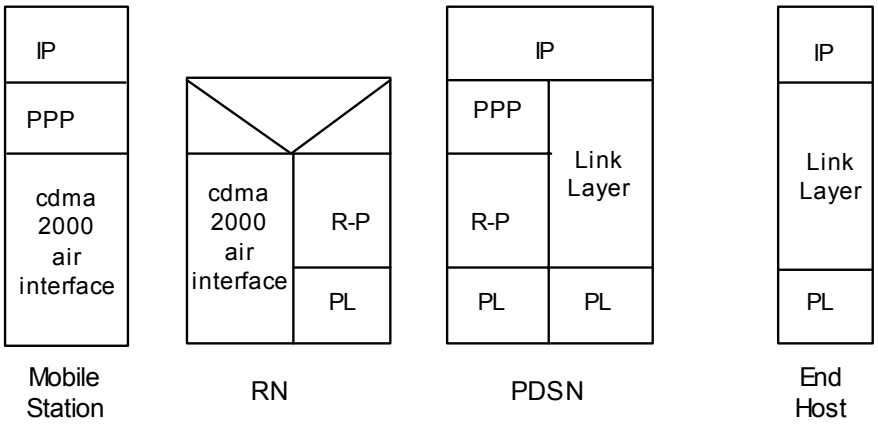

Figure 3 - Protocol Reference Model for Simple IP Access

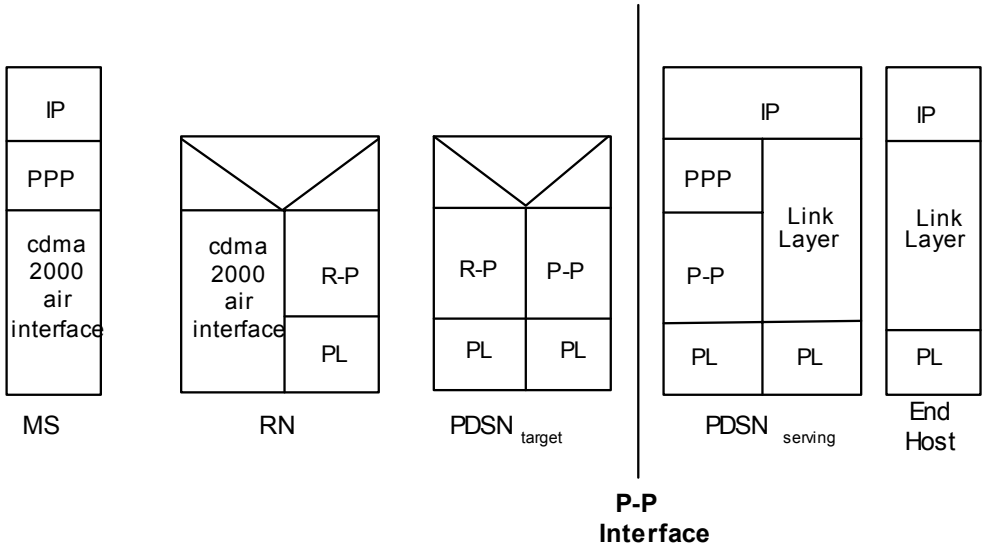

Figure 4 - Protocol Reference Model for Simple IP Access During Fast Handoff

4.3 *Mobile IP*

Figure 5 and Figure 6 show the protocol reference model for Mobile IP control and user data, respectively. IPSec is required in some situations, and not in other situations, as detailed in X.S0011-002-C.

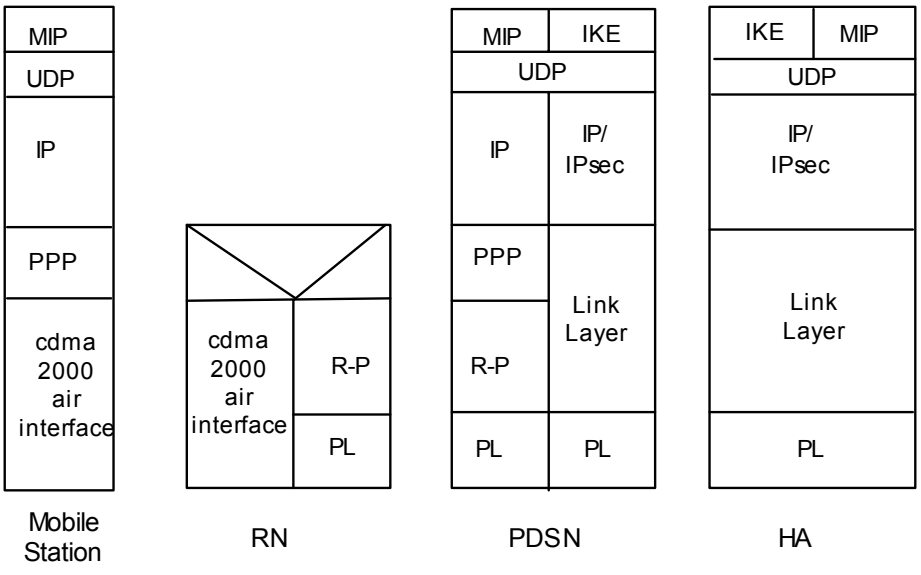

Figure 5 - Protocol Reference Model for Mobile IP Control and IKE

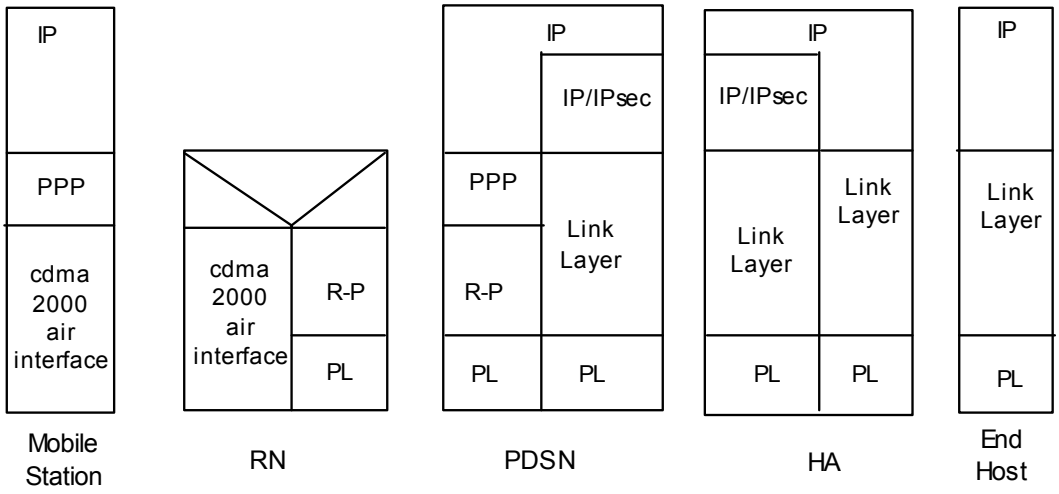

Figure 6 - Protocol Reference Model for Mobile IP User Data

The protocol architecture for Mobile IP control and user data during fast handoff is illustrated in Figure 7 and Figure 8, respectively.

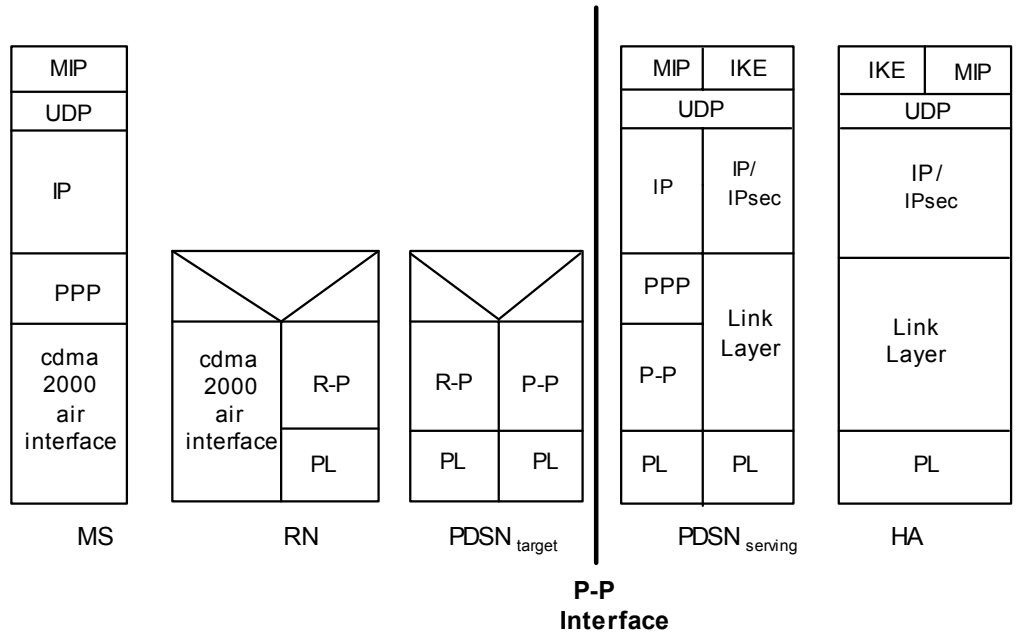

Figure 7 - Protocol Reference Model for MIP Control and IKE During Fast Handoff

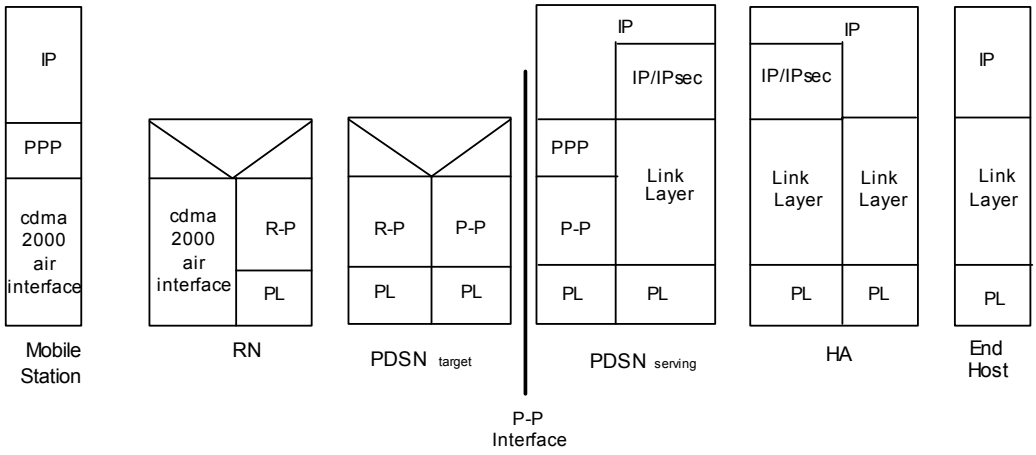

Figure 8 - Protocol Reference Model for MIP User Data During Fast Handoff

The protocol reference models for control and user data during fast handoff are illustrated in Figure 9 and Figure 10, respectively.

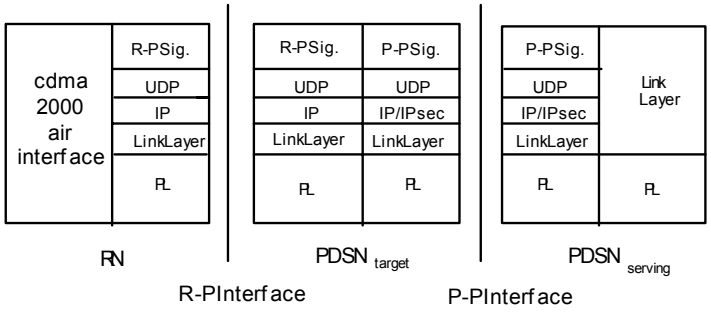

Figure 9 - Protocol Reference Model for Signaling for Fast Handoff

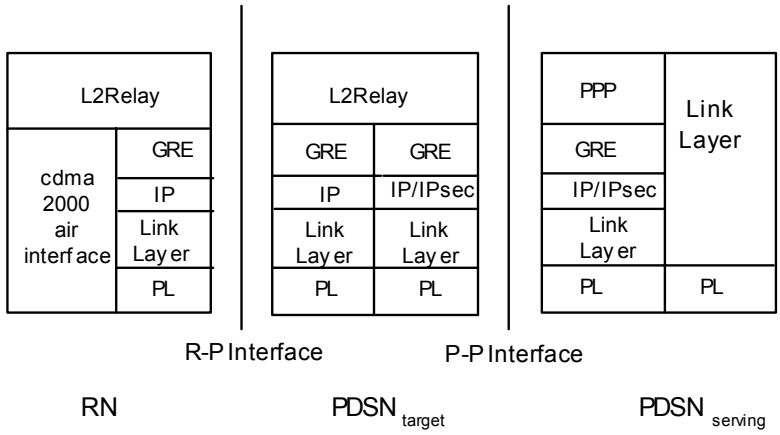

Figure 10 - Protocol Reference Model for User Data for Fast Handoff

4.4 *RADIUS*

Figure 11 shows the protocol reference model for the RADIUS entities in the wireless network (as illustrated in Figure 1 and Figure 2) between the PDSN (RADIUS client) and the Home RADIUS server. In this model, the RADIUS servers in the visited network communicate with the RADIUS servers in the home network via zero or more optional proxy (or Broker) RADIUS servers.

A RADIUS server may run IPv4, IPv6, or both. The method of inter-working between IPv4 and IPv6 RADIUS clients and servers is outside the scope of this specification.

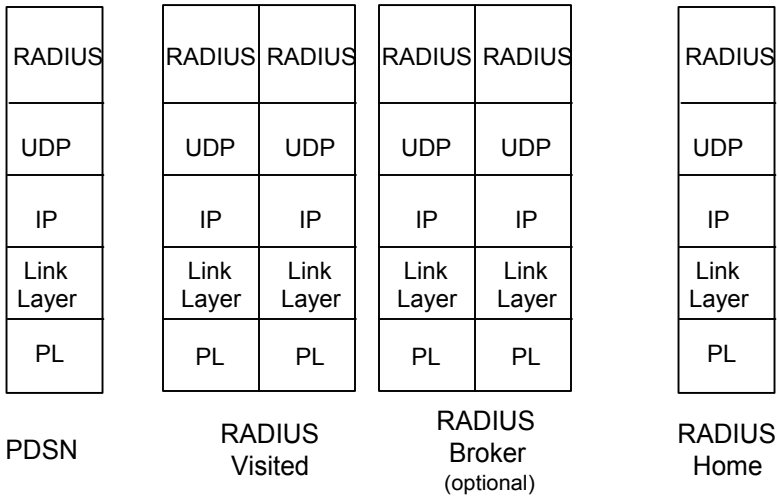

Figure 11 - RADIUS Protocol Reference Model