NRF Interface

Feature Summary and Revision History

Summary Data

Table 1: Summary Data

Applicable Product(s) or Functional Area	5G-PCF
Applicable Platform(s)	SMI
Default Setting	Disabled – Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 2: Revision History

Revision Details	Release
Added new PCF attributes - priority and capacity	2020.02.0
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.

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.

Standards Compliance

The NF and NRF interaction complies with the following standards:

- *3GPP TS 29.510 version 15.0.0 (2018-06)*

- *3GPP TS 29.510 version 15.2.0 (2018-12)*

- *3GPP TS 29.510 CR#124*

- *3GPP TS 29.571 version 15.2.0*

How it 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 initiate 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.

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
      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]** – Specifies 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* – Indicates the MCC value. Comprises of 3 integers.

- **mnc** *mnc* – Denotes the MNC value. Comprises of 2–3 integers.

- **capacity** *pcf_capacity* – Indicates the PCF profile's capacity. *pcf_capacity* must be an integer in the range is 0-65535.

- **instance-id** *instance_id* – Specifies the service registration ID of the profile instance.

- **locality** *locality* – Specifies 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* – Specifies the Data Network Name (DNN) list name.

- **supi-ranges** *supi_range* – Lists 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* – Specifies the SUPI range identifier.

- **start** *start* – Specifies the initial value of a SUPI range. This value permits integers such as IMSI range.

- **end** *end* – Specifies the last value of the SUPI range. This value permits integers such as IMSI range.

- **pattern** *pattern* – Specifies 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* – Denotes 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* – Specifies 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* – It 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* – Specifies 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* – Specifies the name of the nrf group.

- **service** – Enters the service configuration mode.

- **type** *service_type* – Specifies 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* – Indicates the NRF service name.

- **endpoint-profile [name]** – Enters the endpoint profile configuration mode.

- **name** *endpoint_profile_name* – Specifies the name of the endpoint profile.

- **api-uri-prefix** *uri_prefix* – Specifies the apiName. If not configured, it takes the standard API name for the service as per the specification.

- **api-root** *api* – Specifies the deployment-specific service API prefix that is used within the apiRoot.

- **uri-scheme** *uri_scheme* – Specifies the URI scheme as HTTP or HTTPs.

- **uri-version** – Specifies the api/Version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].

- **endpoint-name** – Specifies 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** – Specifies the IP address, FQDN, and Port for the primary endpoint.

- **secondary ip-address** – Specifies the IP address, FQDN, and port number for the secondary endpoint.

- **tertiary ip-address** – Specifies 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]** – Specifies the management group that is associated to a network function.

- **locality** *locality* – Specifies the NF locality.

- **failover** – Enters the failover configuration mode.

- **sla** – Enters the sla configuration mode.

- **reconnect** – Enters the reconnect configuration mode.

- **interval** *interval* – Specifies 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* – Specifies 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* – Specifies 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* – Indicates the NRF service name.

- **endpoint-name** – Specifies 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* – Specifies the {apiName}. If not configured, it takes the standard API name for the service as per the specification.

- **api-root** *api* – Specifies the deployment-specific service API prefix that is used within the apiRoot.

- **uri-scheme** *uri_scheme* – Specifies the URI scheme as HTTP or HTTPs.

- **uri-version { name** *version_name* **| full-version** *full_version***}** – Specifies the api/Version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].

- **primary ip-address** – Specifies the IP address, FQDN, and port number for the primary endpoint.

- **secondary ip-address** – Specifies the IP address, FQDN, and port number for the secondary endpoint.

- **tertiary ip-address** – Specifies 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* – Specifies one or more NF types such as AMF, CHF, PCF, and UDM as the network element profile.

- **subscription-enabled** *subscription_status* – Indicates if PCF is enabled to subscribe to notifications related to the discovered service.

- **subscription-extension** *extension_value* – Specifies the duration (in minutes) for which the subscription is extended.

- **preferred-server** *server_name* – Specifies 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* – Specifies 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* – Specifies the name of the UDR profile.

- **type** *service_type* – Specifies the configured NF service types. The service types vary depending on the configured service.

- **nrf-service-name** *nrf_service_name* – Indicates the NRF service name.

- **api-uri-prefix** *uri_prefix_string* – Specifies the apiName. If not configured, it takes the standard API name for the service as per the specification.

- **api** – Specifies the deployment-specific service API prefix that is used within the apiRoot.

- *uri_scheme* – Specifies the URI scheme as HTTP or HTTPs.

- **uri-version** – Specifies the API/version and the version number. The full version format is <Major-version>.<Minor-version>.<patch-version>.[alpha-<draftnumber>].

- **endpoint-name** – Specifies 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** – Specifies the IP address, FQDN, and port number for the primary endpoint.

- **secondary ip-address** – Specifies the IP address, FQDN, and port number for the secondary endpoint.

- **tertiary ip-address** – Specifies the IP address, FQDN, and port number for the tertiary endpoint.