Technical Information

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CDMA2000 1X RAN FUNCTIONAL DESCRIPTION

SOFTWARE RELEASE 2.16.4.X

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APR 2004
68P09260A55–A

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Foreword

Scope of manual

This manual is intended for use by cellular telephone system craftspersons in the day-to-day operation of Motorola cellular system equipment and ancillary devices.

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NOTE

Presents additional, helpful, non-critical information that you can use.

IMPORTANT

Presents information to help you avoid an undesirable situation or provides additional information to help you understand a topic or concept.

CAUTION

Presents information to identify a situation in which damage to software, stored data, or equipment could occur, thus avoiding the damage.

WARNING

Presents information to warn you of a potentially hazardous situation in which there is a possibility of personal injury.

The following typographical conventions are used for the presentation of software information:

- In text, sans serif **BOLDFACE CAPITAL** characters (a type style without angular strokes: for example, SERIF versus SANS SERIF) are used to name a command.
- In text, `typewriter` style characters represent prompts and the system output as displayed on an operator terminal or printer.
- In command definitions, sans serif **boldface** characters represent those parts of the command string that must be entered exactly as shown and `typewriter` style characters represent command output responses as displayed on an operator terminal or printer.
- In the command format of the command definition, `typewriter` style characters represent the command parameters.

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– the manual title, part number, and revision character
– the page number(s) with the error
– a detailed description of the error and if possible the proposed solution
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A banner (oversized text on the bottom of the page, for example, **PRELIMINARY**) indicates that some information contained in the manual is not yet approved for general customer use.

24-hour support service

If you have problems regarding the operation of your equipment, please contact the Customer Network Resolution Center (CNRC) for immediate assistance. The 24 hour telephone numbers are:

North America	+1–800–433–5202
Europe, Middle East, Africa	+44– (0) 1793–565444
Asia Pacific	+86–10–88417733
Japan & Korea	+81–3–5463–3550

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Remember! . . . Safety depends on you!!

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Ground the instrument

To minimize shock hazard, the equipment chassis and enclosure must be connected to an electrical ground. If the equipment is supplied with a three-conductor ac power cable, the power cable must be either plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter. The three-contact to two-contact adapter must have the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable must meet International Electrotechnical Commission (IEC) safety standards.

NOTE

Refer to *Grounding Guideline for Cellular Radio Installations – 68P81150E62.*

Do not operate in an explosive atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

Keep away from live circuits

Operating personnel must:

- not remove equipment covers. Only Factory Authorized Service Personnel or other qualified maintenance personnel may remove equipment covers for internal subassembly, or component replacement, or any internal adjustment.
- not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed.
- always disconnect power and discharge circuits before touching them.

Do not service or adjust alone

Do not attempt internal service or adjustment, unless another person, capable of rendering first aid and resuscitation, is present.

Use caution when exposing or handling the CRT

Breakage of the Cathode–Ray Tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the equipment. The CRT should be handled only by qualified maintenance personnel, using approved safety mask and gloves.

Do not substitute parts or modify equipment

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification of equipment. Contact Motorola Warranty and Repair for service and repair to ensure that safety features are maintained.

Dangerous procedure warnings

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed. You should also employ all other safety precautions that you deem necessary for the operation of the equipment in your operating environment.

WARNING

Dangerous voltages, capable of causing death, are present in this equipment. Use extreme caution when handling, testing, and adjusting.

Revision History

Manual Number

68P09260A55–A

Manual Title

CDMA2000 1X RAN Functional Description
Software Release 2.16.4.x

Version Information

The following table lists the manual version, date of version, and remarks on the version.

Version Level	Date of Issue	Remarks
A	APR 2004	

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Chapter 1: Introduction

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Overview

Introduction

G16.3 will add several additional circuit elements which continue the evolution of the network in a planned manner to give customers maximum value while preserving their investment.

- The Vocoding Processing Unit (VPU) – The VPU will provide packet based voice processing in a greatly reduced platform footprint.

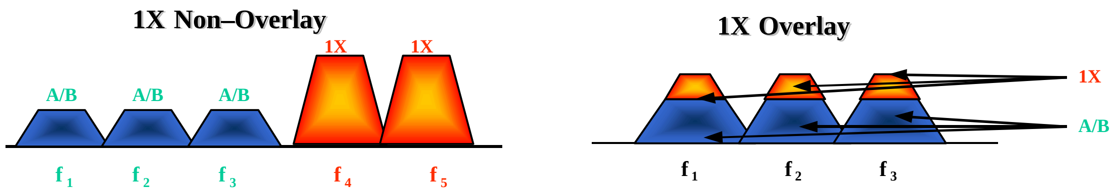
The CDMA 1X Standard

CDMA2000 1X is the first step into third–generation (3G) networks for an IS–95–based network. CDMA2000 1X is a standard that defines the air interface and portions of the core network for delivering 3G services. These standards enable 3G networks to deliver new services for end users and new revenue streams for operators.

The CDMA2000 1X standard delivers higher data rates and improved voice capacity than the existing 2G and 2.5G CDMA technologies. The Motorola implementation of the standard can support data rates up to 144 kpbs and a voice capacity improvement of up to 1.7 times over IS–95A/B. Since CDMA2000 1X is completely backwards compatible with IS–95A/B, it allows a cost– effective migration from IS–95A/B to 1X. Therefore, an operator can upgrade to 1X while maintaining their current infrastructure and handset investments.

The CDMA2000 standard provides a choice of overlay or non–overlay configurations, allowing operators to implement the 1X technology in either their existing spectrum or in a new 3G spectrum. (See Figure 1-1.)

Figure 1-1: Configurations Available with the CDMA2000 Standard



By using the overlay configuration, operators without the new 3G spectrum can use their existing spectrum to implement 1X. The benefit of such a configuration is limited as there are conflicts with the existing IS–95A/B RF links in the spectrum.

On the flip side, operators who buy the new 3G spectrum can assign dedicated 1X carriers to high data rate traffic and can use other IS–95A and IS–95B carriers for the low speed data and voice. Such a configuration is known as the non–overlay configuration. This scheme is particularly suitable for markets where high–speed data traffic is high. By directing all the low speed data and voice traffic to IS–95A and IS–95B carriers, the enhanced 1X air interface can take the full carrier capacity and provide peak data rate radio frequency (RF) links on the 1X carriers under suitable conditions.

System Boundaries

Introduction

This section describes high–level system views, network components, and boundaries.

Defining Network components

This section describes the network from the smallest functional block to the largest to enable the view of the possible variations in the topology.

BSS

The BSS (Base Station Subsystem) consists of the BSS end nodes and the Transport Network devices that connect all those network elements.

The BSS end nodes consist of:

- The BTS, located remotely at the cell–site;
- XC, located at the MTSO;
- SDU, located at the MTSO;
- VPU, located at the MTSO;
- MM, located at the MTSO.

The AN IP Switch and Aggregation Point frames contain the routing and switching equipment used to interconnect all the BSS end nodes, forming the Transport Network.

The scope of a BSS is determined by the end nodes (XCs, BTSs, SDU, etc) that have their call processing controlled by the MM.

> **NOTE**
> Each physical SDU is shared between many BSSs.

BSSAN

The BSSAN consists of a set of *multiple* BSSs that communicate via a co–located portion of the AN Transport Network (connected via LAN).

The Transport Network that supports a BSSAN can consist of multiple pairs of MLSs (contained in the AN IP Switch frames). A BSSAN can also consist of a pair of MLSs supporting multiple BSSs. A BSSAN is also an Autonomous System (AS) running a specific routing protocol (i.e. OSPF). The size of a BSSAN and hence the number of BSSs that can be supported is limited by the size of an Autonomous System (AS), which in turn is limited by routing protocol convergence times and physical interface capacity.

Mobile Telephone Switching Office (MTSO)

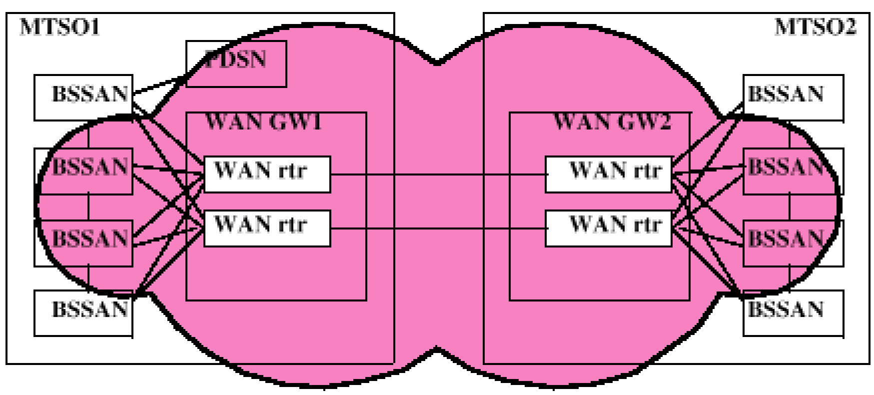
A single MTSO (e.g. an office tower) contains multiple BSSANs (hence multiple ASs) which are themselves inter–connected with LAN connections.

The MTSOs are inter–connected with WAN connections (via the use of a WAN gateway).

To support packet data services from the CDMA IP RAN, an MTSO may contain one or more PDSNs which are connected via LAN to a BSSAN. The traffic from the radio side of the PDSN (R–P) may be contained within the MTSO or may traverse the inter–MTSO WAN links. The traffic from the packet data network (PDN) side of the PDSN (P–I) is not shown here as this is considered to be a separate IP network (i.e. not part of the RAN).

WAN gateways are used to route traffic between MTSOs across WAN links and are themselves unique ASs. In some cases, the WAN GW is also used to route traffic between BSSANs.

Figure 1-2: MTSO Definition



RAN Management Domain (RANMD)

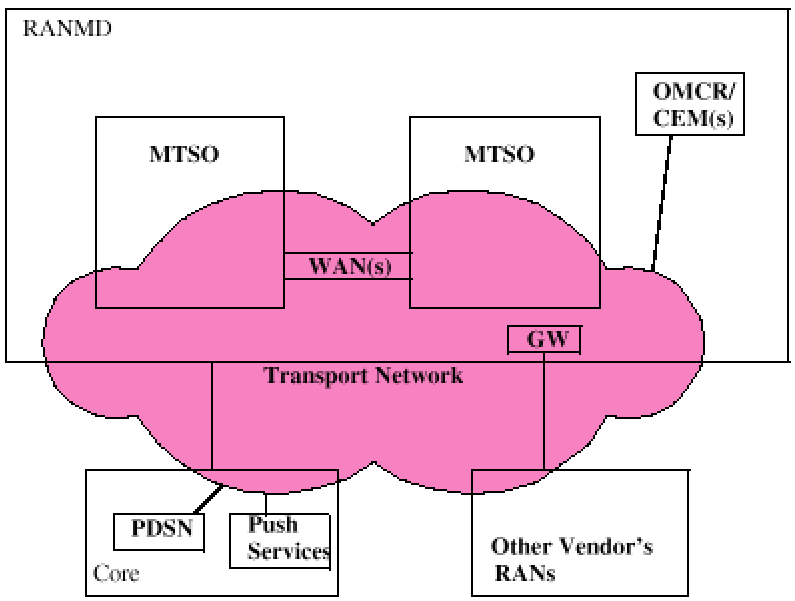
The RAN connects the subscriber devices with the core, providing voice and data services to individual wireless subscriber devices.

For the purposes of management, the RAN is broken down into multiple management domains, each comprised of the components of one or more MTSOs: the O&M controller devices such as the OMCR and CEM, the gateway devices used for communication with other operators networks or vendors equipment, and the Transport Network devices that connect all of these end nodes.

Assuming the CEM has the same or larger scope, the size of the RANMD is defined by the number of end–nodes that can be managed by a single OMCR.

Figure 1-3 shows a RANMD that consists of two MTSOs. The MTSOs are connected together in the Transport Network via a set of WAN interfaces. The OMCR and CEMs manage all the elements that make up the BSSs and Transport Network. The RANMD is connected via the Transport Network to the Core, which provides PDSN and Push services. The Motorola/Cisco RAN is also connected to another vendor's or operators RAN via a Gateway device.

Figure 1-3: RANMD Definition

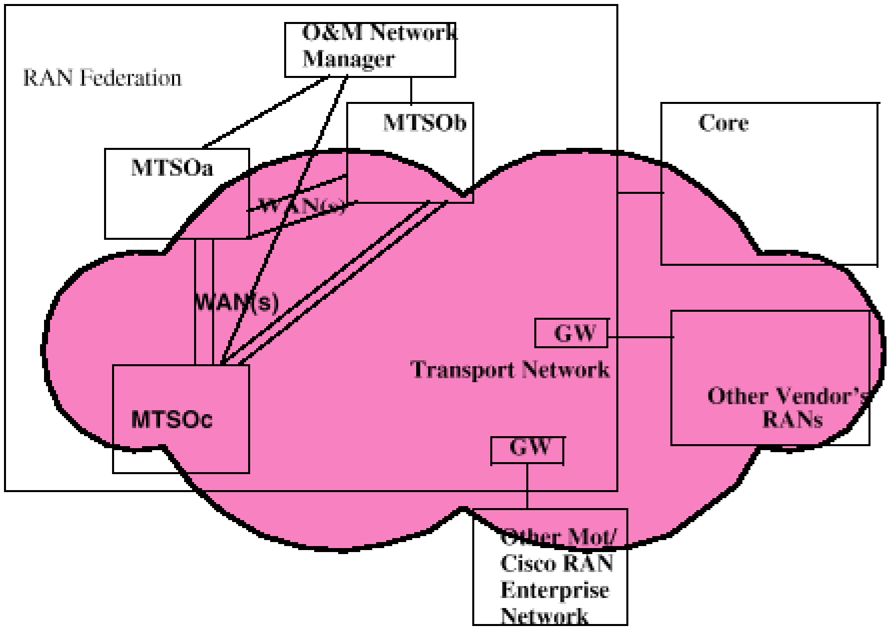


RAN Federation

The RAN Federation is the area within which traffic can be routed without having to travel through a Gateway device. From the Transport Network perspective, inside a RAN Federation, a single IP address space is utilized, allow for all devices to communicate without requiring an address space conversion (e.g. NAT), security or inter–working functions. In addition to the IP address space scope, the RAN Federation's size may be limited by QoS and delay considerations (e.g., # of inter–MTSO links traversed).

The RAN Federation MAY also contain another level of O&M hierarchy, used for Network Management of the entire RAN Federation. As mentioned earlier, the Transport Network that makes up the RAN Federation might be comprised of devices other than BSSAN IP switches, BTS routers and Aggregation Points. Also, for purposes of delay budgets, it is quite possible that the complete Transport Network would not comprise a mesh but would instead be a hierarchical design, using a WAN router for fast routing between the various MTSOs.

Figure 1-4: RAN Federation Definition



Boundaries

There are essentially two areas of consideration in determining a boundary for the system: Distance and Functionality.

Distance

Any time a network exceeds the transmission distance limits of the defined interfaces on the Motorola AN (Cat 5e data (10/100/1000BaseT) and T1/E1) or when the RAN boundaries are crossed, work with Motorola System Engineering to determine what services might be required to make your network operate.

Function

The BSSAN is essentially the borderline for function. Anything leaving the *Catalyst* ™ or SDU is viewed as "the outside". These "borders" can include but are not limited to:

- PDN
- Internet, Intranet, extranet
- WAN to another RAN or MTSO (transport)

The PDN consists of the PDSN, AAA, and optionally the HA. The RAN Packet Control Function (PCF), residing in the XC (16.0) or SDU (16.1), interfaces to the PDN through the PDSN. The AAA may also need a Mediation Device to interface the data billing with a legacy voice billing systems.

Interface to the Internet or other network will work if you do not violate the laws of TCP/IP. Most of the concerns here are those of application compatibility. Some operators may prefer to build a private network for mobile applications that they sponsor and leave any Internet applications to whatever level of operation is available, as the actual performance is beyond their control. Other customers with different business mixes may choose to hang their application on the Internet.

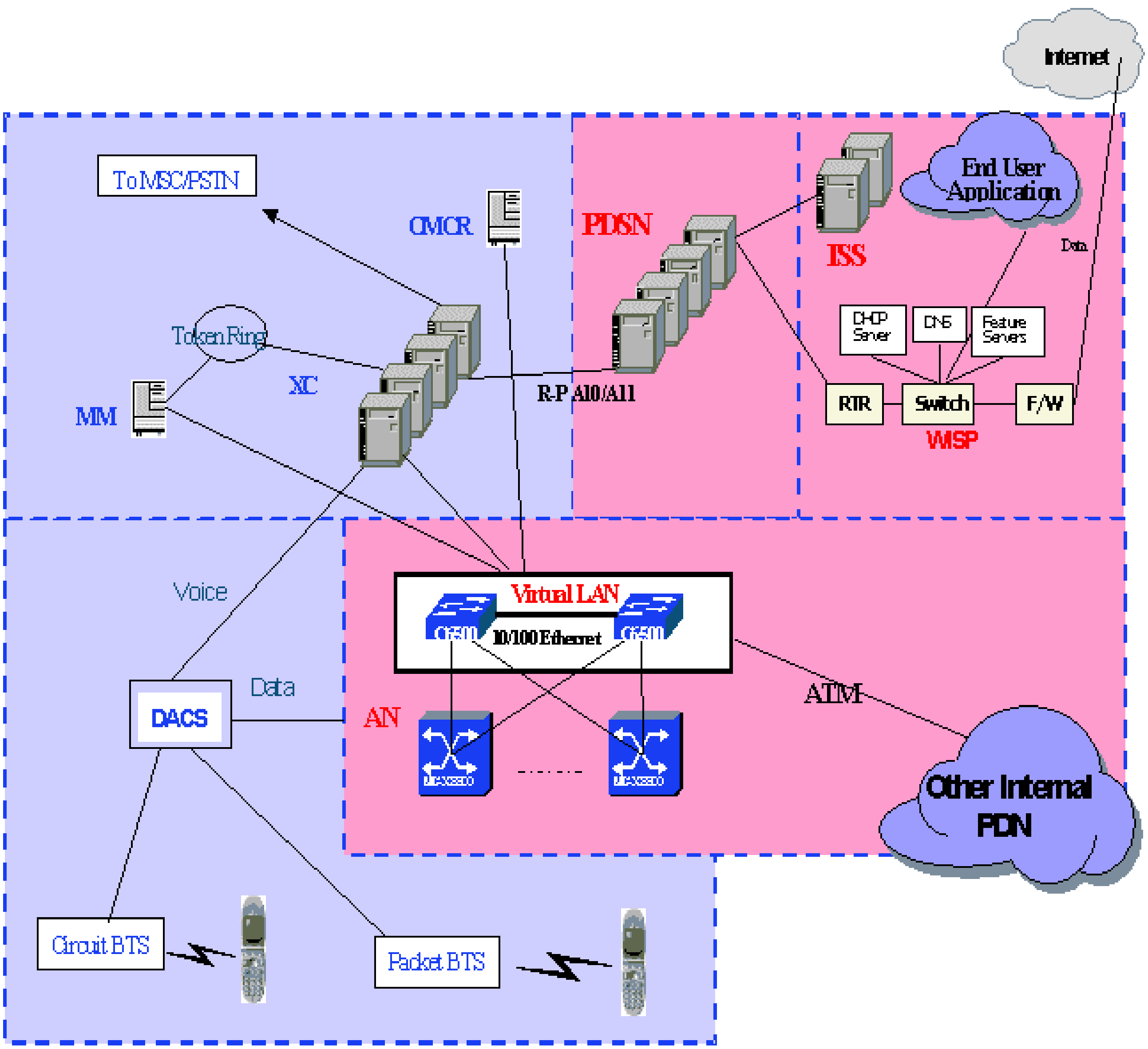
For the interface to the WAN for the RAN or the MTSO, the WAN can be operator owned or a leased service. The same engineering considerations apply (see the “Distance” topic) and the testing should be that which is required by the transported protocol and any transmission quality tests required.

Overview of CDMA 1X IP Solution

3G 1XRTT Design

The high–level logical diagram below illustrates the Access Node (AN), a Packet Data Serving Node (PDSN), IP Core ATM Transit, WISP and a AAA architecture and interfaces with Motorola's 16.0 1st generation CDMA 1X RAN. This end–to–end Packet Data Network (PDN) solution enables 3G 1XRTT high–speed packet data for both 800MHz and 1.9GHz scenarios.

Figure 1-5: Logical Diagram of a 1X RTT Design



IP Core – The *IP Core* consists of:

- Packet Data Serving Node (PDSN)
- Access Node (AN)
- Other switches and routers
- F/W
- Internet

The AN/PDSN connects the Motorola CDMA 2000 1X Network elements (the RAN) into the IP Core network.

The AN provides IP network connectivity, and the PDSN provides Simple IP, Mobile IP, and Proxy Mobile IP services.

Transit IP Core – The *Transit IP Core* consists of the Aggregation Point (*MGX* ™) portion of the AN, providing interfaces for the BTSs.

WISP Architecture –The Wireless Internet Service Provider (WISP) architecture contains devices such as:

- Switches
- FWs
- WEB Servers
- Email servers
- DNS
- NMS
- Accounting servers

The WISP solution is an IP network system that manages the access to the Internet, intranets and *Wireless Application Protocol* (*WAP*) servers for mobile stations interfacing with the existing Motorola CDMA 2000 1X Network elements.

The WISP provides IP based services such as application hosting, basic internet services, email, security and billing to offer wireless Customers additional applications and enhanced functionality at increased access speeds.

Acronyms

Table 1-1 lists the acronyms used in this manual.

Table 1-1: Acronyms and Terms

Acronym/Term	Description
AAA	AAA (Authentication, Authorization, and Accounting) Server
ACL	Access Control List
Aggregation Point	Refer to the “AN” item.
AMR	Alarm Monitoring and Reporting
AN	Access Node (AN). The AN consists of: • IP Switch frame containing the *Catalyst* Multi–layer switches (MLSs) • Aggregation Point frame containing the *MGX* with the Edge Routing function The AN forms the Transport Network.
ARP	Address Resolution Protocol
AS	OSPF protocol Autonomous System
BBX	Broadband Transceiver
BGP	Border Gateway Protocol
BHCA	Busy Hour Call Attempts
BHSA	Busy Hour Session Attempts
BMD	Billing Mediation Device
BSS	Base Station Subsystem
BSSAN	Base Station Subsystem Access Node
BTS	Base Transceiver Station
Catalyst	Refer to the “AN” item.
CBSC	Centralized Base Station Controller
CCD	CDMA Clock Distribution
CDB	Central Database
CDL	Call Detail Log
CDP	CDMA Data Process
CDR	Call Detail Record

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Acronym/Term	Description
CE	Channel Element
CEM	Cisco Element Manager
CFC	Call Final Class
CHAN	Channel
CHAP	Challenge Handshake Authentication Protocol
CIO	Combiner Input/Output
CLI	Command Line Interface
CMIP	Common Management Information Protocol
DACS	Digital Access and Cross Connect
DAHO	Data Assisted Handoff
DXCDR	Data XCDR
Edge Router	Refer to the “AN” item.
EM	Element Manager
EMS	Element Manager System
EPG	Equipment Planning Guide
FA	Foreign Agent
FCAPS	Network Management protocol
FER	Frame Error Rate
FRU	Field Replacement Unit
FTP	File Transfer Protocol
GoS	Grade of Service
GRE	Generic Resource Encapsulation Protocol
GPS	Global Positioning System
HA	Home Agent
HARP	High Availability RADIUS Proxy
HLR	Home Location Register
HSD	High Speed Data
HSO	High Stability Oscillator
HSPD	IS–95B High Speed Packet Data

Table 1-1: Acronyms and Terms

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Table 1-1: Acronyms and Terms	
Acronym/Term	**Description**
HSRP	Hot Standby Routing Protocol
ICBS	Inter–CBSC
ICLINK	Internet Control Links
ICMP	Internet Control Message Protocol
IC SPAN	Inter–CBSC Span
ICSR	Inter–CBSC Soft–handoff Reserve
ICTRKGRP	Inter–CBSC Soft Handoff Trunk Group
IGMP	Interior Gateway Protocol
IOS	Interoperability Standard
IP	Internet Protocol
IPM	Inter–network Performance Management
IP Switch	Refer to the “AN” item.
ITU	International Telecommunications Union
IWU	Inter–working Unit
LAN	Local Area Network
LAPD	Link Access Protocol
MAC	Media Access Control
MAHO	Mobile Assisted Hand Off
MCAP	Motorola Cellular Advance Processor Bus
MGX	Refer to the “AN” item.
MIB	Management Information Base
MLS	Refer to the “AN” item. An MLS can be local or remote.
MM	Mobility Manager
MS	Mobile Station
MSC	Mobile Switching Center
MSID	Mobile Station Identifier
MTSO	Mobile Telephone Switching Office
NAI	Network Address Identifier

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Table 1-1: Acronyms and Terms

Acronym/Term	Description
NIB	Network Interface Box
O&M	Operations and Maintenance
OHCG	Overhead Channel Group
OMC	Operations Maintenance Center
OMC–CLI	Operations Maintenance Center Command Line Interface
OMC–IP	Operations Maintenance Center Internet Protocol
OMC–R	Operations Maintenance Center – Radio
OMP	Operations and Maintenance Processor
OSPF	Open Shortest Path First protocol
OSS	Operations Support Systems
PAP	Password Authentication Protocol
PCF	Packet Control Function. PCF resides on either XC PSI cards or the SDU.
PCM	Pulse Code Modulation
PDN	Packet Data Network (PDSN, HA, AAA)
PDSN	Packet Data Serving Node
PIM	Protocol Independent Multicast routing protocol
PM	Performance Management
PPP	Point–to–Point Protocol
PSI	Packet Sub–rate Interface
PSI–CE	XC PSI card performing the circuit–to–packet conversion function.
PSI–PCF	XC PSI card performing the packet control function.
PSI–SEL	XC PSI card performing the selection and distribution function.
PZID	Packet Zone ID
QoS	Quality of Service
RADIUS	Remote Authentication User Dial–In Service
RAN	Radio Access Network

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Table 1-1: Acronyms and Terms	
Acronym/Term	**Description**
RAS	Reduced Active Set
RC	Radio Configuration
RDBMS	Relational Database Management Systems
RF	Radio Frequency
RLP	Radio Link Protocol
RMON	Remote Monitoring
RNOC	Remote Network Operations Center
RPM	*MGX* Route Processor Modules which perform the edge routing function. Refer to the "AN" item.
SDF	Selector / Distributor function The SDF resides in the SDU on the BPP card and replaces the 16.0 PSI–SEL function.
SDU	Selector Distribution Unit
SHO	Soft Hand Off
SNMP	Simple Network Management Protocol
TCH	Traffic Channels
TDM	Time Division Multiplexing
TN	Transport Network. Refer to "AN".
TSM	BTS Time Slice Manager
UDP	User Datagram Protocol
UIS	User Interface Server
UNIR	Unified Network Information Record
UNO	Universal Network Operations
USART	Universal Synchronous / Asynchronous Receiver–Transmitter
VLAN	Virtual Local Area Network
VLR	Visitor Location Register
VPDN	Virtual Private Dial Network
VPU	Vocoding Processing Unit
WAN	Wide Area Network

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Table 1-1: Acronyms and Terms	
Acronym/Term	**Description**
WAP	Wireless Access Protocol
XC	Transcoder
XCDR	Transcoder Card
XDR	XACCT Detail Record
XIS	Xacct Interface Server

Notes

Chapter 2: System Architecture

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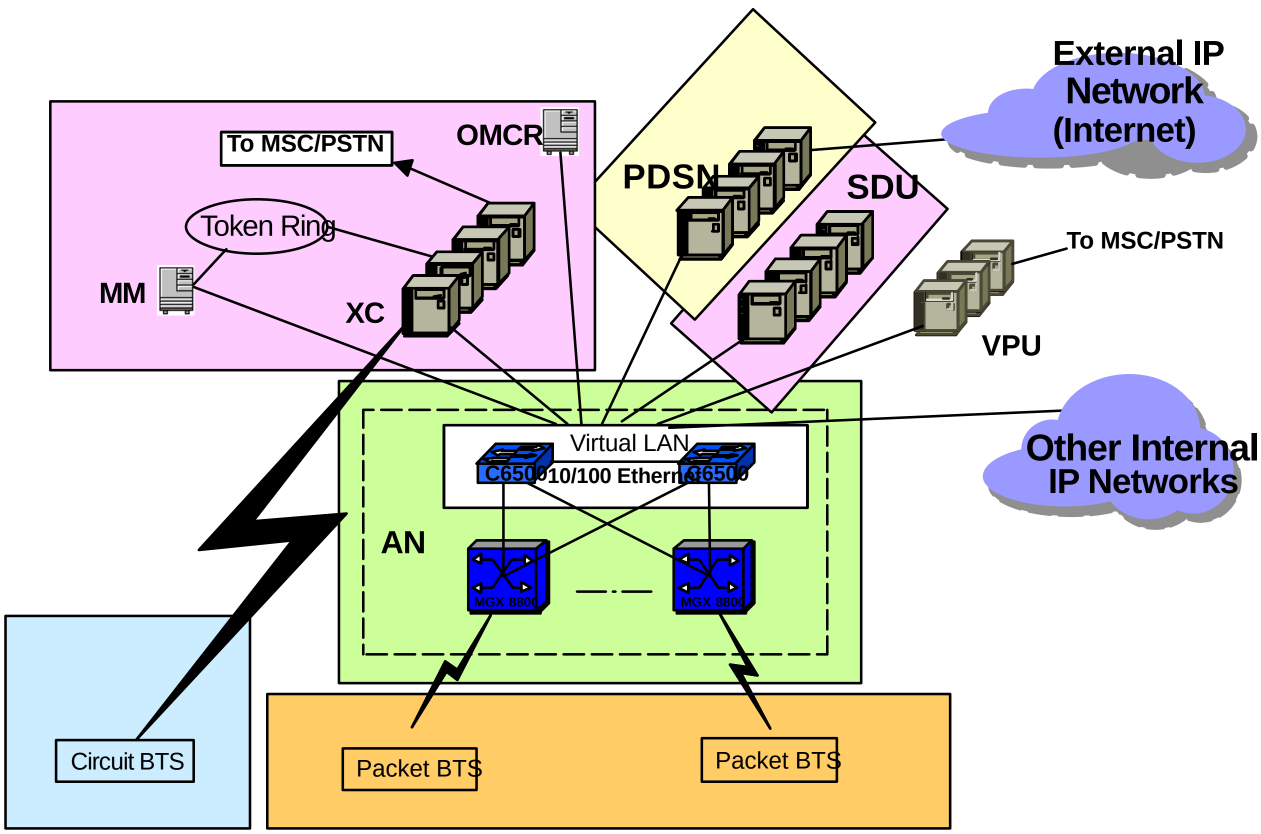
System Architecture 16.4

Figure 2-1 illustrates the major elements of the 16.4 system architecture.

Figure 2-1: 16.4 Motorola Radio–Packet Access Network Architecture



2

System Configuration Variations

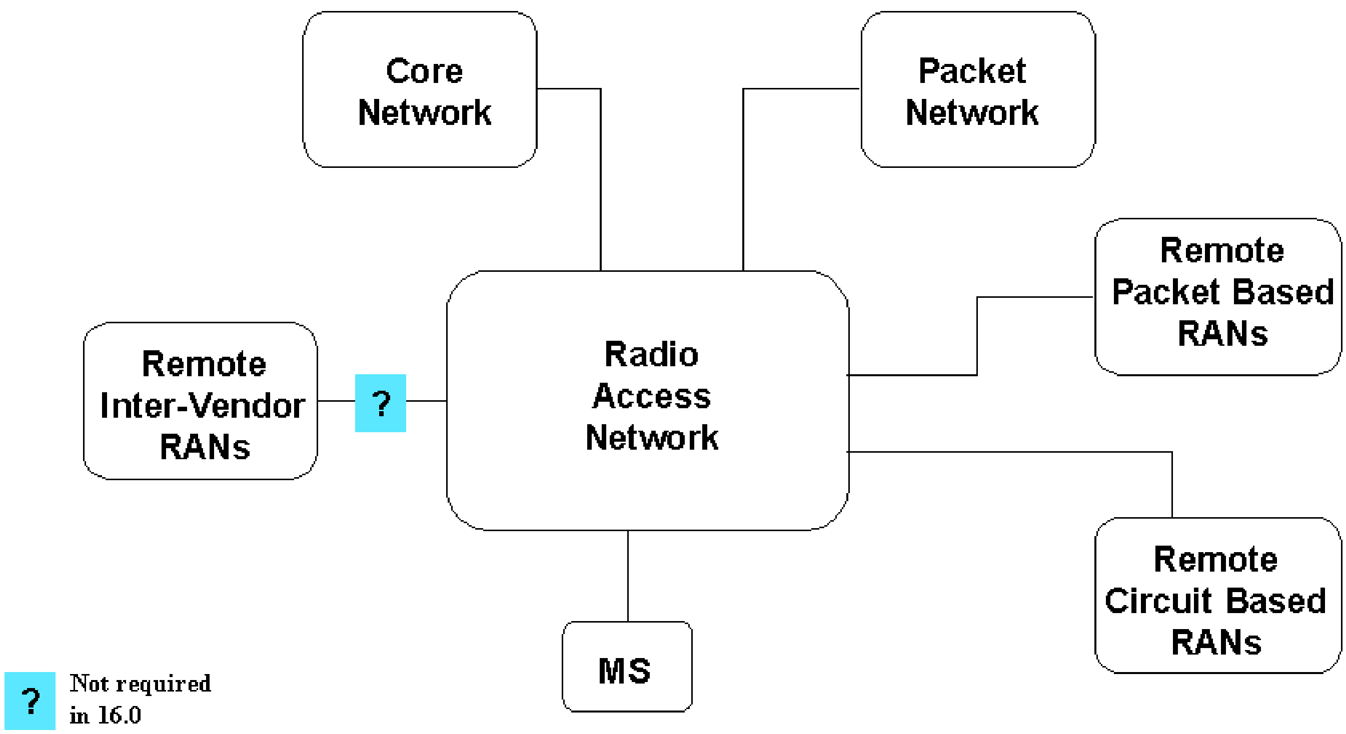
16.1 will allow a number of system configurations to meet various operator requirements. The following configurations are illustrated and briefly described in this section:

- The reference or base architecture
- Interfaces
- IS 95 A/B voice/data and IX voice/data (Packet backhaul)
- IX with voice only (no data)
- 1X data only

Reference Architecture

Figure 2-2 illustrates the CDMA2000 1X Reference architecture.

Figure 2-2: CDMA2000 1X Reference Architecture



Radio Access Network (RAN)

The Radio Access Network (RAN) provides the basic transmission, local control, and management functions associated with processing Subscriber Device services. This involves the management and control of establishing the Subscriber on the Radio Channel, as well as establishing procedures with the Core and Packet Data Network for network level processing (e.g., Call Delivery). The RAN also includes the OMC–R.

Core Network (Core NW)

The Core Network element provides the functional responsibility for establishing connections into the PSTN for Circuit Oriented Services. The Core NW, more specifically the MSC, manages Subscriber information (Static and Dynamic). The Core NW is also responsible for the generation of billing records. The Core NW provides authentication and MS location services via interactions with HLR and VLR core components.

Packet Network (Packet Data Network)

The Packet Network element provides the functional responsibility for establishing sessions into the PSTN (e.g., VOIP) or IP Networks for Packet Data Oriented Services. The Packet Data Network provides basic non–real time data services with the proposed evolution to real–time based applications, such as VOIP. The Packet Data Network currently relies on the Core NW for subscriber authentication and location. Authentication of packet data sessions is performed by the Packet Data Network (AAA server). From a RAN perspective, the Packet NW is viewed as either Packet IWU based or PDSN based.

Mobile Subscriber (MS)

The Mobile Subscriber (MS) element defines the end point for services. The MS is responsible for the initiation services. It also processes service requests from the network to establish services initiated by other end devices. The MS operates a set of procedures to enable the management and control of services with the system, such as Registration.

Circuit Based RANs

The Circuit Based RAN refers to a remote Motorola Circuit Based Radio Access Network which supports connections to the RAN for soft handoff support. This Circuit Based RAN refers to the selected interconnect used between the two CBSCs for Soft Handoff support. For the Remote CBSC to be a Packet CBSC, the operator must choose a Circuit Based Interconnect for soft handoff.

Packet Backhaul Based RANs

The Packet Based RAN refers to a remote Motorola Packet Based Radio Access Network, which supports connects to the RAN for soft handoff support.

Inter–Vendor RANs

The Inter–Vendor RAN refers to a remote non–Motorola Radio Access Network which supports connects to the RAN for soft handoff support.

Interfaces

The following provides an overview of the interfaces to the Motorola RAN.

RAN to Core/MSC:

–A1

–A2

–A5

–A1 over TCP/IP

RAN to PDN:

–L–interface to Packet IWU (viewed only for system configurations containing installed Packet IWUs)

–L–Interface to Circuit IWU

–A10, A11 (R–P) to PDSN

RAN to Mobile Station (MS):

–IS–95 A/B (including HSPD)

–IS–2000

RAN to “circuit based” RAN:

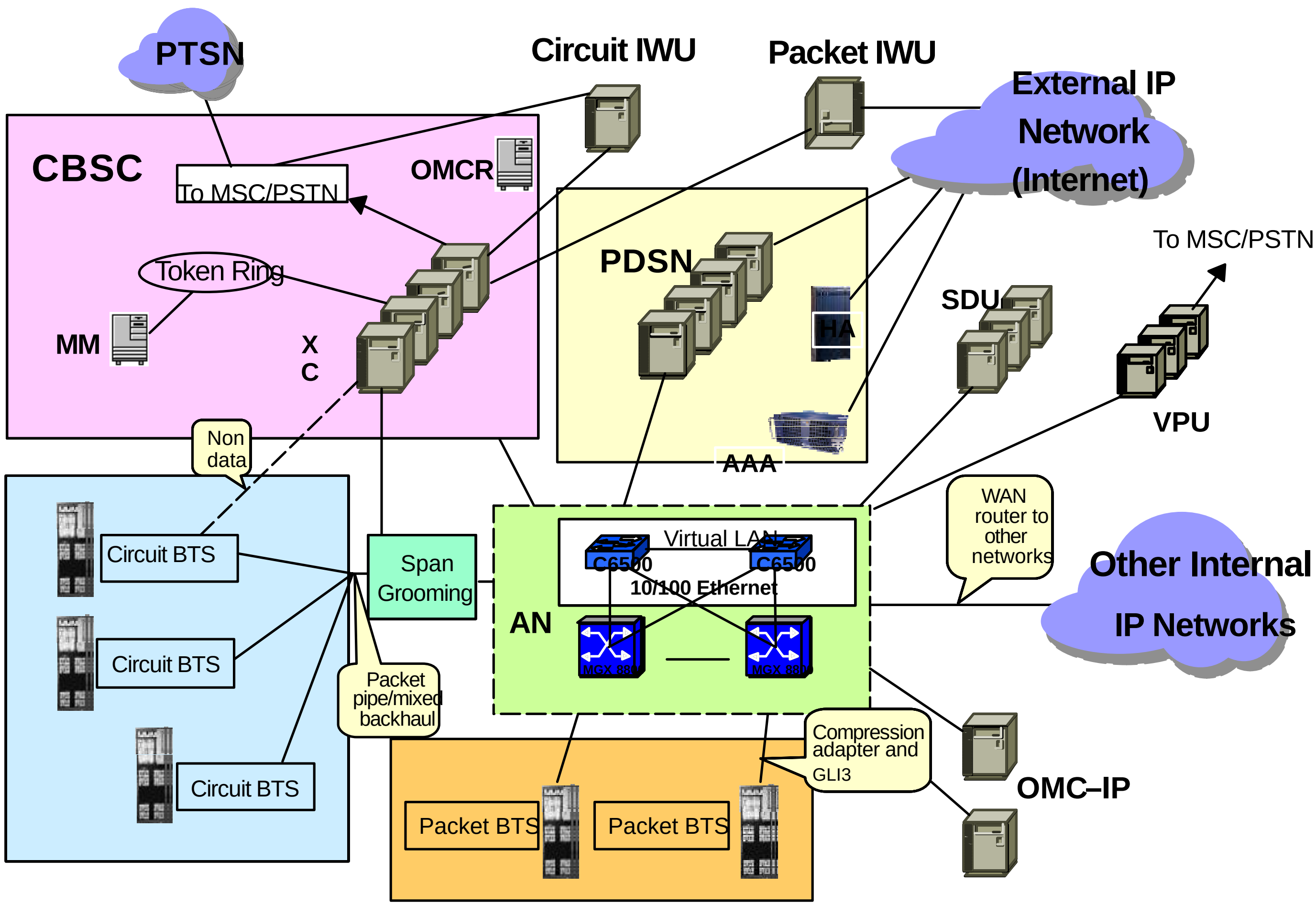
–Anchor PCF support via the Transport Network (ANs)

–Inter–CBSC SHO support via the Transport Network (ANs)

IS–95 A/B Voice/Data, 1X Voice/Data

The configuration illustrated below is anticipated to be the primary one as it takes maximum advantage of all the 16.3 improvements. The configurations that follow this one (*i.e.*, the remainder of this chapter) allow operators to meet specific system requirements.

Figure 2-3: Network Configuration for IS 95 A/B Voice/Data and IS–2000 IX Voice/Data



NOTE

The BTS Router may be present between the Packet BTS and AN.

2

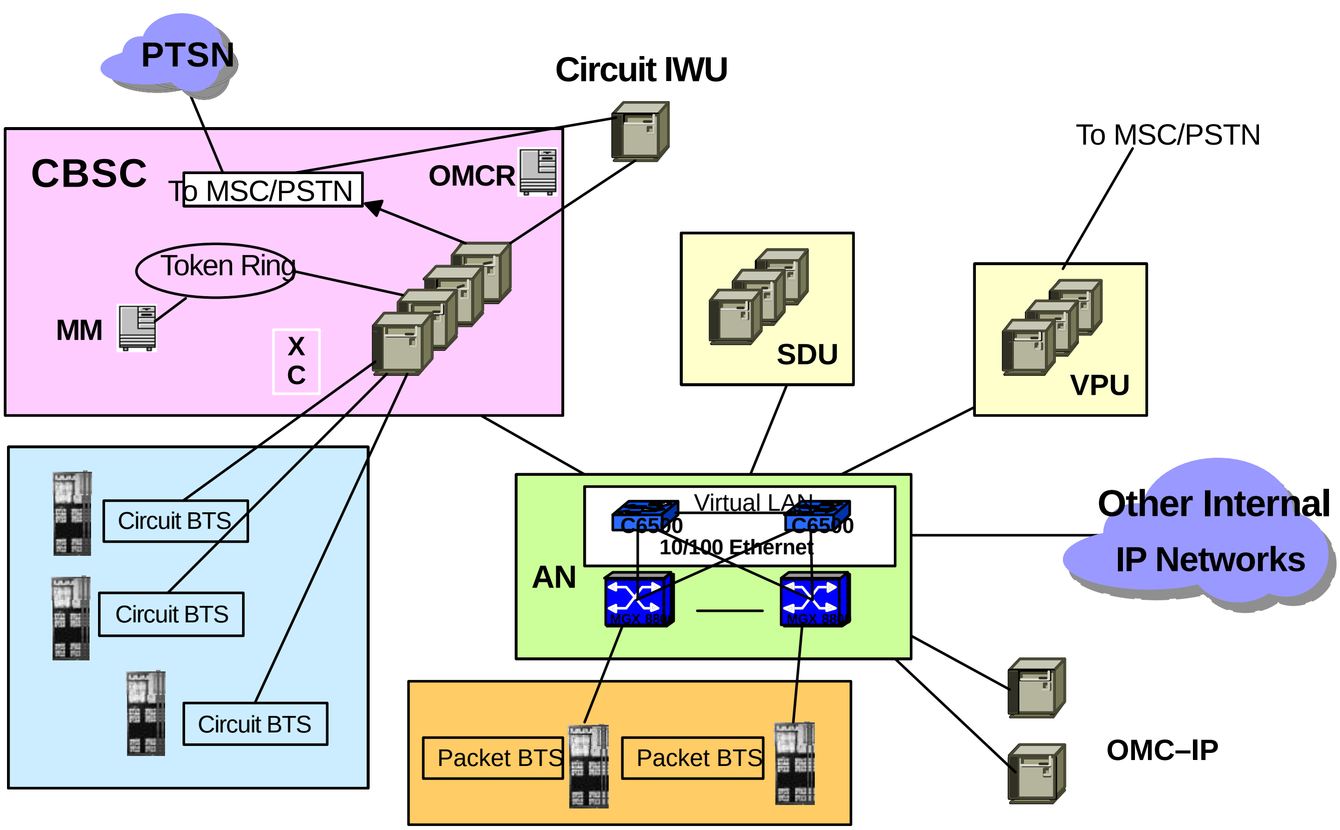
1X with Voice Only (No Data)

This configuration is for operators who have either:

- Minimal data plans that can be met via circuit–based data, or
- An alternate delivery system for data services but want the benefits of 1X voice capacity.

> **NOTE**
>
> This system could have packet or circuit backhaul. Packet backhaul provides maximum efficiency and capacity but requires the AN, OMC–IP, and SDU. Circuit backhaul requires no AN, OMC–IP, or SDU but provides much smaller capacity. Addition of VPU requires AN, SDU, OMC–IP, and mesh elimination.

Figure 2-4: Network Configuration for 1X with Voice Only (No Data)

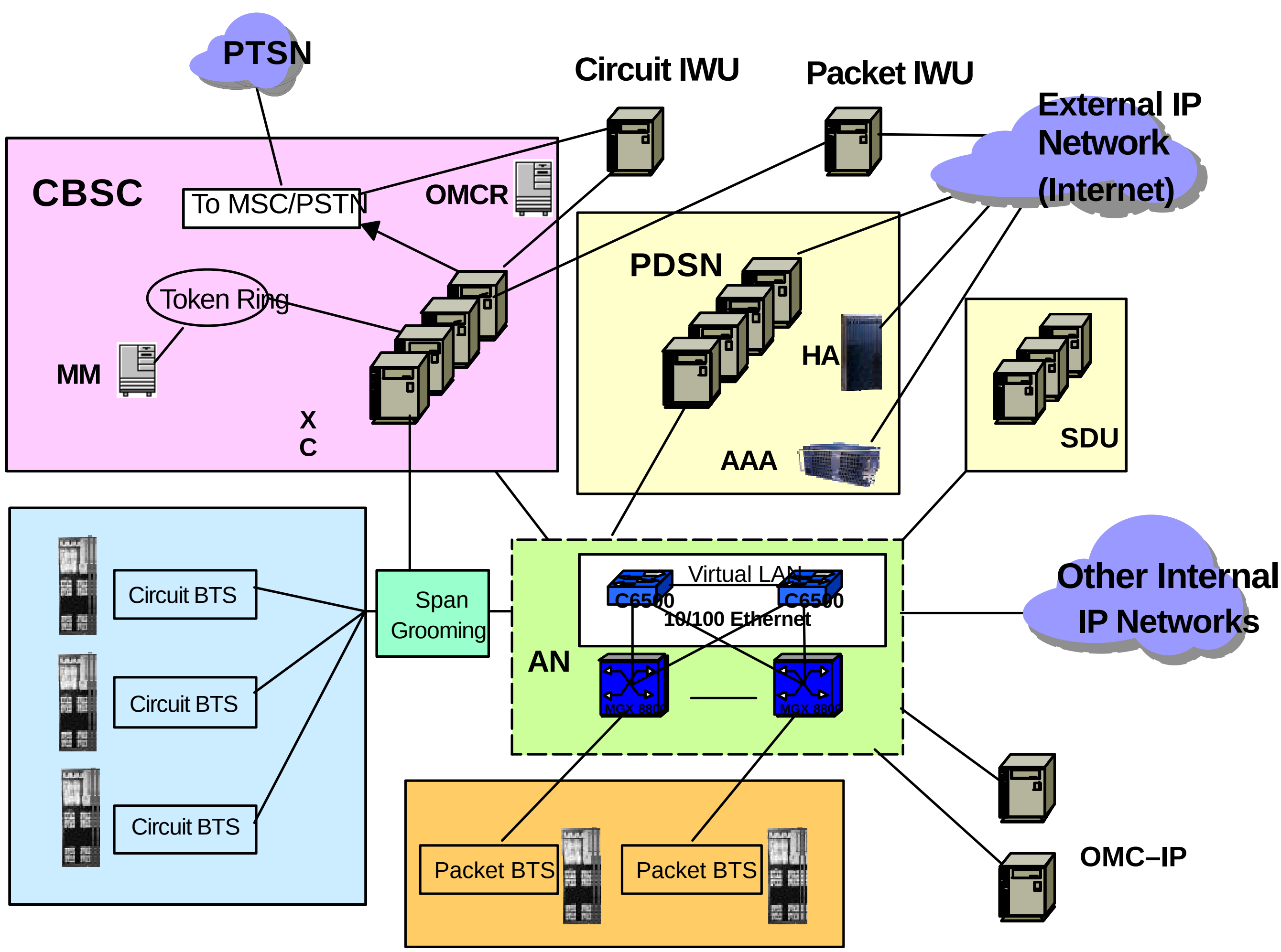


1X With Data Only (No Voice)

This configuration is for operators who have:

- Existing voice capacity and available spectrum for data

Figure 2-5: 1X with Data (IS95 A/B & 1X) Only (No Voice)



2

Notes

Chapter 3: BTS / BTS RTR

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Notes

Overview

Introduction

This chapter provides an overview of the Motorola CDMA MacroCell and MicroCell Base Transceiver Station (BTS) products delivering CDMA2000 1X capability in system release 16.3. The BTS is part of the Motorola SC™ architecture, and provides the necessary equipment to implement the CDMA air interface.

This chapter will focus on providing basic information on the SC 4812T and SC300 for new and 1X upgrade equipment. Legacy MacroCell BTSs are addressed by adding one of the variations of SC 4812 to implement the 1X and retaining IS–95 A&B on the legacy BTS.

SC™ 4812T Starter BTS

Description

The SC™ 4812T is the primary MacroCell within the 4812 platform. Listed below are the additional variations.

Function

The SC™ 4812 BTS portfolio contains the following options:

- **SC™ 4812MF (Modem Frame)** – The SC 4812MF, an indoor unit operating at 800 MHz, is generally intended to act as an expansion frame to support the expansion of existing SC 9600 and HDII 20–channel medium to high–density cell sites, with shared TX functionality. The Modem Frame will rely on external power amplification for the TX path. Accordingly, the SC 4812MF is based on the SC 4812T Expansion Frame, with major changes to the TX path.
- **SC™ 4812T** – The SC 4812T, an indoor unit operating at 800, 1700 & 1900 MHz, has one major difference from its predecessor, the SC 4812 (non–trunked). The difference is the use of a new RF trunking technique that reduces the number of LPAs required and provides increased power capability.

  The SC 4812 product uses 2 single tone LPA modules per carrier–sector to provide 20 watts post duplex per carrier–sector. The SC 4812T uses a set of 4 higher power LPA modules per 3 sectors of one carrier to provide 20 watts simultaneously (60 watts total) per carrier–sector post duplex. The 60W trunked TX power offered by the SC 4812T is intended to provide sufficient power to balance the link with the receive sensitivity improvements of the EMAXX chipset.

  The SC 4812T replaced the non–trunked version of SC 4812. The trunked LPA cage & trunking module and trunked LPA sets are not available to retrofit in the SC 4812 product that was originally shipped with the conventional LPA scheme. The new LPAs can be used in the non–trunked version of SC 4812.
- **SC™ 4812T –48v** – The SC 4812T (–48v), an indoor unit operating at 800 MHz, is functionally the same design as the existing SC 4812T, with one major difference being the use of new internal power conversion hardware which utilizes a supply voltage of –48V rather than the existing +27V nominal.

- **SC™ 4812ET** – The SC 4812ET, an outdoor unit operating at 800 & 1900 MHz, is functionally the same design as the SC 4812T, with specifications for outdoor applications. The SC 4812ET is a self–contained, weatherized version of the SC 4812T. The RF portion of the BTS has been separated from the Power Supply portion, each one having its own cabinet.

  The 800 MHz SC 4812ET was Motorola's first manufacturer supplied 800 MHz CDMA outdoor base station. Previously, customers have in some instances taken a Legacy base station (for example: SC 2400, SC 2450, or SC 9600) and contracted a third–party cabinet supplier to retrofit for outdoor environments. By splitting the RF and Power Supply components into two cabinets, each cabinet will fit into a typical freight elevator.

- **SC™ 4812ET Lite** – The SC 4812ET Lite, an outdoor unit operating at 800 & 1900 MHz, is Motorola's latest CDMA base station product optimal for medium capacity sites and ubiquitous system coverage applications. It requires lower initial capital investment than the larger macro–BTS products, yet is easily expandable for future growth.

  The SC 4812ET Lite packs an indoor/outdoor two–carrier CDMA communications base station in a small, single frame package. The single–frame configuration integrates the Radio Frequency (RF), power rectification and battery backup for cost–effective installation and maintenance.

  The SC 4812ET Lite is expandable to four carriers by adding one expansion frame. It requires only two antennas per sector for any carrier configuration, from one carrier up to four carriers. The single frame design reduces the overall footprint, yielding reduced deployment costs and increased ease of installation. Common spares or Field Replaceable Units (FRUs) shared with the SC 4812ET make equipment management more efficient.

  As we migrate to 3G–1X and beyond, the SC 4812ET Lite will share a common software and hardware migration path with the SC 4812 series of BTS, making upgrades more efficient.

- **SC™ 4812 T Lite – (–48, 27,AC)**
  The SC 4812T Lite single frame CDMA BTS is Motorola's 800 MHz Low Tier CDMA base station product and is designed to support medium to high–density cell sites. The SC 4812T Lite base station is for indoor application and can support up to two CDMA carriers per frame in a 3–sector (or omni) configuration.

  SC 4812T Lite can expand to a maximum of two frames for a total of four CDMA carriers per 3–Sector site. Channel Elements are shared across carriers and sectors within a frame with up to 192 physical channels per frame using MCC1X–48 cards in circuit backhaul mode or 256 physical channels per frame using MCC1X–64 cards in packet mode.

  The BTS<–>CBSC interfaces provide control and traffic communication paths necessary for operation of the SC 4812T Lite base station. The physical interface for all of the frame network and communications is located on the top of the frame.

  The SC 4812T Lite is supported on R16.1.1 with the MCC1X card and does not support non–1X BBX cards or non–1X MCC cards. Full use of channel elements for the MCC1X–64 card requires packet backhaul.
- **SC™ – 4812T–MC Functional Overview** – The SC 4812T–MC single frame CDMA BTS is Motorola's 800 MHz High Capacity CDMA Multicarrier base station product and is designed to support medium to high density cell sites. The SC 4812T–MC base station is for indoor applications. It can support up to four (Only three carriers per frame on converted SC4812T BTSs) CDMA carriers per frame in a 3–Sector, 2–Sector, or OMNI configuration and up to two CDMA carriers per frame in a 6–Sector configuration. The SC 4812T–MC sites can expand to a maximum of two frames for a total of eight (Only three carriers per frame on converted SC4812T BTSs) CDMA carriers per 3–Sector site or up to four CDMA carriers per 6–Sector site. The SC4812T–MC architecture enables flexible CDMA carrier frequency assignment and requires only one TX antenna per sector, including the adjacent carrier configuration. Channel Elements are shared across carriers and sectors within a frame with up to 576 physical channels per frame using MCC1X–48 cards in circuit backhaul mode or 768 physical channels per frame using MCC1X–64 cards in packet mode. There are two input sources that the SC4812T–MC can support: 27V and –48V nominal.

  The BTS<–>CBSC interfaces provide control and traffic communication paths necessary for operation of the SC 4812T–MC CDMA base stations. The physical interface for all of the frame network and communications is located on the top of the frame for the SC 4812T–MC.

The SC 4812T–MC frame consists of the following items: redundant power supplies, fan and cooling equipment for the entire frame, doors, two Alarm Monitoring and Reporting (AMR) Boards, two Span I/O Boards, the Site I/O Board, two Clock Synchronization Modules (CSM), two Multi–Coupler Preselector Cards (MPC), two CDMA Clock Distribution (CCD) Modules, two Group Line Interface (GLI2 or GLI3) Cards, MCC1X or MCC24 or MCC8E Cards, BBX1X (LA, or later version) cards for both primary and a redundant module (note: BBX2 and BBX1X should not be used due to their drive level limitation), multi–carrier LPA, PA backplane Combiner/Splitter, Multi–Carrier Trunking Module and TX Filters, HP BBX Switch Card (C, or later version), HSO, MCIO, and all required frame installation hardware. The –48v frame also includes necessary power conversion equipment.

The SC 4812T–MC is designed for use with internal Multi–Tone CLPAs. The basic Trunking technique utilized in the SC4812T is enhanced to provide forward power sharing capability across sectors and carriers. The SC4812T–MC will provide 81 Watts per carrier (3 sectors) when equipped with the 3x3 Enhanced Trunking Module, or 108 Watts with the 4x4 ETM. The instantaneous TX power per sector is limit to the lower of 60 Watts. The SC4812T–MC is also capable of delivering 81 Watts per carrier (with a 3x3 ETM) in the Omni configuration, but limits to two carriers per antenna and 4 carriers per frame.

The SC 4812T–MC backplane supports the new MCC1X card as well as Motorola’s EMAXX Chipset, via the MCC8E and MCC24. For Release 16.0, the MCC1X is available as either a MCC1X–16 (16 channels) or MCC1X–48 (48 channels). For release release 16.1, the MCC1X card is available as; MCC1X–16, MCC1X–32, MCC1X–48, and MCC1X–64. The MCC1X–64 card requires packet backhaul. All MCC Channel Cards, (MCC1X or MCC8E or MCC24), can be intermixed within a single CCCP shelf.

Inputs and Outputs

The BTS and CBSC interfaces provide control and traffic communication paths necessary for operation of the SC 4812 CDMA base station. The span line transports both control and traffic data between the SC 4812 CDMA BTS and the CBSC. The control channel on the span carries the necessary control information to operate the BTS. Traffic data is transported via the span interface to the appropriate channel–processing element for eventual broadcast over the air interface.

For backhaul of 1X high–speed data channels, a number of DS0s on a span are reserved just for high–speed data backhaul (Circuit backhaul). For packet backhaul the high speed data is packetized with the voice for increased backhaul efficiency.

Span connection to the SC 4812 CDMA BTS is located at the top of the SC 4812 Frame through the Site I/O and Span I/O panel.

NOTE

The term BBX will be used when the information is applicable to both BBX2 and BBX1X. Information specific to one BBX or the other will refer to them by name(BBX2 or BBX1X).

Transmit Path – The SC 4812T can accommodate up to four separate carriers in a three–sector configuration or up to two carriers in a six–sector configuration in a single frame/cabinet. The TX baseband path begins at the MCC card. Traffic channel information is generated by the MCC card, and data is routed to the BBX module for combining and filtering of transmitted digital I and Q signals. Each MCC has a direct connection to each BBX.

The TX RF path begins at the output of the BBX modules. The BBX generates the CDMA RF signal, which will be amplified by the LPAs. A redundant BBX is combined with all sectors and is automatically switched into service in the event of a primary BBX failure. The BBXs output is routed through the CIO card in the C–CCP cage to the LPA trunking backplane of each carrier via a cabled connection. The Trunked LPA Sets amplify the modulated transceiver transmit signal. The LPA output connects to the TX bandpass filter, or cavity combiner modules and is routed to the TX antenna ports (N type connectors) on the I/O Panel at the top of the BTS. Up to four sector–carrier outputs can be combined together via cavity combiner(s) to minimize the number of TX antennas (see Combiner/Filter section) per frame..

Receive Path – For the SC 4812T, the RX signal path in the starter frame begins at the N–type RX antenna inputs located on the I/O Panel at the top of the frame. The signals are routed through the RX Tri–filters, located on the I/O Plate, to the MPC module on the C–CCP Shelf via coax. A frame is equipped with two MPCs, one supporting the main signals and the other supporting the diversity signals. An MPC module provides low noise amplification for the incoming RX signals. The MPC outputs are routed to the Combiner Input/Output (CIO) card via the C–CCP backplane.

The CIO routes the RF receive signals to the respective BBX cards or BBX Switch cards, and provides the expansion output. A primary BBX card is designated to one and only one sector, which is determined by its slot address (physical address). The redundant BBX–13 (i.e., The redundant BBX is number 13) can be connected to any sector via the Switchcard. This configuration allows the redundant BBX–13 card to replace any defective primary BBX. All RX redundant paths are routed from the CIO card to the BBX Switch card. If a BBX fails, the redundant BBX–13 will detect the fault and will direct the Switch Card to switch the RF path to the redundant BBX–13, therefore replacing the defective primary BBX. The BBX demodulates the RF signals to baseband digital I and Q data. The baseband I and Q is then routed to the MCC cards for de–spreading.

A BTS can support up to two SC 4812T expansion frames. The first frame in a three–frame configuration is called the starter; the second and third are referred to as the expansion frames. The first expansion frame receives RX signals from the CIO card in the Starter Frame (after MPC gain). The second expansion frame receives RX signals from the CIO card in the first expansion frame. The EMPC module in each expansion frame provides lower gain amplification for the incoming RX signals. The EMPC outputs are routed the same way as the starter frame..

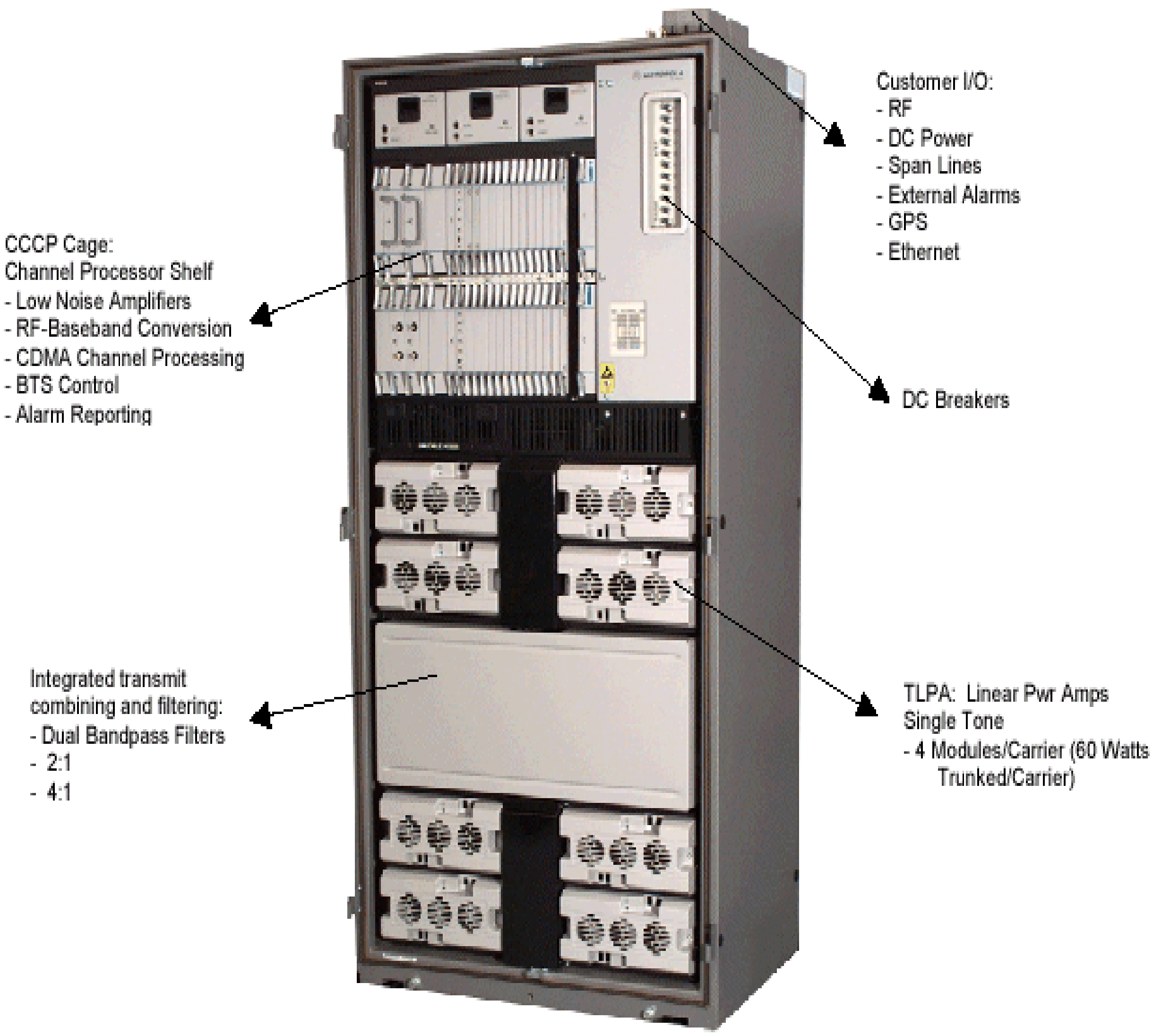
Intra–frame communications – The LAN facilitates intra–frame communications in a single–frame cell site and also inter–frame communications in a multiple–frame cell site. In addition, the LAN also provides the connections for the Local Maintenance Facility (LMF)..

Inter–cell communications – The Inter–cell Link in the SC 4812T is the Span Line Interface (T1/E1). The Inter–cell Link comprises all digital communication links from the cell site to the EMX/CBSC or from the cell site to other cell sites. These links include call traffic as well as control information. A Channel Service Unit (CSU) is required for the inter–cell communications. The CSU is a customer provided option for the SC 4812T..

Frame Description

The following figure shows a SC 4812T Frame without doors.

Figure 3-1: SC™ 4812T Frame without doors



The frame level components consist of the following items:

- Redundant power supplies, fan and cooling equipment for the entire frame
- (1) C–CCP cage
- (2) Alarm Monitoring and Reporting (AMR) Boards
- (1) Span I/O Board
- (1) Cell Site I/O Board

- (2) Clock Synchronization Modules (CSM), one with GPS and one without GPS
- (2) Multi–Coupler Pre–selector Cards (MPC)
- (1) CDMA Clock Distribution (CCD) Module
- (2) Group Line Interface (GLI–2) Cards
- (1) Switch Card
- (1) CIO backplane card (3–S or 6–S)
- All required frame installation hardware
- Doors

The SC 4812T CDMA BTS supports the air interface in any of these configurations:

- Omni–transmit / omni–receive
- 3–sector transmit / 3–sector receive
- 6–sector transmit / 6–sector receive

Module/Card Descriptions

The SC 4812T CDMA frame contains all of the CDMA functions in:

- The Combined CDMA Channel Processor (C–CCP) Cage, and
- The CDMA Trunked Linear Power Amplifier (T–LPA) Shelf

The CCP Cage includes the following items:

- MCC–8, MCC–24 and/or MCC1X (16, 32,48 or 64)
- BBX2 and/or BBX1X
- CIO
- CSM
- AMR
- CCD
- HSO/LFR
- MPC
- Power Supply Converter Card
- Switch Card

C–CCP Cage – The single SC 4812T C–CCP shelf provides the span line interfaces, channel processing, shelf control, and CDMA transceivers. The SC 4812T C–CCP cage supports up to a total of 12 sector–carriers (e.g., 3–sector, 4–carrier or 6–sector, 2–carrier) and up to 768 physical channels (using MCC1X 64 cards).

A fully loaded 1X C–CCP shelf houses the following:

- (13) Broad Band Transceiver boards (BBX–1X¿s), one per sector per carrier with one redundant
- (12) Multi–Channel CDMA cards (MCC1X)
- (1) Switch card

- (1) Combiner Input/Output (CIO) board
- (2) Multi–Coupler Pre–selectors cards (MPCs)
- (2) Alarm Module Reporting (AMR) boards
- (2) Clock Synchronization Manager
- (1) Rubidium High Stability Oscillator (HSO)
- (2) Clock Distribution Modules (CCD)
- (2 or 3) power supply boards

The CDMA T–LPA Shelf includes the following items:

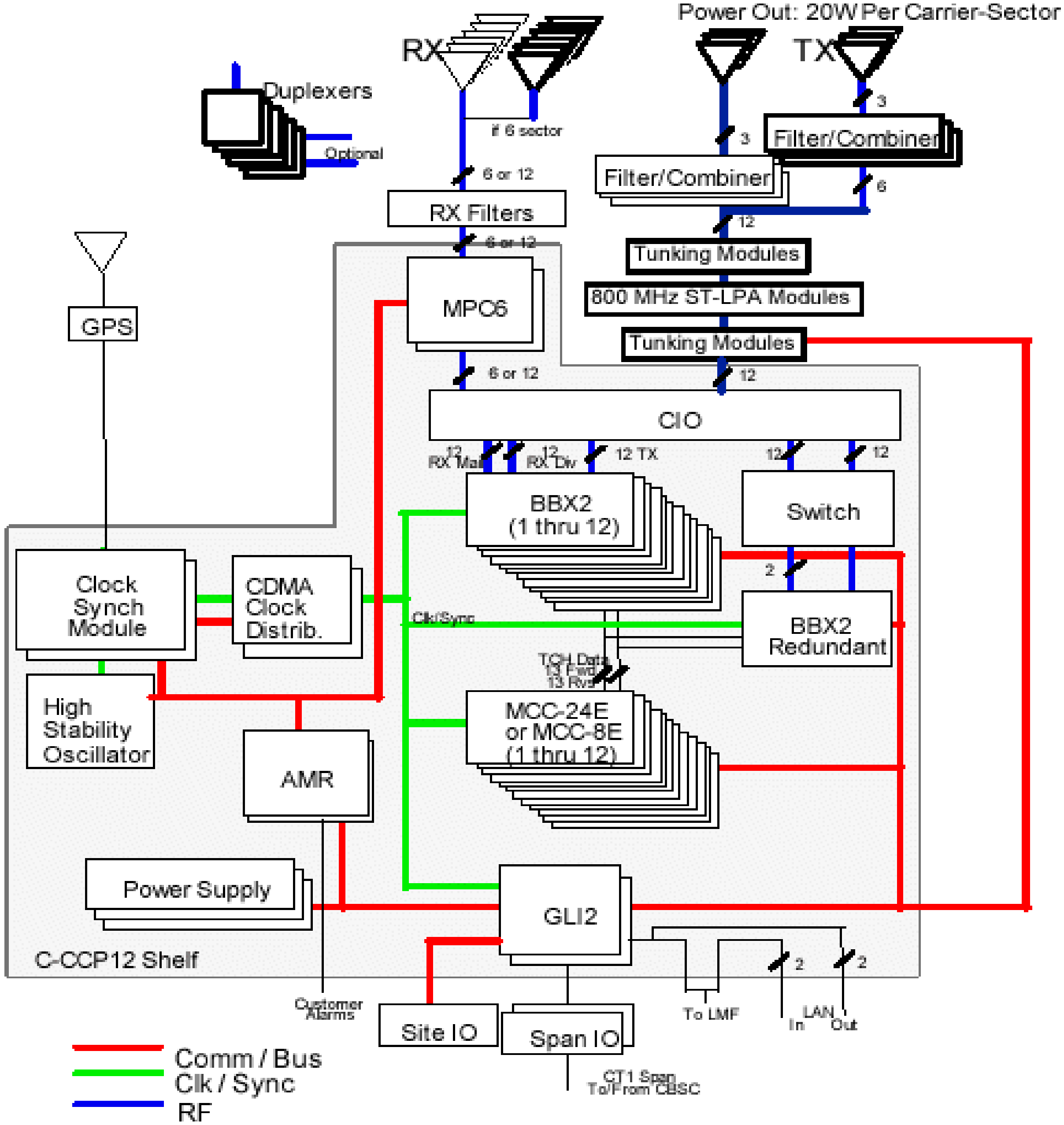
- CDMA T–LPAs
- Trunking Module(s)
- Combiners/Filters

Signal Flow

The following figure illustrates the signal flow in the SC 4812T.

3

Figure 3-2: SC™ 4812T Signal Flow



Redundancy

The SC 4812T has components that are redundant by one of three methods: N+1, 2N, or soft–fail. N+1: MCC, BBX, P/S. 2N: GLI, CSM/CCD, AMR. Soft–Fail: LPA, MPC.

MCC – Overhead channel redundancy is presently supported by equipping N+1 MCCs, where N is equal to the number of MCC cards required to support traffic and overhead channels (without redundancy). For overhead channel redundancy, a three–sector or Omni configuration requires a minimum of two MCCs, and a six–sector configuration requires a minimum of three MCC cards.

P/S – To maintain Power Supply redundancy, a minimum of two supplies are required for a 1 or 2 carrier, 3–sector C–CCP and SCCP shelf. When carrier 3 through 4 are added to a 3–sector C–CCP cage, a third power supply must be added. A minimum of two supplies are required for a 1 carrier, 6–sector C–CCP shelf. A minimum of 3 power supplies must be used when a second carrier is added to a 6–sector frame. In other words: Two cards will support operation of up to 6 sector carriers. Three cards will always be required when seven or more sector carriers are in use.

T–LPA – The four linear power amplifiers (LPAs) per three sectors of one carrier are combined in soft–fail redundancy. In soft–fail redundancy, none of the sectors go out of service if an LPA module fails. In the event of an ST–LPA failure, the LPA module takes itself out of service, sends an alarm to the GLI2, and directs the three sectors supported by that LPA module to operate at 2.5 dB reduced power. Each trunked LPA Set operates independently and is monitored separately. Monitoring and control of the LPAs is via the RS485 bus to the GLI2. The Group Line Interface (GLI2) queries the LPAs for: alarm status, parameters involving Intermodulation Distortion (IM) suppression, electronic ID, and the general state of the device.

For 800 Mhz BTS, the T–LPA is being replaced by the C–LPA. Trunked Power is defined as serving multiple sectors with a bank of shared CLPAs. In this shared (or trunked) arrangement, power is dynamically allocated to each sector as required and thus provides higher effective power with fewer CLPA modules.

Space for up to two Trunked CLPA Sets may be equipped in each SC 4812 XX CDMA frame. in the 4812T/T Lite. Each Trunked CLPA Set consists of three (CLPA) modules, two fan modules, and a trunking backplane.

The linear power amplifiers (CLPAs) per three sectors of one carrier are combined in soft–fail redundancy. In soft–fail redundancy, none of the sectors go out of service if a CLPA module fails. In the event of an CLPA failure, the CLPA module takes itself out of service, sends an alarm to the GLI, and the three sectors supported by that CLPA module operate at approximately 3.5 dB reduced power. Each Trunked CLPA Set operates independently and is monitored separately. Monitoring and control of the CLPAs is via the RS485 bus to the GLI. The Group Line Interface (GLI) queries the CLPAs for: Alarm status, Parameters involving Intermodulation Distortion (IM) suppression, Electronic ID, and the General state of device.

Operations and Maintenance

The Operations and Maintenance Center for the radio (OMC–R) operates as the user interface for the SC 4812 system and supports daily management of the cellular network. The OMC–R, located at the CBSC, manages subsystem events and alarms, performance, configuration, and security.

SC™ 4812T 1X and Packet Backhaul Upgrade BTS

Function

System release 16.0 introduces cdma2000 1X functionality into IS–95A/B systems. SC4812 platform frames deployed in the field can be upgraded to support cdma2000 1X along with IS–95A/B. System release 16.1 introduces full packet backhaul.

The upgraded BTS provides the signal processing functions necessary to implement the various IS–95A/B CDMA channel functions including the pilot channel, sync channel, paging channel, access channel, and fundamental channels. In addition, sites that have installed the cdma2000 1X capabilities can support supplemental channels.

Card Descriptions

There are two types of cards required to upgrade the SC 4812 BTS to support cdma2000 1X in release 16.0.

- MCC–1X
- BBX–1X

Additionally, the TSU–1X module is required to upgrade the IS–95A/B RFDS support cdma2000 1X. The resulting RFDS–1X will support both IS–95A/B and cdma2000 1X.

There are two additional pieces of equipment required to upgrade the SC 4812 BTS to support cdma2000 1X data packet backhaul in release 16.1.

- GLI3
- BTS Router (one of two options)

Signal Flow

See the signal flow section for the SC™ 4812.

Redundancy

The basic redundancy requirements for the MCC–1X and BBX–1X cards are listed below.

- MCC–1X: N+1 redundancy
- BBX–1X: N+1 redundancy

The basic redundancy requirements for the packet backhaul upgrade elements are listed below.

- GLI3: 2N redundancy
- BTS Router: 2N redundancy

SuperCell Legacy w/1X

3

Description

The term “legacy” defines the CCP–3 style, four–digit frames, including, but not limited to the following:

- Option A legacy base stations:
  - HDII
  - SC™ 9600
- Option B legacy base stations:
  - SC™ 2400
  - SC™ 2450
  - SC™ 4820
  - SC™ 4850/2

The 1X upgrade path for a Legacy BTS cell site is to add one of the SC™ 4812 variations listed previously with 1X boards as an expansion frame. This capability will preserve the Legacy BTS while upgrading the cell site to 1X. In this configuration, the legacy BTS will continue to serve IS–95A/B traffic, while the new SC™ 4812T frame will serve cdma2000 1X traffic in addition to IS–95A/B traffic.

Expansion SC™ 4812T

Description

With an Option B overlay, an SC™ 4812T expansion frame with the current equipment needs to be added if present frames are fully utilized. With these deployments, the legacy equipment will continue to support IS–95A/B traffic, while the SC™ 4812T will support cdma2000 1X traffic. The table below outlines which types of SC™ 4812T frames are compatible with the legacy equipment.

Table 3-1: Legacy Overlay Options

Legacy Product	Overlay Options
HDII	SC™ 4812T Modem Frame [1]
SC™ 9600/9650	SC™ 4812T Modem Frame [1]
SC™ 2400	SC™ 4812T Expansion Frame [1]

. . . continued on next page

Table 3-1: Legacy Overlay Options	
Legacy Product	**Overlay Options**
SC™ 2450	SC™ 4812T Expansion Frame [1]
SC™ 4850/2	SC™ 4812T Expansion Frame [1]
NOTE [1]. Only option available.	

SC™ 300 BTS

Description/Function

The SC™ 300 provides superior performance in MicroCell applications where additional coverage is required. Enhancing coverage improves service and offers seamless communications throughout CDMA systems – indoors or outdoors.

The SC™300 is a single Field Replaceable Unit (FRU) that contains all the elements required to support a single Code Division Multiple Access (CDMA) carrier. With additional FRUs, the site can be expanded up to four carriers. It is an Omni Base Transceiver Subsystem (BTS) with a maximum output power level of up to 10 watts and includes the circuitry to support receive diversity. The MicroCell is ideal for various applications:

- Rural
- Hole fill
- Subway or under ground tunnels
- In–building

As shown in Figure 5–6, the SC™300 is a self–contained, stand–alone base station. The entire SC™ 300 BTS consists of the primary MicroCell FRU, mounting brackets, environmental covers, a site input/output (I/O) junction box and an optional short duration battery backup. The site I/O, which includes the connections for the backhaul, modem, customer inputs and GPS, is located separately from the diagnostic area.

This state–of–the–art design allows for convection cooling, which results in an energy efficient platform. By eliminating the need for a conditioned environment and by providing 19” rack, pole, or wall–mount capability, the SC™ 300 greatly simplifies site selection and installation. The discrete size and flexible mounting options of the SC™300 provide a quick and effective solution to accommodate diverse applications. It ships fully configured and calibrated to minimize installation time.

The SC™300 offers seamless, cost–effective integration with the MacroCell base stations (SC™4812) for complete system design flexibility.

3

Figure 3-3: SC™ 300 BTS FRU

The entire SC™ 300 BTS consists of:

- The primary MicroCell FRU (a single carrier BTS requires 1 FRU, for two carriers– 2 FRUs, for three carriers– 3 FRUs, and 4 carriers– 4 FRUs) including mounting brackets, environmental cover, and the appropriate Site I/O junction Box (with or without primary surge).
- An optional short duration battery per FRU
- A Remote GPS Kit (RGPS can be shared between multiple SC™ 300 units)
- The appropriate MicroCell Interface Bus (MIB) terminations/cables that are utilized for Multi–carrier BTS functionality.
- The BTS installation is then completed with conduit, and connectors per FRU. Primary surge must be supplied for the input power, the GPS, the modem, the span, and outdoor antenna(s). This primary surge can be supplied either with the Motorola optional primary surge unit or a customer supplied primary surge unit.

The unit meets the appropriate Bellcore GR–487–CORE and NEBS–63–CORE specifications. Each FRU includes the necessary RF equipment to support the air interface. This includes the radio channel transceiver, power amplifier, and control processor to translate voice traffic between the CBSC and subscriber units.

The main highlights of the SC 300 1X FRU include:

- Self–Contained MicroCell
- Up to four CDMA Carrier Site with four FRU's
- Omni Configuration
- 10W Output Power
- 32 Physical Channel Elements
- Indoor or Outdoor BTS
- T1/E1–a Span Interface
- Non–Volatile Flash Memory
- Universal Mounting Hardware

Inputs and Outputs

The Site Input/Output (I/O) and the Junction Box include the Site I/O board, which acts as the main interface between the FRU and external connections.

The external interfaces are categorized in four main functional areas; power, external site facility connections, intra–unit connections, and antennas.

- The power inputs/outputs include the AC input, DC input. Breakers are provided for both the AC Input and the DC Input.
  - The AC Input terminates the AC power feed to the FRU. This port is not used when the FRU is powered from a DC source.
  - The DC Input port is for one of the following two functions, DC input to the BTS or the short duration battery.
- The facility connections are described below.
  - The backhaul allows for a BTS to BSC link carrying vocoded voice and control data.
  - The Modem is the MMI link between the BTS and a remote location via an analog telephone line.
  - The customer–defined alarms are ground referenced inputs to detect an external ”open” or ”closed” switch position. Because these inputs are generic, they can define alarm events by connection to external switch actuators (batteries, lights, etc.).
  - The Synch Forward and Reverse interfaces provide a connection to the remote GPS receiver and other BTSs with Feature 1165D, for BTS synchronization and absolute time.
- The following section defines the intra–unit connections:
  - The MIB(A) is a multi–purpose interface used to support multi–carrier BTS configurations

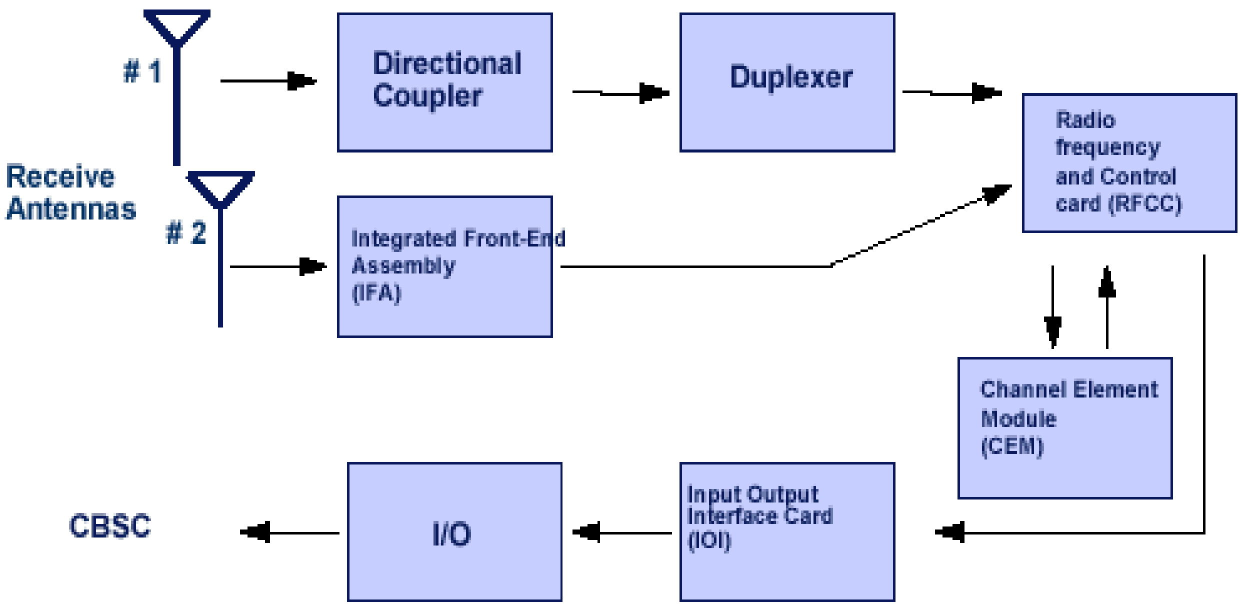
- In single carrier MicroCell applications the MIB(A) must be terminated with a MIB terminator (supplied) to provide the required RF routing for the received signal present at Ant(A).
- MIB(A), MIB(B) and MIB(C) are multi–purpose interfaces used to support multicarrier BTS configurations. The Ant(A) is the receive–only antenna connection for the MicroCell. The Ant(B) is the duplexed antenna connection for the MicroCell BTS. For multi–carrier configurations, different MIB cables are utilized depending on what carrier is being implemented.

- Antennas as external interface
  - For a single carrier, the MicroCell BTS is configured to transmit and receive using two antennas. This configuration employs a two branch spatial diversity receiver scheme to minimize fading effects which requires two antennas. The BTS transmitter output is combined with one of the receiver antennas with a duplexer in a total configuration of two antennas.
  - The SC™ 300 BTS is designed as a stand–alone product and is not intended to share antennas with any other systems. It is possible to share antenna external to the BTS with potential degradation issues.
  - In a multi–carrier site, antennas are shared to reduce the overall number of antennas.

Signal Flow

Receive Signal Path – –The signal flows as shown in the figure below.

Figure 3-4: SC™ 300 Receive Signal Flow

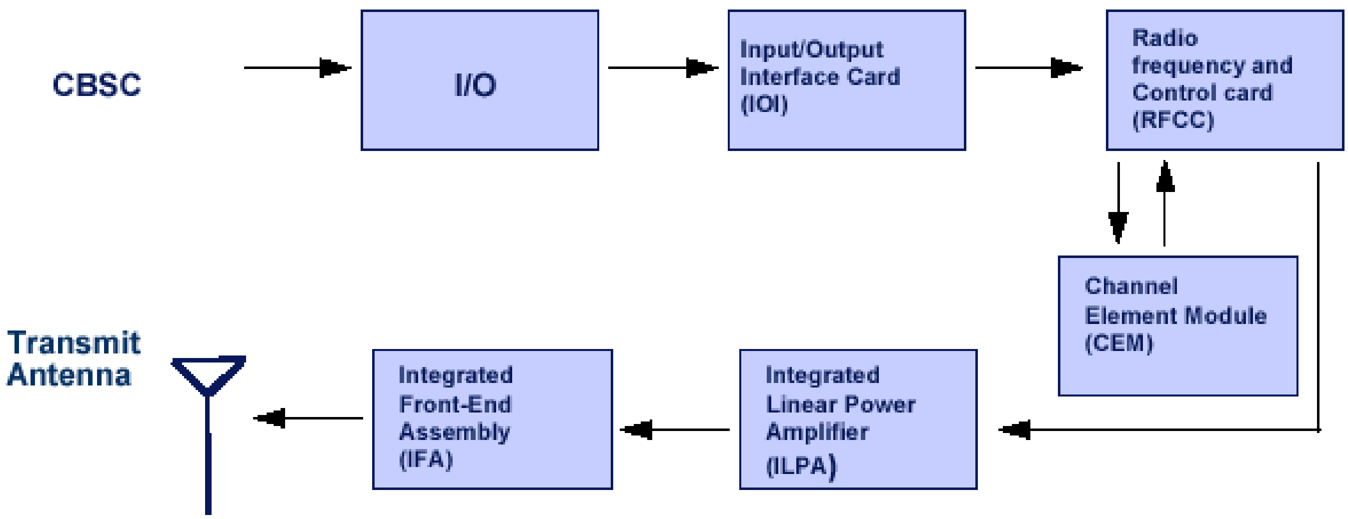


That is, the signal follows these steps:

1. The MicroCell has a second receive path for spatial diversity.
2. A second signal is received at the diversity antenna and is conducted to the Integrated Front–End Assembly (IFA).
3. The IFA filters and amplifies the receive RF signal which is routed to the diversity receiver in the RFCC.
4. Like the main receiver, the diversity receiver in the RFCC amplifies and down–converts the receive RF signal to a baseband CDMA signal which is processed by the CEM.
5. The two receive baseband CDMA signals are demodulated and combined by the CEM and routed to the IOI via the RFCC.
6. The IOI embeds the demodulated data into time slots in the backhaul medium, which leave the BTS via the I/O board.
7. The backhaul connection from the BTS terminates at the CBSC.

Transmit Signal Path – The signal flows as shown in the figure below

Figure 3-5: SC™ 300 Transmit Signal Flow



1. Transmit data is transported from the CBSC to the BTS as an embedded data stream within the backhaul medium.
2. The IOI extracts the embedded data and conducts it to the CEM via the RFCC.
3. The CEM modulates the data into a baseband CDMA signal for processing by the RFCC.
4. The RFCC up–converts the baseband CDMA signal to a transmit RF signal for the Integrated Linear Power Amplifier (ILPA).
5. The ILPA amplifies the transmit RF signal which is routed to the IFA.
6. The IFA filters the transmit RF signal and conducts it to the antenna.

Redundancy

Redundancy will be not be supported with this product.

Operations and Maintenance

The SC 300 is supported by the Cellular Base Station Controller (CBSC) and by the Operations and Maintenance Center–Radio (OMC–R), for all mobility management, (O&M), and transcoding functionality. Because the CBSC to Mobile Switching Center (MSC) communication is defined by an open interface, the switch may be any platform supporting A Interface (IS–634).

SC™ 480 (New in 2.16.4.1.x)

Description

The SC™ 480 is the new primary MicroCell in the SC™ BTS portfolio.

Function

The SC™ 480 is available as an indoor and outdoor (with additional equipment) unit operating at 800 MHz. It is available at –48V for China A Band and at +27V both A and B band. This is a medium to low density site.

The SC™ 480 is an Omni, two carrier site which supports IS95, 1X and 1xEV–DO. Expansion BTS configurations are also supported so that up to 3 units can be added to the base unit to support up to 8 carriers.

The SC™ 480 is capable of either circuit or packet backhaul. A mixture of backhauls is not supported.

The incorporation of the Integrated BTS Router (IBR) functionality in to the SC™ 480 enables operators to deploy an all packet backhaul solution without the need for an external router.

The SC™ 480 utilizes several cards from the macro BTS product lines to reduce the number of configuration options for Motorola BTS' and enable re–use of cards between the micro and macro BTS frames.

Inputs and Outputs

The BTS and CBSC interfaces provide control and traffic communication paths necessary for operation of the SC™ 480 CDMA base station. The span line transports both control and traffic data between the SC™ 480 CDMA BTS and the CBSC. The control channel on the span carries the necessary control information to operate the BTS. Traffic data is transported via the span interface to the appropriate channel–processing element for eventual broadcast over the air interface.

For backhaul of 1X high–speed data channels, a number of DS0s on a span are reserved just for high–speed data backhaul (Circuit backhaul). For packet backhaul the high speed data is packetized with the voice for increased backhaul efficiency.

Span connection to the SC™ 480 CDMA BTS is located at the top of the SC™ 480 Frame through the Site I/O and Span I/O panel.

Application Considerations

This section provides information on the basic operation of the SC™ 480 by discussing the following topics:

- Transmit path
- Receive path
- Intra–frame communications

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- Inter–cell communications

> **NOTE**
>
> The term BBX will be used when the information is applicable BBX1X only.

Transmit Path

The SC™ 480 can accommodate up to two separate carriers in a omni configuration in a single frame. The TX baseband path begins at the MCC card. Traffic channel information is generated by the MCC card, and data is routed to the BBX module for combining and filtering of transmitted digital I and Q signals. Each MCC has a direct connection to each BBX.

The TX RF path begins at the output of the BBX modules. The BBX generates the CDMA RF signal, which will be amplified by the cCLPAs. The BBXs output is routed through the CIO card in the CCP2 cage to the cCLPA via a cabled connection.

Receive Path

For the SC™ 480, the RX signal path in the starter frame begins at the RX antenna input located on the I/O Panel. The signals are routed through to the cMPC module on the CCP2 Cage. A frame is equipped with one cMPC supporting both the main and diversity signals. A cMPC module provides low noise amplification for the incoming RX signals. The cMPC outputs are routed to the Combiner Input/Output (CIO) card via the CCP2 backplane.

The CIO routes the RF receive signals to the respective BBX cards and provides the expansion output. The BBX demodulates the RF signals to baseband digital I and Q data. The baseband I and Q is then routed to the MCC cards for de–spreading.

An SC™ 480 BTS can support up to three SC™ 480 expansion frames. The first frame in a four–frame configuration is called the starter; the second, third and fourth are referred to as the expansion frames.

Intra–frame Communications

The LAN facilitates intra–frame communications in a single–frame cell site and also inter–frame communications in a multiple–frame cell site. In addition, the LAN also provides the connections for the Local Maintenance Facility (LMF).

Inter–frame Communications

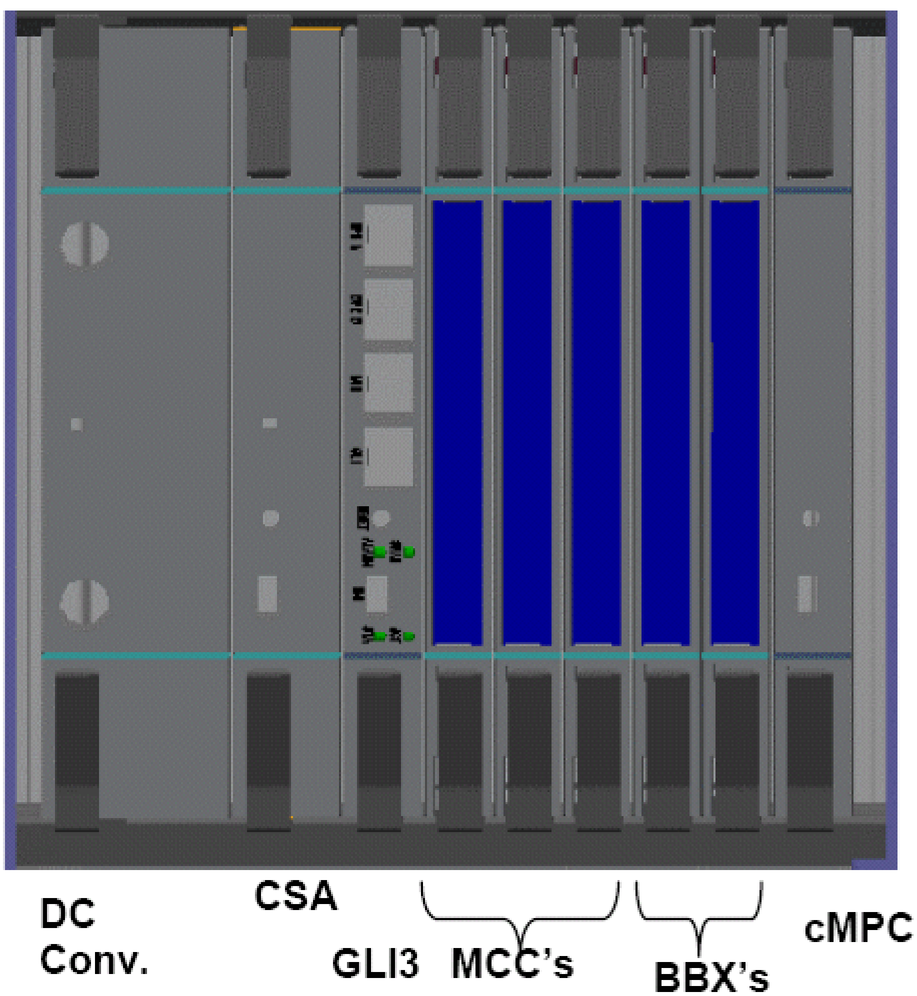
The Inter–cell Link in the SC™ 480 is the Span Line Interface (T1/E1). The Inter–cell Link comprises all digital communication links from the cell site to the CBSC or from the cell site to other cell sites. These links include call traffic as well as control information. A Channel Service Unit (CSU) is required for the inter–cell communications. The CSU is a customer provided option for the SC™ 480.

Frame Description

A fully loaded CCP2 cage houses the following:

- (2) Broad Band Transceiver boards (BBX–1Xs), one per carrier
- (3) Multi–Channel CDMA cards (MCC1X) or (2) MCC–DO + MCC1X
- (1) Group Line Interface (GLI3)
- (1) Clock Synchronization and Alarms Card (CSA)
- (1) compact Multi–Coupler Pre–selector card (cMPC)
- (1) High Stability Oscillator (HSO) or (1) Medium Stability Oscillator (MSO)
- (1) CCP2 Cage Power Supply Card

Figure 3-6: SC™ 480 Chassis Layout



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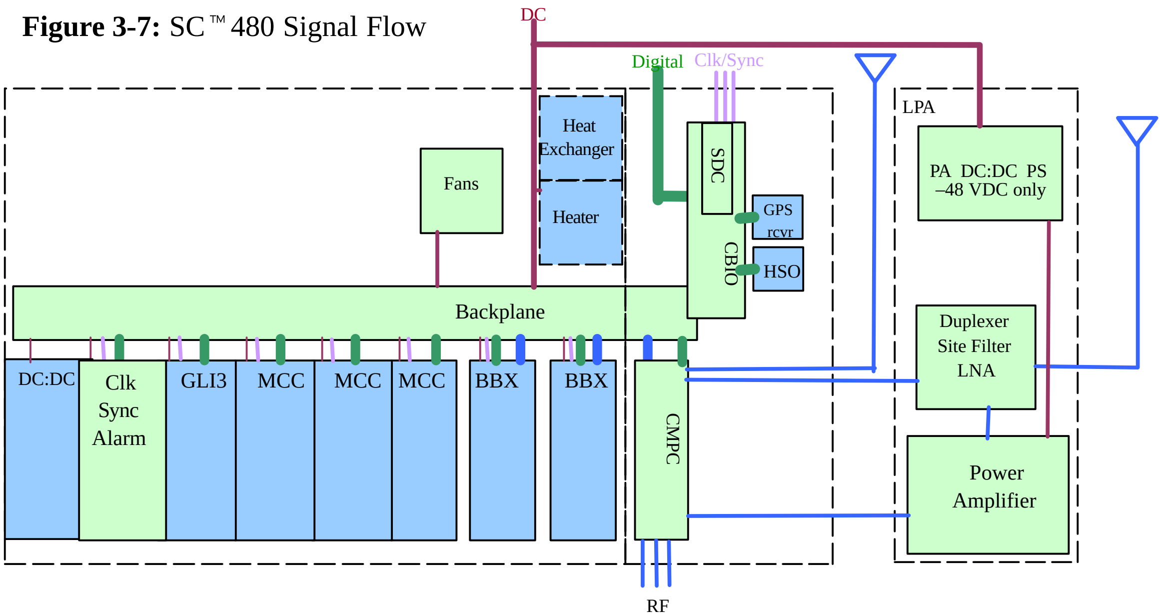
Signal Flow

The following figure illustrates the signal flow of the SC™ 480.

Figure 3-7: SC™ 480 Signal Flow



Redundancy

MCC – Overhead channel redundancy is presently supported by equipping N+1 MCCs, where N is equal to the number of MCC cards required to support traffic and overhead channels (without redundancy). For overhead channel redundancy, an Omni configuration requires a minimum of two MCCs.

O&M

The Operations and Maintenance Center for the radio (OMC–R) operates as the user interface for the SC™ 480 system and supports daily management of the cellular network. The OMC–R, located at the CBSC, manages subsystem events and alarms, performance, configuration, and security.

Integrated BTS Router

Starting with system release G16.4.1, the GLI3 will be capable of providing low capacity, one–span, integrated packet routing functionality capable of supporting up to 120 simultaneous calls (assuming 8k EVRC.)

This is implemented through software upgrade at the BTS. Existing GLI3 hardware installed in the field can be upgraded with software to support integrated BTS router (IBR) functionality.

When the GLI3 is upgraded to IBR, the external BTS router is not necessary to support the first packet span. When additional packet capacity is required, an external BTS router group (redundant or non–redundant) can be added to support up to four physical T1 or E1 packet spans per C–CAP shelf.

Logical BTS configurations and fractional spans are not currently supporting IBR.

The IBR is also compatible with the SC4812 BTS family and the SC48x BTS. Configuring the GLI3 as an IBR will limit support of up to eight MAC modules in the SC4812, SC4812T, SC4812T–MC, and SC4812ET C–CCP shelf; and, IBR will limit support of up to three MCC1X modules in the SC4812T–Lite and SC4812ET–Lite C–CCP shelf.

SC™ 4812T–MC CDMA BTS 2.1 GHz

Description

The SC™ 4812T–MC single frame CDMA BTS is Motorola’s 2.1 GHz High Capacity CDMA Multicarrier base station product and is designed to support medium to high–density cell sites. The SC™ 4812T–MC base station is for indoor applications. In a 3–Sector, 2–Sector, or OMNI configuration, the SC4812T–MC can support up to (per frame):

- Four 1X CDMA carriers
- Three DO carriers with MCC–DO redundancy
- Four carriers in a combination of 1X and DO

Function

Although the SC™ 4812T–MC can expand to a maximum of three frames for a total of twelve CDMA carriers, this document describes hardware supported by the Starter frame only.

The SC4812T–MC architecture enables flexible CDMA carrier frequency assignment and requires only one TX antenna per sector, per frame, including the adjacent carrier configuration.

Channel Elements are shared across carriers and sectors within a frame with up to 576 physical channels per frame using MCC1X–48 cards in circuit backhaul mode or 768 physical channels per frame using MCC1X–64 cards in packet mode. MCC–DO supports 531 traffic channels per frame.

There are two input voltage sources that the SC4812T–MC can support: 27V and –48V DC nominal.

Inputs and Outputs

The BTS<–>CBSC interfaces provide control and traffic communication paths necessary for operation of the SC™ 4812T–MC CDMA base stations. The physical interface for all of the frame network and communications is located on top of the SC™ 4812T–MC frame.

Frame Description

The SC™ 4812T–MC frame accommodates the following items:

- Redundant input DC feeds
- Redundant power supplies
- Fan and cooling equipment for the entire frame
- Doors
- (2) Alarm Monitoring and Reporting (AMR) cards
- (2) Span I/O Boards
- (1) Site I/O Board
- (1) Clock Synchronization Modules (CSM)
- (1) Multi–Coupler Preselector Cards (MPC)
- (2) CDMA Clock Distribution (CCD) Modules
- (2) Group Line Interface (GLI3) Cards
- MCC1X Cards
- MCC–DO Cards
- BBX1X cards for both primary and a redundant module multi–tone CLPA
- PA backplane Combiner/Splitter
- Multi–Carrier Trunking Module and TX Filters
- BBX Switch Card
- HSO
- MCIO
- All required frame installation hardware

The –48v frame also includes necessary power conversion equipment.

The MCC1X card is available as MCC1X–16, MCC1X–32, MCC1X–48, and MCC1X–64. The MCC1X–64 card requires packet backhaul to achieve full card capacity.

The SC™ 4812T–MC is designed for use with internal Multi–Tone CLPAs. The SC4812T–MC will support standard and high power configurations.

NOTE

Optional Items: Duplexer directional couplers, BTS Router, CSU, EV–DO Kit, and CRMS are offered as optional equipment external to the SC™ 4812T–MC. (Note: the BTS Router is required for packet mode, optional for circuit mode).

Figure 3-8: SC™ 4812T–MC (+27v Left) (–48v Right) Frame (shown without doors)

GLI 3 Functional Description

Function

The GLI3 card is added to the BTS in place of the GLI card to enable the packet data backhaul feature. The card is capable of operating in either packet or circuit mode to enable the rapid conversion from circuit to packet and to allow fallback to circuit without a site visit.

Inputs and Outputs

While all the inputs and outputs are bidirectional, the inputs from the BTS are from the MCC24/8E (IS95A/B) and MCC1X cards. The inputs from the CBSC side are packet streams, which are combined by the BTS router to form a single stream or a split span (circuit backhaul) transport depending upon the backhaul type.

Card Description

The GLI3 will meet the following circuit functions:

- Packet Functionality Overlays Circuit
- All existing circuit functions on GLI2 supported
- New Functions for Packet Operation
- Ethernet Switch (Four 100BASE–T ports on front panel)
- GLI3 interconnect (one 100BASE–T port single RJ–45)
- Packet router interconnect (two 100BASE–T RJ–45s)
- Auxiliary/Monitor Port (100BASE–T RJ–45)
- CHI Block for packet protocol translation
- Translates between IP and efficient CHI format
- Provides IP termination for MCCs

Signal Flow

See the “Inputs and Outputs” section for the BTS router.

Redundancy

Redundancy for the GLI3 is 2N with a spare GLI3 per cage.

O & M

Two new O&M concepts require some additional explanation for 16.1:

16.1 will introduce a new maintenance paradigm called SMNE (Self Managed Network Elements). Under the old paradigm, elements would report a fault to a central location and the location would then tell the reporting unit what to do or direct the information to maintenance for action. Under the new paradigm, the management is de–centralized and the elements will usually take care of any required action and then report the action and result only for record keeping. Much of the SMNE piece for the BTS will be resident on the GLI3 card. SMNE operation will only begin to function when the BTS is in the Packet mode.

The second concept for O&M new in 16.1 is that of the “O&M straw” for the BTS Router while the BTS is in the circuit mode. The BTS Router is essentially a Network Element and would normally get its O&M information via a packet based backhaul. When the BTS is still in the circuit mode (before cutover to the packet mode) the BTS Router must get its O&M information via a dedicated DS0 that is routed through the GLI3 as part of the cutover preparation and this DS0 is provisioned and sent to the BTS router so it can perform the O&M while still in the circuit mode.

BTS Router

3

Function

The BTS Router is required to implement packet backhaul at all MacroCell BTS sites that can be upgraded to support 1X (SC™ 4812 platform). The BTS Router essentially interfaces the packet data stream generated by the GLI3 card to the Span based backhaul to the *MGX*/CBSC. The BTS Router is a multi function device with the following basic capabilities.

- High–Performance PPPmux/cUDP Implementation
- Compatible with the Severe Environmental Conditions at a BTS
- Full Remote Management Support via OMCR/CMP Application

Two implementations of the BTS router are available in the release 16.3 product:

- Redundant BTS Router offers redundant protection of packet–backhaul span interface
- Non–redundant BTS Router offers packet backhaul without redundant protection.

Inputs and Outputs

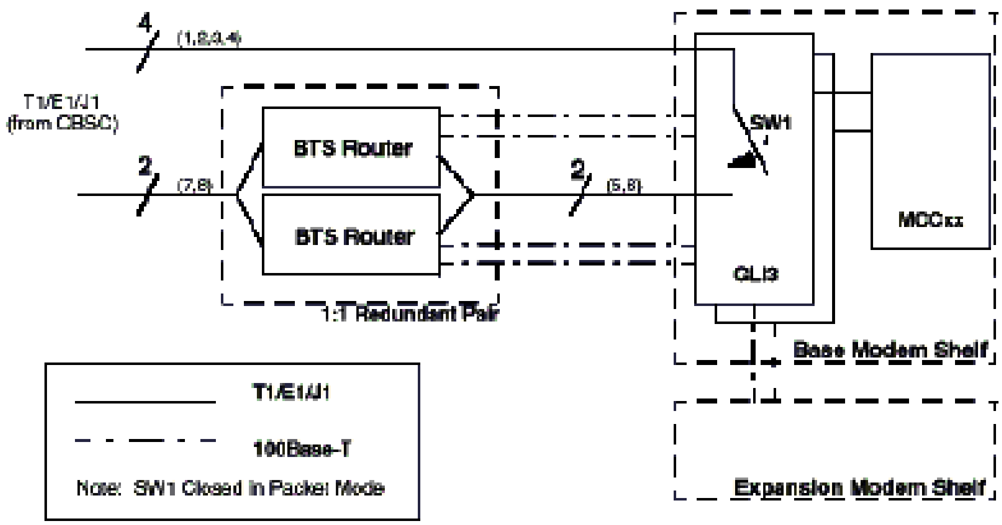
The inputs and outputs are bi–directional. When viewing the BTS Router from the *MGX* or DACs, the inputs are T1 or E1. Coming from a DACs or *MGX*, and the outputs are 100Base T Ethernet going to the GLI3 cards.

Application Considerations

There are numerous configurations for the BTS router. Some sites may require multiple routers per site depending on span count. Only one BTS router/pair is supported per modem frame.

The figure below illustrates the typical configuration.

Figure 3-9: Typical BTS Router Configuration



Card Description

Each BTS router comes with one WIC (WAN Interface Card), which is the interface for the two span lines. An additional WIC can be added to provide two more span lines. The BTS Router is intended to be installed in redundant pairs and can be expanded with additional pairs of routers.

Signal Flow

See “Inputs and Outputs”.

Redundancy

The BTS Router can be deployed in redundant pairs and will support redundancy via Hot–Standby Router Protocol ensuring that only a single router is actively controlling the span interfaces. A relay switch is integral to the WIC and will allow the spans to be Y–cabled to both routers.

Once an active BTS Router has been elected, that router attempts to activate one (or more) PPP links on the span interfaces. The definition of these initial PPP links (span and timeslots) is stored in non–volatile memory on both the routers. This memory may be updated either locally via a terminal or remotely via the OMCR/CMP support application.

After an initial PPP link has been established over the span lines, DHCP and TFTP are used to locate and transfer any additional configuration information. SNMP and Telnet are used for general access and control.

If a router is unable to establish a PPP link within a reasonable timeframe, it will relinquish control of the span interface and allow the redundant router to attempt establishment of the PPP link. This functionality will allow the system to recover from failure in the span interface electronics of a router.

OSPF routing control is used to detect and recover from any failures in the WAN or LAN interconnects.

Router redundancy operates in both packet and circuit modes of operation.

O & M

The *Mobile Wireless Center* (*MWC*) is an application that will implement the workflow steps necessary to configure the BTS Router, the *MGX*, and the *MGX* RPM card. Considered a piece of the overall workflow, *MWC* will provide a template based configuration generation and deployment function. The *MWC*, through an API interface, will populate configurations and on a transactional basis assure the deployment of the configuration. If the configuration action fails, the device can be rolled back to its previous version, thereby assuring consistency and accuracy within the network. The naming convention of the devices will be mapped and persisted for use by components of the OMC–IP. The APIs for the *MWC* will be abstract to provide the most flexibility and deployment and isolate the configuration specifics from the higher–level applications such as the OMC–R and other management systems.

The OMC–IP will be the collector of all alarm and event information required for the BTS routers via MWFM. *CW4MW* will forward the alarms from the BTS routers directly to UNO via SNMP.

Chapter 4: Digital Access and Cross–Connect System (DACs)

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Digital Access and Cross–Connect System (DACs)

Chapter Overview/Function

For 16.3, the DACs is not required in packet backhaul. The DACs can still be used to do span grooming that may be required in certain network topologies. The split backhaul is still allowed as a supported configuration for circuit backhaul for 1X Data. For the SC3XX series of BTS the DACSs is still needed. The information in this chapter is retained for those who wish to use a split backhaul.

Some customers have chosen to use the DACs to concentrate lines from T1 to T3 and they may choose to retain the DACs for flexibility in network configuration.

A new Digital Cross–connect can be required for release 16.3 and this document will use the acronym DCS to distinguish it from the DACs.

DACs Description

Network operators must supply their own DACs, selecting the unit that best meets the needs of their specific network.

Function

To maximize circuit efficiencies, the DACs selected should be capable of switching at a DS0 level. More specifically, it should meet the following requirements:

- Able to cross connect at a 64k bit DS0 signal level in the format of the operator's spans. If this condition is not meant, the operator must ensure that all system elements are compatible with the applied scheme and any required system settings are planned for
- Able to handle E1, T1, J1 inputs as required by the customer
- Compatible with network management supplied by the customer
- Utilize –48 VDC operation or other voltages (–60 VDC) required by the customer
- Utilize possible redundant configuration
- Able to handle backhaul specified in the backhaul plan for the system

Inputs/Outputs

Input for the DACs is a mixture of unsorted voice, circuit–based data, and packet–based data.

Output consists of the following traffic streams:

- Voice: Traveling to the transcoder (XC), located on the Central Base Station Controller (CBSC) if split backhaul is retained
- Packet–based data: and voice traveling to the *MGX* if Packet backhaul is implemented

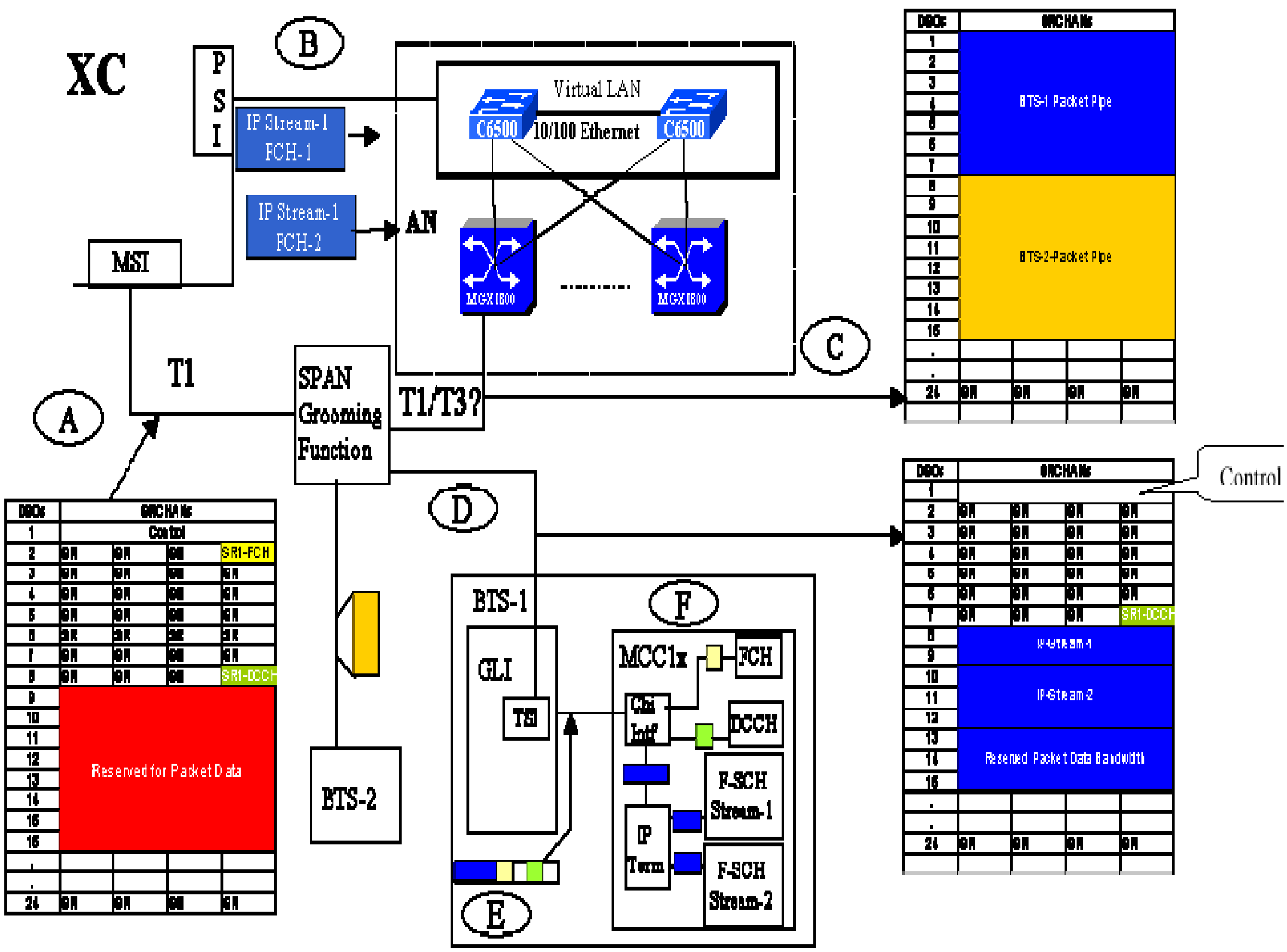
NOTE

For the split backhaul application where Fundamental data channels are backhauled to the XC MSI, the Fundamental data channels are routed to the XC PSI–CE for circuit to packet conversion and eventual combination with the supplemental channels.
With packet backhaul, the FCH and SCH is sent to the AN (*MGX*).

To accommodate the necessary sorting, the DS0s used for 1X data will be grouped contiguously in the bearer medium. That grouping is referred to as a “packet pipe.”

For information about the restrictions placed on packet pipes, refer to Figure 4-1.

Figure 4-1: DACs Illustration



The remaining DS0s in a span are assigned to voice (1X or IS 95 A/B) or circuit–based data (IS95A). Combining packet pipe and voice on the same circuit–based transport is sometimes referred to as “mixed backhaul” or “packet pipe backhaul”.

NOTE

The total backhaul will include all the IS 95 A/B voice and data that existing systems may have had in place, as well as the 1X data and voice.

Application Considerations

Refer to the documentation provided with your specific DACs.

Card Descriptions

For information about the cards in your DACs, refer to the documentation that came with the unit(s).

Signal Flow

In release 16.0 and succeeding releases, if circuit backhaul is retained, voice and data are backhauled from the various Base Transceiver Stations (BTSs) through a circuit–based network to the CBSC. There, the DACs separates voice from data activity, routing voice and data call FCHs to the transcoder (XC) and data call SCHs to the AN.

In Release 16.1/16.3 the backhaul can be converted to packet. With the packet backhaul conversion, both voice and data are co–mingled on the same backhaul with the separation being made via information contained in the packet. All Packetized information flows through the *MGX* (this requires a significant increase in capacity of the *MGX*).

Redundancy

Unless a redundant backhaul is used, the DACs will remain a single point of failure. *To limit any possible downtime in a failure, it is advisable to have a documented contingency plan for either getting to an alternate configuration or replacing a DACs.*

Operation and Maintenance

For more specific information about the operation and maintenance of your DACs, refer to the documentation that came with the DACs. The management of DACs is not included in Motorola provided O&M.

Notes

Chapter 5: CBSC

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Notes

Introduction

Release 16.3 continues the evolution of the Motorola CDMA product towards an all–IP based network with the implementation of the VPU platform.

The introduction of the VPU introduces the need for a new PSI resource type called the PSI–Ter if the cIWU is attached at the XC. The VPU requires an SDU so most customers will probably have PSI cards but additional PBIB–ESs may be required.

NOTE

There is a change in terminology in this version vs. previous versions. The previously referred to PSI (ce) is now called PSI (pktif) to align with the O&M identification of the element.

This chapter covers those CBSC items added in 16.0 and reviews how they are affected in 16.3.

- **Packet Subrate Interface (PSI) cards:** This card has multiple functions in 16.3.
- **Packet BIB cards:** The PBIB–ES and the PBIB–E cards are required to interface between PSI cards and the data network.

Overview

The CBSC contains the XC and the MM. This chapter will focus on changes to the XC.

MM Overview

The MM is the main focal point for call processing in the CBSC/SDU. It directs the sequence of a call in the CBSC/SDU by maintaining state information for the call and responding to message input from the other subsystems. When messages are received from other subsystems, the MM decides what action, if any, should be taken next and invokes that action by sending a message(s) to other subsystem(s).

During the course of a call setup, exceptions may occur which mandate that the call be released. Examples of these exceptions include subscriber validation failure in the MSC, no resources available, and failure of the mobile to acquire an assigned TCH. The MM has the responsibility of detecting call setup exceptions, either via message receipt from the other subsystems or internally, and subsequently taking the appropriate action.

In the 16.0 release, the MM communicates with devices through the Transport Network (TN).

The MM provides the following radio resource management functions:

- Functional Element Coordinator
- Handoff Management
- Global RF Resource Management
- Collection of Statistics

Functional Element Coordinator – the MM serves as the coordinator between the various BSS functional elements for the establishment of calls within the BSS. Essentially, for a given call, the serving MM is the central point of control for that call. This centralization shields other BSS elements from architectural changes.

Handoff Management – the MM handles management of handoff processing within the RAN and coordination of other access network elements to orchestrate handoffs. The control point for handoffs is the Radio Network Control Server (RNCS). The RNCS is a control function that provides interworking between the BTS and the core voice and data service. The RNCS establishes radio access call legs and provides radio resource management call control. The handoff control that the RNCS has includes the inter–BTS, intra–BTS, inter–RNCS, intra–RNCS and soft handoffs. In most cases, these handoffs are negotiated among RNCS(s) of the involved RAN(s) without involvement from the core network.

Global RF Resource Management – The MM provides global RF resource management and admission control of connections and connection attributes (e.g., data service bandwidth) based upon RF resource conditions.

Collection of Statistics – The MM is responsible for collecting statistics used for RF resource utilization (analogous to current performance management statistics). The MM is also responsible for the collection of per–call information and generation of post call records (such as a Call Detail Log) or in real–time via trace facilities.

MSC Interface

As indicated, a major functionality of the MM is the interface to the MSC. The MSC is responsible for receiving the Subscribed Rate parameter provisioned in the subscriber record in the HLR and then passing it onto the RAN. The Subscribed Rate parameter is the maximum allowable data rate that a subscriber can be assigned for IS–2000 1X packet data services. It defines restrictions on the level of packet data service that is to be provided to a subscriber on both the forward and reverse channels. The following Subscribed Rate forward and reverse channel data rates are applicable to IS–2000 1X:

- 9.6 Kbps
- 14.4 Kbps
- 19.2 Kbps
- 28.8 Kbps
- 38.4 Kbps

- 57.6 Kbps
- 76.8 Kbps
- 115.2 Kbps
- 144 Kbps
- 153.6 Kbps

When the operator defines a default/override Subscribed Rate parameter value for roamers, this will be used by the MSC to validate service requests. The MSC will meet the general requirement to allow for default/override capability through the Roamer Profile Override feature. The Roamer Profile Override enables operators to override certain features and functions of a visiting subscriber otherwise specified by their home system. The default/override capability provides default CDMA Service Option List and Subscribed Rate values for a serving network. It supports the new IS–2000 1X service option, 33. Also, the MSC will maintain usage statistics for the CDMA Service Option List and Subscribed Rate override capabilities.

The MSC also queries the VLR for the IS–2000 Mobile Capabilities information when it initiates some paging operation to the mobile (such as voice call or SMS).

SDU functions

Beginning in the 16.1 release, the MM/RNCS will manage devices called the Selector Distribution Units (SDU) as a pool of servers. A method will be implemented to “flag” the presence of the SDU and ensure proper load balance across the SDUs. The MM will interact with the SDU for SDU element allocation/assignment and de–allocation/disconnect, and as well for handoff process sequencing and resource/bandwidth negotiation. Some of the data now gathered in the MM to build the CDL will be migrated to the SDU in release 16.1.

XC Overview

The XC (transcoder) along with the MM combine to make the CBSC. The transcoding function is required in a CDMA system to convert 56Kbps/64Kbps PCM signals into 8Kbps (optional 13Kbps) encoded signals and vice versa. The switching capability within the XC is used to concentrate lightly loaded T1/E1 coming from the base stations into a fewer number of fully loaded T1/E1 going to the MSC. This also provides a common point of interface for many BTSs. The switching function additionally separates control and TCHs coming from the BTS. Traffic channels are sent via the XCDR cards to the MSC, and the control channels are routed to the MM. Lastly, while the CBSC selects the radio channel, the land–side circuits are selected in an A+ (IS–634) interface compliant manner. The switching matrix is used to connect the two together. The switching matrix also allows Intra–BTS and Inter–BTS handoffs to be performed with a minimal involvement of the MSC when radio channel paths involved in the handoff are connected to the same CBSC.

Each XC cage contains two sizes of cards and boards. The larger card is referred to as a full–size card. These include GPROC (or EGP), KSW/DSW, GCLK, XCDR, MSI, and BUS Terminator cards. The smaller cards in the same cage are referred to as the half size cards. These include the KSWX/DSWX, CLKX, and LANX. All shelf–to–shelf interconnections on the transcoder frame are obtained by interconnecting via fiber optic cable using only the half size cards. New to 16.0 is the Packet Subrate Interface (PSI) card that enables new network elements using IP–based communication to work with legacy network elements. The PSI has both circuit and packet configurations within one unit. It supports circuit voice/data and packet data for the 1X system. The data from the RAN is converted from ethernet on the packet side to internal protocols of the XC on the circuit side. Essentially, the PSI is a bridge and a router between the circuit network of the XC and the packet network of the RAN for bearer (STRAU <–> IS–634 conversion) and call control traffic.

PSI Cards

Description

The PSI card can best be described as a highly programmable I/O processor. It is essentially a packet capable version of the Multiple Span–line Interface (MSI) card.

Function

Overview

Depending on which software is loaded on it, the same physical PSI card can handle any one of the following three different functions:

- Packet Interface Function: PSI (pktif)
- Selector Function: PSI (pktsel)
- Packet Control Function: PSI (pktpcf)

PSI (pktif)

The PSI (pktif) acts as both bridge and router for voice, data, and call control traffic traveling between the circuit network of the Transcoder (XC) and the packet network of the SDU/Radio Access Network (RAN).

The **bridge** functionality converts data from gigabit Ethernet on the packet side to internal XC protocols on the circuit side.

The PSI (pktif) has three logical subfunctions:

- PSI–ce: conversion between 16Kbps circuit IOS and packet IOS frames
- PSI–ter: conversion between 64Kbps circuit PCM and packet PCM
- PSI–sig: conversion of SCAP signalling from LAPD to IP

On the circuit side, the PSI **router** works with and routes to and from the following devices:

- MSI card
- Transcoder card (XCDR)
- Front End Processor (FEP)

On the packet side, the PSI routes messages via IPv4.

PSI (pktsel)

Dedicated to the Selector Function, PSI (pktsel) cards are used for high–speed packet data (IS–95B and IS–2000).

Operationally, when packet data signals come from multiple BTSs, the PSI (pktsel) makes its selection based on the basis of load and signal quality. In this way, it acts similarly to the current XCDRs, terminating the Radio Link Protocol (RLP).

These cards are deployed as PSI (pktif) or PSI (ter) cards if the free standing SDU is used.

PSI (pktpcf)

Dedicated to the Packet Control Function (PCF), the PSI (pktpcf) works with the Packet Data Service Node (PDSN) to manage a complete data session. Operationally, the PCF terminates the layer 4 protocol stack from the mobile and the PDSN. The PCF should be viewed as facing and controlling the BSS resources while the PDSN controls the activity toward the IP network.

Together the PCF and PDSN manage all 1X data sessions.

These cards are redeployed as PSI (pktif) or PSI (ter) cards if the free–standing SDU is used.

Inputs and Outputs

Each PSI function has a different set of inputs and outputs. The inputs and outputs are really bidirectional so the designation of input and output is somewhat arbitrary.

PSI (pktif) Cards – PSI (pktif) cards have their input bridged through the MSI card(s) in the XC, to the PSI (pktif) card. The output is coupled through the XC bus to the PBIB–ES card via ribbon cable and then to the AN IP Switch *(Catalyst)* via 1000 BaseT rated Ethernet cable.

PSI (pktsel) Cards – the input for PSI (pktsel) cards is from the AN IP Switch *(Catalyst)*. The output comes from the XC bus to the PBIB–E via ribbon cable and to both AN IP Switches *(Catalysts)* via 100 BaseT Ethernet.

PSI (pktpcf) Cards – These cards get their input from several CBSC functions and send their output to the PDSN via the AN IP Switch *(Catalyst)*.

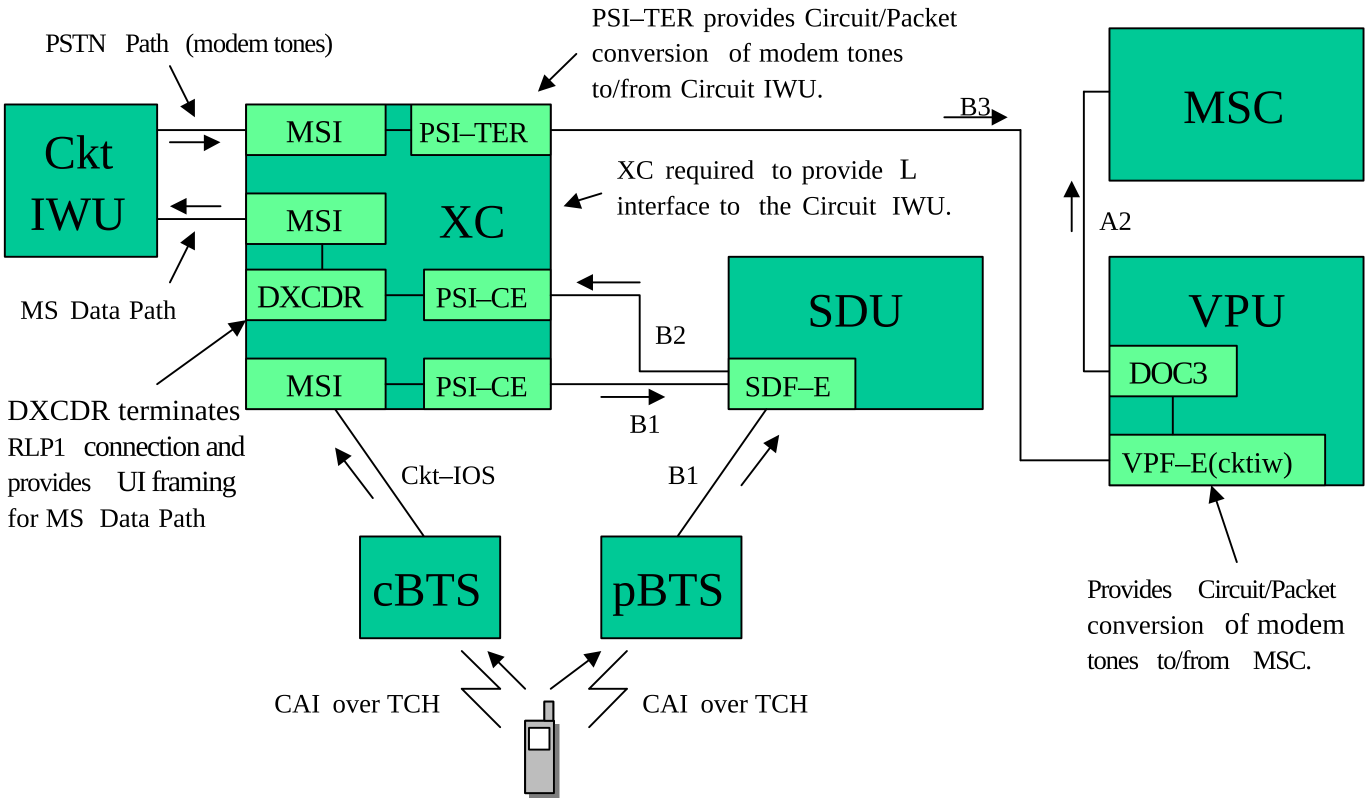
Signal Flow

PSI (pktif) Cards – The PSI (pktif) card provides packet to circuit interworking which allows communication between the circuit domain of the XCDR and circuit backhauled BTSs and the packet domain of the Packet Data Network and the standalone SDU. In 16.0, the interworking applies to 1X data (FCH only) and ICSHO Mesh Elimination voice traffic. In 16.1, the interworking applies to 1X data (FCH only) and voice traffic on circuit backhauled BTSs to the SDU (External) and all voice traffic from the SDU (packet domain) to the XC. Data traffic from packet backhauled BTSs travels directly through the SDU to the PDN and does not impact the XC. For cIWU call setup with VPU, signaling messages are also exchanged with VPU through this card.

PSI (pktsel) cards – The PSI (pktsel) card takes inputs from the various BTSs receiving the same signal and selects the one for use in the system based on signal and traffic criteria. This data selection process is similar to the voice selection that was performed by the XCDR. This function can move to the stand–alone SDU for 16.1 or remain on the CBSC.

PSI (pktpcf) card – The PSI (pktpcf) works with the PDSN to control the data secession with subscriber units. The PSI (pktpcf) can be viewed as the subscriber/RF–facing element of data secession control. The PSI (pktpcf) manages the RF capacity, data buffering, and other issues facing the RF environment while interfacing with the PDSN controlling the network facing management. The inputs (really bi–directional) to the PSI (pktpcf) come from the PSI (pktsel) card and the Catalyst and go to the PDSN through the Catalyst.

Figure 5-1: PSI Card Signal Flow



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Redundancy

The PSI card is used in two redundancy modes:

- **PSI (pktif)** is used in the 2N redundancy mode and a separate PSI (pktif) card is used for each side of the AN IP Switch.
- **PSI (pktsel) and PSI (pktpcf)** use a high availability mode and the same card feeds both AN IP Switches *(Catalysts)*. Inputs to the cards are controlled via poling or pulse checking, ensuring that non–responsive cards are not included in the pool of available cards.

O&M

Like other cards in the XC, provisioning for the PSI (pktsel) and PSI (pktif) cards is handled through OMC–R. Alarms too are handled as with other cards.

The PSI (pktpcf) is provisioned in the same manner as the PSI (pktif) and the PSI (pktsel). In addition however, the PSI (pktpcf) gets a pool of IP addresses from the OMC–R. The addresses are assigned in conjunction with the PDSN and part of the IP management.

BIB Cards

Description

Recall that a Balanced Interconnection Board (BIB) card of any flavor provides connectivity to three card slots.

In 16.0, the current BIB kit continued to be supported and two new types of BIB cards will be introduced, bringing the total number of unique BIB kits to three. All three support Ethernet connectivity between the PSI and AN IP Switch *(Catalyst)*. The original MSI BIB (commonly and currently called “BIB”) will remain unchanged. Like the “BIB,” the pBIB supports three card slots. Each kit type provides a different type of interface provided for each of the three slots served by a single BIB as follows:

- **BIB:** (*For T1/T1/T1.*) This configuration represents the existing BIB kit. The BIB will continue to:
  - Support slots requiring T1/E1 connectivity
  - Provide connectivity to three MSI card slots of T1s or E1s

  With the BIB kit, MSI boards can be installed in any of the three slots served by the BIB. Each MSI card provides 2 T1 or E1 interfaces; therefore, this BIB configuration provides a total 2 * 3 slots = 6 T1 or E1 interfaces.
- **PBIB–ES:** *(For 1G/T1/T1.)* The PBIB–ES kit supports a PSI (pktif) in the first of three slots served by the PBIB–ES, and 2 MSIs in the other two slots. This PBIB–ES card therefore will have 1 RJ–45 connector with the 1G Ethernet interface and 4 T1/E1 interfaces corresponding to the 2 MSI cards in the other two slots.
- **PBIB–E:** *(For 100M/100M/100M.)* The PBIB–E kit supports PSI (pktsel) or PSI (pktpcf) devices in any of the three slots served by the PBIB–E. This PBIB–E card therefore will have 6 RJ–45 connectors corresponding to the 6 100M Ethernet interfaces corresponding to the 3 PSI (pktsel) or PSI (pktpcf) cards that are in the three card slots served by this PBIB–E.

For 16.1/16.3, if the stand–alone SDU is selected, the PBIB–E will be eliminated as the function of those cards will be moved to the SDU, and additional PBIB–ESs will be required to handle the additional traffic associated with having both voice and data packetized. The PSI (ter) will also use the PBIB–ESs so additional quantities may be required.

In the configurations listed above, the formats listed are described more specifically as follows:

- **BIB**: T1 dual–channelized serial links in T1 or E1 frame format, as supported today by the existing BIB.
- **PBIB–E:** 100M / dual 100 megabit Ethernet links. This PBIB–E card will have 3 pairs of RJ–45 interfaces corresponding to the 3 card slots that it serves.
- **PBIB–ES:** 1G / single 1 Gigabit Ethernet link plus 2 T1s.

Function

Both of the pBIBs are essentially output panels that allow a signal taken of an internal bus to be routed to an external device.

Inputs and Outputs

As with most devices, the signals dealt with are bidirectional so the designation of an input is somewhat arbitrary. For the purpose of separating the two, consider the ribbon cable from the CBSC bus the input and the RJ–45 output to the AN IP Switch *(Catalyst)* the output.

Card Description

The following illustrations show the physical layout of the PBIB–ES and PBIB–E cards.

Figure 5-2: PBIB–ES Physical Layout

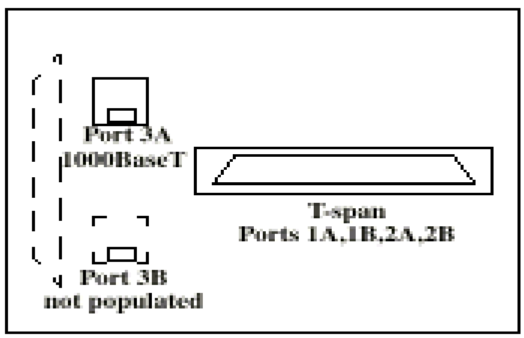
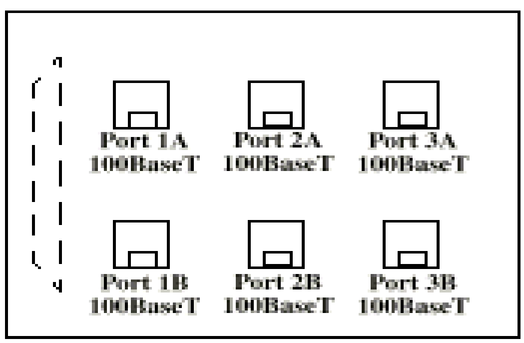


Figure 5-3: PBIB–E Physical Layout



Signal Flow

The card serves only as a tie point for the signal.

Redundancy

The PBIB–ES is deployed in a 2N redundancy and each pBIB card output would go to the different AN IP Switches *(Catalysts)* in pairs.

The PBIB–E is part of a high availability redundancy and each card has two outputs, PSI (pktsel) or PSI (pktpcf), which go to different AN IP Switches *(Catalysts)* in a pair.

O&M

No O&M function associated with this card.

Chapter 6: Access Node (AN)

Table of Contents

Notes

Access Node (AN)

Introduction

AN Overview

The Access Node (AN), a set of IP switches and routers, interconnects all of the cellular infrastructure devices and transports IP–based traffic to and from the CDMA 2000 (1X) cellular network.

The AN hardware architecture consists of two custom frames, the Aggregation Point frame and the IP Switch frame. The Aggregation Point frame houses one or two Aggregation Points (*MGX 8850* WAN switches). The IP Switch frame houses two IP Switches (*Catalyst 6509* Multilayer switches).

The Aggregation Point provides WAN connections to the BTSs and supports JT1, T1, E1 and T3. The IP Switch interconnects the other cellular infrastructure devices and supports various types of Ethernet LAN interfaces.

The Aggregation Point and IP Switch frames, in addition to housing the Cisco equipment, provide power distribution functions.

Release 16.0

Release 16.0 utilizes the AN and packet backhaul for data calls and ICSHO. Release 16.0 splits the existing circuit backhaul to provide packet pipes for 1X data. The voice path uses the existing circuit backhaul. Release 16.1 will utilize the AN for packet backhaul of both data and voice traffic.

Release 16.0 uses the span grooming element (DACs) to groom the circuit traffic and packet data pipe onto the BTS link (from the BTS to the span grooming element). The span element also grooms the packet data traffic off the BTS link and forwards it to the AN.

Release 16.1 and 16.3

Beginning in 16.1, the AN and packet backhaul work together to handle data calls, voice calls, and Inter–CBSC Soft Handoff (ICSHO).

The circuit backhaul is still supported in 16.1.

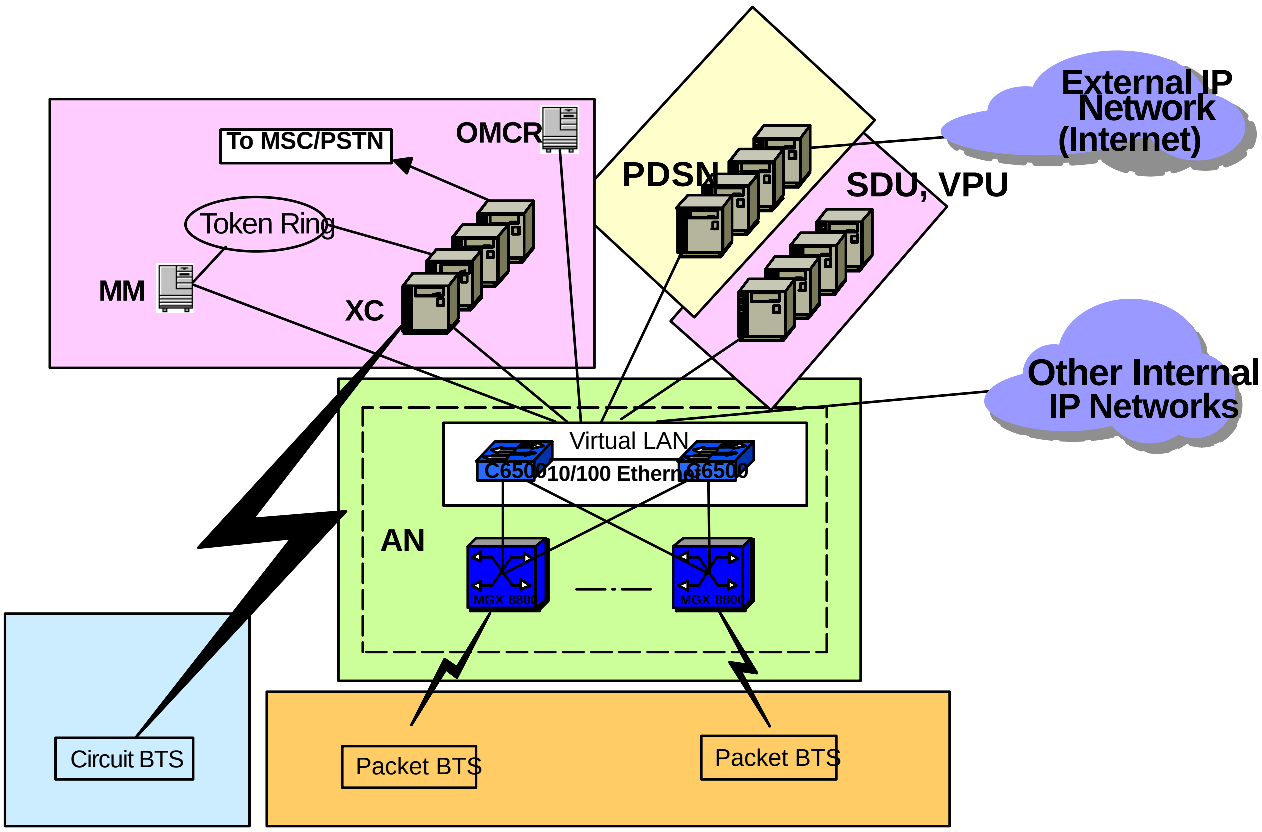
In 16.1 the AN will handle the packet backhaul for both data and voice traffic.

NOTE

A DACs may be used in 16.1 for some customer configurations.

In release 16.3 the VPU becomes another element switched by the AN IP Switch.

Figure 6-1: Access Node (AN)



Overview of AN Functions

This section describes the functions of the Access Node in an overview.

Provide the Transport Network for the CDMA2000 1X system

The main function of the AN is to provide the Transport Network for the CDMA2000 1X system.

The Access Node, which consists of a set of Layer 2 switches and Layer 3 routers, performs the following Transport Network functionality:

- Interconnection all of the CDMA2000 1X system devices into a hub–like formation, using span line and Ethernet interfaces.
- Implement BTS backhaul functions by aggregating span links to/from the BTSs.

  For 16.0, only the CDMA2000 1X Supplemental traffic channel is backhauled from the BTS (through a DACs) to the AN Aggregation Point frame.

  For 16.1, both the CDMA2000 1X Supplemental channel *and* Fundamental channel is backhauled from the BTS Router (no DACs used) to the AN Aggregation Point frame.

NOTE

For Packet BTS only there will still be 16.0–like 1X BTSs.

NOTE

For 16.0 the scenario is called “split backhaul” since the Fundamental channel traffic still follows the old circuit path to/from the BTSs, but the Supplemental channel interfaces directly to the AN. For 16.1 the scenario is called “full packet backhaul” since both traffic channel types interface directly to the AN to/from the BTSs (actually, the BTS Routers).

- The IP Switch performs the Layer 2 switching and Layer 3 routing of all IS–95/IS–2000 call traffic (voice, circuit, and packet data calls), control signalling, and O&M needed to support call processing in the CDMA2000 1X system.

  In 16.0, the IP Switch performs Layer 2 switching and Layer 3 routing for 1X packet data call Fundamental and Supplemental channels.

  In 16.1 with pBTS feature, the IP Switch performs Layer 2 switching and Layer 3 routing for all call types.
- The AN functions as a pass–through network that interfaces the cellular network to IP data networks to transport packet data call traffic. The IP data network elements that must interface to the cellular network are the PDSN, AAA and optionally the HA. The AN can connect to other networks using LAN and WAN interfaces with Layer 3 routing functions.

Integrate separate ANs to increase the borders of the CDMA2000 1X system

To integrate separate ANs (local and/or remote), it is necessary to use LAN–WAN routers. The AN uses the protocols necessary to establish inter–AN communication.

A main purpose of integrating multiple ANs, and therefore multiple BSSANs, under one OMC–R is to extend the O&M and soft handoff boundaries further across multiple AN areas.

Mesh Elimination Feature

The AN enables the Mesh Elimination feature.

Implement the Following Switching and Routing Protocols

OSPF (Open Shortest Path First) is the AN's primary routing protocol. It uses OSPF version 2. The router, when receiving data to send to a destination, determines the best/most efficient path to the network destination based on routing tables that it continually updates with the status of links between network routers (OSPF requires routers in the network to send messages indicating current status of links). Routers using OSPF determine the best path to the network destination based on the metric of bandwidth (other protocols use other metrics, such as hop count for example, which is distance–based). The OSPF protocol supports authentication.

The AN uses other common protocols such as:

- SNMP (Simple Network Management Protocol) which is enabled on the system to manage AN performance and troubleshoot network problems
- PPP (Point–to–Point): PPP is a protocol for transporting data across Point–to–Point links through a WAN to remote networks.
- TCP, UDP, IGMP, PIM, SCTP, BGP, PPP, HSRP, VTP.

IP Switch Frame (*Catalyst*)

Overview

The AN IP Switch (*Catalyst* 6509) is the central IP Switch of the IP RAN Architecture. All Ethernet connections are connected to the *Catalyst* 6509. The *Catalyst* 6509s are deployed in a redundant pair configuration so each device in the network has a redundant Ethernet link to ensure a robust network.

An IP Switch consists of a *Catalyst* 6509 chassis, with redundant power supplies and nine available slots. The backplane capacity is scalable to 256 gigabits. Supervisor cards occupy two of the slots. The remaining seven slots hold a combination of 48 port 10/100 MB Ethernet switching modules and 16 port 1GB Ethernet switching modules. The operator can configure or add additional Ethernet switching modules as required, to accommodate additional connections to the network.

Inputs and Outputs

The *Catalyst* Inputs and outputs (bidirectional) are from almost every card and device in the data portion of the system. The *Catalyst* function is that of a switch so any element that requires switching and that is virtually all Data elements will go through the *Catalyst*.

Application Considerations

The *Catalyst* 6509 must be located with its associated CBSCs and *MGXs*. If transmission lengths exceed 100 meters, special physical media considerations need to be implemented. It will support remote connections to other Access Nodes and an OMC–R through a WAN connection.

Functions

The IP Switch performs the following functions.

Layer 2 (Data–link Layer) Switching

The IP Switch performs Layer 2 switching of bearer and control traffic to and from the IP RAN devices.

Layer 2 switching is a data link layer function that connects the LAN links and forwards data based on physical addresses received from the upper layer (Layer 3, the network routing layer). Layer 2 switching also involves notifying upper–layer protocols of frame errors, and sequencing out–of–order frames.

Layer 3 (Network Layer) Routing

The IP Switch performs Layer 3 routing of traffic to and from:

- Devices directly connected to that particular Access Node.
- Devices connected to other ANs.

> **NOTE**
>
> It is possible to co–locate ANs.

Layer 3 routing has two major functions: path determination and forwarding (transporting incoming packets arriving at one interface port to one or more output ports).

The AN uses the OSPF protocol for the primary routing function.

The BGP protocol is used for inter–AN connections.

The Supervisor card with MSFC (Multilayer Switch Feature card) performs the initial Layer 3 routing decisions using the MLS (Multi–Layer Switching) protocol, which routes the first packet, and then switches the subsequent packets to save router processing.

VLAN (Virtual Local Area Network)

The IP Switch uses the Layer 2 VLAN protocol between the *Catalyst* and the Transcoder PSI cards (all packet PSI interfaces are in one VLAN, and all circuit PSI interfaces are in another VLAN). A VLAN is a logical subnet or a broadcast domain. The VLAN is similar to the subnet at Layer 3.

Load Sharing and Redundancy

A variable number of Gigabit Ethernet links connect two *Catalyst* switches together within the IP Switch frame, using fiber or Ethernet Category 5 cross–over cables. This provides both load sharing and redundancy. This trunk uses ISL, a Cisco protocol, for the connection.

Hot Standby Routing Protocol (HSRP)

HSRP was created to provide a mechanism for routing around router faults without requiring every host to run the routing protocol. This protocol will be used in the CDMA RAN to provide fault tolerance for the XC PSI card and other devices that do not run OSPF (such as the 3com PDSN).

Card Descriptions

Gigabit Ethernet Modules – The 16–port Gigabit Ethernet modules support the physical interface for gigabit connectivity. The Supervisor card uses a Gigabit Interface Converter (GBIC) which works in conjunction with the Gigabit Ethernet Module.

10/100BaseT Ethernet Modules – The 48–port 10/100BaseT Ethernet Modules provide the 10/100BaseT physical interface for Fast Ethernet connectivity.

Supervisor card – The Supervisor card contains the Layer 2 and Layer 3 forwarding engines, with 2 GBIC interfaces. The Supervisor card also contains the MSFC Multilayer Switch Feature, which makes the initial Layer 3 forwarding decisions.

Signal Flow

The signal flow for the *Catalyst* 6509 is typical for an Ethernet switch. Signals are terminated on line cards and switch through Supervisor engines.

10/100BaseT Ethernet Cards – provide Fast Ethernet switching of call, control, and O&M traffic between the *Catalyst* and:

- PDSN
- MM
- OMC–R
- OMC–IP
- *MGX* RPM card (Aggregation Point)
- In 16.0 and 16.1 without SDU: XC PSI–PCF and XC PSI–SEL.

Gigabit Ethernet Modules – provides Gigabit Ethernet switching of call, control, and O&M traffic between the *Catalyst* and:

- SDU
- VPU
- XC PSI (Circuit–to–Packet Interworking function)
- *Catalyst* in the same IP Switch frame

Redundancy

The IP Switch frame contains two *Catalyst 6509* chassis for purposes of redundancy. A variable number of Gigabit Ethernet links (*Catalyst* Gigabit Ethernet modules) connect the two *Catalyst* switches.

For each redundant type of device, the system automatically updates a standby unit to take the place of a primary unit if and when any of the following circumstances occur:

- The system detects the critical failure of a primary unit.
- A primary unit is taken out of service by operator command.
- A primary unit is physically removed from the frame.

Table 6-1: *Catalyst* 6509 redundancy

Component	Hardware Redundancy Type	Comments
Catalyst Sup Eng/MSFC	2N	Routing protocol. HSRP for XC end nodes.
Catalyst GB or FE Ethernet cards	6509 pair (Not redundant in chassis)	Provides Ethernet connectivity. Ethernet path redundancy.
IP Switch Power Supply	2N	Redundant power supply and fans take over in case of failure.

Operations and Maintenance

The operator uses the OMC–R to generate the configuration files for the IP Switch, in terms of adding links to the network, and other functions.

An Operations and Maintenance Center – IP (OMC–IP) will handle operations and maintenance control for the Access Node components and interface with the existing network management architecture, i.e. the OMC–R and UNO platforms. Cisco software products are planned to run on a Sun hardware platform with a Solaris operating system. Other BSC elements, such as the SDU, MM, XC, and BTS are supported and managed by the OMC–R.

Aggregation Point Frame (*MGX*)

Overview

The Aggregation Point frame (*MGX*) implements BTS backhaul functions by aggregating span links to/from the BTSs.

The Aggregation Point frame contains an *MGX 8850* chassis, with redundant power supplies and 32 single height (16 double/full height) function module slots.

The standard configuration reserves two full slots for the redundant PXM1 processing engine, and two half slots for the Service Redundancy Modules (SRM) per shelf. This leaves 12 usable full height slots that can contain T1 cards, T3 cards, etc. or Route Processor Module (RPM) cards. The span termination Frame Relay Service Modules (FRSM) are in the front of the chassis, with span termination cards in back. An eight port T1 card takes a single slot. The RPM card is a double–slot front card with two single slot Fast Ethernet back cards.

16.1 Changes

16.0 introduced 1X voice and data into the system.

For the 16.0 release, the following traffic types were backhauled with the current circuit backhaul functionality.

- voice
- circuit data
- 1X fundamental channel
- IS95B data

1X supplemental channels were backhauled over dedicated DS0s on the same span as the voice circuits and were split out by a DACS or other span–grooming device at the CBSC location and sent to the AN Aggregation Point (Cisco *MGX*8850). Optionally, at large sites where a separate span is needed to handle all the data DS0s, the data DS0 span can be backhauled directly to the *MGX*.

For 16.1, the packet backhaul will bring greatly increase backhaul efficiency and reduced costs. The impact on the AN is the addition of one new card (Compression Adapter) and some additional cards required to handle the increased packet traffic brought on with the inclusion of packetized voice along with the data in 16.0.

Functions

The AN Aggregation Point performs the following functions:

- It aggregates BTS spans containing the voice and data traffic
- The Aggregation Point connects with the IP Switches in order to transport data to and from BTSs to the network. It sends data to and from the AN IP Switch (*Catalyst* 6509 IP Switch).

The spans terminate on a T1, E1, or T3 port card. The processing for span termination occurs on Frame Relay Service Modules (FRSMs). Data is routed on the backplane and switched through the Processor Switch Modules (PXMs) to the Route Processor Modules (RPMs.) Traffic is sent to and from the RPMs via 100Mbit Ethernet to the *Catalyst* 6509.

Point to Point Protocol with Multiplexing – PPPMux is a new protocol that increases the utilization of slow serial links for real–time applications that generate a large number of small packets. The improvement is provided by multiplexing multiple application level packets in a single PPP frame thereby reducing the PPP header overhead per packet.

MuxPPP is used to encapsulate IP packets transported between the BTS Router and the RPM over the WAN interface.

The Compression Adapter card is added to the *MGX* to perform the PPP Mux/de–mux functions.

Table 6-2: MuxPPP in RAN

Network element	Purpose	Communicates with
MGX RPM card (Edge Router)	Transport IP datagrams over its WAN Interface to the BTS Router	BTS Router
BTS Router	Transport IP datagrams over its WAN Interface to the Edge Router (RPM card)	*MGX* RPM card (Edge Router)

Multi link Point to Point protocol – MLPPP is a protocol that provides the capability to coordinate multiple independent links between fixed pair of systems, providing a virtual link with bandwidth equal to sum of the bandwidths for individual links. The aggregated link is called a bundle.

MLPPP will be used to transport HDLC frames over multiple links between the BTS Router and the *MGX* RPM card (Edge Router).

Table 6-3: MLPPP

Network element	Purpose	Communicates with
MGX RPM card (Edge Router)	Transport HDLC frames over multiple links to the BTS Router	BTS Router
BTS Router	Transport HDLC frames over multiple links to the *MGX* RPM card (Edge Router)	*MGX* RPM card (Edge Router)

NOTE

The WAN routers may also use MLPPP.

cUDP – Compressed User Datagram Protocol (cUDP) is a method for compressing the headers of IP/UDP datagrams to reduce overhead on low–speed serial links. In many cases, the two headers can be compressed to 2–4 bytes.

The BTS router uses cUDP for sending UDP data, coming from the Packet BTS, over the packet back haul to the Edge Router (the *MGX* RPM card) where the Compression Adapter converts cUDP to UDP before forwarding it on to the rest of the AN. On the forward link Edge Router uses cUDP to transmit UDP data to the BTS Router over the packet back haul. BTS Router then converts the data back to UDP before forwarding it to the Packet BTS.

The Compression Adapter card implements this feature.

Table 6-4: cUDP

Network element	Purpose	Communicates with
BTS Router	forwarding UDP data	RPM (Edge Router)
RPM (Edge router)	forwarding UDP data	BTS Router

Inputs and Outputs

For Circuit backhaul, the inputs (bidirectional) come from the DACS via T1 or T3 and are the aggregated packet pipes from the various BTSs. The outputs go to the RPM card via the *MGX* bus; they are the packetized version of the backhaul sent to the *Catalyst* for routing to the various modules.

For packet backhaul, the inputs come from the DACs via T3 or from the BTS/BTS RTR via packet backhaul.

Card Descriptions

- PXM1 card – Processor Switch Module. The PXM is the brains of the *MGX* and has a 1.2 Gbps switching capability. The PXM card provides the internal ATM switching fabric for the *MGX*. The PXM also handles RPM redundancy. In the event of an RPM card failure, the PXM signals the redundant RPM to load the configuration of the failed RPM, and re–maps through the mid–plane the appropriate data connections to the newly active RPM. The PXM also has 1:1 hot standby redundancy.
- UI card – Provides connectivity to the user interface.
- FRSM card – Frame Service Module, which provides transport to the RPMs within the *MGX* chassis. The FRSM back cards provide physical termination of the T1/JT1/E1 and T3 links.
- FRSM Redundant back cards – The FRSM redundant back cards provide loopback capability for the redundant FRSM cards so that the corresponding FRSM front cards are recognized as redundant.
- SRM cards – Service Resource Module, provides redundancy control for the FRSM cards.
- RPM cards – RPM cards are the *Edge Routers* for the system. RPM determines the path to route traffic to the next network element. The main RPM function is to route traffic to and from the BTS. RPMs are required for Layer 3 services such as routing, load balancing and load sharing. The front RPM is the route processor engine.

  An individual RPM card feeds two Ethernet back cards. The two Ethernet cards operate in load balancing/sharing fashion. The options, per RPM, include:
  - Two RJ–45 FEs – used for circuit backhaul
  - One 1FE–CP and one RJ–45 FE – used for packet backhaul
  - Two 1FE–CPs, one with the CP (Compression) function disabled and only acting as an FE interface – used to increase capacity for a packet backhaul system. Release 16.4.1 introduces this capability.

- 1FE–CP card – The Compression Adapter / Fast Ethernet backcard provides a Compression Adapter function in addition to Fast Ethernet connectivity.
  - MuxPPP
  - MLPPP
  - cUDP

Signal Flow

For 16.0, signals flow through the *MGX* as follows: from the BTS to the span backcard, to the FRSM, to the PXM1 to the RPM to the Ethernet backcard to the *Catalyst* 6509 IP Switch. The signals to the BTS follow a reverse path.

For 16.1 with the pBTS feature:

- Traffic to/from the BTS Router (HDLC) terminates at the *MGX* FRSM span line card (T1, E1, etc).
- The PXM card switches traffic between the FRSM and RPM using an ATM cell bus.
- The RPM makes the Layer 3 routing decision, and also works with the Compression Adapter function on its corresponding Compression Adapter/Fast Ethernet backcard to process the packets for input/output:
  - MuxPPP processing
  - MLPPP processing
  - cUDP processing
- The RPM card sends/receives UDP traffic through the two Fast Ethernet backcards. Since the RPM card uses the two Fast Ethernet back cards for load sharing purposes, the back card used to output the traffic will depend on current bandwith usage.

The following traffic types flow through the *MGX*:

- For 16.0, only the CDMA2000 1X Supplemental traffic channel is backhauled from the BTS (through a DACs) to the AN Aggregation Point frame.
- For 16.1 with the pBTS feature, both the CDMA2000 1X Supplemental channel *and* Fundamental channel is backhauled from the BTS Router (no DACs used) to the AN Aggregation Point frame.

Redundancy

There are redundant connections from each RPM card to each *Catalyst* (100BaseT Fast Ethernet card).

Table 6-5: *MGX* Redundancy

Component	Hardware Redundancy Type	Impact on *MGX* Services When Failed Unit Recovered
MGX PXM1	2N	Hot standby PXM switches over on detection of failure.
MGX RPM	N+1	Redundant RPM switches over on detection of failure. Upon initiation from PXM1, configuration of the primary card is copied to a standby card after it becomes active.
MGX FRSM T1/JT1/E1	N+1 per shelf	FRSM in each shelf switches over under SRM control.
MGX T1/E1/J1 Back Card	Not Redundant	Provides span connectivity.
MGX FRSM T3/J3	2N	Hot standby FRSM switches over on detection of failure.
MGX T3/J3 Back Card	2N	Provides span connectivity.
MGX SRM	2N	Redundant SRM for each active SRM per FRSM shelf. Note that the SRMs on the top/bottom shelf provide redundancy for the FRSMs on the top/bottom shelf.
MGX Power Supply	2N	Redundant unit takes over in case of failure.

Operations and Maintenance

An Operations and Maintenance Center – Internet Protocol (OMC–IP) will handle operations and maintenance control for AN components and interface with the existing network management architecture; i.e., the OMC–R and UNO platforms. Cisco software products will run on a Sun hardware platform with a Solaris operating system.

OMC–R will continue to support other CBSC elements, such as the Mobility Manager (MM), Transcoder (XC), and BTS.

Overview of IP RAN Protocols

The following pages cover the basic protocols implemented in the IP RAN.

IP

Internet Protocol (IP) is the basic network layer service implemented in the Radio Access Network (RAN), and it forms the foundation for the network's higher–level protocols.

Properties of IP:

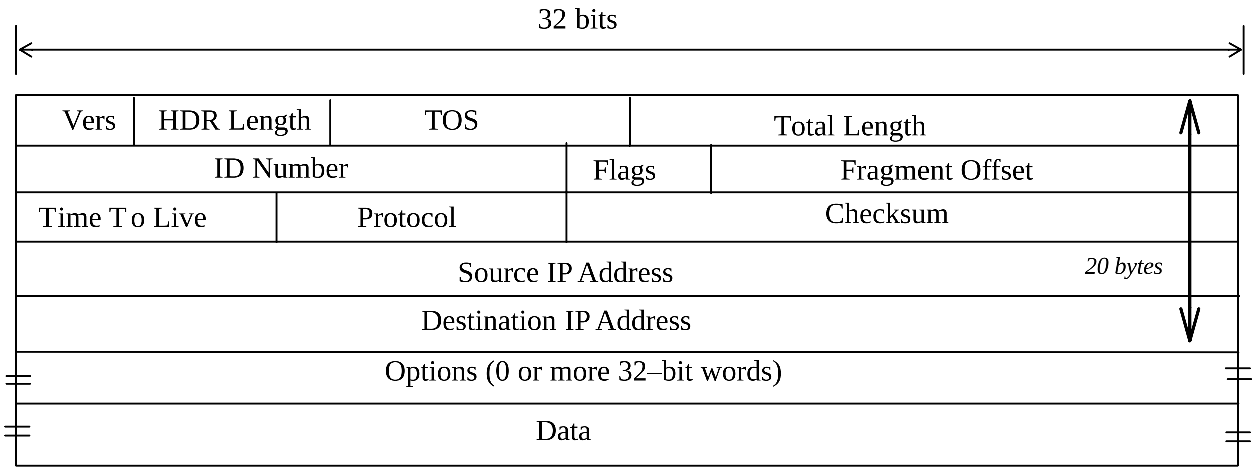
- Connectionless (datagram–oriented) — packets are delivered with "best effort" service

> **NOTE**
>
> The RAN/BSSAN implements QoS functions to improve service. For more information, refer to the "QoS" section.

- Unreliable Transmission — lost packets are not retransmitted (no acknowledgement)
- Segmentation — if necessary, the sending host and/or intermediate routers will segment messages into more than one IP packet
- Reassembly — segmented messages are reassembled by IP at the receiving host

IP packets are made up of two parts: header and payload. The IP packet header is used to address the message so that it can be delivered to its destination. The header also contains other information such as precedence and error detection data. The payload portion of the packet contains the data that is being transported.

Figure 6-2: IP Packets



IP Datagram Format

IP is the network layer mechanism for all applications in the network. Thus, O&M, Call Processing and Bearer Traffic applications all use IP. Similarly, any network element which must communicate with any other network element must implement IP.

The following table lists the network elements that implement IP.

Table 6-6: IP Applications

Network Element	Communicates with
OMCR	Customer Workstations, UNO, MM, XC(OMP), pBTS, SMAP, FEP, Terminal Server, OMCIP, SDU/VPU SPROC
UNO	OMCR, Customer workstation, TCM, PDSN
MM	OMCR, XC (OMP), XC (FEP), XC (PSI–PCF), pBTS, MM (remote), MM (DNP node–to–node), SDU, VPU
XC (OMP)	OMCR
XC (FEP)	MM, OMCR
XC (PSI–SIG)	XC (remote PSI–SIG), pBTS, SDU (SDF), VPU–vpf (cktiw)
XC (PSI–CE)	Remote XC (PSI–CE), XC (PSI–SEL), pBTS, SDU (SDF)
XC (PSI–PCF)	XC (PSI–SEL, local and remote), PDSN, MM

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Table 6-6: IP Applications	
Network Element	**Communicates with**
XC (PSI–SEL)	XC (PSI–PCF, local and remote, PSI–CE), MAWI–1X or MCC–1X (via packet pipe), pBTS
XC (PSI–TER)	VPU–vpf (cktiw)
SDU (SDF)	MM, SDU (PCF, local and remote), XC (PSI–CE), XC (PSI–SIG), pBTS, VPU vpf (a5iw)
SDU (PCF)	PDSN, SDU (SDF local or remote), MM
VPUvpf(voc)	MM, SDU (SDF)
VPUvpf(cktiw)	MM, XC (PSI–SIG)
VPUvpf(a5iw)	SDU (SDF)
VPUvpf–ra	MM
SMAP	XC (FEP), Customer workstation, pBTS, SDU (SDF)
MCC–1X, MAWI–1X	MM, OMCR, XC (PSI–SIG, local and remote), XC(PSI–CE, local and remote), XC (PSI–SEL, local and remote)
OMCIP	OMCR, TN, RPM, *Catalyst*, *MGX*, Cisco PDSN
Customer Workstation	UNO, SMAP
AAA	PDSN
3COM PDSN	XC (PSI–PCF), SDU (PCF), UNO, TCM, AAA
Cisco PDSN	XC (PSI–PCF), SDU (PCF), UNO, OMCIP, AAA
TCM	UNO, IWU, 3COM PDSN
Terminal Server	OMCR
pBTS SPROC	MM, SDU, XC and OMCR
pBTS Payload Function	MM and SDU
MOSCAD RTU	MOSCAD GW
MOSCAD GW	MOSCAD RTU, UNO

TCP

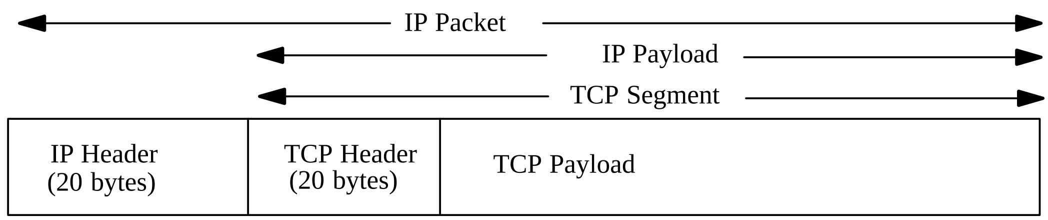
Transmission Control Protocol (TCP) delivers messages between network elements using the underlying IP implementation of the network layer. TCP builds upon IP and provides additional features and capabilities that IP does not provide. The properties of TCP include:

- Connection–Oriented — network elements must establish a connection before they can communicate
- Reliable — lost (unacknowledged) messages are retransmitted
- Flow Control — data rates are adjusted in real time
- Ordered Delivery — messages are delivered in the order intended by the sender

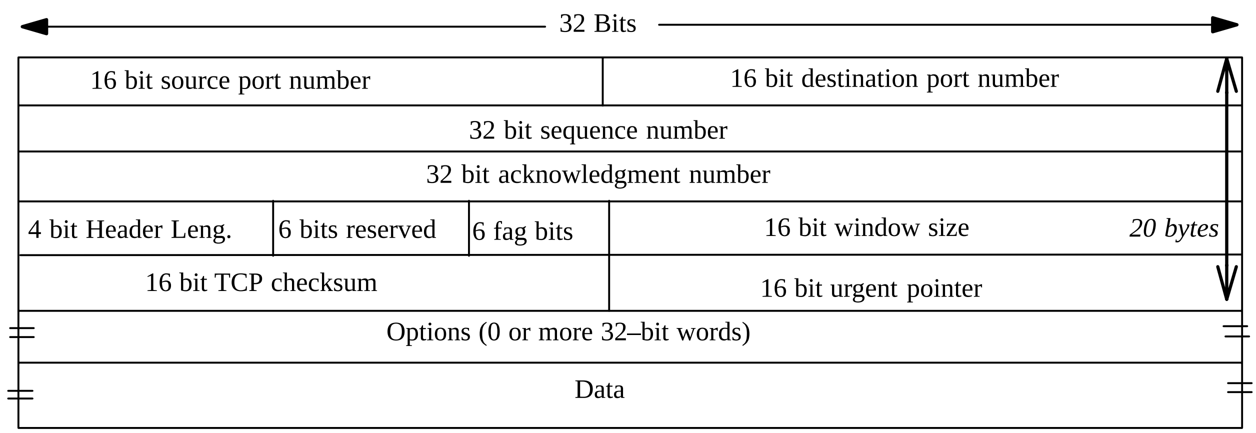
Before data can be exchanged between a client and a server, a point–to–point TCP connection must be established. This is accomplished using a connection establishment protocol performed cooperatively between the two communicating systems. Similarly, connections no longer needed can be cooperatively terminated.

TCP breaks long messages into segments. Each TCP segment is encapsulated in an IP packet (each IP packet contains a single TCP segment).

Figure 6-3: TCP Segments



IP Encapsulation of TCP Segments



TCP Segment Format

TCP is used for O&M applications between the MM and the OMCR. TCP is also used for most communication between the MM and XC devices (for both O&M and for Call Processing). Among other functions, O&M includes data uploads/downloads between the MM and downstream devices (e.g., GLI, MAWI). These functions are performed using the Volume Data Transfer (VDT) application protocol over TCP/IP.

Table 6-7: Network Elements implementing TCP	
Network Element	**Purpose – Communicates with**
OMCR	O&M – MM, UNO, SMAP
MM	O&M – OMCR, XC(FEP), UNO CP – XC–FEP
XC (FEP)	O&M – OMCR, MM, UNO CP – MM
SMAP	PM – OMCR
SDU and VPU	O&M – OMCR
pBTS–SPROC	O&M – OMCR
MOSCAD RTU	O&M – MOSCAD GW
MOSCAD GW	O&M – MOSCAD RTU, UNO

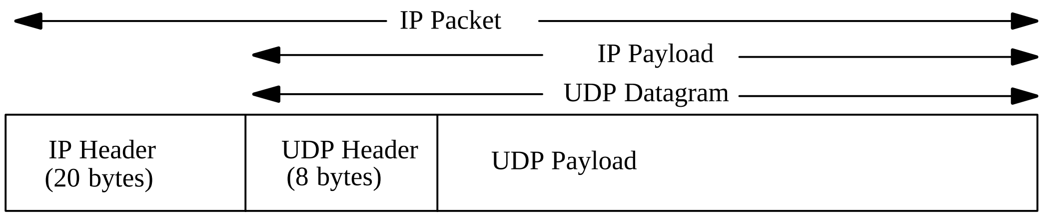
UDP

User Datagram Protocol (UDP) delivers messages between network elements using the underlying IP network layer (similar to TCP). However, UDP is much simpler and provides a much more limited set of capabilities compared to TCP. UDP is primarily used with applications where the additional overhead of TCP is not desired, and reliable delivery at the transport layer is not required. The properties of UDP are:

- Connectionless — no virtual connection is established between sender and receiver
- Unreliable — no provision is made for detecting or retransmitting lost messages
- No Segmentation or Reassembly — no provision is made to segment or reassemble long messages (each UDP message results in a single IP datagram)
- Unordered Delivery — messages are not guaranteed to be delivered in the order they were sent

Each UDP datagram is encapsulated into a single IP datagram.

Figure 6-4: UDP



IP Encapsulation of UDP Datagrams

32 bits

Source Port Number (16 bits)	Destination Port (16 bits)
UDP Length (16 bits)	UDP Checksum (16 bits)
Data (if any)	

UDP Datagram Format

The MM uses UDP for sending Paging request messages to the XC. UDP is also used in some O&M operations (i.e., bulk data downloads/uploads between the MM and OMCR using Trivial File Transfer Protocol, TFTP, which is built on top of UDP, bearer traffic).

In 16.1, the Helix MM uses UDP for communication with the SDU (SDF).

Table 6-8: UDP Implementation		
Network Element	**Purpose**	**Communicates with**
OMCR	O&M	OMP, XC (FEP), pBTS–SPROC & SDU
MM	Paging	XC(FEP), pBTS–SPROC, pBTS–PAYLOAD Function
XC (PSI–SEL)	Supplemental channel management	MCC–1X, MAWI–1X, pBTS–SPROC
	Control	XC(PSI–CE)
	O&M	OMCR
	Bearer	MCC–1X, MAWI–1X, Remote XC(PSI–CE), pBTS–PAYLOAD Function
XC (PSI–PCF)	Control	PDSN, XC(PSI–SEL)
	O&M	OMC–R
XC (PSI–CE)	Bearer	Remote XC(PSI–CE), XC(PSI–SEL), pBTS–PAYLOAD Function
XC (PSI–TER)	Bearer	VPUvpf(cktiw)
MCC–1X, MAWI–1X	Supplemental channel management	XC(PSI–SEL)
	Bearer	XC(PSI–SEL)
Catalyst	Routing protocols	*Catalyst*, *MGX* RPM card (Edge Router)
MGX RPM card (Edge Router)	Routing protocols	*Catalyst*, *MGX* RPM card (Edge Router)
PDSN	Bearer	External networks
SDU (core)	Control	MM (SDU–RA)

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Table 6-8: UDP Implementation		
Network Element	**Purpose**	**Communicates with**
SDU (core)	O&M	OMCR
SDU (SDF)	Bearer Traffic	XC (PSI–CE), pBTS, SDU (PCF), VPUvpf(voc), VPUvpf(a5iw)
	Call Control	MM (Helix)
SDU (PCF)	Bearer Traffic	PDSN, SDU (SDF)
VPU (SPROC)	Control	MM
	O&M	OMCR
VPUvpf(voc)	Bearer Traffic	SDU (SDF)
VPUvpf(a5iw)	Bearer Traffic	SDU (SDF)
VPUvpf(cktiw)	Bearer Traffic	XC (PSI–TER)
pBTS–SPROC	O&M	OMCR
pBTS–SPROC	Control	MM, SDU
	Routing	BTS Router
pBTS Payload function	Control	MM, SDU
	Bearer	SDU
BTS router	Routing protocols	RPM, Packet BTS

SCTP

SCTP (Stream Control Transmission Protocol) is similar to TCP in that it provides for the reliable transport of data via virtual connections. However, the architecture of these connections and the way in which they are managed is very different from TCP. The basic characteristics of SCTP are:

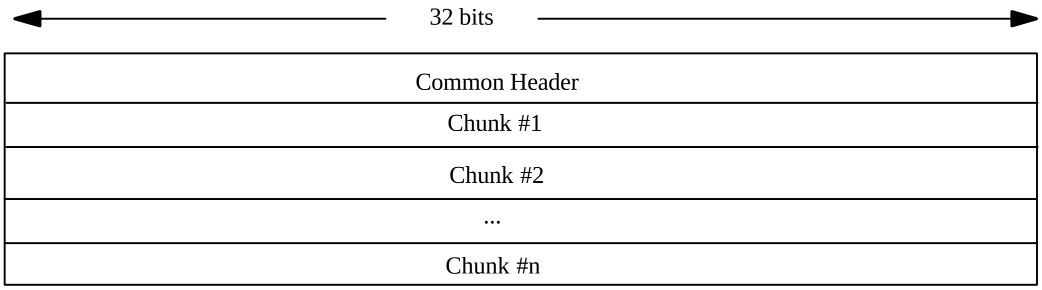
- Connection–Oriented — virtual circuits called associations are established between hosts
- Reliable — the protocol detects and retransmits lost (unacknowledged) messages
- Segmentation — messages are segmented to conform to the discovered path MTU
- Flow Control — data rates are adjusted in real time
- Path Redundancy — multiple destination IP addresses per association provide path redundancy
- Heartbeats — the built–in heartbeat mechanism facilitates link fault management

As mentioned previously, SCTP is connection–oriented (like TCP), however, the connections (called ”associations”) are more sophisticated. When an association is created between two endpoints, each endpoint can provide a list of destination transport addresses (i.e., multiple IP addresses sharing a single SCTP port number) that the endpoint will use to receive messages. Therefore, an association between two endpoints includes all of the possible source/destination IP address combinations, which provides path redundancy.

Functionally, SCTP provides a number of sub–functions. For details refer to the SCTP standards document identified below. To summarize, these functions are:

- Association Startup and Takedown — Associations are initiated on request by an SCTP User. Associations can be terminated gracefully using the TERMINATE primitive or they can be terminated ungracefully using the ABORT primitive.
- Sequenced Delivery within Streams — SCTP Streams are a method of multiplexing several data streams (i.e., sequences of user messages) within an association. This optional function uses a stream identification number to isolate streams of messages from one another within the association. There are no plans to use this functionality in 16.0.
- User Data Segmentation — SCTP will segment user data as required to conform to the re–quirements of lower level protocols such as IP (i.e., the Maximum Transmission Unit).
- Acknowledgment and Congestion Avoidance — SCTP uses Selective Acknowledgement (SACK) to acknowledge specific data chunks within an SCTP datagram. Congestion Avoidance and Congestion Control mechanisms are very similar to those implemented in TCP.
- Chunk Multiplex — SCTP allows the bundling of several user messages (”chunks”) into a single SCTP datagram sharing a common SCTP header. SCTP assembles these multiplexed messages at the sending endpoint and disassembles them at the receiving end–point.
- Message Validation — SCTP uses both a Verification Tag and a Checksum for message validation. A Verification Tag is selected by each of the endpoints during association initialization, and subsequent messages must contain the correct Verification Tag to be accepted. The Adler–32 Checksum validates the accuracy of the data transmitted.
- Path Management — SCTP injects heartbeat messages (in the absence of regular traffic) to constantly monitor the reachability and performance of each destination address in an association. SCTP will direct traffic to the path most likely to provide the best performance at any given time.

Figure 6-5: SCTP Datagrams



SCTP ”chunks” contain either control information or user data. Any number of chunks can be multiplexed up to the MTU (maximum transmission unit) supported by the underlying network layer. Note: there are some restrictions on the types of chunks that can be multiplexed. Refer to the standards document for details.

If a user message does not fit within a single datagram, SCTP will segment it into multiple SCTP datagrams.

Since chunks can be multiplexed into a datagram, each chunk must have its own identification field so that it can be de–multiplexed at the receiver.

Table 6-9: Network elements implementing SCTP

Network Element	Purpose	Communicates with
MM	Call control	XC(PSI–PCF), MM–CP (ICBSC), pBTS, SDU (PCF), SDU (SDF)
	Resource management	pBTS–SPROC, SDU (SDU–RA)
XC (PSI–PCF)	Call control	MM–CP
XC (PSI–SIG)	Call control	XC(PSI–SIG), pBTS–SPROC, SDU (SDF)
SDU (SDU–RA)	O&M	MM
SDU (PCF)	Call control	MM, SDU (SDF)
SDU (SDF)	Call control	MM (Puma), pBTS, SDU (PCF), XC (PSI–SIG), VPUvpf(voc), VPUvpf(a5iw)

table continued next page

Table 6-9: Network elements implementing SCTP		
Network Element	**Purpose**	**Communicates with**
VPUvpf–ra	O&M	MM
VPUvpf(voc)	Call Control	SDU (SDF)
VPUvpf(a5iw)	Call Control	SDU (SDF)
VPUvpf(cktiw)	Call Control	XC (PSI–SIG)
pBTS–SPROC	Resource management	MM, SDU
	Call control	SDU (SDF)

Overview of AN Routing

Routing overview

Routing is the network function used to get a message sent by one host to the correct destination host. Routing in IP networks is done at layer 3 (the Network Layer) using the address that appears in the header of every IP message. Each router in the network is responsible for maintaining a routing table that allows it to forward any incoming message on to the correct host (or the next router in the path).

This table must be updated frequently because routes may fail or hosts may enter or leave the network. Routers become aware of such changes and update their tables. They also share information with other routers in the network so that all other router tables get updated with any new information.

Routing protocols are used to standardize the router–to–router communications and other aspects of the routing function.

Autonomous System Overview

The concept of an Autonomous System (AS) is used to establish routing management domains in large networks. The AS represents a single routing domain managed as a single unit. Routers within an AS work cooperatively to develop the required routing tables for the AS. Routing advertisements for the AS remain within the AS.

Routing outside of the AS is controlled only by routers designated to be AS border routers (ASBR in OSPF routing protocol). Border routers may run different protocols and may be managed differently from other routers within an AS.

Routing within the AS can be further subdivided into areas with a hierarchical relationship. Area hierarchies are used to limit how widely routing information is shared. Typically, routers within an area share a complete routing database. However, routers that share data between areas (known as Area Border Routers or ABRs in the OSPF routing protocol) limit the routing information they share.

The Layered Network Model

A layered model is often used to design large networks. The layered model is useful when discussing routing within a network since it helps determine which functions each component in the network will perform.

It is important to remember that these layers are not necessarily highly distinct. A given layer may be spread across a number of network elements. Conversely, a given network element may play a role in several layers simultaneously.

The Core layer provides the backbone functionality. It provides high–speed switching between routing sub–domains and requires a high degree of route summarization. In the BSSAN AS, this function is provided in the aggregate by the IP Switch MLSs and the Aggregation Point Edge Routing functions. Additional routers may be implemented in the BSSAN to provide WAN connectivity to other BSSANs or connectivity to customer LANs. These routers, if they are present, are also part of the core layer.

The Distribution layer provides functions that require the manipulation of IP packets or the building of routes within non–backbone areas of the network. In the BSSAN AS these services are also provided by the IP Switch MLSs and Aggregation Point Edge Routing functions in the AN. This is possible because these routers lie on the boundary between the Core and Distribution areas. These routers serve both layers simultaneously.

In simplest terms, the Access layer provides an interface to services required by users of the network. In the BSSAN AS, this function is provided by the BSS.

OSPF

The Open Shortest Path First (OSPF) routing protocol is a link state protocol (rather than a distance vector protocol like RIP). This means that each router does not exchange distances with its neighbors. Instead, each router actively tests the status of its link to each of its neighbors. The results of these tests is forwarded on to other neighbors which propagate it on to their neighbors and so on. OSPF embodies a number of concepts that affect the way that the network is configured.

An OSPF router detects neighboring routers by sending a “hello” message to a multicast address reserved for that purpose. When a router detects a neighbor (by receiving a response to its hello message) it attempts to form an adjacency with that neighbor.

Adjacency is a relationship formed between neighboring routers for the purpose of exchanging routing information (not every pair of neighboring routers become adjacent in a typical network but in the CDMA RAN it is likely that all routers will form adjacencies with all their neighbors since they are all on area borders as will be described later). Adjacencies are established during network initialization in pairs, between two neighbors. As the adjacency is established the neighbors exchange information and build a consistent synchronized database between them.

For example, an MM is connected to a *Catalyst*. The MM and *Catalyst* discover each other because they multicast out hello packets on their interfaces. The MM and the *Catalyst* cooperatively create an adjacency because they are neighbors.

OSPF routers will send hello packets to all their neighbors periodically. Any changes in the network's topology (from added, removed or failed routers) will be detected when the hello packets are sent. When a change is detected by an adjacent router using the hello protocol, Link State Advertisements (LSAs) are sent to all other routers in the area. LSAs contain (among other things) the names of all the links that the router is aware of and the cost of these links. LSAs make it possible for all the router databases to be updated. The point at which all the routers have updated databases that are in agreement is called "convergence".

OSPF Hierarchies

OSPF uses a hierarchical routing concept to allow large scale network topologies. Without this hierarchical design, increasing the scale of the network would increases the size of routing tables maintained by each router and the number of inter–router messages needed to update the tables limiting the practical size of the network that can be implemented.

OSPF solves this problem by designating OSPF areas. Routing information for an OSPF area is exchanged between routers within the area. However, routing advertisements external to the OSPF area are restricted to (typically) a single summarized route that encompasses the entire OSPF area.

Several OSPF areas can be connected together by a backbone area (always indicated as OSPF Area 0). The backbone can be a high–speed switching network because it only needs to route to a small number of mostly stable routes.

Within these areas in multiaccess networks (networks supporting more than two routers), the hello protocol elects a designated router (DR) and a backup designated router (BDR). Among other things, the designated router is responsible for generating LSAs for the entire multiaccess network. Designated routers allow a reduction in network traffic and in the size of the topological database. Hello packets are exchanged via IP multicast on each segment. The router with the highest OSPF priority on a segment will become the DR for that segment. The same process is repeated for the BDR. In the case of a tie, the router with the highest RID will win. Both OSPF priority and RID are configurable items. Routers set to OSPF priority 0 (on a given port) will not be selected as the designated router.

OSPF areas have the following characteristics:

- All routers within the area have the same OSPF area ID
- Both internal routes and external routes are summarized wherever possible

In an OSPF routed network, different routers play different roles. There are 4 router roles:

- Internal Router (IR): All networks and hosts directly connected to an IR belong to the same OSPF area. IRs all have the same link state database because they all belong to the same area.
- Area Border Router (ABR): ABRs are located on the border of one or more OSPF areas. ABRs connect their OSPF area to the backbone area. ABRs distribute only summarized routes to the backbone. ABRs have multiple instances of the link–state database, one for each area to which it attaches.
- Backbone Router (BR): BRs typically have an interface to the backbone area (area 0) and several other OSPF areas. BRs do not have to be ABRs.
- Autonomous System Border Router (ASBR): ASBRs are connected to more than one AS and exchange routing information with routers in another AS. Normally, ASBR runs both OSPF and a boarder routing protocol like BGP.

Stubby areas – To reduce the cost of routing, OSPF supports stub areas. A stub area is a LAN connected to an OSPF back–bone in which a default route summarizes all external routes. Typically stubby areas have only a single exit point and are connected to the backbone by a single ABR.

For such areas there is no need to maintain information about external routes. Stub areas do not receive LSAs for external routes. Therefore stub areas differ from regular OSPF areas in that the stub area routers maintain routing information only for intra–area routes and the default route (to the single area exit point).

In addition “totally” stubby areas are supported in OSPF (but only on Cisco routers). As in stubby areas, external routes are not advertised to the totally stubby area. However, in totally stubby areas, routes internal to the OSPF area containing the totally stubby area are also not advertised to other totally stubby areas. This means that intra–area routes are not known to the totally stubby area routers. In summary, this means that no LSA are sent to a totally stubby area and no LSAs are sent out from the totally stubby area except for the default route.

Routers within the stubby area only have entries for the default path to their closest ABR gateway. This path is used for any traffic flowing into or out of the totally stubby area.

OSPF on Cisco routers also supports areas called Not so Stubby Area (NSSA). These areas are similar to a stub area except it has the capability to import AS external routes in a limited capacity within the NSSA area.

BSSAN Implementation

Overview

In R16.0 the BSSAN is equivalent to the Autonomous System (AS) for routing purposes. The BSSAN AS contains the Area 0 (backbone), Area 1 and Area 2.

In 16.1, a single BSSAN contains a Core AS plus one AS for each external network (pBTS and SDU) allocated from the private set of AS numbers. The core AS number is equivalent to the R16.0 BSSAN AS number. The Core AS contains Area 0, Area 1, Area 2 and Area 3. It contains the CBSC devices and the BTS routers (only the links to the *Catalyst*).

1X Circuit BTSs will be connected to the CBSC through span grooming functions on separate T1 (or other) communication spans that terminate on an Aggregation Point using packet pipes. This function remains unchanged in the R16.1 network design.

Area 0

The backbone (Area 0) of the BSAAN AS in R16.0 or BSSAN Core AS in 16.1 is defined to include all AN IP Switches (*Catalyst*s) , Aggregation Points (e.g. *MGX*8850 w/RPM)) and all the interfaces between them. Since all these routers are also on the boundary of Area 0 each router is both a Backbone Router (BR) and an Area Boarder Router (ABR). These routers also provide interfaces external to the AS through WAN connections or gateway routers. If these extra–AS connections are directly connected to the *Catalyst*s, then each *Catalyst* runs BGP on the interfaces and serve as an Autonomous System Boundary Router (ASBR). If the extra–AS connections are provided by adding an additional router (or routers) to serve as the ASBR then links between these routers and the *Catalyst*s are OSPF and links from the ASBR to outside of the AS are BGP.

*Catalyst*s will form adjacencies with all the *MGX* RPM Edge Routers they are connected to and with each other. In addition, they will form adjacencies with other platforms directly connected to them (because they are ABRs). The speed of convergence of OSPF is affected by the number of adjacencies and the number of route entries.

Area 1

The second area is Area 1. Area 1 contains the OMCR, the OMCIP, the Cisco PDSN cluster, the MMs, the AAA, the Terminal Server (TS) and any gateway routers connected to customer LANs.

The area also includes the *Catalyst*s which serve as ABRs for between this area and the backbone (Area 0). Area 1 contains no ASBR routers. It will operate using the default route and will be configured as a totally stubby area. If a device in Area 1 requires more than the default route (if attached to several networks (e.g. O&M LAN and the BSSAN network) then that NE will be configured with the static route(s) summarizing the access to that network (e.g. RAN network could be summarized to 10.x.x.x). Those static routes will alleviate the process of re–distributing in Area 1 external routing information (Type–5 LSA).

Area 2

The third OSPF area is Area 2. This area contains an RPM within an *MGX*, the pBTS router and the connections between them. The RPM card Edge Routers are ABRs for between Area 2 and the backbone (Area 0). This area is actually a series of areas, each one associated with an RPM card Edge Router but having the same area number. This eliminates the need for Edge Routers on each Aggregation Point from having to exchange routing information.

The BTS routers act as ASBR between this area and the pBTS AS. Since Area 2 contains an ASBR, it must be configured as a a "not so stubby area" (NSSA) which limits the flow of LSAs and routes needed to determine the routing functions. However, this allows for external routes from the pBTS to be summarized (as possible) and advertised to area 0. All packets coming from a pBTS can only flow out through the Edge Router and on to the *Catalyst*. The packets flowing into a BTS cannot exit that routing area (stub) and are only terminated there. This purpose of enabling OSPF in this area is to allow the connection to a BTS to be re–parented to another RPM card Edge Router on the same or a different Aggregation Point without changing the configuration files for the pBTS. The Aggregation Point connections may need to be re–configured to match the span provisioning to the pBTS.

Each connection between an RPM card Edge Router and a pBTS router is configured as a totally stubby area. This eliminates the need for route advertisements into or out of these areas (except for the default route) and reduces the routing table on the RPMs /Edge Routers. It also eliminates the need for the RPMs /Edge Routers to exchange routing information about their stubs (because they are totally stubby). Packet pipe connections can also be configured as NSSA so that the same RPM/ Edge Router can be used for both packet pipe connections and pBTS router connections in R16.1 and on. Since these areas are totally stubby and Area 2 is not continuous across all RPMs/Edge Routers, a pBTS router cannot be connected across RPM/Edge Router boundaries.

Hence, area 2 is configure as an NSSA total stub.

IP addressing at each Aggregation Point does not need to be contiguous since there is no summarization at the Aggregation Point level. The addresses for each pBTS are selected from a subnet and can be summarized. All of the spans for a particular pBTS router will generally share a single MLPPP session and must connect to one Edge Router (e.g. one RPM card). However, the spans from a pBTS router may be split into more than one MLPPP group during re–parenting or other operations. Each RPM/Edge Router will connect to two or three pBTSs and can connect to a maximum of 8 BTSs.

Area 3

The fourth OSPF area is Area 3 and is introduced in R16.1. This area contains the SDU and the *Catalyst*s which serve as ABRs between this area and the Core AS back–bone.

For redundancy, each *Catalyst* will have a pair of links per SDU, one link per ISB. Each link is a Gbps Ethernet. The ISBs in the SDU will be configured as ASBRs and therefor this area needs to be configure as NSSA which will allow external–AS LSAs of the SDU to reach the BSSAN. A default route must be provided by the *Catalyst*s to the SDUs to route external addresses.

The only element reachable by SDUs are the *Catalyst*s ABR therefore it is not necessary to advertise inter–area summary LSAs (type–3 and type–4) which will reduce the size of the routing tables of the NEs in area 3.

Area 3 will be configured as a totally stubby NSSA.

Each interface of the *Catalyst* linked to the SDU will be configured to support OSPF load balancing. However, on the reverse traffic, i.e. from the SDU to the *Catalyst* OSPF load balancing will not be supported.

The VPU routers (ASBRs) connecting the VPU AS to the BSSAN Core AS will be part of this Area 3. The VPU has one link per ISB to each Core Router. Each interface of the Core router linked to the VPU will be configured to support OSPF load balancing. The Core Router ABR is the only element directly connected to the VPU. Since this area is configured as an NSSA, the external–AS LSAa from the VPU will re–distributed in the BSSAN Core AS. Since this area is totally stubby, the inter–area summary LSAs from outside Area 3 will not be advertised into this area.

BTS AS

(New to 16.1) Another OSPF area is the packet BTS Area 51 (which is not part of the BSSAN Core AS). Each BTS will,in effect, form its own AS. This area is managed and used internal to the BTS. The pBTS router serves as an ASBR for this area/system and isolates the private addresses used within each BTS from other BTSs and the rest of the network. All pBTSs use the same AS number. The pBTS router does not use BGP to communicate internal addresses so the AS number is not advertised outside of the BTS.

SDU AS

Each SDU forms an AS by itself and is required for the following reasons:

- The SDU uses an internal subnet referred to as the Internal SDU subnet. This subnet is part of the common platform and allows the SDU to use internal IP addresses for communication. All SDUs will re–use the same set of IP addresses for internal communication. This implies that this subnet is not to be advertised by the routing protocol.

- The SDU needs to advertise end points (e.g. BPP subnets, SPROC, etc.) to the BSSAN Core AS and will be summarized via external Type–7 LSAs.

The SDU AS is formed by configuring the ISB routers as ASBR and one or more OSPF areas including the ISBs by them self and other SDU components (e.g. SPROC cards, BPP cards, etc.).

The ISBs are configured to perform external route summarization when distributing routes from the SDU AS to the backbone of the BSSAN Core AS via the NSSA Area 3. This limits the number of routes in the BSSAN Core backbone routing tables. The default route from the BSSAN Core AS needs to be distributed into the SDU AS. The ISBs needs to be configured to perform route filtering so that the private SDU addresses (from the Internal SDU network) are not advertised to the Area 3 NSSA.

VPU AS

The VPU re–uses the same platform as the SDU and the AS description for the SDU also applies for the VPU.

BGP

As described previously, OSPF provides routing within the BSSAN which is equivalent to saying that OSPF provides routing functionality within the Autonomous System. However, a routing function is also required for communication between Autonomous Systems.

The protocol used for this routing is the Border Gateway Protocol (BGP). The main function of a BGP system is to exchange network reachability information with other BGP systems. This includes information on the full path of Autonomous Systems that traffic must transit in order to reach the target network. BGP works on the “hop–by–hop” basis since a given AS only reports those routes it uses to its neighboring ASs.

As stated previously, the BSSAN communicates externally over BGP links. In general the *Catalyst*s within a BSSAN will be used to provide the EBGP links. These links will attach directly to other BSSANs within the same Mobile Telephone Switch Office (MTSO) or to WAN routers that are part of a BGP backbone. The BGP backbone forms a separate AS. The architecture includes designs and rules for an MTSO with a variety of sizes.

BGP uses a reliable transport protocol (i.e., TCP) to exchange routing information. This eliminates the need to perform message segmentation/recovery within the BGP protocol. BGP requirements in this document assume TCP/IP as the underlying transport protocol.

If a particular AS has more than one BGP speaker, care must be taken so that each BGP speaker has a consistent view of routing within the AS. This will ensure that all BGP speakers on the border of the AS are reporting a consistent routing picture to external networks. In the CDMA RAN this is accomplished by requiring that all BGP routers serving as gateways externally to the BSSAN also serve as OSPF routers internally to the BSSAN. The routing updates preformed by OSPF will ensure that each BGP speaking router has a consistent routing picture.

It is also important that all BGP speakers in an AS present a consistent picture of external routes when advertising routing information into the AS. In the BSSAN this is accomplished by requiring that all BGP routers in the BSSAN be inter–connected. Routers that have BGP connections to other routers that are within the same AS are said to be running "Internal" BGP (IBGP).

Routers that are running BGP on interfaces that are external to the AS are said to be running "External" BGP (EBGP). Any two routers that have established a connection (i.e., a TCP virtual circuit) for the purposes of exchanging BGP information are said to be "neighbors" or "peers".

To configure a BGP link to another router three things are required. First, the router must be configured as a BGP router and given the AS ID for the Autonomous System it is part of. Second, the interface IP address of each BGP neighbor must be specified. Finally, the AS ID of each neighbor must be specified.

Specifying the IP address of the BGP neighbor interface has one drawback. Should that interface fail, the route will become unavailable. One way around this is to define the interface IP address to be a loopback interface configured on the neighbor router. This way the neighbor router will always be reachable even if one interface fails (assuming a second route is configured in the network). This capability is selectively implemented.

If EBGP routers are connected and the remote interfaces are loopback interfaces, these interfaces must be defined as "BGP Multihop" connections. This indicates to the router that it is not directly connected to the interface that terminates the BGP connection. More than one hop will be required to reach the loopback connection (i.e., one hop to the direct connect interface then another hop from there to the loopback interface).

In the R16.1 network many BGP routers will be directly connected and to prevent single interface failures from causing an outage, each interface between two ASs will have two physical links. Since the failure of any given interface cannot cause an outage we will not need to configure loopback interfaces and make use of BGP multihop in these cases 16.0.

In some situations, it may not be desirable to use BGP for interfaces between ASs. Instead, static routes could be configured between the ASs and default gateways configured. In this case, BGP requirements do not apply.

QoS (Quality of Service)

The 16.1 CDMA RAN QoS functions for IP datagrams include the following:

- Traffic marking
- Classification and scheduling

The marking function exists at the edge of the devices of the CDMA RAN for ingress traffic. Marking also occurs at the end nodes for originating traffic, e.g. signalling and O&M. The purpose is to ensure consistent marking of all traffic in the Transport Network. In the backhaul interface between the Packet BTS and the Aggregation Point, the Packet BTS will mark the generated traffic.

The system marks the packets in 4 classes. Each class has a different priority level.

- Voice Bearer
- Packet Data Bearer
- Supplemental Data Bearer
- Low Latency Signalling (call processing signalling that requires low transfer delay)

Routing devices, such as the BTS Router and the Aggregation Point RPM card for example, perform the queuing function. During the queuing process, the router gives higher precedence to packets marked with a high priority than packets marked with a lower priority.

NOTE

In a release 16.4.1 system with the RPM Capacity increase feature, the QoS feature is removed from the processing of packets in the forward direction on the RPM. The removal of QoS means that there is no longer priority given to voice packets over the other traffic classes. All packets are processed in the order that they arrive.

IP Addressing

The IP address allocation process at the system level shall follow the guidelines/requirements in the System Address Allocation Strategy, the RAN Network Topology and the RAN IP Routing Architecture and Requirements to determine how many IP addresses each BSSAN needs and how to divide the available IP addresses into different contiguous address pools to satisfy the OSPF routing area requirements. The system level IP addressing allocation process shall produce a detailed plan of IP address allocation at the BSSAN level based on the physical connections.

CDMA RAN (System) Level IP Address Allocation:

A block of IP addresses from 10.a1.b1.c1 to 10.x1.y1.z1 is allocated for BSSAN#1

A block of IP addresses from 10.a2.b2.c2 to 10.x2.y2.z2 is allocated for BSSAN#2

A block of IP addresses from 10.a3.b3.c3 to 10.x3.y3.z3 is allocated for BSSAN#3

Blocks of IP addresses are reserved for the existing circuit system (2G System).

Blocks of IP addresses are reserved for certain O&M systems that are outside the system level IP management domain.

System Level IP Address Allocation:

The IP addresses of the NEs in a BSSAN will be extracted from several pools. The IP addresses in each pool need to be contiguous. There are 4 different pool types per BSSAN: CBSC, AN, BTS and the PCF.

The PCF pool is optional and is used to assigned IP addresses to the PSI–PCF cards. The three other pool are mandatory. The IP addresses of the PCFs could be from the CBSC or the PCF pool but the IP addresses of all PCFs in a CBSC will be allocated from the same pool.

The four other pools are mandatory. Each BSSAN will have its own CBSC, BTS and AN pool of IP addresses while the same range of IP addresses defines the Common pool and is reused in each BSSAN.

Each BSSAN pool contains following pools:

1) IP addresses for CBSC NEs (MM, XC (pPSI (PKTPCF and PKTSEL) and cPSI), SDU and other NEs (OMCR, OMCIP, Cisco PDSN, AAA, terminal server) that are connected with a particular AN. IP addresses for the interfaces between the NEs and the AN.

2) IP addresses for BTSs in a particular AN and IP addresses for the interfaces between the BTSs, BTS routers and RPM.

3) IP addresses for NEs that are inside a particular AN and the interface IP addresses between these NEs.

4) The IP addresses that could be reused in each BSSAN (Common in each BSSAN).

5) IP addresses for the PCFs inside a BSSAN. This pool is optional.

DHCP Client on SDU and VPU

In release 2.16.4.1, the SDU and VPU upgrade adds a DHCP client which supports automatic provisioning of IP addresses by the DHCP server on the Core router (*Catalyst*). The SDU and VPU will discover IP addressing and OSPF parameters using DHCP rather than through manual commissioning (no commissioning device needed). The OMC–R generates the DHCP configuration for the *Catalysts*.

DNS

In release 2.16.4.1, the RAN capabilities for DNS expand to include:

- Linked name space across MTSOs. Operators can navigate to other devices in other MTSOs using DNS names.
- MM and OMC–R upgrade to each include DNS clients. An operator on an MM will be able to navigate from these devices to other devices in the RAN using DNS names.
- Allows creation of a DNS name for every device in the RAN. The OMC–R no longer manages operator defined names for devices.
- Automatic updates of the DNS root server by the subordinate DNS servers.

Notes

Chapter 7: Selector Distributor Unit (SDU)

Table of Contents

SDU Introduction

Overview

Functions

The SDU performs the Selection/Distribution function (SDF) and Packet Control function (PCF) for CDMA2000 1X voice and packet data calls, and IS–95A/B voice and data calls.

Table 7-1 explains which functions are moved from the XC to the SDU.

Table 7-1: Functions Moved from XC to SDU

Function	XC Card	SDU Card
Selection, Distribution for IS–95A/B and CDMA2000 Voice and IWU calls FCH/SCCH	XCDR	BPP–SDF
Selection, Distribution for CDMA2000 1X Packet data calls FCH/DCCH/SCHs	PSI–SEL	BPP–SDF
Packet Control Function for CDMA2000 1X Packet data calls FCH/DCCH/SCHs	PSI–PCF	BPP–PCF

Advantages

The Selection Distribution Unit or SDU is a new hardware realization of existing function that has many advantages:

- Increased capacity of CBSC when used with Packet Backhaul
- Client/server model instead of embedded architecture
- Increased XC efficiency by moving functionality to SDU
- No obsolete equipment
- Network level redundancy
- De–couple capacity planning
- Increased network design flexibility
- Simplified Configuration data management

Overview of SDU Functions

Selection

In a CDMA system, the signal from the handset may be received by multiple BTSs. These signals are sent to the SDU for selection and the SDU picks the signal that is most usable, using a complex algorithm that considers multiple factors including signal strength, error rate, and other factors. The "Selected" signal is then used in the remainder of the system. The selection process is done every 20 milliseconds to ensure continued signal quality. The information used for selection is also used for Soft Handoff (SHO).

Distribution

Distribution is the forward path selection from BTS to handset. Multiple BTSs can service a handset. The "Distribution" algorithm uses power control information, signal to noise, traffic, and other factors to choose the BTSs to service the handset.

Packet Control Function (PCF)

The Packet control function (PCF) is the radio side of the data call connection. Based on mobile requests, the PCF establishes, maintains, and tears down data call sessions with the PDSN. Once a data call session is established, the PDSN and mobile can establish a PPP session to use for IP network access. The PCF performs the following functions:

- A10/A11 interfaces
- A8/A9–like Motorola proprietary interface
- Maintains the dormant session when the MS is not on an RF channel but still connected to a PPP session with PDSN.

Overview of SDU Frame

SDU Cabinet

The SDU has the following physical features:

- Up to 2 SDU Shelves
- 4 Power Supply Modules (PSMs) and Power Distribution Unit (PDU) at Top of Frame
- Front–to–Back Air Cooling
- Front/Rear Access for Maintenance

Each shelf has 19 slots. Four slots are occupied with 2 ISB/SPROCS and 2 CCAs leaving 15 payload slots. All cards are Hot Swappable. The cards described here include CCA, SPROC, BPP, PSM, ISB, Site I/O, and SPAN I/O.

The payload card, called the Bearer Payload Processor (BPP), performs all the functions above with different software loads. The quantity of these cards is the primary sizing/scaling factor of the system.

CCA Overview

The Cabinet and Customer and Alarm (CCA) card provides a 2N redundant collection point for the presence of ”detect” signals from each card. The CCA also provides inputs for shelf level alarms. In addition, the CCA provides termination of any Motorola– or Customer–defined alarms that might be terminated at the SDU shelf. Optional relay contacts that could be used to control the customer’s site equipment are provided by the CCA. The CCA communicates to both ISBs through a standard CP2 interface.

SPROC

Control software for the SDU shelf resides on this card along with some call processing and resource management functionality. The SPROC is a 6U cPCI form factor processor board. This board houses a Power PC750 processor, network interfaces, MMI ports, and local memory.

BPP

The Bearer Payload Processor (BPP) card is a SDU specific payload card that will be developed as part of the SDU feature. The BPP is a general purpose payload card capable of providing the Selection, Distribution, and Packet Control Functions of the SDU application.

PSM

The Power Supply Module provides cage level input power conversion for distribution throughout a given SDU cage.

ISB

The Interface Switch Board is an Ethernet router connecting the SPROC, network interface, and all payload cards.

SITE I/O

The Site Interface Board provides access to/from the customer and Motorola alarms.

Span I/O

The Span Interface Boards provide interfaces to the access node (AN) by gigabit Ethernet lines.

Overview

BPP Configuration

The operator configures a BPP card to perform the SDF set of functions or the PCF set of functions.

NOTE

The *SDF* in the SDU replaces the 16.0 *PSI–SEL* function.

Selector Distributor Function (SDF) Overview

A BPP card with SDF software performs the following main functions:

- Selection and Distribution
- Handoff detection and execution
- Layer 3 Call Control
- Implement IS–95/IS–2000 Control Signalling Messages
- Vocoder connection
- Allocate BTS resources during handoff
- A8 / A9 Packet data call functions
- Support for Supplementary services
- Support for Call Detail Logging and Call Trace
- Interface to Resource Allocation/Management function
- Supports IP–ICSHO with 16.0 CBSCs
- Supplemental channel management
- Reduced Active Set (RAS) determination
- L2 interface to Mobile Station
- UDP Termination
- UDP–ER Termination
- SCTP Termination
- SMAP UDP
- Performs Power control functions
- Performs Segmentation and Reassembly
- Radio Link Protocol
- Multiplexing functions
- cBTS and pBTS termination
- XC Termination

Selection and Distribution

The SDF's main function is Selection and Distribution. After Selection of traffic received from BTSs, the SDU transfers voice traffic to the Vocoder for processing. After receiving voice traffic from the Vocoder, the SDU Distributes the voice traffic to all sectors in the mobile's active set. This is done for circuit and packet BTSs.

As a product of frequent soft handoffs in the CDMA system, the mobile station may have multiple Sectors in its "Active set", meaning the mobile is communicating with multiple Sectors at once during the call. In this case, there is a need for the SDU to pick the best signal from the various "copies" of the signal received from different sectors (intra and inter BTS). Likewise, it must distribute copies of the downlink signal to all sectors in the active set of the mobile.

The selection and distribution capability of each CPE provides the following functionality:

- Receives IOS v4.1 formatted bearer frames; these frames contain the message type and CRC.
- Indicates state changes to Layer 3 Call Control confirming BTS link establishment, mobile station acquisition, etc.
- Verifies the reception of packets and aligns the packets based on the Frame Sequence Number from all appropriate BTSs involved in the soft handoff. This includes declaring time outs and initiating the selection of the best received packet, when necessary.
- From the uplink packets received from each Sector in the mobile's active set, the SDU selects the best packet based on the received Frame Quality Indicator field.
- Extracts Packet Arrival Timing Error (PATE) information, smooths data and generates Time/Frame Alignment requests to the Vocoder when necessary.
- Performs Time and Frame Alignment, on a link–by–link basis, in the forward direction.
- Performs (SIR+RSSI) filtering for SCH management to determine the reduced active set.
- Distributes downlink frames to all BTSs involved in the soft handoff.

Handoff Detection and Execution

Overview

SDF supports handoff procedures including intra–CBSC soft handoff, inter–CBSC soft handoff as well as hard handoff.

Handoff Overview

For CDMA systems, handoff detection processing will take place in the XC (16.0)/SDU (16.1) and in the MM. The XC/SDU will detect the need to handoff, perform handoff pre–processing and identify events. The MM will determine the handoff type, perform target selection and perform channel allocation. Both the MM and the SDU request Packet BTSs to allocate traffic channel resources. For Circuit BTSs, the MM will still perform the traffic channel resource allocation.

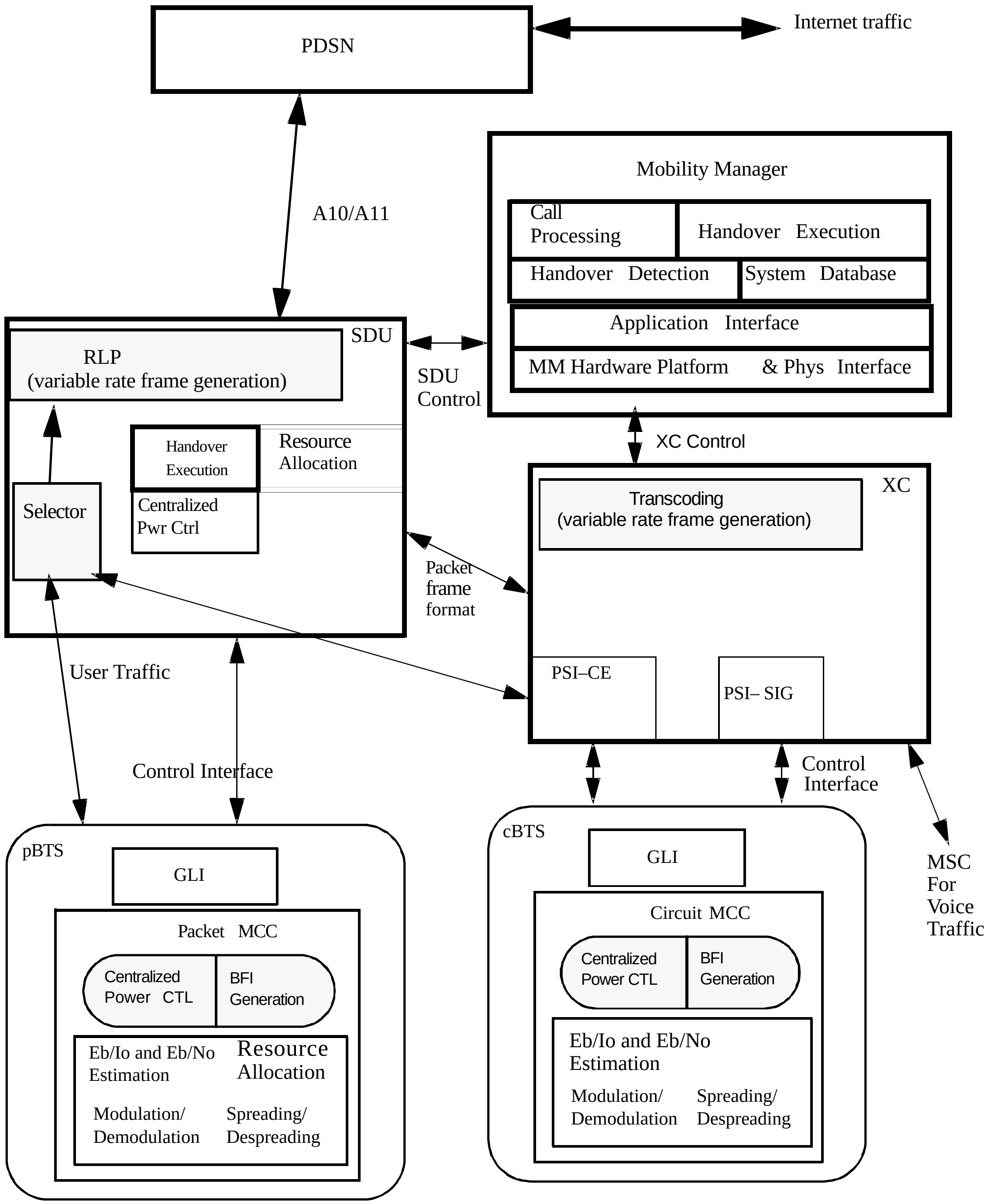
NOTE

Throughout this section, a function performed by "XC/SDU" means that in a 16.0 system the XC performs the function and in a 16.1 system the SDU performs the function if equipped.

16.3 CASHO

In release 16.3, the system supports the CASHO feature where the system can, during call setup, assign the mobile into soft handoff, using the Extended Channel Assignment message.

Figure 7-1: CDMA Handoff Functional Diagram, SDU architecture



NOTE

If equipped, the VPU can replace the XC cabinet for the Vocoding function.

CDMA Handoff Types

CDMA allows for several types of handoff to take place. The following list elaborates and summarizes each possible type of supported handoff. Note that there are always two types of soft and softer handoff. One type called an “add” is used to instruct the mobile to include new pilots in its active set. The other type called a “drop” is used to instruct the mobile to exclude old pilots from its active set.

Handoffs may be triggered by either Mobile Assisted Handoff (MAHO) or Database Assisted Handoff (DAHO) techniques. MAHO techniques depend on measurements made by the mobile and returned to the BTS. DAHO techniques depend on information on cell configuration stored in the CBSC/BTS along with the system’s knowledge of which cells/sectors control a particular call.

MAHO techniques may be used to trigger soft, softer and hard handoffs. DAHO techniques may be used to trigger hard handoffs.

- Inter BTS, intra XC/SDU Soft Handoff: This handoff type is expected to be the highest percentage of handoffs in CDMA systems as this type contributes to the greatest amount of reverse channel interference reduction and capacity increase. A mobile station has simultaneous connections to two or more cells and receives power control orders (for reverse link closed loop power control) from each cell in the soft handoff.
- Inter BTS, Inter–CBSC Soft Handoff: This handoff type denotes a state where a mobile station maintains connections to multiple sectors located under control of different CBSCs. In this case, the CBSCs controlling the BTSs are linked by either special sub–rate trunk circuit connection or by packet network connection.
- Intra BTS, Inter Sector, Intra XC/SDU Softer Handoff: This handoff type denotes a state where a mobile station maintains connections to multiple sectors all based at the same cellsite location.
- Inter or Intra BTS Hard Handoff: This handoff type denotes either a change in operating frequency, a change in 1.25ms frame offset, a change from an IS–2000 radio configuration 1 to another, or a handoff in which the intersection of old active set pilots with new active set pilots is the null set.
- Hard Handoff to Analog: This handoff type is used to transition a multi–mode mobile station from CDMA operation to operation on an analog system.

- CDMA Inter–band Handoff: This handoff type enables CDMA networks to perform inter–band hard handoffs for voice calls in a dual–band CDMA system, for mobiles capable of the two bands involved. This handoff type supports handoffs within a dual–band CBSC, inter–CBSC handoffs, and inter–MSC IS–41 handoffs. As of release 2.16.4.x.x, DAHO and pilot beacon methods can trigger this handoff type. The supported bands are 800 MHz and 1900 MHz bands. Handoffs in both directions are supported. This handoff type supports IS–95A, 1X, and 1xEV–DV (when available). There is one kind of IBHO that will not be supported: when the mobile is moving from a single–band area to a dual–band area; the mobile will stay on its current band (soft handoff).
- 1X Hard Handdown: This handoff type enables the CDMA system to trigger hand downs to IS–95A for 1X voice calls in situations where 1X resources (1X channel elements) are provisioned but are busy or otherwise unavailable for assignment into Soft Handoffs. The MM will not process a hand down request if resource allocation fails for conditions such as RF load, walsh code availability, backhaul capacity, etc. In addition, the MM will proceed with the HHO if the candidate pilot strength is 0.5 * Tcomp stronger than all the active pilots. Both circuit BTS and packet BTS support 1X Hard Handdown.

Complex Handoffs

A complex handoff in a CDMA system is defined as a handoff instruction to the mobile station which makes more than one change to the mobile’s active set. For example, MAHO measurements from the mobile station may indicate that it is desirable to enter into a state where new connections are supported from both the current cellsite location (softer handoff) and from another cellsite location (soft handoff).

The current system supports multiple add operations and multiple drop operations for inter–CBSC soft/softer and intra–CBSC soft/softer handoffs. A maximum active set size of 6 pilots is supported. Multiple add and multiple drop operations are limited to a single channel element each for each handoff detection event.

Pilot shuffling with multiple add–drops, triggered from a single handoff detection event, is also supported to maintain an optimal active set when the number of soft/ softer legs is at the maximum. The system currently support pilot shuffle involving channel elements in up to two BTSs in a single handoff direction message to the mobile station.

Database Assisted Handoff

This handoff detection algorithm is used to determine when to transition a mobile station to another frequency band and/or air interface other than CDMA. Since normal CDMA Mobile Assisted Handoff (MAHO) handoff detection methods cannot be used to determine a suitable target, database–stored information concerning partially or fully overlapping handoff targets must be used to carry out the handoff process.

Inter–CBSC Soft Handoff

Soft and softer handoffs can be performed with a cell under another CBSC by using inter–CBSC soft and softer handoff procedures to connect the target CBSC channel element to the source CBSC via an inter–CBSC subrate channel or an inter–CBSC packet network.

The method of performing inter–CBSC soft/softer handoffs via subrate channels and Motorola proprietary control links between CBSCs is referred to as the trunking method, to distinguish it from the A1 method, using standardized IS–634 procedures, which may be implemented in the future, or from the method where bearer connection between CBSCs can be established through the common AN.

A call can be in inter–CBSC soft/softer handoff with multiple target CBSCs at the same time. A call enters into inter–CBSC soft handoff when the mobile reports a viable candidate pilot that points to an XCSECT (external sector data base), and this XCSECT has inter–CBSC soft handoffs enabled. Note that the XCSECT can be residing in the source CBSC or can be backhauled from target CBSC as part of a previous inter–cbsc handoff procedure. Subsequent inter–CBSC soft and softer handoff operations may occur with pilots that are in the neighbor list of a target CBSC cell. Target CBSC neighbor lists are sent back to the source as part of the inter–CBSC soft/softer procedure. In these “remote neighbor lists”, the source checks for matches with candidates reported by the MS.

The source CBSC remains in control of the call until no source handoff legs remain. At this point the source determines if it should transfer control to a target CBSC via a hard handoff. Such a hard handoff is named “Anchor Handoff”.

Handoff Modes

The system is required to support various “handoff modes”. The handoff mode defines how the handoff detection algorithm and execution procedures operate. The mode defines what triggers the system to add a pilot to the mobile station’s active set. Two modes are defined – “TAdd” and “TComp”. When operating in the TAdd mode, any time a pilot rises above the TAdd or the TComp threshold, the system will attempt to add that pilot to the mobile station’s active set via a soft or softer handoff. When operating in the TComp mode, a pilot must rise above the TComp threshold before the system attempts to add it to the mobile station active set.

NOTE

For further description of the air interface (RF:) messages discussed throughout this chapter, refer to the *SMAP Operator’s Guide*. SMAP is the tool which collects and decodes the air interfaces messages from the XC/SDU.

Mobile Station Operation

The mobile station assists the handoff process by transmitting Pilot Strength Measurement Messages or Extended Pilot Strength Measurement Messages. The mobile measures the strength of the Forward Pilot channels and includes the measured pilot strength in the PSMM or EPSMM along with the PN Offset Index/PN Offset identifying the measured pilots.

Database Parameters

The following are the database parameters which apply to handoff detection.

NOTE

Some parameters are specific to SDU, some are not. This section does not discuss the Complex soft handoff parameters in the MM database. Refer to the *Cellular System Administration Guide* for further information and default values.

- TAdd – Pilot Detection Threshold – The threshold above which a pilot must rise in order for the MS to transmit a pilot strength measurement message. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, RF: Extended Handoff Direction Message, RF: General Handoff Direction Message, RF: Universal Handoff Direction message and the RF: In Traffic System Parameters Message.
- TComp – Active Versus Candidate Set Comparison Threshold – The threshold which a candidate set pilot strength must rise above an active set pilot to cause the MS to transmit a pilot strength measurement message. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, RF: Extended Handoff Direction Message, RF: General Handoff Direction Message, RF: Universal Handoff Direction message and the RF: In Traffic System Parameters Message. This parameter is also used for handover detection event discrimination in the XC/SDU subsystem.
- TDrop – Pilot Drop Threshold – The threshold below which a pilot strength must drop in order for the MS to transmit a pilot strength measurement message. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, RF: Extended Handoff Direction Message, RF: General Handoff Direction Message, RF: Universal Handoff Direction message and the RF: In Traffic System Parameters Message.
- TTDrop – Active or Candidate Set Drop Timer – The amount of time in seconds the MS will allow an active or candidate set pilot strength to remain below the drop threshold before action is taken to remove the pilot from the active or candidate set. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, RF: Extended Handoff Direction Message, RF: General Handoff Direction Message, RF: Universal Handoff Direction message and the RF: In Traffic System Parameters Message.
- Soft_Slope – the slope used by the mobile station to calculate the Add and Drop thresholds for adding a pilot to the active set, or dropping a pilot from the active set. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, the RF: In Traffic System Parameters Message,, RF: Universal Handoff Direction message, and the RF: General Handoff Direction Message.

- Add_Intercept – the intercept used by the mobile station to calculate the Add threshold for adding a pilot to the active set. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, the RF: In Traffic System Parameters Message, RF: Universal Handoff Direction message, and the RF: General Handoff Direction Message.
- Drop_Intercept – the intercept used by the mobile station to calculate the Drop threshold for dropping a pilot from the active set. The system sends this parameter to the mobile station in the RF: Extended System Parameters Message, the RF: In Traffic System Parameters Message, RF: Universal Handoff Direction message, and the RF: General Handoff Direction Message.
- HandOffMode – Specifies to the XC/SDU which handoff mode to use. Currently two modes are defined. TAdd mode and TComp mode. TAdd mode tells the system to add a pilot to a call as soon as it crosses the TAdd threshold. TComp mode tells the system to wait for a pilot to rise above the TComp threshold before it is added to a call. This data exists in the XC/SDU database, not in the MIB.
- PilotInc – Pilot PN Sequence Offset Index Increment – The mobile station uses this field to determine how remaining set pilots should be searched. It is set to the largest increment such that the pilots of the neighboring sectors are integer multiples of the increment. This data is sent to the mobile station in the RF: Neighbor List Message and the RF: Neighbor List Update Message. The XC/SDU must use the same value as is contained in the MIB.
- NeighborList – Neighbor List – This list contains all of the neighbor sector PN offsets for the current call. This parameter is passed to the XC/SDU during a CDMA parameters update.
- DAHO – DAHO Indicator – This parameter indicates whether a sector–carrier is near a border and contains neighboring or overlapping sectors operating on another frequency and/or non–CDMA signalling scheme.
- DAHOHysTimer – DAHO Hysteresis Timer – This parameter is used to prevent “ping–pong” handoffs between two sectors which have been marked with the DAHO flag. After a hard hand–in, origination, or termination in a border sector, majority border checks will be disabled for a period of time in seconds equal to the value of this parameter.
- HandoffMethod – Handoff Method – This parameter specifies the method (none, hard, soft trunking, soft aplus) to be used to hand the call off to a sector external to the CBSC. The scope of this parameter is per external CDMA sector.
- Inter–CBSC Soft Handoff Override – This parameter is used to “turn–off” Inter–CBSC soft handoffs between two MMs. It is checked by both source (in handoff detection) and target procedures. When override is allowed, the alternative action of either no handoffs or hard handoffs is indicated (no handoffs, hard, no override). The scope of this parameter is per inter–CBSC trunk group.

- AnchorHoMeth – Anchor Handoff Method – This per CBSC parameter indicates the condition upon which triggers the source MM to move a mobile in Inter–CBSC soft handoff from a source (or “anchor”) MM to a target MM once all the source legs have been dropped.
- Num_Cand – Number Candidates – The maximum number of candidate pilots reported by the mobile station that will be considered, in strength order, for handoff.
- ICTRKGRP:: ConnToggle: indicates whether an ICSRCHAN based or IP based inter–CBSC handoff connection type shall be used to conduct the soft handoff.
- CBSC:: N–Way Hard Hand Out flag – This flag indicates whether N–way Hard Hand Out is turned on, turn on for hand down only, or turned off.
- Sector/Carrier::Radio Configuration Class Capability: This parameter indicates whether the BTS is capable of supporting 2G voice and packet data calls only, or 2G voice and packet data calls and also 3G voice calls, or 2G voice and pacekt data calls and 3G voice and packet data calls, or 3G packet data calls only. The scope of this parameter is per carrier/sector.
- CBSC::MSCIntVer: Indicates the IOS compliance of the MSC. This parameter can be set to Pre–3G or IOS_4_1

RF Measurements Used in CDMA Handoff and Power Control Detection

For handoffs, the main piece of data to contend with is the contents of the pilot strength measurement message. The RF: Pilot Strength Measurement Message or RF: Extended Pilot Strength Measurement Message is sent autonomously by the mobile station in response to a particular pilot crossing the T_ADD, T_COMP, or T_DROP thresholds. The message contains PN phase measurements and strengths of the pilots that the mobile station is monitoring.

XC/SDU Handoff Detection

Upon reception of the Pilot Strength Measurement message by the XC/SDU, this L3 message is routed to the handoff detection process. Note that the handoff detection process shall store the contents of the last 16 RF: Pilot Strength Measurement Messages or RF: Extended Pilot Strength Measurement Messages. This information can then (if desired) be retrieved by MMI or used in additional handoff detection processing.

The XC/SDU will identify the base stations used in the PSMMs, and identify to the MM whether the pilots in these base stations are currently active pilots or candidate pilots.

The XC/SDU will determine which events caused the mobile station to send a PSMM to the base station. In the current system, the only valid events are: TAdd threshold crossed, TComp threshold crossed, and TDrop threshold crossed. Note also that multiple events may be possible within each message (a complex handoff). In the current system, only a single event will be reported. The precedence will be TComp, TAdd, and TDrop. Pilots not in the active set are scanned to see if their associated strengths have crested over the TAdd threshold, or if their strengths have exceeded the TComp of one of these pilots. The XC/SDU will determine if the events triggering the PSMMs are valid given the mobile's active set state (i.e. the number of pilots in the mobile's active set).

When a PSMM containing valid events is received by the XC/SDU, the XC/SDU will determine whether to signal to the MM that a handoff is necessary.

The MM determines the type of handoff to be performed – either soft or softer and add or drop (or multiple adds/drops) or shuffle.

Handoff Execution

CDMA standards introduces the concept of soft handoff. In this system, a soft handoff is defined as a state where a mobile station is communicating with two or more cell sites simultaneously.

During soft handoff, the mobile station will perform maximal ratio diversity combining on the downlink signals received from each cell site. Each cell site which receives the mobile station's uplink transmission will forward it to the XC/SDU. The XC/SDU then selects the frame to be decoded.

There is a special case of soft handoff called softer handoff. Softer handoff is similar to soft handoff except that two of the cell sites involved are sectors of the same cell. Softer handoff provides equipment savings for the following reason. The mobile station will frequently be in softer handoff, and the CDMA cell site receiver (the MCC, Multi–Channel CDMA card) is designed in such a way that a single channel element can support multiple sides of the softer handoff. A single CDMA channel resource that generates multiple Walsh channels is used in this case.

The MCC uses a RAKE mechanism with multiple taps which can be allocated to any of the sectors within a cellsite location. In softer handoff, maximal ratio combining is performed between two sector antennas to yield one uplink stream to the XC/SDU. This is different than soft handoff which is actually selection diversity on the uplink between multiple cellsite receivers at the XC/SDU.

Handoff execution is the act of bringing together many different pieces of hardware and the associated software, plus the mobile station, into a synchronized procedure to transfer the infrastructure connections and mobile station code programming.

In the simplest case, the following are two of the more important operations that must occur in order to facilitate a handoff.

- The target cell transceiver must be notified of the impending incoming handoff. Information communicated to the target cell may be the type of call, type of mobile and the mobile identity, encryption information for the mobile, and possibly priority of the call that the subscriber is currently engaged in.
- The XC/SDU must be notified of the change in connection from one cell to another. The notion of soft handoff requires a device to select the best traffic channel frame with the lowest error rate from among 2 or 3 possible inputs. In addition, the XC/SDU handles the variable rate data feature of respective CDMA Air interface standards that mobile complies to.

SDU Handoff Execution

This section describes the procedures required for an inter/intra cell, inter/intra–CBSC generic handoff. This section describes the procedures for:

- soft add
- soft drop
- softer add
- softer drop
- (complex handoff) combination of all of the above

Currently, this procedure handles fundamental traffic channel adds, if any, on a BTS, fundamental traffic channel drops, if any, on a BTS which can be the same as the BTS targeted for fundamental traffic channel adds, and supplemental traffic channel adds or drops across all BTSs involved in the hand–off.

NOTE

> In high speed packet data calls, supplemental traffic channels are used in combination with the fundamental traffic channel when greater throughput is required.

This procedure handles the connectivity for both intra–CBSC and inter–CBSC (source side) soft/softer handoff operations. This procedure is applicable to (IS95B FCH/SCCH channels and IS–2000 1X FCHs only) high speed packet data calls, low speed packet data calls, circuit data calls, fax calls, or voice calls.

Upon detection of a soft/softer handoff add and/or drop event, the XC or SDU–SDF signals the MM with the information the MM needs to determine the necessary handoff type. It is possible that the MM will make an alternate decision based upon other information, as in the case of hard handoff.

For example, in the case of a handoff add, the MM notes that a hand–off add has been requested based on information received from the XC/SDU, and begins the call processing procedures to select target cellsites for the handoff operation.

Upon the MM's selection of appropriate target cellsites and, for circuit BTSs, the MM's allocation of appropriate radio channel resources to support the handoff, the MM will send the request for handoff and wait for completion. The Handoff Direction message is "filtered" down through the system with each responsible device (e.g. BTS, SDU) taking the information it needs to execute the handoff, and then an IS–95 or IS–2000 Handoff Direction message is sent to the mobile over the air interface. The final version sent to the mobile includes the information the mobile needs to change to the new active set, such as the list of Sectors, the walsh codes to use for fundamental and/or supplemental traffic channels, and so on.

A couple differences to this scenario are as follows:

- When the handoff target list contains a packet BTS, the MM will notify the SDU–SDF of the BTS resource allocator location. The SDU–SDF is responsible for requesting resources from any Packet BTSs. For packet BTSs, the packet BTS rather than MM will allocate appropriate radio channel resources to support the handoff.
- When a handoff target is a local circuit BTS or remote circuit BTS over ICSRCHAN, the MM will also allocate a CPP and a PSI–SIG and notify the SDU–SDF of their location. This allows the SDU–SDF to communicate with the XC (CPP) to setup connectivity to these circuit BTSs via PSI–CEs.

Intra–CBSC Handoff Scenarios

NOTE

If equipped, the VPU can replace the XC cabinet for the Vocoding function. Refer to the VPU chapter for details on VPU protocols.

Figure 7-2 depicts signalling paths for Intra–CBSC handoff scenarios.

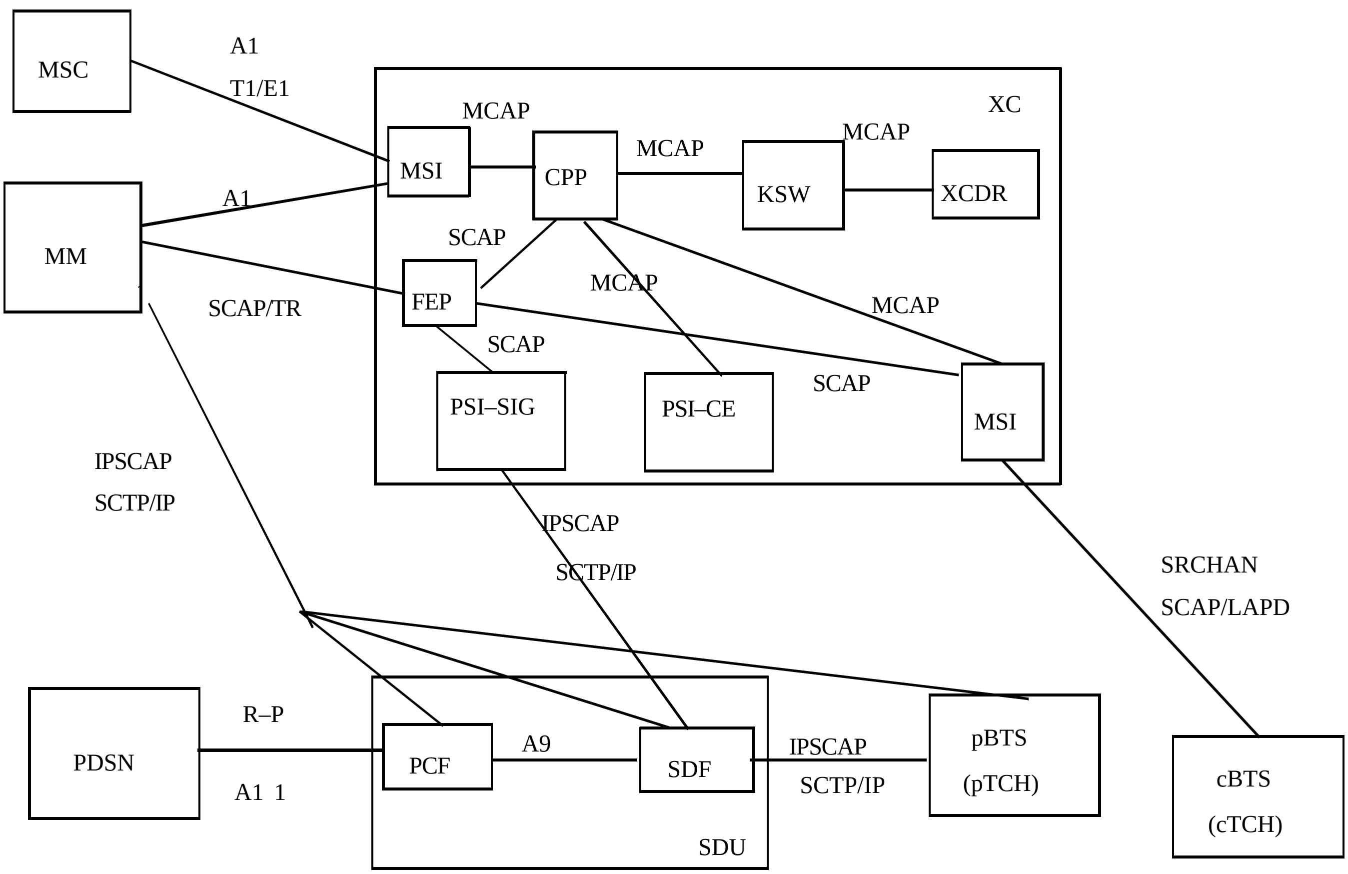
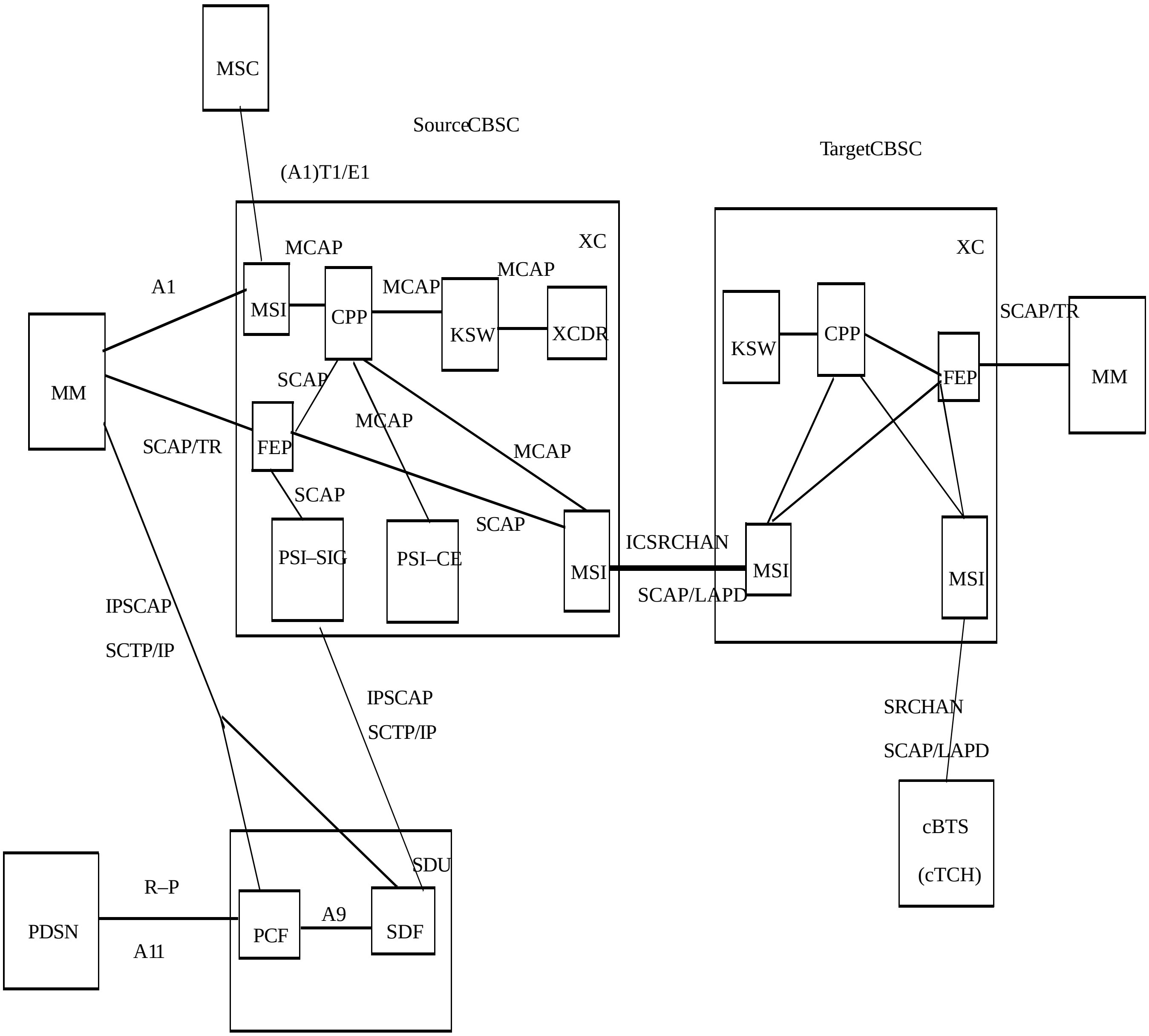


Figure 7-2 Signalling paths – Intra–CBSC Handoff Scenarios

Inter–CBSC Handoff Scenarios with ICSRCHAN

Figure 7-3 depicts signalling paths – Inter CBSC scenarios with ICSRCHAN.

Figure 7-3: Signalling paths – Inter CBSC scenarios with ICSRCHAN



Inter–CBSC Handoff Scenarios with AN

Figure 7-4 depicts signalling paths for inter–CBSC handoff scenarios with the AN.

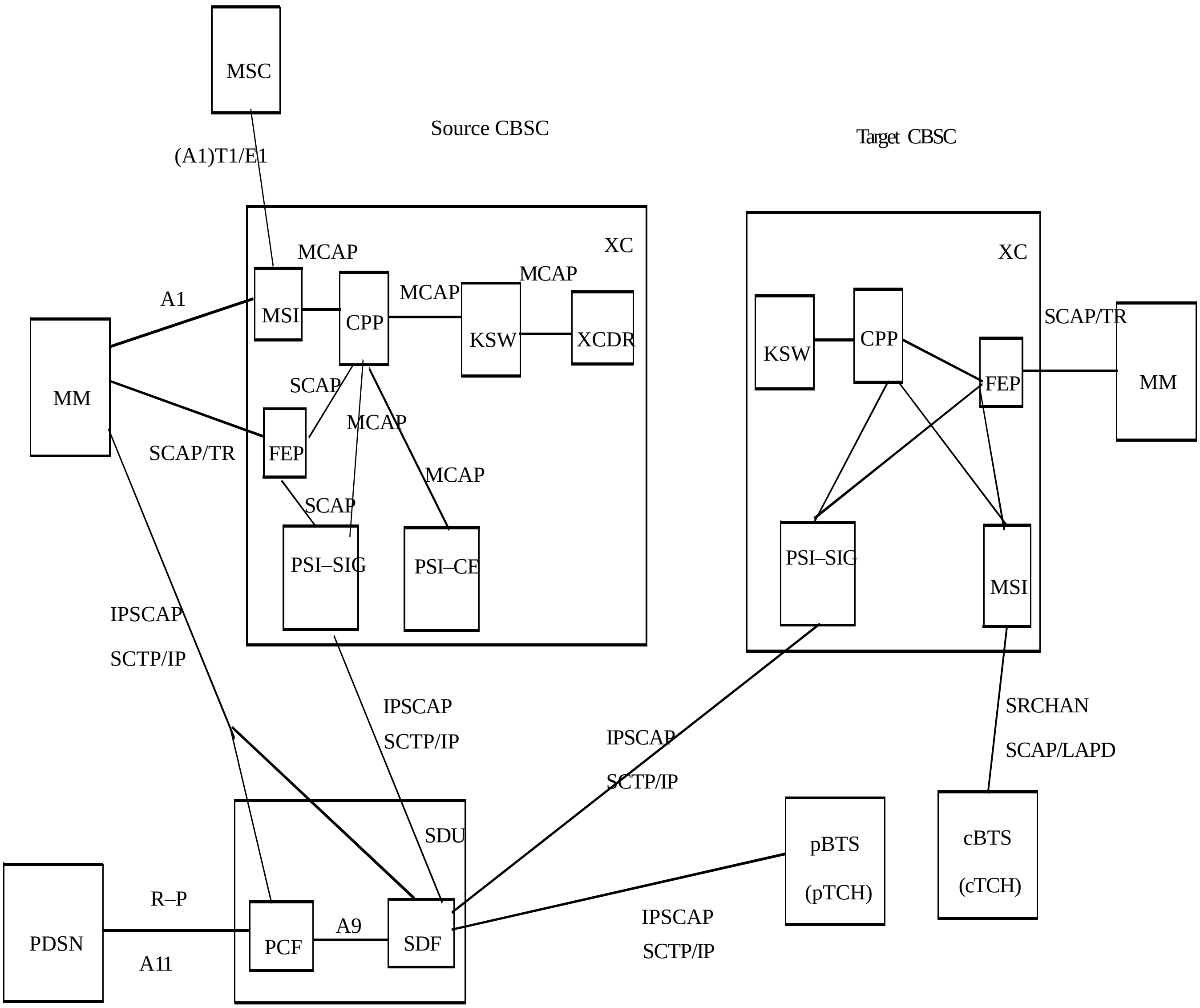
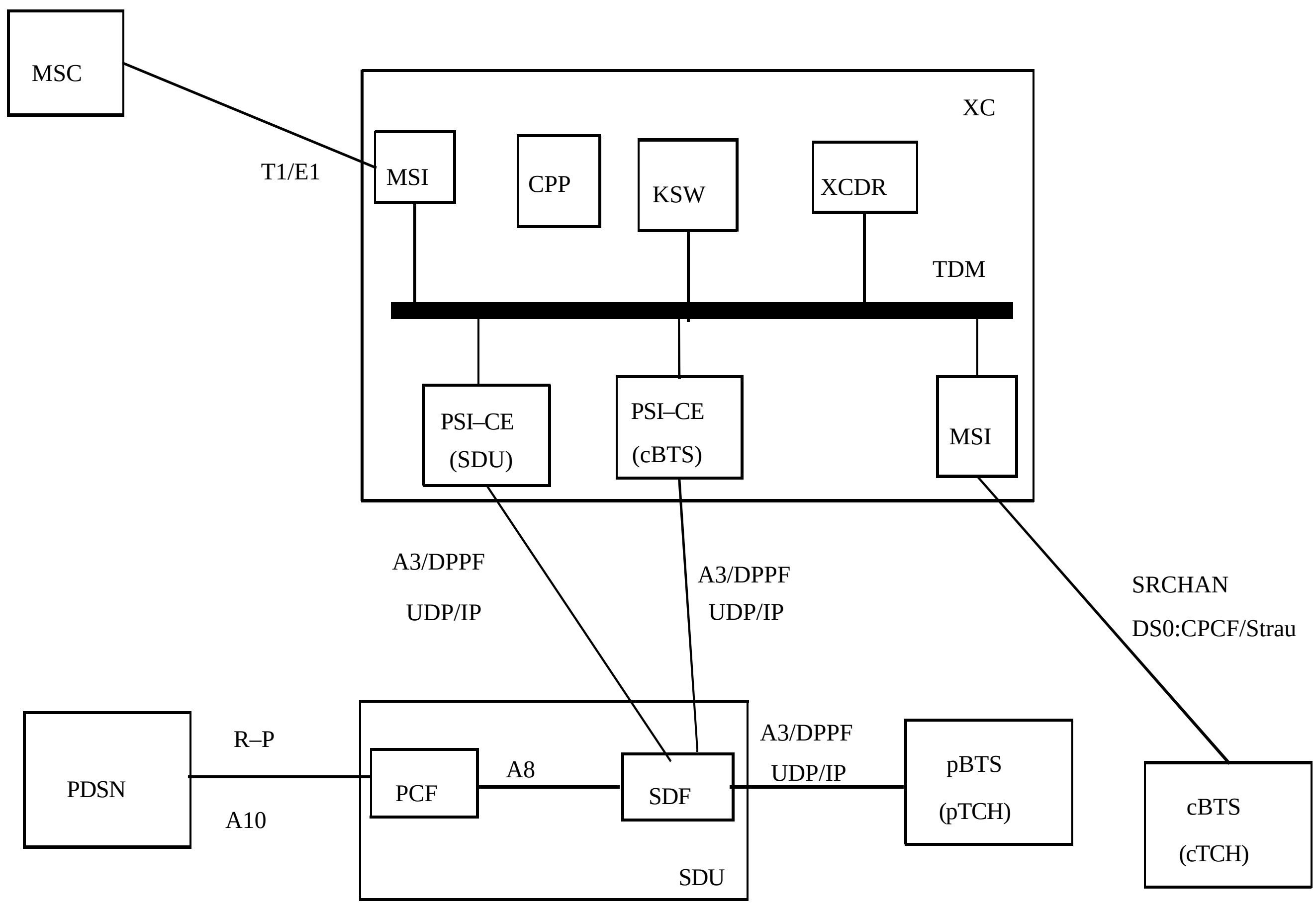


Figure 7-4: Signalling paths – Inter–CBSC scenarios with AN

Bearer Connectivity for Intra–CBSC Scenarios (SRCHAN and AN)

Figure 7-5 depicts bearer connectivity for Intra–CBSC scenarios (SRCHAN and AN).

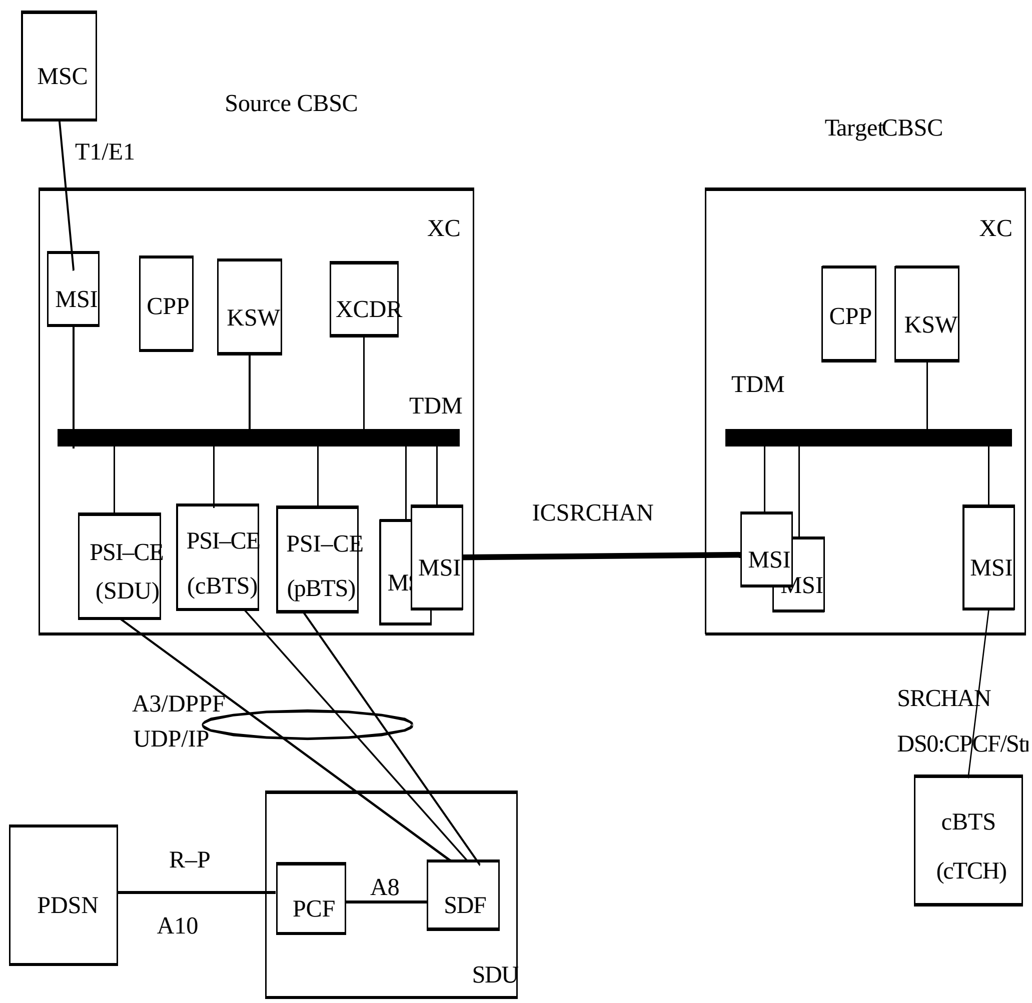
Figure 7-5: Bearer connectivity for Intra–CBSC scenarios (SRCHAN and AN)



Bearer Connectivity for Inter–CBSC Scenarios – ICSRCHAN

Figure 7-6 depicts bearer connectivity for Inter–CBSC scenarios with ICSRCHAN.

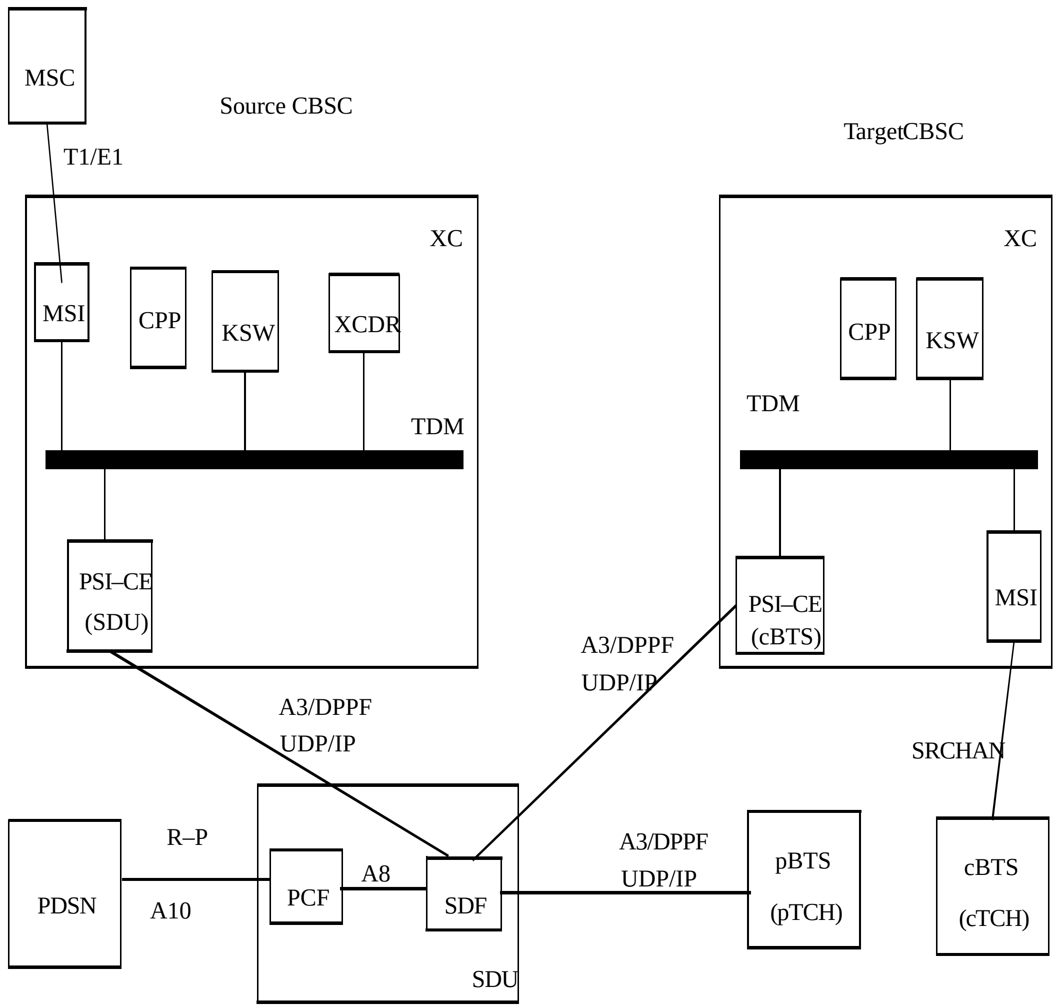
Figure 7-6: Bearer connectivity for Inter–CBSC scenarios with ICSRCHAN



Bearer Connectivity for Inter–CBSC Scenarios – AN

Figure 7-7 depicts bearer connectivity for Inter–CBSC scenarios with the AN architecture.

Figure 7-7: Bearer connectivity for Inter–CBSC scenarios with AN



Layer 3 Call Control (L3 CC)

The BCP element on a BPP card performs Layer 3 Call Control (L3 CC). The BCP L3 CC, in conjunction with the MM and the MSC, controls call setup with service negotiation, call release, handoff, and supplementary services for the mobile station. L3 CC interfaces with external network elements including the MM, BTS, and vocoder to manage call resources.

Implement IS–95/IS–2000 Call Control Signalling Messages

The SDF L3 CC supports IS–95 A/B and IS–2000 RF upper layer control messages over the traffic channel.

Vocoder connection

During call setup, the SDF L3 CC establishes a connection to the vocoder gateway (in the VPU frame or the XC frame) to provide vocoding services for voice calls.

Allocate BTS Resources during Handoff/Call Setup

The SDF L3 CC interfaces with BTSs to establish connections during a handoff:

- If the target cell is a packet BTS, the SDF L3 CC requests the packet BTS to allocate channel elements. In the case of a handoff where a target cell is a circuit BTS, the MM requests that circuit BTS to allocate channel elements.
- If the target cell is a circuit BTS, the SDF L3 CC requests the XCs to provide circuit interworking functionality for the call. This means that the circuit BTS and SDU will process the call through the assigned XC PSI–CE circuit–to–packet interworking card.

The SDF L3 CC performs the same process during call setup.

A8 / A9 Packet Data Call Functions

Overview

For the system to successfully set up a packet data call, the end result must be that the mobile station can establish a PPP (Point to Point protocol) software connection with the PDSN. The mobile station and PDSN use PPP to configure an "OSI model" datalink–layer and network–layer connection, including IP address assignment. Once the PPP session is established, the MS can access the IP network (ISP, Intranet, etc) through its connection to the PDSN.

The following RAN logical, upper–layer connections provide the support for the MS – PDSN interface:

- A10/A11 – a bearer and control interface between the PCF and the PDSN, where the bearer path is established for a particular MS
- A8/A9 – a bearer and control interface between the SDF and the PCF, where the bearer path is established for a particular MS

Once the system establishes the A8/A9 connections and the A10/A11 connections, the communication path exists for the MS – PDSN PPP session setup. In effect, the mobile station and PDSN communication session (control, bearer) runs "over" the A10/A11 and A8/A9 logical connections. The A10/A11 connection acts as a "bridge" between the PDSN and SDU and the A8/A9 connection acts as a "bridge" between the SDU and the BTS to the MS.

L3 CC Role

The SDF L3 CC requests the "A9 manager" to establish A8 connections with the PCF to provide data service for the requested packet data session.

A9 Link Management

A9 Link Management is performed by the BPP card's BCP and provides the IOS V4.1 A9 control functions to and from PCFs. The A9 management functionality includes the following:

- Supports A8/A9 interface setup procedures: including MS initiated call set up events and re–activations from the dormant state, and Network initiated re–activations from the dormant state.
- Supports A8/A9 interface call clearing procedures for both MS and network initiated call releases to the dormant state.
- MS power downs.
- PDSN initiated call releases.

A8 GRE

PCF termination is performed by each BPP card Channel Processing Element (CPE), terminating bearer Generic Routing Encapsulation(GRE) frames to/from the PCF. A8 is Motorola's proprietary version of the A8 IOS interface, modified to account for Motorola specific congestion management and keep alive procedures on the A8 bearer path.

NOTE

All call traffic exchanged between the PDSN and the SDU is wrapped in GRE headers.

A9 UDP

UDP is used for A9 signaling transport to communicate with the PCF control function. A9 is Motorola's proprietary version of the A9 IOS interface, modified to account for Motorola specific SCTP messages between the MM and the PCF, while all the other A9 signaling messages will be carried over UDP between SDF and PCF.

Supports Supplementary Services

The SDF L3 CC supports IS–95 or IS–2000 signalling to the MS needed to support supplementary services, including Flash with information, Feature Notification, DTMF and Short Message Service.

Supports Call Trace

The SDF L3 CC provides call trace support to SMAP, supporting real–time call activity events, layer 2 events and real–time statistic gathering.

CDL Support

The SDF L3 CC provides call detail logging on a per call basis. L3/L2 events and power control related statistics will be gathered by L3 CC and reported to the MM's CDL facility as part of call release procedures.

Supplemental channel statistics appear in CDLs for 1X data calls.

Interface to Resource Management/Allocation Function

During initialization, the SDF L3 CC provides resource capacity information to the SDU Resource Management/Allocation function. This function resides on the SDU's SPROC card.

When the MM receives an Origination or Page Response message from the mobile station triggering setup of a call, the MM communicates with the SDU Resource Management/Allocation function to request SDU resources for the call. It will request a channel processing element (CPE) on the BPP's Board Control Processor (BCP) and that channel element will run SDF or PCF depending upon its configuration. For packet data calls, the MM asks the Resource Management/Allocation function to assign a channel element from an SDF card and a channel element from a PCF card.

The SDF L3 CC also supports resource audits in conjunction with the Resource Allocation application in order to synchronize resource usage.

ICSHO for 16.0 CBSCs

The SDU supports IP–ICSHO with 16.0 CBSCs.

Supplemental Channel Management

The BCP performs supplemental channel scheduling, supporting on–demand time slices for packet data users. The BCP supports on–demand supplemental channel allocations for the 1X forward and reverse channel, including the following functionality:

- Determines the Forward Supplemental Channel data rate required for the mobile based on the buffer information provided by the RLP layer. When the amount of downlink packet data buffered is above a certain threshold, the BCP determines the F–SCH rate to request from the BTS for transmission of the data to the MS.
- Determines the reverse supplemental data rate required upon receipt of IS–2000 Supplemental Channel Request Messages (SCRM) from the mobile. During an established packet data session, the mobile station transmits SCRMs when it has to transmit more data than can be supported by the base Fundamental traffic channel assigned to the call.
- Determines the forward/reverse Reduced Active Set (RAS), selecting a subset of active pilots to provide supplemental service to mobiles in order to increase the efficiency of the radio channel. The forward link RAS is determined by the filtered Ec/Io of each sector and the RSSI+SIR provided by the BTS. The reverse link RAS is determined by filtered RSSI+SIR provided by the BTS.
- Requests supplemental channel resources from the BTSs (selected after RAS determination). The BCP coordinates among multiple BTSs to obtain a common supplemental channel timeslice to provide high speed data service to the mobile.

- Originates IS–2000 Extended Supplemental Channel Assignment Messages to mobiles via BTS radio interface, to assign Forward or Reverse supplemental traffic channels for certain time slices. The SDU sends an ESCAM based on MS request for higher data rate (SCRM) or after the SDU determines that the forward link data rate needs to be increased based on RLP buffer information. Assignment of a supplemental traffic channel in combination with an existing base traffic channel (either Fundamental or Dedicated Control) enables higher transmitting/receiving throughput.

RAS Determination

Periodic PMRM Reporting

For packet data calls operating in on–demand supplemental assignment mode and with Reduced Active Set (RAS) mode enabled through database configuration, periodic Power Measurement Report Message reporting will be turned on. The periodic reports are used by the SDU (or, in 16.0, the XC PSI–Selector function) to determine the reduced active set for assigning supplementals. The mobile station transmits PMRMs to report forward link frame errors and signal strength.

Resource Request Processing

This is the processing that occurs for each databurst. In this phase, the SDU determines that there is a need to request supplemental resources, and determines the active set into which the supplementals should be assigned. For forward supplementals, the decision to request supplementals and the requested rate are driven by the amount of data buffered for the call at the SDU and PCF. For reverse supplementals, this decision is driven by the request from the mobile.

After the decision is made to request supplementals, SDU determines the active set for supplementals. For forward supplemental channel requests, if the database parameter FwdRAS1x is ENABLED, the SDU determines the supplemental active set as a subset of the base channel (fundamental traffic channel or dedicated control traffic channel) active set. For reverse supplemental channel requests, if the database parameter RevRAS1x is ENABLED, SDU determines the supplemental active set as a subset of the base channel (fundamental traffic channel or dedicated control traffic channel) active set. Once the SDU has determined the need for a supplemental and the desired rate, the SDU and the BTS interact to setup the assignment, after which SDU communicates the assignment, if any, to the mobile.

The SDU uses two main sources for determining the RAS:

- The mobile station's measurement of the Ec/Io of each Forward Pilot channel – this is sent to the SDU in the PMRM (as well as PSMM)
- The reverse signal estimate, from the BTS (an estimated RSSI)

L2 MS

The L2 MS function provides assured and unassured delivery service to Layer 3 messages. This implements the ARQ sublayer functionality as specified in the cdma2000 standard.

The functionality includes the following:

- Terminates L2 mobile signaling and forwards it to the upper layer application.
- Inserts message sequence numbers and ack sequence numbers for downlink MS messages.
- Handles L2 retransmissions to provide a reliable transport for layer 3 messages.
- Ensures reliable transmission via per message setting of ack required and/or fast repeat fields.
- Identifies and discards duplicate messages.

UDP Termination

Supplementary channel control messages between the SDU SDF Board Control Processor (BCP) and the BTSs will use UDP.

UDP–ER Termination

Call control application messages between the SDU SDF Board Control Processor (BCP) and the control portion of the BTS will use UDP–ER. UDP–ER is a proprietary enhancement implemented on top of UDP to provide an acknowledge based retransmission mechanism that is transparent to the application.

SCTP Termination

Call control application messages between the BCP and each MM and the control portion of the XC will use SCTP.

SMAP UDP

Call activity, layer 2 logging and statistics gathering will be provided and reported to SMAP using UDP.

BCP/CPE UDP

UDP communication is used between the BCP controller and each CPE for call processing control messages.

Power Control

Power Control Overview

> **NOTE**
>
> In 16.1, the system will only support Centralized Power Control.

The 16.0 release supports distributed and centralized power control. As in IS–95, distributed power control uses Open Loop Power Control, Outer Loop Power Control, and Closed Loop Power control schemes.

Currently in IS–95, power control is done via distributed power control. This means that the power control mechanism is distributed between different functional entities including the channel element. This method will still be supported for 2G calls.

The 16.0 release introduced centralized power control functionality. In 16.0, this functionality is in the XC PSI card, and in 16.1 this functionality is in the SDU if equipped. When a call needs to be setup or handed to a different system, the MM will decide what power control scheme to use, centralized or distributed, based on the mobile's capabilities.

Power Control is performed by each SDU SDF Channel Processing Element, consisting of the following 2G and 3G centralized power control functions:

- Calculates forward link gain ratio and communicates it to the selection/distribution function.
- Calculates reverse link outer loop thresholds and communicates it to the selection/distribution function.

Overview of Open and Closed Loop Power Control

Reverse power control consists of open and closed loop components.

Open loop power control, which is performed at the MS accounts for common or symmetrical losses on the reverse and forward links due to path loss and shadowing. It is relatively slow (with respect to the closed loop) generating new updates roughly every 20 ms. The amount of mobile transmit power necessary to establish the reverse link is estimated by subtracting total noise plus interference measured at the mobile antenna from a factor. The open loop mobile transmit power estimate will be refined by reverse closed loop power control.

The closed power control loop consists of an inner and outer loop. The outer loop is maintained at the base station and involves feedback based on frame erasures to determine an Eb/No set point in order to maintain a constant FER. The inner loop is distributed between the mobile and the base station where the feedback mechanism is based on the power control bit. The closed loop accounts for non–symmetrical (uncorrelated) losses between the reverse and forward links due to Raleigh/Rician (fast) fading, interference level variations (e.g. voice activity or loading), differences in an antenna's transmit and receive gain, and other associated losses (combiners, connectors, duplexers, etc.). It is the fast power control loop being updated at an 800 Hz rate for fundamental channels and at 400Hz for supplemental channels that effectively mitigates small to medium power variations due to fast fading. Fast power control is most effective at slow speeds whereas interleaving is not. (Note: the smaller the power swings or variations measured at the serving base station for each mobile the smaller can be the transmitted mobile power necessary to achieve a 1% FER. This lower required power level results in less interference and hence allows more channels to be supported.)

Overview of Forward Power Control

The purpose of forward channel power control is to minimize the amount of power transmitted to a particular mobile station on the forward link. Minimizing power in a CDMA system reduces interference and thus increases forward channel capacity. However, there is a trade–off between the amount of forward link power dedicated to a mobile station and the forward link voice quality that mobile station will experience. The power control algorithm must balance power against acceptable voice quality.

Forward power control is based on monitoring RF: Power Measurement Report Messages from the mobile station. This message reports the mobile station's count of detected forward link frame errors in addition to the mobile station's measurement of the signal strength of the Forward pilot(s).

Also, J–STD–008 and some IS–95 standards support Erasure Indicator Bit (EIB) for Rate Set 2 calls. The EIB indicates whether a forward frame was an erasure frame or not. This is a good indication of whether the forward power gain should be adjusted or not.

Centralized Reverse Power Control

The XC/SDU guides reverse power control for the IS–2000 call.

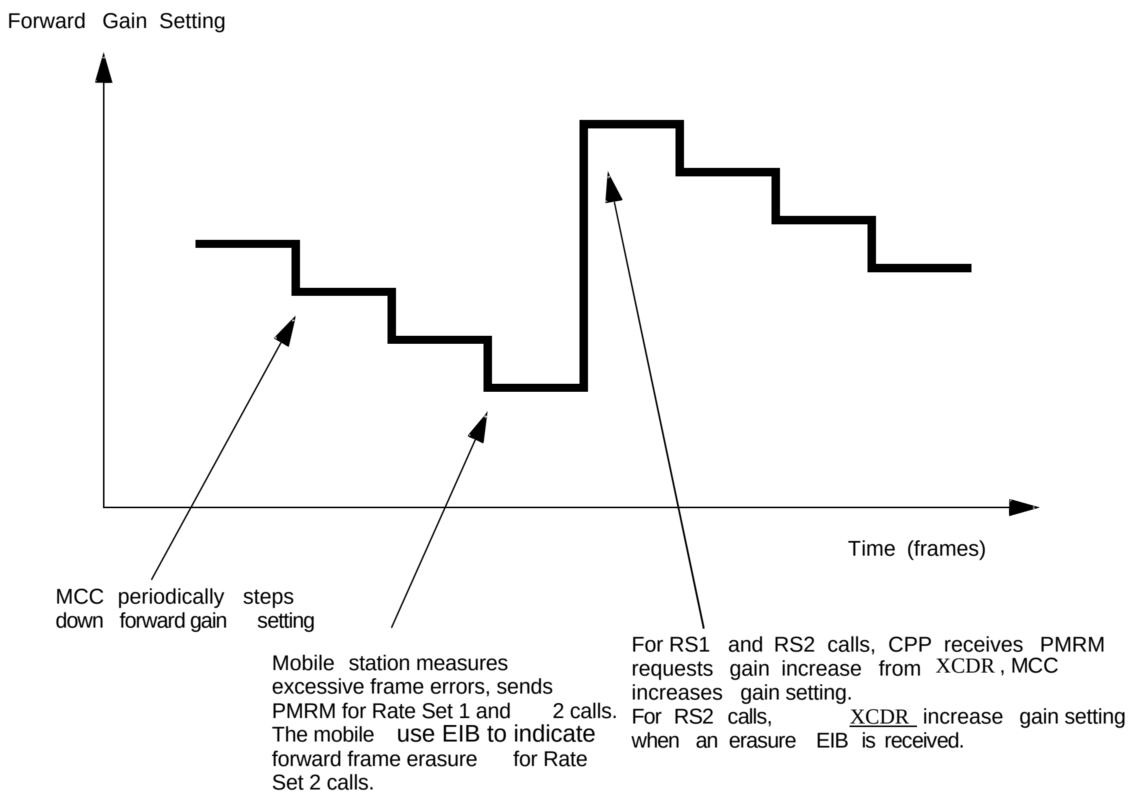
- The XC/SDU designates an MCC–1X channel element to perform reverse power control with the mobile. The MCCces perform reverse power control under the guidance of the XC/SDU.
- The XC/SDU calculates the outer loop threshold and provides the threshold to the MCC–1X channel element which is performing reverse power control for the mobile. The power control outer loop operation uses the post–Selection Frame Quality Indicator (FQI) as input to determine the outer loop threshold. FQI is sent by a BTS involved in a call to the SDU every frame period using an IOS 3G reverse FCH/DCCH packet frame. For a voice call, FQIs of the FCH frames are used; for a data call, the FQIs of the DCCH frames are used.
- The XC/SDU calculates the reverse link set point and propagates the set point to all channel elements supporting the Fundamental/DCCH channel of the call through forward link Fundamental/DCCH frames. The set point is really the reverse pilot set point.
- If the MCC1Xce gets the set point, the MCCce uses certain pieces of information to “translate” the outer loop threshold into reverse pilot Ec/Nt and compares that with the chip energy of each power control group received on the Reverse Pilot Channel. The MCC1Xce sets the power control bit based on that comparison. The mobile uses that power control bit to adjust transmit power. However, before the first forward frame arrives, the channel element sets the outer loop threshold to nominal threshold.

Centralized Forward Power Control

The XC/SDU calculates the Forward traffic channel gain for FCH, DCCH, and SCH and provides the information to the MCC–1X channel elements. The CBSC supports separate forward power control subchannels on the reverse pilot channel for controlling the forward FCH, DCCH and SCH, if required for the call.

Each MCC–1X channel element supporting the call follows the forward power control guidance provided by the centralized call control and the power control indications in the reverse power control to adjust the Forward traffic channel power when transmitting on the forward link to the mobile. However, the effective power is within the maximum and minimum gain of the current hand–off state.

Figure 7-8: Forward Power Control



Segmentation and Reassembly (SAR)

SAR is performed by each Channel Processing Element and provides the following functionality:

- Buffers fragmented uplink LAC PDU frames and reassembles the LAC frame.
- Verifies CRCs and discards frames if a match is not made.
- Appends the CRC on the LAC frame received from Layer 2.
- Segments LAC PDUs received from Layer 2 into a maximum available size to fit in the downlink frame.
- Sends layer 2 confirm messages after transmission of each final frame of air interface signaling messages.

Radio Link Protocol (RLP)

Overview of RLP

The RLP layer is responsible for managing transfer of user data frames in IS–95 and IS–2000 low speed and high speed data calls. The RLP layer resides in the SDF and the mobile station (they are RLP "peer layers").

- maintains and checks the sequencing of the received user data frames to determine if there are any skips in sequencing and therefore any missing/unreceived frames.
- sends NACK control frames to the peer RLP layer to request retransmission of the missing frames.
- resequences the frames (since some are received out–of–order) in its buffer and sends them to the upper layer.
- maintains a NACK list and if it does not get a response in a certain number of rounds of NAK frame transmission, it aborts the frame.
- RLP can also segment frames if necessary

There are three versions of the Radio Link Protocol:

- IS–2000 1X HSPD – RLP 3
- IS–95B HSPD – RLP 2
- IS–95A LSPD – RLP 1

RLP frames consist of three basic types: a frame that contains user data, Idle frames (to maintain the link), or RLP control frames.

For more information on Radio Link Protocol in relation to CDMA data service option calls, refer to the document TIA/EIA/IS–707–A Data Service Options for Spread Spectrum Systems.

Overview of SDU Support for RLP

The following functionality is supported on each SDF Channel Processing Element:

- RLP 1, 2, and 3 protocols.
- Receives forward–link bearer data and buffer–level information from PCFs
- Receives frame–by–frame transmission indications, including bandwidth allocations after multiplexing.
- Transmits the RLP bearer channel for multiplexing and IOS encapsulation.
- Provides aggregate buffer level information from the RLP and the PCF to the Supplemental Channel manager for supplemental channel scheduling purposes.
- Provides flow control signaling to the PCF based on configurable high and low buffer watermarks.
- Receives reverse–link RLP data after multiplexing.

- Routes re–sequenced GRE encapsulated data to the PCF.
- Notifies L2 MS when data inactivity timer has expired.

Multiplexing function

The Mux capability of each SDF Channel Processing Element provides the following functionality:

- Indicates erasures to the vocoder in case of bad packets, late packets or lost packets.
- Extracts frame quality information and EIB (for IS–95 A/B 13K only) and routes this information for use by power control.
- Extracts any L2 information and passes the L2 frame for SAR.
- Extracts traffic data and passes it to the vocoder for voice calls or circuit data calls.
- Extracts traffic data and passes it to RLP for packet data calls.
- Receives L2 messages and determines the transmission schedule based on voice activity, fast repeat requests, etc.
- Generates dim&burst requests as appropriate.
- Receives transmission F–SCH/R–SCH timeslice information via SCH management to control 1X supplemental channel transmission.
- Performs forward multiplexing to combine layer 2 signaling information and packet payload data.

BTS Termination

BTS termination is performed by each SDF Channel Processing Element, terminating bearer (call traffic) UDP/IP packets to/from

- circuit BTSs, via the PSI–CE cards in the XC which provide the circuit–to–packet interworking function, and
- packet BTSs.

XC Termination

XC termination is performed by each SDF Channel Processing Element, terminating bearer (call traffic) IOS frames to/from the XC subsystem.

VPU Termination

VPU termination is performed by each SDF Channel Processing Element, terminating bearer (call traffic) frames to/from the VPU subsystem.

SDU Functions – PCF

Packet Control Function

This section provides a description of the SDU Packet Control Function. The SDU performs Packet Control functions for CDMA2000 1X packet data calls.

PCF Architecture

Overview

For the system to successfully set up a packet data call, the end result must be that the mobile station can establish a PPP (Point to Point protocol) software connection with the PDSN. The mobile station and PDSN use PPP to configure an “OSI model” datalink–layer and network–layer connection, including IP address assignment. Once the PPP session is established, the MS can access the IP network (ISP, Intranet, etc) through its connection to the PDSN.

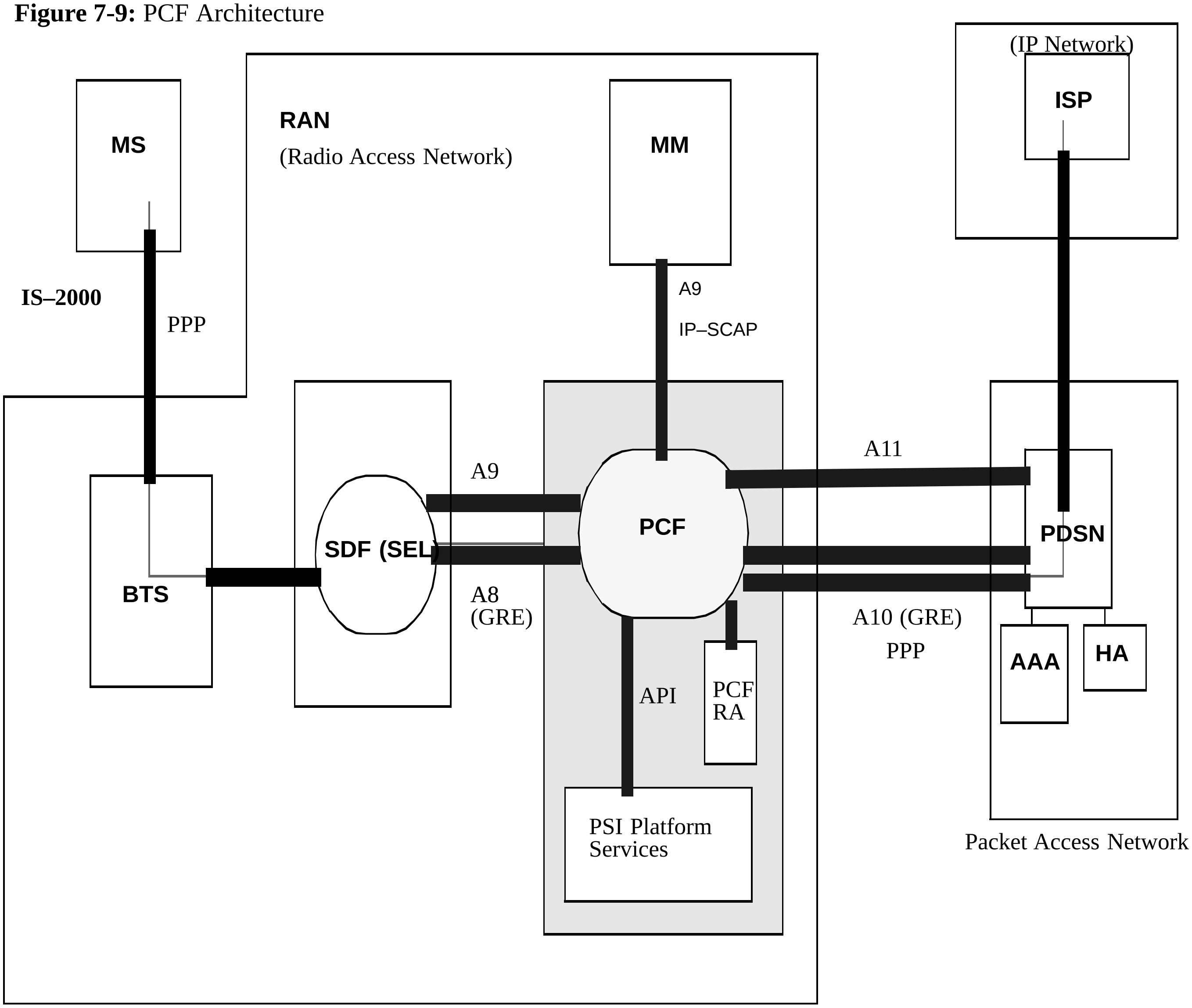
- Simple IP – The PDSN provides the MS with a temporary IP address to use, which the PDSN or associated AAA selects from the IP address pool; or
- Mobile IP – The PDSN allows the MS to use its home network IP address, and sets up a tunnel to the HA in the MS user’s home IP network.

The following RAN logical, upper–layer connections provide the support for the MS – PDSN interface:

- A10/A11 – a bearer and control interface between the PCF and the PDSN, where the bearer path is established for a particular MS
- A8/A9 – a bearer and control interface between the SDF and the PCF, where the bearer path is established for a particular MS

Once the system establishes the A8/A9 connections and the A10/A11 connections, the communication path exists for the MS – PDSN PPP session setup. In effect, the mobile station and PDSN communication session (control, bearer) runs “over” the A10/A11 and A8/A9 logical connections. The A10/A11 connection acts as a “bridge” between the PDSN and SDU and the A8/A9 connection acts as a “bridge” between the SDU and the BTS to the MS.

Figure 7-9: PCF Architecture



MS Functions

The MS (mobile station) is the user of the packet data service. The MS accesses the IP network (ISP, Intranet, etc) through its PPP connection to the PDSN. The RAN provides the support connection for the MS – PDSN interface.

SDF (SEL) Functions

SDF is the Selector / Distributor function as described in the “SDU Functions – SDF” portion of this chapter. SDF manages the A8/A9 link to the PCF supporting packet data calls.

PCF Functions

The PCF manages the A10/A11 interface to the PDSN for each packet data session. The PCF interfaces to the SDF (the SEL) to complete the “bridge” between the PDSN and the RAN.

PDSN Functions

The PDSN acts as the gateway between the landline IP Packet Data Networks and the cellular system. That is, the PDSN transfers packet data traffic between the cellular system and the landline PDN. The PDSN accomplishes this through the interface to the PCF function.

The PDSN, in combination with HA and AAA devices, provides the following types of Internet/Intranet access services to users accessing the system:

- Mobile IP
- Simple IP
- Proxy Mobile IP

HA Functions

An HA performs the following major functions:

- Interface to the PDSN for Mobile IP registration actions and per–call tunnel creation
- Forwarding of Mobile IP call packets from the home network to the PDSN
- Forwarding of Mobile IP call packets from the PDSN to the home network (reverse tunneling)

AAA

The role played by an AAA Server in a data network is to authenticate, authorize, and perform accounting for an incoming client that wants to use network resources for data activities.

The AAA server is a complete implementation of the widely–used IETF standards–track RADIUS (Remote Authentication Dial–In User Service) protocols, and is a full–function AAA (authentication, authorization, accounting) server.

The main functionality provided by the AAA Server is the Visited AAA functionality. It can also offer Home AAA services to mobiles whose home IP network is the same as the home access provider network. (I.E., The home access service provider is also an Internet service provider.) Optionally, the AAA Server may provide Broker AAA functionality to other domains.

PCF Management

PCF Management is performed by the Board Control Processor and provides the following functionality.

- Coordinates with A9 and A11 management to provide tunneling between the PDSN and the SDU.
- Maintains mobile sessions, both active and dormant.
- Allocates the A8 uplink and A10 downlink key field and sets up routing tables in the bearer manager.
- Updates the Resource Management/Allocation function of the mobile session status to keep the Resource Management function (on the SDU SPROC card) in sync with the PCF load.
- For new mobile sessions, the PCF manager provides PDSN selection.
- Provides fault management upon a PDSN failure: for active calls, PCF reselects the PDSN and establishes a A10 connection; for dormant calls, PCF pages the mobile to re–establish a connection with another PDSN.
- Releases A8 connections when an A8 link failure is reported by downlink bearer management.
- Interfaces with the MM to page mobiles when downlink bearer management receives data for a dormant mobile.
- Supports the status audit procedures with Resource Management/Allocation function to ensure resource usage is in sync.
- Provides resource capacity information to the Resource Management/Allocation function during initialization.
- Performs resource allocation between Channel Processing Elements (CPEs) and assigns calls to specific CPEs.

A9 Link Management

A9 Link Management is performed by the BCP and supports:

- A9/A8 setup procedures
- A9/A8 clearing procedures

A11 Link Management

A11 Link Management is performed by the BCP and supports:

- A10 connection setup procedures
- A10 connection registration procedures
- A10 connection release procedures

- A10 connection accounting procedures

SCTP Termination

Call control application messages between the BCP and the MM will use SCTP.

A9 UDP

UDP is used for A9 signaling to communicate with the SDF control function. A9 is Motorola's proprietary version of the A9 IOS interface, modified to account for Motorola specific SCTP messages between the MM and the PCF, while all the other A9 signaling messages will be carried over UDP between SDF and PCF.

A11 UDP

UDP is used for A11 signaling transport to communicate with the PDSN.

Downlink Bearer Manager

Downlink Bearer Management is performed by each CPE via modified A8 and A10 interfaces for bearer traffic from the PDSN to the SDF.

Bearer Management consists of the following for the downlink:

- Extracts key fields in PDSN GRE packets and looks up the A8 SDF destination, including the IP address and key field.
- Provides buffer storage for downlink packets towards the SDF when downlink traffic is congested or the mobile is in a dormant state.
- Provides the remaining downlink buffer information in the proprietary A8 interface.
- Informs the PCF Management when data is received for a dormant mobile.
- Supports downlink flow control when the congestion bit is set in an uplink packet received from an SDF; it will stop sending A8 outbound bearer packets and start buffering the A10 incoming packets received from the PDSN.
- Sends keep alive control packets every so often to ensure link integrity.

Uplink Bearer Manager

Uplink Bearer Management is performed by each CPE via modified A8 and A10 interfaces for bearer traffic from the SDF to the PDSN.

Bearer Management consists of the following for the uplink:

- Extracts key fields in SDF GRE packets and looks up the corresponding A10 PDSN destination, including the IP address and key field.
- Informs the Downlink Bearer Management of congestion control information.
- Monitors A8 connections and reports link loss when packets are not received for a certain duration.

A8 GRE

GRE from the SDF is terminated at the CPE. A8 is Motorola’s proprietary version of the A8 IOS interface, modified to account for Motorola specific congestion management and keep alive procedures on the A8 bearer path. Uplink packets are received from the SDF and routed for uplink bearer management. In the downlink, packets are received after downlink bearer management and forwarded to the SDF over the GRE tunnel.

A10 Termination

GRE from the PDSN is terminated at the CPE. Uplink packets are received from the PDSN and routed for downlink bearer management. In the uplink direction, packets are received after downlink bearer management and forwarded to the PDSN.

SPROC Card – Resource Management Function

Logical Functions

At a high level, the Resource Management application provides the following common functionality on behalf of both SDFs and PCFs:

- Provides SDU resource availability updates to the resource clients (MMs).
- Allocates SDF/PCF resources upon receipt of allocate resource request from the resource clients (MMs).
- Keeps track of resource status via the O&M interface
- Performs resource clean up upon resource failure.
- Places resources back into the resource pool upon resource recovery.
- Performs load balancing by distributing allocations between the payload cards to ensure resources are not overloaded.
- Performs resource audits of payload cards.
- Supports test commands to allow specific resources to be used for test calls only
- Applicable to both SDF and PCFs
- A SDF or PCF resource is provisioned as either Test or Commercial, on a BPP level.
- Collects PM statistics.
- For PCF resources, the Resource Allocator provides the following additional functionality: Maintains mobile session state (idle, active, dormant); stores service configuration information for dormant mobiles; supports an anchor PCF by querying for mobile sessions among external PCF RAs.

Auto Discovery Management

Auto–discovery multicast and registration procedures are used to support multiple MMs.

During initialization, RM obtains the allocatable resources from all payload cards, specifically SDF and PCF payloads. Once RM gathers capacity information from all payload cards, RM informs the MMs of the resource availability.

Under normal operating conditions, resource availability information is updated periodically. However, if a certain resource type (SDF or PCF) becomes unavailable or a new resource becomes available, RM updates resource clients of the change in resource availability.

Client Registration and Link Management

The Client Registration and Link Management functionality provides the resource client registration function in support of registration with multiple MMs as well as the link management function for RM links to these MMs.

SDF Resource Allocation

Upon receipt of an SDF resource request from an MM, RM allocates the requested resource from its available SDF resource pool. RM performs load balancing to distribute the load between the SDF payload cards. Because the data transmission requirements of a call cannot be known ahead of time, a unit called a Band Width Unit (BWU) is used to estimate load on a SDF. A voice or low speed data call is permanently set at 100 BWU while the default setting for high speed data calls will be 200 BWU. The setting for high speed data calls will also be configurable at the OMC–R. When a call is released, the SDF notifies RM of the mobile state. RM then moves the resource back to the available resource pool and updates the capacity status.

PCF Resource Allocation

RM manages mobile dormancy as well as resource allocation. Resource allocation procedures for PCF calls rely on the same calculations for capacity to balance the load as SDF calls. All calls, irrespective of the service option, are assigned the same bandwidth usage. In order to manage mobile dormancy, however, RM checks if it has a dormant session for a mobile upon receipt of a PCF resource request from a MM. If there is no local dormant session, RM queries other remote RAs of any existing dormant session by sending a multicast query message within the PCF zone. If any remote RM has the existing dormant session for the mobile, the remote RM forwards the remote PCF address along with service configuration information, if stored, to the local RM. The local RM then forwards the details of the remote PCF resource to the MM. In the case when the dormant call is not located, either locally or by another RA, a new call be allocated.

For dormant mobiles, PCF resources are reserved. A high water mark is defined such that resource requests will only be honored for dormant mobiles being reactivated. However, if the bandwidth required for the call is not available, the RM will report this back to the MM which will subsequently select a different PCF–RA for the call. RM is also responsible for keeping the service configuration for 1X packet data calls in order to reduce the call set up time by skipping service negotiation. Upon receipt of a service configuration update from an MM for a dormant mobile, RM stores the service configuration locally and informs the MM if the mobile comes back from dormancy at a later point.

Resource Type Specific (SDF/PCF) Event Dispatcher

The Resource Type Specific Event Dispatcher provides functionality required to handle messages for the application specific resources. Any application specific messaging between the SPROC RM application and the BPP SDF or PCF application will be over the proxy interface and dispatched through the Resource Type Specific Event Dispatcher.

SCTP Termination

Resource Allocation messages between the SPROC and the MM will use SCTP as transport to support specific resource allocations and de–allocations as well as client registrations.

UDP Termination

Auto–discovery multi–cast messages between the SPROC and the MM and multi–cast messages to other PCFs will use UDP as transport.

Redundancy Support

2N redundancy is supported for the SPROC, subsequently Resource Management resides on both the active and the standby SPROC. RM on the active SPROC will use HAP platform services and APIs to check point the necessary state information to the standby SPROC RM. When a failure is detected by the HAP platform, fail over is performed and the standby RM takes over the active role and continues to provide resource management service. This fail over of SPROCs maintains stable calls. Externally, a client registration procedure will once again be executed by restarting Auto–Discovery process. Calls will be preserved, therefore, re–registration will not cause any call clean–up activity at the MM.

SDU Frame Description

Overview

The SDU product supports the packet selection, distribution, and control functions. The SDU is physically implemented in a 21 slot chassis utilizing a backplane architecture. Cards such as the T1C (ISB/SPROC) occupy two physical slots each so that the number of physical cards installed will be 19. Plug in circuit cards provide all functional capabilities and comply with hot swap capability. The SDU frame consists of two SDU shelves, independent of one another yet sharing a common cabinet. The Power Supply Modules (PSMs) required for each SDU shelf are housed in a separate cage along with regional circuit breakers. A main circuit breaker panel resides at the top of the frame and provides the main disconnect and circuit protection to the cabinet internal power wiring. The power and signal connectivity to the SDUs is provided at the top of the cabinet with cable plenums to the bottom of the frame provided for bottom entry environments.

Main Breaker Panel (MBP)

MBP Description

The MBP provides a housing for the main circuit breakers. Four main feeds are supported with this panel. The main feeds can be described as Upper SDU PSM–1, Upper SDU PSM–2, Lower SDU PSM–1, and Lower SDU PSM–2. Each feed provides independent power to each of the four PSMs associated with the two SDU shelves. In addition to the PSM circuits, one auxiliary circuit breaker position is provided off of each feed. In total, there are eight circuit breaker positions housed in the panel. Only four positions are filled for the SDU application. On the feed or input side of the panel, connections are made to the power filters at the top of the frame. On the output side of the MBP, connections are made to the PSMs in the PSM shelf. Auxiliary circuit breaker positions remain empty in this application. The panel design calls for circuit breakers which have pin style attachment requiring no tools or screws. The panels primary function is to provide a main disconnect and circuit protection for the SDU shelf. Opening the Circuit breakers will open the –48VDC current path,disconnecting the frame from the facility power.

Circuit Breaker Specification

The circuit breakers are push–pull style. Medium trip delay is specified with current capabilities up to 100Amps.

PSM Shelf

Description

The PSM shelf provides power conversion and distribution to seven circuits for each of the SDU shelves.

The operator may insert or remove any of the modules within the PSM shelf without removing power from the system, however, the removal of a CBM carrier module would cause the complete loss of distribution to the associated SDU shelf.

PSM Chassis

The PSM chassis provides a housing for four PSMs and two CBMs. The shelf provides cable connection and plugability for each of the PSMs and CBMs. The PSM chassis uses 7 units of rack height. The current sharing PSMs will be located vertically, one above the other for each SDU.

PSM Bus Bar

The PSM bus bar is a subcomponent to the PSM shelf. It provides input and output power distribution to and from the PSM. At the input side it receives the nominal –48VDC A and B feeds along with the respective returns from the MBP. At the output side it physically couples the A and B +27VDC feeds and delivers it to the CBM. The output returns are also coupled at this point and provide connection for two 27V returns to/from the SDU shelves.

The +27VDC power output from the PSMs is carried over this bus and input into the CBM module.

PSM

The PSM is a 2000W output power supply accepting –39 to –72VDC at the inputs while providing +27 +/– 0.1 VDC at the output. The output is designed such that it supports a current sharing arrangement with other PSMs. This component is borrowed from the Common BTS Platform unchanged. The output behavior or the PSM under output short circuit conditions is to current limit at approximately 80 amps.

CBM

The CBM, or Circuit Breaker Module, provides +27VDC power distribution to seven regions. This module houses seven removable E–T–A TM circuit breakers. The CBM has interfaces for one +27VDC input, seven +27VDC outputs, and an alarm circuit. The alarm circuit provides a NORMALLY OPEN contact condition when all circuit breakers are closed.

SDU Shelf

Overview

The SDU frame houses two SDU shelves, each independent of one–another. Each shelf is an integral product housing common platform and SDU–specific circuit modules. A backplane provides communication between the modules. Signal I&O is handled primarily through the Site and Span I/O modules plugged in at the top–rear of the shelf. Power and frame level alarm capabilities are interfaced directly through the backplane.

Chassis

The SDU chassis is an EIA 19in. rack mount unit designed specifically for the SDU application. The chassis provides a backplane architecture with 21 physical slots. The ISB/SPROC cards occupy two slots each. The ISB/SPROC and CCA cards have reserved slots at the right and left ends of the cage. Fifteen general purpose payload card slots cover the center of the chassis. The Site and SPAN I/O cards are accommodated via a horizontal mounting plate at the top rear of the chassis. The chassis houses three fan modules, directing airflow from the lower front of the chassis to the rear top of the chassis. An airflow inlet area is provided at the lower front of the chassis. An exhaust plenum area is reserved at the top of the chassis above the circuit cards.

Backplane

The SDU backplane provides intercommunication and power distribution between the SDU cards and modules. Connectors on the backplane provide an interface for the regional power connections and Motorola alarms.

Cabinet

Description

The SDU cabinet provides a mounting structure and will house 1 MBP, 1 PSM cage and 2 SDU shelves.

Top I/O Panel

Description

The cabinet top is left open for the incorporation of a top I/O panel. This panel provides the interface and demarcation point for all SDU interfaces. Essential interfaces such as power and ground interface through fixed portions of the main panel while data I/O connectors will pass through removable sub–panels. All interfaces will have appropriate labels indicating the use of the interface.

The main top plate provides a physical structure for the mounting of power cable filters and I/O sub–panels.

Power enters the frame through power interface filters mounted in the top I/O main panel. The four interfaces are Lower SDU PSM–1, Lower SDU PSM–2, Upper SDU PSM–1, and Upper SDU PSM–2. Each SDU is provided with redundant and independent feeds. The power filters provide a lug connection to the top of the frame.

Three sub–panels types support initial SDU applications:

- The first sub–panel type has two shielded RJ45 receptacles for Gigabit ethernet interfaces from the Span I/O.
- The second panel type will support the Customer alarm I/O connector. This interfaces to both SDUs at the Site I/Os.
- A third type of sub–panel supports T1/E1 Span connections for each Span I/O module in the two SDUs. This panel will be available only as a future upgrade.

Power Distribution and Grounding

Power

Redundant power feeds for each of the SDUs is provided. Redundant nominal –48VDC power is received at the top of the frame at the filter input lugs. After passing through the surge and emissions filters, power is connected to the MBP –48VDC input terminals. After passing through the main circuit breakers, the power is connected to the PSMs through the PSM bus bars. Utilizing the current sharing capability of the PSM–1 and PSM–2 PSMs, the +27VDC outputs are tied together by the PSM bus bar. From here the power is input into the CBM. Within the CBM, seven regional circuits are output from their respective circuit breakers. Cables from the PSM cage bring the regional power to the SDU backplanes where they are terminated on two connectors. Within the SDU backplane, slots are assigned to the different regions.

Grounding

Grounding of the SDU frame follows an Isolated return scheme. Each chassis within the frame will maintain a dedicated ground conductor to a dedicated ground bus bar at the top of the frame. The chassis grounds are bonded to the frame at the top through this dedicated path as well as any incidental paths created within the frame physical structure. The frame maintains isolation from the building structure providing a SINGLE isolated ground path to the site MGB. The frame isolation is accomplished through the use of an adhesive non–conductive pad on the bottom of the frame. Non–conductive bumpers are placed on the side of the frame to set a 3 mm isolation space frame adjacent frames. Mounting hardware for the frame will utilize isolated shoulder washers to insure isolation through the mounting holes. On the 27VDC side of the PSMs, the 27VDC return is bonded to the chassis ground to establish the reference point of the 27VDC side.

Bearer Payload Processor Overview

The Bearer Payload Processor (BPP) card is the general payload card of the SDU.

The BPP provides the following Selection and Distribution Functions (SDF):

- soft handoff selection / distribution
- L1/L2/L3 call processing
- Power Control for the RF traffic channel
- Radio Link Protocol (RLP) for data services
- BTS logical interface termination
- XC (vocoder platform) logical interface termination
- PCF logical interface termination

The BPP provides the following Packet Control functions (PCF):

- SDF logical interface termination
- PDSN logical interface termination
- Buffering of bearer data for packet data services
- Maintenance of service configuration and the PDSN logical interface for mobiles in IS–707 Dormant State

The BPP consists of a Board Control Processor (BCP), a number of Channel Processing Elements (CPEs), and an Ethernet/IP switch performing packet routing within the board.

Board Control Processor (BCP)

The Board Control Processor (BCP) performs certain call processing signaling functions, and general management of the BPP board including initialization, fault detection/management, alarm generation, Ethernet switch programming and SPROC interface termination. The BCP also has 100baseT Ethernet and RS–232 serial port interfaces to the front panel.

Channel Processing Elements (CPEs)

The Channel Processing Element (CPE) performs the application layer processing: SDF, PCF, and call processing. Each CPE utilizes one 100 Mbps interface to the Ethernet Switch for voice and data traffic, and one Host Port Interface link to the BCP for code loading and other initialization operations. There are 12 CPEs on each BPP, implemented with DSPs.

Ethernet/IP Switch

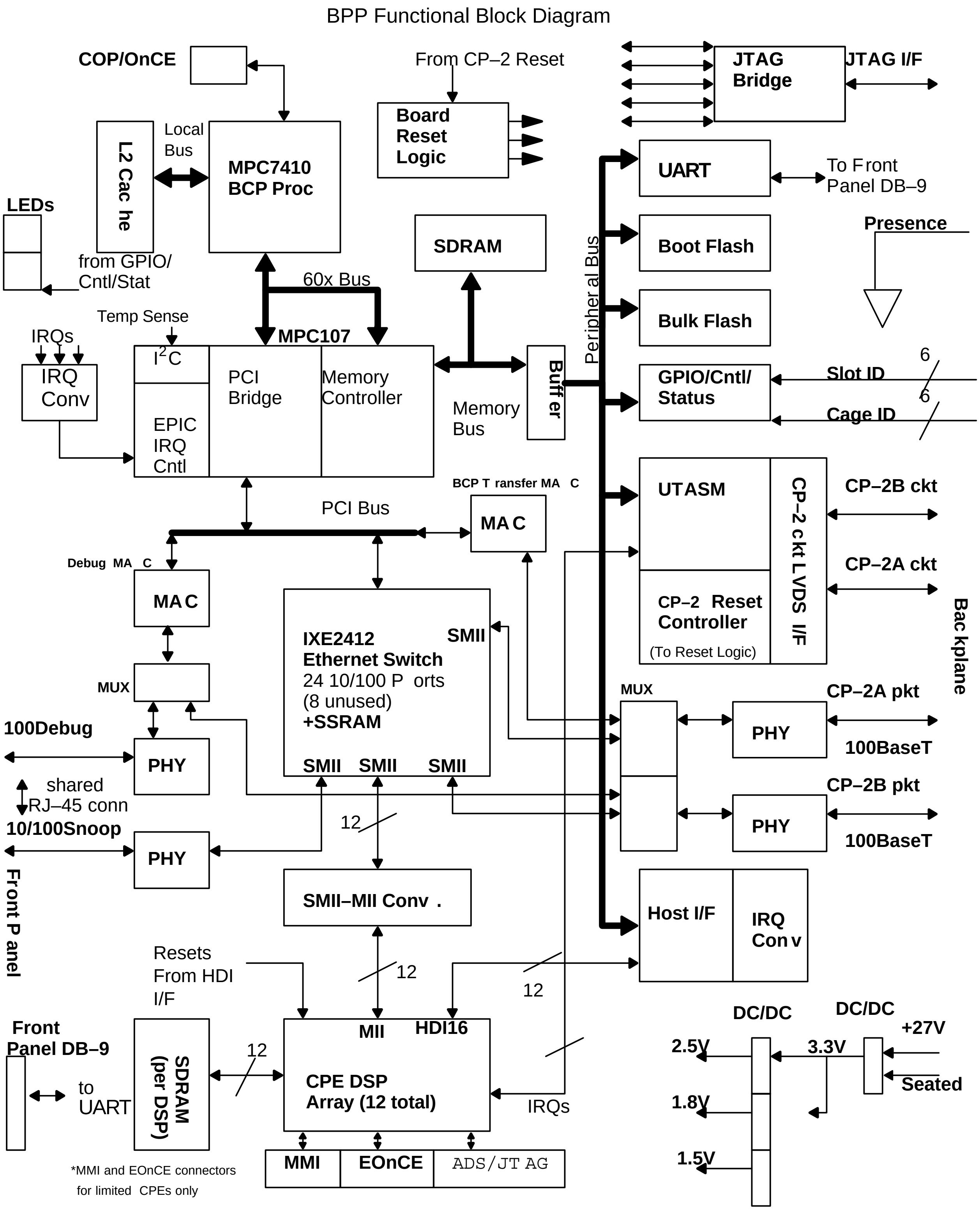
The 10/100baseT Ethernet/IP switch device on the BPP interconnects backplane links, the Board Control Processor and Channel Processing Elements on the Payload card. Inter–processor communication within the payload card also may use the Ethernet/IP switch. The BCP controls the Ethernet/IP switch through a PCI interface.

Overview of BPP Interfaces

The BPP supports a CP2 link to each ISB, with each CP2 link comprised of two different communication interfaces: an Ethernet–based Packet interface (known as CP2–Packet), and a TDM–based Circuit interface (known as CP2–Circuit). On the BPP, the CP2–Packet interface carries all communication and traffic to/from the BTS, XC, SPROC and PDSN via the ISB switch. The CP2–Circuit interface is purely used for clock and reference information. CP2–Circuit is also used to reset the BPP.

In addition, the BPP front panel supports the following interfaces: a green and a red status LED; RS–232 debug interface; Ethernet debug interface.

Figure 7-10: SDU BPP Functional Block Diagram



Board Control Processor (BCP) and Peripherals

The BCP is the central processing unit of the BPP card. In addition, peripheral devices and logic support the BCP. The functions of the BCP and its support logic include:

- Configuring and initializing peripheral components of the BPP
- Supporting bearer processing software applications
- Operations and maintenance for other BPP devices

BCP and Peripherals Overview

The BCP terminates bearer packets and is also responsible for configuration and initialization of the BPP card.

The BCP consists of the following three major functional areas:

- The BCP and support logic:
  - MPC7410 processor (BCP)
  - L2 cache for MPC7410
  - SDRAM for MPC7410
  - the MPC107 PCI Bridge and Memory Controller
  - Interrupt conversion logic
  - test connectors for 60x bus debugging
- BCP Peripherals:
  - UART (MMI for MPC7410)
  - Boot Flash
  - Bulk Flash
  - Status/Control Registers
  - Host Data Interface Controller
  - UTASM
- PCI Bus (Master)– the MPC107 is the PCI bus master; other devices tied to the PCI bus include (discussed in other sections):
  - Debug MAC
  - BCP Transfer MAC
  - Ethernet Switch

BCP and Support Logic

This section describes the BCP and support logic.

- MPC7410 Board Control Processor (BCP) – The BCP is a MPC7410 processor running at 400MHz. The input clock to the MPC7410 is 100MHz.
- BCP RTOS Timers – The BCP has access to four timers via the MPC107. The timers are 31 bit timers, clocked at 1/8 the SDRAM frequency (100MHz/8=12.5MHz).
- BCP Interrupts – The BCP receives one interrupt, directly from the MPC107. The interrupt from the MPC107 is a logic OR of any of the 16 interrupt inputs to the MPC107 (assuming they are unmasked). The BCP can then read an MPC107 register to determine the source of the interrupt.

BCP Peripherals

The following devices all reside on the peripheral device bus.

- Boot Flash Memory – The BCP has 16 MB of boot flash containing the BCP initialization code and the EID, and FPGA images.
- Bulk Flash Memory – The BCP has 64 MB of bulk flash memory containing the application code for the BCP.
- UART/MMI Interface – The UART provides an MMI interface to the BCP, to support card debugging.
- Host Data Controller – The Host Data Interface (HDI) Controller FPGA.
- UTASM FPGA – The UTASM FPGA provides functionality for the CP–2 Circuit Fabric.

PCI Bus

There are three slave PCI devices on the BPP PCI bus.

- MPC107 (Master)
- Transfer MAC (Slave)
- Debug MAC (Slave)
- Ethernet Switch (Slave)

The MPC107 acts as a bridge between the 60x bus of the MPC7410, and the PCI bus on the BPP. The PCI bus is a 32 bit bus (2.1 compliant), running at 33.33 MHz.

CP–2 Packet Fabric

Packet Logical Blocks

The packet fabric consists of the following interfaces and logic blocks:

- A 24 port 10/100BaseT ethernet switch
- A 100BaseT PHY/MAC for debug purposes
- A 10/100BaseT PHY for ethernet switch port snooping
- A BCP Transfer MAC for packet traffic transfer from the ethernet switch to the PCI bus
- Two 100BaseT PHYs for the CP–2A and CP–2B packet interfaces
- CP2A and CP2B packet multiplexing

CP–2 Packet Ethernet Switch

The CP–2 Packet ethernet switch function includes switching of voice/data traffic on the BPP. Its functions are to switch bearer/control traffic between the following ports:

- the CP–2A pkt and CP–2B pkt 100BaseT ports from ISB–A and ISB–B, respectively
- the 100BaseT ports to each CPE (total of 12)
- the 10/100BaseT snoop port
- the BCP Transfer MAC

The ethernet switch consists of the following interfaces and logic blocks:

- Layer 2, 3 and 4 wire–speed switching/routing on all ports
- 24 10/100Mbps (SMII interface)
- 32–bit PCI bus interface, enabling configuration from the BCP
- 4MB of Packet Memory SRAM, expandable to 8MB
- 2 MB of Address Memory SRAM

BCP Debug MAC

The BCP Debug MAC connects to the front panel debug port. Its main use is for injecting traffic into the BCP.

10/100BaseT Front Panel Snoop Port

It is possible to monitor a specific port on the ethernet switch. In this configuration, a mirrored link will be sent out an additional port on the ethernet switch (i.e. the front panel debug port). This allows monitoring equipment to be hooked up to the debug port. The debug port can also be used to simply inject packet traffic into the switching fabric.

10/100 BaseT BCP Transfer MAC

The switching fabric includes a 100BaseT MAC connected to one of the ethernet switch ports (via the SMII–MII converter). This allows packet traffic to flow between the ethernet switch and the BCP. It can not be run at 10BaseT, since it is connected to the ethernet switch via the SMII–MII conversion FPGA.

BPP PHYs

All PHYs on the BPP are within one shared eight port device. This octal PHY has an SMII interface. This eight port device is managed by the ethernet switch via its MDIO port. The octal PHY(s) implement the following:

- 100BaseT CP2–A via ISB–A
- 100BaseT CP2–B via ISB–B
- 10/100BaseT Front Panel Snoop Port
- 100BaseT BCP Debug MAC Port

The PHY(s) interfaces to the ethernet switch via the SMII interface.

CP–2 Packet Multiplexing

In order to allow for a direct ethernet connection into the BCP, the CP2 packet data is multiplexed. This allows CP–2 packet data to be sent directly to the BCP, bypassing the Ethernet switch. The direct Ethernet connection to the BCP is only used during DHCP init and for emergency codeload.

Channel Processing Elements

Overview

The BPP has 12 MSC8101 DSPs, referred to as Channel Processing Elements (CPEs). The CPEs support the following call processing functions:

- SDF
- PCF
- Call processing

CPE Interfaces

The BPP card has an array of 12 Channel Processing Elements (CPEs). The CPEs run at a core frequency of 250 MHz (initial Pilot BPPs). The CPM of the CPE runs at 125MHz. Each CPE consists of the following elements:

- Dedicated 100Mbps MII port from the ethernet switch (part of the CPE CPM)
  - Each CPE terminates 100Mbps ethernet via its FCC1 port. The FCC1 port is an MII interface (part of the CPE CPM).
  - The 10/100 MII port from the ethernet switch (via the SMII–MII converter FPGA) allows for CP–2pkt connectivity between the ISB and a CPE on the BPP.
  - Even though this port is a 10/100 MII port, the port will be configured as a full–duplex fast ethernet 100Mbps port. CPE0 is connected to ethernet switch port0, CPE1 to ethernet switch port1, etc.
- 32 bit 60x bus interface for SDRAM
  - Each CPE has 16MB of SDRAM.
- HDI16 Host Interface port
  - The CPE has a Host Data Interface (HDI16), providing an alternate path on board to the CPEs. This will allow the BCP to communicate with the CPE without depending on the primary ethernet path.
- IRQ interface
  - Each CPE receives five interrupts via the UTASM FPGA. These interrupts are all synchronized to the CP–2ckt interface. These interrupts are maskable by the CPE. The five interrupts are: 125 us, 2 sec, 1 second, 80 ms second, 6.12 second.
- Debug Interfaces (on selected CPEs, not all)

CP–2 Circuit Fabric

The CP–2 Circuit Interface consists of the following blocks:

- The CP–2 circuit LVDS interface
- The UTASM FPGA
- The CP–2 circuit reset controller

The CP–2 Circuit Interface performs the following functions:

- Derive the 6.12S pulse from the CP–2 Circuit interface, and use the 125 us, 80ms, 1S, and 2S references pulses for the UTASM PLL reference signal.
- The BPP will decode reset commands from the CP2–Circuit Interface and trigger a signal to other reset control logic

The CP–2 circuit interface is implemented in hardware but the BPP does not currently use it.

BPP Call Processing Applications

For a description of BPP Call Processing functionality, refer to the “SDU Functions – SDF” and “SDU Functions – PCF” sections of this chapter.

ISB/SPROC Description

SPROC

The SPROC performs the following functions:

- Acts as the SDU system processor.
- Performs the “Resource Allocation/Management” function.

ISB

The ISB is the hub/star switch and the primary network interface.

CCA Overview

Description

The CCA provides inputs for shelf–level alarms In addition, the CCA provides termination of any alarms that might be terminated at the SDU shelf. The CCA also provides optional control of relay contacts that could be used to control operator site equipment. The CCA also monitors the shelf fans and Power Supply Modules (PSMs) and reports failure conditions. Each CCA communicates to both ISBs through standard CP2 interfaces.

Interfaces

The CCA supports the following interfaces:

- Five cabinet alarm inputs.
- Relay drives for 8 customer outputs. The 8 relay drives of a CCA are capable of being “ORed” with another CCA to support 2N redundancy for customer outputs.
- 32 Customer Alarm inputs. The 32 Customer Alarm inputs of a CCA are capable of being “ORed” with the inputs of another CCA.
- SDU Cage status indicators visible from the outside of the left front door.
- An RS–232 port through its backplane connector for debugging purposes.
- Two CP2 connections to its backplane connector (one for each ISB).

Overview of Alarm Collection

The CCA receives alarms from:

- the FRUs (fan trays and power supplies)
- alarm sensors inside the cabinet
- customer equipment.
- SDU has 32 customer alarms.

Some FRUs provide RS–485 physical interfaces for the alarms, while other alarms are single–ended logic lines.

The alarms are received by one of three FPGAs on the CCA, which provide a common alarm processing mechanism and an interface to the SW. The SW can enable/disable any alarms or alarm interrupts and select alarm signal edge types. Alarms from the cooling fan module(s) result in a fan boost signal being sent as needed from the CCA.

CCA Block Diagram

Overview

This section provides a block diagram of the CCA.

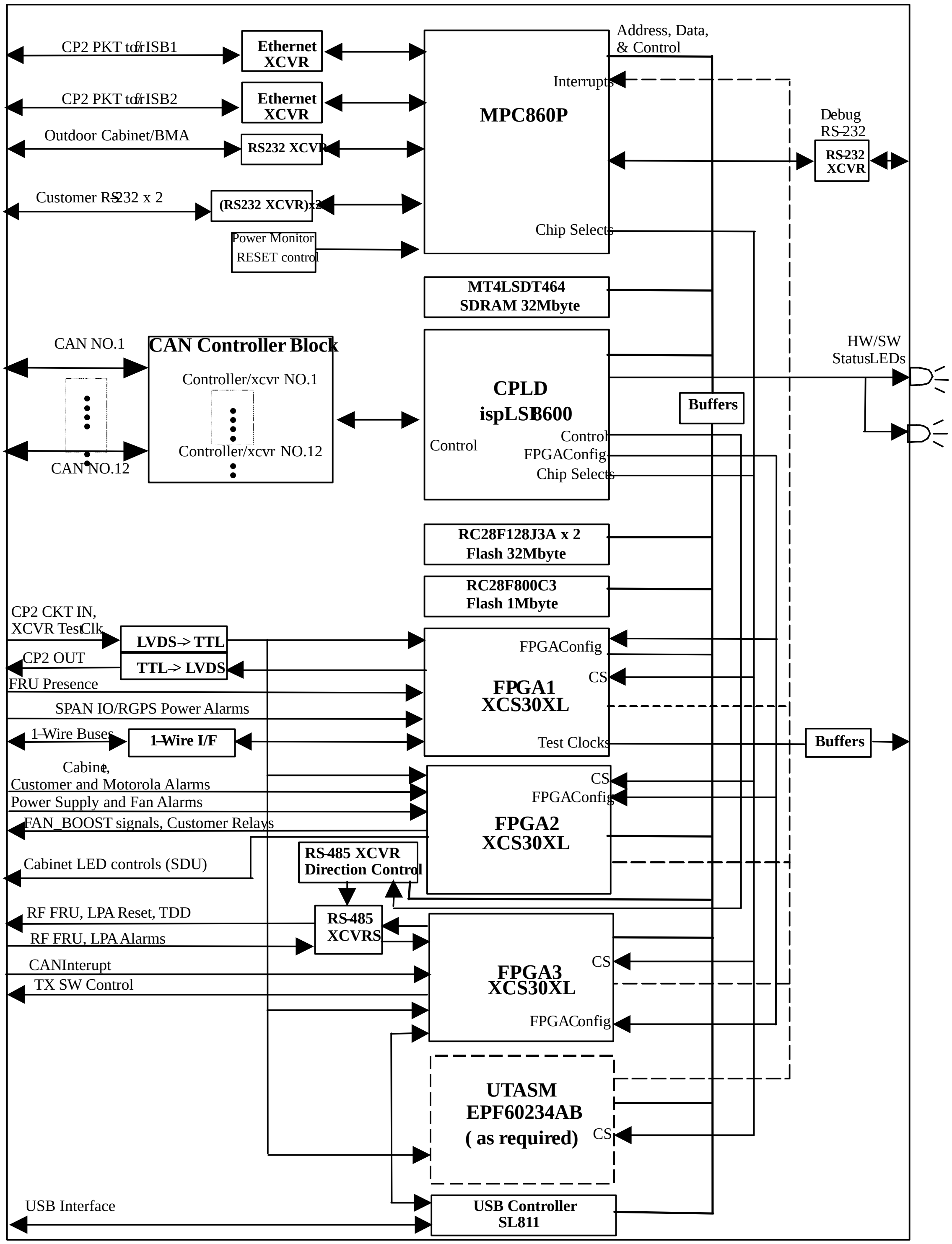


Figure 7-11: SDU CCA Functional Block Diagram

NOTE

The SDU does not use the CAN or USB elements shown in the block diagram.

NOTE

Since CCA is a common platform card, common to both SDU and the BTS, this figure contains some elements which are not relevant in the SDU implementation such as RF FRU inputs.

MPC860P (CPU)

The MPC860ENCZP50 (50 MHz external clock) is the control processor in the CCA board.

SDRAM

A 32 M byte SDRAM is used for fast data storage device. The access side for the SDRAM area is 32–bit.

CPLD

The CCA uses one ispLSI8600v CPLD. Its functionality includes:

- RS–485 XCVR direction register select generation and enable control
- FPGA configuration control and chip select generation
- CP2 reset control
- CCA system reset status management
- CCA on–board watchdog circuit enable control
- CCA HW and SW status LED control
- CCA active/standby status management
- Back plane status information access (SLOT_ID, CAGE_ID and TEST_MODE#)

Flash 32 MByte, Flash 1 Mbyte

Two flash memory types make up the boot–0 memory and the boot–1 memories.

- 32 Mbyte
- 1 Mbyte

FPGA 1

FPGA1 provides the following functionality for the CCA:

- FRU presence status monitor.
  - Each FRU reserves one pin in the backplane interface connector for system presence indication. This pin is grounded at each FRU and is routed through the backplane to both CCAs, where it is terminated in the FPGA1.
  - When a FRU is not present in the back plane, the corresponding presence line is held high by a pull–up resistor. The CCA processor can read the presence status for each FRU by reading registers in the FPGA1.
- 1–Wire bus control
- XCVR test clock management
- SPAN IO power supply output monitor

FPGA 2

FPGA2 provides the following functionality for the CCA:

- FAN module management
- Power supply alarm monitor
- Cabinet alarm monitor
- SDU cabinet LED control
- Customer relay control and external alarm monitor.
  - The CCA provides 16 alarm inputs for unique, customer–defined purposes. Examples of these might be a door alarm, or an alarm for room temperature and air conditioning system.
  - Since these alarm sources are remotely located from the SDU shelf, the alarm inputs are electrically isolated from the CCA circuit. There are 16 opto–isolator devices in the SITE IO. The LED sides of these devices are powered from the power supply in the SITE IO that is isolated from the SDU ground.
  - The customer interface connector allows for customer access to the anode side of these LEDs and the isolated power supply Vcc line as a contact pair. Alarms are recognized when this contact pair is closed.
  - The customer alarms are monitored by the FPGA2, where a 10 K ohm pull–up resistor is place for each alarm input.
  - The CCA provides 8 outputs for customer relays, which are located in the SITE IO module at the frame top. The customer receives both ”normally–open” and ”normally–close” contacts for each relay. The usage of these contacts varies from customer to customer.
- Motorola external alarm monitor.
  - There are 16 alarm inputs for customer equipment status monitoring.
  - The alarm sources are located external to the SDU cabinet, and are isolated from the CCA circuit ground.

– Closing or opening a contact pair at the customer equipment generates an alarm. These alarms are received at the SITE IO board and are the routed to the CCA in the back plane.

UTASM

The Universal Timing and synchronization Module (UTASM) decodes the incoming CP2 circuit data from the ISB. It decodes both primary and redundant links. The UTASM provides both automatic and manual selection of the active link.

The UTASM provides all the necessary timing references, synchronized to the active CP2 circuit link. To maximize system availability, the timing reference signals generated by the core will continue to be produced if the CP2 circuit links fail, or become unstable. However, failure of both CP2 links fail will cause timing synchronization to be lost.

Ethernet XCVR

The CCA has two CP2 Ethernet ports. The ISB uses the CP2 packet link for various CCA control purposes, including sending command packets to the CCA, downloading CCA code and collecting system alarms from the CCA.

RS–232 XCVR

The CCA provides two RS–232 serial links for interfacing with customer–specific equipment local to the SDU shelf.

LVDS <–> TTL

The CP2 Circuit connections that connect the ISBs and the XCVR test clock interfaces use LVDS technology. Signals are converted from LVDS to TTL for the CCA logic block, and from TTL to LVDS for the ISB.

The CP2 circuit link is a bidirectional, point–to–point TDM interface. This link carries various types of clock and timing and control information.

1–Wire I/F

The CCA 1–wire bus technology serves two purposes, and EID collection. FPGA1 is the controller.

RS–485 XCVR

NOTE

RF functionality is not relevant to the SDU.

RS–485 protocol interfaces the CCA to various RF FRUs that are located external to the backplane, therefore requiring high noise immunity.

SDU Signal Flow

Introduction

The following figures illustrate signal flow through the SDU.

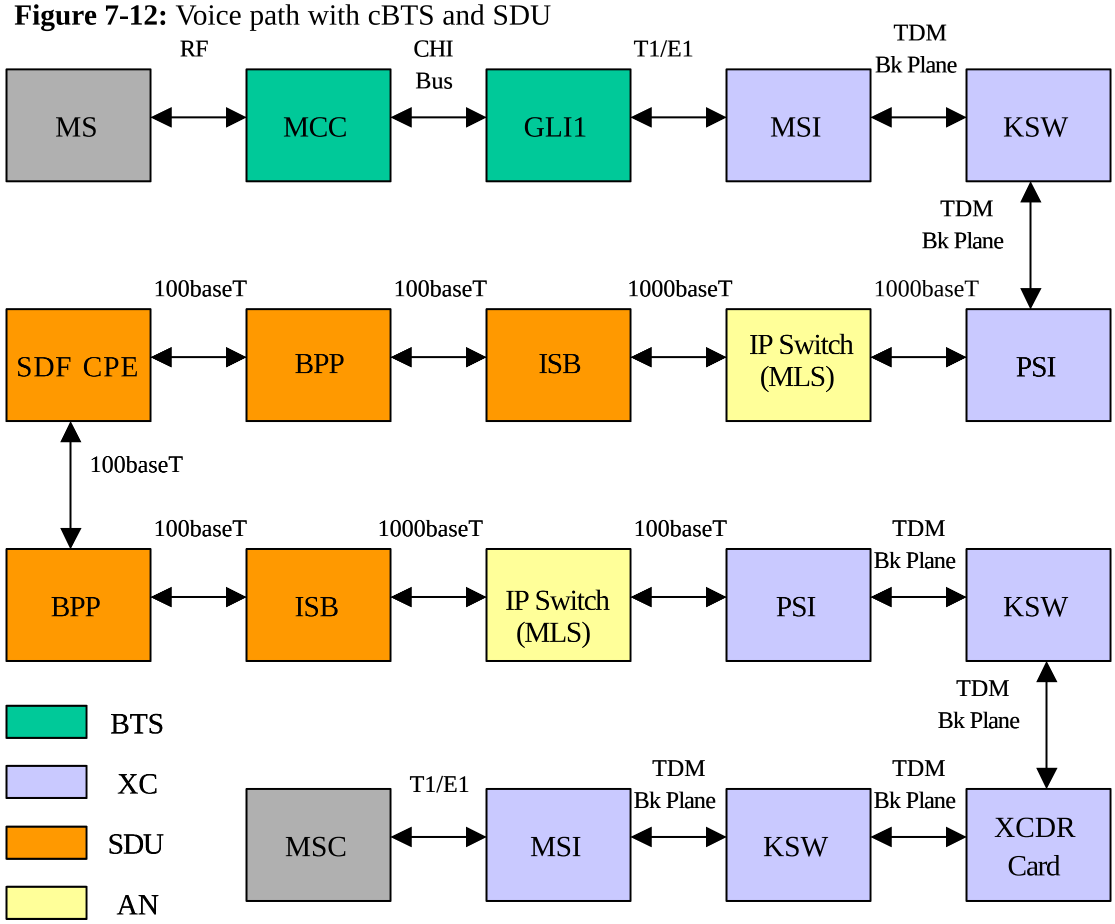
NOTE

Where equipped, the VPU can replace the XC in these flows. The VPU shares the same interface types as the SDU (SPROC, BPP, ISB etc). Refer to the VPU chapter for additional details on signal flow regarding VPU.

Voice path with cBTS and SDU

Figure 7-12 illustrates the voice call bearer path through a system with the cBTS and SDU.

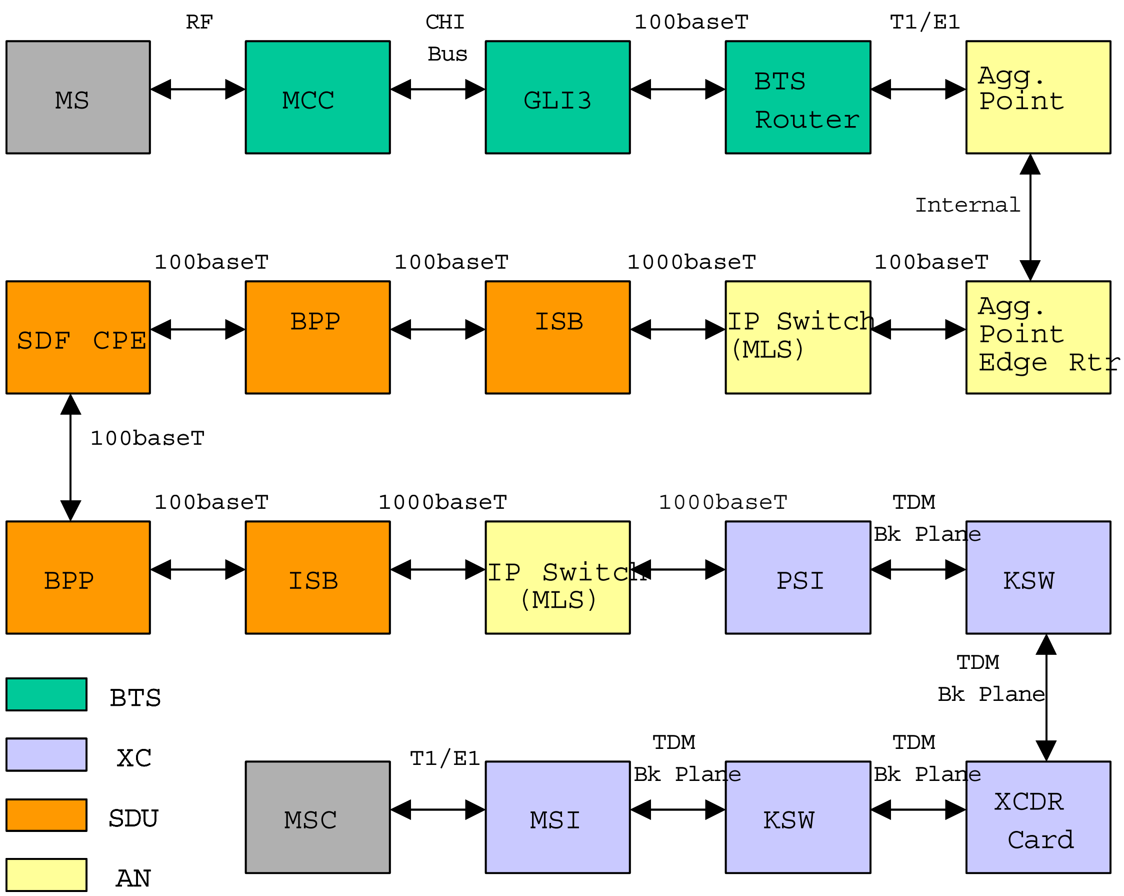
Figure 7-12: Voice path with cBTS and SDU



Voice Bearer Path with Packet BTS and SDU

Figure 7-13 illustrates the voice bearer path through a system with pBTS and SDU.

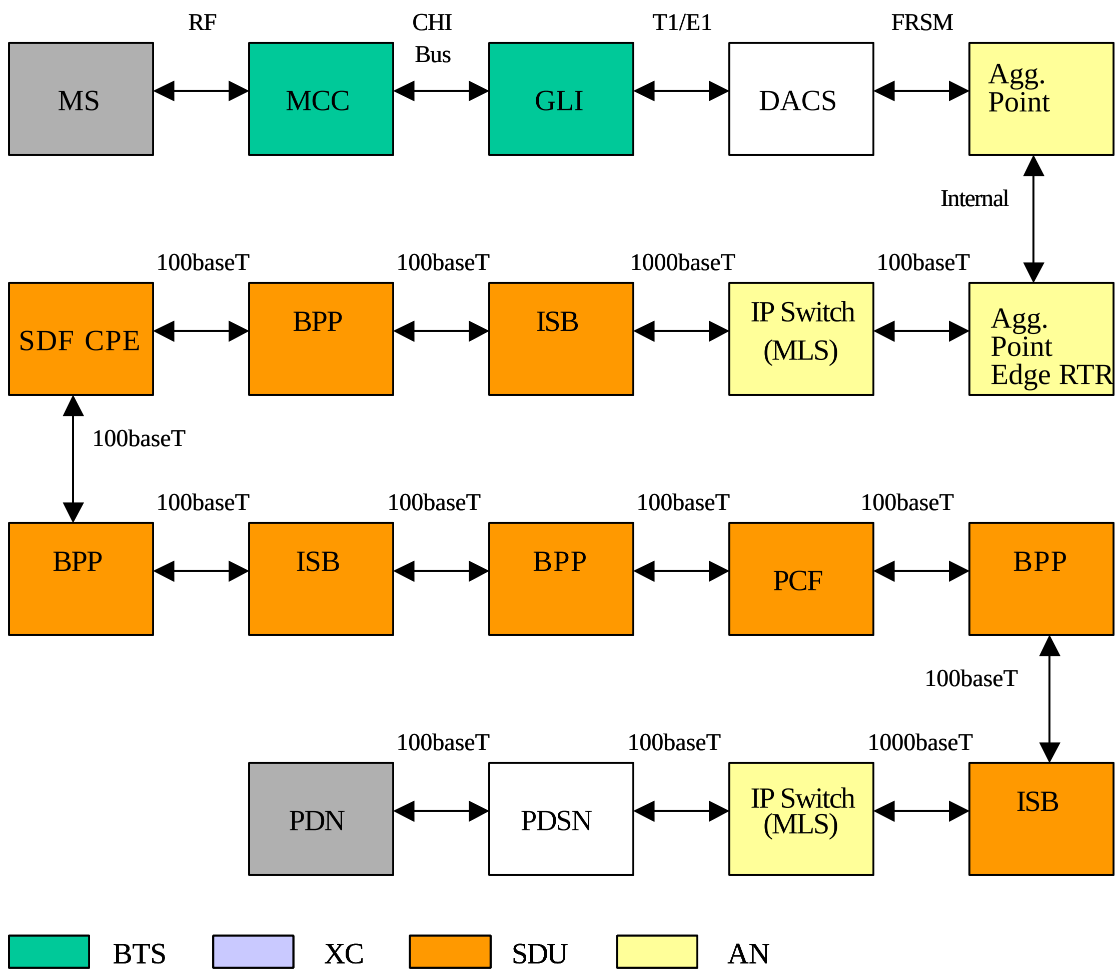
Figure 7-13: Voice path with pBTS and SDU



Packet Data Bearer Path with 1X Circuit BTS and SDU

Figure 7-14 illustrates the flow of data call traffic through a system with 1X Circuit BTS and SDU.

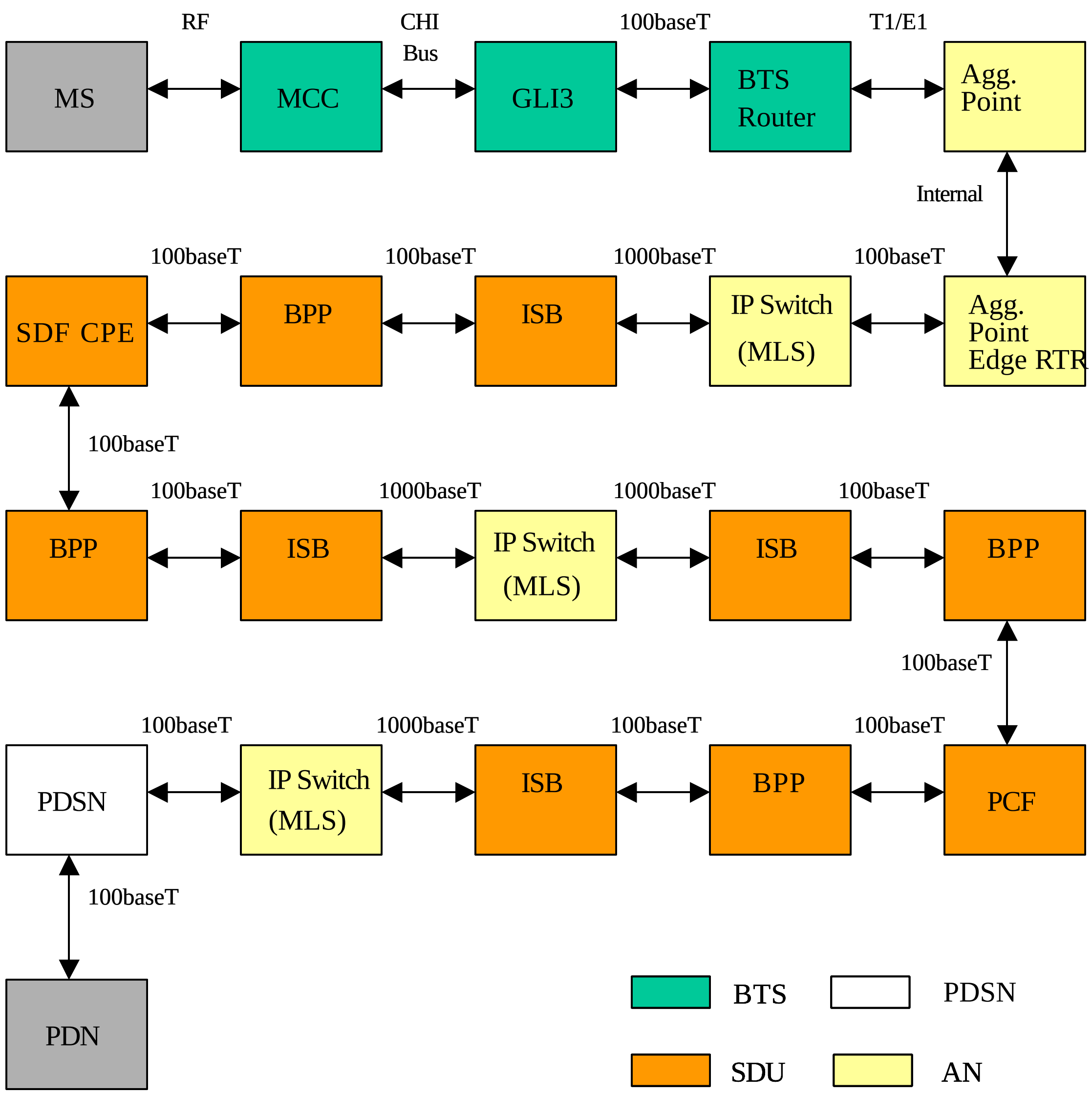
Figure 7-14: Packet Data Path with 1X cBTS and SDU



Packet Data Bearer Path with Packet BTS and SDU

Figure 7-15 illustrates the packet data bearer path with Packet BTS and SDU.

Figure 7-15: Packet Data Bearer Path with pBTS and SDU



SDU Redundancy

Redundancy

Multiple redundancy schemes are used in the SDU to meet various functional requirements.

- There are no redundant BPPs in the SDU for either SDF or PCF
- CCA/SPROC/ISB are 2N redundant
- Redundant Ethernet links exist for each BPP, CCA, and SPROC.
- Gigabit links between the SDU and the AN are redundant.
- The SDU is a pooled device for the MM. The MM can select between SDUs in the pool in case one SDU is not available.

SMNE

The SDU will use the SMNE (Self Managed Network Elements) maintenance paradigm. Under the old paradigm, elements would report a fault to a central location and the location would then tell the reporting unit what to do or direct the information to maintenance for action. Under the new paradigm, the management is decentralized and the elements will usually take care of any required action and then report the action and result only for record keeping.

Chapter 8: Packet Data Network (PDN)

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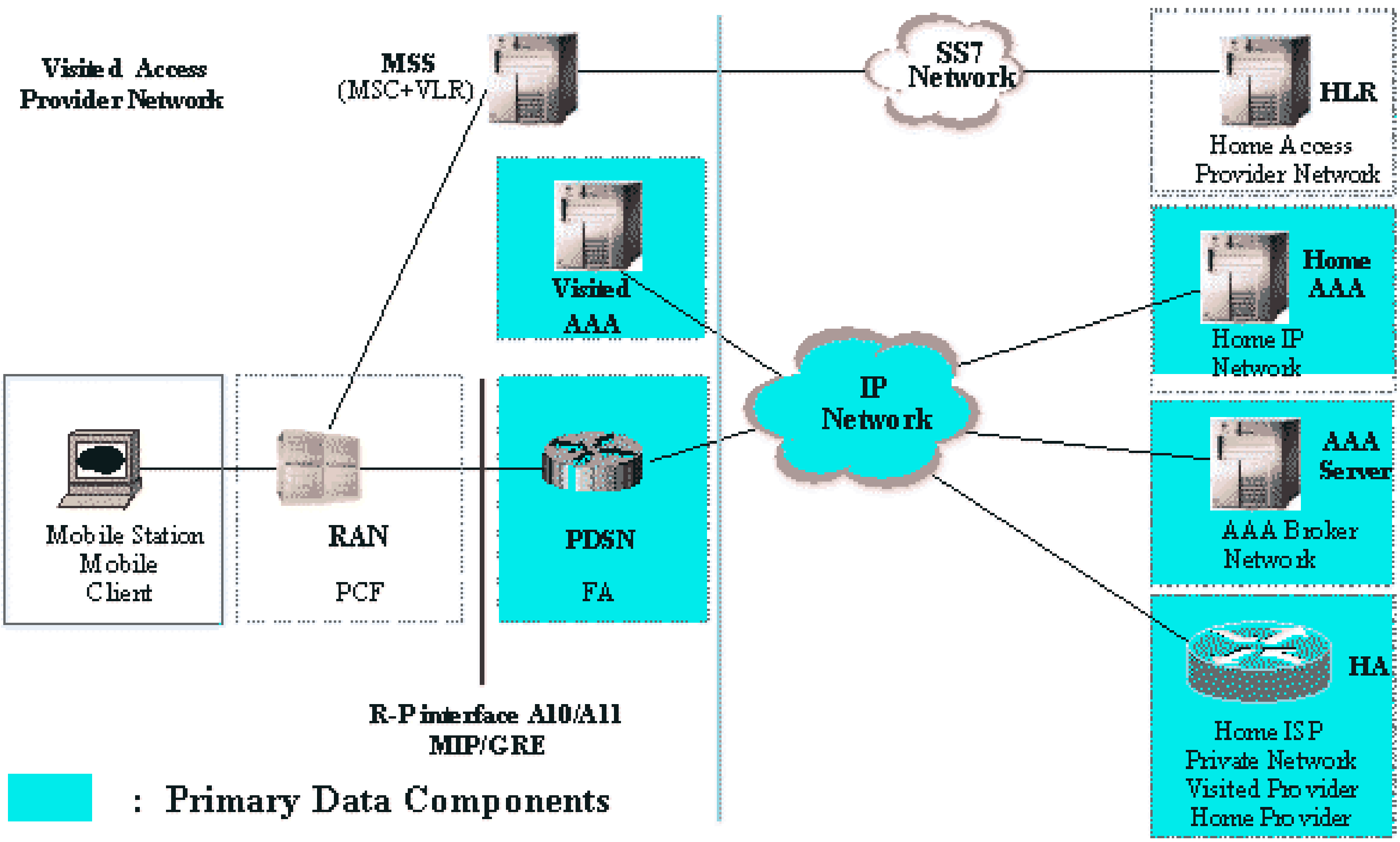
Introduction

Introduced in 16.0, the Packet Data Network (PDN) implements IS–2000 Packet Data, enabling flexible intra/Internet network access for mobiles placing or receiving packet data calls. To accomplish that objective, the PDN includes special software and some dedicated hardware to interface the cellular system to the Internet and intranets.

This chapter includes the following:

- An overview of the PDN, and the data equipment needed for a PDN.
- Describes the Packet Data Service Node (PDSN) equipment, which acts as the gateway between the landline IP PDN and the cellular system.
- Describes the Home Agent (HA), which is responsible for managing the mobility of mobile devices when they leave their home networks.
- Describes the Authentication, Authorization, and Accounting (AAA) Server.



8

Overview of PDN

PDSN description

The PDN provides the following:

- Connectivity for CDMA2000 1X packet data
- Support for IS–95B packet data calls

Although the circuit–based Inter–working Unit (IWU), connected to the XC, will continue to support circuit–based Quick Net Connect (QNC) calls, the IWU can share a common services network for transparency of basic data services such as text–based *Wireless Access Protocol* (*WAP*).

The IS–2000 packet data feature provides subscribers with the ability to wirelessly access the Internet, a carrier–supplied intranet, and/or external corporate intranets. An IS–2000 packet data–capable subscriber device is assigned an Internet Protocol (IP) address and utilizes the CDMA Air Interface to transfer user data between the subscriber device and the land–based packet data networks. The network implements special functions that allow communication with the wireless subscriber device.

Packet data states

Once registered and assigned a PPP session with the CDMA PDN, a CDMA subscriber device can be in either:

- An active state
- A dormant state.

When in an active state, the subscriber device is assigned to one or more RF traffic channels and is capable of transferring data. A single CDMA Fundamental Channel (FCH) or Dedicated Control Channel (DCCH) is assigned to an active subscriber in both the forward (RAN to MS) and reverse (MS to RAN) directions (one for forward and one for reverse). If the subscriber device supports DCCH, then DCCH will always be assigned. If the subscriber device does not support DCCH, then FCH will always be assigned. In cases where additional throughput is required, a Supplemental Channel (SCH) can be assigned to both the forward and reverse links. The decisions to assign a SCH to the forward or reverse link are made independently.

When in a dormant state, the subscriber device is registered with the network (has a PPP context with PDSN), but is no longer assigned to an RF traffic channel and is not capable of transferring data.

Packet data zones

A packet zone is the coverage area managed by a grouping of Packet Control Functions. The PCF grouping is a pooled resource across multiple XCs/SDUs, subtended by a single Mobile Switching Center (MSC).

Limiting a packet zone to a single MSC reduces the complexities associated with setting up calls across MSC boundaries, making it the preferred system design. While it's possible to have multiple packet zones within an MSC boundary, we recommend that a packet zone be kept as large as possible, thereby reducing the number of PCF handoffs and eliminating the must do inter–PCF handoff, which requires the mobile to temporarily move to dormant.

Maintaining large packet zones reduces the number of PCF handoffs because, within a packet zone, the anchored PCF function ensures that the user remains on the same PCF.

Each PCF can connect with up to 16 different PDSNs.

Packet Control Function (PCF)

The XC PSI–PCF or SDU BPP–PCF provides the functional interface to the PDSN portion of the PDN, and is necessary for packet data functionality.

Overview

Introduction

This section describes the PDSN portion of the PDN.

Overview of PDSN

The PDSN acts as the gateway between the landline IP PDN and the cellular system. That is, the PDSN transfers packet data traffic between the cellular system and the landline PDN. The PDSN accomplishes this through the interface to the PCF (XC PSI–PCF or SDU BPP–PCF).

> **NOTE**
>
> For details on how the PDSN works with the RAN/PCF to process data calls, refer to the "Call Flow" chapter.

PDSN Clusters

Operators can choose to group from 2 to 12 PDSNs on the same sub–network, forming a PDSN cluster. Each PDSN in a PDSN cluster periodically broadcasts information about its status and load to all the other PDSNs in the cluster. These broadcasts enable the cluster–based PDSNs to:

- Minimize the number of handoffs between PDSNs in the cluster
- Balance subscriber call load across the PDSNs in the cluster
- Dynamically add and remove PDSNs from the cluster to provide for redundancy and increased service availability

Functions

Internet/Intranet Access Services

The PDSN, in combination with HA and AAA devices, provides the following types of Internet/Intranet access services to users accessing the system:

- Mobile IP
  - An access method allowing a Mobile IP mobile subscriber to access the Internet or an Intranet through its connection to the PDSN.
  - Mobile IP is an access method allowing a mobile to have a static or dynamic IP address belonging to its home network where it can access the Internet/Intranet and receive data, and also roam to foreign networks where it can have data packets forwarded from the home address to the current address. The PDSN registers the mobile with its HA in order to notify the HA of the mobile's current care–of–address so that the HA can redirect the packets to the current location (the PDSN IP address).
- Simple IP
  - An access method allowing a Simple IP mobile subscriber to access the Internet or an Intranet through its connection to the PDSN.
  - The PDSN (or AAA) assigns a temporary IP address to the mobile.
  - When the call is finished the PDSN releases the IP address. If the mobile moves out of the PDSN serving area, the IP address is released and the mobile can no longer receive packets sent to that address. The mobile must set up a session with the new PDSN.
  - The user profile provided by the AAA can contain information for the PDSN to either grant access to the IP network or set up a tunnel to an ISP or a Private network. L2TP access to the intranet is supported.
- Proxy Mobile IP
  - An access method allowing a Simple IP mobile subscriber to access the Internet or an Intranet through its connection to the PDSN, but the PDSN also registers the mobile with the local HA in order to provide Mobile IP type services.

Home Agent (HA)

8

Overview

Introduction

This section describes the HA portion of the PDN.

Overview of HA

An HA (Home Agent) provides Mobile IP Internet/Intranet access services for users belonging to the network. An HA can be located in different types of networks: home ISP networks, private networks, CDMA2000 1X packet data networks (which are visited or home networks depending upon the point of view of the mobile accessing the system). When a mobile is roaming and accesses a CDMA2000 packet data network, the PDSN/FA (Foreign Agent) contacts the mobile's HA which may be located in any of these different types of networks.

NOTE

For details on data call processing with the HA, refer to the "Call Flow" chapter.

Functions

Overview

An HA performs the following major functions:

- Interface to the PDSN for Mobile IP registration actions and per–call tunnel creation
- Forwarding of Mobile IP call packets from the home network to the PDSN
- Forwarding of Mobile IP call packets from the PDSN to the home network (reverse tunneling)

Registration

Mobiles on foreign networks or a new PDSN need to register with their HA to convey their location. This location is called a "care–of address". The HA creates a mobility binding table that tracks the association of a home address with the current care–of address of the mobile.

Registration is the task of the mobile IP client/user located in the mobile for Mobile IP. The mobile IP client/user notifies the HA of the Mobile's location by performing packet registrations. The mobile IP client/user is required by the IS–707A standard to perform a packet registration when it detects a new SID/NID broadcast by the serving system. The mobile IP client/user is also required to perform a packet registration if the Packet Zone ID broadcast by the serving system is non zero and is different than any packet zone id that is on the subscriber device's list of visited packet zones. The IS–707A standard allows for the mobile to have an internal packet zone list with multiple entries. For this implementation of the Packet Data feature, the mobile restricts its internal packet zone list to be of length equal to 1. This will effectively force the mobile to register anytime it moves from one Packet Zone to another.

Care–of–Addresses

While away from home, the mobile will be associated with a care–of address. This address will identify the mobile's current, topological point of attachment to the Internet and will be used to route packets to the mobile while the user visits other locations. Either a PDSN/foreign agent's address or an address obtained by the mobile for use while it is present on a particular network will be used as the care–of address. The former is called a foreign agent care–of address and the later a co–located care–of address.

After the mobile decides on its care–of option, it sends a registration request to it's HA. In this request it lists the options it would like for its registration. Tunneling to mobiles can be done via IP in IP encapsulation (RFC 2003) or generic route encapsulation, GRE (RFC 1701). Cisco IOS has also implement tunnel "soft state" as described in RFC 2003 to aid in path maximum transmittable unit (pMTU) discovery. Tunnel soft state allows the tunnel head to keep track of the tunnel path MTU and return this value to senders of larger packets via internet control message protocol (ICMP) type 4 responses. The registration requests and replies are required to have an authentication extension that includes a keyed MD5 hash of the registration packet as well as a timestamp to ensure the origination of the request and the time it was sent, to prevent replay attacks.

When the home agent receives a registration request, it determines, whether the authentication hash is valid, if the timestamp is within an acceptable range, and if it can honor the request in terms of resources as well as options. It then sends a reply to the mobile. When the mobile and the HA agree upon a set of service options then a mobility binding is put into the HA's binding table and used to associate the mobile's home address with the care–of address. This binding will allow the mobile to receive tunneled datagrams destined for its home address when it is not physically connected to that network. Since the HA is attached to the home LAN of the mobile it will merely accept and forward traffic destined for the registered mobile.

When this binding is first added to the table, the HA sends a gratuitous ARP (Address Resolution Protocol) on the mobile's home LAN so that all directly connected devices can continue to communicate with the mobile through the HA. While the mobile is registered with the home agent, the home agent will proxy ARP for the home address of the mobile and tunnel packets to it using the care of address in its mobility binding. When the mobile moves its point of attachment to the Internet, it will notify the home agent and indicate its new care–of IP address. This change in location is only known to the HA and all other devices can continue to communicate with the mobile transparently. When a mobile returns to its home network it will send a gratuitous ARP responses in order to indicate its return and allow devices to send packets directly to the mobile on its home subnet.

Packet Zone Overview and Relationship with HA

The Packet Control Function (PCF) is responsible for storing and delivering packets to mobiles. PCF is the entity where the MAC state of the mobile is maintained. Anchored PCF is a feature that allows a PCF to be assigned and used over multiple BSS coverage area. An R–P interface (a.k.a., A10/A11 interface) tunnel exists for every active and dormant mobile between a PCF and a PDSN. If the mobile leaves a PCF serving area this tunnel must be moved. Otherwise, the PDSN will send data to the wrong PCF. This could result in data loss.

The coverage area of the PCF determines a Packet Zone. A Packet Zone can be defined as the area in which the system is able to reconnect a dormant mobile to the same PCF that it was using before it went dormant. When a PCF can be reached across multiple CBSC coverage areas, it becomes possible to extend the Packet Zone to include more than one CBSC coverage area.

In packet data service, dormant mobiles are expected to register when they notice a change in the Packet Zone ID, which is broadcast from each sector. This procedure is necessary to update any IP tunnels within the network so that data destined to a dormant mobile can be delivered to the current serving system. The Larger the Packet Zone areas, less frequent are the registrations and data loss.

When a PCF can be reached across multiple CBSC coverage area, it becomes possible to extend the Paging Zone to include more than one CBSC coverage area. The PCF first assigned to a mobile is anchored for the session and the mobile can be served by the same PCF as long it remains within the same Packet Zone. In the Motorola CDMA architecture for release 16, a group of CBSCs communicate with each other and when a dormant mobile becomes active a query is made among the CBSCs to figure out if a PCF is already established to serve this mobile. Each time a dormant mobile originates a call, the CBSC receiving the call will first check its database to see if an anchor PCF exists for the mobile within in its own pool of PCFs. If not, it will query the other CBSCs within the Packet Zone to see if an anchor PCF exists for that mobile. If so, a connection from the serving SDU SEL to the anchor PCF will be established. Include 6–8 CBSCs in a Packet Zone to strike a balance between Packet Zone size and the cost of multicast queries to multiple CBSCs.

Reverse tunneling

The HA also accepts data from the PDSN for routing to the home network (reverse tunneling support).

Inter–PDSN mobility

The HA supports inter–PDSN mobility. Inter–PDSN mobility is important because it allows the user application to not be affected by roaming to a new PDSN. If the mobile session hands off to a new PDSN (the PPP session between the mobile and PDSN is re–negotiated), and the mobile has Mobile IP service, the HA maintains the mobile station's IP address and its communication with any Internet/Intranet correspondent nodes. If the mobile only has Simple IP services, the PDSN may assign it a new IP address and may break any application level connections.

Introduction

Overview of AAA Concepts

The role played by an AAA Server in a data network is to authenticate, authorize, and perform accounting for an incoming client that wants to use network resources for data activities. A short definition of each of the three terms is provided below:

- Authentication – The act of proving a claimed identity through the verification of some pre–determined credentials.
- Authorization – The act of determining whether access to certain network resources can be granted to a mobile client.
- Accounting – The act of collecting information on resource usage for the purpose of billing, auditing, cost allocation or trend analysis.

Overview of AAA Functionality

The AAA server is a complete implementation of the widely–used IETF standards–track RADIUS (Remote Authentication Dial–In User Service) protocols, and is a full–function AAA (authentication, authorization, accounting) server.

Mobile clients obtain data services by negotiating a point of attachment to a "home domain." Mobile clients can migrate from their home domain to foreign domains, and still gain access to resources needed for data activities. The typical scenario is described in the following steps:

- Mobile client attempts to gain access to network resources provided by the local domain.
- The PDSN, acting as the Network Access Server (NAS) in the domain, initiates the authorization process to determine whether access can be granted to the mobile client.
- The mobile client is asked to provide credentials for authentication by the home domain.
- The home domain grants access to the mobile client, specifying the type of services to which the user is entitled.
- The NAS generates accounting information on resource usage for billing purposes.

CDMA2000 1X AAA Implementation

A mobile client's ability to gain services from the home domain, as well as while moving between domains, requires that the system support AAA services.

The AAA Server provides these capabilities in the Motorola CDMA2000 1X CDMA Packet Data Network.

The AAA Server is an enhanced version of the RADIUS Server for remote network access control. The AAA Server is able to support roaming for mobiles served by other AAAs and to collect additional billing data and statistics.

The CDMA2000 1X AAA Server will not play a role in providing mobility to the end user as in IS–95B systems. The only mobility agents in CDMA2000 1X systems are the PDSN and the HA.

Functions

The AAA Server provides Authentication, Authorization and Accounting services specified for CDMA2000 1X networks. The AAA Server incorporates the necessary functionality needed to interact with Packet Data Network elements and with AAA Servers from other networks. It can also specify the quality of service the mobile is entitled to in an effort to provide transparency across multiple wireless networks.

The AAA Server is part of the access service provider network.

The main functionality provided by the AAA Server is the Visited AAA functionality.

It can also offer Home AAA services to mobiles whose home IP network is the same as the home access provider network. (I.E., The home access service provider is also an Internet service provider.)

Optionally, the AAA Server may provide Broker AAA functionality to other domains.

NOTE

Refer to the "Call Flow" chapter for these scenarios.

For billing purposes, the AAA Server delivers accounting data to the operator's Billing Mediation Device.

Inputs and Outputs

The AAA server supports RADIUS attribute formats as defined in RFC 2138 and RFC 2139. Parameters transmitted across the R–P interface follow the RADIUS format.

Attributes of type ”26” defined in RFC 2138 and RFC 2139 are vendor specific, and are used to transport CDMA radio specific parameters:

- Airlink Record Identifier (26/xf0)
- Release Indicator (26/xf1)
- Mobile Originate/Mobile Terminated Indicator (26/xf2)

The PDSN sends RADIUS UDR data to the AAA Server.

All of the RADIUS accounting attributes that the AAA server receives from the PDSN, are reformatted and logged to a comma–delimited file. A file of this format is easily imported into spreadsheets and database programs for report generation and billing.

Signal Flow

If the mobile station uses CHAP/PAP, the AAA server will receive a RADIUS Access Request from the PDSN with CHAP/PAP authentication information, and shall forward the RADIUS Access Request to the home network if it does not have the authority to accept/deny the request.

The AAA server will later receive a RADIUS Access Accept message from home network. The AAA server shall then send the RADIUS Access Accept to the PDSN.

Later on, the RADIUS server will receive a RADIUS Accounting Start/Stop from the RAN via the PDSN. If the AAA server is in the serving network, the Foreign AAA server shall forward the RADIUS accounting messages to the Home AAA server.

Chapter 9: Operations and Maintenance (O&M)

Table of Contents

9

Notes

Overview

This chapter provides the following:

- An overview of Operations and Maintenance (O&M) functionality
- An overview of the Universal Network Operations (UNO), Operations and Maintenance Center – Radio (OMC–R), and Operations and Maintenance Center – Internet Protocol (OMC–IP) management platforms
- Introduction to the SMNE concept

Description

The OMC solution for the CDMA2000 1X network is an integration of these OMC building blocks, each of which was designed and developed to serve the specific needs of the elements of its domain.

- OMC–R
- UNO
- OMC–IP
- SMNE (Introduced in G16.1)

Figure 9-1: O&M Hierarchy – 16.0 system

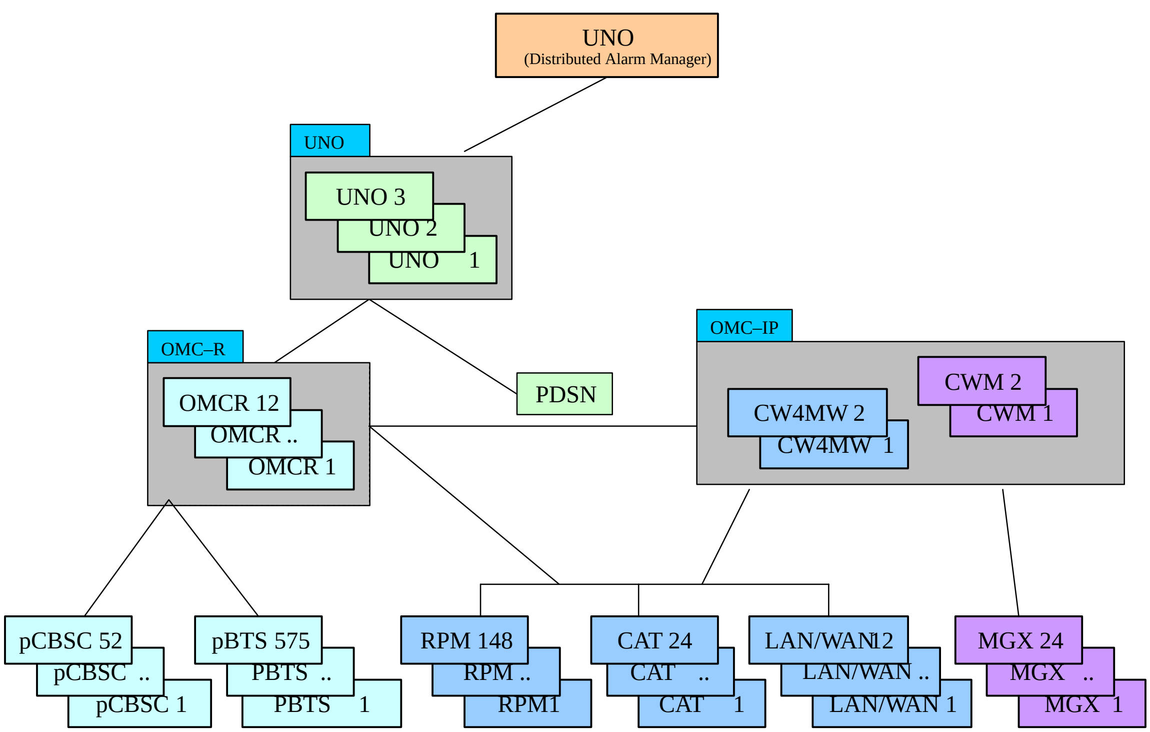
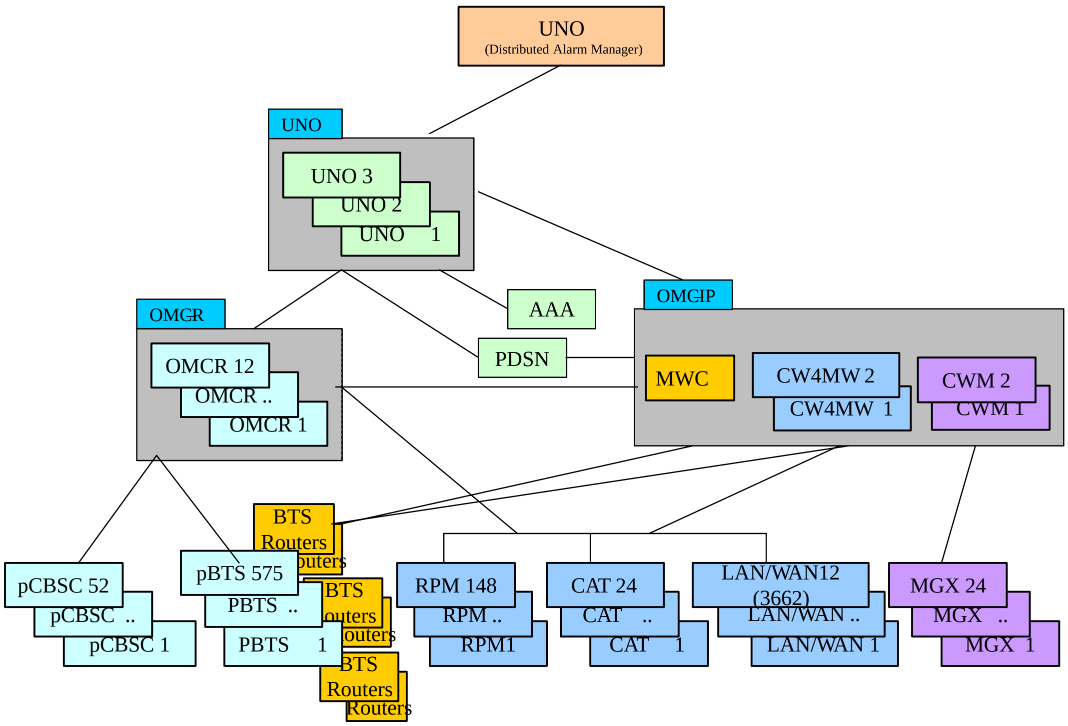


Figure 9-2: O&M Hierarchy – 16.1/16.3 system



OMC–R Overview

Overview

Like UNO, OMC–R plays a number of key roles in the CDMA 1X architecture. The following are the new roles assigned to the OMC–R in the 1X architecture:

- Coordinate configuration of the radio/IP network intersection
- Collect alarm and event information by connecting to the Cisco WanManager applications and the Cisco elements

Some may view these OMC–R activities as an elevation to a partial network management role. But seen within the context of the AN's role as an extended element of the Radio Access Network (RAN), the new functionality is consistent with OMC–R's charter as an Element Management System (EMS).

OMC–R Coordination Role

The OMC–R was selected for the coordination role based on its proximity to the elements supported, its ownership of the data model that defines the RAN network, and the capabilities the platform already possessed from its support of 2G networks.

The OMC–R coordination function is critical because each new IP–based RAN deployment or re–deployment involves configuration on both the Motorola radio side and on the Cisco IP side. The OMC–R's specially designed management tools greatly simplify these deployment activities, insulating the operators as much as possible from the specifics of the configuration needed to make the IP RAN elements communicate and operate together.

OMC–R Connection and Collection Role

OMC–R ability to connect to the Cisco WanManager applications and Cisco elements to collect alarm and event information is a secondary but no less important role. By having this information flow through OMC–R for eventual display on the UNO or other network management solutions, OMC–R is able to apply the contextual knowledge it has about the AN devices to the messages sent to the higher level managers. Consequently, the total management solution can both tell operators which AN routers or switches have failed and identify what the impact will be on the radio components of the solution.

UNO Overview

Description

UNO provides integrated and consolidated monitoring of 1X IP–RAN, 2G RAN, and other network elements.

For the CDMA 1X solution, the UNO product satisfies two key roles within the element and network management space. First and foremost, by providing alarm, state, and performance functionality that is an extension of the capabilities of OMC–R, UNO continues to complete the element management picture for the CDMA RAN. Secondly, by providing some integrated support for equipment introduced with CDMA 1X, UNO allows Motorola to offer better end–to–end management of the IP–based CDMA solution.

For the components of the AN introduced with the G16.0, UNO provides the operator with a workable solution for consolidated fault management of these new devices as well as for the circuit–based architecture devices traditionally associated with the Motorola CDMA RAN solution. The UNO solution includes the capability to sort, filter, store, analyze, track, notify–on, *etc*. alarms generated by the AN in the same format and to the same capacity as alarms generated by the other elements of the RAN.

The northbound interface from UNO's alarm manager provides a single connection point for other third–party network management systems (NMS), and this data stream can be configured to take advantage of UNO's value–add alarm functionality, which includes user–defined alarms and performance thresholding.

Logical and physical representation of the AN devices in the UNO Command Center also provides the operator with a visual reference for the relationship between the devices of the IP–RAN and the AN. With these displays and the context provided via communication with OMC–R, operators are able to "see" the impact that any failure of an AN device will have on the IP–RAN devices it supports. Without this context, an individual router or IP switch just becomes one of many, with a less obvious scope of impact.

The UNO solution also gives the operator the ability to access the individual element management systems and applications (provided by Cisco) from a single operator station and keyboard. This second item effectively reduces the amount of different stations and terminals a single operator would otherwise need to utilize, which in turn reduces the amount of operations desk space required to hold the management tools.

NOTE

OMC–IP is only integrated at the operator terminal level; there is no integration of applications or operations data of OMC–IP (Cisco Works for Mobile Wireless, *CW4MW* or Cisco WanManager, *CWM*).

OMC–IP Overview

Overview

OMC–IP provides element management capabilities for the Cisco components of the RAN, playing an important enabling role in the data component of the 1X solution. Cisco Works 2000 for Mobile Wireless (*CW4MW*), Cisco WanManager (*CWM*) and Mobile Wireless Center (*MWC*) are the main components of OMC–IP. These products provide device–level support and the fundamentals for domain–level management of the IP aspect of the network.

CiscoWorks 2000 for Mobile Wireless (*CW4MW*)

In the 16.1 architecture, Cisco Works 2000 has been upgraded to Cisco Works 2000 for Mobile Wireless, which provides updated functionality and new applications like Mobile Wireless Fault Mediator (MWFM).

Cisco Works is the major element management component of the architecture. It provides element management functionality for such IOS–based devices as the *Catalyst* switches and the route processor modules (RPM). This suite of applications will provide the following:

- A chassis view of the equipment
- Image and configuration management
- Numerous tools and aids for the operator managing the IP domain of the RAN

The Mobile Wireless Fault Mediator (MWFM) is a value added feature for the CDMA environment. The MWFM correlates, filters, and determines root cause in relation to the Layer 3 Transport portion of the IP RAN equipment through the BTS Routers. Its feature sets has been specialized to support the IP enabled CDMA environment and assists in the integration and persistence of events with respect to OMC and UNO management environment.

Cisco WanManager (*CWM*)

The Cisco WAN Manager manages the Layer 2 switch infrastructure of the *MGX 8850*, a component of the AN. *CWM* is a series of applications that provide comprehensive configuration, connection, fault, performance, and security management through GUIs and flow–through interfaces that deal with the specifics of the *MGX*.

By presenting the operator with a standardized interface to OMC–R and by mediating between the *MGX* device and OMC–R, *CWM* is also part of the integrated fault management solution in the CDMA 1X network.

Operators can access the *CWM* applications either through a connection from an UNO management platform or, more directly, through a terminal connected to the *CWM* supporting Sun Microsystems server.

Mobile Wireless Center (*MWC*)

The Mobile Wireless Center (*MWC*) provides a single point–of–entry to manage all the mobile wireless functionality. *MWC* provides configuration management for the BTS Routers, RPM and *MGX* in a wireless provider network. The *MWC* alleviates the need for the provider or a system integrator to create specific interfaces and functions for managing multiple Cisco EMSs that configure and monitor numerous pieces of Cisco devices. It provides an abstraction layer on top of the Cisco EMSs from configuration management aspects. It also allows rapid development of OSS for managing the complete wireless network by providing the flow through management capabilities (published APIs).

SMNE (Self–Managed Network Elements)

SMNE is a new O&M maintenance paradigm for Motorola GTSS infrastructure. SMNE will change the O&M from a central/ hierarchical to a distributed model. In the past most actions were controlled from a central location. An event was reported up to a controller, which decided what action to take and sent the information back to the element for action.

In the distributed model, each element has enough knowledge to take its own action and the event and results are reported up for record keeping and not of analysis and action. The distributed model will place the responsibility for managing an element as part or the development of the element and not as a separate and dependant activity. All communication between an element and its manager is in the form of a defined file structure with the common types being:

- Network Element Configuration File Overview
- Bulk Configuration Change Request File
- Auto–provisioning File
- Key Statistical Interval File
- Alarm Summary File
- Object Status Summary File
- Global Event Log File
- Diagnostics Results File
- Calibration Data File
- Software Load Information File
- Entity Type Definition File
- Available Key Statistics List File
- Streaming Data Format

By using this standard method of element to manager communications, development of O&M becomes much less tied to development of elements. For G16.1, the SDU and the GLI3 cards will have the SMNE feature. This will be extended to other elements in future releases. SMNE is a software and design architecture that is designed to be platform independent and no new hardware is involved in the SMNE implementation.

OMC–R

Description

The OMC–R is a highly available, UNIX–based O&M platform that supports the core components of the CDMA RAN, including the Central Base Site Controller (CBSC), the Base Transceiver Stations (BTS), and IP components for circuit and packet networks. This Element Manager (EM) platform interfaces directly to the elements via Ethernet and acts primarily as a data collection and mediation device for alarms, events, statistics, and configuration.

The OMC–R consists of a Sun Microsystems E4500 Enterprise server, D1000 Disk Array, and other third party equipment integrated into a NEBS Level 3 seismic–compliant cabinet. The OMC–R provides O&M functions for both IS95A/B and CDMA2000 1X network topologies. Together the OMC–R, OMC–IP, UNO, and SMAP platforms provide total O&M functions for both the traditional radio network and the new IP network.

Function

The OMC–R provides the following primary functions:

- **Event/Alarm Management –** OMC–R collects and logs alarm and event information from the RAN and AN devices, making this information available through ASCII and Common Management Information Protocol (CMIP) interfaces. The data can be viewed using tabular or graphical reports on OMC–R and/or UNO.
- **Performance Management –** OMC–R provides a temporary store of performance management (PM) and Call Detail Log (CDL) data that can be uploaded to external platforms, such as Motorola's UNO, for longer–term storage and analysis. The OMC–R can gather other CBSC performance–related information such as CPU utilization, disk usage, and processor status, creating another avenue for system analysis. This data can also be viewed using tabular or graphical reports on OMC–R and/or UNO.
- **Security Management –** By allowing each operator to be assigned a user ID and password, OMC–R helps control access to the operations and maintenance functions. OMC–R's security management also provides special features for the management of dial–up lines, and for the management of terminals connected to OMC–R using only on–premises cabling. All CLI commands are validated and executed concurrently for different users. The security settings can be changed instantaneously and the mechanism is scalable to achieve any level of granularity (*i.e.*, on a per–user, per–group, or per–command basis, as needed).

- **Configuration Management –** In the 1X network, OMC–R has a critical new function: to coordinate configuration management of the Radio/IP network intersection. That is because each new IP–based RAN deployment or re–deployment involves configuration on both the Motorola radio side and on the Cisco IP side. The OMC–R's specially designed management tools greatly simplify these deployment activities, insulating the operators as much as possible from the specifics of the configuration needed to make the IP RAN elements communicate and operate together.
- **Fault Management –** This function provides the capability to query and change device states of elements under OMC–R's control. It controls RF diagnostics by enabling the execution of loopback and forward/reverse power tests, allowing operators to selectively test the call–processing capability of the RAN. Because the fault management function is integrated with UNO's scheduling capabilities, operators can create automated verification of network operation.

Inputs and Outputs

Standard Ethernet connections are provided for LAN access to OMC–R. Each Mobility Manager (MM) connection is provided on separate, isolated primary and redundant Ethernet LANs.

A separate LAN is provided for the UNO connection, and a fourth LAN is provided for a customer–specific LAN. Communication with OMC–R is provided via CMIP and ASCII output streams. The OMC–R also supports Motorola's Super Cell Application Protocol (SCAP) and SNMP messaging protocols.

Refer to the *RAN Hardware Installation* manual for details on physical interfaces for the different types of hardware used for the OMC–R.

Signal Flow

The OMC–R now manages the new VPU platform. Other connections remain unchanged from the previous release.

Redundancy

OMC–R availability does not affect call–processing capability. However the redundancy described in this section is built into the system to maximize OMC–R availability and data integrity and thus preserve the critical data collected by OMC–R.

The OMC–R architecture uses the following:

- Two (2) CPU modules, each with its own cache memory
- Two (2) memory modules
- Mirrored disks
- Dual paths for I/O
- Dual power paths

In addition, the operating system supports mirrored disks that write identical information to two disk drives simultaneously. Mirroring preserves data integrity and provides continuous data access despite the failure of an I/O path, a disk, or a disk controller.

O&M

While OMC–R provides O&M functions for the elements under its control, it uses the Sun Validation Test Suite (VTS) software to perform diagnostics on any subsystem within either the E4500 or Netra platforms.

UNO

Description

UNO is designed to provide the centralized point from which operators have access to the data and interfaces needed for network administration. UNO's user interfaces are standards–based Graphical User Interfaces (GUIs) built upon the latest technologies, including web–supporting Java applications. For the specialized interfaces of the Element Management Systems (EMS) needed for the different components of the mobile network, UNO executes its "*Don't Get Up*" philosophy by providing integrated access to these interfaces.

UNO currently provides integrated support for CDMA OMC–R, OMC–IP, CBSC, and BTS for:

- PDC, cdmaOne, IS2000 1X, and CDMA2000 1X Radio Access Networks
- Access Node(AN)
- Motorola's EMX 2500 and 5000 Mobile Switching Stations (MSC)
- Circuit and packet Inter–Working Units (IWUs)
- Motorola's MOSCAD environmental monitoring system
- Radio Frequency Diagnostics Subsystem (RFDS)
- Packet Data Service Node (PDSN)

The roadmap for the UNO platform/software has several key goals:

- Integrated management of diverse network elements utilizing standard interfaces such as CMIP, SNMP, and CORBA
- Consolidation of operations to a single operator's station
- Support for the "Don't get up" philosophy of operator station integration
- Provider of open access to network wide configuration, performance, alarm, event, and call data with integrity and in a timely manner
- Support of end–to–end Network Operations, Planning, and Optimization activities through integration with external analysis applications such as Motorola's NetPlan and SMAP
- Provider of advanced analysis applications that simplify operational tasks and automatically identify and remedy network problems before they impact system availability and performance

Function

UNO focuses on these management areas: device status, alarm and performance management. The UNO Alarm Manager presents the operator with a customizable interface that displays alarm and event information from all supported elements in a consistent and highly readable format. From this interface, operators can sort, filter, define, search, acknowledge, and clear the alarms received. With integration to trouble ticketing and automated user notification systems, operators can leave the constant monitoring of the system to UNO, only paying attention to events defined by the operator to be critical to operations.

For state and status management, UNO offers *Command Center*, a geographical, logical, and hierarchical display that provides the operator with a clear view of current device status within the network. Through application integration, the operator can also quickly gather performance and alarm information on the devices displayed in the *Command Center*, allowing him or her to quickly assess and address network problems.

In the performance management functional area, UNO provides short–term and long–term storage of performance and CDL data. Operators are able to access this relational database stored information either through UNO's own report generation tools or via an interface for processing in off–line analysis systems. UNO's User Defined Measurements suite of applications allows operators to define their own counters and to establish thresholds that automatically alert their staff when the system is operating outside of expected parameters.

Additional UNO applications support operators in tasks as diverse as access to on–line system documentation, loop–back test scheduling and analysis, element software distribution, Call Final Class (CFC) analysis, load analysis for element processors.

Inputs and Outputs

The Motorola Universal Network Operations (UNO) system is an open network management system whose framework is based on the Telecommunications Management Network (TMN) series of international standards (ITU Recommendation M.3100). Communication to the network's element managers (EMs) and elements is accomplished through agent software utilizing CMIP (Common Management Interface Protocol, ITU X.711), SNMP (Simple Network Management Protocol) and/or other standard methods of communication; *e.g.*, FTP (file transfer protocol) for bulk–data transfers. Applications implement the functionality specified by the system management areas defined by the ITU in the X.730/740 series of standards for configuration management, fault management, security management, and performance management.

Card Description

UNO is built upon industry–standard hardware available from Sun Microsystems and various third–party software solutions.

Signal Flow

(Not applicable)

Redundancy

UNO does not have redundancy requirements. However, you do have the option of inserting a local element management layer at the OMC–R in addition to the UNO Market Manager. This can be done with a MM at the highest level working with either another MM or an EM at the local level.

O&M

In the area of O&M, UNO is at the top of the flow chart. All O&M of the elements within the RAN, start with UNO. Therefore, UNO does not have O&M requirements.

OMC–IP

Description

The Operations and Maintenance Center – IP or OMC – IP, is a vital component to the CDMA Network Operations, Planning, and Optimization solution for the CDMA IS2000–1X deployment. In this deployment, the OMC–IP is a logical suite of functionality that consists of an integrated solution of Sun Microsystems server platforms, Cisco element managers, Motorola software and other third party applications. The primary function of this OMC–IP is to provide Element Management capabilities for the Cisco technology domains, including Layer 2 switching and Layer 3 Internet Protocol (IP) enabling components of the IS2000 1X IP RAN.

The Cisco element management systems are mature commercial products with added mobile wireless features. The primary components of the solution are Cisco System's Cisco WanManager (*CWM*), Cisco Works 2000 for Mobile Wireless (*CW4MW*) and Mobile Wireless Center (*MWC*). These pieces of software provide the customer with the element management control needed to configure, manage and troubleshoot the Cisco network elements that make management simple and mobile IP a possibility. These software components also provide integration with Motorola's Radio Access Network (RAN) management solutions (OMC–R and UNO), needed to make the management of this new architecture an easier task for the cellular operator.

Function

The Cisco WanManager manages the Layer 2 switch infrastructure of the *MGX* 8850. The Cisco WanManager (*CWM*) is an element management system with WAN network visibility that enables operations, maintenance, and management of multi–service WAN networks. *CWM* provides comprehensive configuration, connection, fault, performance, and security management through GUIs and flow–through interfaces.

Cisco WanManager is an SNMP–based, multi–protocol management software package designed specifically for wide–area multi–service networks. It provides integrated service management and process automation to simplify the management of even the most complex networks. The Cisco WanManager allows you to easily monitor usage, provision connections, detect faults, configure devices, and track network statistics.

Based on a robust, scalable architecture, Cisco WanManager not only meets today's business requirements for control and operation, but also integrates with other Cisco network management products to provide end–to–end service management of wide–area multi–service networks.

The Cisco Works 2000 for Mobile Wireless (*CW4MW*) suite is based on applications in the commercially available Cisco Works 2000 (CW2K) line of products, along with enhancements to support the mobile wireless environment.

Cisco Works 2000 for Mobile Wireless is a commercial product with applications that provide FCAPS. The element management application bundle has been developed to support each IP enabled Cisco elements. This product suite has been enhanced for the CDMA functionality.

The Cisco Works 2000 for Mobile Wireless features a set of Web–based management tools for configuring, administering, monitoring, and troubleshooting the IP–based wireless network. Cisco Works 2000 for Mobile Wireless provides management for the *Catalyst* Router, the RPM and the BTS routers.

The Cisco Works 2000 for Mobile Wireless solution consists of operationally focused tools useful in managing the day–to–day operations of critical services and links found in an enterprise campus network. These tools include scalable topology views, sophisticated configuration, Layer 2 / Layer 3 path analysis, traffic monitoring, end–station tracking, and device troubleshooting capabilities.

The Mobile Wireless Fault Mediator (MWFM) is a value added feature for the CDMA environment. The MWFM correlates, filters, and determines root cause in relation to the Layer 3 Transport portion of the IP RAN equipment through the BTS Routers. Its feature sets has been specialized to support the IP enabled CDMA environment and assists in the integration and persistence of events with respect to OMC and UNO management environment.

The Mobile Wireless Center (*MWC*) provides a single point–of–entry to manage all the mobile wireless functionality. *MWC* provides configuration management for the BTS Routers, RPM and *MGX* in a wireless provider network. The *MWC* alleviates the need for the provider or a system integrator to create specific interfaces and functions for managing multiple Cisco EMSs that configure and monitor numerous pieces of Cisco devices. It provides an abstraction layer on top of the Cisco EMSs from configuration management aspects. It also allows rapid development of OSS for managing the complete wireless network by providing the flow through management capabilities (published APIs).

Inputs and Outputs

The OMC–IP, and the software that executes on these servers, primarily act as interfaces for the human operator to the network elements they support. The I/O on one side (that facing the operator) is a collection of graphical/text interfaces, and standard open interfaces to other managers. The I/O on the other side (facing the supported elements) is a set of interfaces, both standardized and proprietary.

Card (Platform) Description

The platform for each application of the OMC–IP is a Sun Microsystems UNIX server.

At this time Cisco does not recommend and does not support installing Cisco Works 2000 for Mobile Wireless, *CWM* and *MWC* on a single server platform. Therefore a single instance of the logical OMC–IP would actually consist of multiple instances of the hardware platforms. A combination of the applications on a single server platform is not supported as well.

Signal Flow

The integrated O&M architecture of the 1X network involves communication between Cisco element managers running on the OMC–IP and the UNO and OMC–R management platforms of the radio components. Through these connections it is possible to integrate all of the alarms collected by these platforms.

Redundancy

All versions of the OMC–IP platform are deployed with mirrored disk storage to provide integrity for all data deposited and collected on the systems.

Since loss of a Cisco WanManager (*CWM*), Cisco Works 2000 for Mobile Wireless (*CW4MW*) and Mobile Wireless Center (*MWC*) platforms will in no way impact the operations of the AN elements it supports, complete redundancy is not required.

O&M

By utilizing the Sun Management Center, the customers will be able to monitor the OMC–IP platform.

Chapter 10: Vocoding Processing Unit (VPU)

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Notes

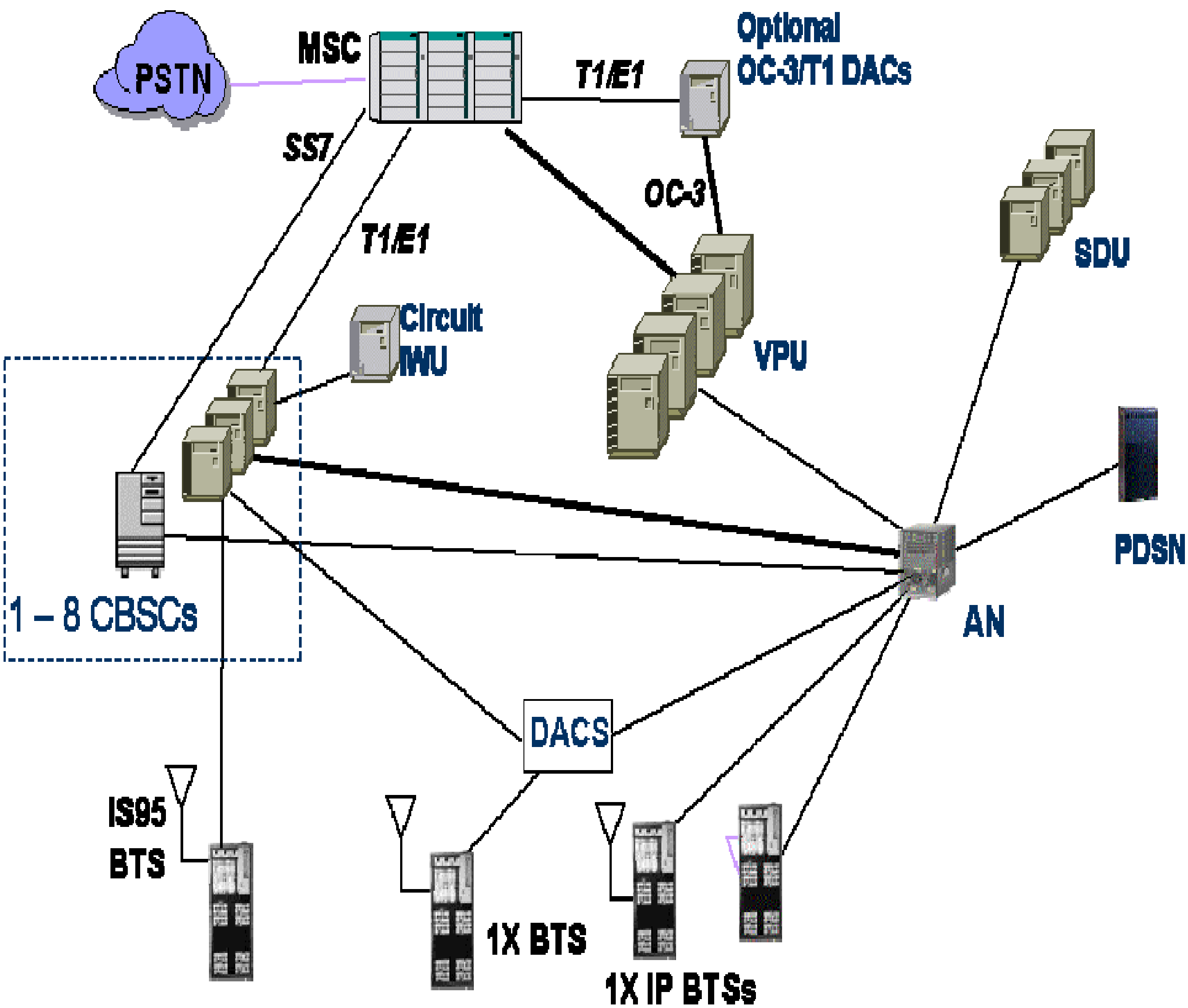
Vocoding Processing Unit (VPU)

Overview

The Vocoder Processing Unit or VPU is a new hardware realization of existing Transcoding functions. The VPU has many advantages:

- High Capacity (5000 Erlangs per frame)
- Move from an embedded functionality to a Client – Server model
- High speed Optical interface to MSC
- No obsolete equipment
- Network level redundancy
- Greatly reduced foot print for functionality
- Increased network design flexibility
- Shares some common hardware with SDU to reduce spares expense
- The VPU uses a common platform with significant architectural advantages that adds additional value in the continuing product evolution.

Figure 10-1: 16.3 VPU Implementation



Function

Functions

The VPU has multiple functions but its name gives its most important function of vocoder processing. PCM to any selected CDMA vocoding (8K EVRC, 8K CELP, 13K QCELP) format can be accomplished. The VPU has full functional transparency to the existing Transcoder, including echo cancellation, but it uses a packet interface for compressed mobile traffic rather than circuit. A list of VPU functions is given below:

1. The conversion of vocoded frames to PCM for uplink frames (which entails speech decoding).
2. The conversion of PCM to downlink vocoded frames prior to distribution by the SDU (which entails speech compression) in addition to echo cancellation from the network side.
3. The support for CDMA 13 Kbps Qualcomm Code Excited Linear Predictive (QCELP) vocoder, the 8 Kbps Enhanced Variable Rate Coder (EVRC) and the 8 Kbps Basic Variable Rate vocoder.
4. TTY/TDD encoding (forward link) and decoding (reverse link).
5. The termination of SONET/SDH OC–3 circuit PCM interfaces from the MSC/DCS.
6. The termination of IP over Gigabit Ethernet connection from the Access Node (AN).
7. The support of DTMF tone generation in PCM format.
8. The support of circuit data calls when the circuit IWU is located at the XC (packet to circuit interworking only, with no transcoding).
9. The support of circuit data calls when the circuit IWU is located at the MSC and the CBSC contains an XC (ISLP framing over the A5 interface with no transcoding).
10. The support of a VPU to SDU interface and a VPU to XC interface.

Inputs and Outputs

The physical I/O of the VPU is Ethernet (1000 Base T) towards the BSS and SONET or SDH towards the MSC. For MSCs that do not support the SONET/STM–1 interface, a DCS will be required to adapt physical interfaces and line rates.

Card Description

Frame Overview

The VPU frame will have the following features:

- House up to 2 Shelves
  (Note the shelves in a frame are totally separate units and have no connectivity between them).
- 4 Power Supply Modules (PSMs) and Power Distribution Unit (PDU) at Top of Frame.
- Front–to–Back Air Cooling
- Front/Rear Access for Maintenance

Each shelf has 19 front slots and eleven in the rear of the shelf. Four of the front slots are occupied with 2 ISB/SPROCS and 2 CCAs leaving 15 payload slots. All cards are Hot Swappable. The cards described here include AIO, CCA, SPROC, BPP2, PSM, ISB, DGBEs, and DOC3s.

NOTE

VPU contains boards in common with the SDU. The ISB/SPROC and CCA are common with the SDU. The SDU BPP card was enhanced to support VPU functions (BPP 2), as described below. The AIO is a repackaging of the 16.1 Site I/O card for the vertical back–card form factor. The DGBE is a repackaging of the 16.1 Span I/O card for the vertical back–card form factor.

The BPP 2 enhancements included: additional capacity to support the PCM serial interfaces to the DOC3's; a time–slot interchanging function to support any–to–any mux/demux of octets to/from individual CPE resources; and additional CPEs to handle the 2500 Erlang total VPU shelf capacity requirement.

Refer to the SDU chapter for block diagrams of these boards.

CCA

The CCA provides card presence detection as well as module EID retrieval for the AIO and DGBE cards. Additionally, it provides inputs for shelf level alarms (such as the fans and the PSMs) and control over shelf level LEDs. The CCA also provides termination of customer defined alarms that can be terminated at the VPU shelf. Customer defined alarms are made available to the OMC–R by the O&M functions of the VPU. Alarm outputs can be defined for interface to site alarms collection facilities through relay contacts provided on the AIO. Alternately, these relays may be used to control other site equipment.

SPROC

The SPROC coordinates all shelf O&M. It houses a Power PC750 processor, network interfaces, MMI ports and local memory. The primary functions of this card are:

- Download, stores code and configuration data for entire VPU from OMCR.
- Acts as download server for ISB, BPP2, and CCA, and DOC3.
- Fault Management (Fault monitoring and recovery, Alarm reporting to OMCR, and Redundancy State Management).
- PM Data collection and forwarding to OMCR.

The SPROC performs central call processing resource management and is implemented in a 2N Redundant configuration. The SPROC is coupled with the ISB as a single Field Replaceable Unit.

ISB

The ISB (Interface Switch Board) is the master time based reference for the VPU. It provides Layer 3 routing to the AN and provides the packet switching function for the VPU. The Board Control Processor (BCP) supports local O&M operations including bootstrap, code and data load, alarm/event reporting, etc. The ISB is a common FRU also used in the CBTS Platform and SDU equipment, and carries the SPROC (literally). The ISB interfaces to the RAN, specifically to the AN, via Gigabit Ethernet links. It is implemented as 2N Redundant allowing for route failover to be accomplished via OSPF routing protocols on the AN, ISB, and BPP2. Additionally, the SPROC is physically part of the same FRU as the ISB.

BPP 2

The BPP2 board is the general payload board of the VPU. The Board Control Processor (BCP) on the BPP2 supports local O&M operations including bootstrap, code and data load, alarm/event reporting, etc.

The BPP2 will provide the following:

- Vocoding, i.e, transcoding between PCM and CDMA encoded voice.
- Interworking of vocoded payload to UDP/IP/MAC.
- Bypass (for circuit data calls) of transcoding.
- A5 Interface function (for circuit data calls using a IWU at MSC) i.e., ISLP framing.
- Interworking of circuit data payload to UDP/IP/MAC.
- Termination of circuit TDM interface from the DOC3.

Most of the BPP2 functionality is provided by the Vocoding Channel Processing elements, which are supported by the Board Control Processor (BCP) and an Ethernet switch. The BPP2 performs either Vocoder Processing Functions (VPF) or vocoder bypass. The phrase "vocoder bypass" here simply means the bearer data stream traverses the BPP2 without being transcoded back to PCM format. The BPP2s allow for implementing of a load sharing configuration for vocoding by distributing calls among all the VPF BPP2 cards in the shelf.

PSM

The Power Supply Module provides cage level input power conversion for distribution throughout a given VPU cage.

AIO

The AIO slot resides in the rear portion of the VPU shelf assembly and accommodates one AIO board. The AIO board is the interface for the alarm I/O. The board interfaces with the CCAs through the backplane. An individual AIO board is capable of accepting 16 Customer alarm inputs, and providing 8 Customer alarm outputs. Each CCA relays the alarms to the Platform Management O&M function which notifies the OMCR of the alarm condition. The AIO card will also be the input if BITS (Building Integrated Timing Source) is used.

DGBE

The DGBE resides in the rear portion of the VPU shelf assembly. The shelf accommodates two DGBE boards. Each DGBE board interfaces to a Gigabit Ethernet signal. The 1000BaseT Ethernet connections provided by the DGBE board are used to interface from the VPU to the Access Node (AN). Gigabit interfaces are cabled to the top of the frame.

DOC3

The Dual Optical Carrier 3 Interface card (DOC–3) resides in the rear portion of the VPU shelf assembly and accommodates two DOC–3 boards. The DOC3 converts (multiplexes/demultiplexes) between SONET Optical Channel 3 (*The corresponding (ITU–T) SDH version of OC–3, i.e., STM–1, is also supported) signals at a rate of 155.520 Mbps and DS0–level signals at a rate of 64 Kbps. In other words, it terminates channelized OC–3 from the DCS or MSC, and distributes (via fan–out) the PCM octets to designated BPP2 cards (forward link). The DOC–3 multiplexes reverse link octet streams from BPP2 cards into common OC–3/STM–1 streams back to the DCS or MSC.

Two DOC3 cards interface to the ISB, and are managed by the SPROC. The DOC3 provides the following functionality:

- Termination of two OC–3 SONET/ STM–1 SDH optical interfaces, each having an active and a standby optical fiber interface. Each OC–3/ STM–1 active interface supports 2016 channels of 64Kbps PCM (DS0).
- Supports OC–3/STS–1 pointer processing and STM–1/AU–4 pointer processing.
- Distribution of PCM stream via high speed circuit connection fabric to each BPP2 (forward direction).
- Multiplexing of N payload slot PCM streams to a given OC–3 SONET/ STM–1 SDH stream (reverse direction).
- Automatic Protection Switching (APS).
- O&M interface to SPROC via PMI for SONET/SDH APS alarm and failure alarm indications, host processor code management, Fault Management rules, and responses.

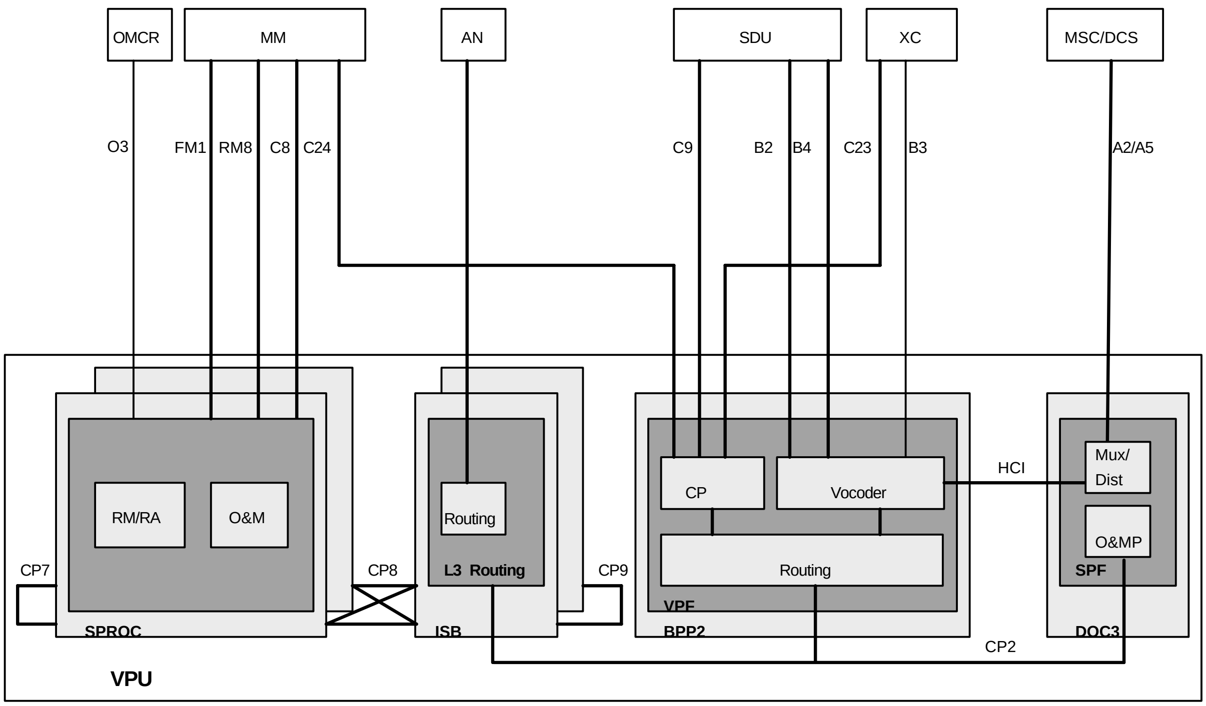
There will be one, plus one redundant DOC3 cards per VPU shelf, for a total of 2. The DOC3 supports Dual OC3 SONET/ STM–1 SDH interfaces to either a DCS or MSC and interconnects with all 15 BPP2s through the High Speed Circuit Interconnect Interface.

Signal Flow

Overview

This section describes the logical Control, Bearer, and O&M interfaces supported by the VPU.

Figure 10-2: VPU External Interfaces



Call Processing Control Paths

Control interfaces are terminated at the following points in the CDMA VPU architecture:

1. Vocoder Call Control (C8) – This is a signalling and control interface between the MM call processing and the RM/RA (Resource Management/Resource Allocation) function of the VPU. It is proprietary and used to establish and maintain services such as voice vocoding and circuit data through requests for vocoder re–sources and MSC connection requests.
2. VPU–SEL Control (C9) – This is a signalling and control interface between the SDU–SDF and the CP function of the VPU. It is proprietary and used to carry vocoder signalling and control information for voice calls and circuit data calls when the IWU is located at the MSC.
3. VPU–XC (C23) – This is a signalling and control interface between the XC and the CP function of the VPU. It is proprietary and used to carry vocoder signalling and control information for circuit data calls when the IWU is located at the RAN.
4. VPU–MM (C24) – This is a signalling and control interface between the MM call processing and the CP function of the VPU. It is proprietary and used to carry vocoder bypass and release messages. After a call has been established using C8 messaging, all subsequent signalling messages are sent via the C24 interface.

Traffic Paths

The CDMA VPU supports the following Bearer interfaces and termination points:

1. IOS–A2 Interface (A2) – This is a bearer traffic interface used to carry 64 kbit/sec PCM information. The A2 interface is defined by IOS and connects the VPU and the MSC. The A2 interface carries a duplex stream of user traffic.
2. IOS–A5 Interface (A5) – This is a bearer traffic interface used to carry circuit data IWU interface between the VPU and the MSC. It is used when the IWU is located at the MSC. The A5 protocol is ISLP over the DS0 PCM bearer.
3. VPF–Traffic (B2) – This is a bearer traffic interface that is internal to the CBSC and is used to carry duplex traffic for voice calls between the VPU and the SDU–SDF. This interface is primarily for the transfer of compressed speech information between the selection distribution function on the SDU–SDF and the vocoding function VPF card within the VPU.
4. PTCIF/PSI–TER–Traffic (B3) – This is a bearer traffic interface that is internal to the CBSC and is used to carry duplex traffic for circuit data calls where the IWU is located at the RAN. The interface is between the XC and the CKTIW function on the VPF of the VPU.
5. A5IF–Traffic (B4) – This is a bearer traffic interface that is internal to the CBSC and is used to carry duplex traffic for circuit data calls where the IWU is located at the MSC. The interface is between the SDU–SDF and the A5IW function on the VPF of the VPU.

O&M Paths

The CDMA VPU O&M interface paths are:

1. VPU/MM–RM (RM8) – This is a resource management signalling interface between the MM and the RM/RA function of the VPU. This interface is used to discover, register, and request re–sources from the VPU. SCTP is used as the transport mechanism.
2. VPU/MM–FM (FM1) – This is a signalling interface between MM fault management and the RM/RA function of the VPU. This interface is used to report terrestrial circuit block and unblock messages.
3. CNEOMI O&M–Control (O3) – This is an O&M signalling interface between the OMC–R and the O&M function of the VPU. This interface is used to initiate O&M related activities. The management protocol between the OMC–R and the VPU is SNMPv2 over UDP in order to support the required CNEOMI interface.

Redundancy

Multiple redundancy schemes are used in the VPU to meet various functional requirements.

- CCA, ISB, DGBE, PSM, DOC3 and SPROC use 2N redundancy
- The BPP2 uses load sharing/over provisioning redundancy
- The pool of VPU shelves uses load sharing redundancy with an MM load manager handling distribution of the VPU load.

O&M

The VPU will use the SMNE (Self–Managed Network Elements) paradigm started in release 16.1 with the SDU and BTS (packet) and now expanded to the VPU for release 16.3. Primary O&M interface will be provided by the OMC–R.

VPU DCS Description

Description

With the introduction of the VPU, the RAN is OC–3/STM–1 capable at the A2/A5 interface. The DCS is a new optional network element for release 16.3. If an MSC's interface with the RAN is not OC–3/STM–1 capable, a point–to–point DCS configuration is needed to provide multiplexing/demultiplexing between T1/E1 interfaces and a OC–3/STM–1 interface.

The DCS is not provided as part of the Motorola RAN solution. If the Network Operator's MSC can not be equipped with an OC3/STM–1 interface, then the operator must supply their own DCS.

Function

The DCS (de)multiplexes between T1/E1 and OC–3/STM–1 at a DS1/E1 and VT1.5/VT2 level. The DCS selected should meet the following minimum requirements:

- Support E1 or T1 inputs as appropriate for the customer site.
- Support OC–3 or STM–1 as appropriate for the customer site.
- Cross–connect at a DS1/E1 to VT1.5/VT2 level.
- Support DS1/E1 capacity as appropriate for the customer site.
- Support 1+1 linear APS.
- Support dual BITS input or other suitable network timing interface.

Inputs and Outputs

The DCS will typically support the following inputs and outputs:

- T1/E1
- OC–3/STS–1 and/or STM–1/AU–4
- BITS
- Communication ports (O&M)

Card Description

The DCS may be new equipment supplied by the customer chosen third party vendor. For specific information on the cards in the DCS, consult the DCS product documentation. A typical DCS will consist of a NEBS compliant frame with 1 or more racks mounted within. The DCS will typically contain the following primary board types or functions:

- T1, T3, or E1 terminates links from the MSC.
- OC–3 or STM–1 terminates OC–3/STM–1 links from the VPU. Supports linear 1+1 APS.
- Support for OC–3/STS–1 and/or STM–1/AU–4 pointer processing
- Clock card(s) – General equipment clocking and also supplies backup synchronization timing when the timing source (e.g. BITS) fails.

- Processor card(s) – Providing O&M and FM functionality.
- Switch subsystem– supports DS1/E1 level cross–connect between T1/E1 and VT1.5/ VT2 on a OC–3/STM–1.

Signal Flow

Prior to 16.3, all circuit and voice data between the MSC and RAN was carried over T1/E1 spans. With the introduction of the VPU in 16.3, voice and circuit data is carried over an optic fiber, OC–3/STM–1. If an MSC attached to the VPU does not support OC–3/STM–1 links, then a DCS is required to multiplex/demultiplex T1/E1 signals to an OC–3/ STM–1 between the MSC and the VPU. With linear 1+1 APS, each OC–3/STM–1 span has a working/protection relationship with another OC–3/STM–1 span. For outbound data, the working/protection pair sends the exact same data on both pairs. For inbound data, the DCS chooses to extract data from either the working or protection OC–3/STM–1 span based on its APS configuration and the condition on the OC–3/STM–1 spans.

Restrictions:

- The VPU only allows Working/Protection to be designated at a DOC3 card level (as opposed to at a OCPORT level).
- The VPU does not allow both DOC3s to have “Working” OC–3 spans at the same time.
- The DCS must also allow Working/Protection to be designated at a OC–3 card level for the previous configuration to be feasible.
- The following configuration would be required if the DCS only allows Working/Protection to be designated at an OC–3 port level (as opposed to on an OC–3 card level). Cross Connecting the OC–3/DOC3 cards as shown would result in the loss of one of the OC–3 span pairs if the DCS OC–3 card fails.

Redundancy

See the DCS manufacturer information for specific redundancy information. The DCS’s OC–3/ STM–1 spans are provided in working and protection pairs in order to deploy Automatic Protection Switching (APS).

O&M

All O&M is supported through the DCS’s O&M application. Provisioning of the DCS must be consistent with the provisioning of the VPU at the OMCR for the following:

- T1/E1 to VT1.5/VT2 mapping on the OC–3/STM–1.
- SDH Frame Type selection corresponds to VPU STM–1/AU–4 pointer processing and SONET Frame Type selection corresponds to VPU OC–3/STS–1 pointer processing.
- Working and protection OC–3/STM–1 ports and fibers.
- Linear 1+1 APS unidirectional/bidirectional and revertive/non–revertive provisioning.

Also clock references source types, such as BITS, must be provisioned on the DCS in accordance with the DCS vendor recommendations.

Description of VPU Timing Options

Overview

The VPU has three timing options. There are two external timing options, BITS and MSCVPUSPAN. There is one internal timing option, free–run mode. It is recommended that the BITS external timing option be used as the first choice as this will provide the most accurate VPU timing configuration. The MSCVPUSPAN timing option is recommended as the second choice and if neither external timing option is available, the VPU can operate on its internal clock in the free–run mode and meet the OC3 SONET operating requirements.

Function

The VPU internal clock, one per ISB, is used to establish an internal timing reference for all of the VPU Payload boards. The ISBs keep their internal clocks locked together so that if the master ISB clock should fail, the other ISB clock can immediately take over as the VPU timing source. The VPU internal clock can be disciplined by the use of the external timing options, BITS and MSCVPUSPAN. The VPU internal clock will automatically use the following order of precedence for disciplining the internal clock: 1st–BITS, 2nd–MSCVPUSPAN, and 3rd– Free–Run mode. The VPU can be configured to use BITS, MSCVPUSPAN, or both as external timing sources, with the VPU automatically enforcing the timing reference source order of precedence.

The VPU internal clock is also used as the OC3 transmit timing source. The OC3 S–byte, which is one of the bytes in the SONET overhead field, is always set by the VPU to Do Not Use (DUS) for timing. The VPU is considered the end of a timing chain and in order to ensure that a timing loop is not possible, the VPU S–Byte is permanently set to the DUS state so that the Network Entity (NE) on the other end of the OC3 link will not attempt to recover timing from the VPU.

Inputs and Outputs

The VPU has two BITS connector inputs at the top of the frame. The BITS connector is a DB–9 with a wire–wrap mating connector that is provided standard with each frame. If wire–wrap is not the preferred interconnect method, then the wire–wrap mating connector can be removed and the VPU frame female DB–9 connector can be used.

NOTE

The R16.3 product release has the hardware support for two BITS inputs (BITS–1 and BITS–2), but the software support for only BITS–1. The R16.4.1 release will support the second (BITS–2) input by software upgrade only.

> **NOTE**
>
> Should only the BITS–1 input be wired during R16.3 installation, it is recommended that the BITS cable to the rear AIO board be unplugged when wiring the second (BITS–2) input on a live system. (The AIO board connector should be removed any time wiring changes are made to the BITS–1 or BITS–2 wire–wrap connectors on a live system.) The VPU will remain in–service if the AIO cable is unplugged and will automatically begin using the BITS inputs again when the AIO board connector is plugged back into the rear AIO board.

BITS External Timing Source Input

The VPU will accept a 2.048 MHz square wave as a BITS timing reference source in accordance with ITU–T Table11/G.703(ver. 11/2001) & Figure 20/G.703(ver. 11/2001). The BITS connector is located at the top of the VPU Frame. This clock source type is available from BITS equipment suppliers as a timing module that plugs into a BITS equipment shelf, typically with up to 10 clock ports per card. For reference purposes, a Larus BITS configuration is provided in the BITS Timing Source section.

MSCVPUSPAN External Timing Source Input

Once the MSCVPUSPAN has been equipped via the VPU MSCVPUSPAN OMC–R CLI command, the VPU CLOCKSOURCE OMC–R CLI command is used to designate the MSCVPUSPAN as the clock source.

> **NOTE**
>
> The VPU can terminate terrestrial circuits from more than one MSC. The external MSCVPUSPAN external timing option should be used only when there is one MSC being served by the VPU or when all MSCs use the same timing source.

BITS External Timing Source Description

A Building Integrated Timing Source (BITS) can be rack mounted and managed with its own management system. The BITS equipment typically requires an accurate timing source as its timing reference, a timing source such as GPS. The BITS equipment can be used as the master timing source for an entire MTSO. The BITS shelf will accommodate different clock modules in order to provide compatible timing signals to the different Network Elements within an MTSO. For instance, the MSC and DCS may require a 1.544 MHz external timing reference from the BITS while the VPU will use a 2.048 MHz square wave reference.

An example of a compatible BITS Source for use with the VPU is a Larus 5400 Series BITS system with a 5409–3 Clock module or a Larus 54500 Series BITS system with a 54574 Clock module. The 5409–3 module generates up to 10 clock outputs per clock module. The VPU will accept a 2.048 MHz square wave as a BITS timing reference source in accordance with ITU–T Table11/G.703(ver. 11/2001)& Figure 20/G.703(ver. 11/2001).

The VPU BITS inputs are transformer–isolated inputs with input impedances of 120 ohms. A BITS clock source that is rated to drive a 120 ohm input should not require the use of an impedance matching Balun.

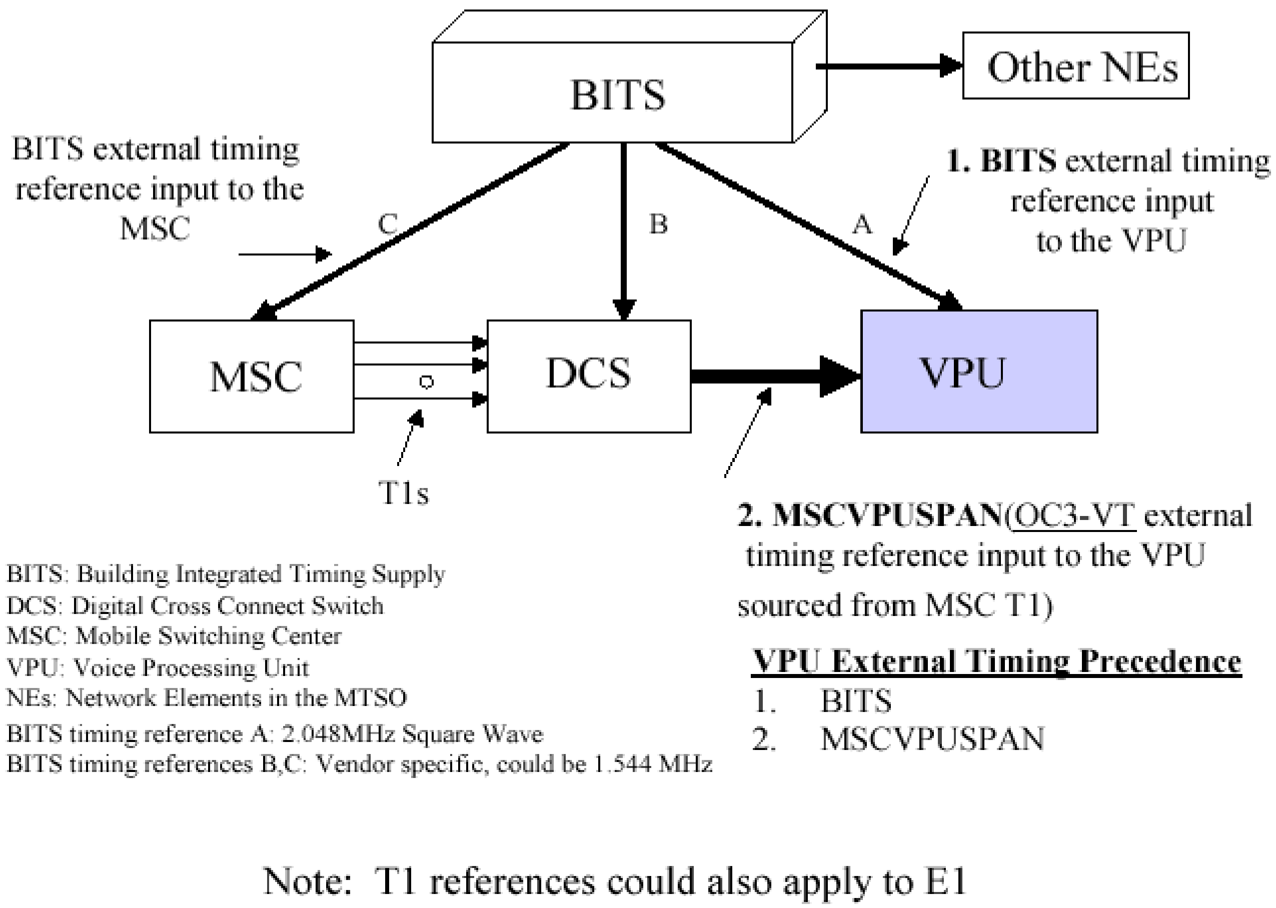
MSCVPUSPAN External Timing Source Description

The OMC–R will only allow the VPU to be configured to use one of the Working MSCVPUSPAN as it external timing reference. The OMC–R automatically maps the MSCVPUSPAN device ID to a DOC3 OC3 port and VT number on the Working/Protection DOC3 pair. There is only one Working/Protection DOC3 pair as a standard configuration in VPU release R16.3. The VPU will automatically choose the same OC3 port and VT number on the Protection OC3 should an automatic protection switch over to the Protection DOC3 occur.

VPU External Timing Signal Flow

The signal flow for the VPU external timing sources are as shown in the following figure.

Figure 10-3: VPU External Timing Sources



Redundancy

The VPU internal clock source is located on each of the two ISBs. However only the active ISB provides the VPU timing. Upon ISB failover to the warm–standby ISB, the VPU timing source moves to the warm–standby that is turned into the active ISB. A VPU clock source change from one ISB to the other is accomplished without being service affecting.

Each ISB will accept external timing from the VPU BITS and from the MSCVPUSPAN inputs when the VPU is configured for the external timing reference inputs. VPU release R16.3 supports the VPU BITS–1 input in software and supports both BITS–1 and BITS–2 inputs in hardware. The R16.4.1 VPU release will provide software support for both BITS inputs. Both BITS inputs are at the highest precedence level so if one input should fail, the VPU will automatically choose the second BITS input. Should both BITS inputs not be available or fail, the VPU will automatically choose the next highest precedence external timing source, the MSCVPUSPAN if provisioned. Else, the VPU will enter free–run mode and operate using the ISB internal clock and still meet the OC3 SONET operating requirements.

O&M

The VPU timing is provisioned from the O&M interface using the command line interface (CLI) command EDIT VPU CLOCKSOURCE.

The OMC–R CLI interface will prompt the user to specify at least one external timing reference, either MSCVPUSPAN or BITS. If the MSCVPUSPAN timing source is used, the user will need to specify at the OMC–R CLI which Span device ID number to use. The OMC–R will automatically map the SPAN device ID to an OC3 port and OC3–VT number to a Working/Protection DOC3 pair.

The VPU will automatically use the Working DOC3 board OC3 interfaces if external timing is provisioned for a MSCVPUSPAN. If protection switching from the Working DOC3 to the Protection DOC3 should occur, then the Protection DOC3 OC3–VT will automatically become the external clock source.

Once the VPU is put into service, should the VPU enter the free–run mode of operation an “all external references out–of–lock” alarm is issued. If no external timing sources are available by choice, then this alarm should be ignored. The alarm is automatically cleared upon the return of either the MSCVPUSPAN or the BITS external timing sources.

Notes

10

Chapter 11: Call Flow

Table of Contents

Notes

Call Flows Overview

Overview

This chapter contains the following information:

- Call flows
- Description of 1X data service call processing.

Reference Information

For detailed Call Flows for Voice and Data Calls, refer to the *CDL/CFC Reference Manual*, “Call Flows” chapter

Network Call Flow

Overview

This section describes the following aspects of call flow:

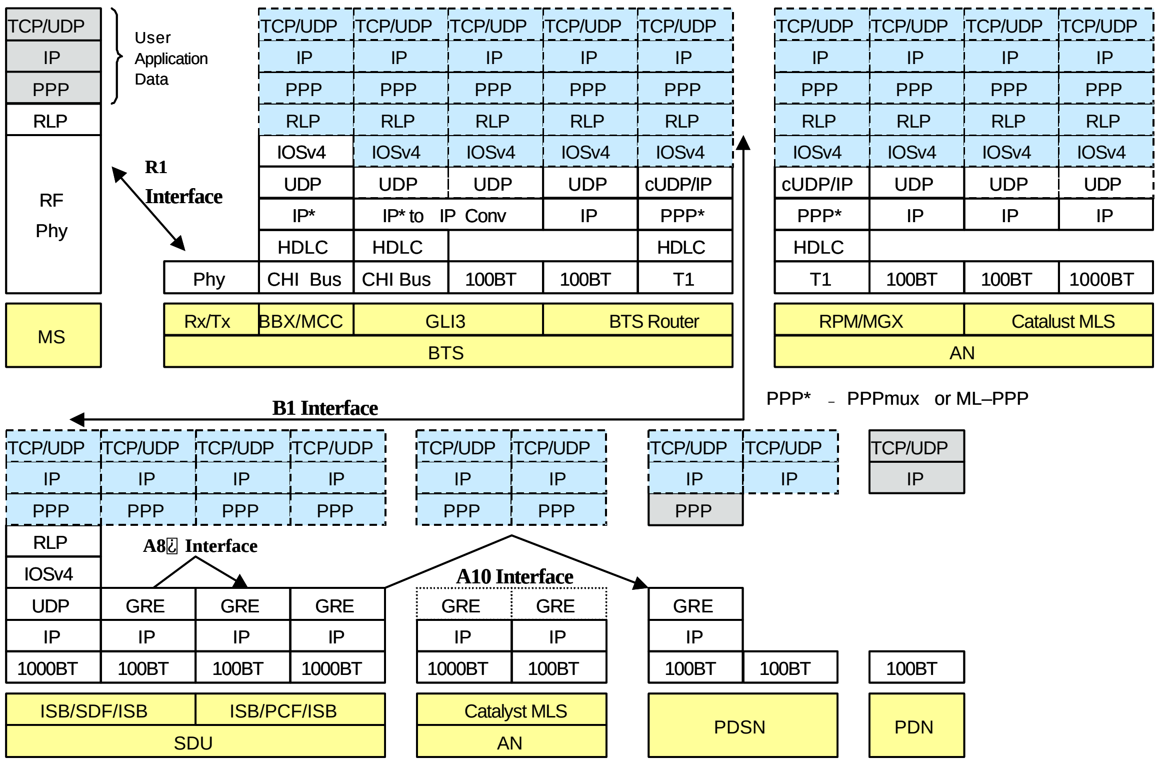
- RAN Protocol Stacks
- RAN Traffic and Signaling Flow
- RAN Architecture

RAN Protocol Stacks

Packet Data Call Path with Packet Backhaul and SDU

Figure 11-1 depicts the protocols used in the RAN with Packet Backhaul and SDU, to support the packet data call traffic.

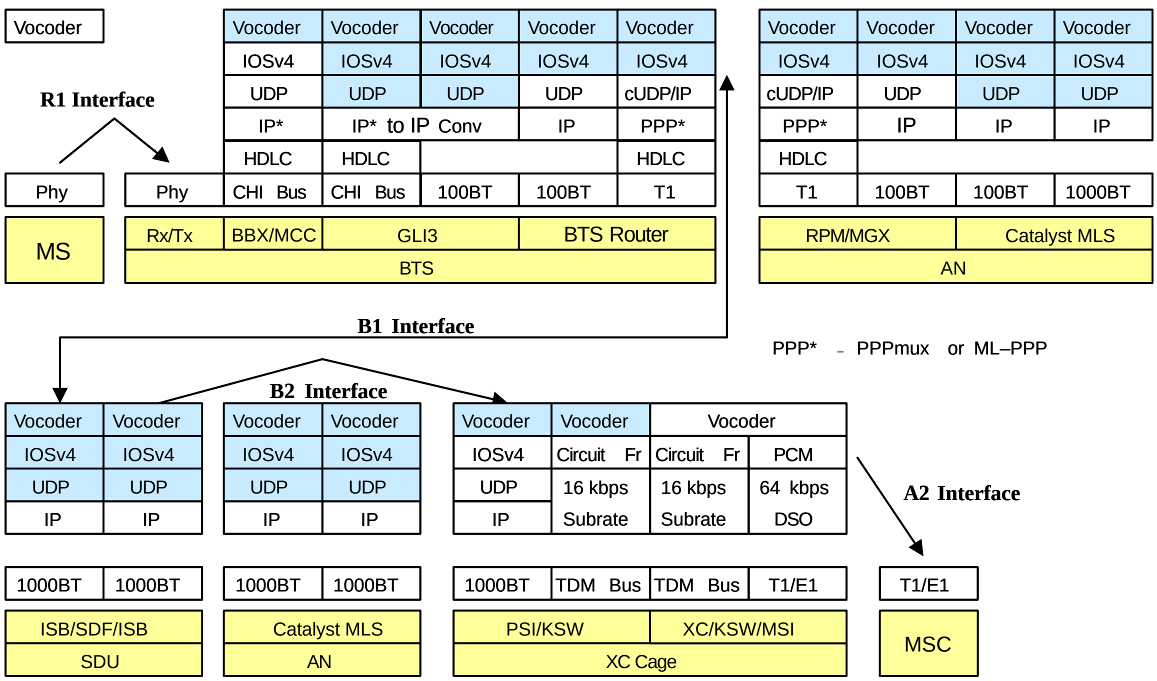
Figure 11-1: Packet Data Call Path with SDU



Voice Call Path with Packet Backhaul and SDU

Figure 11-2 depicts the protocols used in the RAN with Packet Backhaul and SDU, to support the voice call traffic.

Figure 11-2: Voice Call Path with Packet Backhaul and SDU



NOTE

Where equipped, the VPU replaces the XC frame. The VPU performs the same Vocoding functions. The physical I/O of the VPU is Ethernet (1000 Base T) towards the BSS and SONET or SDH towards the MSC. Refer to the VPU chapter for details.

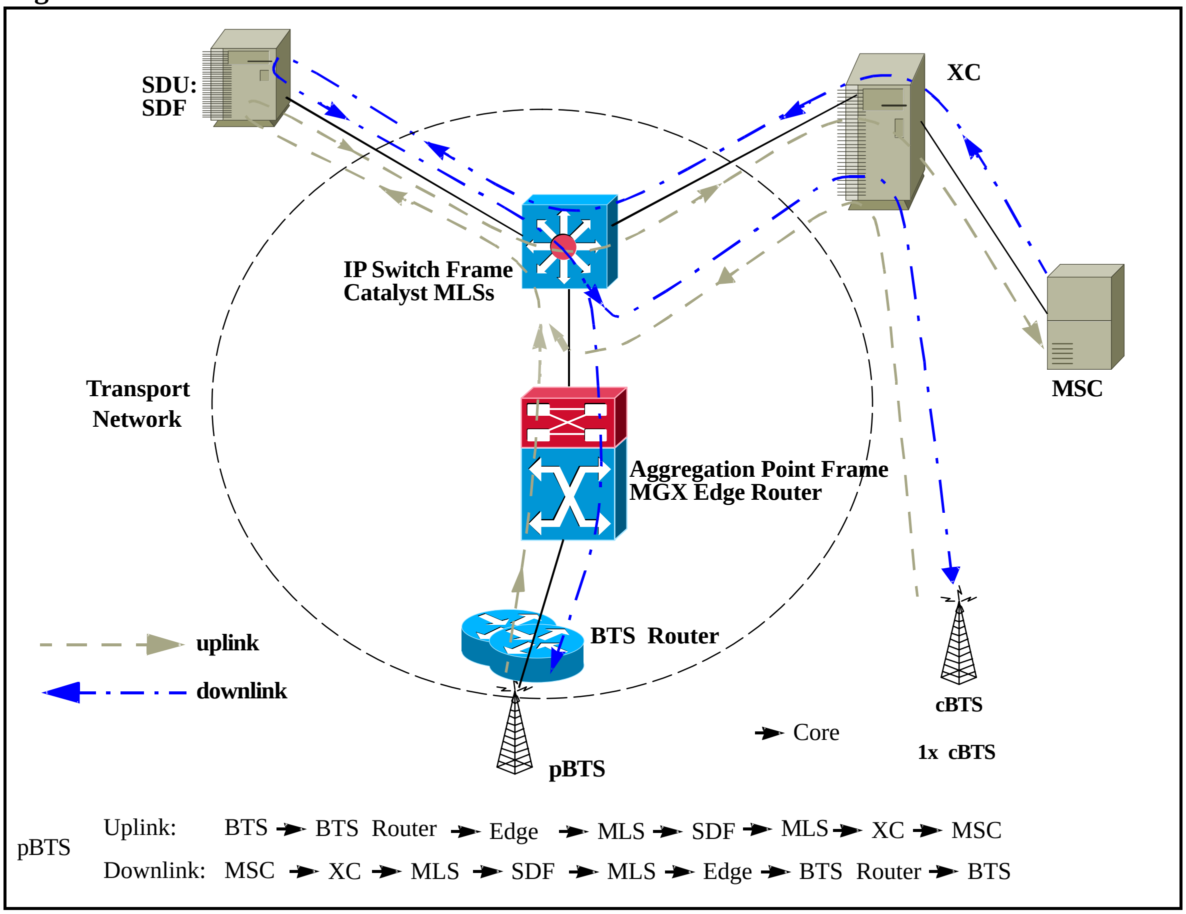
11

RAN Traffic and Signaling Flow

Voice Traffic Flow

Figure 11-3 illustrates voice traffic flow between the BTS and the MSC.

Figure 11-3: Voice Traffic Flow



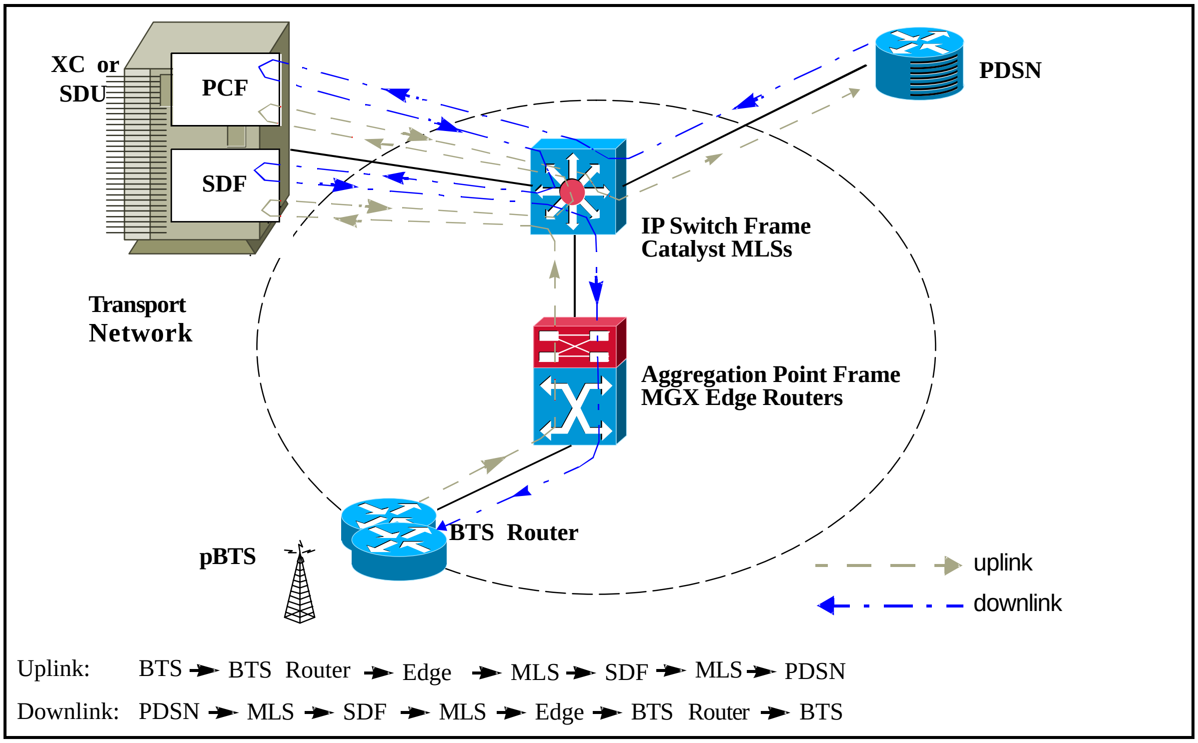
NOTE

The VPU frame can replace the XC in Figure 11-3, however, the VPU only directly interfaces with the AN and MSC.

Packet Data Call Traffic Flow

Figure 11-4 illustrates packet data call traffic flow between the BTS and the PDSN.

Figure 11-4: Data Traffic Flow



Signaling Traffic Flow

Figure 11-5 illustrates signaling traffic flow from the MM to the BTS, and Figure 11-6 illustrates signalling traffic flow from the SDU to the BTS.

Figure 11-5: Signaling Traffic Flow: MM to BTS

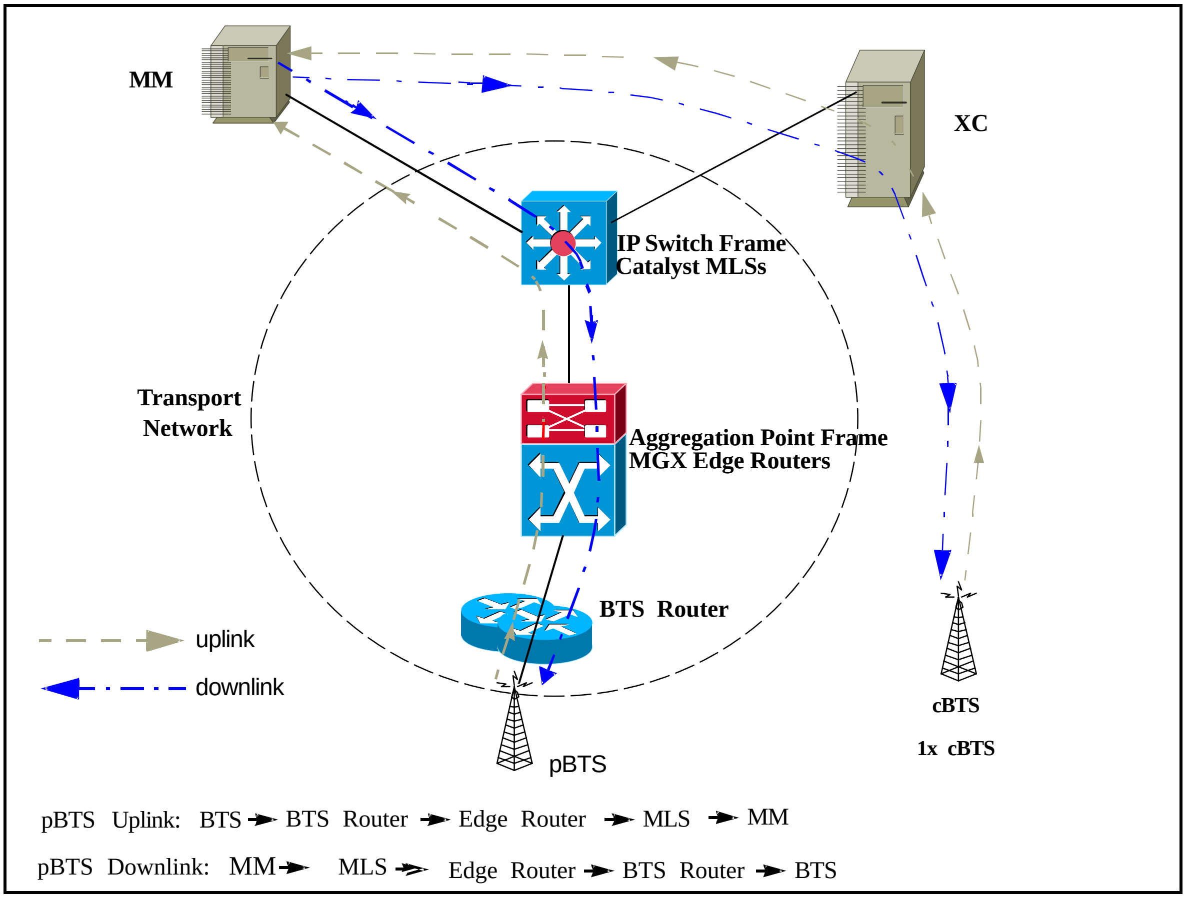
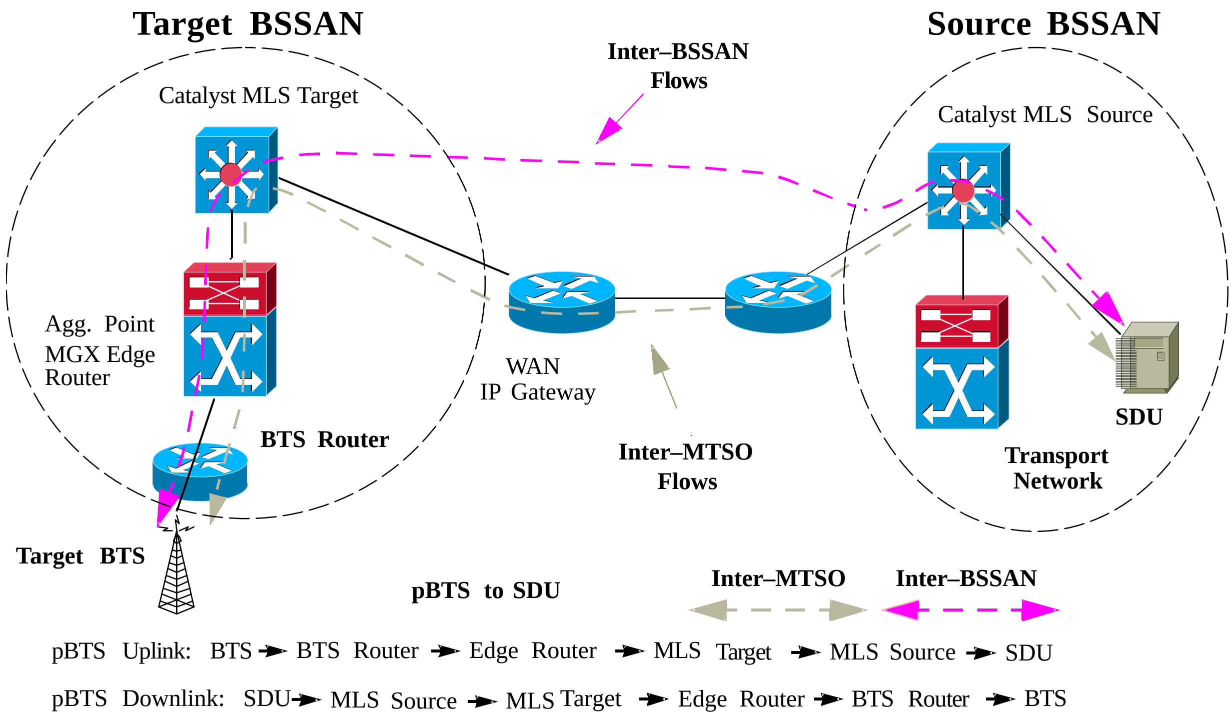


Figure 11-6: Signaling Traffic Flow: SDU to BTS



RAN Architecture

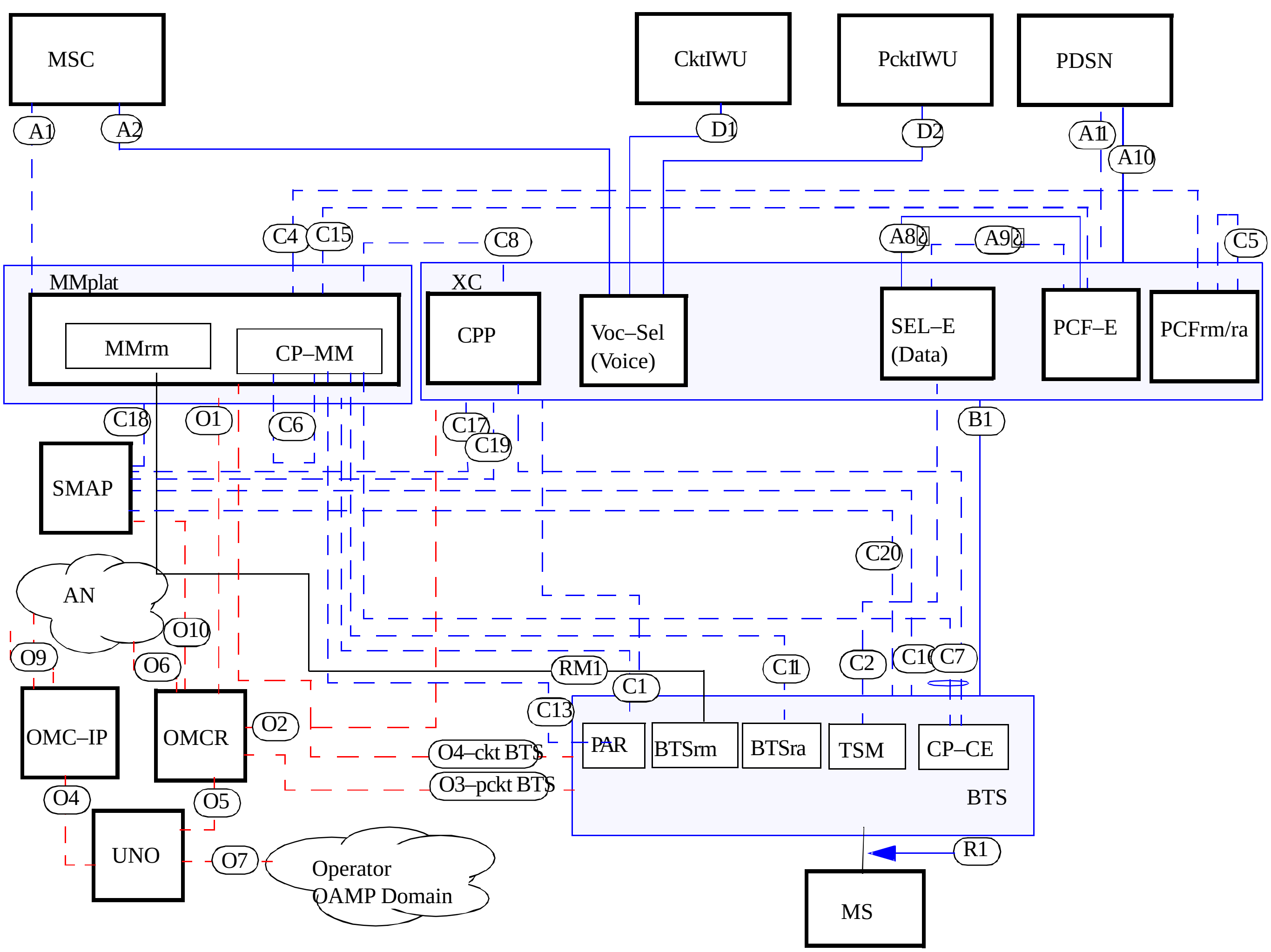
This section describes the XC–based architecture and the SDU–based architecture.

> **NOTE**
>
> For details on the functions performed at each interface, such as SEL, PCF, TSM, RM/RA, etc., refer to the chapter for the applicable RAN network element.

XC–Based Architecture

Figure 11-7 depicts the XC–based architecture.

Figure 11-7: XC Based Architecture

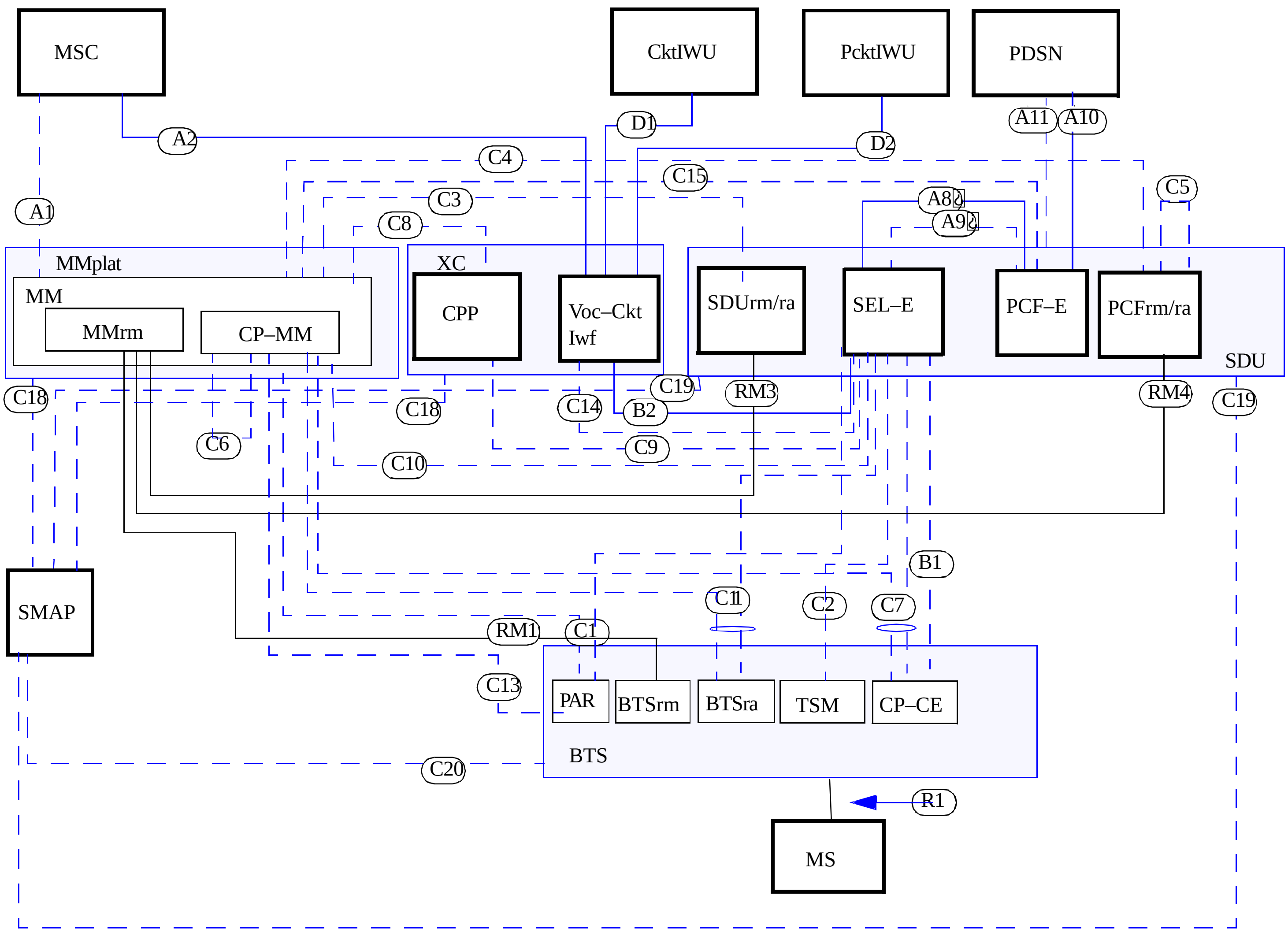


SDU–Based Architecture

Figure 11-8 depicts the SDU–based architecture.

> **NOTE**
>
> Where equipped, the VPU replaces the XC frame. Refer to Figure 10-2 for details on VPU–specific interfaces.

Figure 11-8: SDU Based Architecture



Packet Data Call Flow

Introduction

This section describes the flow of a packet data call through the logical and physical interfaces of the CDMA2000 1X packet data system and the Packet Data network (Internet, Intranet).

Packet Data Call Description

This section provides an description of Mobile IP, Simple IP, and Proxy Mobile IP packet data calls as supported by the PDSN, HA, and AAA through the mobile's connection to the CDMA network.

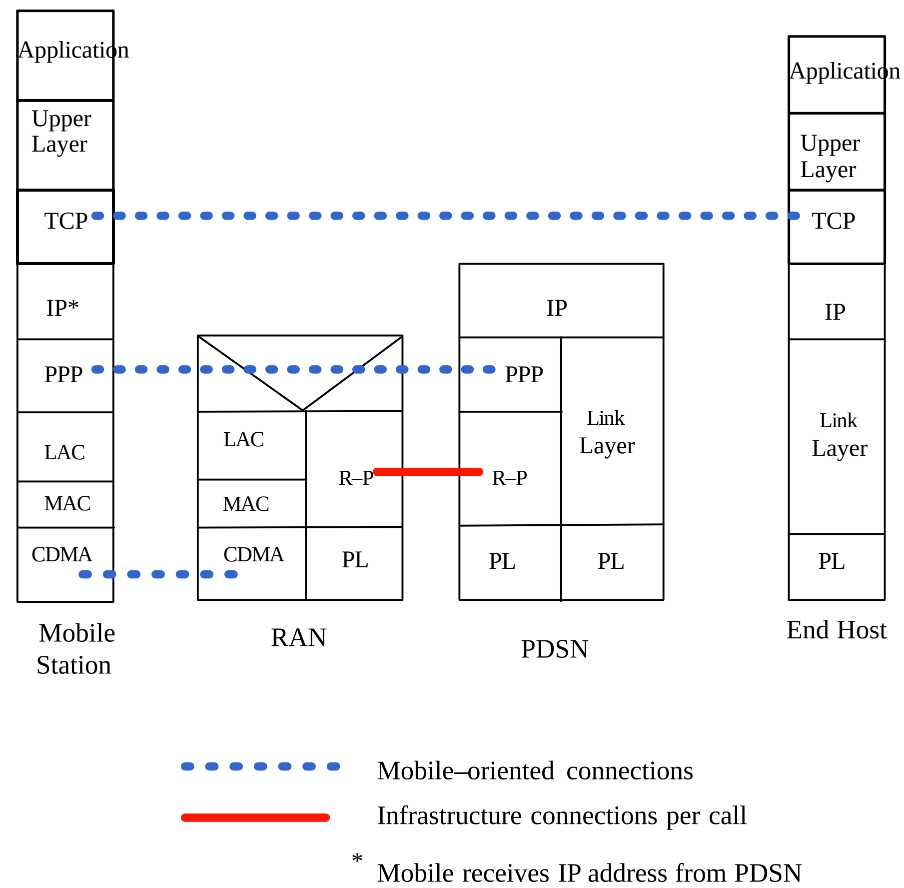
Simple IP

Simple IP is an access method allowing a Simple IP mobile subscriber to access the Internet or an Intranet through its connection to the PDSN.

1. The PDSN (or AAA) assigns a temporary IP address to the mobile using PPP.
2. The user profile provided by the AAA can contain information for PDSN to either grant access to the IP network or set up a tunnel to an ISP or a Private network. L2TP access to the intranet is supported.
3. The PDSN sends/receives IP packets for the mobile.
4. When the call is finished the PDSN releases the IP address. Also, if the mobile moves out of the PDSN serving area, the IP address is released and the mobile can no longer receive packets sent to that address. The mobile must set up a session with the new PDSN.

See Figure 11-9 for an illustration of Simple IP call flow.

Figure 11-9: Simple IP flow.



Mobile IP

Mobile IP is an access method allowing a mobile subscriber to access the Internet or an Intranet through its connection to the PDSN and HA (see Figure 11-10 and Figure 11-11).

Overview of Mobile IP services

The Mobile IP access method is a service allowing a mobile to have a static or dynamic IP address belonging to its home network where it cam access the Internet/Intranet and receive data, and to also be able to leave the home network and roam across different "foreign" CDMA2000 packet data networks and still be able to receive data packets sent to its home address by an Internet or Intranet correspondent node. The home network contains an HA and the network type can be a CDMA2000 packet data network, a home ISP, or a private network.

When a mobile roams into a new CDMA2000 packet data network, the mobile registers with a PDSN/FA, which in turn locates the mobile's HA and sends it a Mobile IP registration. By receiving PDSN/FA registrations, the HA can track the current location of the mobile through its care–of–address at the current PDSN/FA, and therefore redirect to the care–of–address any packets it receives addressed to the mobile's home address. The mobile continues to receive packets forwarded from its home address as it travels from PDSN to PDSN.

The HA that the PDSN/FA contacts depends upon whether the mobile is attempting to access a private network, or a home ISP network, or the public network. If the mobile is attempting to access a private network or a home ISP network, the PDSN/FA contacts the HA in that network. If the mobile is roaming and attempting to access the public network, the PDSN/FA contacts either the HA in the home or the visited CDMA2000 packet data network depending upon the configuration of the visited CDMA2000 packet data network.

Description of call flow (user data) in Mobile IP

Data call flow in the Mobile IP scheme is slightly more complicated than in Simple IP, so this section offers the following analogy: the relation between the serving CDMA2000 1X network (including the PDSN) and the Mobile IP subscriber's HA/AAA, as somewhat like the relationship between a foreign post office and a home post office as you leave home and choose to forward your mail to your current location.

You, as a Mobile IP user, want to view and maybe download data from a webpage, or send and receive email, and to do so must establish a packet data transaction with the CDMA2000 1X system and PDSN. To view a webpage or use email you must be able to receive and send packets to and from the Internet. To be able to send and receive this "mail", you need an address where people can reach you, and a post office to send your mail.

As a Mobile IP subscriber, you have a home network that contains an HA and AAA that act as your home post office. Your HA/AAA assigns you an IP address / user@domain.com that is much like a home street address which is a subset of the location of your home post office: the mail first arrives at the town and zip code, then the street address. The home network is a network that matches the subnet address of the home address assigned to the mobile.

The CDMA2000 1X system and serving PDSN/FA (in this role also called the Foreign Agent) are the foreign post office that you are visiting, and that you have only temporarily moved to.

Your home address remains with your home post office.

Because your home address remains the same, but you are currently out of town and in communication with a foreign post office, any mail that someone sends to your home address will necessarily first end up at your home post office.

But since you are out of town and still want to get your mail, you need to contact your home post office and ask them to forward your mail to your present "foreign" post office. The present "foreign" post office can then send it to you.

In technical terms, then:

1. You "forward your mail" when the mobile registers with the CDMA2000 1X cellular system, requests the packet data service option, sets up a traffic channel, and initiates the PCF to register the mobile with the PDSN/FA. Once you register with the PDSN/FA, the PDSN/FA contacts the mobile's HA and tells it where to forward packets to.
2. Whenever an Internet user sends email to your user@domain.com for example, OR, for example, you have requested to view a webpage by entering the URL and are waiting for a response from the server to send you the packets for viewing the webpage (or even downloading from it), the packets from the server eventually reach your mobile's HA and that HA forwards the packets to the PDSN.

> **NOTE**
>
> This chapter refers to the Internet/Intranet application sending data to the mobile's home address as the "Correspondent Node" and is any end host that the mobile is communicating with through the PDSN–HA connection.

3. The PDSN receives the packets from the HA and sends them to the PCF, which routes the user data through the system so that the BTS can transmit the data to the mobile.

4. If the packets to send are large and require more RF and MCC channel element resources, then the BTS sends an Extended Supplemental Channel Assignment message to the mobile requesting the mobile to start processing the specified Supplemental traffic channels (specifies the walsh codes to use), at the specified data rates (number of information bits per frame) in order to receive the data burst.
5. The mobile than passes this data to the application layer for the user to see either on the LCD of the mobile or the laptop attached to the mobile.

In the case of the mobile sending packets to an Internet destination, though, a slight variation on the post office analogy creeps in. In the mail world, when you send a letter to someone's home address, your current "foreign" post office does not need to first send the mail to your home post office in order for the mail to reach the post office of the person you are sending the mail to. In the case of "Reverse Tunneling" functionality, the PDSN (foreign post office) has to first send it to your HA/AAA (your home post office) for routing to the destination address.

Proxy Mobile IP

An access method allowing a Simple IP mobile subscriber to access the Internet or an Intranet through its connection to the PDSN, but the PDSN also registers the mobile with the HA (in the same CDMA PDN) in order to provide Mobile IP type services. This allows the mobile to maintain the same IP address as it roams across PDSNs. The proxy Mobile IP user must be provisioned in the AAA server as a Proxy Mobile IP device.

Figure 11-10: Mobile IP flow, bearer

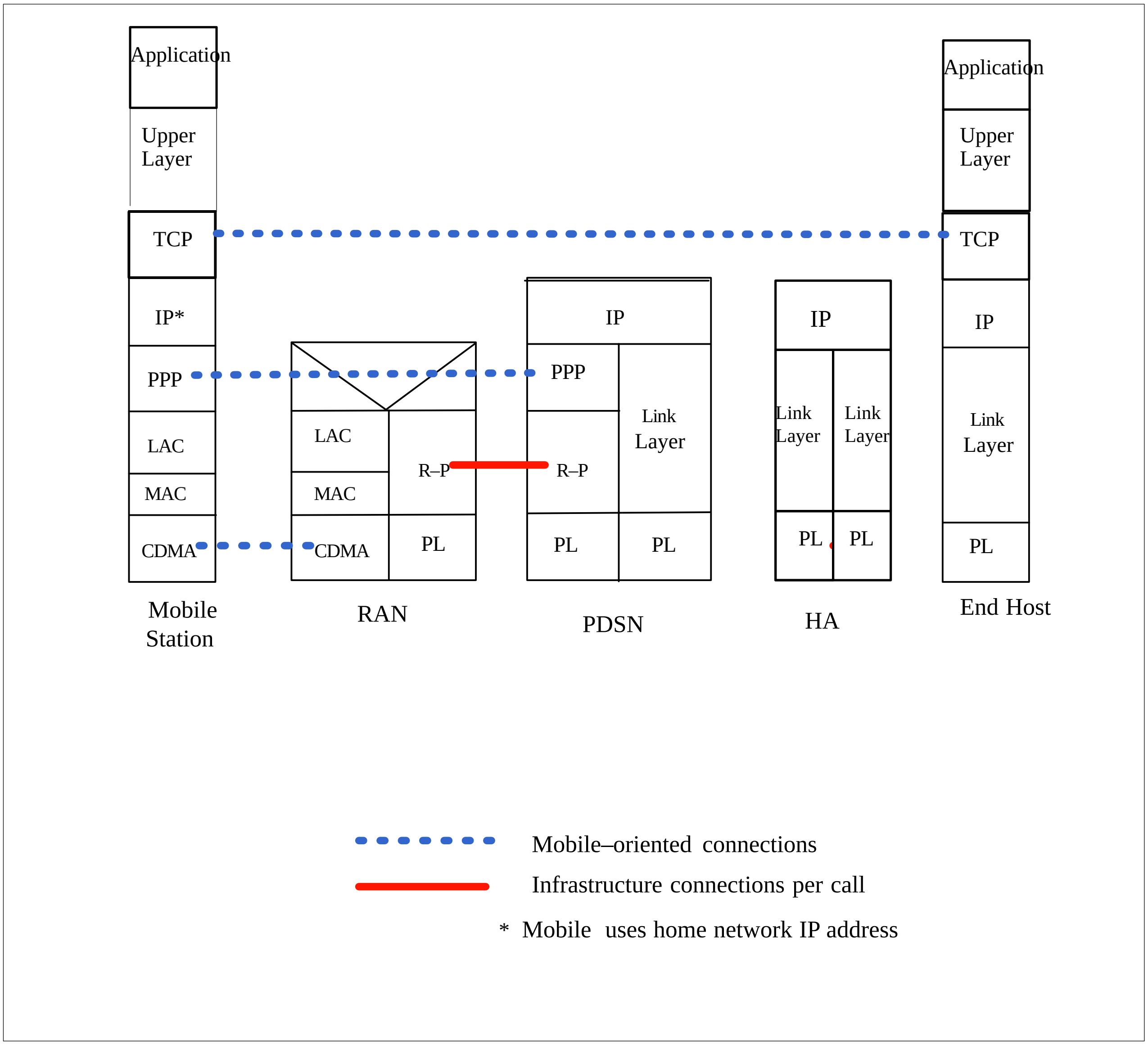
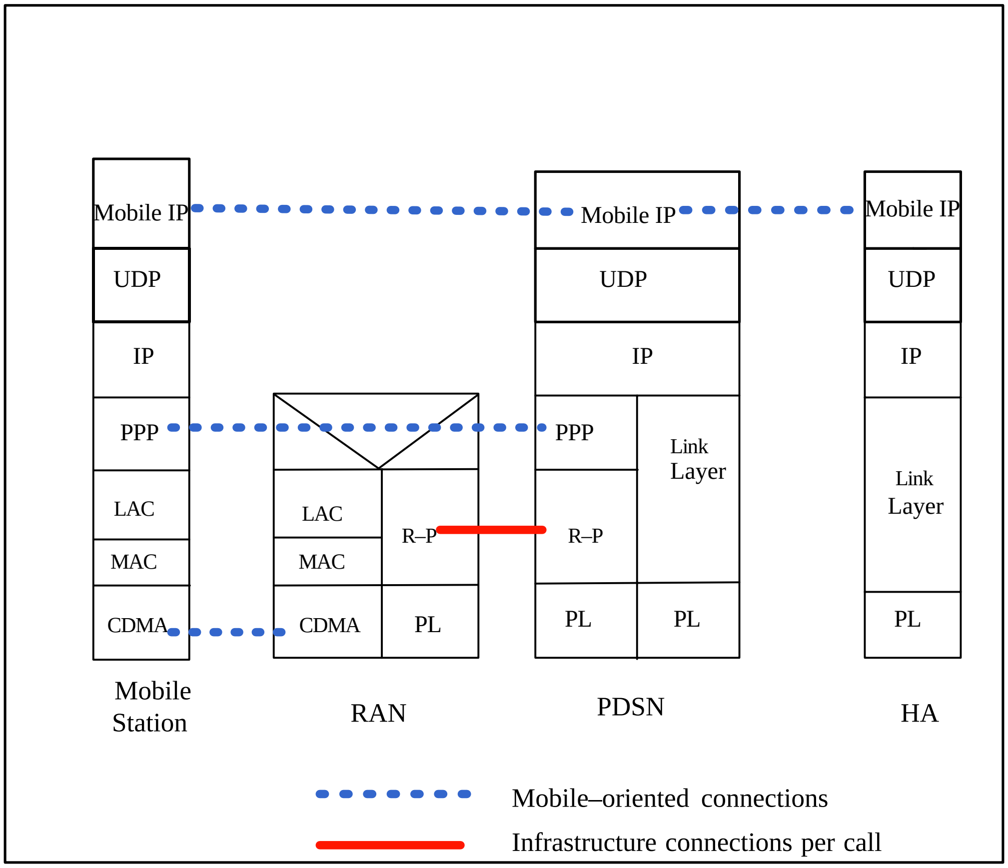


Figure 11-11: Mobile IP flow, control



Packet Data Call Setup

Introduction

This section describes how a packet data call is set up between a mobile user and the Internet/Intranet by the devices in the BSSAN (BTS, XC, SDU, PDSN, Proxy AAA). This section describes call flows and logical interfaces:

- Setting up CDMA2000 1X Traffic channels with the High Speed Packet Data Service Option (144k).
- Setting up the PCF – PDSN Connection. It is necessary to set up connections between the PCF and PDSN in order to relay data traffic from the cellular world to the packet data world. This connection between the PCF function and the PDSN is called the “RP tunnel”.
- Setting up Mobile IP/Simple IP Internet Access. This part of the process involves the PDSN setting up access to the Internet for the packet data call and involves an HA and AAA.
- Service Connect – Packet Data Session Start.
- Maintaining the packet data session.
- Processing Data Bursts. This part of the process involves setting up CDMA2000 1X Supplemental channels to process bursts of packet data. When PDSN or mobile has “larger” packets to send, the CDMA2000 1X BTS needs to support this by processing data bursts using Extended Supplemental channel assignments.

Mobile Terminated Calls

In the packet data call scenario, the only case in which a Mobile Terminated call occurs is when the mobile has released the traffic channel but the data call remains in the dormant state with the PDSN. If the call is in the dormant state, the PPP session still exists and the mobile is still registered. If the PDSN receives packets for the mobile, it will initiate the PCF to cause the BTS to Page the mobile with a request for the packet data service option. In this case, the mobile sends a Page Response message to set up the resources. Otherwise the process is much like Mobile Origination in a packet data call.

Mobile Terminated calls do not occur in other scenarios because the PDSN will not be able to receive any packets to send to the mobile until the mobile registers with the PDSN through the PCF functionality.

Setting Up CDMA2000 1X Traffic Channels

This section describes packet data call setup in terms of the first stage, setting up the CDMA2000 1X traffic channels.

System Access and Registration

This section does not go into much detail for system access and mobile registration since CDMA2000 1X packet data calls follow a process very similar to IS–95A and IS–95B registration.

CDMA 2000 1X mobiles, whether they use a packet data service option or a voice service option, perform the registration process with the BTS/CBSC(MM)/MSC/VLR/HLR much like in IS–95A and IS–95B. The HLR supports changes for CDMA2000 1X in user profiles.

Mobile Origination

The Mobile Origination process occurs when the user starts some application on their CDMA2000 1X packet data capable mobile to start access to the Internet/Intranet(s).

1. The mobile has a packet to transmit.
2. The mobile sends an Origination message on the Access channel. The Origination message requests the Packet Data Service Option.
3. The BTS sends an Acknowledgement Order on the Paging channel to indicate receipt of the message.
4. The BTS sends control messages through the system to the MM to request a CDMA channel.
5. The MM receives the request for a CDMA channel, determines that it is a request for a CDMA2000 1X high speed packet data call, and starts the cellular part of the authentication process.

Cellular Authentication

In this part of the process, the MM works with the MSC and VLR/HLR to validate the user in terms of the CDMA 2000 1X packet data service option. The HLR is updated to support these capabilities.

1. The MM communicates with the MSC to transfer the authentication data to the VLR.
2. The VLR sends a request to the subscriber's HLR.
3. The HLR checks to see if the subscriber has "access" to the CDMA2000 1X high speed packet data service option, and sends a response to the MSC which notifies the MM.
4. The MM now knows that, for the specific subscriber, the packet data service option is either enabled, or set to negotiate for the packet data service option during call setup. This description assumes that the call is set to negotiate.

Channel Setup

This section describes how a traffic channel is set up.

1. The MM requests the XC or SDU(if equipped) to set up an *SDF* and a *PCF* resource for the call. The SDF performs Selection and Distribution functions. The PCF is the data call processing entity that interfaces to the PDSN.
2. The MM sends a CM Service Request message to the MSC to request set up of the call.
3. The MM allocates the BTS MCC 1X traffic channel resources and XC/SDU resources.
   For cBTSs applications, the MM signals the BTS to allocate MCC–1X traffic channel elements.
   For pBTSs applications, the SDU signals the BTS to allocate MCC–1X traffic channel elements.
4. The BTS starts transmitting Null traffic on the Forward traffic channel.
5. The MM sends an SS7: SCCP Connection Request and Complete Layer 3 Information message (CM Service Request) to the MSC.
6. The MSC sends an SS7: SCCP Connection Confirm message to the MM.
7. The BTS sends an Extended Channel Assignment message on the Paging channel, “addressed” to the mobile.
8. The mobile is monitoring the Paging channel and receives the Extended Channel Assignment message. The mobile “reads” information from the message and uses that information to acquire the Forward Traffic channel and to transmit on the Reverse traffic channel(s).
9. The mobile acquires the Forward Traffic channel and can begin transmitting on the Reverse link. At this point the BTS has been sending NULL TCH data to help the mobile acquire the channel.
10. The BTS transmits variable rate traffic channel frames to the mobile.
11. The XC/SDU resources are now set up. The XC/SDU resources enable transfer of data from the BTS MCC 1X cards to the XC/SDU, and the opposite direction.
12. The mobile sends a traffic channel preamble on the Reverse link to the BTS (MCC 1X traffic channel element).
13. The BTS MCC 1X card traffic channel element acquires the mobile by receiving the frames. The channel elements sends the frames to the PSI which also acquires the mobile.
14. The BTS transmits a BS Acknowledgement Order to the mobile.
15. The mobile sends Null TCH data on the Reverse traffic channel to the BTS’s MCC 1X traffic channel element.
16. The mobile sends a Mobile Station Acknowledgement Order on the Reverse traffic channel to the BTS’s MCC 1X traffic channel element.
17. The mobile is now “on” the traffic channel: the mobile has acquired the Forward traffic channel and can process frames; the relevant BTS

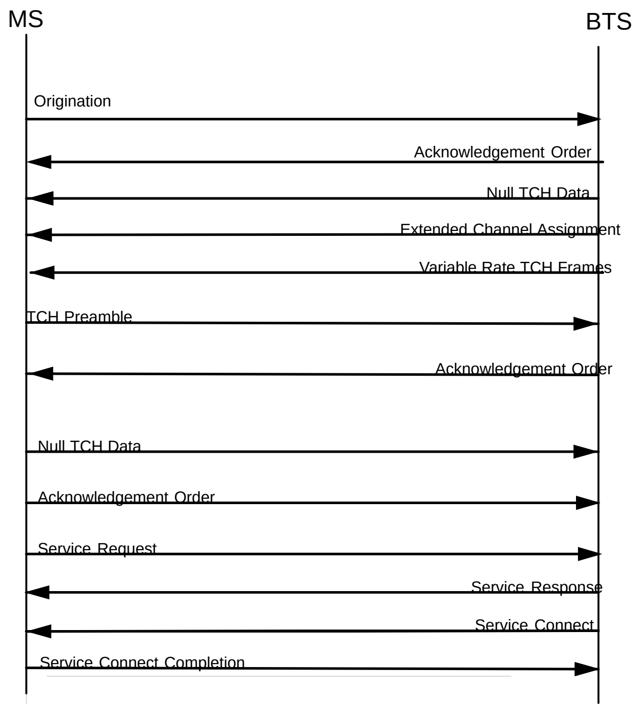
MCC 1X traffic channel element and XC/SDU resources can send Forward frames and receive valid Reverse frames; and the MM has allocated an SDF and PCF resource for the call.

Service Negotiation

This section describes the service negotiation portion of call setup. Service Negotiation might not always occur. The mobile and BTS only exchange Service Request and Service Response messages if Service Negotiation is enabled at the base station.

1. The mobile and BTS exchange Service Request and Service Response messages. The Service response accepts or rejects a request.
2. The MSC sends an SS7 Assignment Request message to the MM. The MSC Assignment Request message may include the mobile subscriber’s subscribed rate information for the MM to send to the CPP for use for the PCF assignment.
3. The MM sets up the PCF assignment with the CPP/SDU–SPROC. It is at this point that call setup is considered successful, both the traffic channel and PCF resources are set up. At this point, the PCF will be set up for using the appropriate service configuration for the packet data call.
4. To indicate to the MSC that the call setup is complete, the MM sends an SS7: Assignment Complete message. The MM can now start performing soft handoffs.

Figure 11-12: Traffic Channel Setup



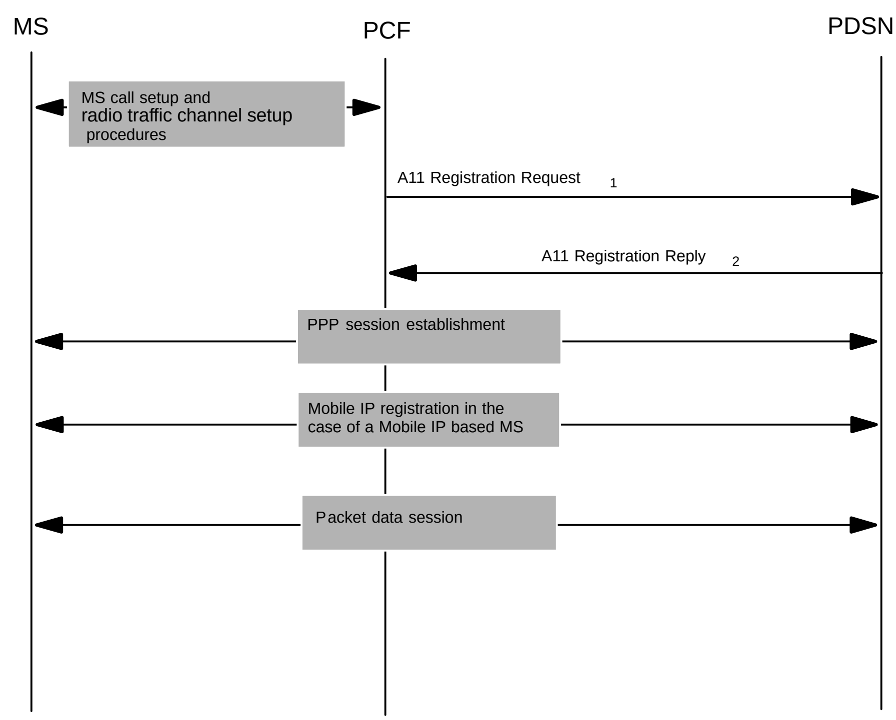
Setting Up PCF – PDSN Connection

Now that the traffic channel and PCF resources are set up for the call, the system establishes a packet data traffic and control connection with the PDSN. The PCF function must set up a packet data bearer path and a control signaling path to the PDSN. The bearer and control paths between the PCF and PDSN are called the RP interface. This connection allows packets to be sent from the CDMA2000 1X network to the packet data network (Internet, Intranets).

1. To set up the packet data traffic path between the PCF and the PDSN, the PCF sends an A11 Registration Request $_1$ message to the PDSN. This message requests the RP tunnel setup by sending the mobile's Service Option (CDMA2000 1X high speed packet data), and identifiers for: the PCF making the request, the mobile (IMSI), and the BSC/MSC/Packet Zone. The message also conveys records that the PDSN will forward to the AAA for accounting (an RP Session Airlink record, and an Active Start Airlink record).
2. The PDSN sets up the packet data traffic path with the PCF by sending an A11 Registration Reply $_2$ to the PCF. This message may contain Mobile–Home Authentication Extension protocol parameters and authenticator value (a protocol optionally used for setting up a secure connection between the PDSN and the mobile's HA).
3. The RP tunnel is now set up for the call and the PDSN and PCF can exchange packets for the data call.

4. Due to the RP tunnel set–up, the PDSN sends an Accounting–Request Start Record (RADIUS protocol) based on a UDR, to the local AAA server. The UDR is a usage data record that contains radio–specific accounting information obtained from the PCF in the Airlink records, and packet specific accounting information. There is one UDR per IP address per mobile, per RP tunnel session.

Figure 11-13: Mobile–initiated setup



Setting up Mobile IP/Simple IP Internet Access

Once the bearer and control path between the PCF and PDSN is setup, the PDSN sets up a PPP (Point to Point protocol) session with the mobile in order to configure both devices for providing Simple IP, Proxy Mobile IP, or Mobile IP access to the subscriber.

PPP is a WAN protocol used for establishing a point–to–point link between devices, and PPP negotiation between two devices is used for setting up a data–link layer connection and a network–layer connection (including setup of IP addressing).

Simple IP Setup (PAP Authentication)

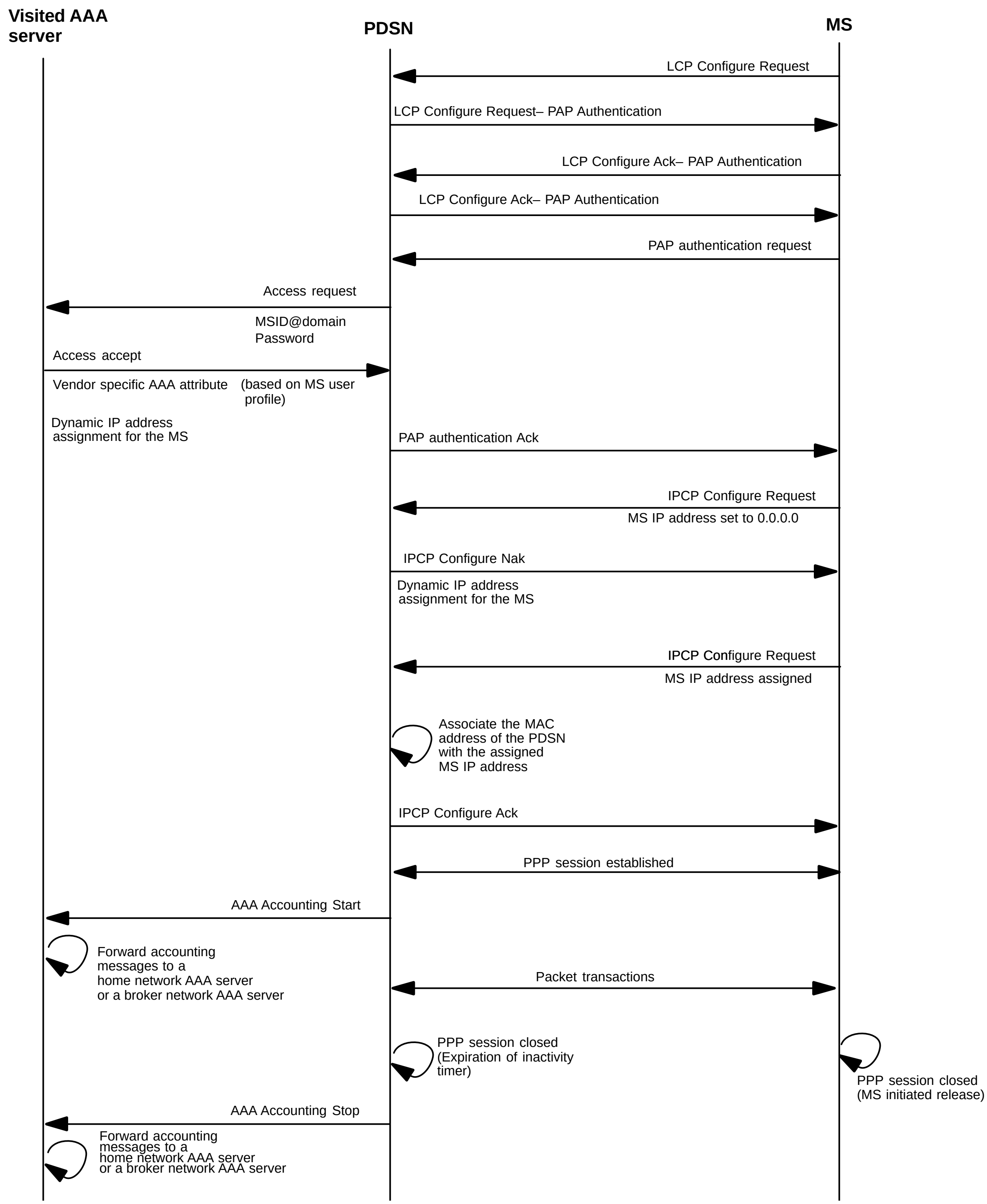
This section describes how a Simple IP packet data call is set up. After setup is complete, the mobile can send/receive data to/from an Internet or Intranet correspondent node through the PDSN.

This call flow shows PPP connection and Internet access using Simple IP with the Password Authentication Protocol (PAP).

1. The mobile sends an LCP Configure Request message to the PDSN. This message initiates the setup of the data–link layer connection between the mobile and the PDSN.
2. The PDSN requests the mobile's data–link layer and authentication information by sending an LCP Configure Request – PAP authentication.
3. The mobile receives the message and send an LCP Configure Acknowledgement – PAP authentication message to the PDSN. This message contains the configuration information that the PDSN uses to set up the connection.
4. The PDSN sends an LCP Configure Acknowledgement – PAP authentication to the mobile to acknowledge that it received the message.
5. The mobile and PDSN have configured the data–link layer connection and can now proceed to set up the network–layer connection.
6. The mobile requests AAA authentication from the PDSN, by sending a PAP Authentication Request message.
7. The PDSN receives the PAP Authentication Request message and sends an Access Request message to the Foreign AAA server. The Access Request relays the mobile subscriber's MSID@domain (also called an NAI) and Password to the AAA.
8. The Foreign AAA server sends an Access Accept message to the PDSN, providing a dynamic IP address assignment for the mobile.
9. The PDSN receives the Access Accept message and sends a PAP authentication Acknowledgement to the mobile.
10. The mobile sends an IPCP Configure Request to the PDSN. In this Request the mobile's IP address is set to 0.0.0.0 (since the mobile is Simple IP and will be assigned an IP address for the packet data session from the PDSN/AAA).

11. The PDSN assigns the dynamic IP address to the mobile by sending an IPCP Configure Nak message.
12. The mobile receives the IPCP Configure Nak message sends an IPCP Configure request message to the PDSN, indicating that the mobile’s IP address is now assigned/accepted.
13. The PDSN now associates the MAC address of the PDSN with the mobile’s assigned IP address.
14. The PDSN sends an IPCP Configure Acknowledgement message to the mobile. This message indicates that the network–layer connection is complete.
15. A PPP session is now established between the mobile and the PDSN, and the following activities can occur:
    - The PDSN can start sending accounting records to AAA and on to a home or broker AAA.
    - The mobile and PDSN can start exchanging packets. For a more detailed description of flow of user data during a Simple IP call, refer to the “Packet Data Call Flow” section of this chapter.

Figure 11-14: Simple IP Operation– Setup and teardown of a PPP session after the RP tunnel is setup. PAP Authentication.



Simple IP Setup (CHAP Authentication)

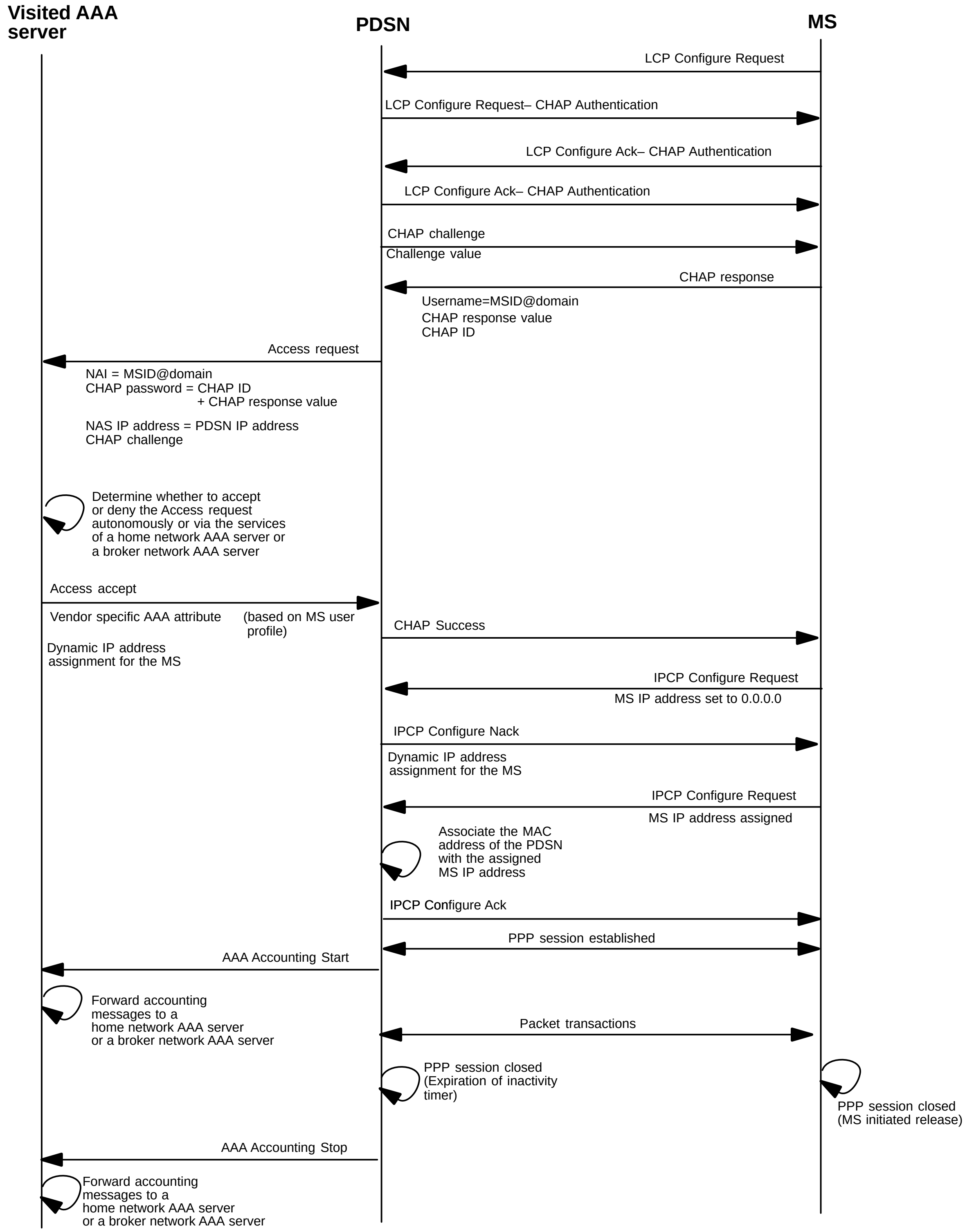
This section describes how a Simple IP packet data call is set up. After setup is complete, the mobile can send/receive data to/from an Internet or Intranet correspondent node through the PDSN.

This call flow shows PPP connection and Internet access using Simple IP with the Challenge Handshake Authentication Protocol (CHAP).

1. The mobile sends an LCP Configure Request message to the PDSN. This message initiates the setup of the data–link layer connection between the mobile and the PDSN.
2. The PDSN requests the mobile's data–link layer and authentication information by sending an LCP Configure Request – CHAP authentication.
3. The mobile receives the message and send an LCP Configure Acknowledgement – CHAP authentication message to the PDSN. This message contains the configuration information that the PDSN uses to set up the connection.
4. The PDSN sends an LCP Configure Ack – CHAP authentication to the mobile to acknowledge that it received the response. The mobile and PDSN have configured the data–link layer connection and can now proceed to set up the network–layer connection.
5. The PDSN sends a CHAP challenge to the mobile. The CHAP challenge message contains a challenge value used for authentication.
6. The mobile sends a CHAP response to the PDSN with:
   – Username=MSID@domain (MSID= mobile station's ID)
   – CHAP response value
   – CHAP ID
7. The PDSN sends an Access Request message to the Foreign AAA server. The Access Request message contains:
   – NAI= MSID@domain
   – CHAP password = CHAP ID + CHAP response value
   – NAS IP address = PDSN IP address
   – CHAP challenge
8. The Foreign AAA server determines whether to accept or deny the Access Request autonomously or use the services of a home network AAA server or a broker network AAA server.
9. The Foreign AAA server sends an Access Accept message to the PDSN, providing a dynamic IP address assignment for the mobile.
10. The PDSN receives the Access Accept message and sends a CHAP Success message to the mobile indicating that it was authenticated.
11. The mobile sends an IPCP Configure Request to the PDSN. In this Request the mobile's IP address is set to 0.0.0.0 (since it is Simple IP and will be assigned an IP address for the packet data session from the PDSN/AAA).
12. The PDSN sends an IPCP Configure Nak message to the mobile. This message contains the dynamic IP address assignment for the mobile (from the Foreign AAA).

13. The mobile sends an IPCP Configure request message to the PDSN, indicating that the mobile's IP address is now assigned/accepted.
14. The PDSN now associates the MAC address of the PDSN with the mobile's assigned IP address.
15. The PDSN sends an IPCP Configure Acknowledgement message to the mobile. The network–layer configuration is complete.
16. A PPP session is now established between the mobile and the PDSN, and the following activities can occur:
    - The PDSN can start sending accounting records to AAA and on to a home or broker AAA.
    - The mobile and PDSN can start exchanging packets. For a more detailed description of flow of user data during a Simple IP call, refer to the "Packet Data Call Flow" section of this chapter.

Figure 11-15: Simple IP Operation: Setup and Teardown of a PPP session after the RP tunnel is setup. CHAP Authentication.



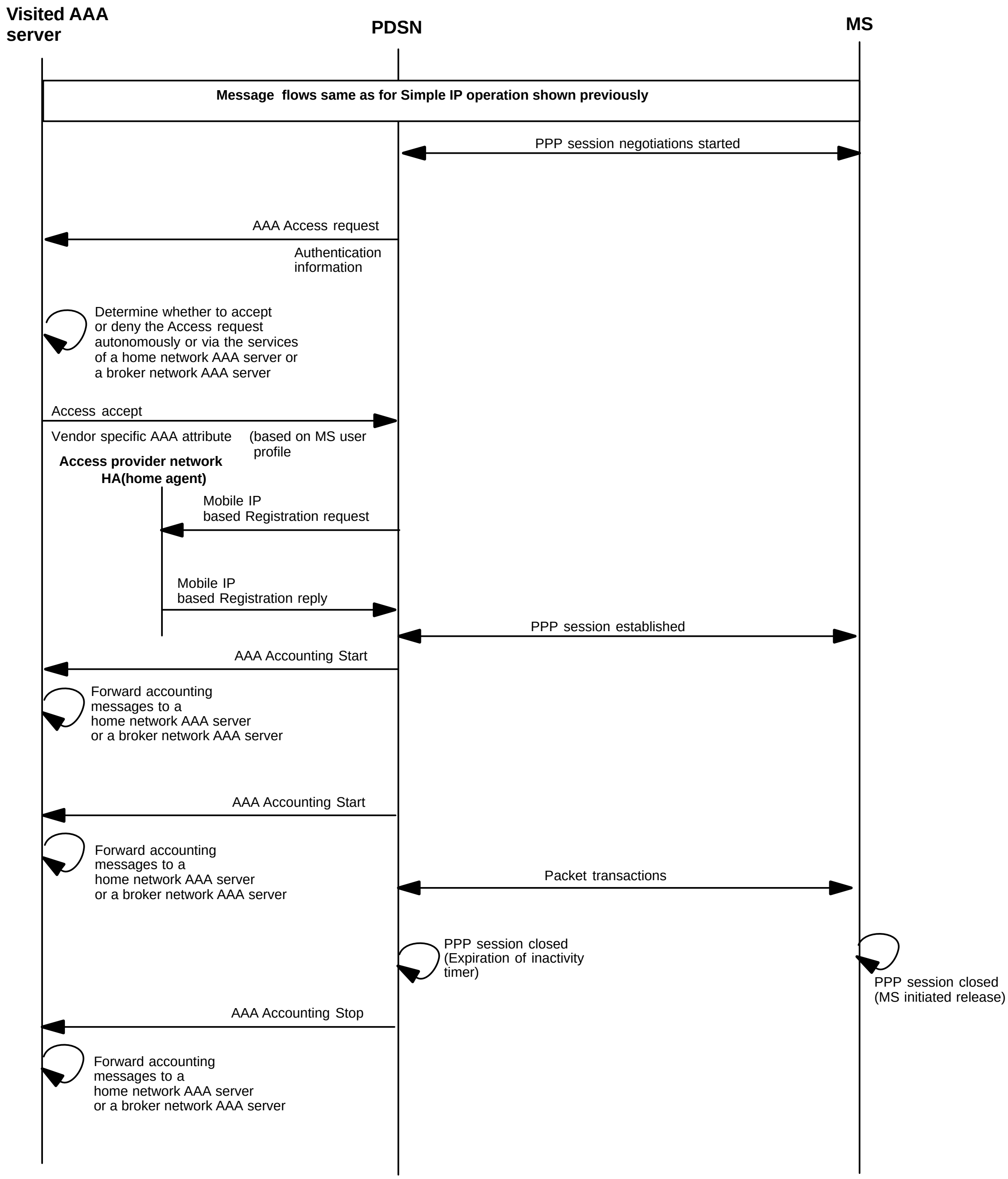
11

Proxy Mobile IP

This section describes how a Proxy Mobile IP packet data call is set up. After setup is complete, the mobile can send/receive data to/from an Internet or Intranet correspondent node through the PDSN – HA interface.

1. The PPP portion of the call setup is the same as in the Simple IP scenarios.
2. The PDSN sends a AAA Access Request to the Foreign AAA server. The message contains the mobile's authentication information.
   - NAI (mobile ID @domain)
   - User password (PAP) in case of PAP authentication, or CHAP password in case of CHAP authentication
   - IP address of the PDSN
   - CHAP Challenge
3. The Foreign AAA server determines whether to accept or deny the Access Request autonomously or use the services of a home network AAA server or a broker network AAA server.
4. The Foreign AAA server sends an Access Accept message to the PDSN, providing the:
   - IP address for the mobile
   - IP address of an HA to use for sending and receiving packets.
5. To set up a connection to the Internet or Intranet, the PDSN sends a Mobile IP protocol Registration Request to the HA.
6. The HA uses the information in the Registration Request to set up Internet access for the mobile by forming the binding record for the mobile station.
7. The PDSN can start sending accounting records to the Foreign AAA. The Foreign AAA forwards the accounting records to a broker AAA or home AAA.
8. The Proxy mobile IP user can now access the Internet/Intranet through the connection set up between the PDSN and the HA. For a more detailed description of flow of user data during a Proxy Mobile IP call, refer to the "Packet Data Call Flow" section of this chapter.

Figure 11-16: Proxy Mobile IP Operation: Setup and Teardown of a PPP session after RP tunnel is setup.



11

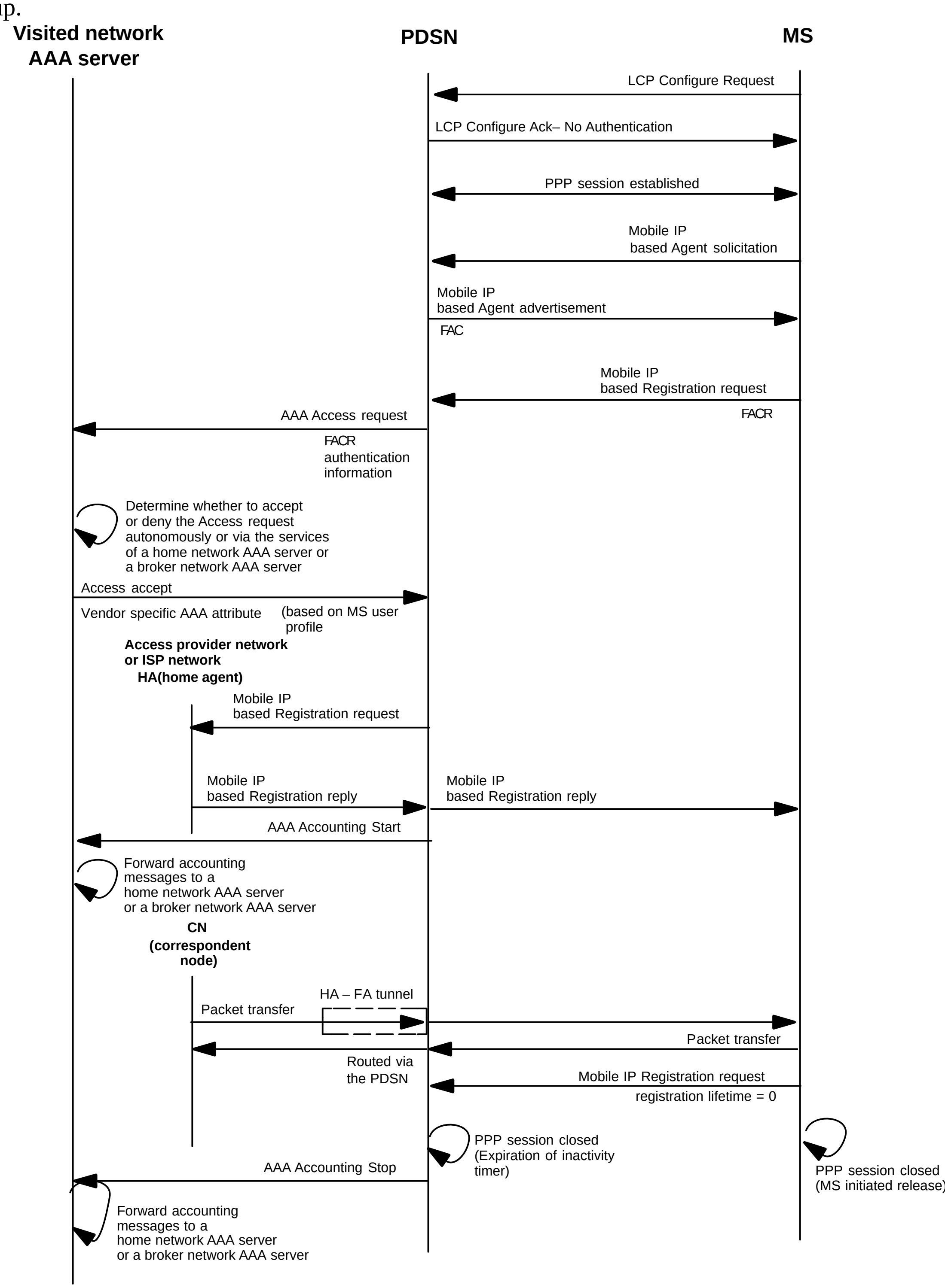
Mobile IP

This section describes how a Mobile IP packet data call is set up. After setup is complete, the mobile can send/receive data to/from an Internet or Intranet correspondent node through the PDSN – HA interface.

1. The mobile sends an LCP Configure Request message to the PDSN. This message initiates the setup of the data–link layer connection between the mobile and the PDSN.
2. The PDSN sends an LCP Configure Acknowledgment – No Authentication message to the PDSN. “No authentication” means that the PDSN will not attempt to authenticate the mobile during PPP setup.
3. The mobile and PDSN perform the IPCP (network layer) phase of the PPP setup process. The mobile can register using its own static IP address assigned by the HA, or request a dynamic IP address from its HA for the duration of the call. If the mobile is configured to use its own static IP address, the mobile specifies a non–zero source IP address in the IP–Address Configuration option during the IPCP phase of the PPP negotiations. If the mobile is configured to use a dynamic IP address, it does not use the IP–Address Configuration option during the IPCP phase of the PPP negotiations.
4. The PPP session is established between the mobile and PDSN.
5. The mobile sends a Mobile IP based Agent Solicitation message to the PDSN. This is a request for using an HA for Mobile IP Internet access. This HA will be the mobile’s HA located in its home network which may be a home ISP, a private network, a home access provider network, etc.
6. The PDSN sends a Mobile IP based Agent Advertisement message with a “Foreign Agent Challenge” to the mobile. A Foreign Agent Challenge is a method of authentication.
7. The mobile sends a Mobile IP based Registration Request message with the Foreign Agent Challenge Response to the PDSN.
   - If the mobile is configured for dynamic IP address assignment, the Registration Request specifies the mobile’s source IP address as 0.0.0.0. The purpose of using 0.0.0.0 is to initiate the HA to assign a dynamic IP address to the mobile.
   - If the mobile is configured for using a static IP address, the mobile includes its IP address in the Registration Request.
8. The PDSN sends an Access Request to the Foreign AAA. The message contains the Foreign Agent Challenge Response authentication information.
9. The Foreign AAA determines whether to accept or deny the Access Request using the services of the home AAA server or a broker network AAA server.
10. The Foreign AAA server sends an Access Accept message to the PDSN to indicate that the mobile user can access the services.

11. The PDSN sends a Mobile IP based Registration Request to the mobile's HA. By registering the mobile with its HA, the HA can track the location of the mobile by PDSN IP address, and when the HA receives any packets addressed to the mobile, it can redirect those packets to the PDSN.
12. The HA sends a Mobile IP based Registration Reply to the PDSN.
13. The PDSN sends a Mobile IP based Registration Reply to the mobile.
14. The PDSN sends a AAA Accounting Start message to the Foreign AAA.
15. The Foreign AAA forwards accounting messages to the user's home network AAA server or a broker network AAA server.
16. The mobile IP user can now access the Internet/Intranet through the connection set up between the PDSN and the HA.
    - The PDSN–HA tunnel enables the sending and receiving of IP packets to and from the correspondent Internet node.
    - The HA receives packets from the Internet/Intranet node corresponding with the mobile, and redirects them to the current PDSN.
    - The HA receives packets from the PDSN and routes them to the Internet/Intranet node corresponding with the mobile. Tunneling of data from the mobile to the HA only occurs in the case of Reverse tunneling.
    - For a more detailed description of flow of user data during a Mobile IP call, refer to the "Packet Data Call Flow" section of this chapter.

Figure 11-17: Mobile IP Operation: Setup and Teardown of a PPP session after RP tunnel is setup.



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Packet Data Session Start

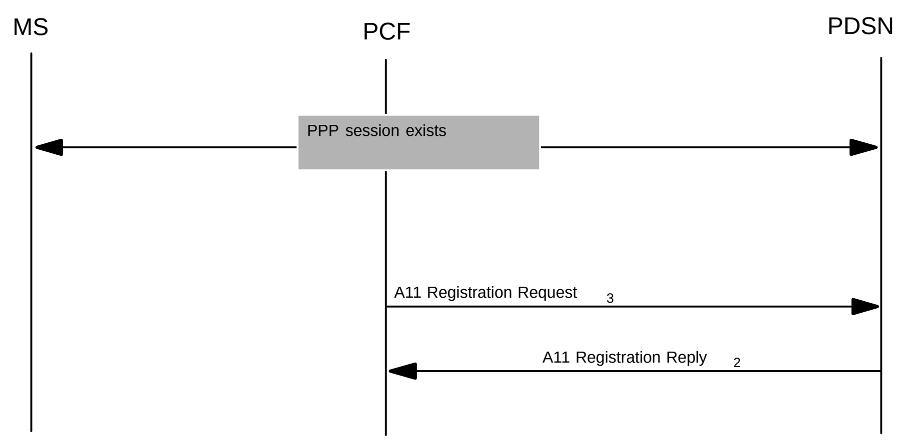
After the connections are set up between the mobile and the RAN, the PCF and the PDSN, and the PDSN and the Internet, and accounting is started with the AAA, the packet data call starts.

1. The base station sends a Service Connect message ordering the mobile to start using the high speed packet data service option.
2. The RAN and mobile start processing frames based on the service option.
3. The mobile sends a Service Connect Complete message to the base station indicating that it has started processing frames according to the service option.

Maintaining the Packet Data Session

The PCF maintains the packet data call (keeps it in an active state where there can be end–to–end processing of packets) by periodically sending A11 Registration Request $_3$ messages to the PDSN. The PDSN acknowledges/renews the session and sends an A11 Registration Reply $_2$.

Figure 11-18: RP session renewal (active or dormant packet data call)



Processing Data Bursts

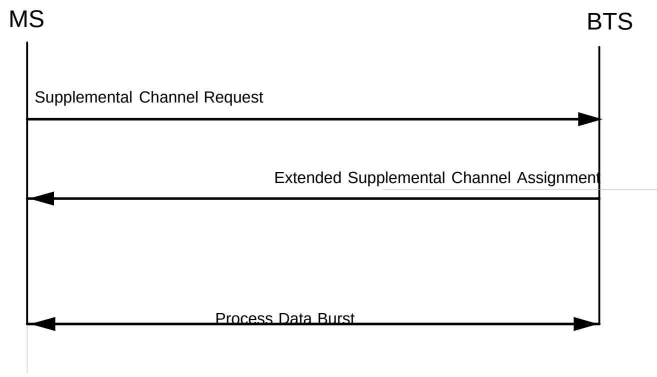
Supplemental Channel Assignment

This part of the process involves setting up CDMA2000 1X Supplemental channels to process bursts of packet data. When the PDSN or mobile has “larger” packets to send, the CDMA2000 1X RF and MCC channels need to support this by processing data bursts using Extended Supplemental channel assignments.

The function of assignment of CDMA2000 1X Reverse link and Forward link Supplemental channels is to provide faster data throughput rates for Internet use (up to 144k) through a combination of faster data rates (more information bits per frame) and the use of multiple simultaneous traffic channels.

1. The mobile or BTS determines that it has one or more large data packet to send and must increase the number of Supplemental channels to increase throughput/data rate.
2. If the mobile is the side requesting more throughput, it sends a Supplemental Channel Request message on the traffic channel.
3. The BTS transmits an Extended Supplemental channel assignment message to the mobile. The Extended Supplemental channel assignment assigns Reverse and/or Forward Supplemental channels.
4. The mobile receives the assignment.
5. The BTS and/or mobile process the data bursts in the following manner, based on the following information contained in the Extended Supplemental Channel Assignment message:
   – The time to start processing the data burst
   – The amount of time to continue processing the data burst
   – The number of Supplemental channels to process
   – The Pilot PN code(s) and walsh codes corresponding to the Forward Supplemental channels to process
   – The data rate to use on the Supplemental channel(s) (the number of information bits to use per frame).
6. Supplemental channel assignment initializes the RLP protocol between the XC or SDU and mobile. The RLP protocol manages the data–link layer process for Supplemental channel data frames. RLP is a protocol that “monitors” the received CDMA2000 1X Supplemental channel data frames to determine whether or not there are any missing frames that should have been received. If the RLP entity (XC or SDU and mobile) detects any missing frames, it sends a NAK Control message to the other RLP entity requesting that it retransmit the missing frame.

Figure 11-19: Supplemental Channel Assignment



Packet Data Handoffs, Active and Dormant Sessions

Introduction

This section describes the following data call scenarios:

- Processing packet data calls during handoff
- Intra–PDSN, inter–PCF dormant handoff
- Inter–PDSN, inter–PCF handoff
- Transition from active state to dormant state
- Transition from dormant state to active state

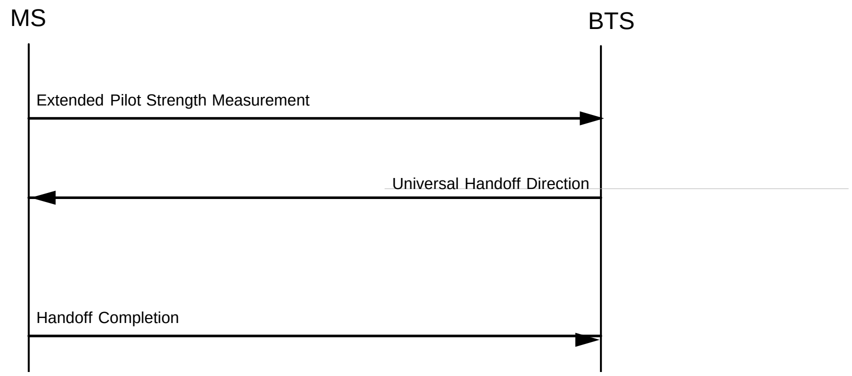
Processing Data Calls during Handoff

When a soft handoff to a new traffic channel occurs, the processing of a data call can continue. In general, during a soft handoff a BTS change occurs, but the XC/SDU remains unchanged.

1. The mobile measures the strengths of the pilots in its active set to determine the impact on Supplemental channel operation.
2. If the strength of a pilot falls to a weak enough level indicating it will affect operation of the channels processing the packet data call, or if the mobile detects a strong pilot, it sends a CDMA2000 1X Extended Pilot Strength Measurement Message reporting this to the RAN. The Extended Pilot Strength Measurement Message triggers the addition of a new BTS to the call (in the case of a strong pilot at the target BTS) or triggers the drop of the BTS from the call (in the case of a weak pilot).
3. The RAN receives the message and determines that the mobile should perform a handoff to a new BTS, or drop a BTS. It sends a CDMA2000 1X Universal Handoff Direction message on the Forward traffic channel.
4. The mobile receives the Universal Handoff Direction message and uses it to do the following:
   – Acquire the new channel or drop the BTS
   – If the mobile is currently processing a data burst (also called a Supplemental channel timeslice): it will either continue processing the current data burst, or start processing a new data burst, using Supplemental channel assignments included in the message. The Supplemental channel assignments determine the number of channels, the walsh code of the Forward channels to acquire, the data rate to use, duration time, and so forth. In general, during a soft handoff, all the BTSs in the mobile's active set transmit the Supplemental channel timeslice in the Universal Handoff Direction message when the reservation for the Supplemental channel burst takes place. The Supplemental channel does not perform a soft handoff in real–time (the DCCH does)– the active set does not change during the current timeslice allocated for the Supplemental channel.
5. The mobile sends a Handoff Completion message to the appropriate BTSs.

6. The packet data call continues.

Figure 11-20: Processing Data Calls during Handoff



Handoff– Intra PDSN, Inter PCF Dormant Handoff

An intra–PDSN, inter–PCF dormant handoff occurs in the following situation:

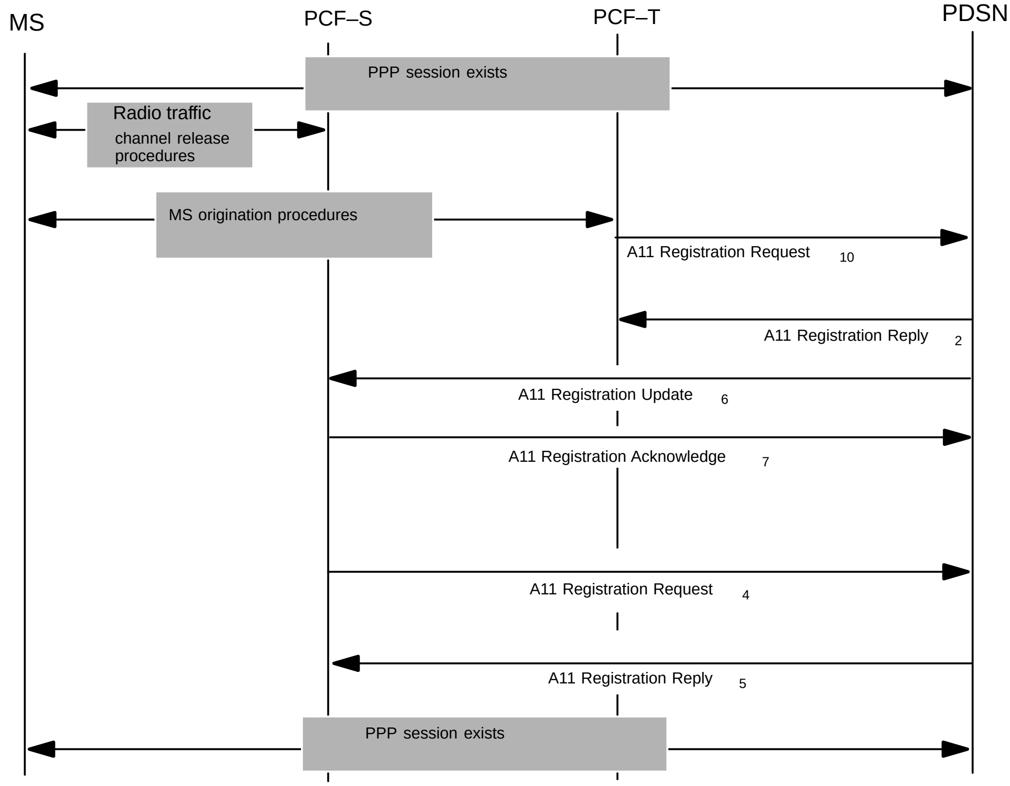
- The mobile has released the traffic channel resources set up with the RAN.
- The packet data call completed a transition into the dormant state– meaning even though the traffic channel is disconnected, the PDSN has maintained the PPP session with the mobile by saving its context. As a result, the mobile and PDSN do not have to repeat the processes of PPP negotiation that result in authentication, IP address assignment, and connection to the HA for sending and receiving packets.
- The mobile (still with a dormant packet data session) restarts the data call setup procedures and those setup procedures involve a CDMA channel associated with a different PCF but the same PDSN.

The target PCF registers with the source PDSN to re–open the data call session:

- The Target PCF sends an A11 Registration Request $_{10}$ to the PDSN.
- The PDSN sends an A11 Registration Reply $_{2}$ to the Target PCF.
- The PDSN sends an A11 Registration Update $_{6}$ to the Source PCF.
- The Source PCF sends an A11 Registration Acknowledge $_{7}$ to the PDSN.
- The Source PCF sends an A11 Registration Request $_{4}$ to the PDSN. The Registration Request contains a Lifetime timer field set to 0 which terminates the A10 tunnel (traffic tunnel) set up for the call.
- The PDSN sends an A11 Registration Reply $_{5}$ to the Source PCF.

At this point, the new connection for the packet data session is established.

Figure 11-21: Intra–PDSN, Inter–PCF Dormant Handoff



Handoff– Inter PDSN, Inter PCF Dormant Handoff

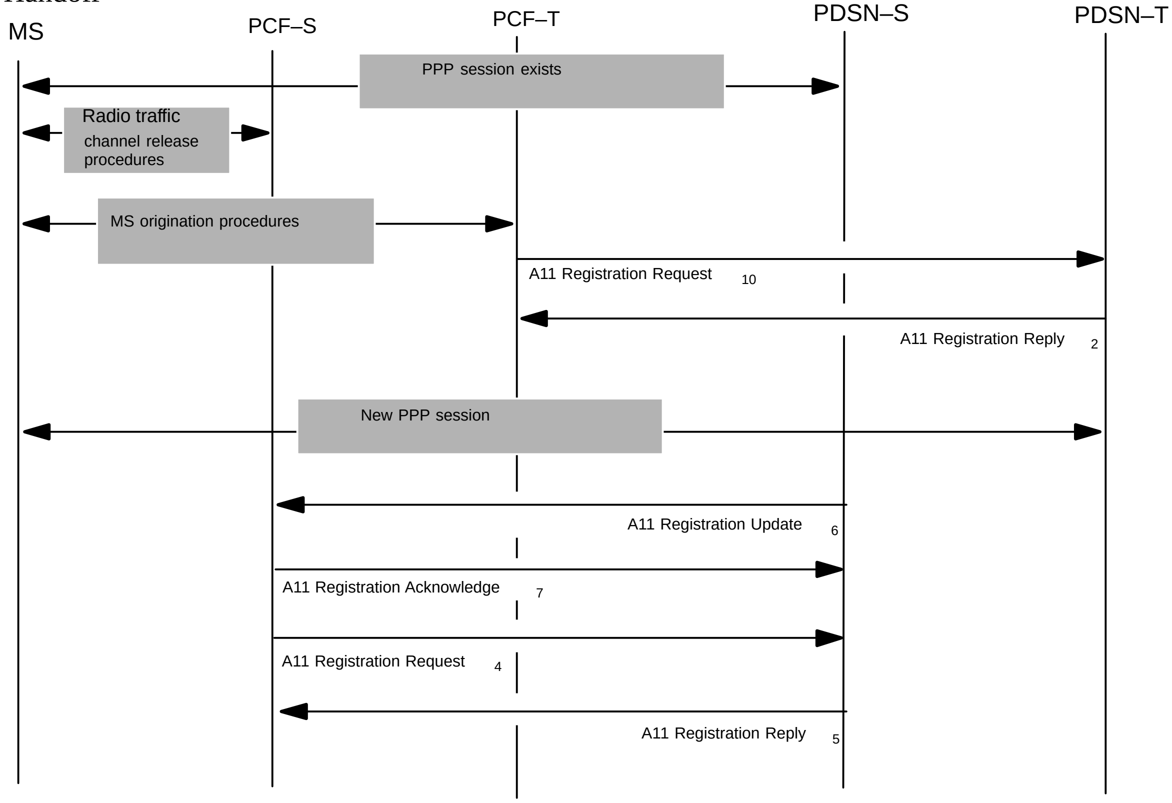
An inter–PDSN, inter–PCF handoff occurs when the mobile has a dormant packet data session and hands off to a base station in a different PDSN serving area:

- The mobile has released the traffic channel resources set up with the RAN.
- The packet data call completed a transition into the dormant state– meaning even though the traffic channel is disconnected, the PDSN has maintained the PPP session with the mobile by saving its context. As a result, the mobile and PDSN do not have to repeat the processes of PPP negotiation that result in authentication, IP address assignment, and connection to the HA for sending and receiving packets.
- The mobile (still with a dormant packet data session) restarts the data call setup procedures and those setup procedures involve a CDMA channel associated with a different PCF and a different PDSN.

The target PCF and PDSN must establish a new PPP session for the packet data call:

1. The Target PCF sends an A11 Registration Request $_{10}$ to the Target PDSN.
2. The Target PDSN sends an A11 Registration Reply $_{2}$ to the Target PCF.
3. The Target PDSN and the mobile establish a new PPP session. Refer to the "Packet data call setup" section for more information.
4. The Source PDSN sends an A11 Registration Update $_{6}$ to the Source PCF.
5. The Source PCF sends an A11 Registration Acknowledge $_{7}$ to the Source PDSN.
6. The Source PCF sends an A11 Registration Request $_{4}$ to the Source PDSN. The Registration Request contains a Lifetime timer field set to 0 which terminates the A10 tunnel (traffic tunnel) set up for the call.
7. The Source PDSN sends an A11 Registration Reply $_{5}$ to the Source PCF.
8. The packet data call can continue between the mobile and the new serving PCF and PDSN.

Figure 11-22: Inter–PDSN, Inter–PCF Dormant Handoff



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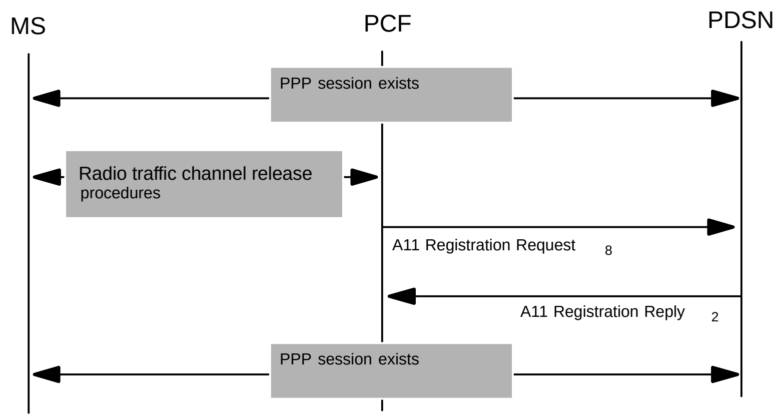
State Transition: Active to Dormant

A packet data call transitions from an active state to a dormant state when:

- The mobile has released the traffic channel resources set up with the RAN.
- The PDSN has maintained the PPP session with the mobile by saving its context. As a result, the mobile and PDSN do not have to repeat the processes of PPP negotiation that result in authentication, IP address assignment, and connection to the HA for sending and receiving packets.

The PCF that served the call orders the PDSN to transition the call into dormant state by sending an A11 Registration Request 8 to the PDSN. The PDSN responds with an A11 Registration Reply 2 to the PCF.

Figure 11-23: Active to dormant state transition



State Transition: Dormant to Active

A packet data call is in the dormant state when:

- The mobile has released the traffic channel resources set up with the RAN.
- The PDSN has maintained the PPP session with the mobile by saving its context. As a result, the mobile and PDSN do not have to repeat the processes of PPP negotiation that result in authentication, IP address assignment, and connection to the HA for sending and receiving packets.

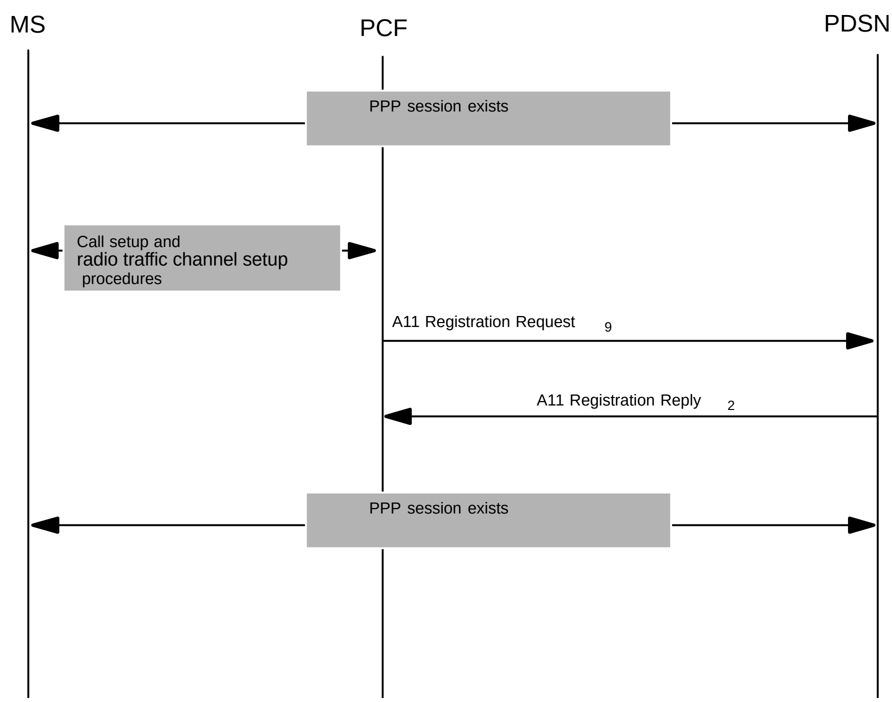
When the call is in the dormant state, and either the mobile or PCF/PDSN have a packet to send, then either the mobile or PCF triggers the BTS to establish the traffic channel necessary to support the packet data call in the active state.

For a packet data call to be in the active state, it must set up traffic channel and PCF–PDSN resources as shown in the “Packet Data Call Setup” section.

In the case where a dormant packet data call exists for the mobile, and the PDSN/PCF have packets to send to the mobile, the call setup process varies from the one shown in the “Packet Data Call Setup” section in that the call is set up when the BTS sends a Paging message to the mobile and the mobile responds with a Page Response message containing the packet data service option. To complete call setup, the mobile sends a Connect Order and the MM sends an SS7 Connect message to the MSC. The MSC responds with an SS7 Connect acknowledgement. The intermediate processes are the same as the mobile–origination case shown in the “Packet Data Call Setup” section.

1. The PPP session exists between the mobile and PDSN.
2. Call setup procedures occur between the mobile and PCF.
3. The PCF sends an A11 Registration Request $_9$ to the PDSN to transition the call to the active state.
4. The PDSN sends an A11 Registration Reply $_2$ to the PCF to set up the connection.
5. The mobile and PDSN can now exchange packets through the PCF – PDSN path.

Figure 11-24: Dormant to active state transition

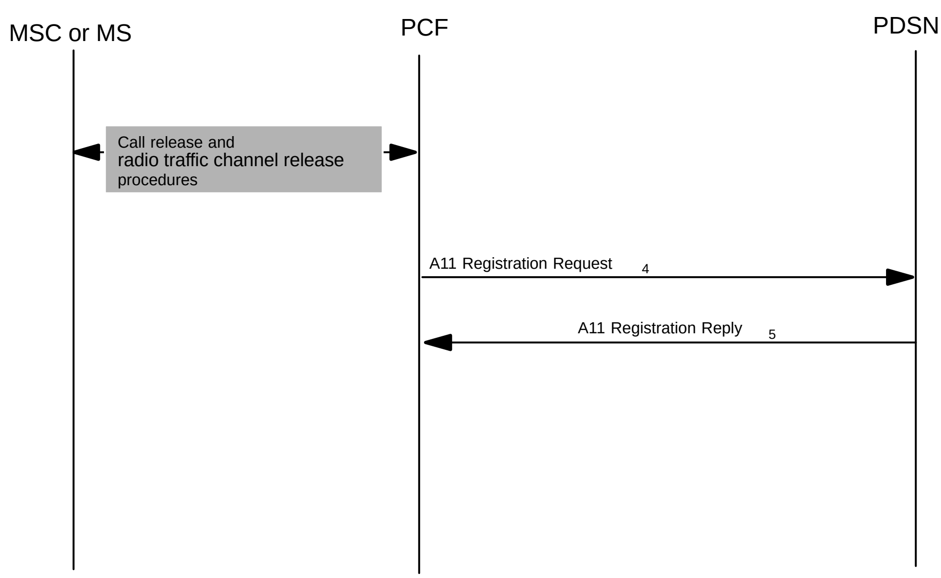


Teardown– MSC Initiated Release or MS Power Down

An MSC–initiated teardown of a packet data call, or a mobile power–down release, triggers the teardown of the session between the PCF and the PDSN. The MSC can initiate a tear down of a packet data call as the result of a reset.

1. MSC or mobile triggers call release and traffic channel resource release procedures with the PCF.
2. The PCF sends an A11 registration request 4 message to the PDSN to tear down the call.
3. The PDSN responds with an A11 Registration Reply 5 to PCF to tear down the PCF–PDSN session.

Figure 11-25: MSC initiated release or mobile power–down release



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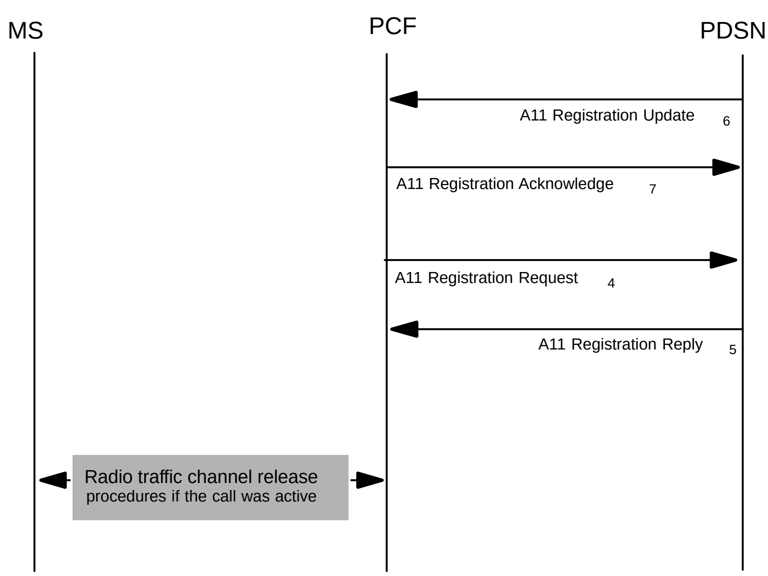
Teardown– PDSN Initiated Release

The PDSN will tear down a packet data call if either the PPP session inactivity timer has expired, or the Mobile IP registration lifetime has expired, or as a result of an internal PDSN condition. The signal flow is:

1. The PDSN sends an A11 Registration Update $_6$ to the PCF.
2. The PCF sends an A11 Registration Acknowledge $_7$ to the PDSN.
3. The PCF sends an A11 Registration Request $_4$ to the PDSN. The Registration Request contains a Lifetime timer field set to 0 which terminates the A10 tunnel (traffic tunnel) set up for the call.
4. The PDSN sends an A11 Registration Reply $_5$ to the PCF.
5. Radio traffic channel release procedures if the call was active.

Figure 11-26: PDSN initiated release



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Technical Information

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