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## ***cdma2000 Femtocell Network: Overview***

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# Revision History

<b>Revision</b>	<b>Date</b>
1.0	January 2010

## cdma2000 Femtocell Network: Overview

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# FOREWORD

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(This foreword is not part of this Specification.)

This document was prepared by 3GPP2 TSG-X.

This document is a new specification.

This document is part of a multi-part document. The multiple parts together specify the cdma2000®<sup>1</sup> Femtocell Network.

This document is subject to change following formal approval procedures. Should this document be modified in the future, it will be re-released with a change-of-release date and an identifying change in version number as follows:

X.S0059-000-X-n

where:

- X: a numerical or uppercase alphabetic character [A, B, C, ...] that indicates the revision level;
- n: a numeric string [1, 2, 3, ...] that indicates the point release level.

This document uses the following word usage conventions:

- “Shall” and “shall not” identify requirements to be followed strictly to conform to this document and from which no deviation is permitted.
- “Should” and “should not” indicate that one of several possibilities is recommended as particularly suitable, without mentioning or excluding others, that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is discouraged but not prohibited.
- “May” and “need not” indicate a course of action permissible within the limits of the document.
- “Can” and “cannot” are used for statements of possibility and capability, whether material, physical or causal.

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<sup>1</sup> 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.

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# 1 Introduction

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This document provides an overview of the series of documents that specify the HRPD and cdma2000 1x Femtocell network.

## 1.1 Scope

---

This series of documents defines an architecture model and set of specifications for an HRPD and cdma2000 1x Femtocell network that can support existing services provided by HRPD and cdma2000 1x.

This revision of the Femtocell network series of documents includes the following capabilities specified in [X.S0059-100]:

- Femtocell Access Point (FAP) authentication and authorization;
- Quality of Service (QoS) operation on backhaul;
- FAP Auto-configuration;
- Local IP access;
- Remote IP access;
- Packet data call mobility between femtocell and macro system;
- FAP accounting enhancements.

This revision of the Femtocell network series of documents includes the following capabilities specified in [X.S0059-200]:

- FAP registration;
- MS call origination and termination;
- Short Message Service (SMS) procedures;
- Emergency call procedures;
- Idle and active mobility procedures between femtocell and macro system.

## 2 References

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### 2.1 Normative References

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This section provides references to other specifications and standards that are necessary to implement this document.

- [1] 3GPP2: X.S0002-0 v2.0, *MAP Location Services Enhancements*; June 2006.
- [2] 3GPP2: X.S0024-0 v1.0, *IP-Based Location Services*; November 2005.
- [3] 3GPP2: C.S0022-B v1.0, *Position Determination Service for cdma2000 Spread Spectrum Systems*; April 2009.
- [4] Joint ATIS/TIA: J-STD-036-C, *Enhanced Wireless 9-1-1 Phase II*; January 2009.
- [5] 3GPP: TS 23.002 v9.1.0, *Network Architecture (Release 9)*; September 2009.
- [6] 3GPP2: X.S0011-E v1.0, *cdma2000 Wireless IP Network Standard*; November 2009.

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## 3 Definitions and Abbreviations

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This section provides definitions, symbols and abbreviations that are used throughout the document.

### 3.1 Definitions

---

For the purposes of this document, the following definitions apply.

#### **Femtocell Access Point**

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A Femtocell Access Point (FAP) is a wireless access point that provides coverage in a small area, usually a private residence or a small office and connects the MS to an operator's network via a broadband connection (e.g., DSL, cable). The FAP can be operating in cdma2000 1x mode, HRPD mode, or both modes.

#### **Femtocell Access Control**

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This function allows any MS that is part of the Access Control List (ACL) for a FAP to access services through that FAP. The types of femtocell access control include open association, restricted association, and signaling association.

#### **Open Association**

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Any MS can register with the FAP and access the services provided by cdma2000 1x and HRPD.

#### **Restricted Association**

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Only an MS in the ACL for a given FAP is allowed to register and access the services provided by cdma2000 1x and HRPD.

#### **Signaling Association**

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Any MS can register with the FAP, but during a service access, the MS may be redirected to a macro base station if that MS is not included in the FAP ACL (i.e., the MS is not authorized to access service through the FAP).

### 3.2 Abbreviations

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3GPP2	3rd Generation Partnership Project 2
AAA	Authentication, Authorization and Accounting
AC	Authentication Center
ACL	Access Control List
ACS	Auto-Configuration Server
AKA	Authentication and Key Agreement
AN	Access Network
BS	Base Station
BSC	Base Station Controller
CPE	Customer Premises Equipment
CWMP	CPE WAN Mobility Protocol

DSL	Digital Subscriber Line	1
FA	Foreign Agent	2
FAP	Femtocell Access Point	3
FCS	Femtocell Convergence Server	4
FMS	Femtocell Management System	5
HA	Home Agent	6
HLR	Home Location Register	7
HRPD	High Rate Packet Data	8
IKE	Internet Key Exchange	9
IMS	IP Multimedia Subsystem	10
IP	Internet Protocol	11
IPsec	IP Security	12
ISC	IP Multimedia Service Control	13
L1	Layer 1	14
L2	Layer 2	15
L3	Layer 3	16
LAC	Link Access Control	17
LIPA	Local IP Access	18
LMA	Local Mobility Anchor	19
LMSD	Legacy MS Domain	20
MAC	Media Access Control	21
MAG	Mobile Access Gateway	22
MAP	Mobile Application Part	23
MC	Message Center	24
MGCF	Media Gateway Control Function	25
MGW	Media Gateway	26
MIP	Mobile IP	27
MS	Mobile Station	28
MSC	Mobile Switching Center	29
PCF	Packet Control Function	30
PCRF	Policy and Charging Rules Function	31
PMIP	Proxy Mobile IP	32
PDSN	Packet Data Service Node	33
PDST	Packet Data Service Termination	34
PSAP	Public Safety Answering Point	35
QoS	Quality of Service	36
RIPA	Remote IP Access	37
RPC	Remote Procedure Call	38
RTP	Real-Time Transport Protocol	39
SeGW	Security Gateway	40
SIP	Session Initiation Protocol	41
SMS	Short Message Service	42
TCP	Transmission Control Protocol	43
UA	User Agent	44
UDP	User Datagram Protocol	45
VoIP	Voice over IP	46
WAN	Wide Area Network	47
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## 4 List of Parts

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The parts that comprise the initial release of this document are shown in Table 1. Each document in the series is numbered as a Part. Each Part represents an area of focus within the series of documents.

**Table 1 List of Parts**

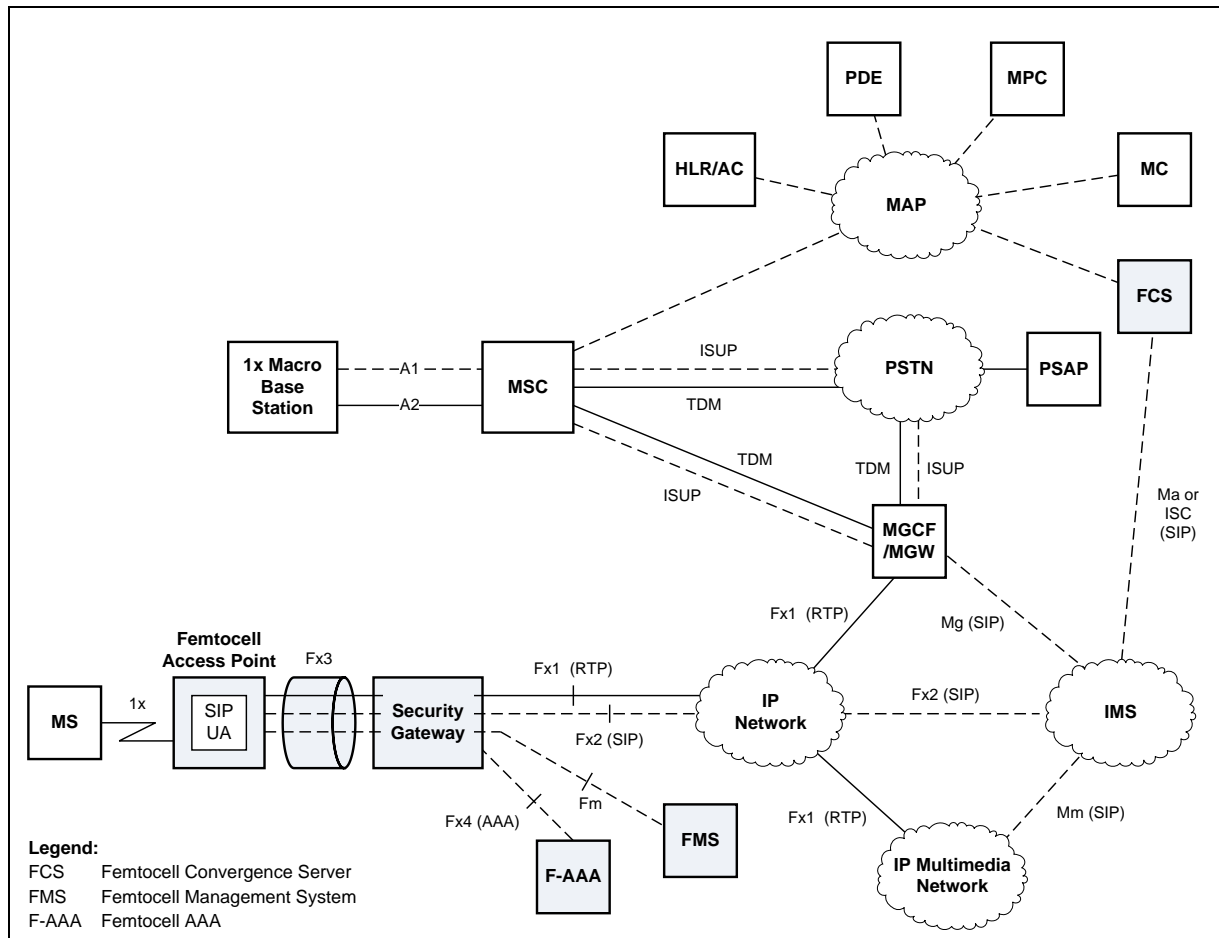
<b>Part</b>	<b>Title</b>
000	cdma2000 Femtocell Network: Overview
100	cdma2000 Femtocell Network: Packet Data Network Aspects
200	cdma2000 Femtocell Network: 1x and IMS Network Aspects

# 5 Architectural Model and Reference Points

## 5.1 Femtocell cdma2000 1x Circuit Service Architecture

### 5.1.1 Femtocell cdma2000 1x Circuit Service Architecture with MSC

The figure below shows the access network reference architecture for cdma2000 1x circuit service access from a Femtocell base station. This figure represents the architecture used with an MSC.



**Figure 1 cdma2000 1x Circuit Service Femtocell Network Architecture with MSC**

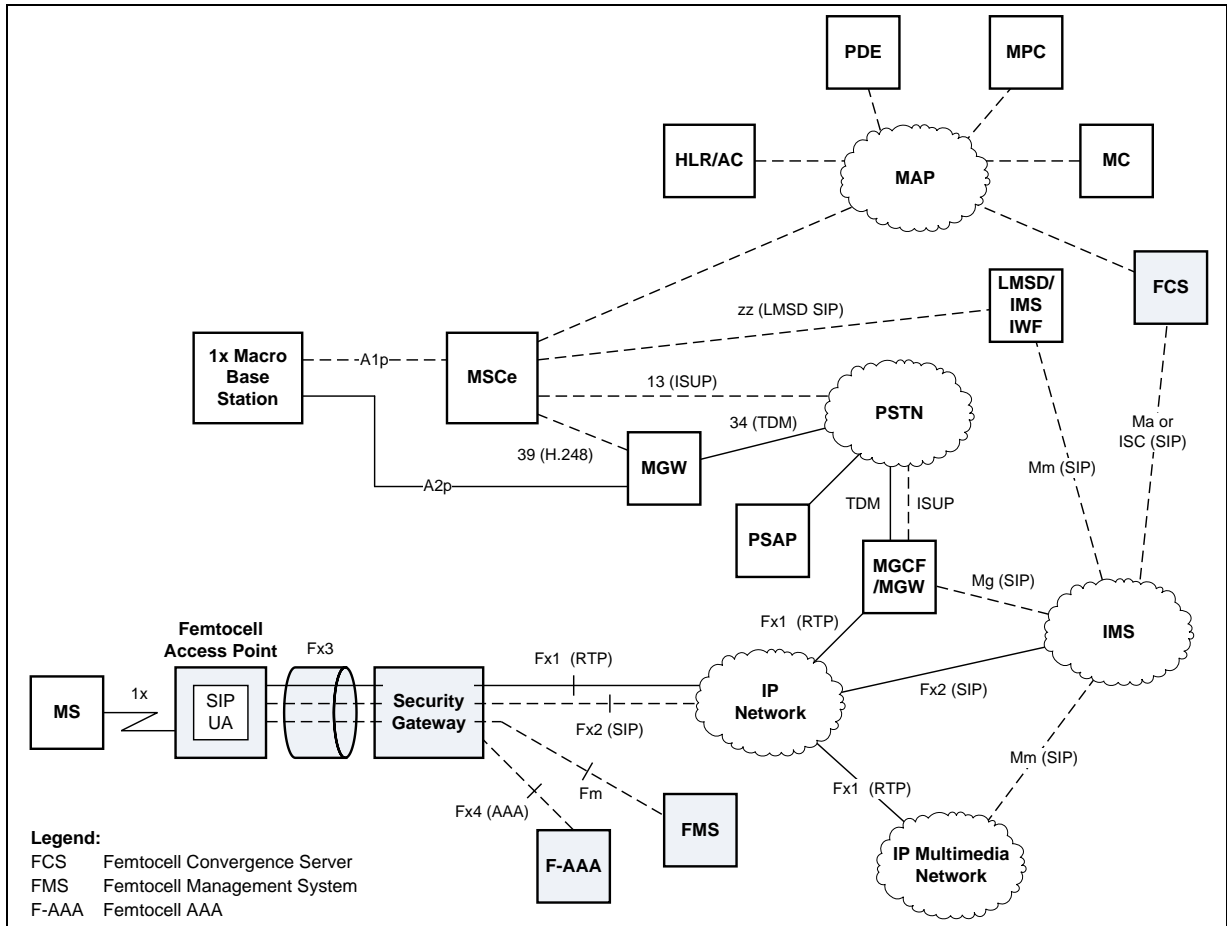
Notes:

1. Location Based Services are supported using X.S0002 [1], X.S0024 [2], and C.S0022 [3]. Emergency services calls are supported using J-STD-036 [4].
2. The Ma, Mg, Mm and ISC reference points are as defined in TS 23.002 [5].

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## 5.1.2 Femtocell cdma2000 1x Circuit Service Architecture with MSCe

The figure below shows the access network reference architecture for cdma2000 1x circuit service access from a Femtocell base station. This figure represents the architecture used with an MSCe in support of LMSD.



**Figure 2** cdma2000 1x Circuit Service Femtocell Network Architecture with MSCe

Notes:

1. The LMSD-IMS Interworking Function (LIWF) provides interworking between the MSCe [X.S0025] and IMS by interworking LMSD SIP and IMS SIP. This function is outside of the scope of this document.
2. The Ma, Mg, Mm and ISC reference points are as defined in TS 23.002 [5].

## 5.1.3 Network Entities

This document defines five new network entities:

- Femtocell Access Point (FAP);
- Security Gateway (SeGW);
- Femtocell AAA;
- Femtocell Management System (FMS); and

- Femtocell Convergence Server (FCS).

### **Femtocell Access Point**

---

The FAP is a cdma2000 1x access point that provides coverage in a small area, usually a private residence or a small office, and connects the MS to an operator's network via a broadband connection (e.g., DSL, cable). This entity provides access to cdma2000 1x voice/SMS users by providing a conversion function between cdma2000 voice/SMS and IMS-based VoIP traffic and signaling. This entity also provides a femtocell access control function.

### **Security Gateway**

---

The Security Gateway (SeGW) provides security functions for FAP access to the cdma2000 core network. It supports: secure tunnel management procedures between itself and the FAP, including establishment and release of the tunnel; allocation of an IP address to the FAP from the serving cdma2000 network; and encapsulation and de-capsulation of packets to and from the FAP. Through the interface to the Femtocell AAA, the SeGW supports Femtocell level authentication and transfer of authorization policy information.

### **Femtocell AAA**

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The Femtocell AAA provides a FAP authorization function. It sends authorization policy information to the SeGW.

### **Femtocell Convergence Server**

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The Femtocell Convergence Server (FCS) is an IMS Application Server that provides interworking among: the FAP that is supporting the cdma2000 1x mobile; the SIP environment of IMS; and the appropriate MAP network elements (e.g., HLR, MC, MPC, cdma2000 1x MSC).

### **Femtocell Management System**

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The Femtocell Management System (FMS) is a network entity that resides in an operator's network and aids in the auto-configuration of the FAP before the MS can access services through the FAP.

## **5.1.4 Reference Points**

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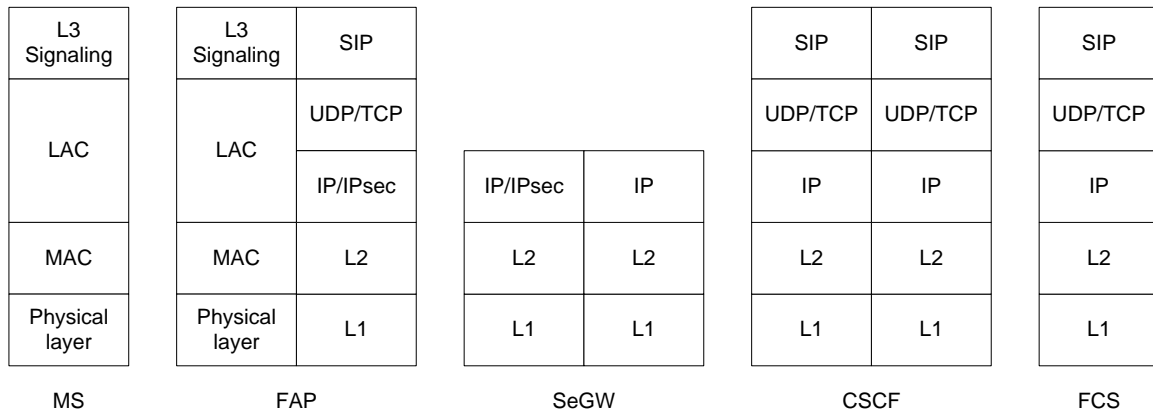
The following reference points are introduced:

- |     |                                                                                                     |
|-----|-----------------------------------------------------------------------------------------------------|
| Fx1 | The RTP bearer interface between the FAP and the Media Gateway (MGW) that carries the RTP payloads. |
| Fx2 | The signaling interface that carries user SIP signaling between the FAP and the IMS core network.   |
| Fx3 | The IPsec tunnel between the FAP and the SeGW.                                                      |
| Fx4 | The signaling interface between the Security Gateway and the Femtocell AAA.                         |
| Fm  | The interface between the FAP and the FMS for auto-configuration.                                   |

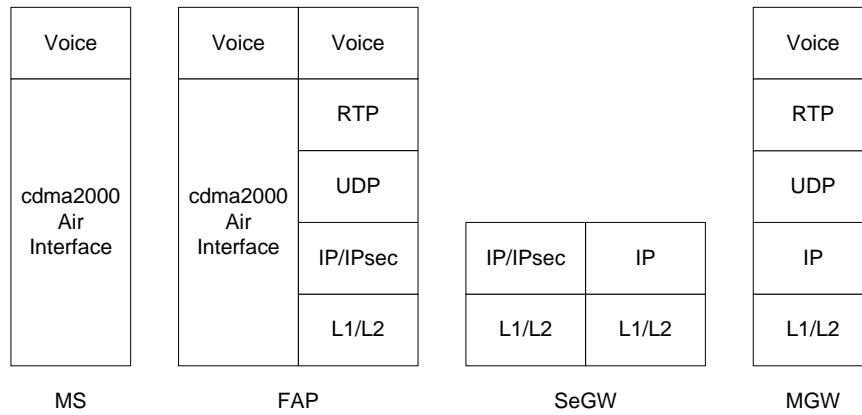
## **5.1.5 cdma2000 1x Circuit Protocol Stack**

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**5.1.5.1 Control Plane between MS and FCS for Voice/SMS**



**5.1.5.2 User Plane between MS and PSTN for Voice**



## 5.2 HRPD/cdma2000 1x Packet Data Femtocell Architecture

The following figures show the HRPD or cdma2000 1x Packet Data Femtocell Phase 1 and Phase 2 network architecture. In these figures, the only new interfaces introduced (see X.S0011 [5]) are: the interface between Femtocell Access Point and Security Gateway; the interface between Femtocell Access Point and Femtocell Management System; and the interface between the Security Gateway and Femtocell AAA.

The HRPD femtocell network architecture also supports Local IP Access (LIPA) which allows an MS to access either local IP networks or the internet through the local interface.

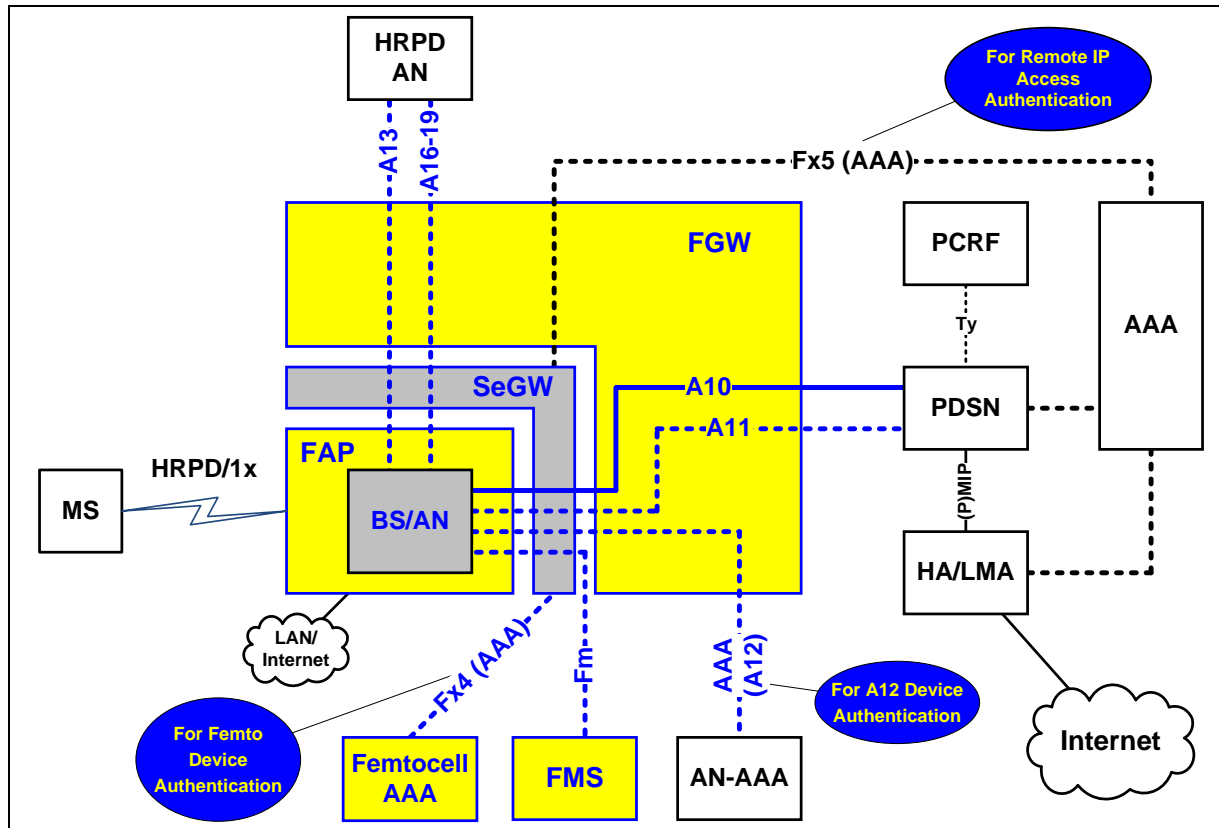


Figure 3 Phase 1 HRPD/cdma2000 1x Packet Femtocell Network Architecture



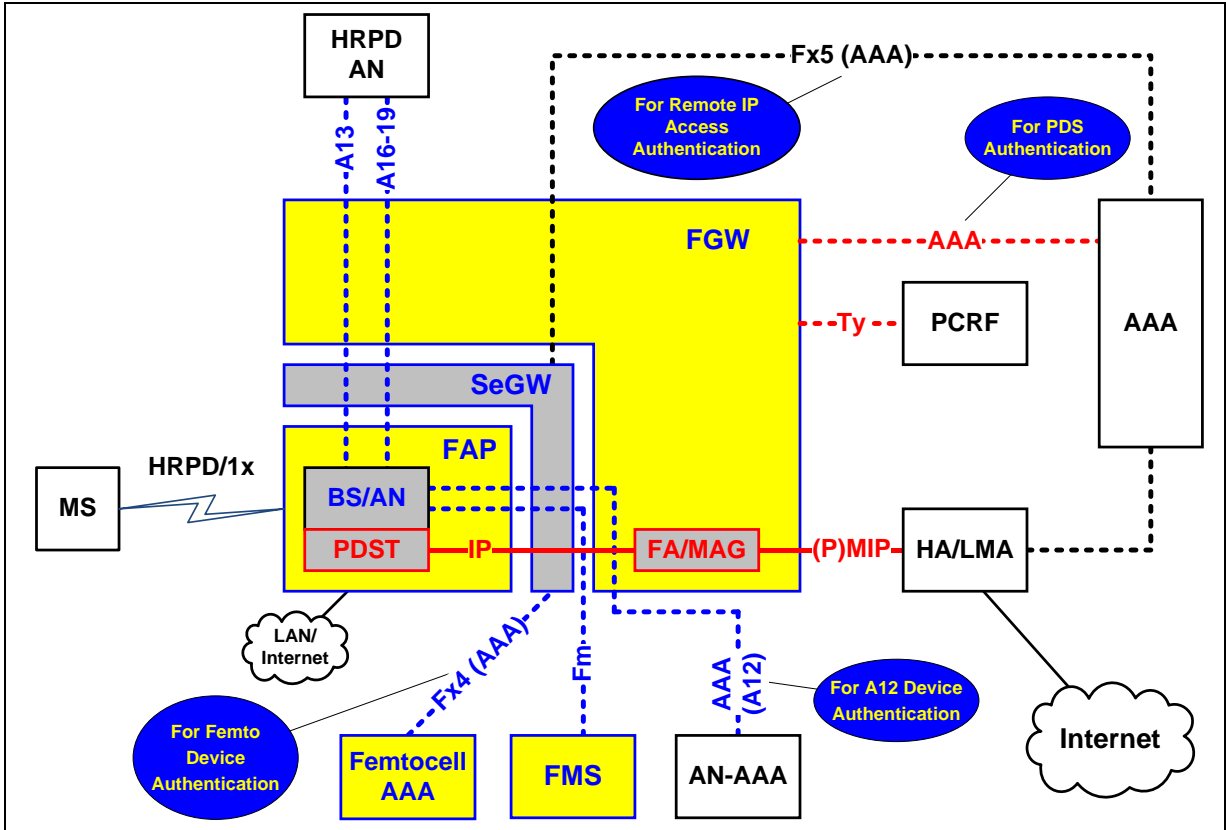


Figure 4 Phase 2 HRPD/cdma2000 1x Packet Femtocell Network Architecture

Notes:

1. All interfaces that pass through the SeGW entity are transported within a secure tunnel between the FAP and the SeGW.

### 5.2.1 Network Entities

A description of new network entities and entities with new functions is provided below.

#### Femtocell Access Point

The FAP is a cdma2000 wireless access point that provides coverage in a small area, usually a private residence or a small office, and connects the MS to an operator’s network via a broadband connection (e.g., DSL, cable). This entity also provides a femtocell access control function.

#### Security Gateway

The Security Gateway (SeGW) is a network entity that resides in an operator's network and provides secure access for the Femtocell Access Point to access services within the system operator’s network.

#### Femtocell Gateway

The Femtocell Gateway (FGW) is a network entity that resides in an operator's network and provides aggregation and proxy functions for the Femtocell Access Point to access services

within the system operator's network. The FGW also provides MAG/FA function in the Phase 2 architecture.

### **Femtocell AAA**

---

The Femtocell AAA provides a FAP authorization function. It sends authorization policy information to the SeGW.

### **Femtocell Management System**

---

The Femtocell Management System (FMS) is a network entity that resides in an operator's network and aids in the auto-configuration of the FAP before the MS can access services through the FAP.

### **AN-AAA**

---

In addition to the function described in [3] and [4], the AN-AAA also provides a femtocell access control function and LIPA authorization function. For LIPA authorization, the AN-AAA may access the Home AAA for authorization information, but this interface is outside the scope of this Specification.

## **5.2.2 Reference Points**

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The following new reference points make use of existing protocols and interfaces that are specified by 3GPP2 TSG-A, TSG-X, and IETF:

- A12 for HRPD access authentication between the AN function in the FAP and the AN-AAA.
- A13 for HRPD idle session handoff between the AN function in the FAP and another HRPD AN (AN). Identical to the HRPD A13 interface between two ANs.
- A16-19 for HRPD active session handoff between the AN function in the FAP and another HRPD AN. Identical to the HRPD A16-19 interface(s) between two ANs.
- A10/A11 interface between the AN/PCF function in the FAP and the PDSN.
- MIP/Proxy MIP between the FA/MAG function in the FGW and the HA/LMA.

The architecture contains the following new reference points:

### **Femtocell Access Point – Security Gateway (Fx3)**

---

The interface provides IPsec tunnel between Femtocell Access Point and Security Gateway.

### **Security Gateway – Femtocell AAA (Fx4)**

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The interface provides authorization to the Femtocell Access Point.

### **Femtocell Access Point – Femtocell Management System (Fm)**

---

The Fm interface enables auto-configuration of the FAP by the FMS.

### **SeGW – AAA (Fx5)**

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The Fx5 interface enables the AAA to authorize the MS for Remote IP Access (RIPA) to the FAP.

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## 5.2.3 Protocol Stack

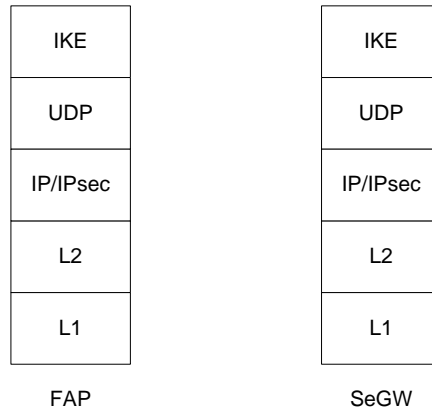
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### 5.2.3.1 Control Plane

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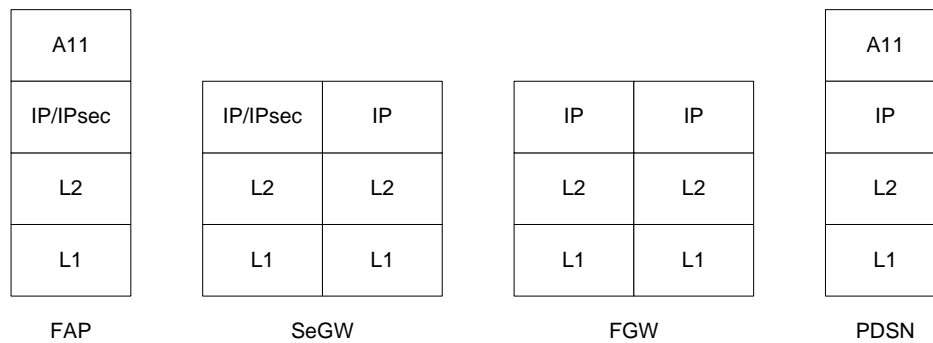
#### 5.2.3.1.1 Control Plane between FAP and SeGW

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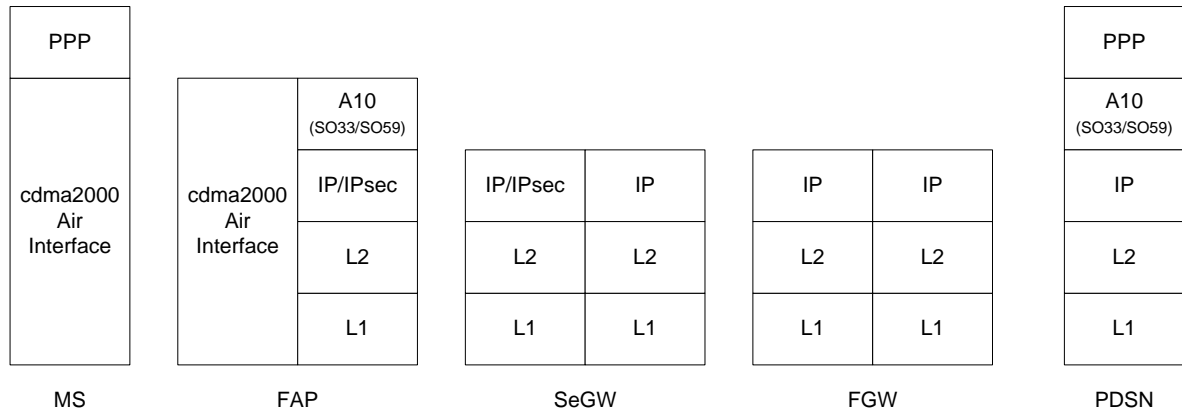


#### 5.2.3.1.2 Control Plane Between FAP, FGW, and PDSN

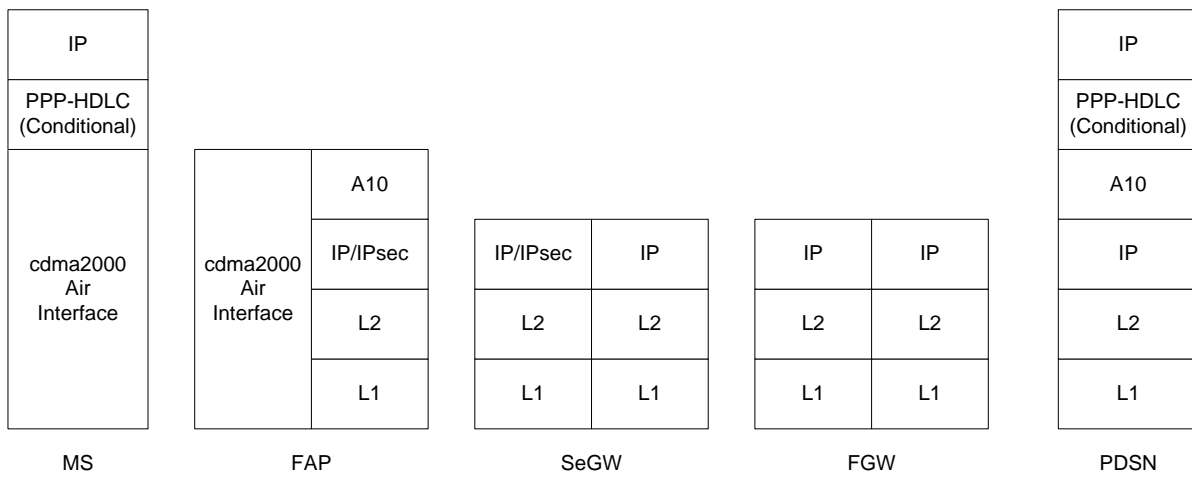
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**5.2.3.1.3 Control Plane Between MS and PDSN**



**5.2.3.2 User Plane**



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