



iAX™ PCC

Service Description

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Revision History

The table below details the revision history for this document.

Date	Rev#	Author	Change Description	Section	Product Release#
27/03/2012	1.2	n/a	Initial Document Release.	n/a	n/a
25/05/2012	1.4	n/a	Updated to include new CDR fields and other minor changes.	n/a	n/a
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10/01/2014	2.8	n/a	Updated for release 4.4.0	n/a	n/a
14/04/2014	3.0	n/a	Updates for PCC 4.4.1	n/a	n/a
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28/07/2016	4.4	GM	Updates per SPCM 4.6	3.1.2	PCC 5.1.0
07/12/2018	4.6	AM/GM	Added GSU explanation in Chapter 4.4 --- Added missing section to address shutdown featur	4.4 and 4.10	n/a
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26/03/2020	5.0	GM	Added information on the LS in Chapter 8	Chapt 8	PCC 6.8.1

Preface

About this Guide

This guide provides an introduction to the Tango Policy & Charging Control (iAX PCC) platform. It provides the user with an overview of the platform and describes the main components of the platform along with the call detail records (CDRs) and statistics generated by the iAX™ PCC service.

Who Should Read this Guide?

The following people should read this guide:

- System Administrators who require an introduction to the iAX PCC platform and who are tasked with managing and monitoring the iAX PCC service.
- System Operators who require an introduction to the iAX PCC platform.

Conventions Used in this Guide

Typefaces

The typefaces used in this guide are detailed below.

Typeface	Definition	Example
ABCabc	Indicates a button, entry field or hyperlink displayed on the screen.	Press the login button.
"ABCabc"	Indicates an information, confirmation or error message displayed on the screen.	The message " Please enter the user name. " is displayed.
ABC > abc	Describes a menu path.	Click on the System > Load path in the PMI menu.
ABCabc	Indicates that there is a glossary entry for this word/phrase.	The list is stored on the <i>in-memory database</i> .
ABCabc	Indicates words, UNIX commands, notes, directory and filenames displayed on the Tango iAX Platform.	Enter cd /tango to go into the tango directory.

Symbols

The symbols used in this guide are:




	Provides information that all users of a Tango service should read.
	Alerts the user to a situation or procedure that, if not followed properly, may complicate or corrupt the normal operation of the software. It is important that all users read these notes and take the appropriate action.
	Alerts the user to a situation or procedure, which may corrupt or damage the software, or may stop the system completely. It is essential that all users read these warnings and take the appropriate action.

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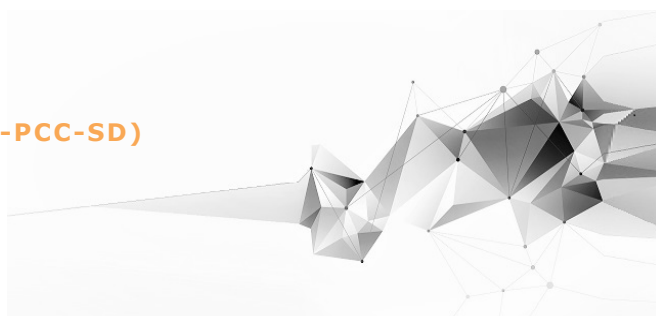
CHAPTER 1

iAX PCC Introduction

This chapter provides an introduction to the Tango Policy and Charging Control (iAX PCC) platform. It contains the following sections:

- [Introduction on page 2](#)
- [Network Context on page 5](#)

iAX PCC Service Description v5.0 (iAX-PCC-SD)



1.1 Introduction

The Tango Policy and Charging Control (iAX PCC) platform provides network operators with the capability of performing functions such as Quality of Service (QoS) control, charging control and gating of data flows on their network. The iAX PCC also supports location, time and APN based rules functions. Practical applications of the iAX PCC include fair-usage enforcement, bill-shock control, parental control and QoS boost.

The core component of the Tango Policy and Charging Control (iAX PCC) platform is the Policy and Charging Rules Function (PCRF) which is used to provide PCC rules for a service flow such that policy enforcement and charging management can be performed.

The PCC rules which are determined by the PCRF are enforced by a component called the Policy and Charging Enforcement Function (PCEF) which may reside within the PDN gateway or between the serving gateway and PDN gateway.

The PCRF combines the session information received from an Application Function (AF) and the input received from the PCEF, with user specific policies and data from the Tango Subscriber Policy and Charging Manager (SPCM) or a third party Subscription Profile Repository (SPR) to form session level policy decisions and provide those to the PCEF. The PCRF also forwards events between the PCEF and the AF.

1.1.1 Key Features



This section includes the features available in the Tango iAX PCC platform. Depending on the network, you may not have all of the features and specifications listed below.

The key features of the Tango iAX PCC are as follows:

- Standards based PCRF for 3GPP, 3GPP2 and WiMax Forum networks
- Standards based Policy and Charging Control (PCC)
- Configurable rules engine for selecting PCC rules
- Data plan categorisation
- QoS control to dynamically allocate bandwidth per session and optionally per service/application
- Session & subscriber awareness including location and network events
- Integration with Application Function's (AF) to control operator provided services
- Service/application awareness
- Usage monitoring control to track usage per subscriber and optionally per service
- Implement Fair Usage Policies (FUP)
- Bill-shock prevention, in particular to avoid roaming bill-shock
- Compliant with EU Bill-shock regulations

- Dynamically managed QoS
- Diameter signalling to PCEF, BBERF and AF
- Fully integrated SMS notifications
- Web-based O&M for ease-of-use
- Highly-available, scalable, carrier grade platform
- Integrated USSD self-care solution
- Subscriber provisioning API
- Self-care API
- Online charging interface for data-plan payments
- GUI for subscriber and data-plan management, PCRF rules configuration, etc.
- User Experience Management
- LBO SMS Provisioning
- Policy Promotion Service (PPS)
- PCRF Hotswap to ensure high availability

1.1.2 Benefits of iAX PCC

The Tango iAX PCC provides a network PCRF which addresses the subscribers need for quality service & cost control and the operators need to dynamically manage their network resources to maximise revenue and differentiate themselves from competitor networks.

The following key benefits are provided by the iAX PCC:

Dynamic Network Resource Management

- Protect network from over-use by a small number of heavy data users and provide better quality of experience to premium users
- Restrict access for specific services, e.g. P2P at peak times, streaming at busy locations
- Detect cell-congestion and apply policies to counter this

Dynamic Controls For Roamers

- Bill-shock prevention
- Restrict access for specific services

New Revenue Creation

- Up-sell bandwidth for special events and services, i.e. “turbo-boost” or “bandwidth-on-demand”
- Prepaid data plans for cost conscious subscribers

- Simple to understand data subscriptions with Fair Usage Policy (FUP)

Personalization Of Data Services

- Configurable smart usage limits
- Restrict access by time and service
- Parental control
- Corporate data plan

1.2 Network Context

Figure 1-1 shows the network context of the Tango iAX PCC platform. It contains a 3GPP-compliant PCRF.

	<p>The SPR functions are performed by the Tango Subscriber Policy & Charging Manager (SPCM) on the Tango iAX PCC platform.</p>
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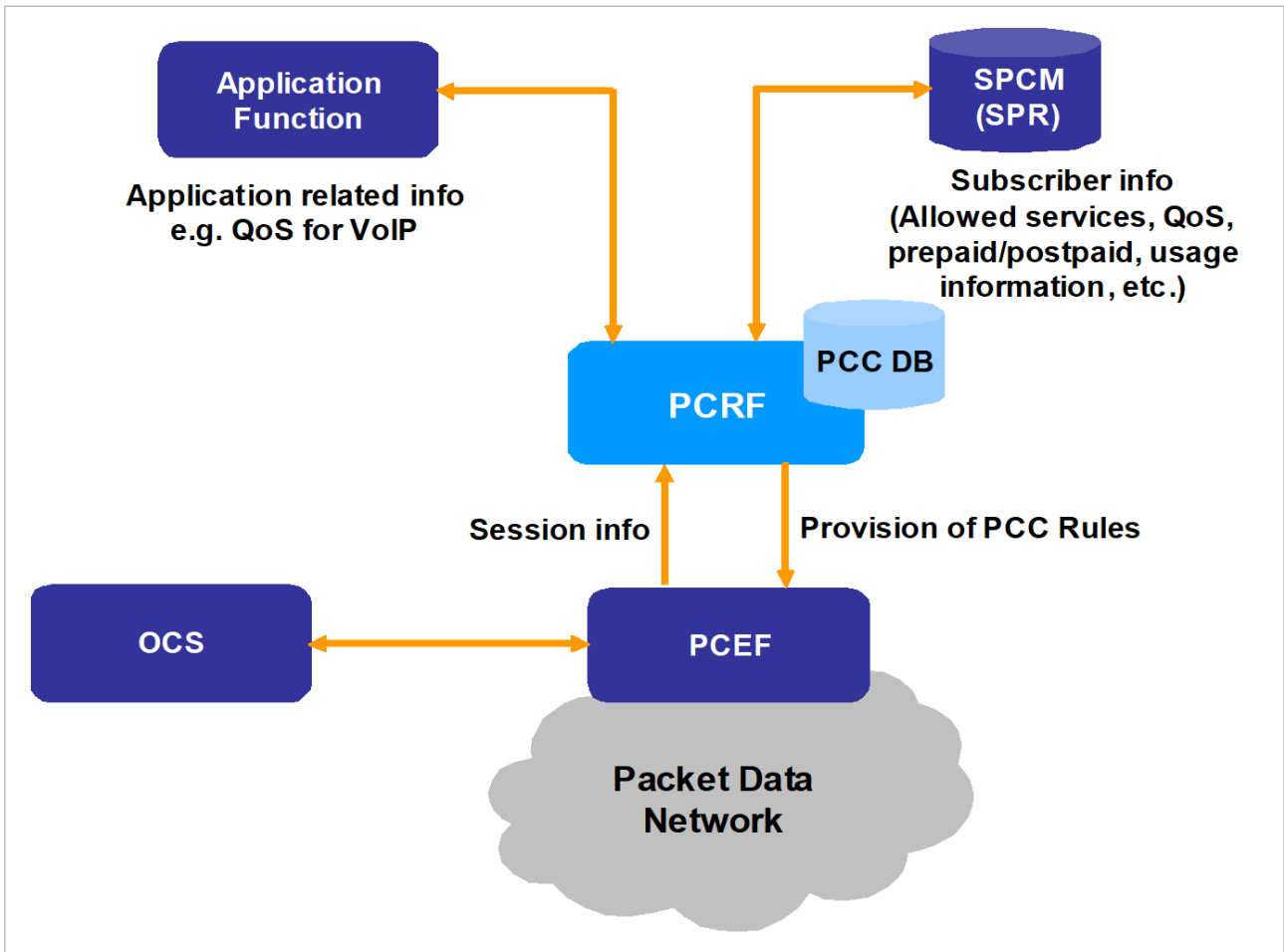


Figure 1-1 iAX PCC Network Context

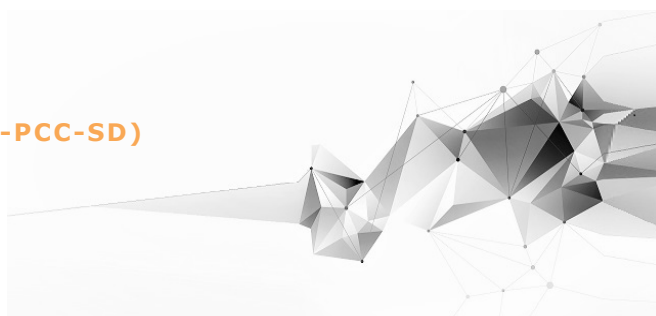
CHAPTER 2

Network Integration

This chapter provides an overview of the main interfaces to the Tango Policy and Charging Control (iAX PCC) platform. It contains the following sections:

- [Overview on page 7](#)
- [iAX PCC Interfaces on page 8](#)

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2.1 Overview

The Tango Policy and Charging Control (iAX PCC) is deployed outside the packet data network to apply policy and charging control to data traffic. The Policy and Charging Enforcement Function (PCEF) resides in the PDN network and carries out the following tasks for data traffic:

- Meter the duration and volume of data usage
- Perform deep packet inspection
- Perform real-time charging and control

The Tango iAX PCC may be deployed in GPRS/3G, CDMA, WiMAX or other IP networks.

Figure 2-1 shows the iAX PCC network integration.

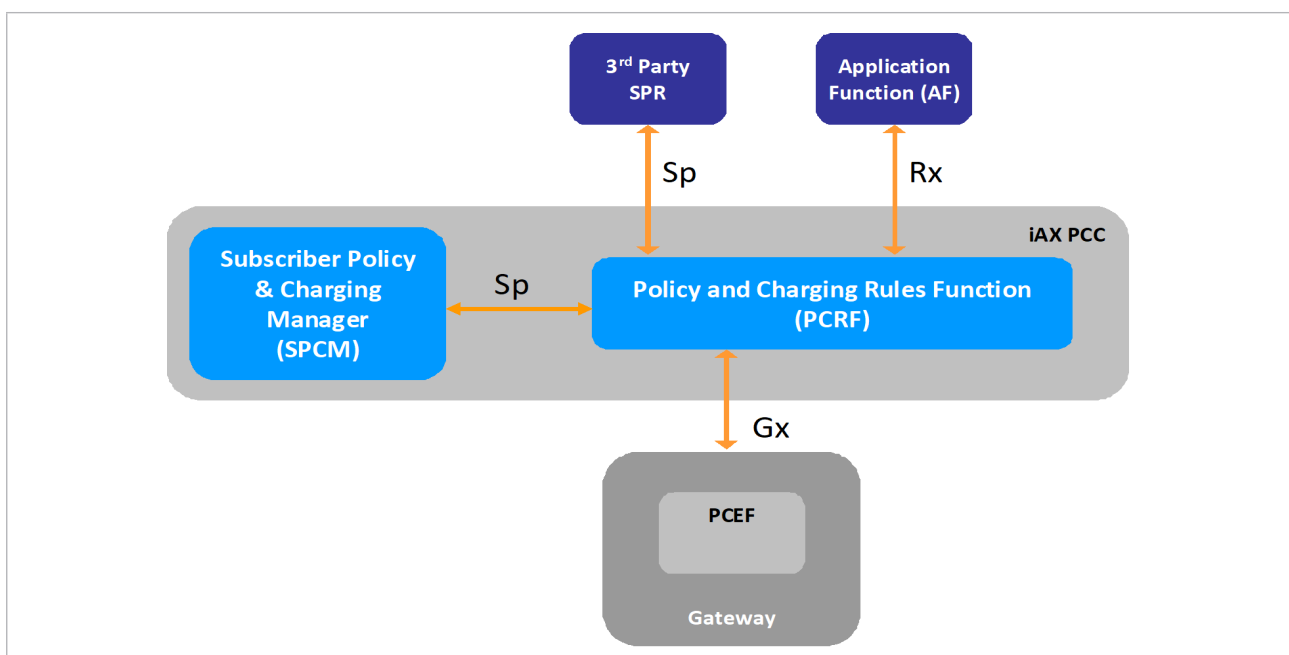


Figure 2-1 iAX PCC Network Integration

2.2 iAX PCC Interfaces

The Tango iAX PCC system is made up by the following functional blocks:

- Policy and Charging Rules Function (PCRF)
- Subscriber Policy and Charging Manager (SPCM)

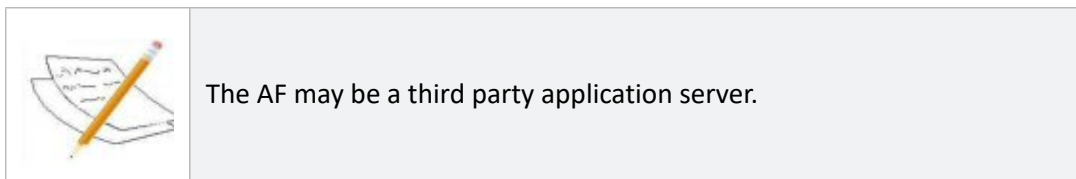
Other important network components include:

- Policy and Charging Enforcement Function (PCEF)
- Application Function (AF)
- Online/Offline Charging System (OCS)
- Subscription Profile Repository (SPR)

The following sections describe the interfaces between the main functional blocks as shown in **Figure 2-1**.

2.2.1 Rx Interface

The Rx interface resides between the Application Function (AF) and the PCRF.



This interface enables the transport of application level session information from the AF to the PCRF. Such information includes, but is not limited to, the following:

- IP filter information to identify the service data flow for policy control and/or differentiated charging
- Media/application bandwidth requirements for QoS control

The Rx interface enables the AF to subscribe to notifications on the IP-CAN bearer level events (e.g. signalling path status of AF session) in the IP-CAN.

2.2.2 Gx Interface

The Gx interface resides between the PCRF and PCEF and allows for the provisioning and removal of PCC rules from the PCRF to the PCEF and the transmission of traffic events from the PCEF to the PCRF.

The Gx interface supports the following functions:

- Request for PCC decision from PCEF to PCRF
- Provision of PCC decision from PCRF to PCEF
- Negotiation of IP-CAN bearer establishment mode (UE-only or UE/NW)

- Gx usage monitoring
- Push rules to the PCEF based on Sp notifications
- PCRF rules update based on event reports from the PCEF (location-change, revalidation-time-expired, etc.)
- Termination of Gx session (corresponding to an IP-CAN session) by PCEF or PCRF



The PCRF decision to terminate a Gx session is based on operator policies. It should only occur in rare situations (e.g. the removal of a UE subscription) to avoid service interruption due to the termination of the IP-CAN session.

2.2.3 Sp Interface

The Sp interface lies between the Tango SPCM or third-party SPR and the PCRF.

The Sp interface allows the PCRF to request subscription information related to the IP-CAN transport level policies from the SPCM or SPR based on the Subscriber ID (MSISDN or IMSI).

The interface allows the SPCM or SPR to notify the PCRF when the subscription information has been changed if the PCRF has requested such notifications. The SPCM or SPR shall stop sending the updated subscription information when a cancellation notification request has been received from the PCRF.

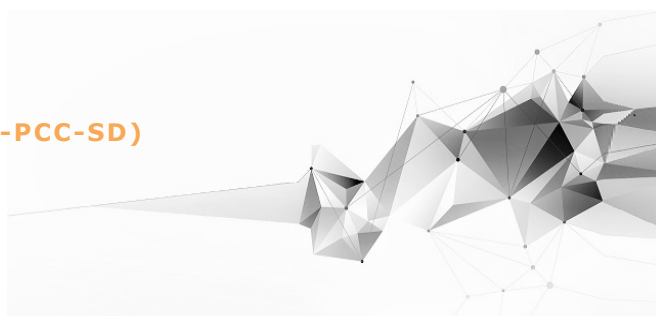
CHAPTER 3

Solution Overview

This chapter provides an overview of the Tango Policy and Charging Control (iAX PCC) platform and describes the main components. It contains the following sections:

- [Key Components on page 11](#)

iAX PCC Service Description v5.0 (iAX-PCC-SD)



3.1 Key Components

This section provides an overview of the Tango iAX PCC solution. The main components of the iAX PCC are described along with the main interfaces that make up the iAX PCC solution.

Figure 3-1 shows an overview of the Tango iAX PCC solution.

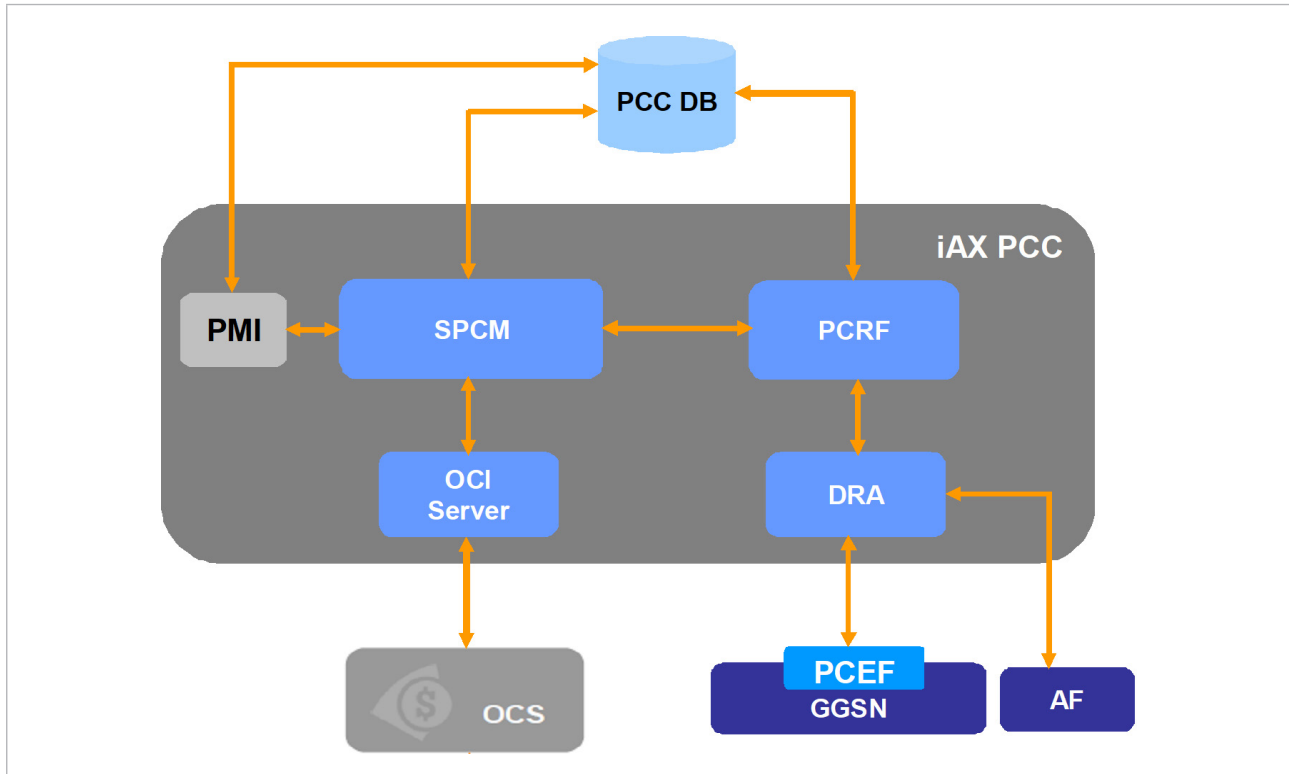


Figure 3-1 iAX PCC Solution Overview

The main components of the iAX PCC solution are described in the following sections.

3.1.1 PCRF

The PCRF performs the core function of generating rules that enforce policy and charging control on a PCEF. The PCRF contains a diameter stack which supports a Gx interface for interaction with a third-party PCEF and an Rx interface for Application Functions (e.g. VoIP call-session controller).

The PCRF service logic is called when a user initiates a data-session on their handset. The service logic controls the generation of policy and charging control rules for the PCEF data-session based on the following set of inputs:

- Parameters received from the PCEF over the Gx interface.
- Parameters received from an Application Function (AF) over the Rx interface.
- Subscriber profile information received from the SPCM or a third-party SPR.
- PCRF rules data which has been configured in the PCC database.

In addition to this, the PCRF service logic also performs the following functions:

- Manages the PCEF usage-monitors and passes usage information from PCEF usage reports to the SPCM.
- Manages PCEF event triggers such as location change and provides PCC rules updates to the PCEF for event reports.
- Manages asynchronous notifications from the SPCM or a third-party SPR and provides PCC rules updates to the PCEF for subscriber profile changes.
- Manages asynchronous notifications from application functions and provides PCC rules updates to the PCEF for application sessions.
- Manages time-bands and provides PCC rules updates to the PCEF for time-band transitions.
- Provides default rules to the PCEF if the subscriber profile information is not available from the SPCM or third-party SPR.

3.1.2 Subscriber Policy and Charging Manager

The Subscriber Policy and Charging Manager (SPCM) manages subscriber data plans and notifies the PCRF if a policy or charging control change is required. Subscriber provisioning is also managed in the SPCM.

The SPCM has an Sp interface with the PCRF which is used to carry out the following:

- Provide the PCRF with subscriber profile information at the start of a session.
- Provide the PCRF with usage-tracking parameters and process the subsequent usage reports received from the PCRF.
- Notify the PCRF of subscriber profile changes, e.g. due to the data-usage threshold being exceeded or data plan expiry.

Data usage may be tracked for a subscriber's core data plan and for any additional active data plans they may have. Furthermore, usage may be categorised by time-band (e.g. Peak/Off-Peak), location (e.g. Home/Roaming) or APN. The SPCM may perform the following actions if total data-usage or a usage category exceeds a configured threshold value:

- Notify the PCRF to change policy and/or charging control for data-sessions.
- Send an SMS notification to the subscriber.

The SPCM contains a subscriber self-care function to allow subscribers to purchase data plans, manage multiple data plans and view usage information.

The SPCM uses the Tango Open Charging Interface (OCI) server to charge for the data plans which are purchased by subscribers. The OCI server can be configured to use a specific online charging protocol as required by the third-party Online Charging System (OCS).

An API is also provided for third-party provisioning platforms to create and update subscribers in the Tango PCC database.

The SPCM can run in an active or passive mode, as determined by configuration settings at startup. When in active mode the SPCM behaves as usual. When in passive mode the SPCM does the following:

- Ceases to execute jobs.

- Removes itself from the resource manager.
- The web service only accepts GET requests and OAM POST requests.
- Ceases to process received SE messages.

3.1.3 Diameter Routing Agent

The Diameter Routing Agent (DRA) ensures that all Diameter sessions established over the Gx and Rx interfaces reach the correct PCRF when multiple, separately addressable PCRF's have been deployed in a Tango iAX PCC cluster. This effectively provides scalability and high availability to the Tango iAX PCC platform.

3.1.4 Open Charging Interface Server

The Open Charging Interface (OCI) server provides an IDL to the SPCM to charge for data plans which are purchased by subscribers via one of the self-care interfaces or by a customer care agent via the PMI.

The OCI server can be configured to use one of the many Tango charging clients depending on which protocol is required by the third-party Online Charging System (OCS) e.g. Diameter Credit-Control (DCC).

The OCI server may be configured to use an event-based (i.e. direct-debit) or session based (i.e. reserve & debit) charging process as required by the third-party OCS for data plan charging.

3.1.5 iAX PCC Databases

The PCC database is a highly-available MySQL database that provides persistent data storage for the following Tango iAX PCC software modules:

- PCRF rules handler
- SPCM
- PMI

Depending on the hardware configuration of your network, the PCC database may be deployed on separate nodes at the back-end of the iAX PCC platform or on iAX PCC platform nodes.

The PCC database uses a master-slave configuration with replication and logical IP management in order to ensure that the PCC database is highly available.

3.1.6 Platform Management Interface GUI

The Platform Management Interface (PMI) is a web application which provides a graphical user interface (GUI) to manage subscribers and their data plans and to configure the policy and charging control information for subscriber data plans.

The Policy section of the PMI allows you to carry out the following specific functions:

- Data plan creation and management.
- Data plan categorisation.
- Subscriber creation and management.
- Configuration of the following low-level PCRF parameters which are used to generate policy and charging control rules:
 - IP filter lists
 - QoS parameters
 - Charging parameters and rating group tables
 - Location lists
 - Time bands
 - APN lists
 - Application policy information
- Display O&M information for the iAX PCC platform

3.1.7 Tango PCEF

In cases where a PCEF is not available on the GGSN as shown in **Figure 3-1**, the optional Tango PCEF can be provided. See **Section 4.5** for details.

CHAPTER 4

Policy and Charging Rules Function

This chapter provides an overview of the Tango Policy and Charging Rules Function (PCRF) operations. Typical operational flows are also described. It contains the following sections:

- [Introduction on page 16](#)
- [Defining Policy Rules on page 17](#)
- [iAX PCC Rules Generation on page 18](#)
- [Usage Tracking on page 22](#)
- [Tango PCEF Adaptor on page 24](#)
- [Dynamic Pricing Service on page 26](#)
- [User Experience Management on page 28](#)

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4.1 Introduction

The core function of a Policy and Charging Control (iAX PCC) platform is the generation of rules that enforce policy and charging control on a PCEF.

The PCRF uses the following inputs to generate policy and charging control rules:

- Data session parameters from the PCEF over the Gx interface
- Application and media information from Application Functions over the Rx interface
- Subscriber profile information from a third-party SPR or the Tango SPCM
- PCRF rules configuration data from the PCC database

As well as the PCC rules, event triggers are installed on the PCEF to track certain events such as location change and usage monitors are installed to track data usage by subscribers. Usage monitors and event triggers may cause a change in PCC rules.

The PCC rules generation process is illustrated in [Section 4.3](#).

In addition to these functions, the PCRF allows you to configure the following low-level parameters which are used in the rules generation process:

- **Quality of Service (QoS)** - The QoS parameters define the uplink and downlink rates that can be applied to various service profiles and are used by the PCRF to set the quality of service in specified scenarios.
- **Location** - The location parameters define specific locations in which a particular quality of service, service list and charging control may be applied. Network locations can also be defined for specific networks.
- **Service Flows** - The service flows allows you to define the services that are used in the PCRF. Each service can be assigned as a downlink, uplink or bidirectional service.
- **Charging** - The charging profiles allow you to define and manage the charging parameters such as charging method, metering method and rating groups, which can be applied to specific services.
- **Application** - The application profiles allow you to specify how applications interact with the PCRF by controlling what media types are allowed for specific applications and what QoS level is applied to each media type.
- **Time** - The time profiles allow you to manage specific time periods during which a particular QoS, service list or charging control is applied.
- **APN** - The Access Point Name (APN) profiles allow you to manage special APNs for which a particular QoS, service list and charging control is applied. The APN to be used by a particular subscriber is determined by the SPCM.

4.2 Defining Policy Rules

Policy Control Rules are defined on the PCRF using the web based PMI GUI and stored in the PCC database.

The following parameters can be defined for each rule:

- IP quintuple filter lists - for service flows
- QoS parameters - including maximum upstream and downstream speeds
- Charging parameters - online/offline charging, etc.
- Location lists - cell ID list and SGSN source IP
- Location rates - for bill-shock control
- Time-bands - using detailed time expressions
- APN lists

In the case where multiple PCC rules could be applied, rule precedence is taken into account. A default rule is defined as a catch all in the case where a subscriber may not exist in the SPCM database, or if no applicable rule can be found.

4.3 iAX PCC Rules Generation

The core function of the Policy and Charging Control (iAX PCC) platform is the generation of rules that enforce policy and charging control on a PCEF.

The PCRF uses the following inputs to generate Policy and Charging Control rules:

- Data session parameters from the PCEF over the Gx interface
- Application and media information from Application Functions over the Rx interface
- Subscriber profile information from the Tango SPCM or third party SPR.
- PCRF rules configuration data from the PCC database

As well as the PCC rules, event triggers are installed on the PCEF to track certain events such as location change. Usage monitors are installed to track data usage by subscribers. Usage monitors and event triggers may cause a change in PCC rules.

The PCC rules generation process is illustrated in **Figure 4-1**.

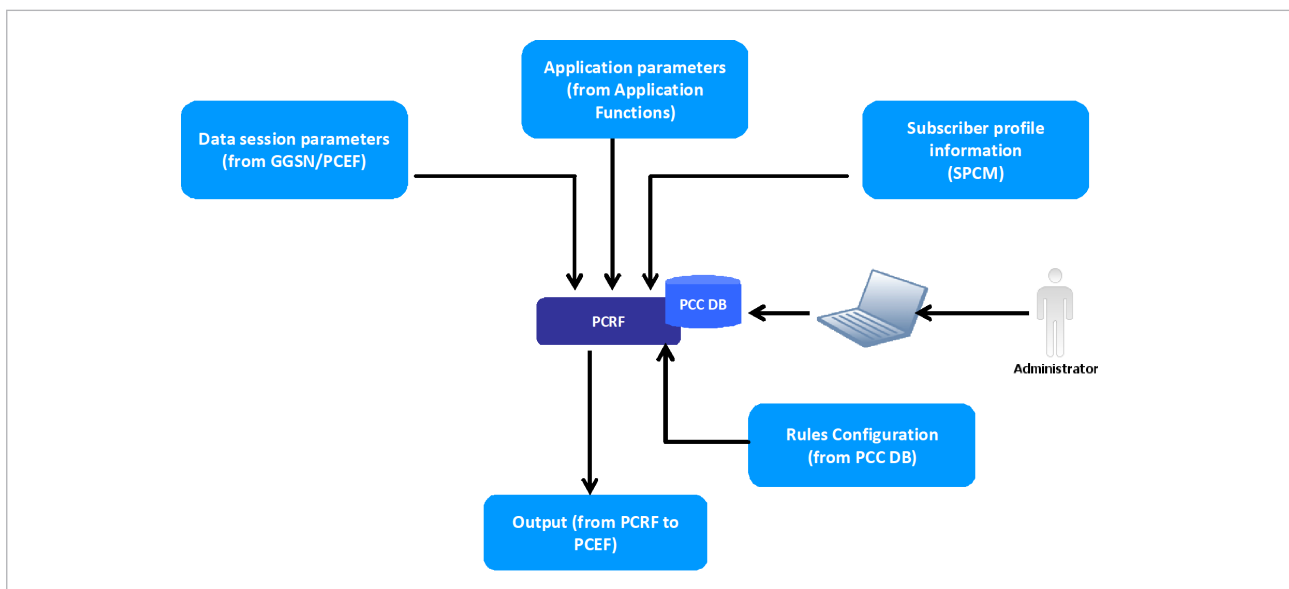


Figure 4-1 iAX PCC Rules Generation Process

The main parameters from each of these rules inputs are as follows:

Data Session Parameters (from GGSN/PCEF)

The following parameters are passed from data session (GGSN/PCEF) to the PCRF and used as part of the rules generation process:

- MSISDN
- IMSI
- Bearer Identifier
- Access Point Name (APN)
- SGSN Address
- Requested QoS

- QoS Negotiation Flags
- Location Information
- Usage Information

Application Parameters

The following parameters are passed from an Application Function (AF) to the PCRF and used as part of the rules generation process:

- Application Identifier
- Flow Descriptions
- Media Type and Context
- Maximum QoS

Subscriber Profile Information

The following parameters are passed from the Tango Subscriber Policy and Charging Manager (SPCM) to the PCRF and used as part of the rules generation process:

- Allowed Data Services
- Allowed QoS
- Charging Parameters
- Location Information
- Time-bands
- Usage Tracking Parameters
- APNs
- DPS Parameters

Rules Configuration

The following rules configuration parameters are passed from the PCC database to the PCRF and used as part of the rules generation process:

- IP Quintuple Filter Lists (for service flows)
- QoS Parameters
- Charging Parameters (e.g. rating-group tables)
- Location Parameters (e.g. cell IDs, SGSN addresses)
- Location Rates (e.g. for bill-shock control)
- Time Bands (e.g. Peak/Off-Peak)
- APN Lists

Output From the PCRF to PCEF

Once the PCRF has taken the inputs and processed them, the following is sent to the PCEF:

- Event Triggers
- Usage Monitor Information
- List of Policy and Charging Control Rules which may contain:
 - Plan Name
 - Plan Type
 - Rule Name
 - Precedence
 - Service Identifier
 - Service Status (enabled/disabled)
 - Service Flow Filter(s)
 - QoS Parameters
 - Charging Parameters
 - Discount Rate

Experimental result codes that can be sent from the PCRF to the PCEF are detailed in [\[Ref. 8\]](#) iAX™ PCC Administration Guide.

4.3.1 PCC Rules Generation Call Flow

Figure 4-2 shows a typical rules generation call flow.

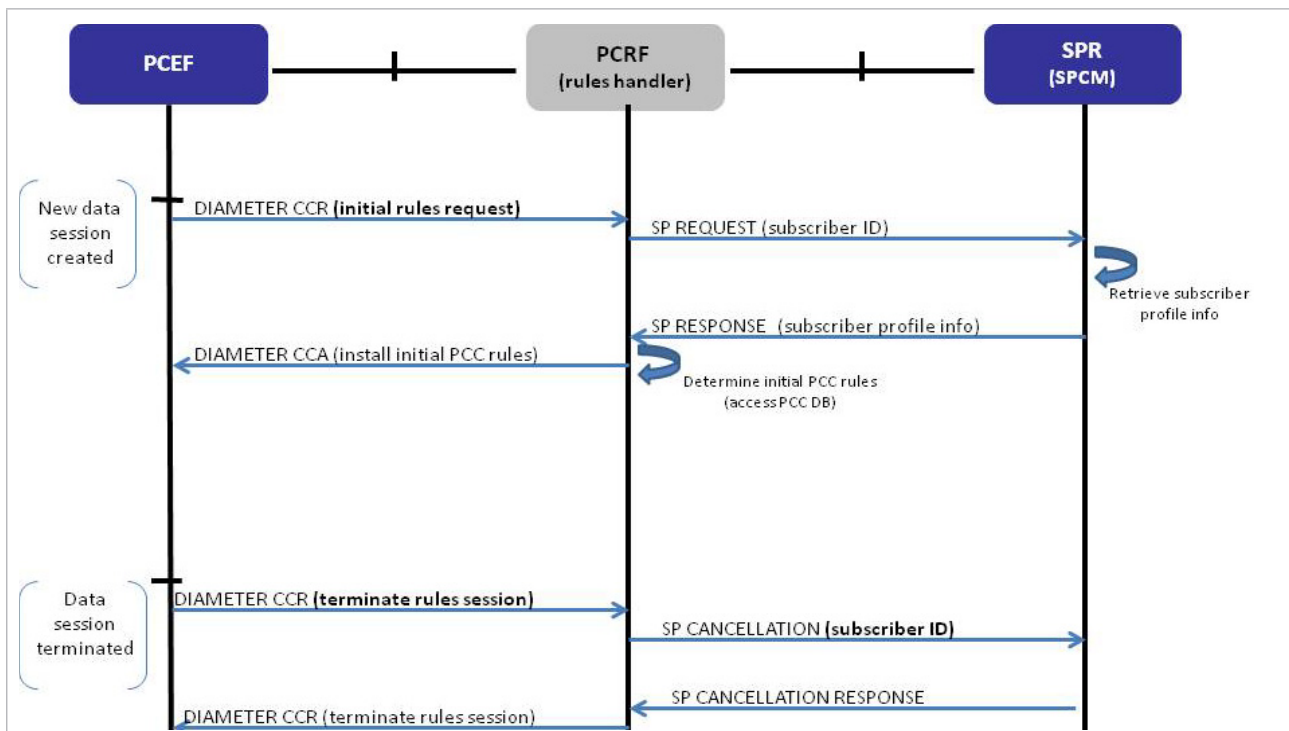


Figure 4-2 Rules Generation Call Flow

- When a new data session is established, a request is sent to the SPR or Tango SPCM for subscriber information.
- The subscriber profile information is returned to the PCRF where the initial PCC rules are determined.
- The initial PCC rules are installed on the PCEF.
- When the data session is terminated, a rules termination message is sent to the PCRF.
- The PCRF sends a cancellation for the subscriber to the SPR or Tango SPCM.
- The SPCM sends a cancellation response to the PCRF.

4.3.2 Session IP Resolver

The PCRF rules handler contains a UE IP resolver IDL which returns the MSISDN of the subscriber based on the UE IP address assigned to the subscriber for a data session. The resolver also returns other data session parameters such as user location and PCRF session status.

The returned MSISDN can then be used to query the SPCM for subscriber account and data plan information. This allows subscriber information to be determined on a redirected web portal which might only have the UE IP address available as subscriber information.

4.4 Usage Tracking

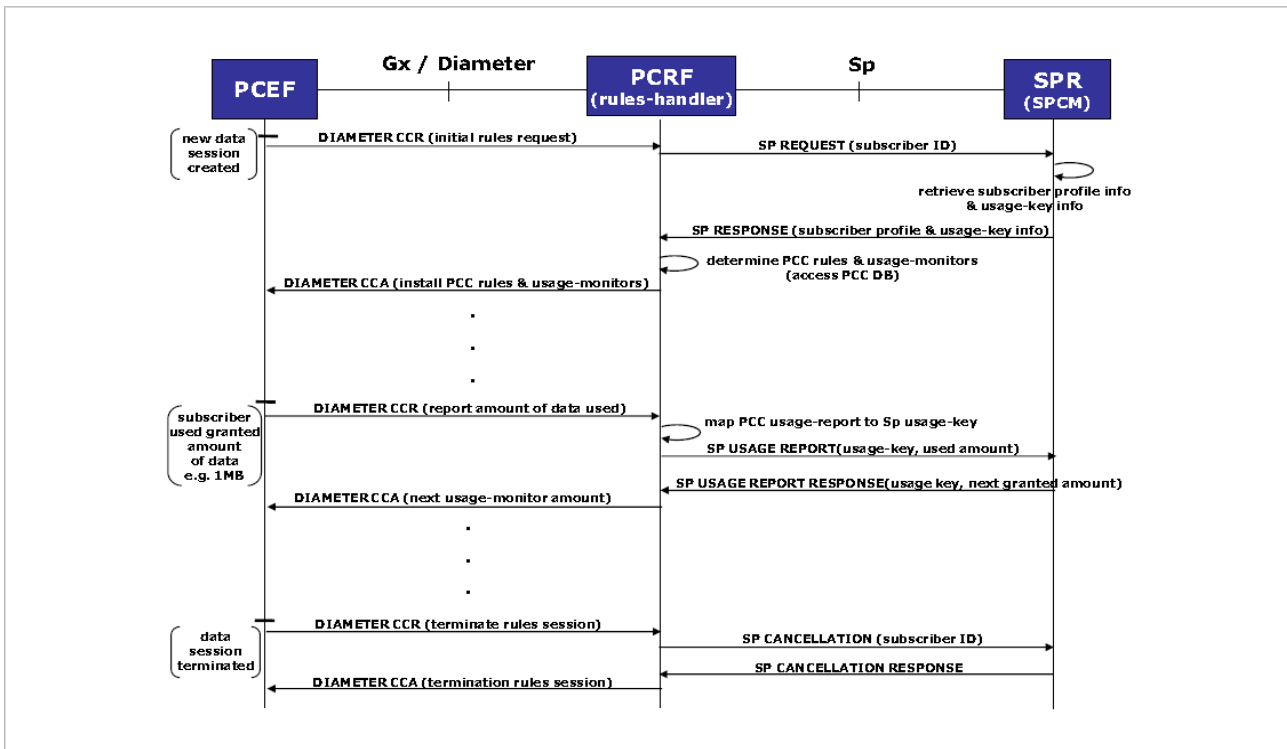


Figure 4-3 Tango PCC usage-tracking call-flow

At the start of a session the PCRF retrieves information about the subscriber profile from the SPCM. Included in this information are usage-keys which allow the PCRF to correlate data usage reports from the PCEF back to the SPCM. This enables the SPCM to track total usage per subscriber. The PCRF generates a list of PCC rules. A usage monitor is applied to each rule which allows data-usage to be categorised as it is being tracked, e.g. roaming usage can be tracked separately to domestic usage.

The usage monitors on the PCEF will return a usage report when the amount of data granted by the SPC/PCRF is consumed by the end-user. The PCRF maps this usage report to an SPCM usage key and returns a corresponding usage report to the SPCM. The SPCM can subsequently apply usage thresholds to trigger actions such as a QoS downgrade or an SMS alert.

4.4.1 Granted Service Units

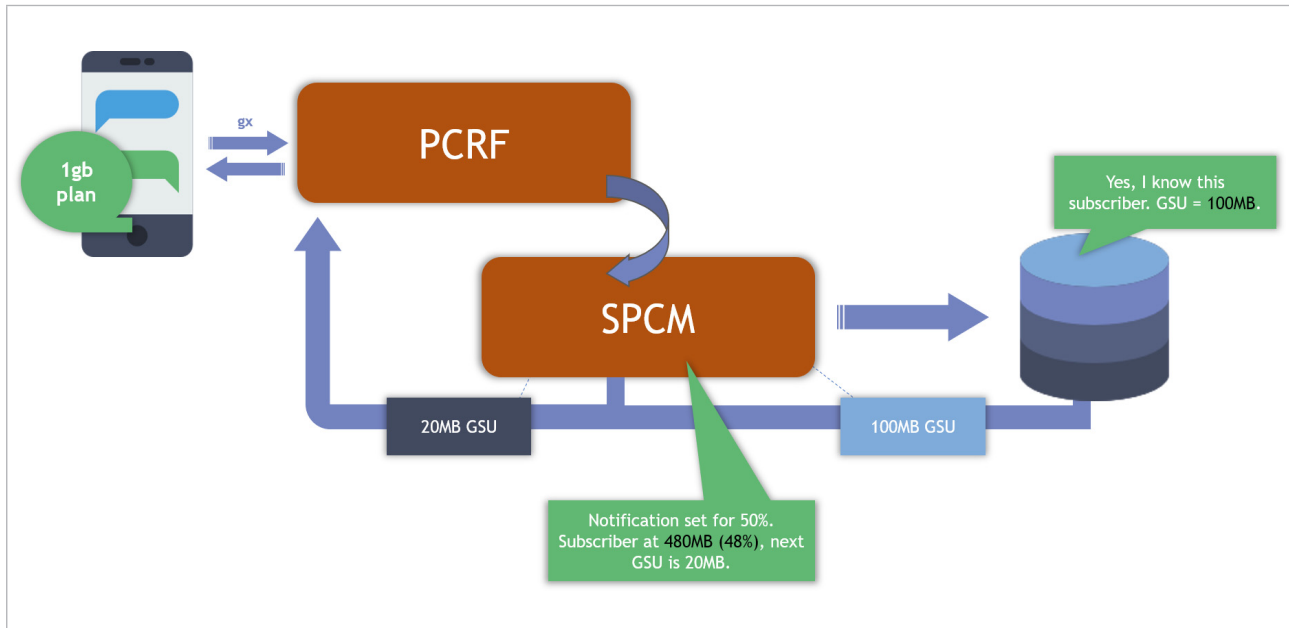



Figure 4-4 GSU Flow

The usage monitor includes the tracking of **Granted Service Units (GSUs)** which are defined per plan definition in your PMI configuration. This first starts at the beginning of a data session and again when the usage report update is received.

	<p>To find this on the PMI, go to:</p> <p>Policy > SPCM > Plan Definition > Subscriber Plans</p> <p>Within an existing plan definition or when creating a new one, go to the section entitled “Maximum usage allowed between usage reports”, where you can set the slider to the maximum GSU.</p>
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Though a maximum GSU is configured, say for example 100mb or 10% of a plan, the SPCM dynamically sends GSUs back to the PCRF based off any rules defined such as a notification threshold or data usage warning. So, if the subscriber is only 20mb or 2% away from the rule, the GSU sent to the PCRF will be that 20mb or 2% and not the maximum GSU.

4.5 Tango PCEF Adaptor

In cases where an operator's network does not have a PCEF, the optional Tango PCEF Adaptor can be supplied which is designed to work with the Tango PCRF and Tango GTP data proxy.

Figure 4-5 shows an overview of how the Tango PCEF Adaptor integrates into the network.

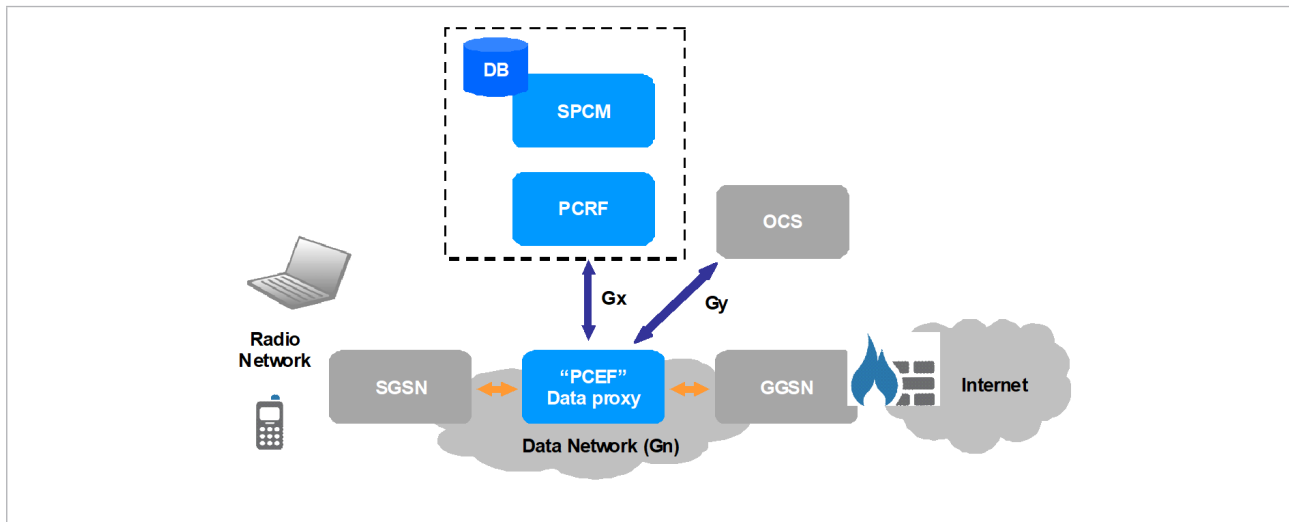


Figure 4-5 Tango PCEF Adaptor Network Overview

It is assumed that the network already contains an existing Serving GPRS Support Node (SGSN), Gateway GPRS Support Node (GGSN) and an online charging system (OCS).

4.5.1 Key Features

The following is a list of the key features supported by the Tango PCEF Adaptor and what the Tango PCEF Adaptor can provide:

- **Rating Groups:** The PCRF can assign a rating group for a data session. This rating group is used to select a table of rates in the adaptor which are passed to the data proxy. These rates apply to the traffic classes identified by the data proxy.
- **Quality of Service:** The Quality of Service (QoS) may be modified at the start of a data session by the PCRF, if QoS negotiation is supported by the data network.
- **Usage Monitoring:** The overall usage for a data session can be monitored and reported to the PCRF using the monitoring key specified by the PCRF. Only one monitoring key may be used per data session at any given time. This allows the usage to be accumulated for each subscriber based on, for example, APN, roaming or not roaming, location (if this is provided by the data network), peak or off-peak, etc.
- **Data Plan Support:** Because usage is reported to the PCRF and rates can be set by the PCRF, Data Plans can be implemented in the PCRF. For example, a subscriber can purchase a 2GB data plan with a validity period of 1 month.
- **Bill Shock Control:** Because usage can be tracked by the PCRF, a number of standard PCC services, such as bill shock, can be provided.

In addition to the features listed above, the following standard data proxy features are also available:




In many cases, these features can not be directly controlled by the PCRF.

- Volume or duration based rating.
- Traffic analysis and classification rules may be used in the data proxy. In particular, WAP or HTTP flows can be identified using lists of URLs configured in the data proxy.
- Selected traffic classes can be blocked using configuration on the data proxy, but this cannot be controlled by the PCRF.
- The data session may be blocked with redirected DNS and HTTP traffic. Different server IP addresses and URLs can be configured depending on the charging cause code, APN or subscriber type.
- A variety of charging interfaces is supported, including Diameter “Gy”.
- The data proxy generates data session CDRs, which include the usage per traffic class.
- Advanced deep packet inspection (DPI) using pattern matching, behavioural, statistical and heuristic analysis is an optional feature of the data proxy.
- The data proxy has configurable policies which determine what should happen in various failure conditions.

4.6 Dynamic Pricing Service

The PCRF rules handler supports DPS for data. DPS can be enabled at the subscriber or plan level via the PMI. If DPS is enabled for a subscriber then the PCRF will perform a DPS lookup to determine real time pricing and discounts for that subscriber.


	<p>DPS settings made at plan level take precedence over DPS settings made at subscriber level, so DPS is available to subscribers with a DPS-enabled plan regardless of subscriber-level DPS settings. As a result, subscriber opt-in/opt-out is not supported for DPS.</p>
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PCRF supports the following functions in relation to DPS:

Request Discount Rate from DPS

The PCRF rules handlers sends a request to the DPS in the following situations:

- During initial profile request if subscriber has subscribed to DPS or has a DPS enabled plan.
- When profile update notification is received from SPCM and the subscriber has subscribed to DPS or has a DPS enabled plan.
- When user changes location cell-id/lac and the event is reported to PCRF.
- When a revalidation timeout event is reported to the PCRF.
- The PCRF will request revalidation at the same intervals as the DPS discount rates are configured.

	<p>If an error is returned from the DPS or a timeout occurs waiting for a response, then no discount will be applied to the subscribers plans.</p>
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Indicate Discount Rate To PCEF For Pay-per-use Plans

When a discount rate is returned from DPS, the discount rate must be reported to the PCEF for all pay-per-use plans which have DPS enabled or for all subscribers pay-per-use plans if the subscriber is DPS enabled.

- For plans generating dynamic rules, the discount rate is supplied via the Gx Diameter Interface.
- For plans generating static or base rules, the discount rate is supplied by appending the rate to the rule name, e.g. `FACEBOOK_20`. This rule name must be setup on the PCEF.
- If a monitoring key is also needed (e.g. to support billshock feature), then the discount rate must also be appended to the monitoring key so that the monitoring key is unique to each rule name.



The hex value of the discount rate is appended to the monitoring key, i.e. if the monitoring key is 05DE and the discount rate is 30%, then the final key is 05DE1E, where 1E is the hex representation of 30.

Apply Discount to Reported Usage for Bundle Plans

When a discount rate is returned from the DPS, the discount must be applied to the reported usage for all bundle plans which have DPS enabled or for all subscriber bundle plans if the subscriber is DPS enabled.



- The discount is removed from the reported usage before sending on to the SPCM.
- The `reportUsage` message between the PCRF rules handler and the SPCM includes the discount rate and type. The discount type is either (0)None, (1)Fixed - referring to the existing plan metering discount or (3) Dynamic - referring to a DPS discount.

A discount is typically updated during a session but this is configurable. If the operator does not want an applied discount updated during a session then the following steps will occur.

- 1 At the start of the session if DPS is found (subscriber has a DPS plan or has DPS at subscription level) then the DPS discount is looked up.
- 2 If the discount is available and not 0% then that value is set as the applied discount.
- 3 If there is no discount or 0% discount then on the usual triggers we check for DPS, and if DPS found for what ever reason, a DPS discount is looked up, and a value > 0 becomes the applied discount.
- 4 If DPS becomes inactive (e.g. location changed and DPS was for old location) then the PCRF will stop applying the DPS applied discount.
- 5 If DPS becomes active (e.g. location changed and DPS is for new location) then the PCRF will apply the DPS applied discount it has remembered.
- 6 If DPS is no longer available (e.g. plan expired) then the applied discount is reset.
- 7 If DPS is acquired/found again (i.e. plan renewal, or new purchase) the PCRF will look up the new DPS discount and a value > 0 becomes the applied discount.

4.7 User Experience Management

The User Experience Management (UEM) feature facilitates an upgrade or downgrade of service experience per plan relative to the historical cell load percentage.

A subscription profile key is added to the plan PCC profile and this key indicates the level of user experience adjustment to be allowed. The historic cell load information is retrieved via a DPS lookup and this information combined with the subscription profile information enables a service upgrade or downgrade to be implemented at the appropriate level.



- UEM is only applied where the IP-CAN-Type is 3GPP-EPS.
- If a PCC profile has either a Service, QoS or Charging Profile then it **cannot** have a subscription profile.
- Time, Device and Location Profiles can be configured in conjunction with the subscription profile key.
- If two or more plans exist and each have a subscription profile key, then the subscription profile key from the highest priority plan will be used and all others are set to inactive.
- If a PCC profile has a Time profile and a subscription profile, timing will be implemented via setting the re-validation time and **not** via activation times.

For further details on setting the subscription profiles, refer to the PMI Online Help [\[Ref. 7\]](#), additionally for details on configuring subscription profiles, refer to the iAX™ PCC Administration Guide [\[Ref. 8\]](#).

4.8 PCRF Hotswap

The PCRF Hotswap feature allows a Gx session on a failed PCRF to be picked up and handled by another PCRF to support continuous service for the subscriber.

The PCRF Hotswap feature:

- Detects when a PCRF instance fails.
- Re-routes incoming Gx messages for that session to another PCRF instance.
- Saves the PCRF's session context to an external store.
- Restores the session on the new PCRF instance.
- Transfers information about the Gx session between the primary and secondary PCRF.

4.8.1 Session Context Store (SCS)/Generic Db

The session context data is backed up to an external store in the case of PCRF failure; records will be stored, updated and deleted in the SCS. Session data includes Gx parameters from the PCRF rules handler, rules and monitor keys installed on the PCEF and other miscellaneous session data values.

The Generic Correlation Database (GenericDb) process will act as the SCS. For details on configuring the GenericDb refer to the iAX PCC Administration Guide [\[Ref. 8\]](#).

Figure 4-6 shows an example of a PCRF session being 'hot-swapped'.

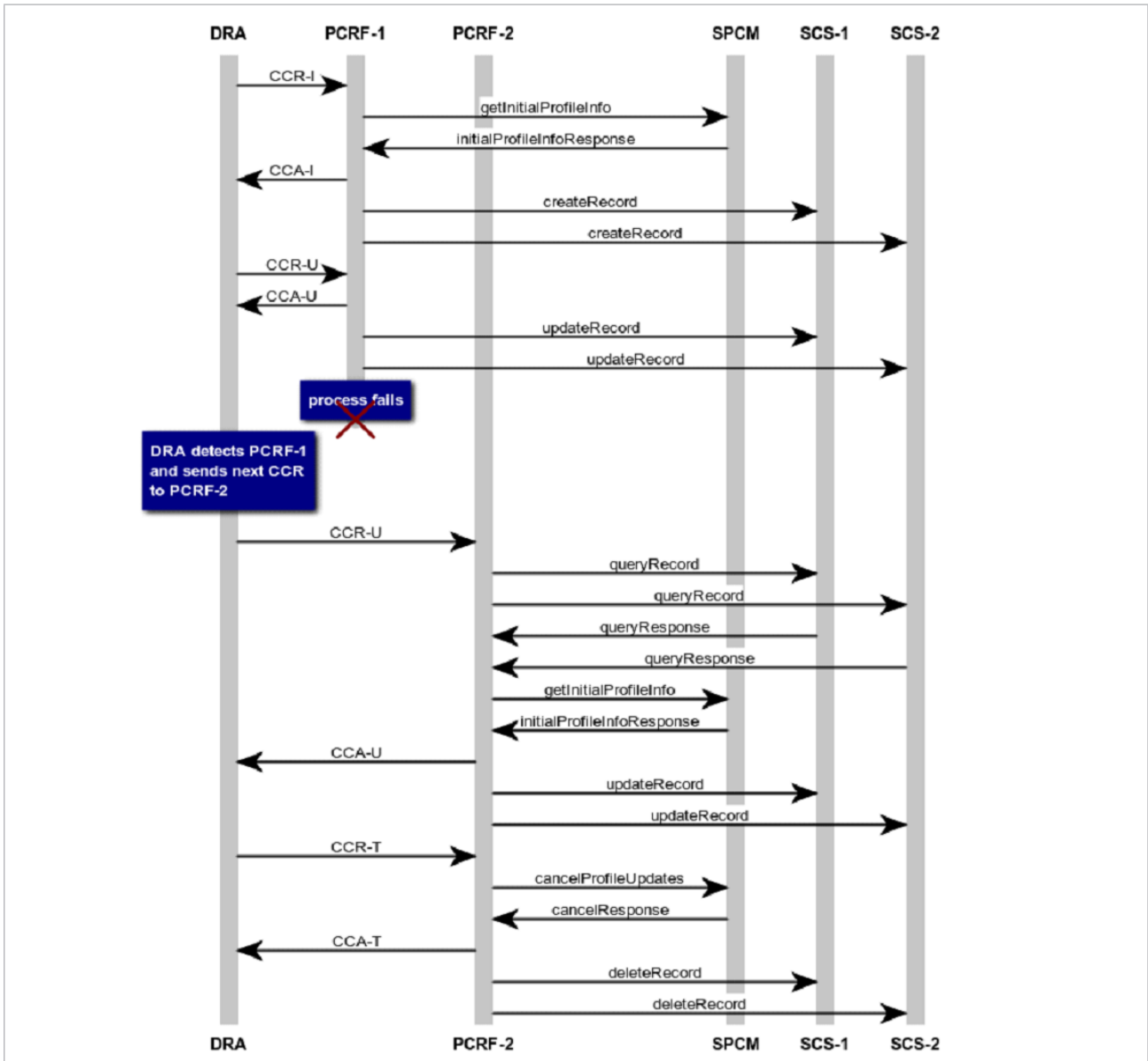


Figure 4-6 PCRF Session Hotswap

4.9 Discount Schedule

The Discount Schedule (DS) feature allows a subscriber to select an hour of the day for which they wish to avail of a configured discount.

The operator configures the schedule on the PMI via the DS Web Service, which runs as a managed process under Process Manager (PM) control.

The discount schedule contains the hours of each day of the week for which a particular discount percentage applies. The subscriber selects a discount hour via the USSD menu.

When a subscriber opens a data session during their selected hour, the PCRF rules handler checks if the subscriber has an active DS plan. If the check is successful, the PCRF sends a request to the DS service to get the subscriber's current DS discount. If the DS returns an OK response and a discount value, this discount is applied to usage reported for any plans the subscriber is using.

For data bundle plans, the discount is applied to the usage reported from the PCEF before it is sent to the SPCM.

For pay-per-use plans, the discount is appended to the rule name for predefined rules or specified in the Discount-Rate proprietary AVP in the Charging-Rule-Definition AVP for dynamic rules.

A subscriber may change their discount hour at any time but they may only use one discount hour on any day. If the subscriber has already used their discount hour that day, any change to the discount hour will only begin to apply on the following day.

4.10 Graceful Shutdown

You can gracefully shutdown the PCRF Rules Handler by setting it to run in an OFFLINE mode using the SE interface. In OFFLINE mode it does the following:

- rejects any new session requests
- terminates any existing session
- continues to process usage reports until all sessions are terminated

When moved to ONLINE, it does the following:

- stops the session terminations
- allows new sessions to be started again

The batch size and interval at which active sessions are terminated when in OFFLINE mode are configurable, as is the interval at which the number of busy instances is checked and output.

The shutdown process works as follows:

- 1 On starting up the PCRF rules handler, the diameter state manager state machine will be initialized as with other state machines.
- 2 When the Gx session, Rx session and rules handler service logic state machines initialize, each registers callbacks with the state manager to obtain the maximum number of instances, the number of busy instances, and check if an instance is busy. Only the Gx session state machine enables shutdowns when registering the callbacks as this is the entry point for Gx sessions in the PCRF and terminating a session here will trigger the session to be terminated in the rules handler service logic and the Rx session.
- 3 When the PCRF needs to be shut down for an upgrade, the operator sends an SE message to the diameter state manager state machine instructing it to go offline (set the stopSessions parameter to 1).
 - (a) This both stops new sessions and triggers the shutdown of all existing sessions in batches, as configured.
 - (b) In each interval, the diameter state machine sends a shutdown message to any busy instances of state machines that enabled shutdowns when registering their callbacks. In the case of the PCRF, this only entails the Gx session state machine.
 - (c) The Gx state machine must handle the shutdown message by requesting that the session be terminated on the PCEF. This triggers a CCR-T from the PCEF to the PCRF, which will terminate the session as required.
 - (d) While shutting down active sessions, the diameter state machine also checks the number of still busy instances on each of the registered state machine at the configured interval and outputs the result to the pm.log file. This informs the operator when all sessions have been terminated. The checking of busy instances can be enabled or disabled for the Gx session, Rx session, and rules handler service logic state machines as required.

- (e) At any point, the PCRF can be returned to ONLINE mode through a request to the diameter state manager. This stops the process of terminating existing sessions and also allows new sessions be started.
- 4 The current state and the number of busy and maximum instances in each of the registered state machines can be checked at any time by sending a request to the diameter state manager.

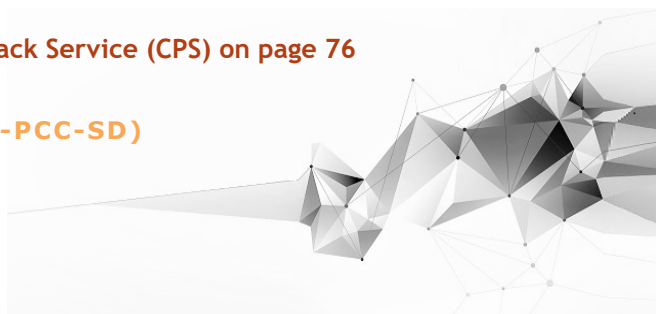
CHAPTER 5

Subscriber Policy and Charging Manager

This chapter provides an overview of Subscriber Policy And Charging Manager (SPCM) in the Tango Policy and Charging Control (iAX PCC) platform. It contains the following sections:

- [Introduction on page 35](#)
- [Data Plans on page 36](#)
- [Subscriber Provisioning on page 48](#)
- [Subscriber Self-Care on page 61](#)
- [Subscriber Notifications on page 66](#)
- [Group Accounts on page 68](#)
- [Policy Promotion Service \(PPS\) on page 73](#)
- [Combo Pack Service \(CPS\) on page 76](#)

iAX PCC Service Description v5.0 (iAX-PCC-SD)



5.1 Introduction

The Tango Subscriber Policy and Charging Manager (SPCM) allows for the management and configuration of subscriber accounts and data plans in the Tango iAX PCC. Notification messages can also be managed and configured in multiple languages.

The main function of the SPCM is to manage subscriber data plans (which can be purchased by the subscribers) and to notify the PCRF rules handler if a policy or charging control change is needed. In the event of such a change it will also notify the subscriber via SMS.

The SPCM:

- provides the PCRF rules handler with subscriber profile information at the start of a data session.
- provides the PCRF rules handler with usage-tracking parameters and processes the subsequent usage reports received from the PCRF rules handler.
- notifies the PCRF rules handler of subscriber profile changes, e.g. due to data-usage thresholds being exceeded or a data plan expiring.

Data usage can be monitored for a subscriber's data plans. The data usage may be categorised by time-band (e.g. Peak/Offpeak), location (e.g. Home/Roaming) or APN. If the total data usage exceeds a configured threshold value, the following actions may be taken:

- Notify the PCRF to change policy and/or charging control for data sessions.
- Send an SMS alert to the subscriber.

The SPCM also provides the following functionality:

- A self-care HTTP API to allow subscribers to purchase data plans, manage multiple data plans and view usage information.
- Tango Open Charging Interface (OCI) server to charge for data plans which are purchased by subscribers. The OCI server can be configured to use the appropriate online charging protocol as required by the third-party Online Charging System (OCS).
- An API to a third-party provisioning platform to create, update and query subscribers in the Tango PCC database.
- Maintenance of multiple usage counters for a data plan, e.g. daily or weekly counters with fair usage thresholds.
- Automatically provision subscribers who are not already on the system but who purchase a data plan via self-care.
- Batch provisioning of subscribers, including migration from legacy systems.
- A policy promotion web service to grant bonus plans to subscribers who have consumed a configured amount of existing plans.
- A combo pack service to bundle voice, SMS, or MMS plans as a bonus for subscribers who purchase a data plan.


5.2 Data Plans

Data plans can be defined under the **Policy > SPCM > Plan Mgmt** menu of the Tango PMI GUI. The Tango iAX PCC allows subscribers to purchase data plans. It tracks the data usage and manages quotas and policies on a per subscriber basis. Usage can be debited from a data plan before switching to the normal prepaid or postpaid **pay per use** charging when the data plan has been exhausted.

5.2.1 Core Data Plans

A Core plan is a plan that is automatically assigned to a subscriber when the subscriber is provisioned. A Core plan has the following attributes:

- Core plans cannot be deactivated
- Core plans are automatically activated on purchase
- Core plans must be recurring
- There cannot be more than one core plan (may be none)
- Core plans can be chargeable or non-chargeable
- Core plans are typically lower in precedence than add-on plans (unless the add-on plan is blocking all data access in which case any plan in a service blocking state will have the lowest precedence)

	<p>Generally plans are given precedence based on the following criteria:</p> <ul style="list-style-type: none"> • Plans with a service profile that blocks all data are given lowest precedence while plans with a non-blocking service profile are given the highest precedence • Plans with the same service blocking state are given precedence based on the precedence value assigned to them when the plan is created • For plans with the same assigned precedence value, QoS bit-rates are checked, with the higher rate taking precedence • For plans with the same QoS bit-rates, activation dates are checked, with the earlier activation taking precedence
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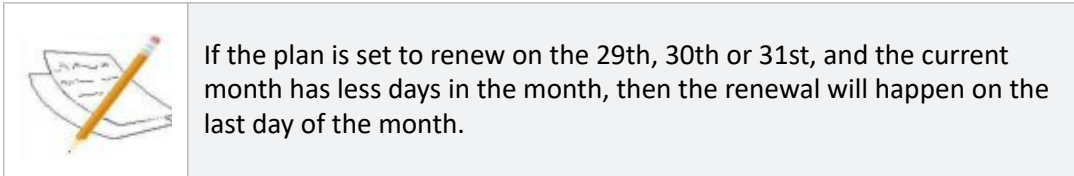
- Core plans will not appear on the self-care list of data plans that are available to be purchased
- There may be a pay-per-use type core plan which supports unlimited usage with no policy thresholds and no usage reset

5.2.2 Recurring Data Plans

A recurring plan is a data plan that is automatically recharged and the usage is reset after the validity period has expired. Recurring plans continue to be recharged automatically, until

cancelled by the user. This is in contrast to single-use data plans which are no-longer available once they have been exhausted.

Monthly recurring data plans also allow you to set a day-of-month for plan renewal. This allows you to set a specific day in the month for the plan to renew, e.g. on the 1st of every month.



Pro-Rating for Monthly Recurring Plans

A subscriber can purchase a recurring plan at any time during the month. If the subscriber buys the plan on a date that coincides with the start date for the plan then the subscriber has the full month to consume the plan (cost and/or volume). If however, the subscriber buys the plan at any other time during the month, the plan cost and allowed volume for the first billing period is calculated on a pro-rata basis depending the number of days (from plan activation) until the first plan renewal day-of-month.

The pro-rating feature can be enabled or disabled as required via configuration and is a system-wide feature. The following restrictions apply:

- Only applies to monthly recurring plans.
- If a monthly plan is configured with daily counters, these daily counters are not pro-rated, e.g. daily Fair Usage policy of 100MB - this daily counter is not pro-rated.
- Time-based usage thresholds are not supported.

The following examples illustrate how the pro-rating is applied.

Example 1

Plan A is a simple 1GB plan recurring on the 1st of every month with an SMS notification being sent to the subscriber at 80% usage. Assuming a 30-day month, if a subscriber buys the plan on the 15th of the month then they will be allowed 500MB of data usage for the remainder of the month and an SMS notification message will be sent to the subscriber at 400MB usage. **Table 5-1** shows an example pro-rating billing cycle.

Day of Month	Data Volume	SMS Notification Sent
1st	1GB allowed	800MB consumed
15th	500MB allowed	400MB consumed
21st	300MB allowed	240MB consumed
27th	100MB allowed	80MB consumed

Table 5-1: Pro-rating for First Billing Cycle - Simple Plan

Example 2

Plan B is a complex 1.25GB plan recurring on the 1st of every month (assuming a 30-day month) where: 1st 500MB is delivered at 21Mbps, 2nd 500MB is delivered at 1Mbps and the remainder is delivered at 128Kbps. An SMS notification is sent to the subscriber at 50%

consumed and at 80% consumed. **Table 5-2** shows an example pro-rating billing cycle for this plan.

Day of Month	Data Volume @ QoS			1st SMS Notification	2nd SMS Notification
	500MB @ 21Mbps	500MB @ 1Mbps	250MB @ 128Kbps		
1st	500MB @ 21Mbps	500MB @ 1Mbps	250MB @ 128Kbps	50%	80%
15th	250MB @ 21Mbps	250MB @ 1Mbps	125MB @ 128Kbps	312.5MB consumed	500MB consumed
21st	150MB @ 21Mbps	150MB @ 1Mbps	75MB @ 128Kbps	187.5MB consumed	300MB consumed
27th	50MB @ 21Mbps	50MB @ 1Mbps	25MB @ 128Kbps	62.5MB consumed	100MB consumed

Table 5-2: Pro-rating for First Billing Cycle - Complex Plan

Roll Over Usage for Recurring Plans

Subscriber usage that is not consumed in one time period can be carried over to the next recurring period. Plans can be configured to allow rollover or not during the plan definition process.

If rollover is enabled, a limit can be defined for the volume of usage that is allowed to be carried over. Any unused data above the rollover limit is lost to the subscriber.

For example: A subscriber has a monthly recurring plan with 1GB of data usage. Last month he had 300MB of unused data left over at the end of the month. The plan has a rollover limit of 200MB. Only 200MB from his unused data can be rolled over into the next billing cycle.

Limited Cycles for Recurring Plans

This feature enables the operator to set limits on how many times a plan can recur.

If the operator wants to limit the plan to 3 renewals, this is achieved by setting a maximum occurrence limit of 4 during the plan definition process.

At the plan renewal time, the system will check the “occurrenceCount” of the plan. If it matches the “maxOccurrenceCount” then the plan will not be renewed.

For example: If the “maxOccurrenceCount” is set to 4 the following cycle occurs. The plan is renewed 3 times as desired which means there are a total of 4 occurrences of the plan.

Subscriber Usage	Occurrence Count	MaxOccurrence Count	Action at Expiry Time
1st time plan is used	1	4	Plan is renewed
2nd time plan is used	2	4	Plan is renewed
3rd time plan is used	3	4	Plan is renewed

4th time plan is used	4	4	Plan is not renewed; Expiry Warning notification is sent (if configured).
-----------------------	---	---	---------------------------------------------------------------------------

The following rules apply to the maximum occurrence count for data plans.

- The “maxOccurrenceCount” parameter is set per plan and not per subscriber.
- There is no overall expiry timer on the plan. It expires based on the cycle (i.e. weekly, monthly) in conjunction with the maximum occurrence count. Therefore, if the plan is configured as weekly and the maxOccurrenceCount is 3, it will have a lifetime of 3 weeks.

5.2.3 Plan Top Up

This feature supports adding volume or time to a plan via the PMI.

- If a subscriber has a 1GB plan and 0.1GB is unused, it is possible to add 200MB to the plan. It then becomes a 1.2GB plan with 0.3GB unused.
- If the rollover feature is enabled, the volume added via plan top-up is treated the same as normal plan volume where unused data is rolled-over up to the maximum limit. When the plan thresholds are exceeded notifications will be sent multiple times.
- If a plan is consumed and a volume top-up is done, the plan will revert to active status.
- Threshold notifications will be sent multiple times when the top-up feature is used, e.g. a notification is sent when 80% of the plan is consumed; volume is subsequently added reducing the usage to 70%; when the usages exceeds 80% again a notification will be sent for the second time.
- If a plan is due to expire at 16:30pm and two hours are added then the plan will now expire at 18:30pm.



The following top-up requests will be rejected:

- Validity period top-up for a recurring plan
- Validity period top-up for a plan with no validity period
- Volume top-up for an unlimited plan
- Any type of top-up when plan is in the process of being purchased or expiring

5.2.4 Add-On Data Plans

Add-on data plans can be purchased as a supplement to the core or recurring data plans at any time for an additional charge. This allows the subscriber an additional specified amount of data for a limited time period. An add-on data plan can also be assigned as a bonus plan to a subscriber whereby the subscriber gets the bonus data plan on sign-up, on special occasions, etc.

Add-on plan precedence is determined by the following criteria in order:

- 1 It's service-blocking state
- 2 The precedence value assigned when the plan is created
- 3 It's QoS bit-rate
- 4 It's activation time

5.2.5 Time-Metered Plans

For time-metered plans, subscriber usage is based on active time quotas where active means the length of time a rule from the plan is installed **and** active¹ on the PCEF. There are a few restrictions with time-metering as follows:

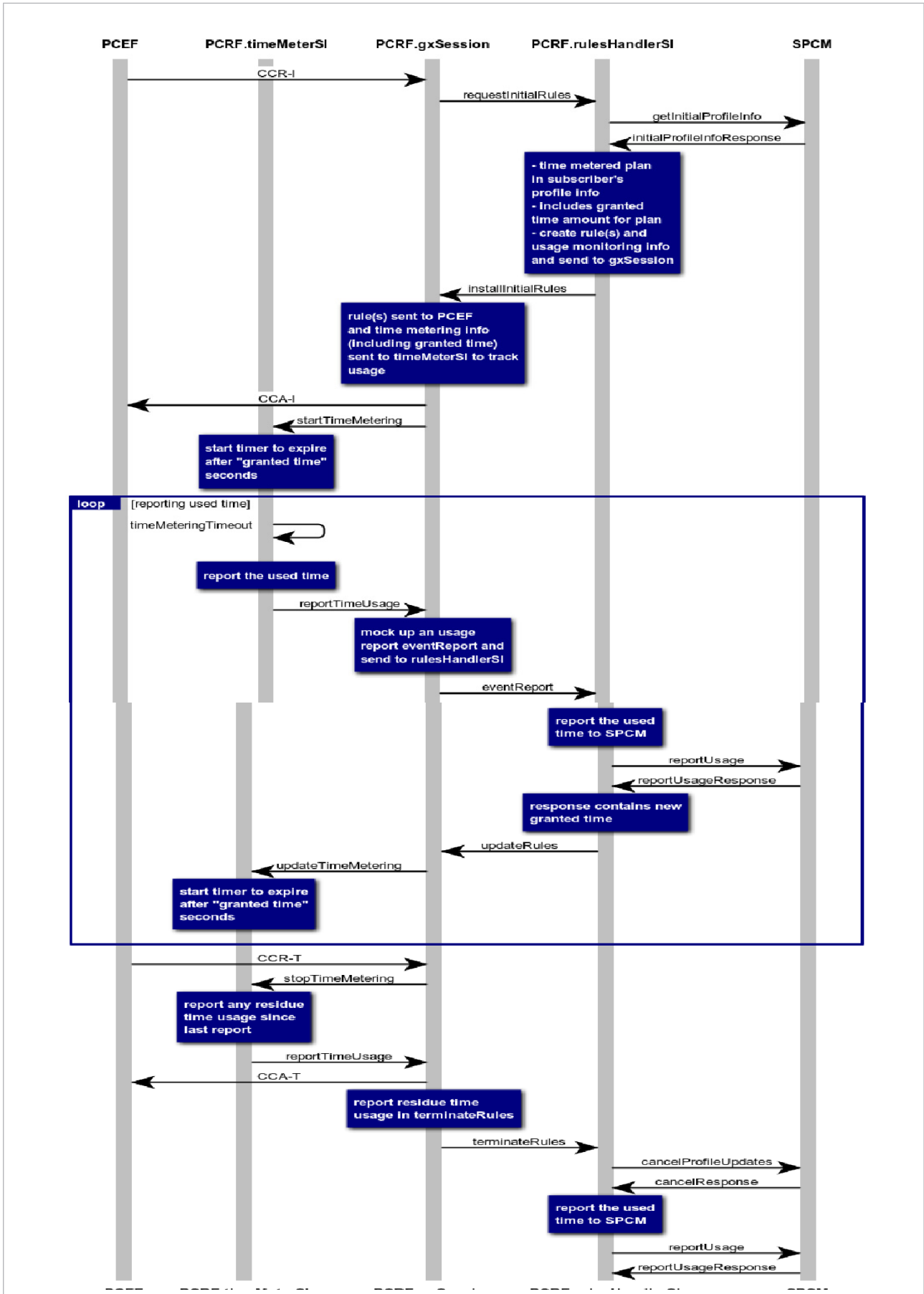
- Time Metering cannot be service or rule specific so only time metered plans that allow all services are supported. They are measured internally based only on the length of time that a rule from the time metered plan is installed and active on the PCEF.
- A subscriber cannot have another active plan (either volume or time metered) if they have an active time-metered plan. For example, if a subscriber had a time metered plan (e.g. two hour plan enhanced QoS) and also a volume metered Facebook plan, then both plans would be installed on the PCEF. The PCRF would start counting time for the time metered plan but the subscriber could actually be using Facebook, therefore double counting the Facebook usage.

When a subscriber terminates his/her session, the time tracking stops. This makes it possible to pause/resume a time metered plan and therefore consume the plan over multiple sessions.

The state machine timeMeterSI assigns a time meter to each rule generated from a time metered plan and periodically checks which time meters have reached their granted time quota. It then reports the used time to the existing gxSession state machine which in turns reports it to the rulesHandlerSI state machine and SPCM.

The following sequence diagram shows the flow of messages between state machines and processes where a subscriber has a time metered plan which he uses during a session:

1. Time-metered plans are considered active based on the time they are scheduled to become active and deactivate via Rule Activation Time and Rule Deactivation Time AVPs.



- 1 The session starts as normal when the gxSession state machine receives a CCR-I from the PCEF.
 - (a) The gxSession requests rules from the rulesHandlerSI which in turn requests subscriber profile information from the SPCM.
 - (b) SPCM responds with subscriber profile which contains the subscriber's time metered plan information. (This will indicate the metering type is "time" and the information will also include the granted time for the plan).
 - (c) The rulesHandlerSI processes the plan information as normal, creating rules, usage monitoring info etc. and sends them to gxSession
- 2 The gxSession sends the rules in a CCA-I to the PCEF. However, as the usage monitoring for the rules is time metered, the usage monitoring information is not included in the CCA-I.
 - (a) Instead the time metering info is sent to the timeMeterSI via the startTimeMetering message to start time metering for this session
- 3 The timeMeterSI starts a timer to expire when the granted time has been used up
 - (a) The timer reports the used time to gxSession via a reportTimeUsage message, which in turn reports the time usage to the rulesHandlerSI via a usage report eventReport (event trigger 26)
 - (b) The rulesHandlerSI handles the usage report as normal by reporting the usage to SPCM, waiting for the response and then responding to gxSession with the updated usage monitoring information containing the new granted time for the rule
 - (c) The gxSession restarts the time metering for the session by sending an updateTimeMetering to the timeMeterSI with updated time metering info (including new granted time amount)
 - (d) Step 3 then repeats over and over until the plan's time quota is fully consumed (at which point SPCM would send a subscriber profile update notification which would trigger a RAR to PCEF to remove the rules from the time metered plan) or until the session is terminated
- 4 When the subscriber does terminate the session, the PCRF's gxSession receives a CCR-T
 - (a) The gxSession sends a stopTimeMetering request to timeMeterSI to stop the time metering for the session
 - (b) The timeMeterSI reports any residue usage since the last usage report back to gxSession which it forwards to the rulesHandlerSI in the terminateRules request
 - (c) This usage is then reported to the SPCM as normal

5.2.6 Data Plan Categorisation

Data plan categorisation allows you to define categories of subscribers which are permitted to purchase certain data plans. The subscriber categories may be based on billing type

(prepaid/postpaid), subscriber class (e.g. standard/premium) or IMSI range (e.g. MVNO brand).

5.2.7 QoS Boost

An add-on can be purchased with QoS boost for a limited period to enhance the quality of service delivered to the subscriber.

This QoS boost will supersede the default QoS of the core plan and can be started via subscriber self-care.

5.2.8 Bill Shock Control

The following features are supported to enable bill shock control as required by EU regulations:

- Tracking of credit usage by location.
- Calculation of credit usage based on a configurable rate which is applied to volume usage.
- Configuration of SMS credit usage warnings via the PMI GUI for data-plans.
- Blocking or restricting of data services (via QoS downgrade) when credit usage threshold is reached.
- Counters for daily/weekly/monthly credit usage.
- Disabling of warnings or policy changes related to credit usage via self-care.
- Modification of credit usage warnings or policy changes threshold values via self-care.
- Re-activation of disabled warnings or policy changes after a configurable period of time.
- Configuration of rates and usage rules via customer-care GUI based on geographic zones.

5.2.9 Data Plan Lifecycle

This section describes the lifecycle of a data plan in the Tango iAX PCC platform. **Figure 5-1** shows an illustration of the data plan lifecycle.

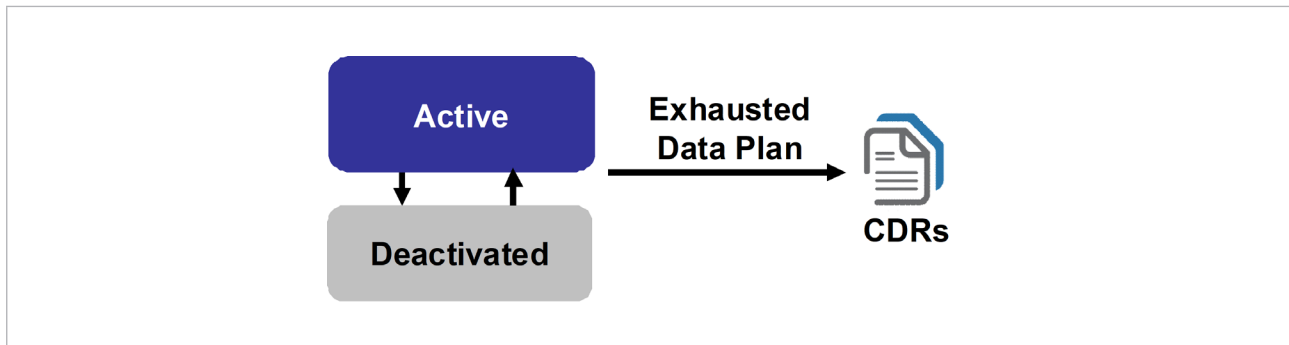


Figure 5-1 Data Plan Lifecycle

Plan Activation

Plans can be activated in any of the following ways:

Default

The plan is automatically activated on purchase.

Deferred Activation

The subscriber can request that the plan becomes active at a future date and time.

The future date and time (**activationtimestamp**) is specified when the plan is purchased by a subscriber. The plan will be in a state of “Activation Pending” until that time and date is reached. The plan will move into an “Active” state at the specified time and date.

If the plan is not activated on purchase and a future date and time is not set, then the plan must be activated via the PMI or an API call. The current date and time will be used if an activation date is not supplied.

The following rules apply to deferred plan activations:

- There is an overall restriction of 5 plans per subscriber. Each deferred plan will count as one plan against the 5 plan limit. The plan limit is configurable and can be set to less than 5 if desired.
- The activation date and time must be greater than the current date and time; if the date is in the past the plan will be activated immediately.
- For non-recurring plans a validity period can be set. The validity period means the plan is valid for a defined period from the purchase date and **not** the activation date.

Deferred plan activation is not supported for recurring plans.

First Usage Activation

The plan is in an activation pending state after purchase and when the first usage report for the plan is received the plan will be activated; the **validity** period of the plan starts and **expiry timestamp** is calculated at this stage.

In this case the plan definition will have an activation pending timeout period and plans will be terminated if they are not activated within this time period.

First Usage plan activation is not supported for recurring plans.

Active Data Plans

A subscriber can have multiple active data plans. The following rules apply to determine which data plan is used when a subscriber has purchased multiple data plans:

- When a data plan is defined, it is assigned a precedence value. This data plan information is passed by the SPCM to the Tango PCRF which then prioritises the rules accordingly.
- If the data plans have equal precedence, the data plan activation date is taken into account, where the oldest data plan is used first, followed by the next oldest data plan, etc.
- Add-on data plans always have a higher precedence than core data plans and will be used first.

Activated/Deactivated Data Plans

An active data plan can be deactivated and subsequently reactivated by the subscribers via their self-care application. The following rules apply to deactivating/activating data plans:

- All plans, **except for Core plans** can be deactivated. If a time-based plan is deactivated, the expiry period of the plan is extended by the length of time the plan was deactivated for.
- All data plans can be set to deactivated at purchase time, so that they can be later activated via self-care or on the PMI.
- When a data plan is deactivated, the subscriber will not be able to access any data services using that plan. However, data services may be available if the subscriber has another active data plan.
- Each data plan (except Core plans) has a configurable maximum number of deactivations.
- Each data plan (except Core plans) has a configurable maximum deactivation time, e.g. 2 weeks. The data plan will automatically be activated after this time period has elapsed.

Exhausted Data Plans

Exhausted data plans are data plans that have reached their volume or time limits. The next active data plan (if available) is then activated for use.

5.2.10 Plan Versioning

An operator can create a new version of an existing Plan Definition. This allows for changes in requirements for plan definitions that are already in use. It allows the flexibility to create a new version of the same plan with the necessary changes included. Only one version of a plan definition can be 'Available' at any one time.

Plans purchased will be created based on the 'Available' plan definition version. Existing plans will continue to use the old version until they renew.

It is also possible to clone a plan definition to create second plan with exactly the same features.

5.2.11 Data Plan Rules

The following set of rules set out the criteria that is used to control the creation and use of data plans in the Tango Policy & Charging Control (iAX PCC) platform.

- Before a subscriber uses the data network for the first time, they are asked to purchase a data plan. If the subscriber does not want to purchase a data plan, they can select the **pay per use** option.
- When a new subscriber purchases a data plan via self-care they are automatically provisioned on the system. If multiple data plans are active, the data plan to be used is determined by the active data plan rules described in **Plan Activation on page 44**.
- When a subscriber ,who is not currently provisioned on the system, purchases a data plan via self-care, that subscriber is automatically provisioned.
- All data plans have a time limit. The timer is started when the data plan is activated.
- When an active data plan has been exhausted, the next active data plan (as determined by the active data plan rules described in **Plan Activation on page 44**) is used. If no active data plan is available, the subscriber is notified and the charging automatically switches to **pay per use**.
- Volume-limited data plans are exhausted when the volume limit is reached, or the time limit is reached, whichever happens first. If the time limit is reached first, the remaining volume is discarded.
- Time-limited data plans are exhausted when the time limit expires.

5.2.12 Fair Usage Policy

A fair usage policy can be applied to all data plans. A fair usage limit is a volume limit which can be applied to time-limited data plans. When this configurable volume limit (fair usage limit) for a time-limited data plan is reached, the data plan is deemed to be exhausted and the next active data plan (as determined by the active data plan rules described in **Plan Activation on page 44**) is used. A fair usage policy can also be configured to downgrade the QoS at a configurable usage threshold level.

If no active data plans are available, the subscriber is notified and **pay per use** charging is applied.

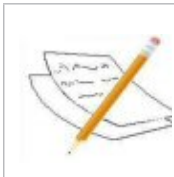
5.2.13 Data Plan Policy Management

The SPCM manages configurable policy profiles which are associated with data plans. A data plan can have multiple policy profiles which may be activated depending on the subscriber usage.

A policy profile may contain the following attributes:

- Service Profile - allowed IP addresses
- QoS Profile - QoS parameters
- Charging Profile - rating group, metering method, payment type

- Location Profile - location constraint for Service, QoS, Charging
- Time Profile - time constraint for Service, QoS, Charging
- APN Profile - APN constraint for Service, QoS, Charging



A Policy Profile must contain at least a Service Profile or QoS Profile.

5.2.14 Meter at Discount Rate

This feature allows operators to configure (via the PMI) what percentage of the total data consumed by a subscriber is reported, based on a selection of parameters. Percentages may be assigned to the plan usage counters based on conditions such as:

- Location
- Time-band
- Device
- Network

This means that an operator can set a percentage discount, e.g. off-peak, based on a specific location or based on network type, etc.

5.3 Subscriber Provisioning

The Tango iAX PCC subscriber provisioning service provided by the SPCM allows third-party platforms to provision and update subscriber accounts on the Tango iAX PCC platform. Subscribers can be provisioned individually via the PMI GUI or self-care, or they can be provisioned in bulk by importing the subscriber information from a file (including existing legacy data plans). A subscriber purchasing a data plan for the first time is also automatically provisioned on the system if they are not already included. Some features of the provisioning service include:

- Subscribers may be auto-provisioned when they purchase their first data plan.
- A welcome SMS is sent to the subscriber.
- Up to 100,000 subscribers may be batch-provisioned from a single file.
- Subscribers with active plans from other platforms may be migrated to the Tango iAX PCC with no disruption to the active data plan.

The following subscriber parameters may be defined for each subscriber by the provisioning platform:

- MSISDN (mandatory)
- IMSI
- Payment Type: prepaid, postpaid or unknown
- Subscriber Class
- Language
- Core Plan (if previously defined for the subscriber)
- Status: active or inactive
- Location Zone
- Billing Day of Month

The Tango iAX PCC subscriber provisioning platform also allows subscriber updates. The following subscriber attributes may be updated:

- IMSI
- Payment Type: prepaid, postpaid or unknown
- Subscriber Class
- Language
- Status: active or inactive
- Location Zone: home location zone for the subscriber
- Billing Day of the Month

The Tango iAX PCC system will return an error report per subscriber in the case of provisioning failures.

5.3.1 Subscriber Provisioning Call Flows

The following sections show the call flows associated with subscriber provisioning over the HTTP REST API in the Tango iAX PCC.

Provisioning a Single Subscriber with a Chargeable Core Plan

Figure 5-2 shows the call flow for this subscriber provisioning task.

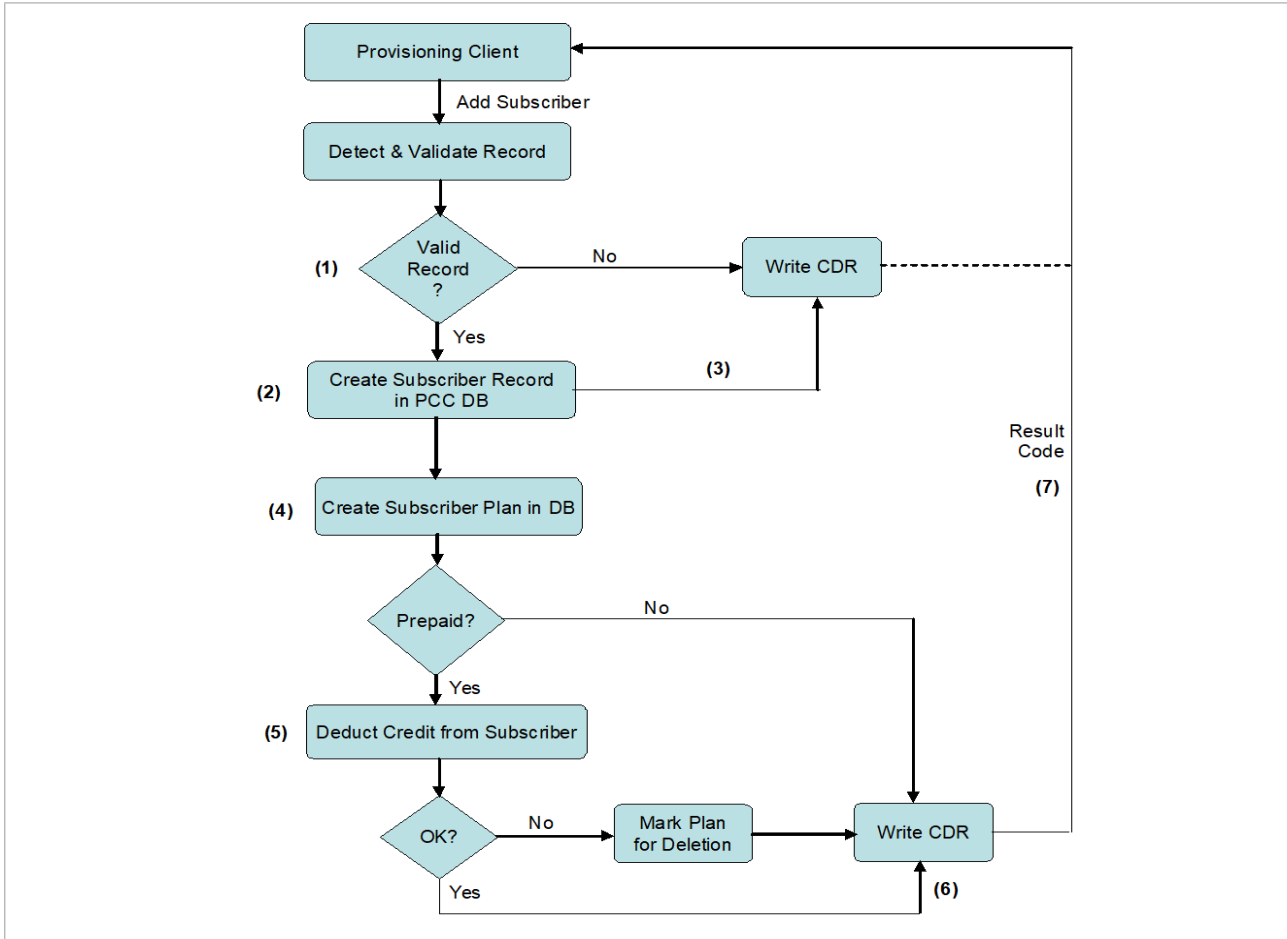


Figure 5-2 Provisioning a Single Subscriber with a Chargeable Default Plan

- 1 The SPCM detects and validates the subscriber provisioning request.
- 2 The SPCM creates a subscriber record in the PCC database.
- 3 The SPCM generates a Subscriber Creation CDR.
- 4 The SPCM creates the subscriber plan record in the PCC database which includes the following information:
 - Plan status (depends on whether the plan is auto-activated or purchased)
 - Plan recurrence flag
 - Usage counters
 - Usage rules

- Usage timers
- The SPCM debits the charge for the data-plan from the subscriber's account over the open charging interface.
 - The SPCM generates a Subscriber Plan Added CDR.
 - The SPCM returns a successful result code to the subscriber provisioning client.

Provisioning of Multiple Subscribers from a Remote Client - successful

Figure 5-3 shows the call flow for this bulk provisioning task.

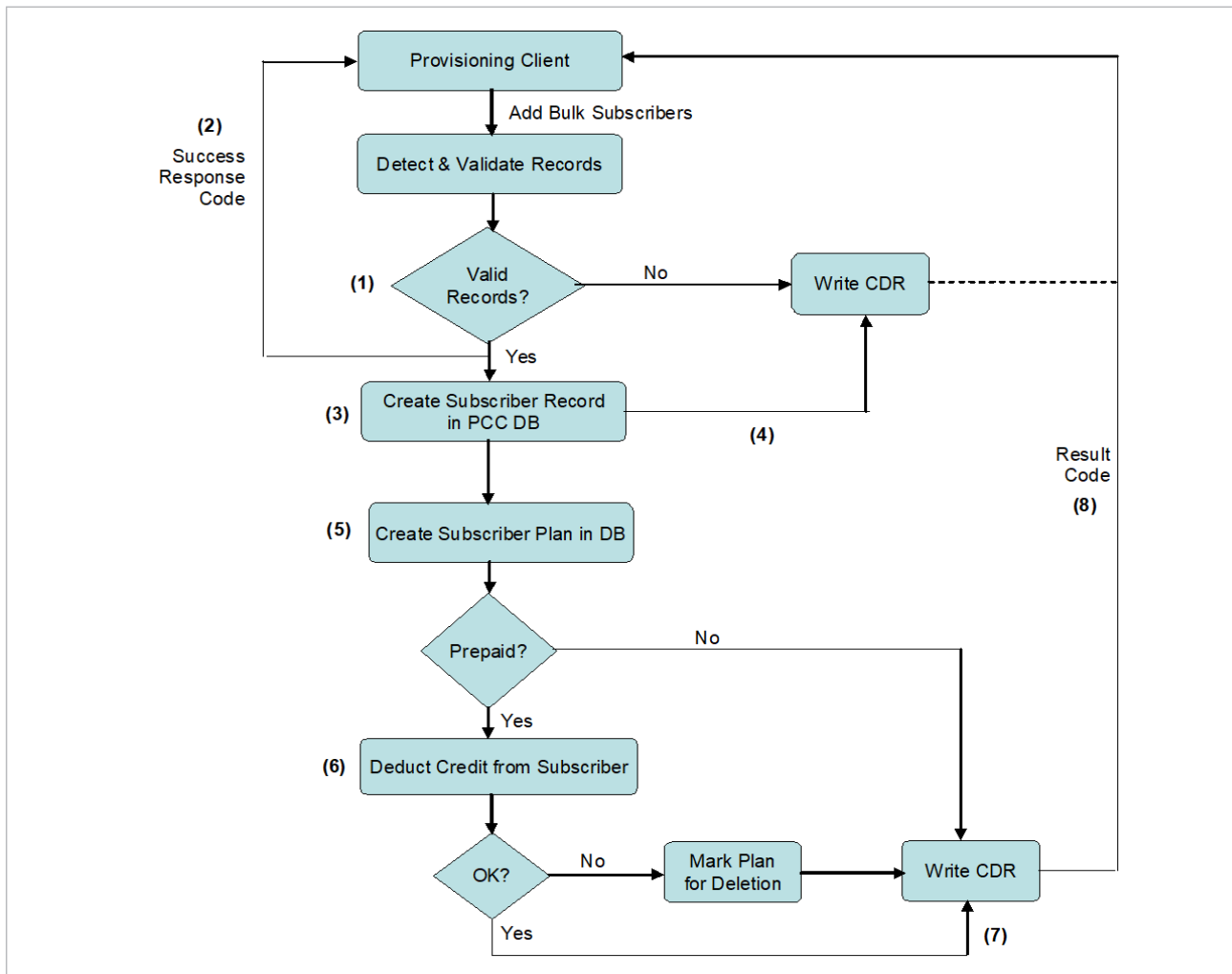


Figure 5-3 Bulk Subscriber Provisioning - All Successful

- The SPCM detects and validates the subscriber provisioning request. All the subscriber provisioning requests are detected as valid.
- The SPCM returns a success response code to the subscriber provisioning client.



The SPCM may be configured to return this response code after validation or after subscriber creation.

- 3 The SPCM creates the subscriber records in the PCC database.
- 4 The SPCM generates a Subscriber Creation CDR.
- 5 If a core plan is specified, the SPCM creates the subscriber plan records in the PCC database, including the following information:
 - Plan status (depends on whether the plan is auto-activated or purchased)
 - Plan recurrence flag
 - Usage counters
 - Usage rules
 - Usage timers (e.g. validity-expiry, usage-reset)
- 6 If a charge is applicable for the core plan the SPCM debits the charge from the subscribers account over the open charging interface.
- 7 The SPCM generates a Subscriber Plan Added CDR.
- 8 The SPCM returns a successful result code to the subscriber provisioning client.

Bulk Provisioning of Multiple Subscribers with Some Failures

Figure 5-4 shows the call flow for this bulk provisioning task.

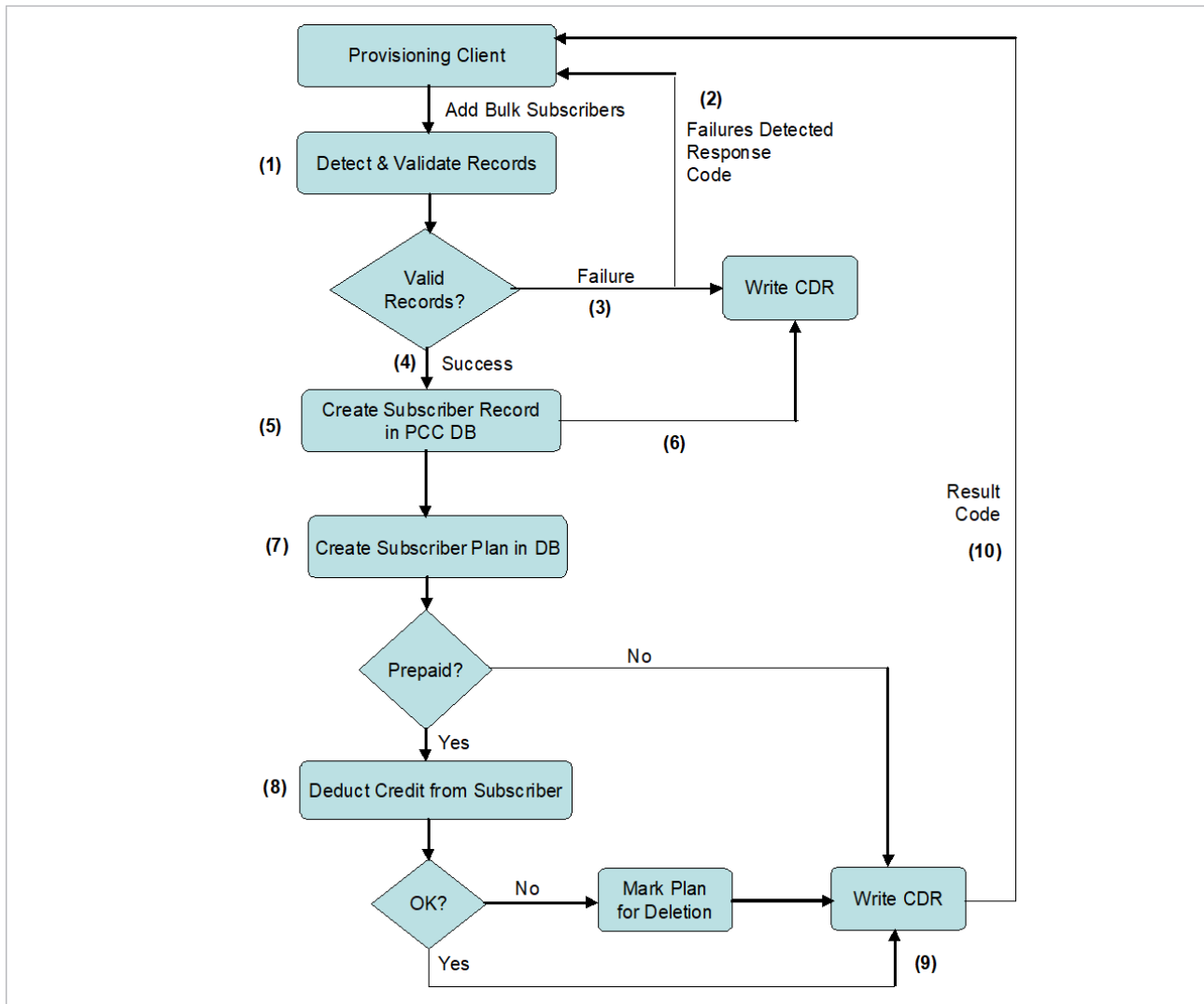
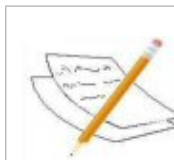


Figure 5-4 Bulk Subscriber Provisioning - Some Failures

- 1 The SPCM detects and validates the subscriber provisioning request and some subscribers are detected as already existing.
- 2 The SPCM returns a response to the subscriber provisioning client with a report on the subscribers that failed.

There is an entry for each subscriber with MSISDN, IMSI and failure code (subscriber already exists).



The SPCM may be configured to return this response after validation or after subscriber creation.

- 3 The SPCM generates a Subscriber Creation Failure (subscriber already exists) CDR for each subscriber that already exists.
- 4 Provisioning continues for valid subscribers.
- 5 The SPCM creates the subscriber records in the PCC database.

- 6 The SPCM generates a Subscriber Creation CDR.
- 7 If a core plan is specified, the SPCM creates the subscriber plan records in the PCC database, including the following information:
 - Plan status (depends on whether the plan is auto-activated or purchased)
 - Plan recurrence flag
 - Usage counters
 - Usage rules
 - Usage timers (e.g. validity-expiry, usage-reset)
- 8 If a charge is applicable for the core plan the SPCM debits the charge from the subscribers account over the open charging interface.
- 9 The SPCM generates a Subscriber Plan Added CDR.
- 10 The SPCM returns a successful result code to the subscriber provisioning client.

5.3.2 Subscriber Meta-data

A web service is available that allows the provisioning of subscriber meta-data along with the normal SPCM subscriber account fields. Batch provisioning of subscriber meta-data is also supported via the batch provisioning tool.

Table 5-3 describes the meta-data fields that are supported.

Field Name	Type	Description
MSISDN	String	Subscriber identity
First name	String	Subscriber name string
Initial	String	Subscriber middle name string
Second name	String	Subscriber name string
Date of birth	Date	Number of seconds that have elapsed since the subscribers date of birth.
Sign up date	Date	Number of seconds that have elapsed since the subscriber was provisioned.
Gender	String	Male or female subscriber
IMSI	String	The IMSI for the subscriber
Notification Profile	NotificationProfile	The preferred notification type for the subscriber. The following options are available: <ul style="list-style-type: none"> • None • SMS • SMS Alternative • Email • Email Alternative
Audit Info	AuditInfo	The audit information for the subscriber.

Table 5-3: Subscriber Meta-data Fields

Field Name	Type	Description
Custom Field 1	String	The custom fields section allows for storage of metadata custom information. NOTE: Each field is 64 characters wide.
Custom Field 2	String	
Custom Field 3	String	
Custom Field 4	String	
Custom Field 5	String	
Custom Field 6	String	
Custom Field 7	String	
Custom Field 8	String	
Custom Field 9	String	
Custom Field 10	String	
Custom Field 11	String	
Custom Field 12	String	

Table 5-3: Subscriber Meta-data Fields

Subscriber Meta-Data Batch Provisioning

The bulk provisioning tool provides the facility for loading subscriber meta-data via a comma separated file. The format of the comma separated file is shown below:

```
<tag>,<msisdn>,<first name>,<initial>,<second name>,<date
of birth>,<signup date>,<gender>,<imsi>,<notification
type>,<primary email>,<secondary email>,<secondary
msisdn>,<cumulative spend>,<custom fields>
```

An example meta-data batch provisioning file entry is shown below:

```
Metadata,22345,John,J,Doe,1960-03-06,2011-12-
14T00:00:00,male,22345-
0,sms,p@email.com,s@email.com,223452,2.34,custom1,custom2
,custom3,custom4,custom5,custom6,custom7,custom8,custom9,
custom10,custom11,custom12
```

5.3.3 Batch Provisioning Tool

A subscriber batch provisioning tool is available for the bulk entry of subscribers into the Tango DRE system. The tool is run on a permanent basis as an application under the control of the process manager.

You can provision subscribers and provision the corresponding plans for each subscriber. The subscriber details and plan details are loaded from a CSV-formatted file. The file is automatically processed when copied (or sent by FTP) into a configurable file-input directory. When the CSV input file has been processed, a report is written to file and a log file is also generated.



The insertion of a large number of new subscribers is a very intensive database activity so it is recommended that this tool should only be exercised during periods of low traffic on the system.

When running this application the user must provide a CSV file containing the subscribers. The format of the input file is described in section

When the script is running as a managed process in provisioning mode you copy the CSV file into the pre-configured file input directory, the file will be automatically processed and a report and log files generated. Note: When provisioning subscribers it is important that the subscribers are only provisioned on the node with the active database. So, do not copy the CSV file on to the node with the backup database.

CSV file format

The CSV format file can have two types of records:

- Subscriber
- Plan

The subscriber type record is defined below in **Table 5-4**.

Parameter Name	Mandatory /Optional	Definition	Sample
recordType	M	The record type defines if a subscriber or plan is being added. When set to the string "subscriber" then a subscriber record will be added. Note field is case sensitive.	subscriber
msisdn	M	The E.162 subscriber number in international format including the CountryCode (CC) and National destination Code (NDC).	353871234567
imsi	M	The subscriber IMSI number.	98712345987
subscriberType	M	String defining the subscriber type. Allowed values are as follows: <ul style="list-style-type: none"> • prepaid • postpaid • unknown NOTE: The field is case sensitive.	prepaid
SubscriberClass	M	String defining the subscriber class. Note field is case sensitive.	standard
SubscriberStatus	M	String defining the current subscriber status. Permitted values include the following: <ul style="list-style-type: none"> • active • inactive • barred NOTE: This field is case sensitive.	active

Table 5-4: Subscriber CSV File Format

Parameter Name	Mandatory /Optional	Definition	Sample
language	M	String defining the subscribers preferred language, for example English, French, German, Spanish, Italian etc. NOTE: This field is case sensitive.	English
dpsEnabled	O	This Boolean flag indicates whether the subscriber is subscribed to DPS for Data	true
dpsNotificationEnabled	O	This boolean flag indicates whether the subscriber's DPS notification enabled flag is set or not. Defaults to value in property <code>spcm.subscriber.dps.notification.enabled.default</code> .	true
imei	O	The International Mobile Station Equipment Identity of the subscriber's handset.	54654688
locationZoneName	O	The name of the subscriber's home location zone.	Zone1
subscriberBillingDate	O	Day of month for subscriber billing date (1-31). Setting this field to 0 indicates no subscriber billing date is set.	0
eosNotificationEnabled	O	This Boolean flag indicates whether the subscriber's end-of-session notification message is enabled or not. It defaults to the value set in the property <code>spcm.subscriber.eos.notification.enabled.default</code> .	true
paygNotificationEnabled	O	This Boolean flag indicates whether the subscriber's pay-as-you-go notification message is enabled or not. It defaults to the value set in property <code>spcm.subscriber.payg.notification.enabled.default</code> .	true
AlternateNotificationMsisdn	O	This is an alternate MSISDN that will be used as a destination address for notifications if configured.	353877654321
tag	O	This is an optional field for providing extra information about a subscriber or their category.	abc123

Table 5-4: Subscriber CSV File Format

The plan record type is defined below in table

Parameter Name	Mandatory /Optional	Definition	Sample
recordType	M	The record type defines if a subscriber or plan is being added. When set to the string "subscriber" then a subscriber record will be added. Note field is case sensitive.	plan

Table 5-5: Plan CSV File Format

Parameter Name	Mandatory /Optional	Definition	Sample
msisdn	M	The E.162 subscriber number in international format including the CountryCode (CC) and National destination Code (NDC).	353871234567
imsi	M	The subscriber IMSI number.	98712345987
planName	M	This is a string defining the name of the plan being added for the subscriber. The plan should already exist on the system. NOTE: This field is case sensitive	30DAY_1GB_Prepaid_NO_CHARGE
planState	M	This string defines the current state of the plan. The allowed values are <ul style="list-style-type: none"> active inactive NOTE: This field is case sensitive.	active
volumeUsed	M	This numeric value defines the volume of data previously used by the subscriber before migration to the Tango DRE platform. This value is in bytes. The default value is zero. This parameter would only be used in migration mode.	2345678
expiryDateTime	M	This string defines the expiry date for the plan for the specific subscriber. If the parameter is not present then the plan will be unlimited. Format: "YYYY-MM-DDThh:mm:ss" where: <ul style="list-style-type: none"> YYYY indicates the year MM indicates the month DD indicates the day T indicates the start of the time section hh indicates the hour mm indicates the minute ss indicates the second 	2013-03-12T17:44:10
planInfo		Identifier used to record the plan instance purchase source.	98797

Table 5-5: Plan CSV File Format

For example, if a subscriber has a core plan (e.g. `PayPerUse_Prepaid`) and an addon plan (e.g. `30DAY_1GB_PREPAID_NO_CHARGE`), there will a single row of record type `subscriber` and two rows of record type `plan`.

```
subscriber,353870000000,870000000,prepaid,standard,active,English,,,
```

```
plan,353870000000,870000000,PayPerUse_Prepaid,active,2345678,2013-03-12T17:44:10,2121
```

```
plan,353870000000,870000000,30DAY_1GB_PREPAID_NO_CHARGE,active,2345678,2013-03-12T17:44:10,2121
```

Subscribers can be added without any plan records. Subscriber can be added with multiple plan records; there is no limit of the number of plans that can be configured for each subscriber.

File input directory

The CSV file is automatically processed when it is copied or sent by FTP into the file-input directory. The default directory location is `/tango/data/spcm-provision/file-input` but you can modify that location in the properties file. Files placed in this directory that do not conform to the expected format are processed but the report file will indicate errors (i.e. skip count).

Report file

Subscriber batch provisioning job reports are deposited in the reports directory. The default directory location is `/tango/data/spcm-provision/report` but you can modify that location in the properties file. A report file is created for each input file.

The following is a sample report file:

```
/tango/data/spcm-provision/report/2MSubs-From-0640000000_1.report
```

```
File Name : 2MSubs-From-0640000000_1.csv
```

```
Start Time : 2013-10-02T14:06:05
```

```
Read Count : 2000000
```

```
Write Count : 2000000
```

```
Skip Count : 0
```

```
Step Exit Status : COMPLETED
```

```
Batch Status : COMPLETED
```

The fields of the report file are defined in **Table 5-6**.

Parameter Name	Definition	Sample
File Name	The name of the file processed.	2MSubs-From-0640000000_1.csv
Start Time	The date and time the file was processed.	2013-10-02T14:06:05
Read Count	The number of records (rows) read from the file.	2000000
Write Count	The number of records processed and added to the system.	2000000
Skip Count	The number of records skipped due to error.	0
Step Exit Status	The exit status for the batch provisioning tool. Possible values are: <ul style="list-style-type: none"> • COMPLETED • FAILED 	COMPLETED

Table 5-6: Report File Output Fields

Parameter Name	Definition	Sample
Batch Status	The result of the batch processing. Possible values are: <ul style="list-style-type: none"> • COMPLETED • FAILED 	COMPLETED

Table 5-6: Report File Output Fields

Log file

The subscriber batch provisioning log resides by default at `/tango/logs/policy/spcm/spcm-subscriber-provision-batch.log`

You can change this default location in the `PM.cfg` file using the command line argument `-l`.

This file is rolled over at midnight and date and time stamped.

5.3.4 Locations and Location Zones

The Tango PCC solution supports different policy treatment based on the subscribers location. Locations are defined and grouped as follows in the system:

- The **Network Location** is the actual location on the network where the subscriber is, this has a unique value/ID assigned to it.
- A **Location** is a group of network locations and rates are assigned per location.
- A **Location Profile** defines a group of locations. The location profile is used when a plan is being created to allow different policy control settings and constraints to be applied based on the underlying subscriber location.
- A **Location Zone** defines a group of location profiles. The location zone is used when a subscriber is being added to identify the subscribers location (typically the home location). A location zone can have up to 4 location profiles associated with it.

Location Zones

The location zone feature allows for the creation of plans that can only be used when a subscriber is in their home location zone. Furthermore this feature allows for service differentiation based on specific location profile within the their home location zone.

This feature supports 4 location profiles within a subscribers home location zone.

The features of location zones include:

- Location zones can be created and managed via the GUI.
- A location zone can be specified for a subscriber when they are provisioned. Each subscriber can have one home location zone.
- Each location zone has unique name and has up to four locations associated with it.
- Typically, the location zone and associated location profiles are a one off configuration set up on the UI. However, a location zone can be modified via the UI. The location zone name and the underlying subscriber location profiles can also be changed.

5.3.5 Billing Date

Each subscriber can define a billing date to suit themselves. It is possible to set and change the subscribers monthly billing date on the UI. The subscriber billing date has higher precedence than a plan renewal date; therefore if a billing date is not set the plan renewal date will be used by default.

There are two modes of operation to choose from at installation as follows:

Billing Date Changed Immediately

- The subscribers current recurring plan is terminated and is restarted from the current time with the new billing date.
- The subscriber loses any remaining usage allowance from the previous recurring plan.
- For the first billing cycle of the new recurring plan, the cost and usage allowance is pro rated until the new billing date.

Billing Date Changed on Next Occurrence of Current Billing Date

- The subscribers current recurring plan is terminated and is restarted with the new billing date on completion of the current billing cycle.
- For the first billing cycle of the new recurring plan, the cost and usage allowance is pro rated from the old billing date until the new billing date.



If the PCC has the group accounts feature enabled then the following applies:

- When a subscriber billing date is changed, the plans affected are the subscribers non-shared plans and/or any group plans where the subscriber is the chargeable member.
- If a plan is shared, the billing date of the chargeable subscriber is used.

5.4 Subscriber Self-Care

The Tango iAX PCC self-care API is a HTTP REST service provided by the SPCM which allows subscribers to purchase and manage data packages.

The self-care API may be used when the Tango SPCM is performing the role of SPR and subscriber accounts are provisioned on the Tango iAX PCC platform.

The self-care API allows subscribers to perform the following actions:

- Get a list of data plans that are available to purchase.
- Purchase data plans.
- Get a list of the subscribers currently purchased data plans.
- Activate or deactivate a data plan.
- Get usage information and policy information for a data plan.
- Deactivate usage rules.
- Change usage rule thresholds.



All self-care functions can also be performed via the Tango PMI GUI.

The self-care API may be accessed by the subscriber through one of the following three methods:

- USSD menu
- Web-portal²
- Phone application¹

In the case of the USSD menu option, the Tango USSD Gateway translates USSD requests over MAP into the self-care API requests. Web portals and phone applications may use the self-care HTTP API directly.

5.4.1 Subscriber Self-Care Call Flows

This section describes the call flows for subscriber self-care in the Tango iAX PCC.

Subscriber Purchases Data Plan - Charge Successful

Figure 5-5 shows the call flow for this subscriber self-care task.

2. The Web-Portal and Phone Applications are not supplied by Tango Telecom Ltd.

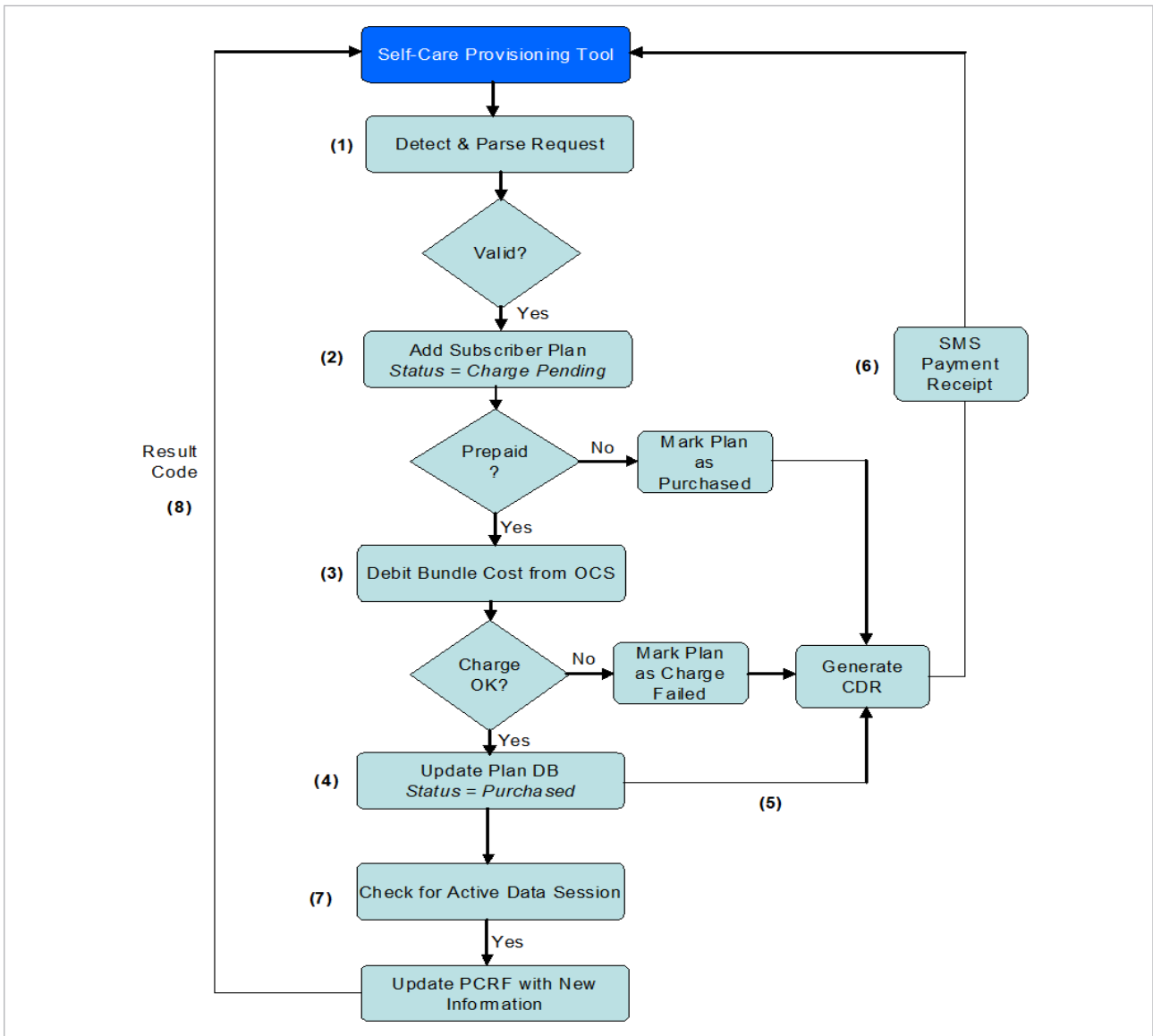



Figure 5-5 Subscriber Purchases Data-Plan via Self-Care Client (success)

1 The SPCM detects and parses the self-care request.



It is assumed that the plan is chargeable.

2 The SPCM initialises subscriber plan records in the PCC database, including the following information:

- Plan status (Charge Pending)
- Plan recurrence flag
- Usage counters
- Usage rules

- Usage timers (e.g. validity-expiry, usage-reset)
- 3 The SPCM debits the charge for the data-plan to the subscriber's account over the open charging interface.



The open charging interface determines whether the charge is prepaid or postpaid.

- 4 The charge debit is successful so the SPCM sets the subscriber plan status to “active” if auto-activated on purchase or “purchased” if not.
- 5 The SPCM generates a Subscriber Plan Purchased CDR.
- 6 An SMS payment receipt is sent to the self-care client.
- 7 If the SPCM detects that a data-session is active for the subscriber:
 - the SPCM sends a notification to the PCRF with an updated list of PCC profiles related to the subscribers active data-plan(s).
 - the PCRF generates PCC rules based on the updated subscriber PCC profiles received from the SPCM and installs these new rules along with usage-monitors onto the PCEF over the Gx interface.
- 8 The SPCM returns a result code to the self-care client.

Subscriber Purchases a Data Plan - Insufficient Balance

Figure 5-6 shows the call flow for this subscriber self-care task.

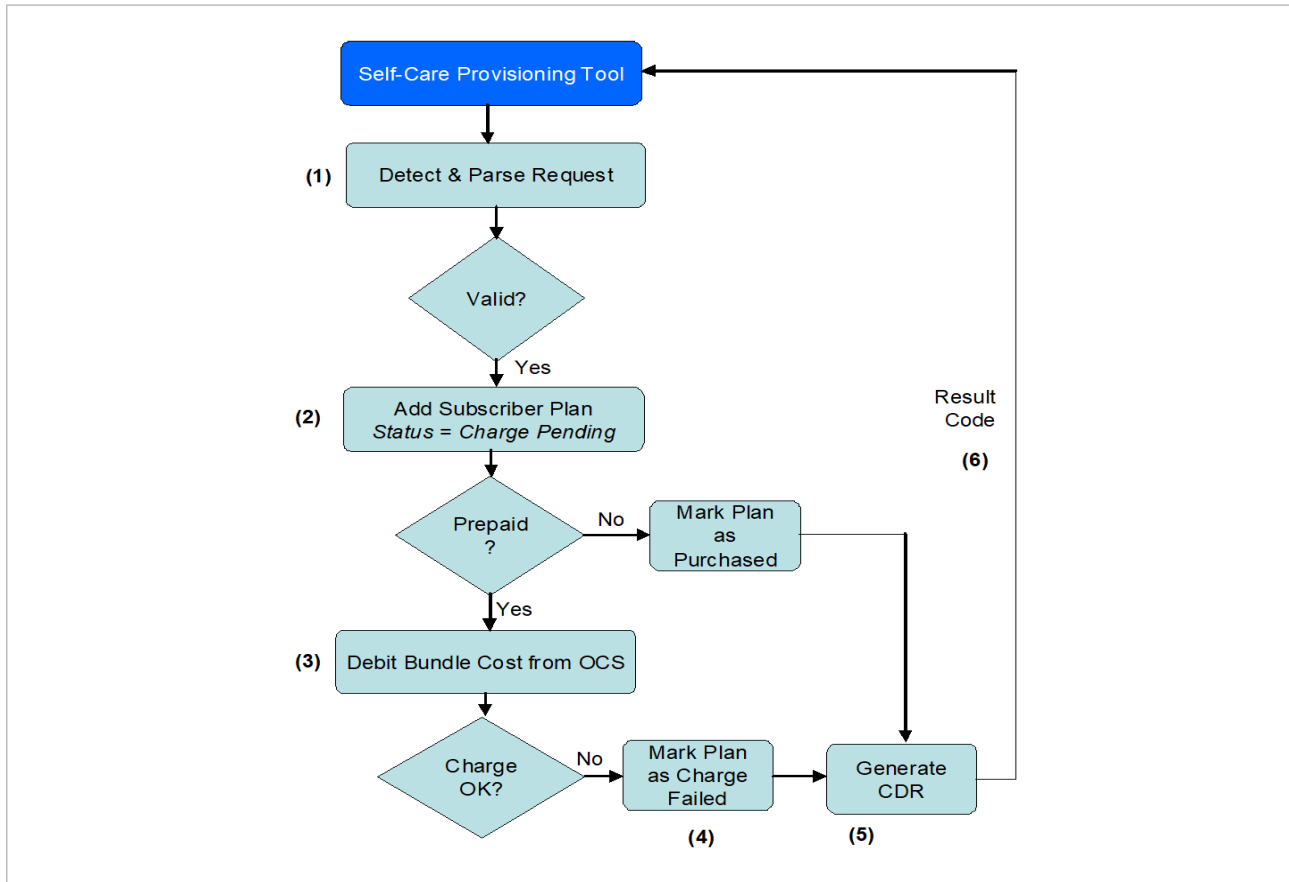
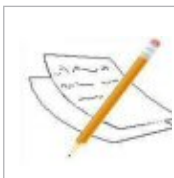


Figure 5-6 Subscriber Purchases Data-Plan via Self-Care Client (insufficient balance)

- 1 The SPCM detects and parses the self-care request.



It is assumed that the plan is chargeable.

- 2 The SPCM initialises subscriber plan records in the PCC database, including the following information:
 - Plan status (“charge-pending”)
 - Plan recurrence flag
 - Usage counters
 - Usage rules
 - Usage timers (e.g. validity-expiry, usage-reset)
- 3 The SPCM attempts to debit the charge for the data-plan to the subscriber’s account over the open charging interface.
- 4 The SPCM sets the subscriber plan status to “charge-failed”.

- 5 The SPCM generates a “subscriber plan purchase failure due to insufficient balance” CDR.
- 6 The SPCM returns a result code to the self-care client.

Subscriber Requests Usage Information

Figure 5-7 shows the call flow for this subscriber self-care task.

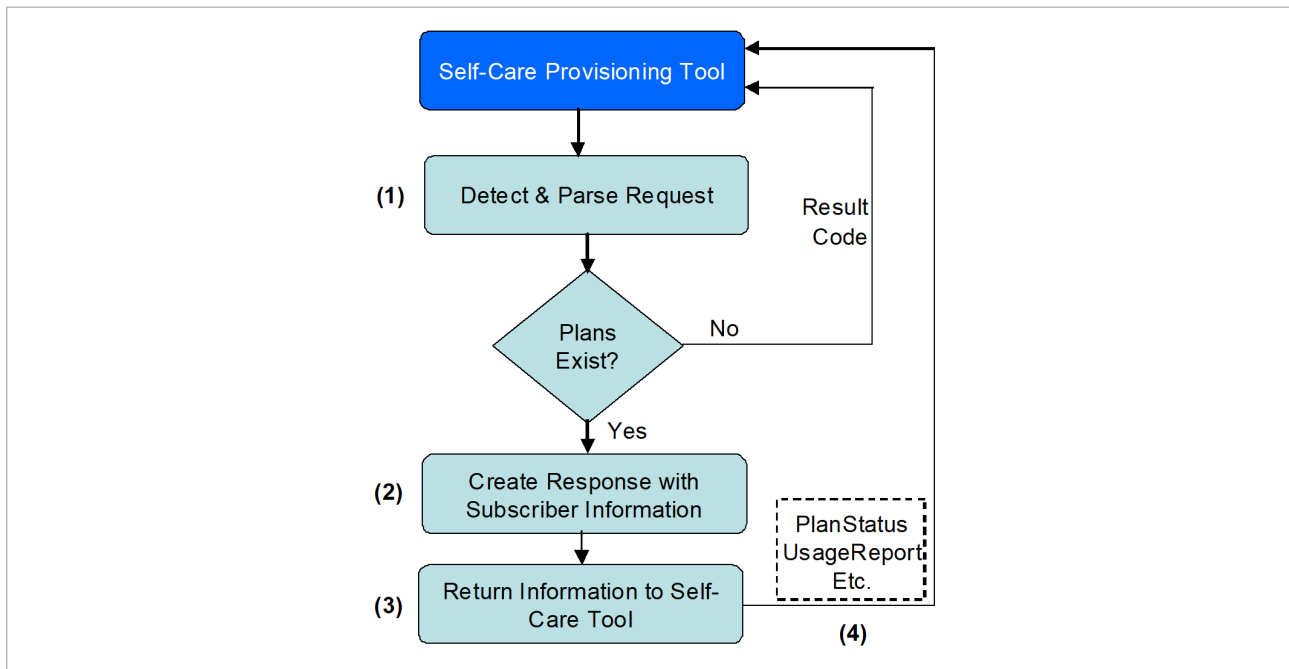


Figure 5-7 Subscriber Requests Usage Information via Self-Care Client

- 1 The SPCM detects and parses the self-care request.
- 2 The SPCM retrieves a list of the subscriber’s data plans and usage information for each plan. The following information is retrieved for each plan:
 - Status of data-plan (active/inactive)
 - Usage counter levels
 - Usage rules and status
 - Usage timers (e.g. validity-expiry date, usage-reset date)
- 3 The SPCM constructs a response with subscriber usage information.
- 4 The SPCM returns subscriber usage information to the self-care client.

5.5 Subscriber Notifications

The SPCM allows you to configure the notification messages that are sent to subscribers when configurable actions occur. For example, a message such as "**You have exceeded the fair usage limit.**" could be sent to a subscriber that has gone over the configured fair usage threshold for data traffic. These notification messages can be sent in a configurable number of different languages as required.

Subscriber notifications are sent for the following events:

- Usage Limit notification (based on thresholds)
- Plan Expiry notifications
- Data Plan Charging notifications (both success and failure)

5.5.1 Subscriber Notifications Call-Flow

The Tango iAX PCC solution includes an SMPP (v3.4) client which will bind to the operators SMSC for sending SMS notifications. **Figure 5-8** shows the flow for this operation:

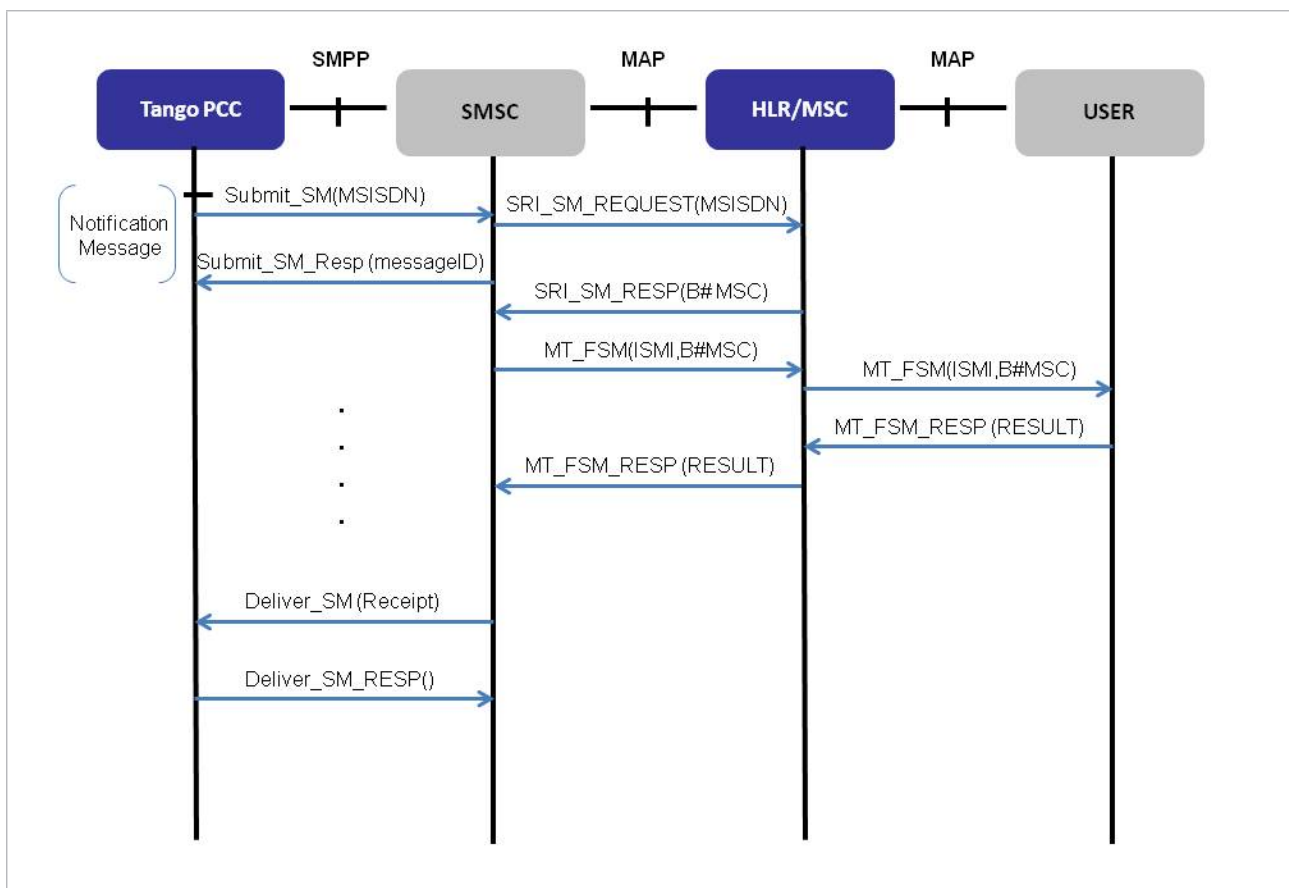


Figure 5-8 Subscriber Notification Call-Flow

5.5.2 SMS Address and Alternative Address

The SPCM SMS notifications can be configured to send the notifications to a secondary MSISDN using the meta-data notification settings via the meta-data web service (see [Section 5.3.2](#)) or the batch provisioning tool [\[Ref. 6\]](#).



The SMS notifications are only sent to one MSISDN.

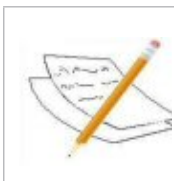
5.6 Group Accounts

The group accounts features allows a number of subscribers (prepaid and postpaid) the option to be grouped together to share the same account. They can share data quotas and avail of group plans. A GUI is provided for the creation and management of group accounts. Some examples of where group accounts can be used include:

- Family groups, e.g. parent accounts and child accounts
- Small businesses
- Individuals with multiple devices where each device has its own unique MSISDN and IMEI

Group accounts are configured via the Platform Management Interface (PMI) GUI. Administrators must be assigned to the group account and the administrator privileges include changing group members, assigning member usage quotas and purchasing shared data plans for the group account. The following features/settings can be configured for group accounts/members:

- Usage quota may be assigned per group member as a percentage of the total group volume.
- Policy control actions for the consumption of the group usage quota may be assigned per group member. This means a group members use of a shared plan may be restricted (block-all-data or downgrade QoS or denied once they have consumed their quota of the shared plan).



Changes to the group account settings for “quota percentage” and “quota consumption action” have immediate effect for each subscriber.


- The group member to be charged for the plan purchase may be assigned from the list of group members. This member is charged for any shared plans which are purchased for the group. Usually the administrator is the member who is charged.

5.6.1 Group Account and Group Plan Rules

The following rules apply to group accounts and group plans in the iAX PCC:

- A subscriber may only be a member of one group account.
- A role is assigned to each group member and the member is only allowed to perform actions which are defined in the role.
- A group account may have a single shared core plan and multiple shared add-on plans.
- Individual group members can purchase their own individual add-on plans which are not shared by the group.

- Individual plan features are inherited by group plans, e.g. policy and charging control by location/time-band/device/network, policy and charging control by usage tracking, etc...
- Group plan precedence is managed in the same way as for individual plan precedence:
 - Core plans (shared or individual) are usually lower in precedence than add-on plans (unless the add-on plan is blocking all data access in which case any plan in a service blocking state will have the lowest precedence).
 - Add-on plan precedence is determined by the following criteria in order:
 - (i) Its service-blocking state
 - (ii) The precedence value assigned when the plan is created
 - (iii) Its QoS bit-rate
 - (iv) Its activation time



Generally plans are given precedence based on the following criteria:

- Plans with a service profile that blocks all data are given lowest precedence while plans with a non-blocking service profile are given the highest precedence
- Plans with the same service blocking state are given precedence based on the precedence value assigned to them when the plan is created
- For plans with the same assigned precedence value, QoS bit-rates are checked, with the higher rate taking precedence
- For plans with the same QoS bit-rates, activation dates are checked, with the earlier activation taking precedence

- All group members receive SMS notification on group account activation, individual quota consumption and group limit consumption.
- When the total shared plan usage limit is consumed, the plan is unavailable to all members until the next plan renewal date in the case of a recurring plan or the plan is terminated in the case of a non-recurring plan.

5.6.2 Group Plan Types

Group accounts can have a range of plans and attributes. These plans and associated attributes are described in **Table 5-7**.


Plan Type	Plan Status	Group Account Functionality
Core Plan	Purchased for the group account.	The core plan is accessible to all group members.

Table 5-7: Group Plan Types

Plan Type	Plan Status	Group Account Functionality
Recurring Plan	Recurring plan purchased for the group.	A recurring plan is a data plan that is automatically recharged and the usage reset after the validity period has expired. Recurring plans continue to be recharged automatically until cancelled via the PMI or a configurable expiry date has been reached. This plan is shared among all members.
Add-on Plan	Add-on plan(s) purchased for the group	The add-on plan is accessible to all group members according to the “quota percentage” assigned to each member.
Add-on Plan	The plan currently being consumed by the group.	A group account may have multiple active plans. The following rules apply to determine which data plan is used when a group has purchased multiple data plans: <ul style="list-style-type: none"> • When a data plan is defined, it is assigned a precedence value. This data plan information is passed by the SPCM to the Tango PCRF which then prioritises the rules accordingly. • If the data plans have equal precedence, the data plan activation date is taken into account, where the oldest data plan is used first, followed by the next oldest, etc. • Add-on data plans always have a higher precedence than core data plans and will be used first.
Individual Member Plan	Group members purchases a plan for individual use.	Other group members do not have access to these individual plans.

Table 5-7: Group Plan Types

Otherwise shared plans inherit all of the features of normal subscriber plans such as listed below:



These features are applied on a per plan basis and not per subscriber/group member.

- Core/Add on plans
- Recurring/Non Recurring plans
- Plan activation/deactivation/deferred activation
- Service filtering
- QoS control
- Charging control
- Subscriber notifications for plan purchase, activation, consumption, expiry warning, expiry, renewal, or when plan-specific usage thresholds are exceeded


- Usage tracking based on time, location, device or network parameters such as RAT type and APN
- Change of PCC rules based on usage, e.g. Fair Usage Policy
- Pro-rating of cost and usage limit
- Roll-over of unused data (for recurring plans)
- Renewal day of the month (for recurring plans)
- Limited occurrences of a recurring plan
- Location zones
- IMEI locking
- Gifted bonus plan

5.7 LBO SMS Provisioning

Local Breakout (LBO) enables mobile network operators to offer affordable data roaming to inbound international roamers by allowing them to register on the operators local network.

This is facilitated by the LBO SMS Provisioning service as follows:

- The roaming subscriber purchases an LBO voucher and sends an SMS with the voucher number to a specific LBO MSISDN to register for the LBO service.
- The LBO SMS Provisioning service verifies that the MSISDN is from a country and network that is permitted to use the LBO service.
- The voucher is validated via an external voucher management system (VoMs), where the face value is determined and the LBO Provisioning service applies the appropriate data plan to the subscriber.
- The LBO SMS Provisioning service sends an SMS to notify the subscriber that the registration attempt was successful.



The subscribers MSISDN is foreign to the local network and therefore it is assigned a “dummy” MSISDN that will be recognised by the network when consuming the voucher.

The LBO SMS Provisioning service appears as a mobile device on the local network. This enables it to “act” as a HLR in order to accept the foreign networks initial SRI-SM request to retrieve the MSISDN of the inbound roamer. It subsequently “acts” as an MSC to handle the FWD-SM message.

Figure 5-9 shows the message flow from the start of the registration attempt.

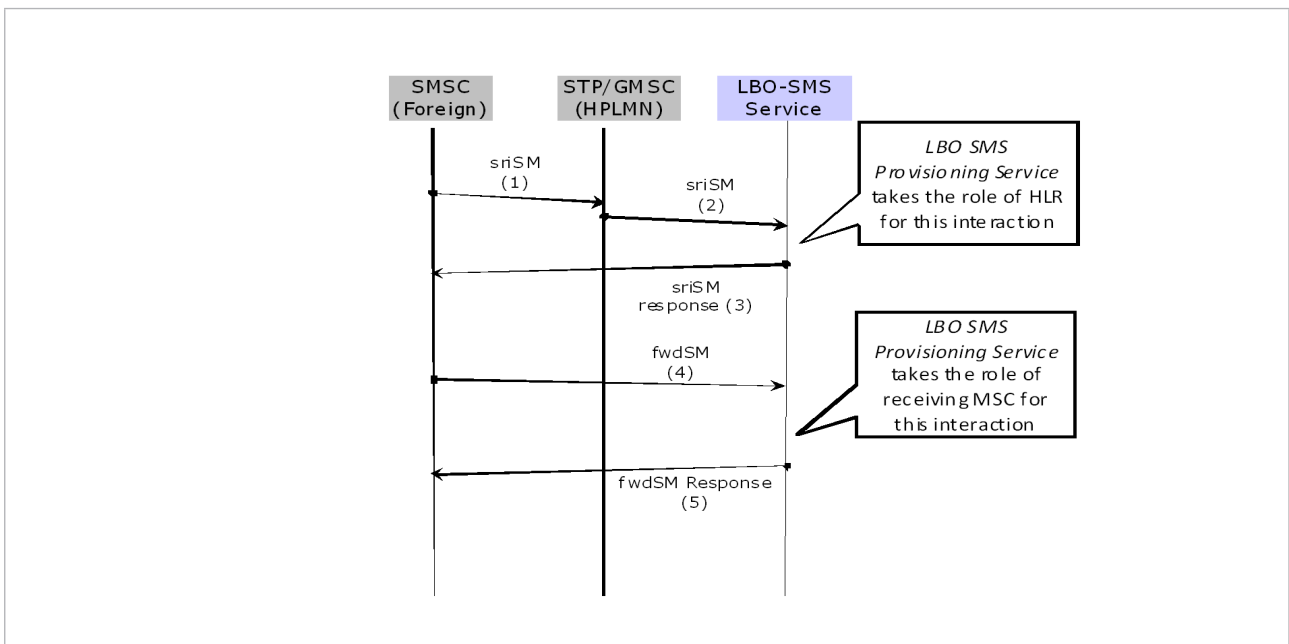


Figure 5-9 Message flow for SMS delivery to LBO VPS MSISDN

5.8 Policy Promotion Service (PPS)

The Policy Promotion Service (PPS) facilitates the provision of bonus plans to subscribers who have purchased a configured volume of data plans within a configured time period.

The PPS is composed of the following components:

- PPS web service (PPS-WS)
- PPS-Executor

5.8.1 PPS Process Description

The PPS process is illustrated in **Figure 5-10**.

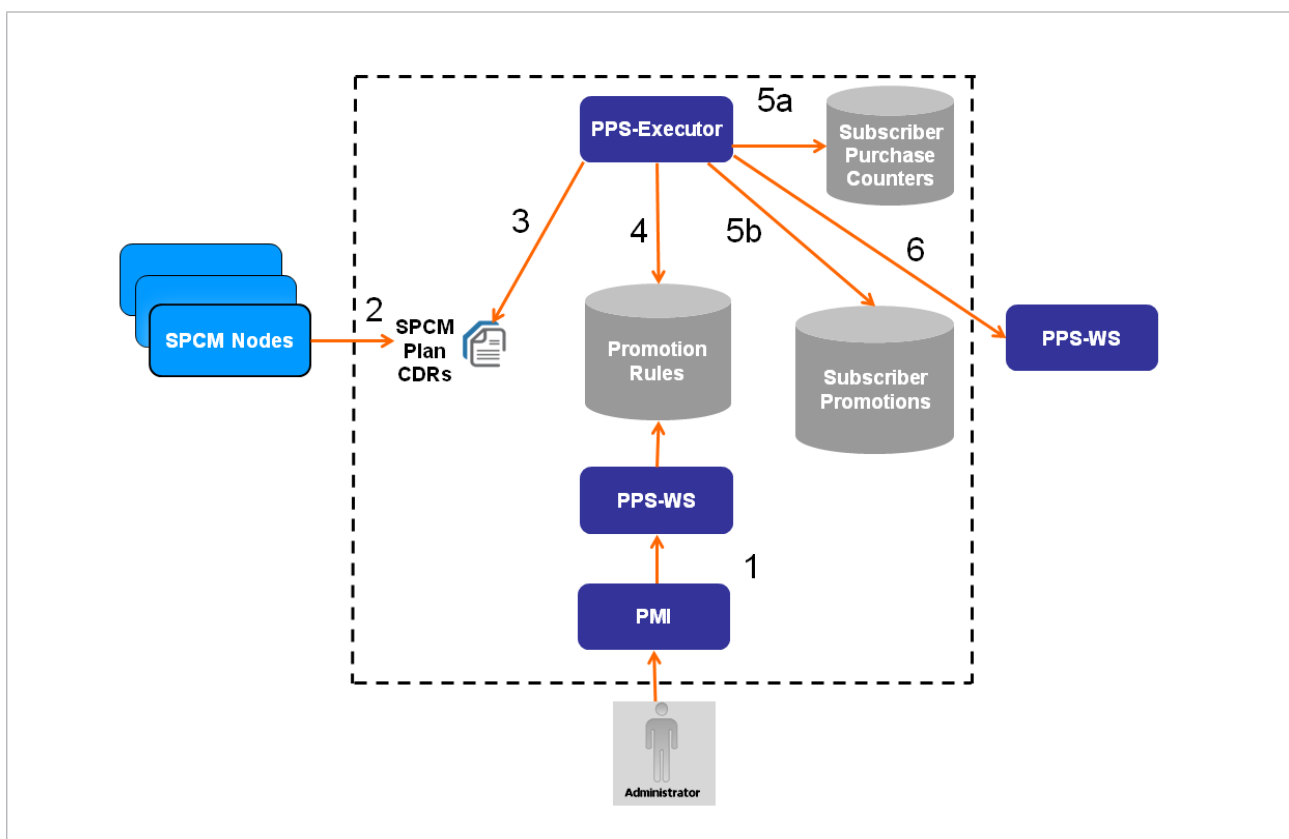


Figure 5-10 PPS Process

- 1 Using the PMI, the administrator creates the promotion rules and the plan identifier whitelists via the PPS-WS. For example, a promotion rule may state that subscribers are given a bonus data plan (BonusPlan1) on purchasing 10Gb worth of data plans over a 10 day period from a specified list of allowable plans.
- 2 A periodic task/cron is executed on each live traffic SPCM node to copy SPCM plan CDRs to the configured PPS base directory on the PPS node.
- 3 Periodically, the PPS-Executor scans the PPS base directory for SPCM plan CDRs.
- 4 The PPS-Executor reads the promotion rules before processing each CDR file.

- 5 The PPS-Executor does the following for each CDR file:
 - (a) Updates the relevant purchase counters for any matching promotion rules found.
 - (b) When the promotion rule threshold has been reached, schedules a bonus plan promotion for purchase at the next scan of the promotion table.
- 6 A separate task scans the promotion table for new bonus plan entries. A plan purchase request is sent to the SPCM WS for any new promotions and the result is recorded in the promotions table.

5.8.2 PPS-WS

Promotion rules define conditions under which subscribers are granted bonus plans. The PPS-WS provides a HTTP REST interface through which you can create, delete, and update promotion rules. Additionally, the PPW-WS manages whitelists of eligible promotion plans. Promotion rules compare the plan name in the SPCM CDR against a promotion plan whitelist to determine if the plan usage is to be processed for that subscriber.

For more information on the HTTP REST API of the PPS-WS, see the Tango iAX PCC API Guide [Ref. 9].

5.8.3 PPS-Executor

The PPS-Executor analyses and processes SPCM plan CDRs, evaluates them against promotion rules configured through the PPS-WS, and executes a request to purchase bonus plans for subscribers when criteria specified in the promotion rules are met.

PPS File Processing

CDRs are filtered by service ID, transaction type, plan state, and plan purchase type. CDRs not meeting the filter criteria are discarded. When a configured batch size has been reached, the PPS-Executor commences processing the CDR files.

The PPS-Executor compares the CDR plan name against the promotion rules plan whitelist. Each time a CDR's plan name matches a rule, the subscriber's purchase counter is incremented with the CDR's volume usage limit. If the counter reaches the promotion rules threshold, a bonus plan (as configured in the promotion rule) is queued for purchase via the SPCM WS API.

Each promotion rule has a maximum bonus plan limit within a specified time period (the reset period). If a subscriber reaches the maximum bonus plan of a rule, no more bonus plans can be applied by the promotion rule until the reset period has expired. When the reset period expires, the subscriber's usage count for the promotion rule is reset and a new reset period commences.

PPS Promotion Processing

A PPS-Executor job runs at configurable intervals to purchase any promotions pending and delete non-pending entries older than a configured time period.

To purchase promotions the PPS has its own HTTP REST client that uses SPCM REST API to interact with the SPCM. The PPS can be configured to work with a list of SPCM servers to

which the PPS will send requests on a round-robin basis. It can be configured to retry on another server in the case of a problem connecting, a status 404 error, or a status 500 error.

5.9 Combo Pack Service (CPS)

The CPS feature enables you to bundle voice, SMS, or MMS plans as a bonus for subscribers who purchase a data plan.

Operators create a combo pack via the Tango PMI. The combo pack can then be associated with an existing plan definition.

When a subscriber purchases a plan, the SPCM creates an event. A CPS Agent process handles such events. If the name of a purchased plan matches the name of a combo pack in the DB then the agent adjusts accounts on the online charging service (OCS) as defined by the configuration for that Combo Pack in the DB.

If an OCS failure occurs, the CPS Agent requests the SPCM to refund the plan. If the refund fails on the SPCM, for example due to no available connection to the charging platform, the SPCM produces a Refund Deferred CDR. This CDR can be post-processed if required.

Interactions with the OCS produce CDRs.

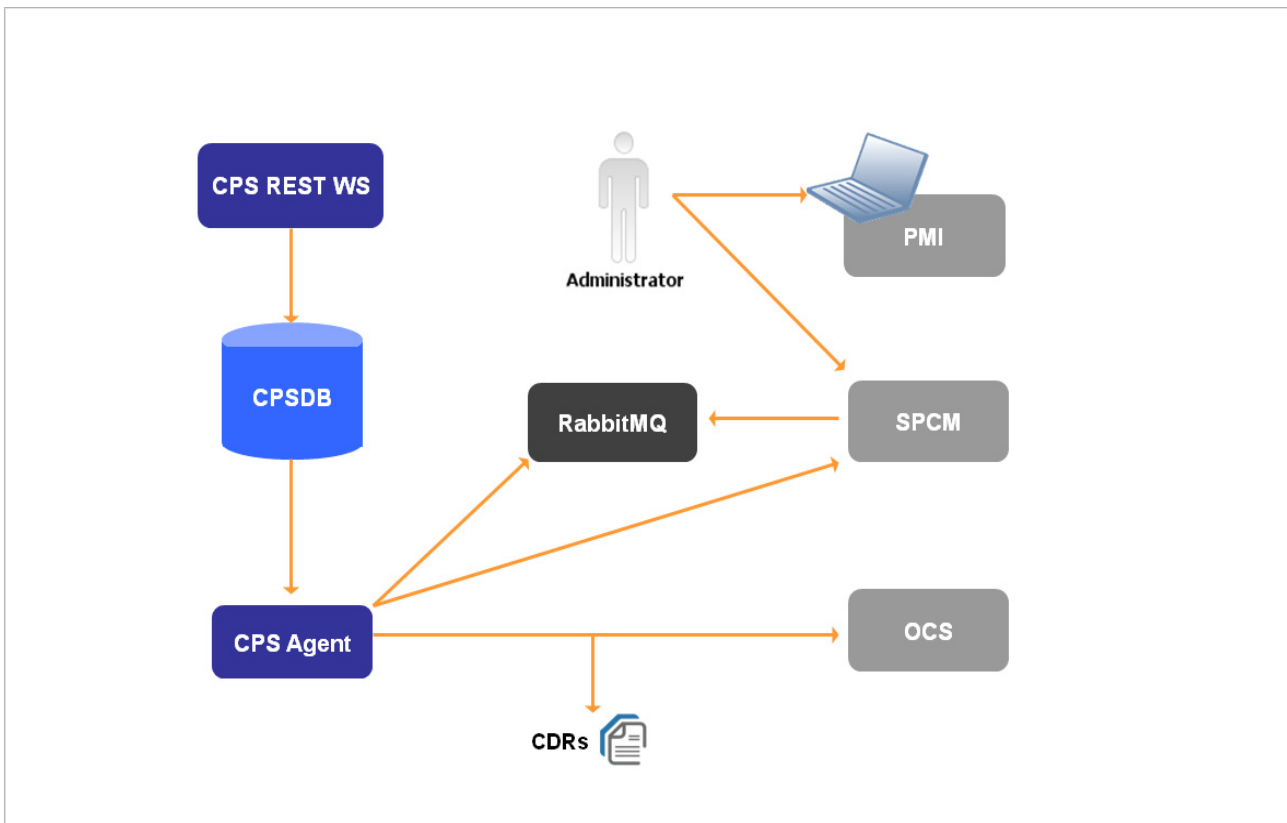


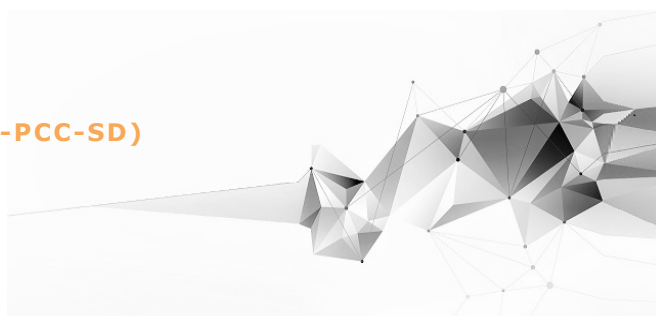
Figure 5-11 CPS Process

CHAPTER 6

Dynamic Routing Agent (DRA)

This chapter provides details on the Dynamic Routing Agent.

- **Overview**
- **DRA- PCRF High Availability**
- **DRA Information Synchronisation**
- **DRA Switching**



6.1 Overview

The DRA provides load balancing across multiple PCRFs and session binding for diameter to ensure a specific PCRF handles a full control dialogue for a given session. It also handles the fail over between PCRFs in case of network failures.

The DRA is a functional element that ensures that all Diameter sessions established over the Gx, S9, Gxx and Rx reference points for a certain IP-CAN session reach the same PCRF when multiple and separately addressable PCRFs have been deployed in a Diameter realm.

The DRA layer acts as a “front end” for the PCRF, hiding the multiple internal PCRF servers which provide the main logic of the PCRF. The DRA layer provides load sharing and high availability capabilities for the PCRF’s Diameter interfaces.

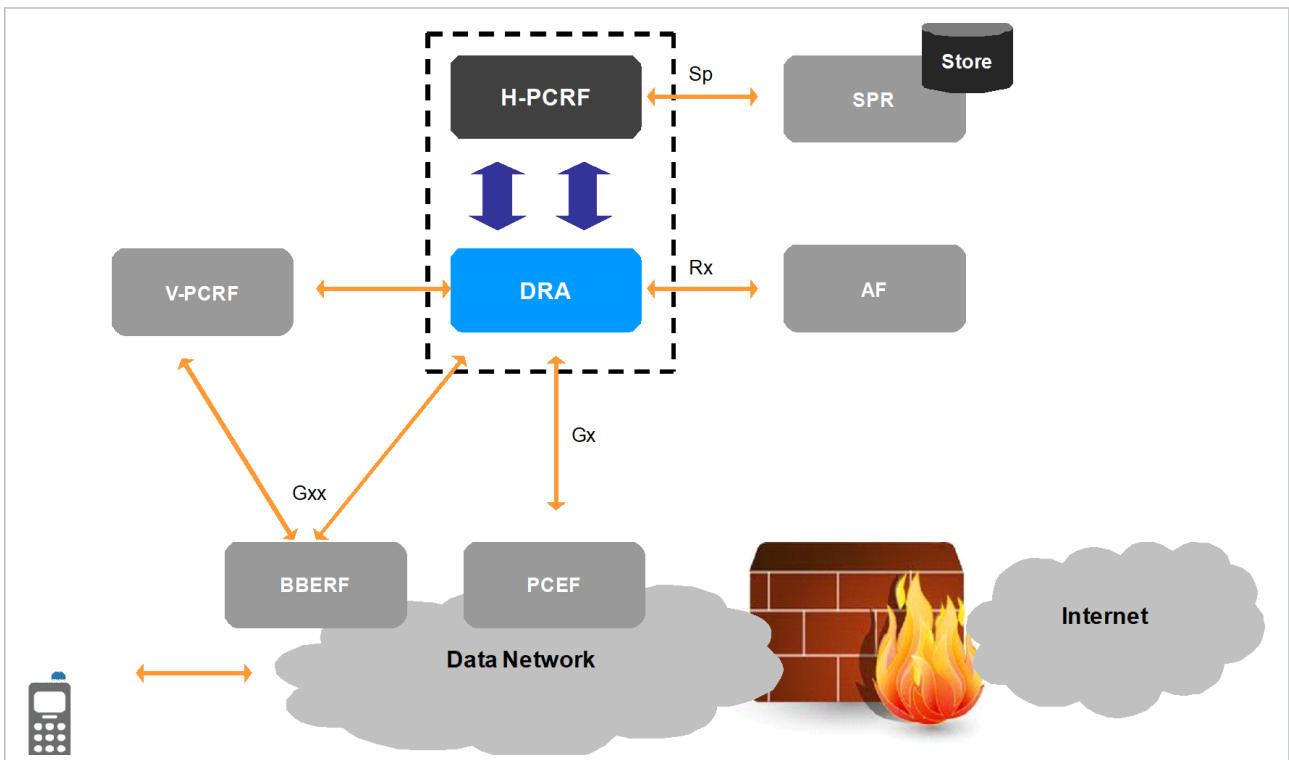


Figure 6-1 Network Context of the Diameter Routing Agent

6.2 DRA- PCRF High Availability

The DRA layer is highly available, and will be run as two active/active processes on different blades (or nodes) in a cluster. A TCP connection exists between the two DRAs to replicate PCRF binding information between them, with a restarting DRA first having to obtain a complete copy of the information (known as a “bulk transfer”) from the other DRA. Multiple PCRF server processes will be run per blade with the DRA layer hiding these multiple 3rd party PCRF servers from Diameter clients. Although external Diameter clients will be configured to connect to the primary DRA and the other DRA, it is assumed that there is no real control over which connection will be used at any given time.

In general, clients switch to the secondary DRA if the primary link fails, and back to primary once it recovers. DRA PCRF/subscriber binding information elements are synchronised between primary and secondary DRAs, and both have Diameter connections with each PCRF.

Using the PCRF server status from both DRA processes, each DRA implements an algorithm to decide which PCRF server should handle each new request. Every time a PCRF binding is allocated by a DRA, the information is sent immediately to the other DRA. If PCRF binding information is available for a subsequent request, this information is used to route the request or answer to the correct Diameter peer. When the PCRF binding information is no longer needed, the DRA removes the information and informs the other DRA.

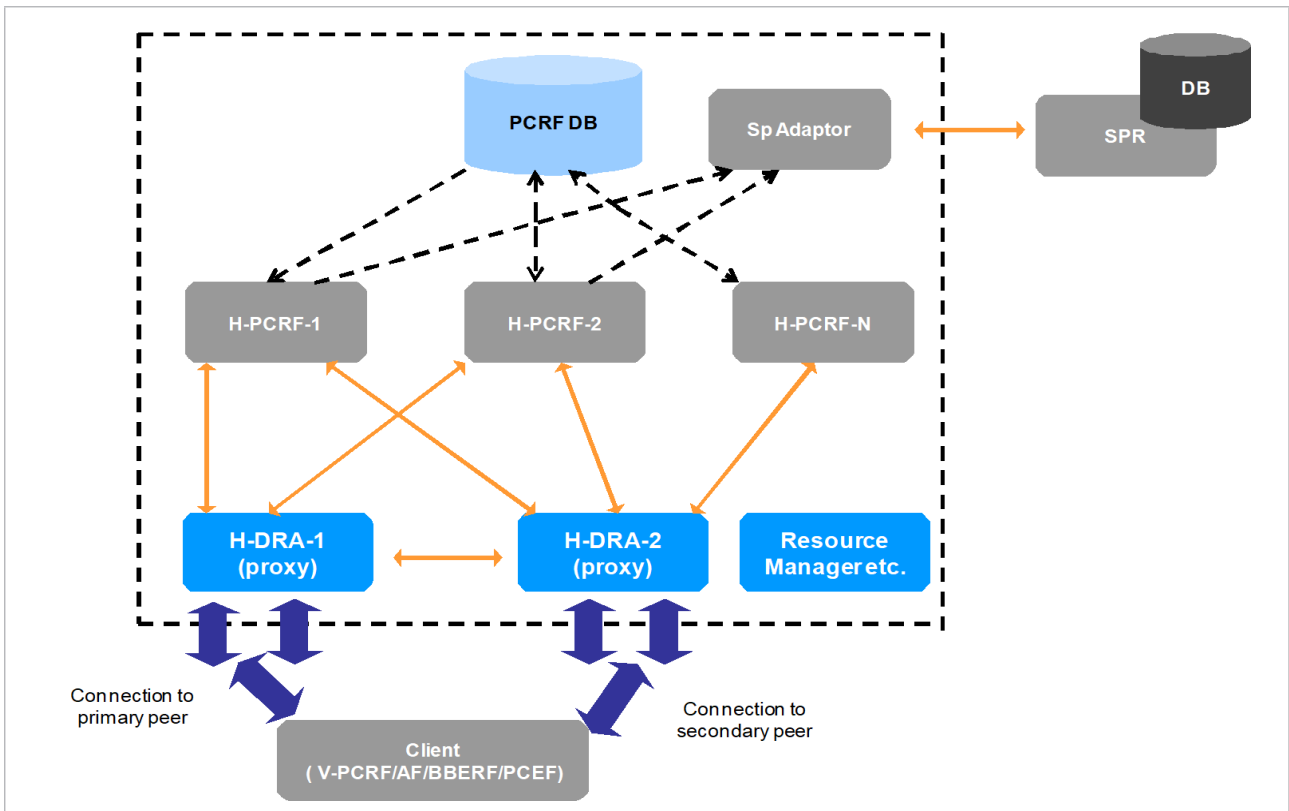


Figure 6-2 DRA Overview

6.3 DRA Information Synchronisation

A DRA which is restarting firstly has to obtain a complete copy of the session state information from the other DRA. If a lot of information has to be transferred, the bulk transfer could take a considerable period of time.

Each DRA is configured with a list of servers within the PCRF. The DRA has basic information about each Diameter server, such as node IP address and port. For each configured server, the DRA stores information about the server status as part of an “available server list”. Each DRA passes its own view of the server availability to the other DRA.

After the bulk transfer is complete, the DRAs will share status information with each other.

6.4 DRA Switching

In general, clients switch to the secondary DRA if the primary link fails and back to primary once it recovers. PCRF/subscriber binding information elements are synchronised between primary and secondary DRAs, and both have Diameter connections with each PCRF.

The main failure case that can occur in the system is when a PCRF node fails. In this scenario, the DRA starts using a link to (another) secondary PCRF. If there is a failure the following can occur:

- DRA removes the failed node from its routing list.
- Mid-session REQs for the failed node are rejected by DRA.
- If the primary link recovers, then requests start arriving on the primary link again; responses to these requests are sent back on the primary link.
- Responses to requests already received on the secondary link are sent on the secondary link.

Another failure case that can occur in the system is where a DRA node fails. In this scenario, the clients start using their link to a secondary DRA. There are a few points to note:

- The secondary DRA determines the correct PCRF from synchronised routing data and thus routes the REQs.
- The PCRF now sends REQs to the secondary DRA (PCRF needs to detect the new source of incoming messages).
- If the primary link recovers, then requests start arriving on the primary link again; the PCRF should also revert at this point to sending outgoing messages to the primary DRA.

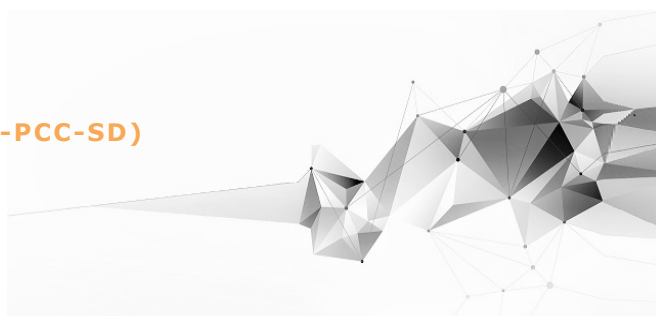
CHAPTER 7

Standard Compliance

This chapter details the standards with which the Tango iAX PCC complies. It contains the following sections:

- [Diameter on page 83](#)
- [SS7 on page 83](#)
- [IP Interfaces on page 84](#)

iAX PCC Service Description v5.0 (iAX-PCC-SD)



7.1 Diameter

The Tango iAX PCC supports the following Diameter interfaces:

- IETF Diameter RFC 4006/3583
- Diameter SCAP (Ericsson proprietary interface)

7.2 SS7

The Tango platform uses an industry-standard SS7 product for ITU-T/ANSI SS7 signalling. The following physical interfaces are provided on the plug-in PCI cards:

- E1 interfaces per ITU-T: G703, G704, G821. Balanced or unbalanced
- T1 interfaces per ITU-T: G.703, G.704
- The SS7 stack supports the following signalling protocols and versions, all of which have been extensively tested in network scenarios:
- ITU-T (“Blue book” and “White book”), MTP2, MTP3 (Q.701-Q.708), SCCP (Q.711 to Q.714), TCAP (Q.771 to Q.775).
- ANSI (1992) MTP2, MTP3 (T1.111.1 - T1.111.8), SCCP (T1.112.x), TCAP (T1.114.x)
- GSM 03.66 MAP (Phase 2+), version 7.1.0, support for Mobile Number Portability
- GSM 09.02 MAP (Phase 2+), version 7.5.1 and earlier
- IS-41 MAP

7.3 IP Interfaces

The Tango iAX PCC supports the following IP-based interfaces:

- A subset of MGCP 1.0 as defined by the Internet Engineering Task Force (IETF)
- Sigtran
- GTP v.0 and GTP v.1
- SMPP
- CORBA
- SOAP/XML
- PARLAY
- UCP
- Diameter Credit-Control

7.4 Policy & Charging Control

The Tango iAX PCC supports the following 3GPP Policy and Charging Control standards:

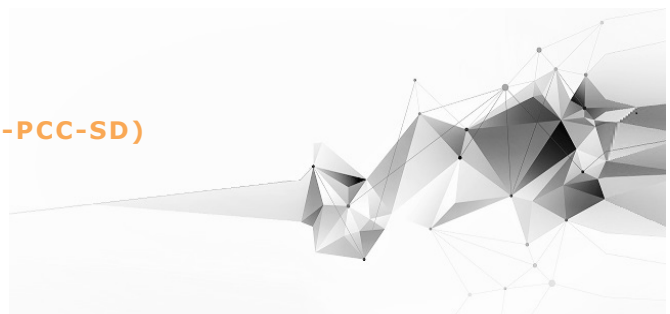
- Policy and Charging Control Architecture - 3GPP TS 23.203 V9.3.0
- Policy and Charging Control Signalling Flows - 3GPP TS 29.213 V9.3.0
- Policy and Charging Control over Gx Reference Point - 3GPP TS 29.212 V9.3.0
- Policy and Charging Control over Rx Reference Point - 3GPP TS 29.214 V9.3.0

CHAPTER 8

PCC Database Scaling

This chapter provides an overview of how to horizontally scale a PCC subscriber database by spreading the database across multiple shards on multiple physical servers. It also outlines how multiple tenants can share the same DRE instance. It contains the following sections:

- [Introduction on page 86](#)
- [Logical Groupings on page 87](#)
- [System Slices on page 88](#)
- [Multi-Tenancy on page 92](#)



8.1 Introduction

The Tango DRE system, as depicted in **Figure 8-1**, traditionally operates with a single PCC subscriber database.

For scaling purposes, an alternative approach is also possible whereby the PCC subscriber database is instead divided into multiple shards that can reside across multiple physical servers.

Advantages to this sharded approach include the following:

- an efficient and stable way to manage system scaling
- an ability to cater for virtualised installations
- facilitation of partial upgrades

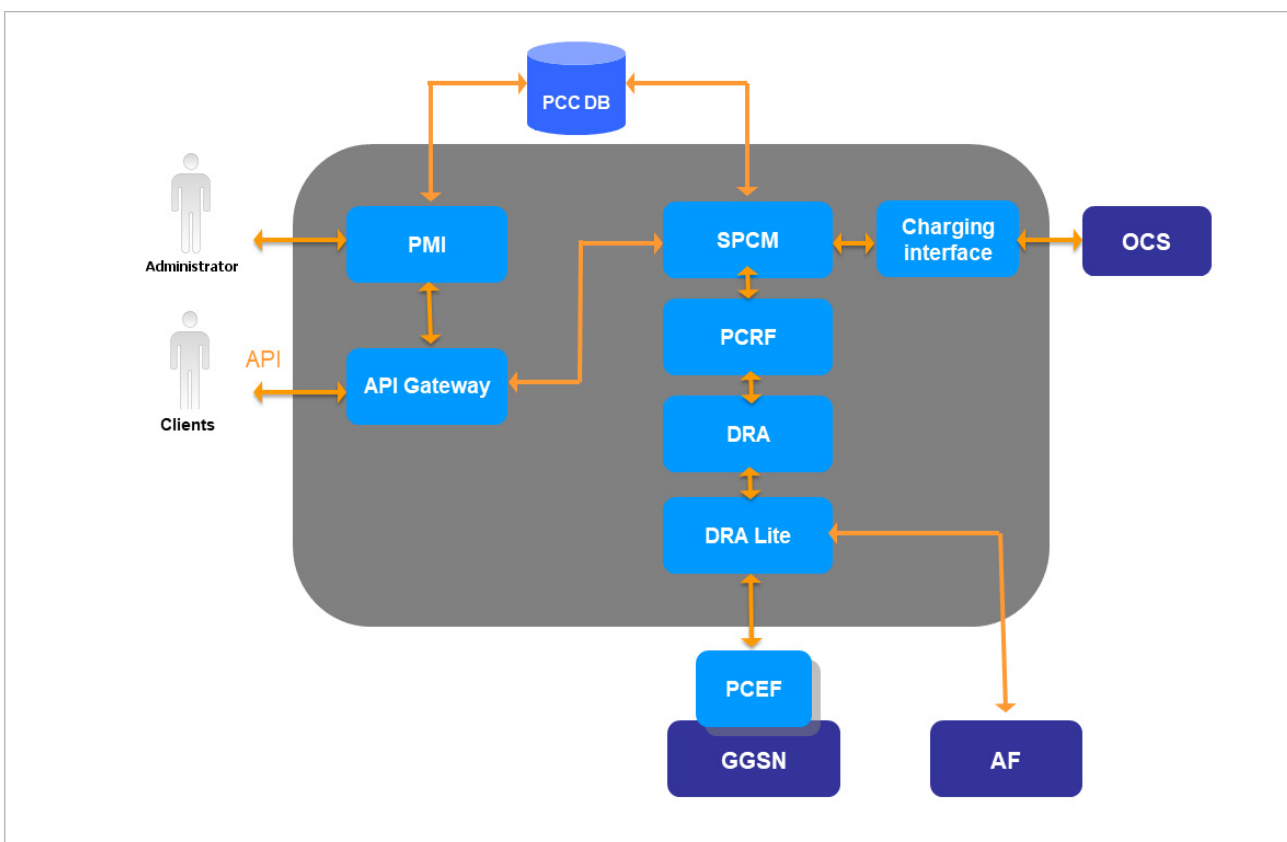


Figure 8-1 Traditional DRE System

In the traditional DRE system, as illustrated in **Figure 8-1**, the API gateway component operates as a single entry point for HTTP API requests from clients. The API gateway also routes requests onwards to backend services, manages encryption (HTTPS termination), and translates protocols.

The DRA Lite component operates as a single point of entry for network Diameter traffic.

8.2 Logical Groupings

Logically, the elements of the DRE system can be grouped as follows:

- The PMI and API Gateway comprise the PCC OAM interface
- The SPCM, charging IF, PCRF, and DRA comprise the PCC core
- The DRA Lite comprises PCC network interface with the PCEF and AF

These logical groupings are illustrated in **Figure 8-2**.

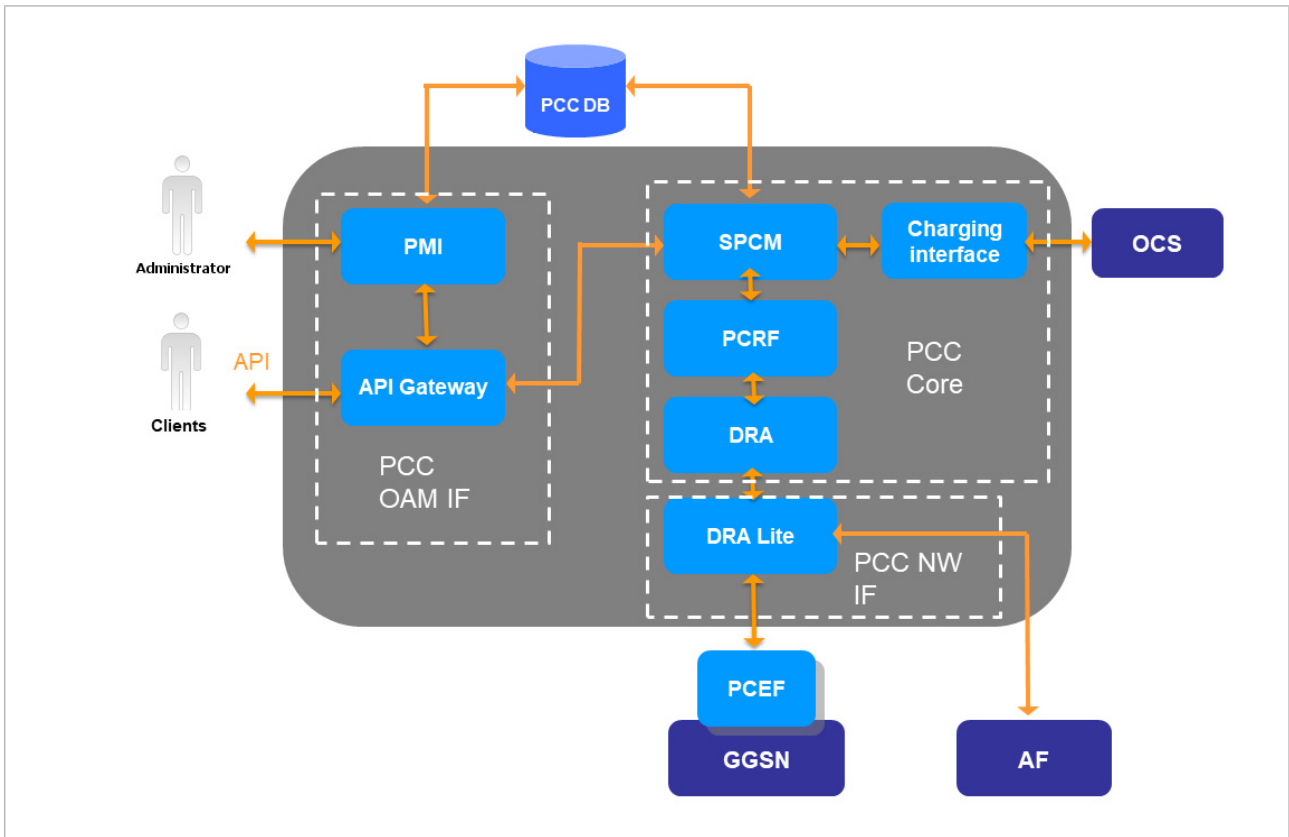


Figure 8-2 Logical Grouping of the DRE elements

8.3 System Slices

The PCC core grouping of components can be replicated and scaled horizontally to meet growing traffic demands. Each PCC core group is referred to as a system slice. In a sliced system each slice can handle API and data session requests for a subset of subscribers.



A subset of subscribers can be defined as those belonging to a particular tenant in a multi-tenant arrangement, a range of subscribers, a static list of subscribers, a set of subscribers that match a particular expression such as, for example, those for which the last digit of MSISDN is zero, or any combination thereof.

To facilitate routing of incoming requests arriving at the DRE to the appropriate slice, a Location Service (LS) component is added to the DRE architecture.

An API gateway queries this Location Service to route API requests. Internally an NGINX proxy is used to perform this Location Service lookup.



NGINX provides SSL termination, security, and API throttling. For some deployments it may be necessary to deploy NGINX in a separate network segment to provide secure access to external clients. For example, NGINX could be deployed alone in the DMZ and all other services placed behind a firewall.

Routing can be based on MSISDN or IMSI (prefixes or ranges).



The API gateway can also provide blocking capability during upgrade/maintenance windows whereby requests for a specific subscriber subset can be locally terminated (e.g. by responding with HTTP 503 - Service Unavailable).

The DRA also queries the Location Service to route Diameter INIT requests to the correct subscriber slice (the correct PCRF or pool of PCRFs). The DRA automatically routes the remaining diameter requests (for example, USAGE, TERMINATE, etc.) to the correct subscriber slice based on the destination host AVP.

A sliced system is illustrated in **Figure 8-3**.

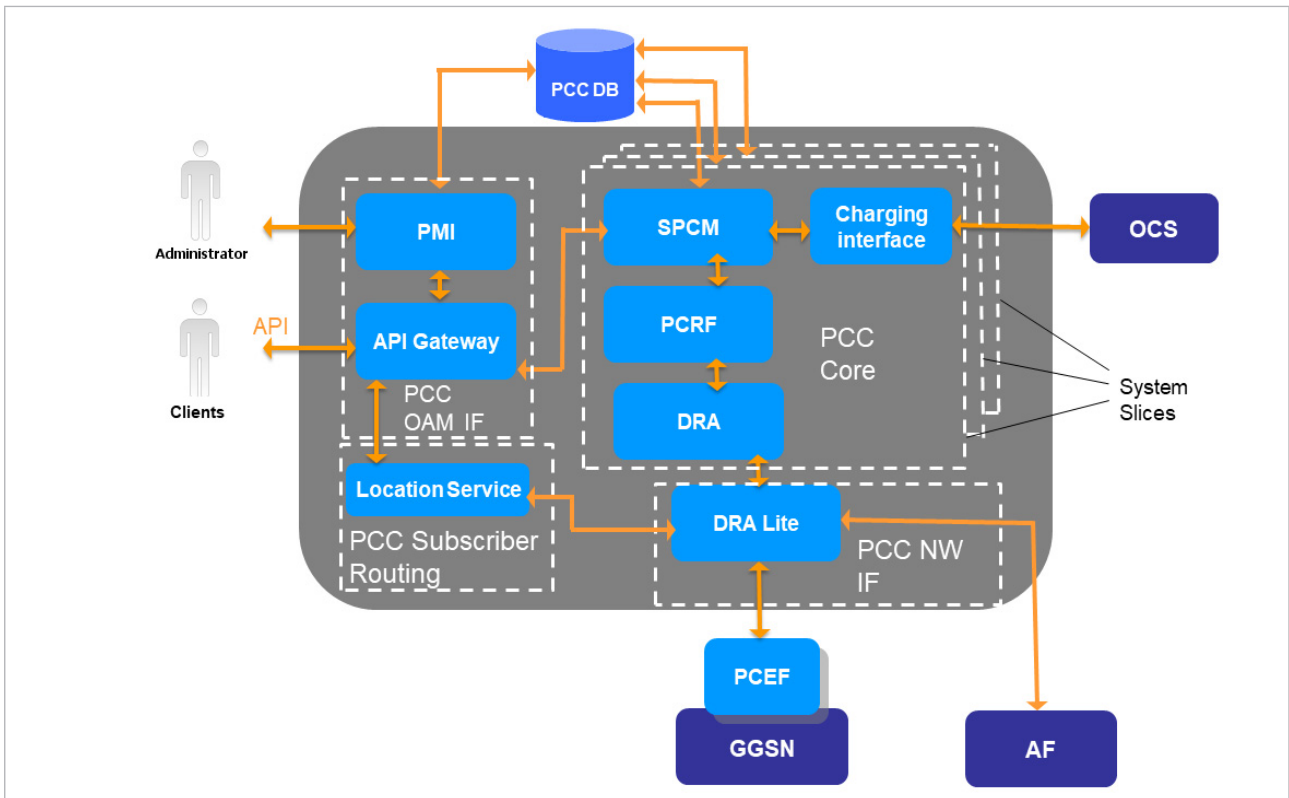


Figure 8-3 System Slices

When system slices have been set up, you can shard the backend database and thereby horizontally scale a single monolithic subscriber database. Each shard contains a subset of the subscribers.

A sharded database system structure is illustrated in **Figure 8-4**.

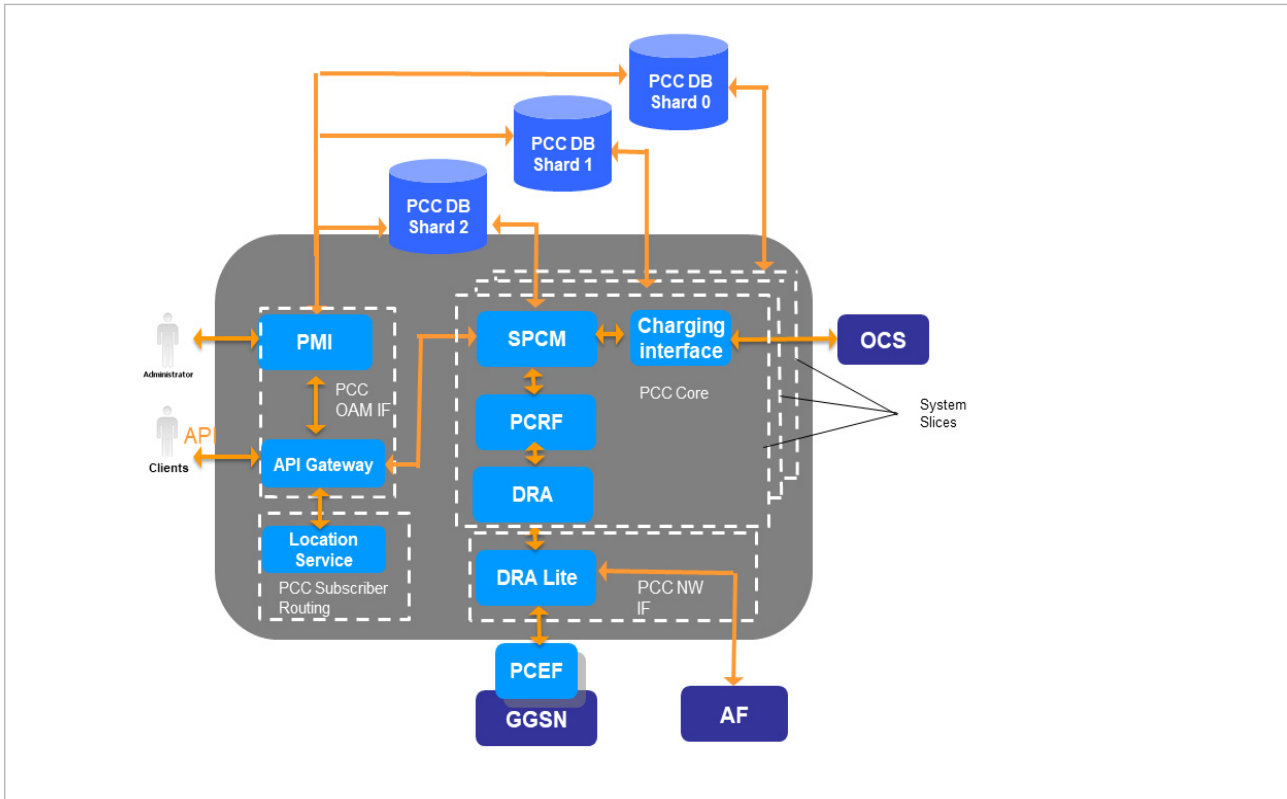


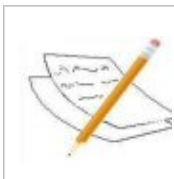
Figure 8-4 Sharded Database

8.3.1 The Location Service

Where slices are employed, the LS maps incoming requests from clients to the appropriate system slice. Applications query the LS to establish the location of a given subscriber.

The LS uses algorithms to determine the following information for any given subscriber:

- the subscriber status, allowed or blocked, through a check against subscriber lists
- the location routing key (slice ID) to be returned to the application, using a primary key such MSISDN or IMSI



Algorithm rules are defined in a local subscriber routing configuration file. An SE method reloads this configuration file as required. For more information, see the iAX™ PCC Administration Guide [Ref. 8].

The LS facilitates location queries made through the following three interfaces:

- **SE** - SE request sent to the LS and SE response received from the LS
- **HTTP** - HTTP GET request sent to the LS and HTTP response received from the LS
- **Diameter Gx** - CCR sent to the LS and CCA received from the LS. Diameter Gx supports the TCP and SCTP protocols

The function of the LS is illustrated in **Figure 8-6**.

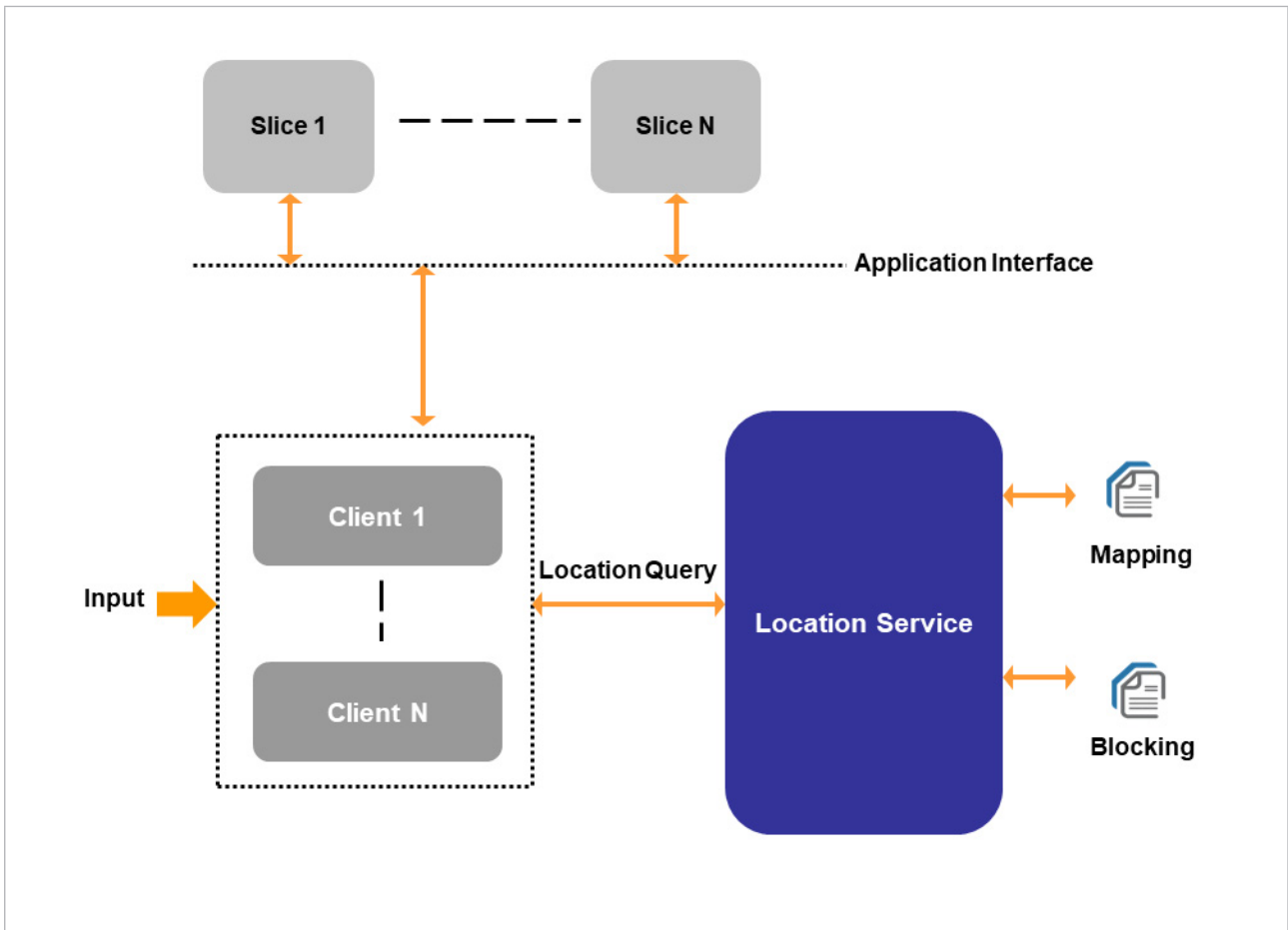


Figure 8-5 Location Service Context

8.4 Multi-Tenancy

A single DRE platform can be shared by multiple operators or tenants. Each tenant shares the same OAM, NW IF, and subscriber routing layers while one or more system slices are allocated to each tenant.

Each tenant has its own PCC core system, PMI login (data access limited to their own data), and discrete subscriber database.

All HTTP and data session traffic is routed to a single pool of SPCMs and PCRFs using a provided Tenant ID header or via a Location Service lookup request.

Each tenant has a separate database schema.



Any given tenant using a multi-tenancy DRE platform can employ multiple slices.

A multi-tenant system is illustrated in **Figure 8-6**.

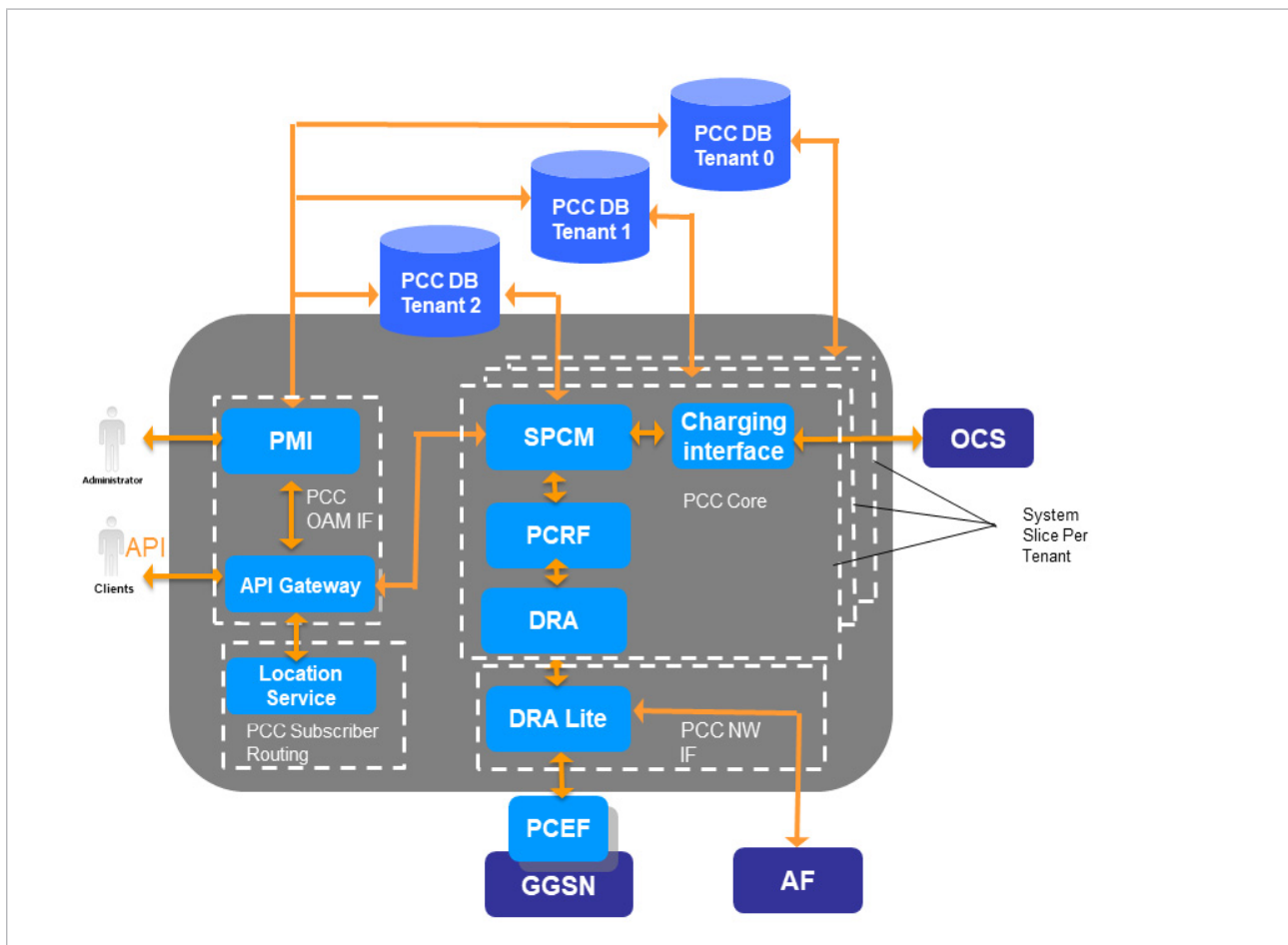


Figure 8-6 Multi-Tenant System

Appendix

A.1 References

- [Ref. 1] Policy and charging control architecture, 3GPP TS 23.203 V9.3.0
- [Ref. 2] Policy and Charging Control over Gx reference point, 3GPP TS 29.212 V9.3.0
- [Ref. 3] Policy and Charging Control over Rx reference point, 3GPP TS 29.214 V9.3.0
- [Ref. 4] Tango Alarm Reference Sheet
- [Ref. 5] iAX Platform Administration Guide
- [Ref. 6] iAX PCC SPCM Subscriber Batch Provisioning Tool
- [Ref. 7] PMI Online Help
- [Ref. 8] iAX™ PCC Administration Guide
- [Ref. 9] iAX™ PCC API Guide

A.2 Abbreviations

AF	Application Function
API	Application Programming Interface
APN	Access Point Name
ASR	Automatic Speech Recognition
BBERF	Bearer Binding and Event Reporting Function
CDR	Call Detail Record
DCC	Diameter Credit Control
DRA	Diameter Routing Agent
DRE	Data Retail Engine
GGSN	Gateway GPRS Support Node
GUI	Graphic User Interface
HLR	Home Location Register
HTTP	Hypertext Transfer Protocol

ICI	Internal Charging Interface
IDL	Interface Description Language
IF	Interface
IMSI	International Mobile Subscriber Identity
IP-CAN	IP Connectivity Access Network
MAP	Mobile Application Part
MSISDN	Mobile Subscriber ISDN Number
OAM	Operations and Maintenance
OCI	Open Charging Interface
OCS	Online Charging Server
PCC	Policy and Charging Control
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rules Function
PDN	Public Data Network
PMI	Platform Management Interface
QoS	Quality of Service
SGSN	Serving GPRS Support Node
SIBB	Service Independent Building Block
SMPP	Short Message Peer-to-Peer
SMS	Short Message Service
SMSC	Short Message Service Centre
SOAP	Simple Object Access Protocol
SPCM	Subscriber Policy and Charging Manager
SPR	Subscription Profile Repository
UDP	User Datagram Protocol
UE	User Equipment
UNS	User Notification Service
USSD	Unstructured Supplementary Service Data
VAT	Value Added Tax

VOIP	Voice Over IP
XSLT	Extensible Stylesheet Language Transformation