PRIVATE MOBILE NETWORKS

Private Mobile eXchange ™

PMX ™

GSM Mobile Switching Centre

Product Highlights – IP softMSC

- 3GPP switching compliant
- GSM Compliant 'A' Interface - IP
- Multiple Vendor Radio Access Networks supported
- Call forwarding (conditional, unconditional), call waiting, call hold, call transfer
- Calling party based routing, Intelligent call routing
- Caller Id; CLIP/CLIR
- Connected Line Id; COLP/COLR
- Operator determined barring
- E.164 support
- Support for Lawful Call intercept
- SIP RFC 3261 Support
- Call Detail Recoding
- SOS: Default or LA originated intelligent routing of emergency calls
- Distributed Network Architecture
  Multiple processing units & redundancy, High Availability, Scalability & Flexibility
- MSC, GMSC, HLR, VLR Central HLR (Network)
- MAP-C, MAP-D, MAP-E, MAP-F
- IP: SS7 over SIGTRAN and SIP support
  TDM: SS7 over TDM via Gateway
- GTT translations, STP supported
- Support for SMS (MT/MO)
- Explicit/Implicit IMSI detach & VLR purge
- GPRS & EDGE support (Gr over SS7)
- CSD Support - secure phones + PSTN Gateway
- Optional built-in SMSC, AuC and EIR function
- Optional voicemail, conferencing and external WAP, multi-media message entity platforms
- Optional Media Termination Point [Transcoding outbound & Inbound]

Enterprise Support Highlights

- Full PBX network node support
- Translation table, Inbound & Outbound
- Extensive Routing Tables
- Optional:
  Push-To-Talk – PMR replacement
  Private Mobile Office – Personal Number, Personal Assistant, Unified Messaging, Call recording, conferencing, IVR incl. Call Queuing etc

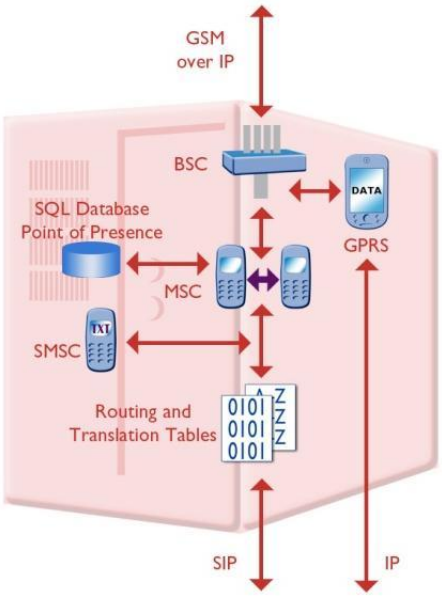
Contents

1 Introduction

Private Mobile eXchange (PMX™) is a mobile network switching subsystem implemented in software with all the components for switching mobile calls, switching short message service calls, storing and transmitting SMS and providing Packet Data (GPRS and EDGE) in software complete with translation and routing tables to act as a replacement PBX and/or MSC. PMX is a GSM product – 2G and 2.5G (with packet data optional).

The Radio Access Network is connected via IP to PMX through the Base Station Controller (BSC) which in turn connects to the access points, the Base Transceiver Station (BTS). The GSM voice calls and SMS are compatible with both 3G and 2G phones and terminals. PMX supports RANs from more than one supplier.

The PMX (see diagram – right) components are:



Database: The database is Microsoft SQL. SQL provides for the Home Location Register (HLR) which stores comprehensive details of authorised subscribers.

The database supports multiple tenancies with discreet networks and dial plans enabling operators to share infrastructure and to provide for flexible multiple enterprise and flexible network deployments. The SQL Database provides for all structured storage requirements of the product.

Mobile Switching Centre (MSC): The MSC, 3GPP compliant switching core, manages all call traffic; registration of authorised handsets, making, connecting, transferring and terminating calls. The MSC also manages the handover of calls on the RAN. External voice calls, inbound and outbound are SIP compliant with the codec used on the network providing the digital voice coding.

Short Message Service Controller (SMSC): The SMSC manages the receipt, routing and transmission of SMS messages – mobile originated or terminated.

Multimedia Message Service Controller (MMSC): The MMSC manages the receipt, routing and transmission of MMS messages provided by a multi media message entity platform (3rd party).

General Packet Radio Service (GPRS)-optional**:** The GPRS components include a GSN (GGSN and SGSN).

Translation and Routing Tables: The PMX has extensive translation and routing capability enabling PMX to be deployed as a mobile network switching core in a mobile network or to replace an enterprise Private Branch eXchange (PBX) or to act as a node in an enterprise switch network.

Interoperability:

Mobile Networks: HLR/VLR interconnection via MAP over SIGTRAN. Interconnection to TDM networks through SS7 Signalling Gateway. A Gateway would be required for SIP to TDM connectivity (such as SS7 ISUP).

Enterprise: Interconnection with other enterprise IP switches is enabled using SIP and through gateways into a TDM network.

2 PMX Specification [V4.0]

The features and functions listed in this specification are dependant of the Radio Access Network supporting the features and functions within the GSM specifications implemented by the manufacturer. Any RAN dependant features or functions are highlighted.

2.1 Administration

All administration and documentation is in UK English. Version 4 will be released with a new secure Web Graphical User Interface Administration package.

2.2 Database

The PMN database holds information subscriber information relevant to Home Location Registers (HLR, LHLR and CHLR), active subscriber information, Visitor Location Register (VLR), and Equipment Identity Register and all other information stored by the system. It contains certain features which are different to normal GSM operation (although the GSM standards may contain analogous elements). Such features are:

Multi-tenanted: May separate user groups into separate tenancies.
Alias IDs: Allow user to be identified by multiple numbers/aliases.
Class of Service: Options to specify what access individual users have - e.g. internal calls only, local calls only, national, international etc.

The Database is MS SQL.

2.3 Mobile Switching Centre

The Network switching subsystem (NSS) is the GSM core network for GSM services such as voice calls, SMS and circuit-switched data calls. The Mobile Switching Centre (MSC) is the primary service delivery node for GSM in PMX.

The MSC sets up and releases the end-to-end connection, handles mobility and handover during calls.

The MSC is compatible with 3GPP (Phase 2+ Release 1998).

Voice Calls via RAN and via SIP:

- Call Connect
- Call Disconnect
- Call Hold
- Call transfer
- Calling Line Identity
  Restriction: ability to turn off CLI presentation when making calls
  Name Display; Database name forced when originating a mobile call to the outbound leg to on-net or via SIP.
- Registration: Authentication and ciphering, Ki authentication between SIM and network
  IMSI
  IMEI

Supplementary Services

SS group	Supplementary services		Standalone HLR / VLR	Central HLR	TS
Line Identification					
	Calling line identification presentation	CLIP	✓	✓	02.81
	Calling line identification restriction	CLIR	✓	✓	02.81
	Connected line presentation	COLP	✓	✓	02.81
	Connected line restriction	COLR	✓	✓	02.81
Name identification					
	Calling name presentation	CNAP	✓	✓	02.96
Call forwarding					
	Call forwarding - unconditional	CFU	✓	✓	02.82
	Call forwarding - busy	CFB	✓	✓	02.82
	Call forwarding - no reply	CFNRY	✓	✓	02.82
	Call forwarding - not reachable	CFNRC	✓	✓	02.82
Call offering					
	Explicit call transfer	ECT	✓	✓	02.91
Call completion					
	Call waiting	CW	✓	✓	02.83
	Call hold	CH	✓	✓	02.83
Call Barring					
	Barring of all outgoing calls	BAOC	*	*	02.88
	Barring of outgoing international calls	BOIC	*	*	02.88
	Barring of outgoing international calls except to the home country	BOIC-exHc	*	*	02.88

* Currently only via Operator determined barring

Note: CNAP for SIP to Mobiles, any display text (alias) in the "From" header of a SIP Invite message will be passed onto the Mobile Handset – not all handsets are capable of displaying this name text.

Handset Information Display (HID)

- Calling *#100# from a handset will display the PMX extension number of the handset when on the PMX network.

Codec specification: GSM-EFR or AMR (if supported) as an alternative to GSM-FR (not possible to mix).

Follow me service: Call forwarding based on a preset number list – sequential.

SOS: Configurable call routing based on Default route (when no specific route is given) or LA dependant routing (route depending on the originating LA receiving the call).

Emergency Call Support: Emergency state support permitting the immediate and graduated restriction of subscribers' ability to utilize resources.

SMS:

- Mobile Originated (MO): Message Send
- Mobile Terminated (MT): Message Receive

Unstructured Supplementary Service Data (USSD) support: Phase 2 supported

A HTTP interface is provided for transmission and response of USSD if not using MAP.

Call Detail Recording (CDR)

Lawful Call Intercept: The ability to remote monitor/transit calls on a subscriber basis to a Lawful Intercept Gateway.

CSD [RAN Dependant]

- Handsets Tested:
  - Sectera *TalkSecure* Wireless [V.32]
  - Enigma (Tripleton T301B) [V.110]
  - GSMK CryptoPhone G10i [V.32/V.110]
  - GSMK CryptoPhone CP300 [V.32/V.110]
- 9.6 Kbps support for Base Station to Base Station for encrypted calls.
- 9.6Kbps CSD transparent mode calls off-net Inbound & Outbound [V.110] – Requires optional PMN VoIP Gateway.

The following is a list of GSM standards to which the MSC conforms (either fully or partially):

GSM 03.09: Handover Procedures
GSM 04.08: Mobile Radio Interface Layer 3
GSM 08.08: BSS-MSC: Layer 3
GSM 11.30: Mobile Services Switching Centre

GSM 03.40: Technical realisation of Short Message Service (SMS) Point-to-Point (PP)

GSM 09.02: Mobile Application Part (MAP) [When SS7/SIGTRAN connection is used]

2.4 SIP input/output support.

The PMX Telephony, PBX / PSTN input/output is via IP SIP. The interface conforms to;

- SIP standard RFC 3261
- Other endpoint must support re-INVITEs for RTP media redirection
- RTP media must be that supported by the PMX
- DTMF via SIP INFO messages RFC 2976 (no RFC 2833 support)
- MSC can register to a SIP server as a single entity but not for individual GSM extensions
- Support for REFER messages RFC 3515
  Note: The RTP codec for both input and output is required to match the setting for the RAN. All codec transcoding and protocol conversion is a function of an external gateway.

2.5 HLR

The **home location register** (HLR) is a database containing details of each mobile phone subscriber authorised to use the GSM network or part of the network. The HLR stores the details of every subscriber identification module (SIM). Each SIM has a unique identifier, international mobile subscriber identity (IMSI) which is the primary key to each HLR. Each IMSI has an associated MSISDN (mobile telephone number) and aliases– the MSISDN is also a primary key to the HLR. The HLR data is stored for as long as the subscriber remains with the mobile phone operator.

Example of data stored;

- GSM services available
- GPRS settings to allow access to packet services
- Current location of subscriber (VLR and serving GPRS support node/SSGN)
- Call divert settings
- Authentication values Ki and class of service data

The HLR receives and processes MAP transactions and messages from elements of the GSM network (e.g. the location update messages received as mobile phones roam).

User Account suspension supported.

HLR conforms to; 3GPP TS 09.02 (Phase 2+) version 7.15.0 (2004-03) Mobile Application Part (MAP) specification (Release 1998)

2.6 AuC

The **Authentication Centre** (AuC) is a function to authenticate each SIM attempting registration. Once the authentication is complete the HLR is allowed to manage the SIM and associated services.

The AuC does not engage directly in the authentication process, but generates data known as *triplets* for the MSC to use during the procedure. The security of the process depends upon a shared secret between the AuC and the SIM called the Ki. The Ki is securely burnt into the SIM during manufacture and securely replicated into the AuC. The Ki is never transmitted between the AuC and the SIM, but is combined with the IMSI to produce a challenge/response for identification purposes and an encryption key called Kc for use in over air communications.

2.7 VLR

The **visitor location register** (VLR) is a temporary database of subscribers who have roamed or registered to an area of the network served by the VLR. A VLR has an associated MSC - VMSC. A subscriber cannot be present in more than one VLR.

Example of data stored;

- IMSI
- Authentication data
- MSISDN
- GSM services available
- GPRS settings to allow access to packet services
- The HLR address of the subscriber

The primary functions of the VLR are:

- To inform the HLR that a subscriber has arrived in a particular area of the network covered by the VLR
- To track where the subscriber is within the VLR area (location area) when no call is ongoing
- To allow or disallow which services the subscriber may use
- To allocate roaming numbers during the processing of incoming calls
- To purge the subscriber record if the subscriber becomes inactive whilst in the area of the VLR. The VLR deletes the subscriber's data after a fixed time period of inactivity and informs the HLR (e.g. when the phone has been switched off or left off or when the subscriber has moved to another area with no coverage for a long time)
- To delete the subscriber record when a subscriber explicitly moves to another area of the network as instructed by the HLR.

The VLR receives and processes MAP transactions and messages from elements of the GSM network (e.g. the location update messages received as mobile phones roam).

MSC/VLR conforms to; 3GPP TS 09.02 (Phase 2+) version 7.15.0 (2004-03) Mobile Application Part (MAP) specification (Release 1998)

2.8 Equipment identity register (EIR)

The **equipment identity register** (EIR) keeps a list of mobile phones (identified by their international mobile equipment identifier - IMEI) which are to be banned from the network or monitored. This is designed to allow for tracking of stolen mobile phones. In theory all data about all stolen mobile phones should be distributed to all EIRs in the world through a central EIR. This is not universal. The MAP messaging for EIR notification is supported for a central EIR.

2.9 MSC/VLR

The MSC/VLR and Proxy VLR are written to the following standard:

- 3GPP TS 09.02 (Phase 2+) version 7.15.0 (2004-03) Mobile Application Part (MAP) specification (Release 1998)

2.10 Short Message Service Centre (Built-in Option)

The SMSC supports SMPP v3.4 and can operate as an SMPP server and/or an SMPP client.

Supported SMPP operations are:

- BIND_TRANSMITTER
- BIND_RECEIVER
- BIND_TRANSCEIVER
- SUBMIT_SM
- DELIVER_SM
- QUERY_SM
- CANCEL_SM
- ENQUIRE_LINK
- UNBIND

Support for message receipt from external 3rd party SMS provider via Microsoft Message Queue.

2.11 Multi-media Message Service

Support for MMS via 3rd party MMSC (using SMPP to SMSC).

3 General Packet Radio Service – GPRS

Introduction

The PMX GSN provides General Packet Radio Service (GPRS) services using a GPRS Support Node (GSN) that combines the functionality of both a Serving GPRS support node (SGSN) and a Gateway GPRS Support Node (GGSN) in the same physical node.

A proprietary interface (i.e. Local Gr interface) exists between the SGSN and PMX database, which accesses the relevant HLR information for maintenance of subscriber data. The GSN software has support for Local as well as for Remote HLR (via SS7).

3.1 PMX GSN Features and Support

Please note, further 3rd Party components may be required to support certain features.

3.1.1 GSN as an SGSN

When GSN is implemented as an SGSN, it supports the following:

- All Mobility Management functions including Attach, Detach and Routing Area Update.
- Session Management functions including Quality of Service (QoS) negotiation.
- SMS
- CDR generation
- Ciphering
- Compression
- Anonymous PDP Context Activation/Deactivation procedures
- Circuit-switched procedures over the G_s interface

3.1.2 GSN as an GGSN

When GSN is implemented as a GGSN, it supports the following:

- Security using RADIUS authentication·
- RADIUS accounting
- IPCP support
- Anonymous PDP Context Activation/Deactivation procedures· Static/dynamic address allocation
- IPCP support
- Network-requested PDP Context Activation procedures
- G_c Interface with HLR
- Dynamic address allocation through DHCP and RADIUS

3.1.3 PMX GSN as a Combined GSN

GSN running as a combined GSN supports the functionality of both SGSN and GGSN. In the combined mode, GSN supports inter-SGSN procedures and serves as the GGSN for the PLMN in which it is deployed. In addition, it serves as the GGSN for subscribers who have roamed into other PLMNs.

3.2 Standards Conformance

GSN conforms to the following standards:

Interface	Protocol	Specs Compliance
G_b	SNDCP (SGSN & MS)	GSM 04.65 version 7.1.1 Release 1998
	LLC (SGSN & MS)	GSM 04.64 version 7.1.1 Release 1998
	BSSGP (SGSN & BSS)	GSM 08.18 version 7.1.0 Release 1998
	NS (SGSN & BSS)	GSM 08.16 version 7.1.0 Release 1998
G_s	SGSN-VLR Gs interface network service specification	GSM 09.16 version 7.0.1 Release 1998
	SGSN-VLR Gs interface layer 3 specification	GSM 09.18 version 7.1.0 Release 1998
G_d	PP-SMS: SGSN & SMS-IWMSC SGSN & SMS-GMSC	GSM 04.11 version 7.0.0 Release 1998
G_r G_f G_c	MAP (SGSN & HLR) MAP (SGSN & EIR) MAP (GGSN & HLR)	GSM 09.02 version 7.1.0 Release 1998
G_p	GTP (GSN & GSN)	GSM 09.60 version 7.3.0 Release 1998
G_i	IP (GGSN & External IP)	GSM 09.61 version 7.1.0 Release 1998:
G_a	GTP' (GSN & CG)	GSM 12.15 version 7.4.0 Release 1998
SS7	TCAP	ITU-T Recommendation Q.771 to Q.774 ANSI Recommendations T1.114.1 to T1.114.4 (1996)
	SCCP	ITU-T Recommendation Q.711 to Q.714 ANSI Recommendation T1.112 (1996)
	MTP3	ITU-T Recommendation Q.704 ANSI Recommendations T1.111.4 and T1.111.7 (1996)
	MTP2*	ITU-T Recommendation Q.701 ITU-T Recommendation Q.703 ITU-T Recommendation Q.752 ANSI T1.111
Frame Relay*		ITU-T Recommendation Q.922 ITU-T Recommendation Q.933 ANSI T1.606, T1.617, T1.618
IP	IP	IETF STD 5
	UDP	IETF STD 6
Others	RADIUS (GGSN & RADIUS)	IETF RFC 2865, IETF RFC 2986
	SNMP	IETF RFC 1157
	GPRS Service Description Stage 2	GSM 03.60 version 7.4.0 Release 1998
	Mobile radio interface signalling layer 3; General aspects	GSM 04.07 version 7.3.0 Release 1998
	Mobile radio interface signalling layer 3 specification	GSM 04.08 version 7.4.0 Release 1998

3.3 Supported Communication interfaces

PMX GSN supports the following combination of interfaces to enable communication with Network Elements (NEs) such as BSS and other SS7 nodes such as MSC/VLR, HLR, and SMSC:

- FR/E1-based communication towards BSS and SS7/E1-based communication towards all SS7 nodes (SS7 compliant to ITU-T standards)·
- FR/E1-based communication towards BSS and SS7/IP-based communication towards all SS7 nodes (SS7 compliant to ITU-T standards)·
- IP-based communication towards BSS and SS7/E1-based communication towards all SS7 nodes (SS7 compliant to ITU-T standards)·
- IP-based communication towards BSS and SS7/IP-based communication towards all SS7 nodes (SS7 compliant to ITU-T standards)·
- FR/E1-based communication towards BSS and SS7/T1-based communication towards all SS7 nodes (SS7 compliant to ANSI standards)·
- FR/E1-based communication towards BSS and SS7/IP-based communication towards all SS7 nodes (SS7 compliant to ANSI standards)·
- IP-based communication towards BSS and SS7/T1- based communication towards all SS7 nodes (SS7 compliant to ANSI standards)·
- IP-based communication towards BSS and SS7/IP-based communication towards all SS7 nodes (SS7 compliant to ANSI standards)
- FR/E1-based communication towards BSS and Localized Gr based communication towards Local HLR and SGSN.
- IP based communication towards BSS and Localized Gr based communication towards Local HLR and SGSN.
- FR/E1-based communication towards BSS and both SS7/E1-based and localized Gr based communication towards HLR and SGSN.
- IP based communication towards BSS and both SS7/E1-based and localized Gr based communication towards HLR and SGSN.

The usual configuration supported by PMN is to use IP transport for the interface to the BSS (NS over IP) and to use the Local HLR interface into the PMN database, with the option of simultaneously using SS7 over SIGTRAN (IP transport) for communication to SS7 nodes.

3.4 Supported GPRS interfaces

PMX GSN supports GPRS interfaces as mentioned in the following table

Table 3-1: GPRS Interfaces Supported by PMX GSN

Interface	Interfacing Entities
G_b	SGSN and Base Station Subsystem (BSS)
G_c	GGSN and Home Location Register (HLR)
G_r	SGSN and HLR
G_s	SGSN and Mobile Switching Center/Visitor Location Register (MSC/VLR)
G_d	SGSN and Short Message Service (SMS)-Gateway MSC (GMSC)/SMS-Interworking MSC (IWMSC)
G_i	GPRS and external packet data network
G_n	Two GSNs within the same Public Land Mobile Network (PLMN)
G_a	SGSN/GGSN and CGF

3.5 Wireless Application Protocol (WAP)

Optional; Supported using 3rd party WAP server entity.

4 Mobile Application Part (MAP)

PMX Map Gateway Subsystem (MGS)
PMX provides an integrated MAP/SS7 over SIGTRAN + SIP and through a signaling gateway MAP/SS7/over C7 + ISUP.

PMX MAP stacks are compliant to GSM, GSM Phase 2+, 3GPP R99, R4 specs.

4.1 MAP/SIGTRAN Stack

MAP Interface	Message	Sent	Received
MAP-C			
	SendRoutingInfo	(only T-MAP)	(only T-MAP)
	SendRoutingInfoForSM	✓	✓
	InformSC		✓
	AlertServiceCentre	✓	✓
	ReportSMDeliveryStatus	✓	✓
MAP-D			
	UpdateLocation	✓	✓
	CancelLocation	✓	✓
	InsertSubscriberData	✓	✓
	DeleteSubscriberData		✓
	PurgeMS	✓	✓
	SendAuthenticationInfo	✓	✓
	ProvideRoutingNumber	✓	✓
	ReadyForSM	✓	✓
	RegisterSS	✓	✓
	EraseSS	✓	✓
	ActivateSS	✓	✓
	DeactivateSS	✓	✓
	InterrogateSS	✓	✓
	RegisterPassword	✓	
	GetPassword		✓
	ProcessUSSRequest	✓	
	USSRequest		✓
	USSNotify		✓
MAP-E			
	MOForwardShortMessage	✓	✓
	MTForwardShortMessage	✓	✓
MAP-F			
	CheckIMEI	✓	✓
MAP-Gd			
	MOForwardShortMessage	✓	✓
	MTForwardShortMessage	✓	✓
MAP-Gr			
	UpdateGPRSLocation	✓	✓
	CancelLocation	✓	✓
	InsertSubscriberData	✓	✓
	DeleteSubscriberData		✓
	PurgeMS	✓	✓
	SendAuthenticationInfo	✓	✓

4.2 Signalling conforms to;

SS7 Specifications

- ITU Recommendation for TCAP Q.771 to Q.774(1996)
- ITU Recommendation for SCCP Q.711 to Q.714(1996)

SIGTRAN Specifications

- RFC 3332 for MTP3 User Adaptation Layer (M3UA)
- RFC 2960 for Stream Control Transmission Protocol (SCTP)

MAP Specifications

- ETSI GSM 09.02 (Phase 1) version 3.11.0 May 1995 – Mobile Application Part Specifications
- ETSI GSM 09.02 (Phase 2) version 4.19.1 – Mobile Application Part Specifications
- ETSI GSM 09.02 (Phase 2+) version 7.5.1 – Mobile Application Part Specifications (Release 1998)
- 3GPP TS 29.002 (Phase 2+) version 3.8.0 (2001-03) Mobile Application Part (MAP) specification (Release 1999)
- 3GPP TS 29.002 (Phase 2+) version 4.8.0 Mobile Application Part (MAP) specification (Release 4)

4.3 TDM Signalling Gateway

Scalability: Scales to 128 SS7 Signalling links in a dual redundant deployment
Redundancy: Carrier Grade, 1+1 Dual Plane worker/hot standby redundancy (Single Point Code)
A, F link support.

SS7 Specifications

- ISUP: International variants optional
- SCCP: ITU-T Q.711-Q.714
- MTP L1-L3: ITU-T Q.701-Q.707

SIGTRAN Specifications

- RFC 3332 Signaling System 7 (SS7) Message Transfer Part 3 (MTP3) - User Adaptation Layer (M3UA)
- RFC 2960 Stream Control Transmission Protocol (SCTP)

5 Distributed Network Architecture

PMX has been designed to operate in the mobile environment as outlined below; networking HLR/VLR subscriber information and networking MSC/VLR for call control. The interoperation with mobile networks is performed through MAP Gateway Subsystem. The connectivity into the mobile operator network is standard SS7 over SIGTRAN for the MAP signalling and SIP for call control or with an additional Gateway to provide a TDM interface taking in the SS7 over SIGTRAN and SIP and connecting using TDM SS7 (MAP & ISUP).

The PMX is also designed to act as an IP Private Branch eXchange (PBX) replacement/substitute, as a node within a private telephone network or as a switch providing mobility alongside a PBX. The telephone network can be a legacy network with PMX working through gateways, an IP PBX directly connected over IP or a combination of legacy and IP. PMX is defined with the traditional Translation and Routing tables plus specific support for gateways and protocols (optional media termination point, MTP)

5.1 PMX, MSC/HLR/VLR Platform.

The PMX platform as a standalone system or as a system node (MSC instance) is capable of deployment on a single server (as in the Rapid Deployment Unit within a case) or as multiple servers with redundancy to provide high availability, scalability and redundancy.

The larger TeleWare platforms are designed around a Distributed Network Architecture at the platform level. The servers are standard industry servers and are specified with resilience options for power (dual power supplies often with separate power sources), teamed network interfaces and RAID discs where disc storage is local. The servers are organised in functionally similar clusters providing redundancy at server level. This enables continuing availability when there is a failure of a server, the others assume the load. All platform deployments are recommended to have Uninterruptible Power Supplies (UPS) with, where possible, two different power sources. Rack mounted servers (blades are an option) are wired for redundant networks and switches. The SQL data storage (including HLR and VLR) can be located on Storage Areas Networks (SAN) to provide scalability, backup and multi point access from clustered server farms. The current platforms often use virtualization to maximize efficiency and usage.

The use of the proven Distributed Network Architecture provides the ultimate in flexibility and manageable incremental growth and cost efficient deployments whilst retaining the integrity of the service to subscribers.

5.2 Distributed HLR

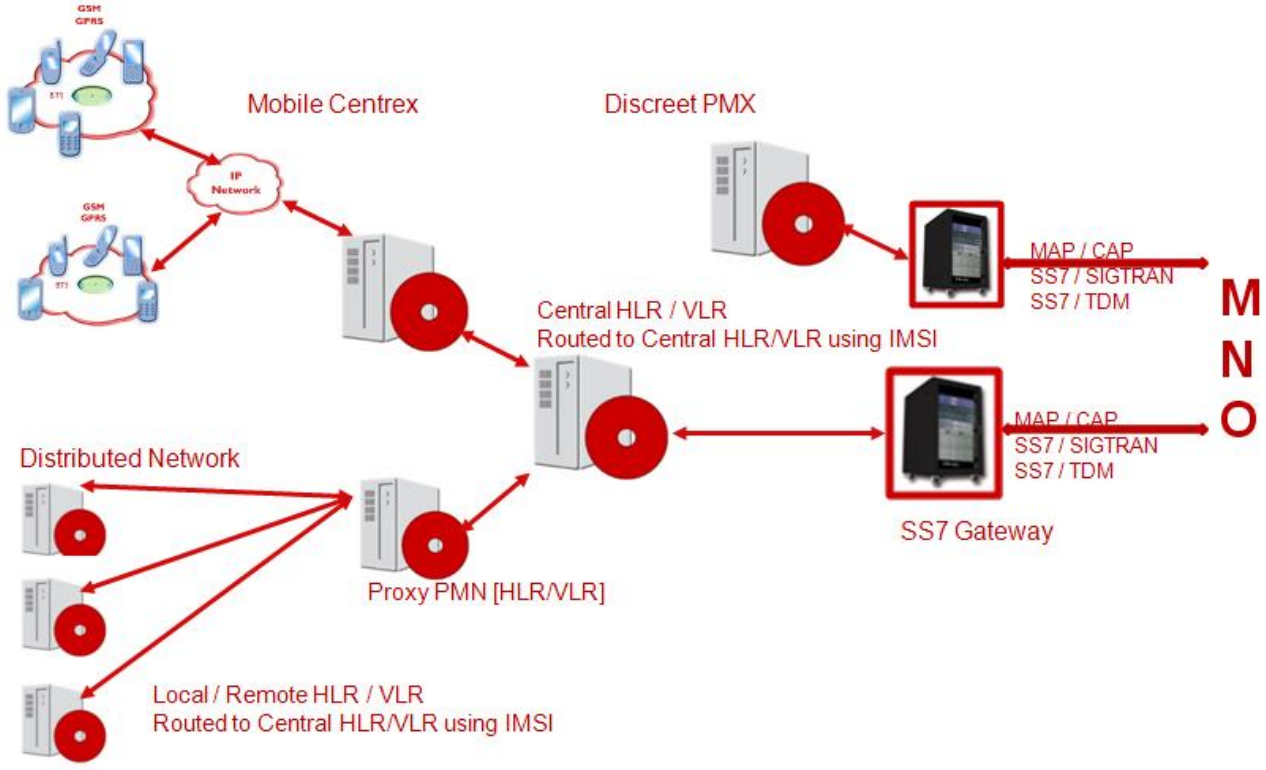
PMX / MSC network architecture provides for flexibility within a multi operator/enterprise environment. A Local HLR (LHLR) may authorise subscribers to a specific MSC/VLR and the attached RAN only as a standalone PMX or as an instance in a network.

There is provision for multiple instances of MSC/VLR (and LHLR) to share central HLR (CHLR) enabling common subscribers across multiple MSC/VLRs or RANs. The CHLR has capability to restrict subscriber to individual instances of MSC/VLR.

To provide an intermediate level of clustering of MSC/VLR instances there is a Hub HLR where as part of a larger network there is required a level of subscriber registration and authentication across a grouping of MSC/VLR instances (e.g. an operator or a common grouping for a larger enterprise with multiple PMX/MSC instances deployed.

A proprietary MAP based protocol, T-MAP, has been developed enabling network messaging between networked PMN component HLRs and the MAP Gateway Subsystem.

From the Central HLR the network will provide connection into a telephony network and / or access through the MAP Gateway for roaming into and out of the PMN network from/to other mobile network operators.

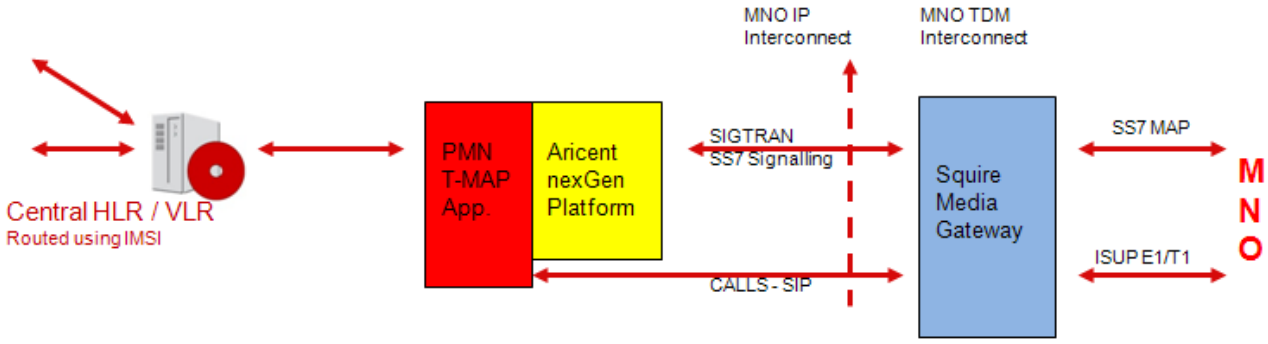


5.3 Distributed MSC/VLR and HLRs

The PMX/MSC network architecture provides for flexibility within a multi operator/enterprise environment to provide multiple instances of MSC/VLR. The networking of HLRs is outlined above for the interchange of subscriber information.

5.4 Gateways to Mobile Networks

At the edge of the PMN Network, at the point of interconnect to the Mobile Network the PMN MAP Sub System, MAP Gateway System (MGS), based on the Aricent nexGen platform, will service the SS7 over SIGTRAN signalling and the PMN SIP Sub System (SGS) will service the Call interoperation.



If a TDM interface is required for interoperation with an existing mobile network this is facilitated by an SS7 Signalling and SIP Gateway into SS7 over TDM (for MAP & ISUP) from a third party.

5.5 Networked PBX/PMX

The platform is designed as a node within a digital switch network operating on a peer-to-peer level or as a replacement/substitute PBX. The PMX is an IP based switch interfacing with other IP switches via IP SIP and with legacy TDM products through gateways for ISDN, Q931 and QSig etc.

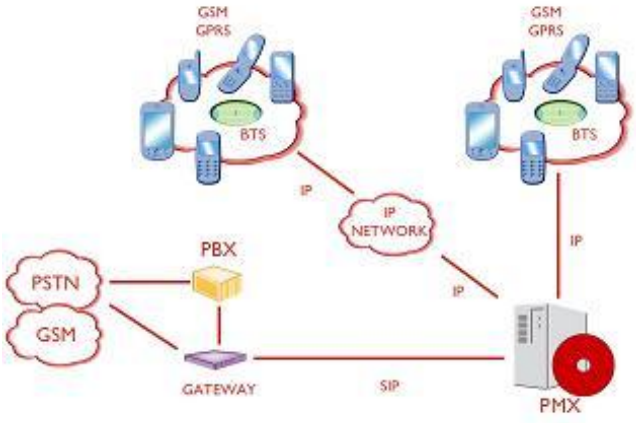
6 Radio Access Networks

Radio Access Networks (RAN) are supported based on equipment from a number of manufactures and may consist of one or more Base Station Subsystem (BSS) each supporting one or more Base Transceiver Station (BTS) and one or more Base Station Controllers (BSC). The number of BSS supported depends on the chosen Manufacturer equipment and throughput.

The deployable configurations are outlined and illustrated below;

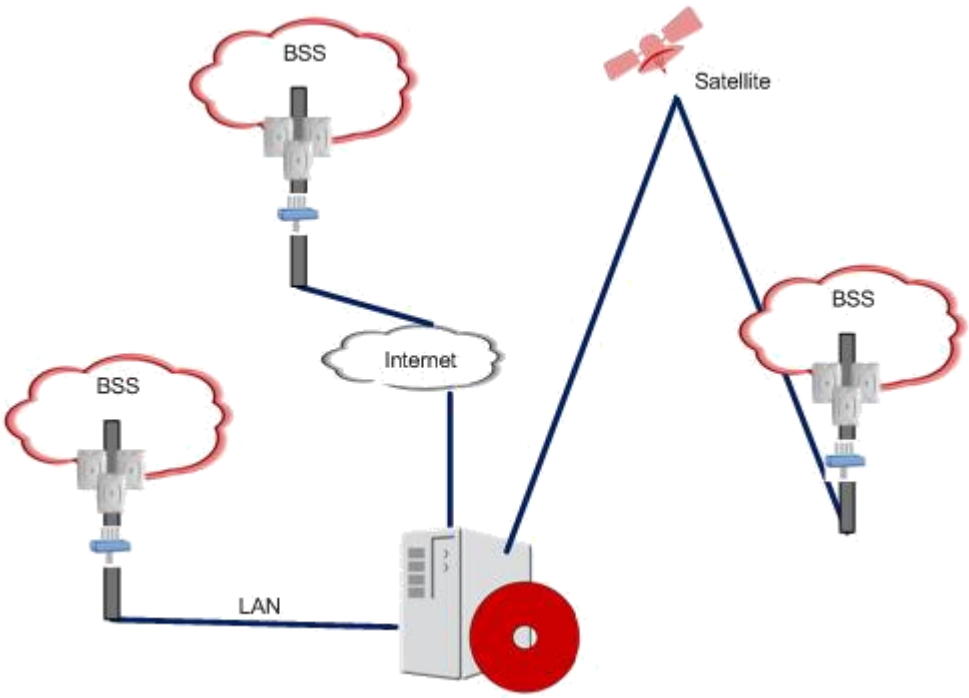
> *Note: The two illustrations below are based on two manufacturer's RANs; each will differ in detail depending on manufacturer. MSC features and facilities are maintained, where possible, regardless of RAN manufacturer. Each PMX may support a RAN from more than one manufacture concurrently. A deployment may support more than one MSC and RANs from more than one manufacturer.*

The BTS, radio access points, are distributed throughout the area of coverage connected via LAN and or WAN back to the Base Station Controller (BSC). The BTS support up to 7 Base Station connections (typically mobile phones calls) using standard rate (GSM) and optionally 14 Base Station connections using AMR (i.e. 7 or 14 concurrent calls)



The Base Station Controller (BSC) acts as a controller between the links serving the BTS radio channels and the MSC. The BSC handles the handover of calls between BTSs under its control and between itself and other BSCs subject to direction from the MSC dictated by the PMX Database.

Where manufacturer equipment is specified in clusters (i.e. 1, 2 or 3 BTSs + BSC as a BSS) then a number of BSC clusters or a number of BSCs may be specified as input to the MSC. Diagram below:

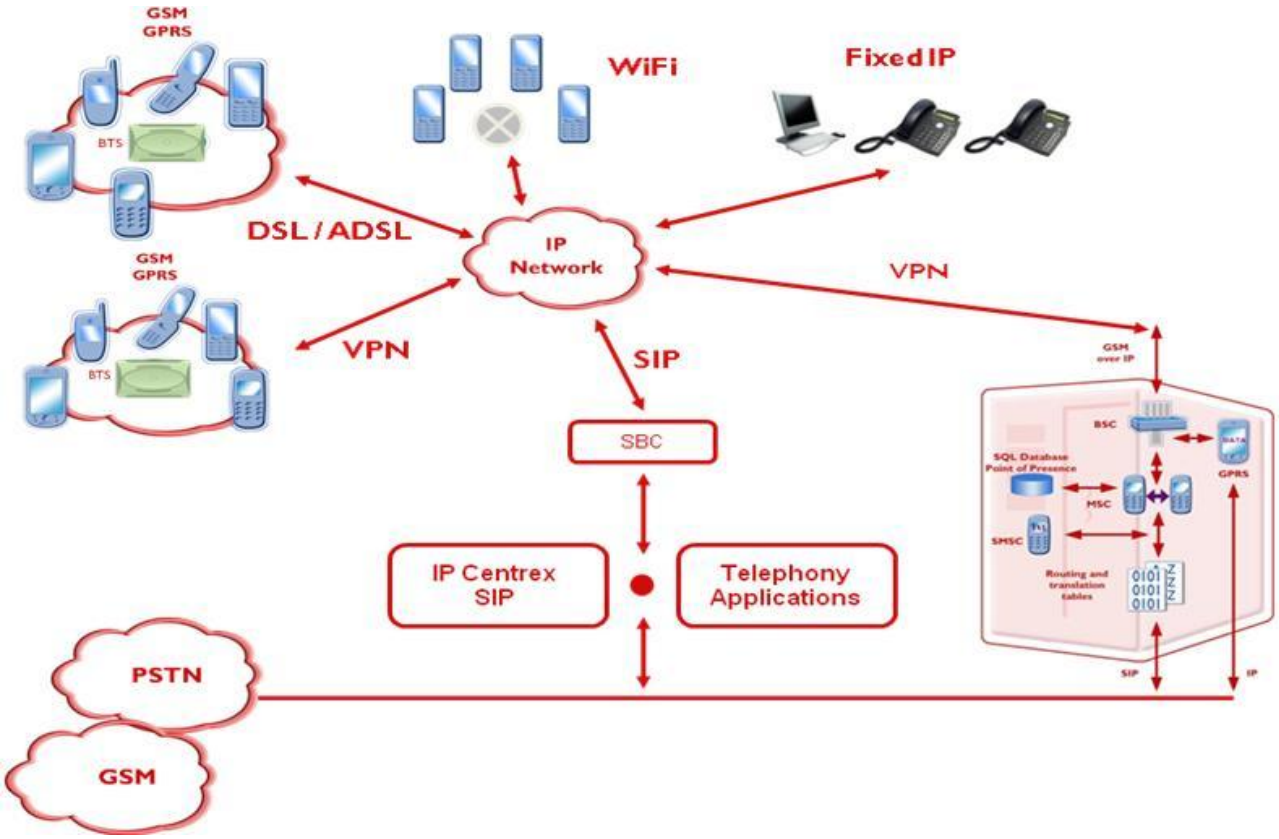


The BSS clusters, BTSs + BSC are connected back to the PMX (MSC) by IP, LAN, internet or satellite. The MSC then manages the network as one network, enabling calling across BSCs. There is currently no handover between MSCs. These clusters can vary in BTS and the maximum BTSs in a cluster according to manufacturer.

The above diagrams show a Private Mobile Network deployed as a Mobile Network Operator or as an enterprise PBX replacement using standard gateways into the PSTN and Mobile Networks.

The components of a PMX may be installed on a single Server (as above) or PMX components scaled for capacity and high availability (resilience and redundancy) over multiple servers for each component is architected as a distributed network server allowing continuation of service in the event of failure of one or more component. The database is an SQL database with its own resilience and replication features.

Distributed Network Architecture



The diagram, above, shows the connectivity and distribution of a hosted service, integration with an IP switch and applications platform. An extensive range of integrated services are provided over a mobile network or an enterprise/user over the common network. The PMX Database controls access to authorised parts of a network and any interoperation/access (i.e. direct dialling).

7 Acronyms

AMR	Adaptive Multi-Rate (codec)
ANSI	American National Standards Institute
AuC	Authentication Centre
BAOC	Barring of all outgoing calls
BOIC	Barring of outgoing international calls
BOIC-ex Hc	Barring of outgoing international calls except to the home country
BSC	Base Station Controller
BSS	Base Station Subsystem
BTS	Base Transceiver Station
CAMEL	Customised Applications for MOBILE Network Enhanced Logic
CCBS	Completion of Call to Busy Subscriber
CDR	Call Data Record
CF	Call Forwarding
CFB	Call Forwarding on Mobile Subscriber Busy
CFNRc	Call Forwarding on Mobile Subscriber Not Reachable
CFNRy	Call Forwarding on Mobile Subscriber No Reply
CFU	Call Forwarding Unconditional
CH	Call Hold
CHLR	Central Home Location Register
CLI	Calling Line Identity
CLIP	Calling line identification presentation
CLIR	Calling line identification restriction
CNAP	Calling Name Presentation
CODEC	Coder/Decoder
COLP	Connected line presentation
COLR	Connected line restriction
CSD	Circuit Switched Data
CW	Call Waiting
DHCP	Dynamic Host Configuration Protocol
DTMF	Dual Tone Multiple Frequency
ECT	Explicit Call Transfer
EDGE	Enhanced Data Rates for GSM Evolution
EFR	Enhanced Full Rate
EIR	Equipment Identification Register
ETSI	European Telecommunications Standards Institute
GGSN	Gateway GPRS Support Node
GHLR	Gateway Home Location Register
GMSC	Gateway Mobile Switching Centre
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
GSN	GPRS Support Node
GTT	Global Title Translation

HID	Handset Identification Display
HLR	Home Location Register
HTTP	Hypertext Transport Protocol
HHLR	Hub Home Location Register
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPCP	Internet protocol Control Protocol
ITU	International Telecommunication Union
ISDN	Integrated Services Digital Network
ISUP	ISDN user part
IVR	Interactive Voice Response
Kc	Cipher/Decipher Key
Ki	Subscriber Authentication Key
LAC	Location Area Code
LAN	Local Area Network
LHLR	Local Home Location Register
MAP	Mobile Application Part
MGS	MAP Gateway Subsystem
MMS	Multi-media Messaging Service
MMSC	Multi-media Messaging Service Centre
MNO	Mobile Network Operator
MO	Mobile originated
MSC	Mobile Switching Centre
MSISDN	Mobile Station ISDN Number
MT	Mobile Termination
MTP	Media Termination Point
NSS	Network Switching Subsystem
PBX	Private Branch eXchange
PDP	Packet Data Protocol
PLMN	Public Land Mobile Network
PMR	Private Mobile Radio
PMX	Private Mobile eXchange
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RADIUS	Remote Authentication dial-in user service
RAID	Random Array of Inexpensive Discs
RAN	Radio Access Network
RFC	Request For Comment (IETF Standards Specification)
RTP	Real Time Protocol
SGSN	Serving GPRS Support Node
SIGTRAN	Signalling Transport

SIM	Subscriber Identification Module
SIP	Session Initiation Protocol
SMPP	Short Message Peer-to-Peer Protocol
SMS	Short Message Service
SMSC	Short Message Service Centre
SQL	Structured Query Language
SS7	Signalling System No 7
SSS	SIP Gateway Subsystem
STP	Signalling Transfer Point
T-MAP	Proprietary May base protocol - PMX Networking
TDM	Time Division Multiplex
TMSI	Temporary Mobile Subscriber Identity
UPS	Uninterruptible Power Supply
USSD	Unstructured Supplementary Service Data
VLR	Visited Location Register
VMSC	Visited Mobile Switching Centre
WAN	Wide Area Network
WAP	Wireless Application Protocol
3GPP	3GPP Specifications & Technical Reports