PCF Overview

Product Description

The Cisco Policy Control Function (PCF) is one of the control plane network functions (NF) of the 5G core network (5GC). Cisco PCF is an evolution from Cisco Policy and Charging Rules Function (PCRF) on the existing Cisco Policy Suite Cloud Native Docker container-based platform.

In the 5G network, PCF has the following features and functions:

- Support 5G QoS policy and charging control functions and the related 5G signaling interfaces. The 3GPP standards, such as N5, N7, N15, N28, N36, and Rx, define these interfaces for the 5G PCF.
- Provide policy rules for control plane functions, which include network slicing, roaming, and mobility management.
- Collect the subscriber metrics in context with their network, usage, applications, and more. The operators analyze this information to optimize resources and make informed decisions to segment users.
- Provide the real-time management of subscribers, applications, and network resources based on the business rules configured for a service provider.
- Accelerate and simplify deployment and upgrades using the ConfD CLI, increased speed and efficiency, and low latency by adopting the cloud-native implementation.
- Collaborate with other NFs through NRF, which provides a unified communication platform for the NFs to interact with each other.

For information on how to deploy and configure PCF, see Deploying and Configuring PCF through Ops Center.

Use Cases

The policy charging solution can be potentially applied to address various business scenarios. Some of the key application scenarios are described in this section.

Base PCF Configuration

PCF base configuration provides a detailed view of the configurations that are required for making PCF operational. This includes setting up the infrastructure to deploy PCF, deploying PCF through SMI, and configuring the Ops Center for exploiting the PCF capabilities over time.

This use case involves the following steps:

1. Prerequisites—Provides the list of resources that are required to deploy PCF in your environment successfully. See Prerequisites for details.
2. Deployment through SMI—All the 5G network functions are deployed through the SMI platform. The platform simplifies the cloud-native NF deployments and monitors the NF performance while providing an integrated experience.

   See Deploying PCF for details.
3. Configuring Ops Center—The PCF Ops Center provides an intuitive console for interacting with PCF in terms of configuring and gaining visibility into resources and features that you have subscribed to.

   The Ops Center lets you review the current and historical configurations corresponding to your environment. See Accessing the PCF Ops Center for details.

Infrastructure

With moving to 5G Core, Cisco has built PCF to have a robust and flexible infrastructure. Considering the rapidly evolving industry trends in the area of capacity and bandwidth, the infrastructure is also continuously altered by converging various components to make it more reliable, scalable, and secure.

Some of the key integrations that PCF infrastructure has undergone include the Cisco Common Data Layer—PCF supports the Geographic Redundancy (GR) for the Cisco Common Data Layer (CDL). See Cisco Common Data Layer for more information.

Interoperability with CHF

Complying with the charging architecture published in 3GPP December 2018 release 15. In the 5G Service-based architecture, PCF interoperates with the CHF. For instance, PCF determines the policy decisions that are based on the status of the policy counters available in the CHF.

This use case involves the following steps:

- N28 Interface—PCF allows retrieval of policy counters and their use in policy decisions. See N28 Interface for details.
- Forwarding the NAP and LDAP requests—The Policy Server relies upon the NAP and LDAP server to collect the subscriber details. With the revised Policy Server, PCF processes the subscriber detail requests and sends it to the appropriate function that is PCF or PCRF. It determines the function considering the technology that the subscriber has subscribed to. See Session Queries over LDAP for details.

Interoperability with NRF

The Network Repository Function (NRF) is one of the key network entities in the 5G Core Network (5GC). It primarily maintains the NF profile of the available NF instances and their supported services. It permits the NF instances to subscribe to, and get notified about the registration in NRF of new NF instances. The NRF supports the service discovery function by receiving the NF Discovery Requests from NFs and providing the information of the available NF instances by satisfying specific criteria such as supporting a given service.

This use case involves the following:

- NRF Interface—The NRF offers a platform for the NFs to communicate with each other and to exchange information for carrying out their operations. However, to build this communication framework, the NFs similar to PCF must register their profiles and services with the NRF. The NFs use the NRF's native management and discovery services to establish this framework. See NRF Interface for details.
- NRF Subscription to Notifications—PCF supports NRF and the associated repository functions such as the interface discovery, registration for renaming NRF, change type, and removal or addition of new API attributes. PCF extends this support as per the 3GPP December 2018 specification compliance. See Network Repository Function Subscription to Notifications for details.
- Heartbeat—The NF heartbeat configuration enables the network functions to notify their operational status to the NRF periodically. PCF invokes a heartbeat at the configured intervals. If the NRF is unavailable, then PCF switches between the registered primary, secondary, and tertiary NRF depending on their availability. See Heartbeat for more information.
- N28 Interface—PCF discovers the NFs based on the Instance ID which the NFs provide such as CHF and UDR. See for N28 Interface and UDR Interface for details.

Configuring LDAP for Subscriber Query

The policy charging solution combines with LDAP to sends and receives trusted information about the modified subscriber or subscriber details through the LDAP interface.

PCF has constructed the following capabilities to optimize the services that LDAP offers:

- **PCF as an LDAP Client**

  LDAP and Sh Interface—PCF acts as an LDAP client and establishes communication with Home Subscriber Server (HSS) and downloads the subscription profile over a Sh Interface. This enables PCF to update the policies automatically in the SMF when the Sh, LDAP, or local configuration sends a subscription change notification. See LDAP and Sh Interface for details.

- **PCF as an LDAP Server**

  Forwarding the NAP and LDAP requests—PCF acts as an LDAP server. The Policy Server relies upon NAP and the LDAP server to collect the subscriber details. With the revised Policy Server, it now processes the subscriber detail requests and sends it to the appropriate function that is PCF or PCRF. It determines the function considering the technology that the subscriber has subscribed to. See Session Queries over LDAP for details.

Parity with 4G

4G introduced cutting-edge solutions that redefined the way humans consumed cellular technology. It turned out to be an inherent part of exponential growth and amplified human advancement with AI, IoT, and other applications that exploit the technology. When 5G was conceived, some of the key capabilities of 4G were rebuilt on the 5G’s tech stack and infrastructure to provide a more scalable and positive experience to the customer base.

PCF has adopted the following feature from the 4G implementation:

Rx Authorization—PCF provides a method for service providers to regulate the services available to individual subscribers. You can configure the bearer-level regulation through the configuration of the Rx Authorization. The configuration lets you control the services available to each subscriber. See Rx Authorization for details.

VoNR

In the new 5G spectrum, the subscribers are aware of the transitioning infrastructure that offers high-speed, increased capacity, reduced cost, real-time interaction, and other innovative offerings. However, the expectation that is associated with telecommunication still revolves around making regular voice calls, emergency calls, exceeding quality audio, and sending SMS. Service providers are being competitive over providing a positively differentiated experience to the user while making the Audio, Video, and Emergency calls. Like 4G, the providers can access the VoNR through PCF, which is the preferred approach.

This use case involves the following:

- VoNR through the Rx Interface—With PCF in 5G supporting full Diameter stack with the supported standard Diameter Rx interfaces, PCF accepts Rx messages for processing and Rx session binding with N7 sessions. See VoNR through the Rx Interface for details.
- Specification Compliance - N5, N7 and N28—Enhancements to the N7 and N28 interfaces of PCF to comply with the 3GPP December 2018 specification and enhancements to the N5 interface of PCF to comply with the 3GPP December 2020 specification. See Specification Compliance - N7 and N28 for details.
- Predefined Rule and Rulebase—Provision to configure PCC rule ID for predefined rule and rulebase is available in PCF. SMF uses these rules when configuring the User Plane Function (UPF) for performing data flow tasks, such as shaping, policing to provide bandwidth, and charging functions. See Predefined Rules and Rulebase for more information.
- Dynamic Rules and Table-driven Charging Rules—PCF supports the provisioning of the table-driven dynamic charging rules. See Dynamic Rules and Table-Driven Charging Rules for more information.
- Dummy N7 Notify Request—If PCF has not subscribed to specific event triggers during the session initiation, it can send a dummy N7 Notify Request, which is an intermediate request to fetch those event triggers. The events must correspond to the configured Media-Type specified in the AAR message from the IMS. See Dummy N7 Notify Request for more information.

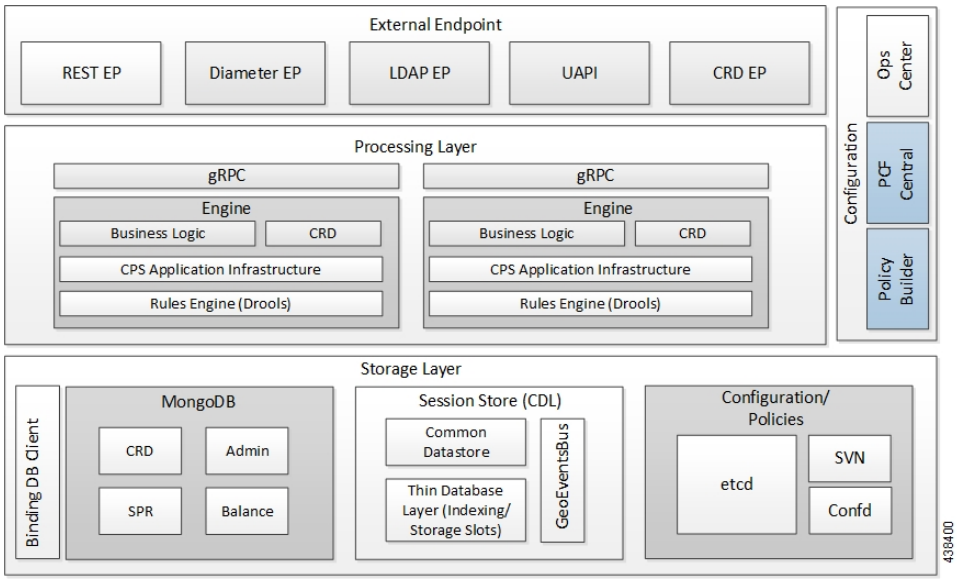
Deployment Architecture and Interfaces

The Cisco PCF is part of the 5G core network functions portfolio with a common mobile core platform architecture. These network functions include Access and Mobility Management Function (AMF), Session Management Function (SMF), Network Function Repository Function (NRF), Policy Control Function (PCF), Network Slice Selection Function (NSSF), and User Plane Function (UPF).

PCF Architecture

The PCF architecture is built on a multi-layer platform, which enables efficient policy control and management in the 5G Core network.

Figure 1: PCF Architecture



At a high level, the components in the architecture perform the following:

1. External Endpoint
   - REST-EP—It is a RESTful interface, which provides a channel for the 5G inbound and outbound messages.
   - LDAP-EP, UAPI, and CRD API—Provides interfaces for PCF communications.
   - Diameter-EP—Responsible for routing the Diameter traffic.
2. Processing Layer
   - grPC—Provides a framework that enables the internal processes to communicate with each other and synchronize their events.
   - PCF-Engine—Hosts the business logic of PCF and responsible for driving the rules engine for making crucial policy decisions.
3. Configurations
   - Policy Builder—Allows configuration of the PCF cluster of virtual machines (VMs) and configuration of services and advanced policy rules.
   - PCF Central—Provides a unified GUI that allows you to configure Policy Builder, manage custom reference table data, and start the Web-based applications and utilities.
   - Ops Center—Allows you to configure and manage the applications and pods configuration.
4. Storage Layer
   - Binding Database Client—Provisions the client to look up the PCRF Mongo Binding Database for information about the secondary key lookup across 4G and 5G.
   - MongoDB—Preserves the subscriber-specific, balance data, and admin configuration data.

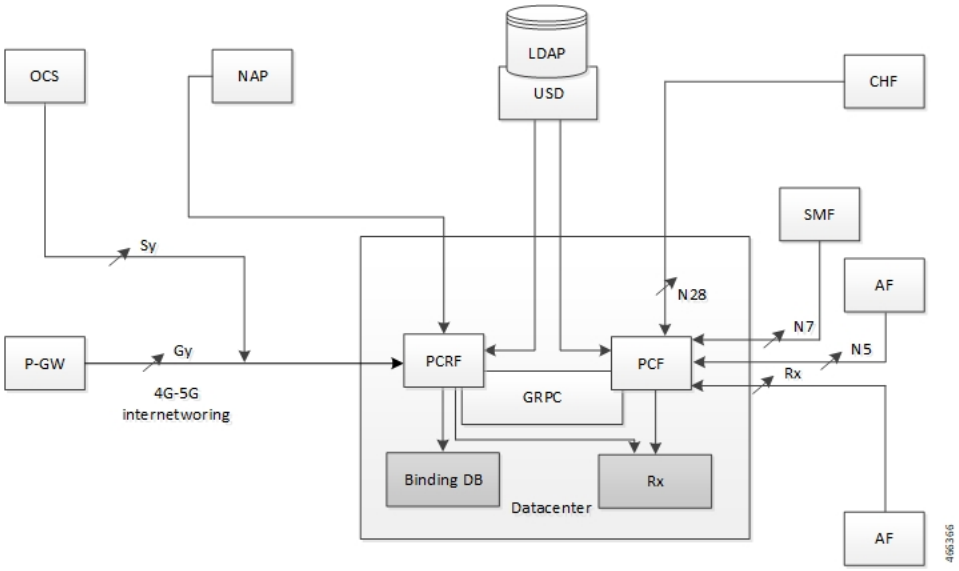
- Session store—Contains the data which CDL accesses for processing a session persistence activity. Stores the PCF sessions.
- Etcd—Contains the Diameter endpoint configurations.

PCF Deployment Architecture

The PCF reduces the deployment complexity by integrating PCRF and PCF in a unified environment.

The following figure illustrates the PCF deployment.

Figure 2: PCF Deployment



Note

- The PCRF's deployment architecture includes:
  - One Region = Two sites. Each site has one cluster (total two clusters in a region).
  - Noncloud-native deployment along with cloud-native 5G PCF.
  - External binding database is the local database for PCRF.
  - MongoDB is the dedicated session database for PCRF.
- The PCF's deployment architecture includes:
  - One Region = Two sites. Each site has one cluster (total two clusters in a region).
  - Cloud-native deployment that deployed along with 4G PCRF.
  - Cisco CDL is the dedicated session database for PCF.

Supported Interfaces

PCF and other NFs in 5GC use the following:

- Rx– Reference point for interworking with AF, PCRF, and PCF
- N5– Reference point between PCF and AF
- N7– Reference point between PCF and SMF
- N15– Reference point between PCF and AMF
- N28– Reference point between PCF and CHF
- N36– Reference point between PCF and UDR
- LDAP– Reference point between PCF and external subscriber profile