NRF Interface

Feature Summary and Revision History

Summary Data

Table 1: Summary Data

Applicable Product(s) or Functional Area	PCF
Applicable Platform(s)	SMI
Default Setting	Disabled – Configuration required to enable
Related Documentation	Not Applicable

Revision History

Table 2: Revision History

Revision Details	Release
Enhancement introduced. Configuration updated for N5 interface service.	2022.01.0
Enhancement introduced. PCF supports dual stack (IPv4 and IPv6) connectivity on all NRF external interfaces/endpoints.	2022.01.0

Revision Details	Release
Enhancement introduced. PCF supports IPv6 connectivity on all NRF external interfaces/endpoints.	2021.04.0
Enhancement introduced. Added new PCF attributes - priority and capacity	2020.02.0
Enhancement introduced. Introduced instructions on how to register an NF profile with NRF.	2020.01.0
First introduced.	Pre 2020.01.0

Feature Description

The NRF provides a fabric for all the NFs to register their profile and the supported services which facilitate in discovering each other. The registration enables the NFs to discover the other NFs based on the NF Type, Instance ID, and other conditions. In a broader view, this enables the NFs to exchange information that is required to carry out the diversified service requirements outlined for each NF.

PCF supports both IPv4 and IPv6 connectivity on its external endpoints (inbound and outbound).

With compliance to the *3GPP December 2018 29.510v15.2.0* specification, NF is equipped to use the NRF management and discovery services. These services allow you to invoke the following service operations:

NRF Management Services (nnrf-nfm)

- PCF uses the NFRegister service to register its profile and other parameters with the NRF. The registration process involves of PCF registering the npcf-am-policy-control and npcf-smpolicycontrol services with the NRF along with the list of services that the PCF instances expose.

  Note PCF endpoint registers with the NRF only if there is a reachable pcf-engine. Registration is complete when the heartbeat between the endpoint and engine is successful. If the heartbeat fails, the deregistration process is initiated.

- PCF uses the NFDeregister service to deregister its NF profile and the services that it has registered in the NRF. The NFDeregister service is initiated during a graceful endpoint shutdown.
- PCF applies the NFStatusSubscribe service to subscribe to the notifications when the NF_REGISTERED, NF_DEREGISTERED, and NF_PROFILE_CHANGED events occur on the individual NF instance. The instance is associated with the registered service, such as nchf-spendinglimitcontrol (CHF) and nudr-dr (UDR).
- The NFStatusNotify service enables the NRF to notify the subscribed PCF when the status of the individual NF instance change.
- PCF uses the NFStatusUnsubscribe service to unsubscribe to the notifications that are invoked when the status of an NF instance changes.

- PCF that is registered in NRF periodically contacts the NRF by sending a heartbeat. PCF attempts the contact by invoking the NFUpdate service operation to indicate that it is still operative.
- PCF monitors the NF profile (NFProfile) by periodically polling the NFProfile configuration to determine the modified parameters. If it detects a modified parameter, then PCF informs NRF about the update by sending a PATCH request containing the details of the modified parameter.
- When the PCF's registration status changes from REGISTERED to UNDISOCVERABLE or conversely in the NFStatus, PCF sends a PATCH request to NRF for the new status.

NRF Discovery Service (nnrf-disc)

- PCF uses the discovery service to discover the CHF and UDR NFs that support the nchf-spendinglimitcontrol and nudr-dr services.

How it Works

This section describes how this feature works.

At the startup, PCF registers its profile with the NRF endpoint of the highest priority. After the registration is complete, it periodically sends a heartbeat to the NRF along with its profile.

When PCF requires a service of another NF, it checks for the profile of that service in the cache. If PCF detects the NFProfile (profile), then it uses the information to consume the service. If the NFProfile is not found in the cache, PCF uses the configured NRF endpoints to discover the NF to which the service belongs. The information that is fetched by the discovery service is stored in the cache and reused until the validity period is met. If PCF does not find the NRF endpoint for discovery or receives an invalid response, it falls back on the local configuration looking for the required service.

After discovering the service from the NRF endpoint, PCF subscribes to the NRF for changes that happen in the NF profile. In response, a notification URI is called back for the event notification.

PCF updates the cache when NRF notifies it about the changes such as registration, deregistration, and modifications that happen in the NFPofile.

PCF periodically polls the NFProfile to determine the updated NF parameters. If it detects a modified parameter, PCF updates the configuration that is running. If PCF is registered to an NRF, then it sends a PATCH request to that NRF containing the details of the modified parameter in the payload. For example, `[{"op":"replace","path":"/capacity","value":33}]`.

If PCF determines that it is not registered (or deregistered) to an NRF, then it does not start the NRF Update Request.

The endpoint selection of the NF and NRF endpoints for registration and discovery is based on the probabilistic load-balancing algorithm (IETF RFC 2782) that uses priority and capacity parameters. In addition, for the discovery service, the locality of the NF is used in the algorithm as:

1. The first set of NFs is from the preferred locality which are sorted based on the locality for priority or capacity in the profile and endpoint.
2. The second set of NFs is from the geo-server locality which are sorted among the locality for priority or capacity in the profile and endpoint.
3. The third set of NFs is from the discovered NFs. These NFs are not part of the first and second set.
4. The fourth set contains the locally configured NFs.

Note Before PCF is shut down, it unregisters its profile and unsubscribes to the events that it has subscribed to.

Standards Compliance

This feature complies with the following standards specifications:

- *3GPP TS 29.510 version 15.0.0 (2018-06) "Network Function Repository Services"*
- *3GPP TS 29.510 version 15.2.0 (2018-12) "Network Function Repository Services"*
- *3GPP TS 29.510 CR#124 "Network Function Repository Services"*
- *3GPP TS 29.571 version 15.2.0 "Common Data Types for Service Based Interfaces"*

Configuring the PCF Profile

This section describes how to configure the PCF profile with NRF.

PCF registration involves associating the PCF profile with the NRF and registering the services such as npcf-am-policy-control and npcf-smpolicycontrol with the NRF. If you do not register any service, then the smfService is registered as the default service.

A PCF instance is discoverable by other NFs only after the PCF profile successfully registers with NRF. The PCF invokes the NFRegister service to complete the profile registration with the NRF.

Note Each NF Profile has a mapped Instance ID which the other NFs use to determine the profile.

To configure a PCF profile, use the following configuration in the Policy Ops Center console:

```
config
  service-registration
    profile
      allowed-plmns [ mcc mnc ]
        mcc mcc
        mnc mnc
      capacity pcf_capacity
      instance-id  instance_id
      locality locality_string
      pcf-info
        dnn-list dnn_list_name
        supi-ranges [ supi-range-id ]
          supi-range-id supi_range_id
            start start_integer
            end end_integer
            pattern regular_expression
      plmn-list [ mcc mnc ]
        mcc mcc
```

```
      mnc mnc
    priority pcf_priority
    snssais [ sst sd ]
      sst sst
      sd sd
  services
    [afService | smfService]
      allowed-nssais [ sst sd ]
       sst sst
       sd sd
      allowed-plmns [ mcc mnc ]
       mcc mcc
       mnc mnc
      api-version [ 1.0.0 | 1.0.2 ]
      end
```

NOTES:

- **service-registration**—Enters the service registration configuration mode.
- **profile** —Enter the profile configuration mode.
- **allowed-plmns [mcc mnc]**—Specify the PLMN code which is identified by a globally unique. The PLMN consists of Mobile Country Code (MCC) and Mobile Network Code (MNC). Typically, it is a 5 – 6 integers that identify a country, and a mobile network operator in that country represented in the form 001-01 or 001-001.
- **mcc** *mcc*—Specify the MCC value. Comprises of 3 integers.
- **mnc** *mnc*—Specify the MNC value. Comprises of 2–3 integers.
- **capacity** *pcf_capacity*—Specify the PCF profile's capacity. *pcf_capacity* must be an integer in the range is 0-65535.
- **instance-id** *instance_id*—Specify the service registration ID of the profile instance.
- **locality** *locality*—Specify the location of the NF instance such as geographic location and data center.
- **pcf-info**—Configures the PCF information such as Data Network Name and SUPI information.
- **dnn-list** *dnn_list_name*—Specify the Data Network Name (DNN) list name.
- **supi-ranges** *supi_range*—Specify the ranges of SUPIs, which the AUSF instance serves. If you do not specify a SUPI range, the AUSF instance determines a SUPI to serve.
- **supi-range-id** *supi_range_id*—Specify the SUPI range identifier.
- **start** *start*—Specify the initial value of a SUPI range. This value permits integers such as IMSI range.
- **end** *end*—Specify the last value of the SUPI range. This value permits integers such as IMSI range.
- **pattern** *pattern*—Specify a regular expression according to the ECMA-262 dialect that represents the set of SUPIs belonging to the specified range.
- **plmn-list [mcc mnc]** —Configures the PLMN code of the network function. Specifies the PLMN code which is a unique code. The PLMN consists of MCC and MNC. Typically, it is a 5–6 integers that identify a country, and a mobile network operator in that country represented in the form 001-01 or 001-001.

- **priority** *pcf_priority*—Specify the PCF profile's priority order. *pcf_priority* must be an integer in the range is 0-65535.
- **snssais [sst sd]**—Configures the S-NSSAIs of the network function.
- **sst** *sst*—Specify the Slice or Service Type to signify the expected Network Slice behaviour in terms of features and services. The acceptable range is 0–255.
- **sd** *sd*—Specify complements one or more Slice or Service Types to allow differentiation among multiple Network Slices of the same Slice or Service Type. Specifies the Slice Differentiator in a hexadecimal representation.
- **services** —Enters the services configuration mode.
- **allowed-nssais [sst sd]**—The Serving PLMN provides the NSSAI during the registration procedure. The NSSAI consists of the S-NSSAI values, which the UE uses in the serving PLMN for the current registration.
- **api-version** *api_version*—Specify the API version of the services that are deployed. The default version is 1.0.0.

Defining the PCF Registration Status

This section describes how to configure the PCF's registration status.

The registration status of PCF reflects its capability to transact with NRF and other NFs. The PCF instance that is registered with an NRF periodically contacts that NRF by invoking the NFUpdate service operation to indicate that it is operative.

You can now define the registration status as UNDISCOVERABLE. The UNDISCOVERABLE status is typically assigned when you want to perform preventive maintenance, or operations and maintenance activities. During this period, PCF would be in a dormant state, which means all the operations involving the PCF instance are suspended.

The feature to modify the registration status is compliant with *3GPP TS 29.510 CR 124*.

To configure the registration state as UNDISCOVERABLE, use the following configuration in the Policy Ops Center console:

```
config
   service-registration profile nf-status
   [ REGISTERED | UNDISCOVERABLE ]
   end
```

NOTES:

- **service-registration profile nf-status [REGISTERED | UNDISCOVERABLE]** —Configures the network function's registration status. The default NFStatus is REGISTERED.

Configuring the NRF Endpoint for Management Services

This section describes the configurations that you must perform to enable the NRF's management services.

1. Configuring the NRF Endpoint Group

2. Configuring the Management Service

Configuring the NRF Endpoint Group

This section describes how to configure the NRF Groups.

To configure the nnrf-nfm service for enabling the management service, use the following configuration in the Policy Ops Center console:

```
config
  group
   nrf
    mgmt [ name ]
     name nrf_group_name
     service
     type service_type
      nrf [ nrf-service-name ]
       nrf-service-name nrf_service_name
       endpoint-profile [ name ]
         name endpoint_profile_name
         capacity endpoint_capacity
         priority  endpoint_priority
         api-uri-prefix uri_prefix
         api-root  api
         uri-scheme  uri_scheme
         version
       uri-version [ name ]
        name version_name
        full-version full_version
       endpoint-profile [name]
        name endpoint_name
        priority endpoint_priority
        capacity endpoint_capacity
        primary ip-address
          ipv4 ipv4_address
          ipv6ipv6_address
          fqdn fqdn
          port port_number
        secondary ip-address
          ipv4 ipv4_address
          ipv6  ipv6_address
          fqdn fqdn
          port port_number
        tertiary ip-address
          ipv4 ipv4_address
          ipv6 ipv6_address
          fqdn fqdn
          port port_number
          end
```

- **group**—Enters the group configuration mode.

- **nrf**—Enters the NRF configuration mode.
- **mgmt [name]** —Enters the management configuration mode.
- **name** *nrf_group_name*—Specify the name of the nrf group.
- **service**—Enters the service configuration mode.
- **type** *service_type*—Specify the configured NF service types. The service types vary depending on the configured service. The PCF service supports the nnrf-nfm service.
- **nrf-service-name** *nrf_service_name*—Specify the NRF service name.
- **endpoint-profile [name]**—Enters the endpoint profile configuration mode.
- **name** *endpoint_profile_name*—Specify the name of the endpoint profile.
- **api-uri-prefix** *uri_prefix*—Specify the apiName. If not configured, it takes the standard API name for the service as per the specification.
- **api-root** *api*—Specify the deployment-specific service API prefix that is used within the apiRoot.
- **uri-scheme** *uri_scheme*—Specify the URI scheme as HTTP or HTTPs.
- **uri-version**—Specify the api/Version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].
- **endpoint-name**—Specify the endpoint name and priority for the service to select the appropriate profile using the load-balancing logic. The priority must be an integer in the range of 0-65535. Capacity denotes the node capacity for the endpoint. It must be an integer in the range of 0-65535.
- **primary ip-address**—Specify the IP address, FQDN, and Port for the primary endpoint.
- **secondary ip-address**—Specify the IP address, FQDN, and port number for the secondary endpoint.
- **tertiary ip-address** —Specify the IP address, FQDN, and port number for the tertiary endpoint.

NOTES:

Configuring the Management Service

This section describes how to enable the management service for the NRF.

To configure the NRF Management service, PCF locality, and associating them to the NRF Endpoint, use the following configuration in the Policy Ops Center console:

```
config
  group
   nf-mgmt [ name ]
     name nf_management_group_name
     nrf-mgmt-group  -> /group/nrf/mgmt/name
      locality locality
     failover
       sla
         reconnect
           interval interval
           end
```

NOTES:

- **group**—Enters the group configuration mode.
- **nf-mgmt [name]**—Specify the management group that is associated to a network function.
- **locality** *locality*—Specify the NF locality.
- **failover**—Enters the failover configuration mode.
- **sla**—Enters the sla configuration mode.
- **reconnect**—Enters the reconnect configuration mode.
- **interval** *interval*—Specify the time interval after which NF must attempt a reconnect operation.

Configuring the NRF Endpoint for Discovery Service

This section describes the configurations that you must perform to enable NRF's discovery services.

1. Configuring the NRF Endpoint Group
2. Configuring the Discovery Service
3. Configuring the Local NF Endpoint

Configuring the NRF Endpoint Group

This section describes how to configure the NRF endpoint groups for the discovery of different NFs using the discovery (nnrf-disc) service.

To enable discovery of the NRF groups, use the following configuration in the Policy Ops Center console:

```
config
    profile
    nrf
    discovery [ name ]
     name discovery_group_name
     service
      type service_type
       nrf [ nrf-service-name ]
       nrf-service-name nrf_service_name
       endpoint-profile [ name ]
        name endpoint_profile_name
        capacity endpoint_capacity
        priority endpoint_priority
        api-uri-prefix uri_prefix_string
        api-root api
        uri-scheme uri_scheme
        version
         uri-version [ name ]
          name version_name
          full-version full_version
```

```
endpoint-name
 name endpoint_name
 priority endpoint_priority
 capacity endpoint_capacity
primary ip-address
 ipv4 ipv4_address
 ipv6 ipv6_address
 fqdn fqdn
 port port_number
secondary ip-address
 ipv4 ipv4_address
 ipv6 ipv6_address
 fqdn fqdn
 port port_number
tertiary ip-address
 ipv4 ipv4_address
 ipv6 ipv6_address
 fqdn fqdn
 port port_number
 end
```

NOTES:

- **profile**—Enters the **profile** configuration mode.
- **nrf**—Enters the **nrf** configuration mode.
- **discovery [name]**—Enters the **discovery [name]** configuration mode.
- **name** *discovery_group_name*—Specify the name of the discovery group. Discovery group is the logical link to the NRF endpoint groups (nrf-group). For each NF type, you can associate a discovery group and the locality information.
- **type** *service_type*—Specify the configured NF service types. The service types vary depending on the configured service. The PCF service supports the nnrf-disc service.
- **nrf-service-name** *nrf_service_name*—Specify the NRF service name.
- **endpoint-name** —Specify the endpoint's name and priority for the service to select the appropriate profile using the load-balancing logic. The priority must be an integer in the range of 0-65535. Capacity denotes the node capacity for the endpoint. It must be an integer in the range of 0-65535.
- **api-uri-prefix** *uri_prefix_string*—Specify the {apiName}. If not configured, it takes the standard API name for the service as per the specification.
- **api-root** *api*—Specify the deployment-specific service API prefix that is used within the apiRoot.
- **uri-scheme** *uri_scheme*—Specify the URI scheme as HTTP or HTTPs.
- **uri-version { name** *version_name* **| full-version** *full_version***}**—Specify the api/Version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].
- **primary ip-address**—Specify the IP address, FQDN, and port number for the primary endpoint.
- **secondary ip-address**—Specify the IP address, FQDN, and port number for the secondary endpoint.

- **tertiary ip-address**—Specify the IP address, FQDN, and port number for the tertiary endpoint.

Configuring the Discovery Service

This section describes how to enable the discovery service for the NRF.

To configure the NRF Discovery and PCF locality and associating them to the NRF Endpoint, use the following configuration in the Policy Ops Center console:

```
config
    profile
      nf-pair
        nf-type [ type ]
          type nf_type
        nrf-discovery-group -> /group/nrf/discovery/name
        subscription-enabled subscription_status
        subscription-extension extension_value
        locality
          client -> /service-registration/profile/locality
          preferred-server server_name
          geo-server geo_server
          end
```

NOTES:

- **type** *nf_type*—Specify one or more NF types such as AMF, CHF, PCF, and UDM as the network element profile.
- **subscription-enabled** *subscription_status*—Specify if PCF is enabled to subscribe to notifications related to the discovered service.
- **subscription-extension** *extension_value*—Specify the duration (in minutes) for which the subscription is extended.
- **preferred-server** *server_name*—Specify the preferred server locality information. Preferred server locality is the locality that is considered as the locality of preference during the corresponding NF discovery.
- **geo-server** *geo_server*—Specify the geo-server locality information. Geo-server locality is a geo redundant site for the preferred locality and is used as the next suitable server locality after preferred locality, during NF discovery.

Configuring the Local NF Endpoint

This section describes how to configure the local NF endpoint.

The PCF becomes aware of the various NFs in the 5G fabric through the NF discovery service that is exposed by the NRF or through the CLI configuration. If the NRF is unavailable, then PCF relies on the local configuration of the NF endpoints to discover the NFs.

To configure the local configuration for the NF services that PCF uses, use the following configuration in the Policy Ops Center console:

```
config
  profile
  nf-client
   nf-type
    udr
    udr-profile [ name ]
      name udr_profile_name
      locality
        name udr_locality_name
        priority priority
     sevice
      name service_name
      type [ type ]
       type service_type
       endpoint-profile [ name ]
         name endpoint_profile_name
         capacity endpoint_capacity
         priority endpoint_priority
         api-uri-prefix uri_prefix_string
         api-root api
         uri-scheme uri_scheme
         version
           uri-version [ name ]
             name version_name
             full-version full_version
       endpoint-profile [ name ]
         name endpoint_name
         priority endpoint_priority
         capacity endpoint_capacity
       primary ip-address
         ipv4 ipv4_address
         ipv6 ipv6_address
         port port_number
       secondary ip-address
         ipv4 ipv4_address
         ipv6 ipv6_address
         port port_number
       tertiary ip-address
         ipv4 ipv4_address
         ipv6 ipv6_address
         port port_number
    chf-profile [ name ]
     name chf_profile_name
     locality [ name ]
      name locality_name
      priority priority
     service
      name service_name
      type [ type ]
       type service_type
     endpoint-profile [ name ]
```

```
endpoint-profile [ name ]
  name endpoint_profile_name
  capacity endpoint_capacity
  priority endpoint_priority
  api-uri-prefix uri_prefix_string
  api-root api
  uri-scheme uri_scheme
  version
    uri-version [ name ]
      name version_name
      full-version full_version
endpoint-profile [ name ]
  name endpoint_name
  priority endpoint_priority
  capacity endpoint_capacity
primary ip-address
  ipv4 ipv4_address
  ipv6 ipv6_address
  port port_number
secondary ip-address
  ipv4 ipv4_address
  ipv6 ipv6_address
  port port_number
tertiary ip-address
  ipv4 ipv4_address
  ipv6 ipv6_address
  port port_number
  end
```

NOTES:

- **udr-profile [name]**—Enter the UDR profile configuration mode.
- **name** *udr_profile_name*—Specify the name of the UDR profile.
- **type** *service_type*—Specify the configured NF service types. The service types vary depending on the configured service.
- **nrf-service-name** *nrf_service_name*—Specify the NRF service name.
- **api-uri-prefix** *uri_prefix_string*—Specify the apiName. If not configured, it takes the standard API name for the service as per the specification.
- **api**—Specify the deployment-specific service API prefix that is used within the apiRoot.
- *uri_scheme*—Specify the URI scheme as HTTP or HTTPs.
- **uri-version**—Specify the API/version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].
- **endpoint-name**—Specify the endpoint name and priority for the service to select the appropriate profile using the load-balancing logic. The priority must be an integer in the range of 0-65535. Capacity denotes the node capacity for the endpoint. It must be an integer in the range of 0-65535.
- **primary ip-address**—Specify the IP address, FQDN, and port number for the primary endpoint.

- **secondary ip-address**—Specify the IP address, FQDN, and port number for the secondary endpoint.
- **tertiary ip-address**—Specify the IP address, FQDN, and port number for the tertiary endpoint.