



SAPC 1 Operation and Configuration



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SAPC Solutions



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Chapter Objectives



On completion of this chapter, the participants will be able to:

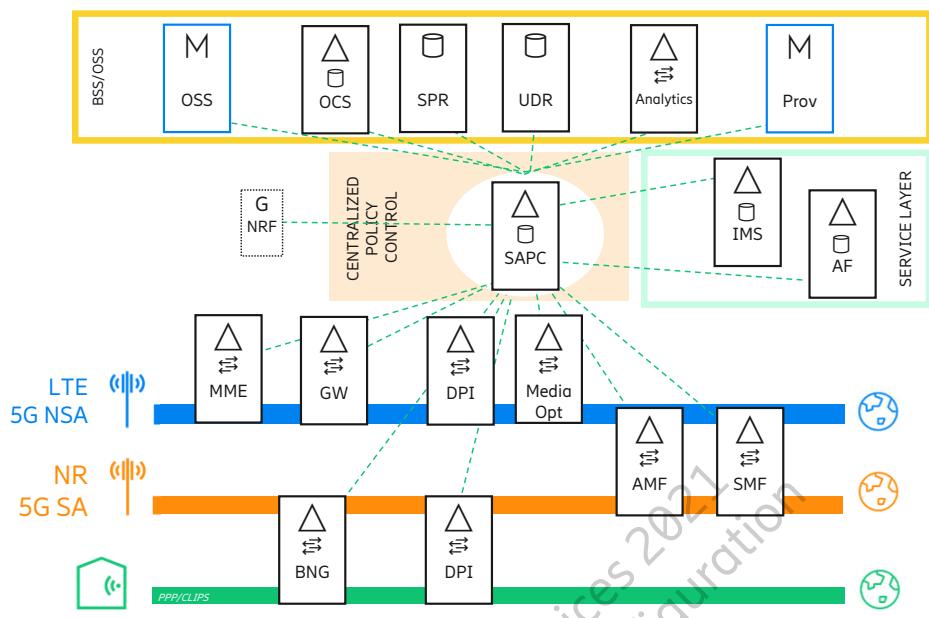
- Explain the 5G EPC SAPC PCF reference model
- Describe the SAPC main functions
- Explain the SAPC interfaces and their protocols
- Describe the SAPC in 5G EPC as well as Policy Controller in 5GC
- List the main features in SAPC 1

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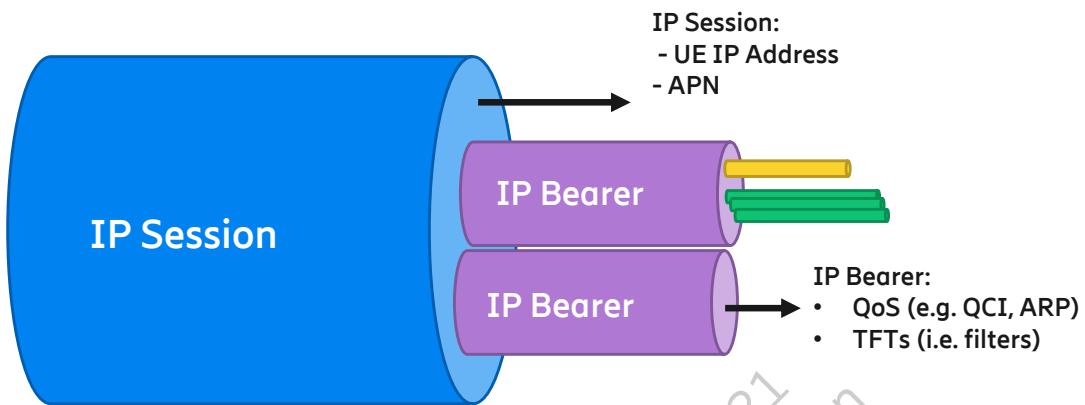


The SAPC PCF Reference Model





Policy Charging and Control (PCC) - IP Session vs IP Bearers

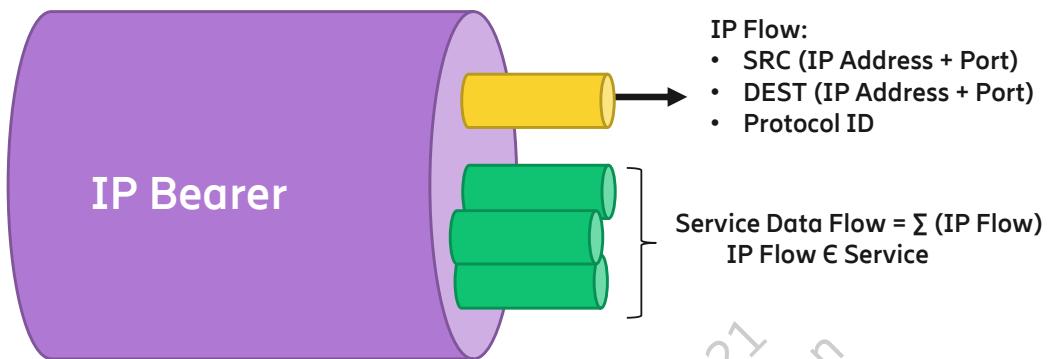


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Policy Charging and Control (PCC) and Service Data Flows (SDFs)



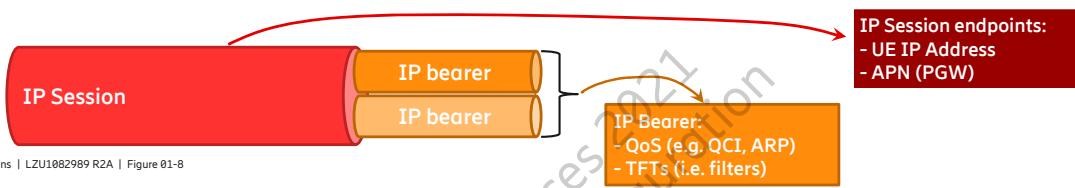
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QoS Control for Network-Initiated Dedicated Bearers

- Dedicated bearers are extra logical transmission paths that relate to a particular set of QoS characteristics
- Contain a set of filters that define which IP flows pass through the bearer and classify the IP flow into the correct bearer (Traffic Flow Templates)
- All packet flows mapped to the same bearer receive the same packet-forwarding treatment
- Ensures optimal user experience while accessing services that use a varying bandwidth
- Through dedicated bearers, the operator has the capability to provide a QoS granted for specialized user experience services, controlling and achieving predictable service delivery
- Ensures optimal use of network resources
- This use case relies on client devices which are capable of marking IP packets
- Service applications' IP markings are preserved and passed across the LTE network



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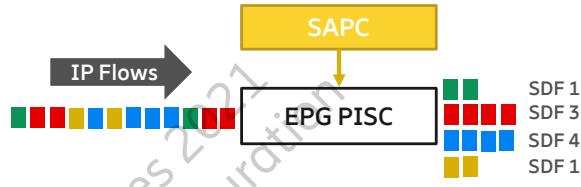


QoS Control – PCC rules

```
PUT /profiles/content-qos/QosPr_Critical_OTHER
{
    "gbrDownlink" : 2048,
    "gbrUplink" : 1024,
    "mbrDownlink" : 4096,
    "mbrUplink" : 2048,
    "profileId" : "QosPr_Critical_OTHER",
    "qci" : 1
}
PUT /rules/QoS_Critical_OTHER
{
    "condition" : "AccessData.bearer.accessType!=1000",
    "outputAttributes" :
    [
        {
            "attrName" : "qos",
            "attrValue" : "ServiceQosProfile[\"QosPr_Critical_OTHER\"]",
            "result" : "permit"
        }
    ],
    "ruleName" : "QoS_Critical_OTHER"
}
PUT /policies/QoS_Streaming
{
    "policyName" : "QoS_Critical",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "QoS_Critical_UTRAN", "QoS_Critical_OTHER" ]
}
PUT /dataplans/Gold/locators/resources/Critical/contexts/qos
{
    "policies" : [ "QoS_Critical" ]
}
```

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No.	Time	Source	Destination	Info
2	2013-04-12 14:35:04,292562	10.42.83.245	10.37.151.146	cmd=Credit-Control Answer(272)
<				
> AVP: CC-Request-Type(416) l=12 f=-MP val=INITIAL_REQUEST (1)				
> AVP: CC-Request-Number(415) l=12 f=-MP val=0				
> AVP: Gx-Capability-List(1068) l=16 f=V- vnd=Ericsson val=1				
> AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=QoS_CHANGE (1)				
> AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=TAI_CHANGE (26)				
> AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=REVALIDATION_TIMEOUT (17)				
> AVP: Charging-Rule-Install(1001) l=76 f=VM- vnd=TGPP				
AVP Code: 1001 Charging-Rule-Install				
> AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set				
AVP Length: 76				
AVP Vendor Id: 3GPP (10415)				
> Charging-Rule-Install: 000003edc00000f000028af39393900000003edc00000f..				
> AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=999				
> AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=199				
> AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=101				
> AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=100				
> AVP: Charging-Rule-Install(1001) l=68 f=VM- vnd=TGPP				
AVP Code: 1001 Charging-Rule-Install				
> AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set				
AVP Length: 68				
AVP Vendor Id: 3GPP (10415)				
> Charging-Rule-Install: 000003edc00000f000028af323030000000413c0000010..				
> AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=200				
> AVP: Rule-Activation-Time(1043) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:35:04 00:00:0000 UTC				
> AVP: Rule-Deactivation-Time(1044) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:36:01 00:00:0000 UTC				
> AVP: Revalidation-Time(1042) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:36:00 00:00:0000 UTC				
> AVP: QoS-Information(1016) l=44 f=VM- vnd=TGPP				
> AVP: Default-EPS-Bearer-QoS(1049) l=88 f=VM- vnd=TGPP				
> AVP: Supported-Features(628) l=56 f=VM- vnd=TGPP				
> AVP: Bearer-Control-Mode(1023) l=16 f=VM- vnd=TGPP val=UE_ONLY (0)				
> AVP: Origin-State-Id(278) l=12 f=-M- val=7				





QoS Control

Based on the previous slide's example, the EPG will be informed from the SAPC for the content "Critical"

We assume that "Critical" is a predefined rule type identified by a specific SDF

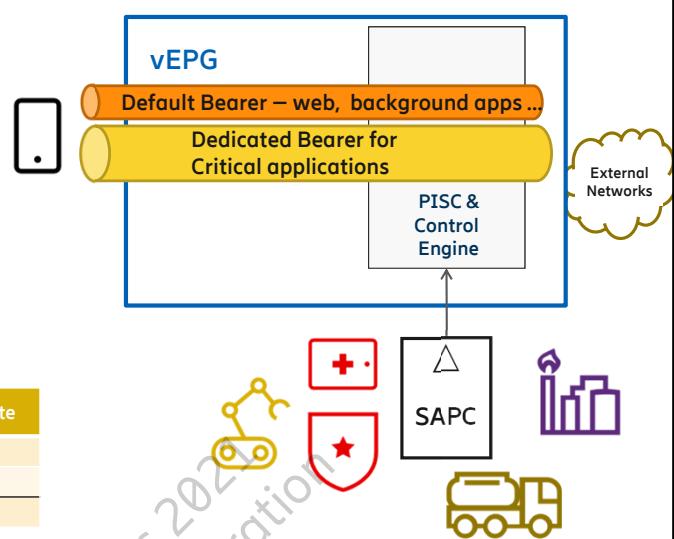
That content (service) should be related to QCI 1

So for that service, EPG should create a dedicated bearer with QCI 1 (GBR)

With the corresponding TFTs, all packet of "Critical Service" should go through that dedicated bearer

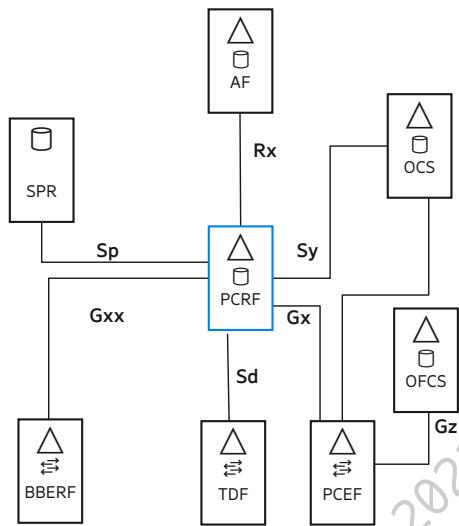
QCI	Resource Type	Packet Delay Budget	Packet Error Loss rate
1	GBR	100 ms	10^{-2}
2	GBR	150 ms	10^{-3}
5	Non-GBR	100 ms	10^{-3}

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SAPC Reference Architecture (3GPP– PCC)

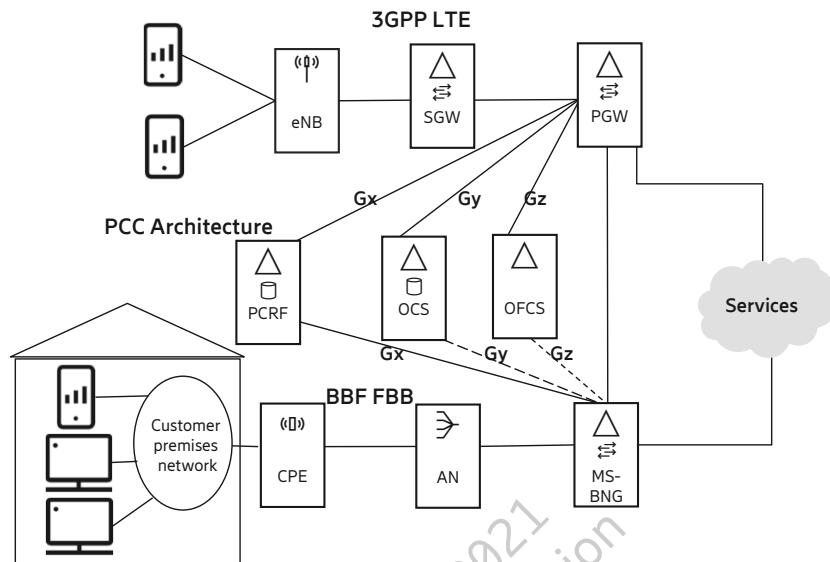


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3GPP and Broadband Forum (BBF)

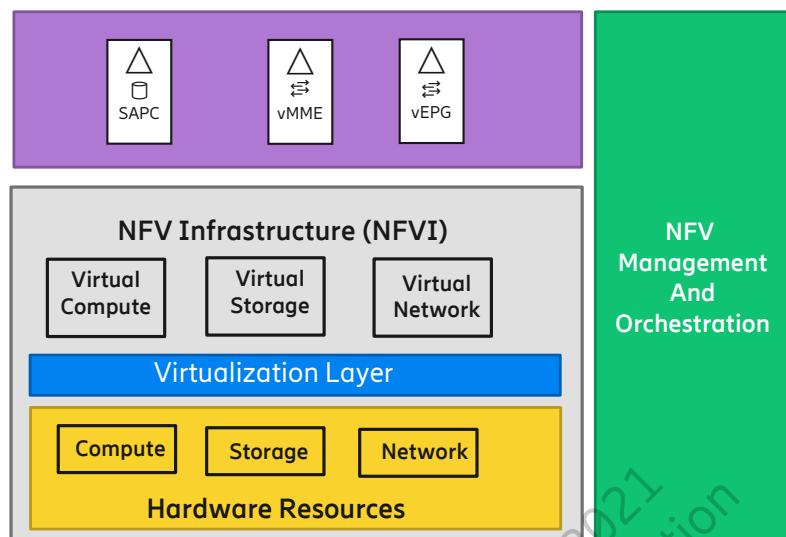


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ETSI Network Function Virtualization (NFV) Framework

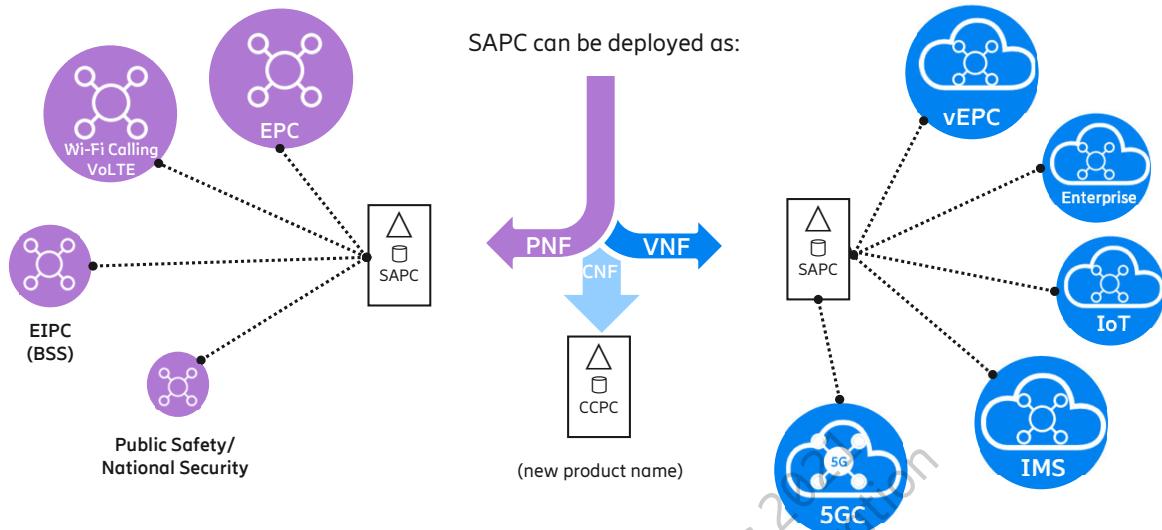


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SAPC Naming Convention

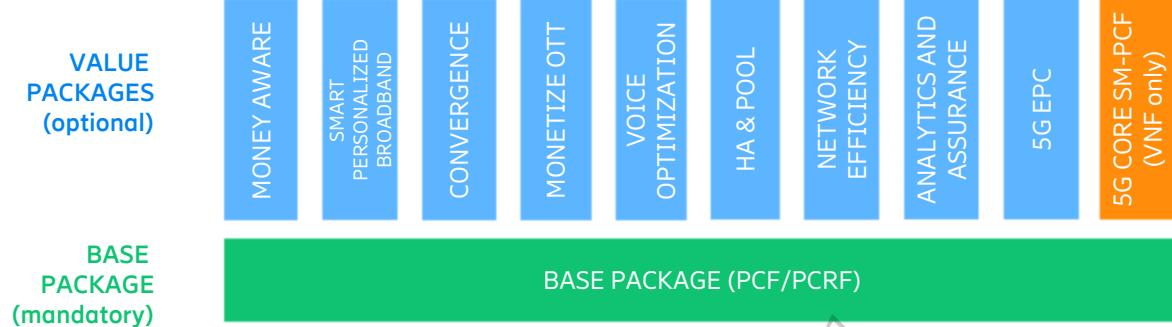


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SAPC PCF Software Model



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SAPC 1 in Virtual EPC (vEPC in 5G)



Virtual (5G) EPC VNS including SAPC Value Packages

New products including SAPC

Enterprise Core

MI
(Massive IoT)

Solutions (VNS) including SAPC

MBB/
DMBB

Specific VPs created for these VNS:es Including SAPC functionality

Same VPs as SAPC's ones

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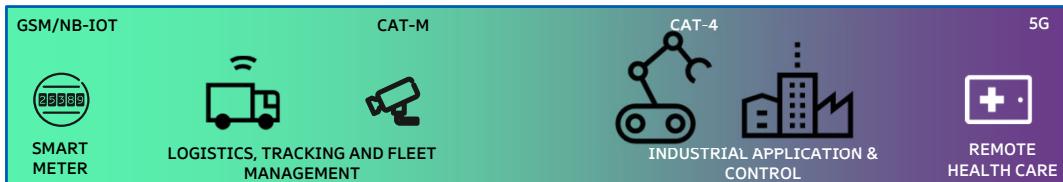


Policy for IoT



Massive IoT

Low cost, Low energy, Small data volumes.



Fraud Prevention

- Access Control based on RAT, location, device type, time of day.....

Massive IoT monetization

- Data Consumption control
- Quota control of group of devices

Critical IoT

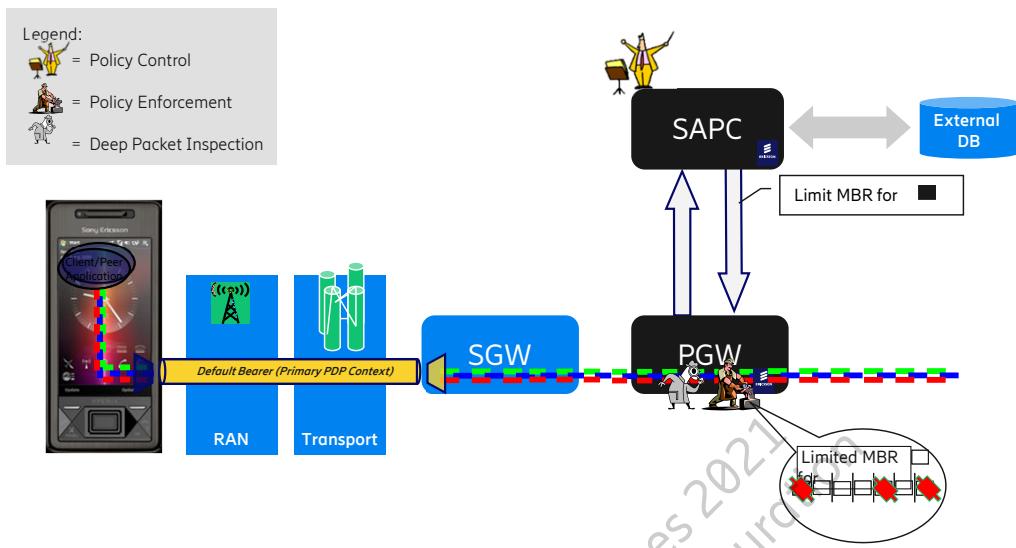
Ultra reliable , Ultra low latency, high availability

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Bandwidth Management - Throttling

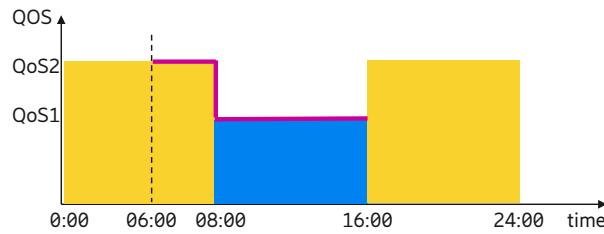


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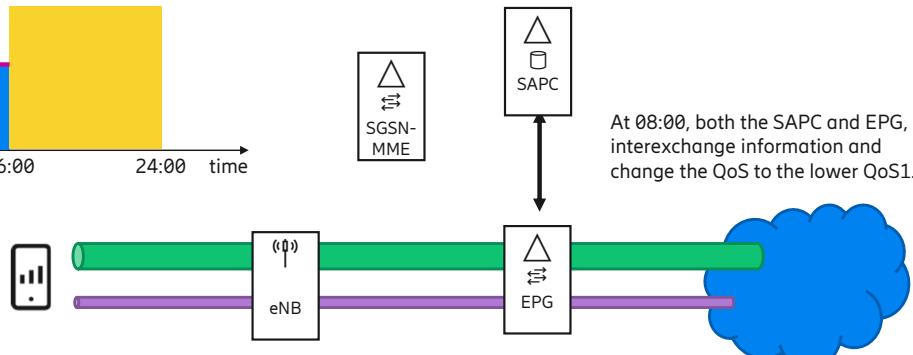
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SAPC Time of Day Based Use Case



The session started at 06:00.
The session used the QoS=QoS2
when the session started.



The PDP Context (Default Bearer) is downgraded
from QoS2 to the lower QoS1

Ongoing PDP Context
(Default Bearer) with
negotiated QoS2



Enhanced Policy Control



- Users can dynamically be captured without dedicated external provisioning flows
- So a default policy and charging rules are assigned to them (Unknown Subscriber SAPC function)
- Or Auto-provisioning them by applying Auto-provisioning policies based on APN
- Auto-provisioning enables the automatic provisioning of users in SAPC at their first IP session
- For specific users, the SAPC Admin specifies manually policy & charging rules
- The SAPC enables the activation/deactivation of service offerings based on dynamic information through policies
- The dynamic group selection function consists of the dynamic authorization of the applicable subscriber groups per IP session
- This is done by means of using Group Selection policies, including configured conditions based on dynamic access information, accumulated usage, time and date conditions etc.

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Enhanced Policy Control example



- SAPC associates the group "4g-group" to autoprovisioned subscribers when the access type is E-UTRAN (rule condition (AccessData.bearer.accessType == 1004)). It also provisions usage limits for the "4g-group" dataplan

```
PUT /rules/rAutoprovisioning
{
    "condition" : "(AccessData.bearer.accessType == 1004)",
    "outputAttributes" :
    [
        {
            "attrName" : "dataplan",
            "attrValue" : "\"4g-group\"",
            "result" : "permit"
        }
    ],
    "ruleName" : "rAutoprovisioning"
}

PUT /policies/pAutoprovisioning
{
    "policyName" : "pAutoprovisioning",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "rAutoprovisioning" ]
}

PUT /locators/resources/any/contexts/autoprovisioning
{
    "policies" : [ "pAutoprovisioning" ]
}
PUT /dataplans/4g-group
{
    "dataplanName" : "4g-group"
}
PUT /dataplans/AutoProvFixed
{
    "dataplanName" : "AutoProvFixed",
    "usageLimits" :
    [
        {
            "absoluteLimits" :
            {
                "dlVolume" : 1048576,
                "resetPeriod" :
                {
                    "volume" : "monthly"
                },
                "description" : "Total traffic"
            }
        }
    ]
}
```

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Fair Usage Control Function



- Provides the capability to control the accumulated volume or time consumed by a subscriber for a service or for a group of services during a period (ex. monthly or during an IP session)
- The SAPC can take actions, such as QoS change, Rating Group change or deny access to a service whenever any of the usage limits configured for a subscriber are surpassed
- At IP session activation, the Enforcement Function requests for authorized data for the subscriber
- SAPC evaluates Fair Usage Control policies and directs the EF to report usage downloading a quota
- If a quota is received the EF performs usage detection
- After the quota is consumed or an event is reported, the SAPC receives the usage reporting
- The usage reporting consists of volume information consumed by the subscriber, Time quotas are controlled internally by the SAPC

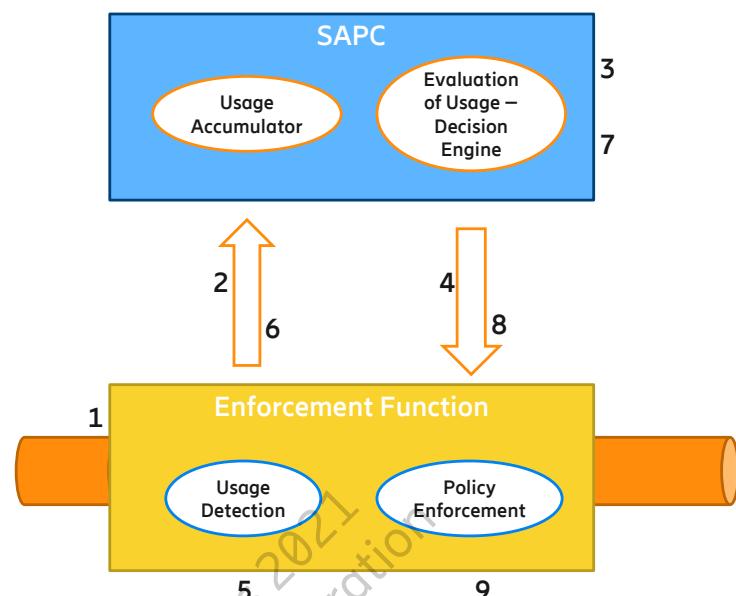
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Fair Usage Control Function

1. IP Session activation
2. Quota Requested
3. Evaluation of Usage
4. Quota sent
5. Traffic Ongoing, Quota deducted
6. Usage Reporting
7. Accumulator updated, usage evaluation
8. Action Request (ex. Modify IP Session QoS, Session abortion etc)
9. Change QoS profile

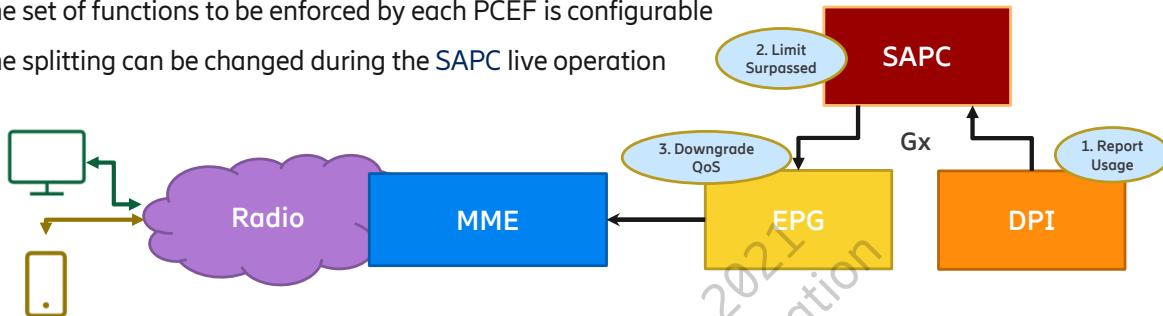


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Multiple PCEF support

- SAPC can provide the policy decisions for a single session to two or more PCEFs simultaneously
- Therefore the SAPC is able to decide what policy control can be enforced by each PCEF for that session
- Also SAPC may take use information received from one PCEF for making a policy decision that is enforced in second PCEF
 - Ex. Getting usage reporting from DPI, while policy decisions based in accumulated usage enforced in another
- The set of functions to be enforced by each PCEF is configurable
- The splitting can be changed during the SAPC live operation



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Fair Usage – Shared Dataplans



- The data volume limits can either be set per subscriber or use the SAPC function Shared Data Plans
- Shared Data Plans enables the possibility to assign volume limits to a group of subscribers
 - Ex. a department, and also sub-limits for different roles within the department
- Enables the possibility to establish a common usage limit for all the employees, a limit per department, etc., for a more efficient usage of the network
- Limits are defined at subscriber group level and the usage performed by all the members of the shared data plan is accumulated in the same usage accumulator (associated to the shared dataplan)
- When the usage limit associated with a shared dataplan is reached by one member, the SAPC applies the configured actions to this subscriber but not to all members associated to the shared dataplan
- To apply configured actions to each member the SAPC waits for their usage reporting (once their granted slice is consumed)
- SAPC permits the usage control of a common subscription over different devices (multi-SIM) for employees who access the network from different devices (PCs, tablets, phones)

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Advanced Sy capabilities



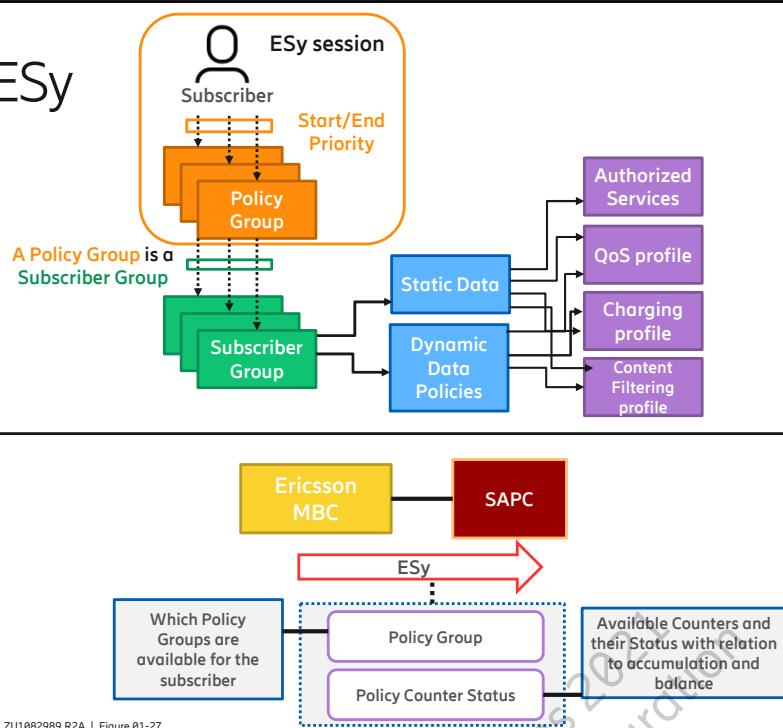
- Ericsson Sy allows the operator to centralize and consolidate MBC and SAPC subscription info
- When the credit limit is reached, MBC informs the SAPC via ESy and SAPC can decide to throttle the bandwidth, notify or terminate the PDN connection
- The subscriber database can be kept in MBC, including both the relation between the data products that have been subscribed and also the information about the subscriber accumulated usage
- SAPC gets the necessary information from MBC when needed, avoiding duplicities
 - Rating policies and accumulation usage for the contracted Data Products are handled in the OCS
 - User policies that define the allowed services, bandwidth limits, and so on are handled in the SAPC
- Ericsson OCS indicates to the SAPC the set of Data Products available to the subscriber by the ESy interface, using an Ericsson concept called Policy Groups
- ESy conveys together with Policy Counter status, the Policy Groups available to the subscriber
- The Policy Groups are assigned to a subscriber and are sent over ESy interface to indicate the Service Offering applicable to a subscriber, for example "PayAsYouGo"
- The SAPC allows for dynamic selection of the received Policy Groups, using Group Selection

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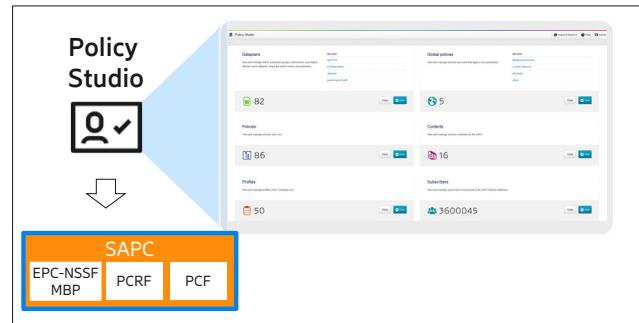


Ericsson ESy





Core Policy Studio



Cutting edge graphical user interface for one touch policy configuration:

- Same tool for all the policy nodes (SAPC, CCPC, CCRC)
- Same tool to configure 4G, 5G EPC and 5GC use cases
- Using cutting edge displaying techniques

Benefits

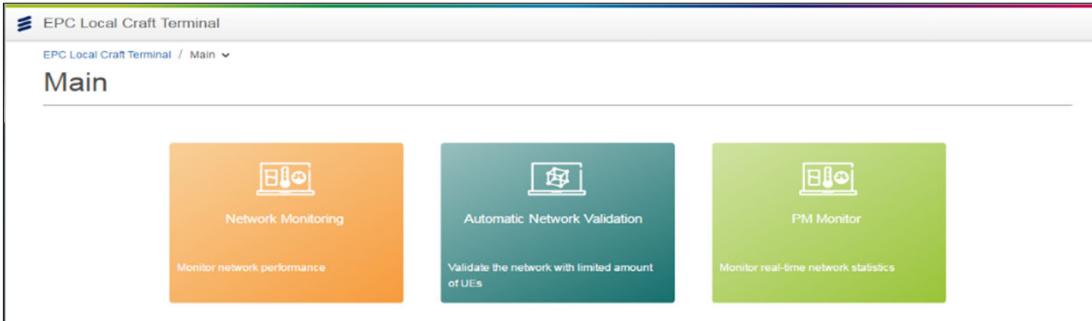
- Intuitive policy configuration
- Faster TTM for new policies and data packages
- Same tool for 4G and 5G
- Online and offline mode
- Policy templates

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Support of Core Network Operations Manager (CNOM)



The screenshot shows the 'Main' screen of the EPC Local Craft Terminal. It features three cards:

- Network Monitoring**: Monitors network performance.
- Automatic Network Validation**: Validates the network with limited amount of UEs.
- PM Monitor**: Monitors real-time network statistics.

Common tool for O&M of
Packet Core nodes

Easy way to track SAPC
node status (Interfaces,
Processors, ...)

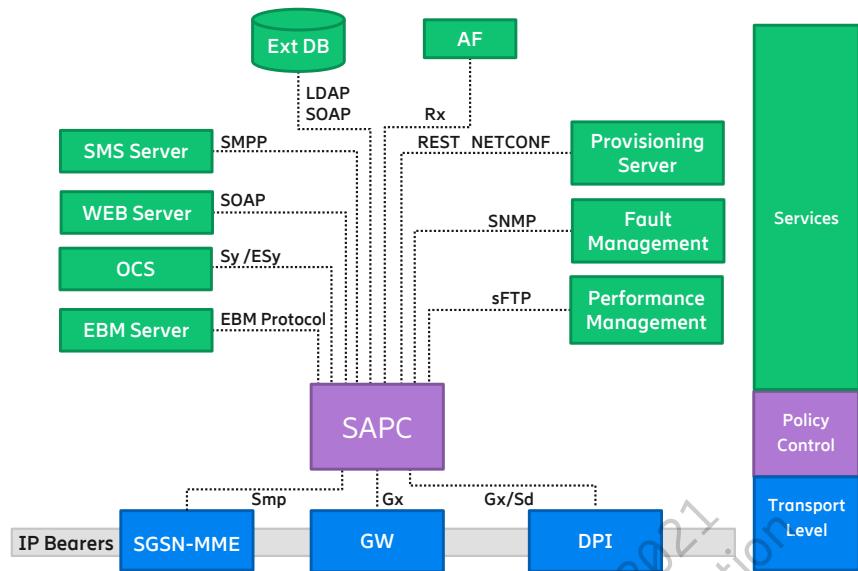
GUI included as part of ENM
offering

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SAPC Interfaces Overview

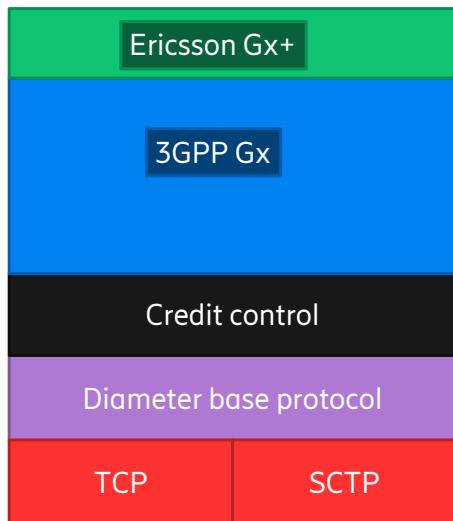


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Protocols and standards – Gx and Diameter interfaces



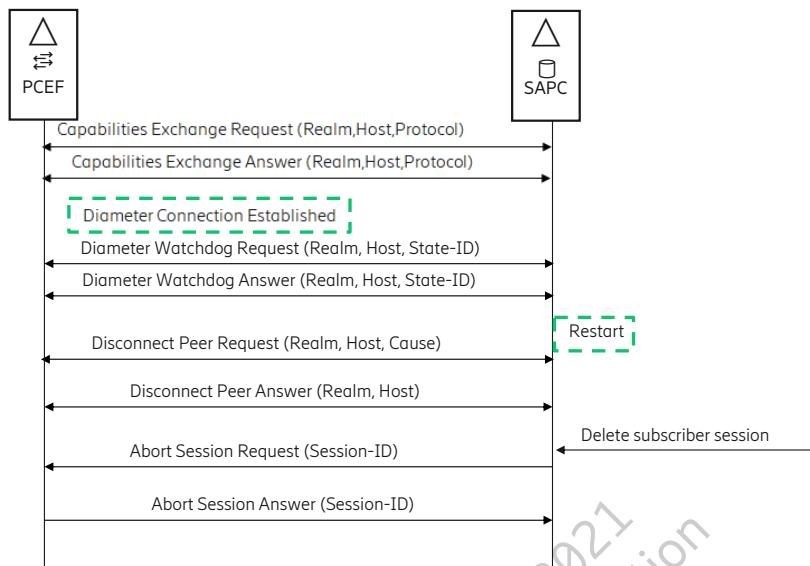
- 3GPP TS 29.212
 - Policy and Charging Control over Gx reference point
- RFC 4006
 - Diameter Credit Control
- RFC 3588
 - Diameter Base Protocol

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Diameter messages (Gx/Gy)

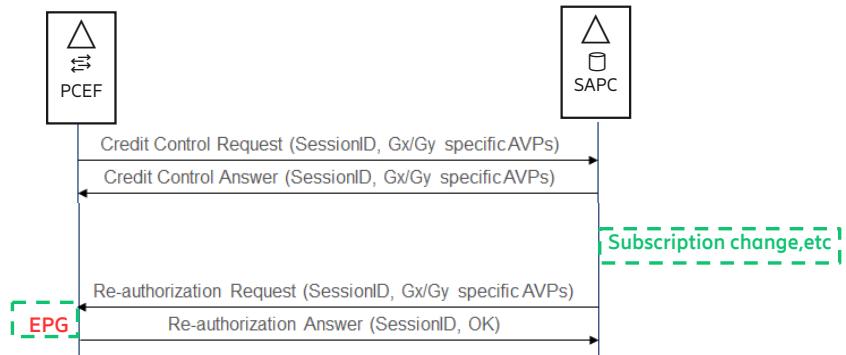


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Gx/Gy Messages

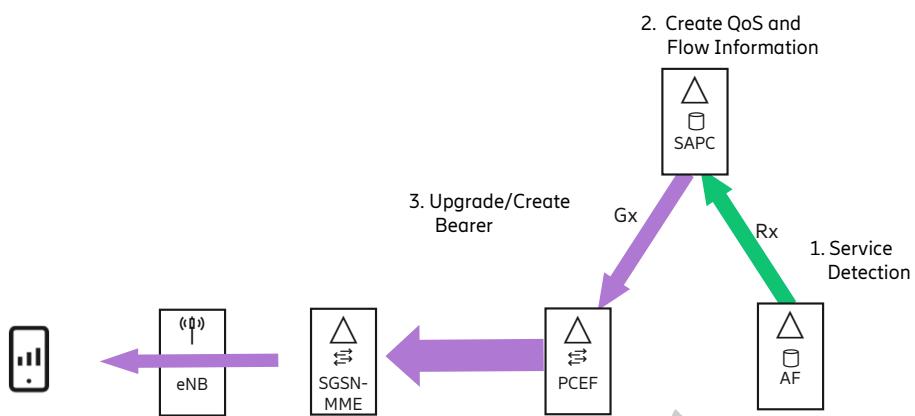


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Service Detection – Rx

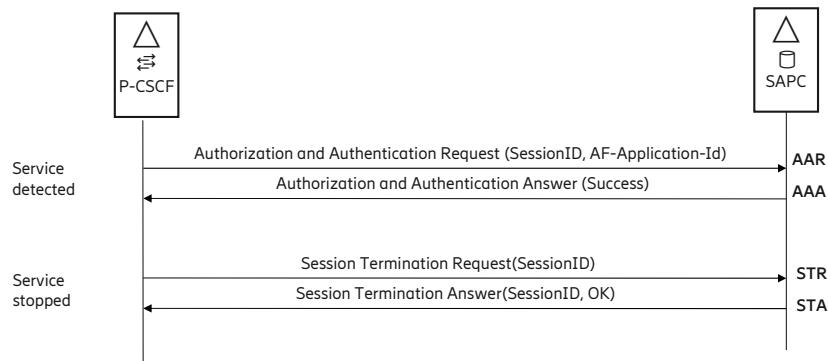


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Rx Messages

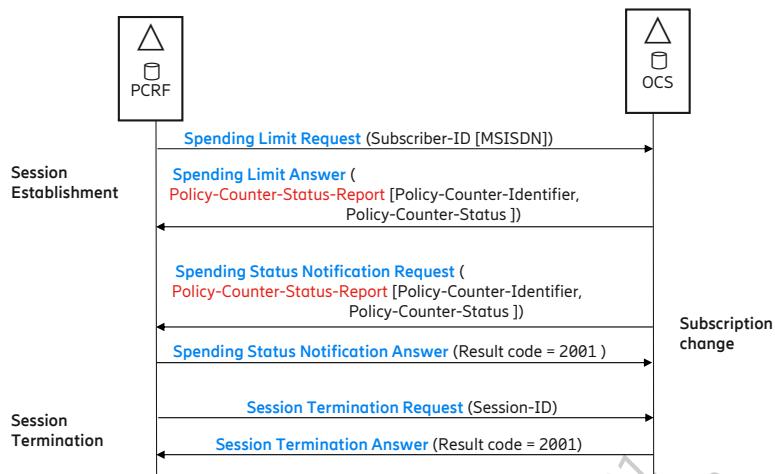


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3GPP Sy Messages

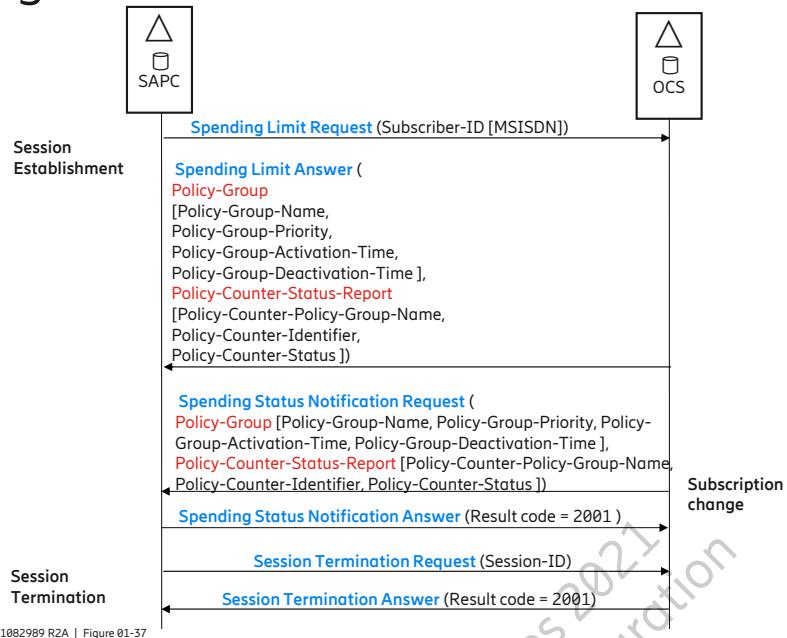


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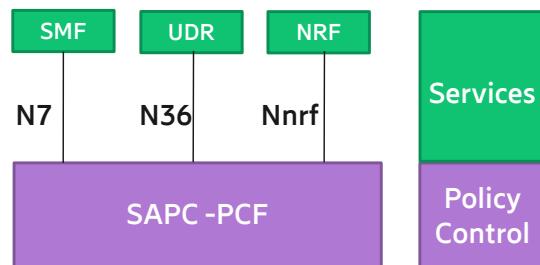


ESy Messages





SAPC PCF Interfaces

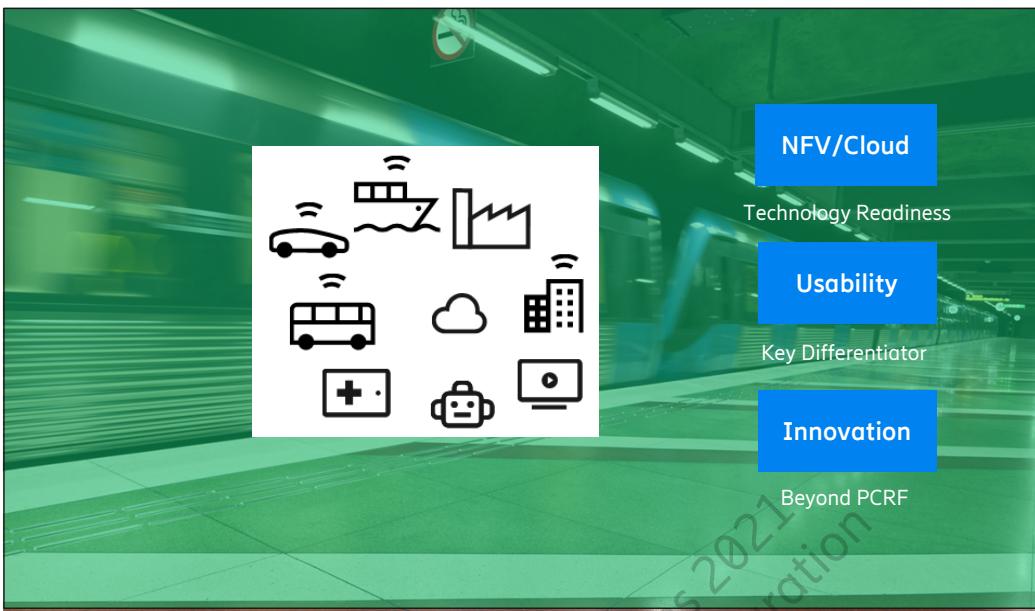


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5G Capabilities

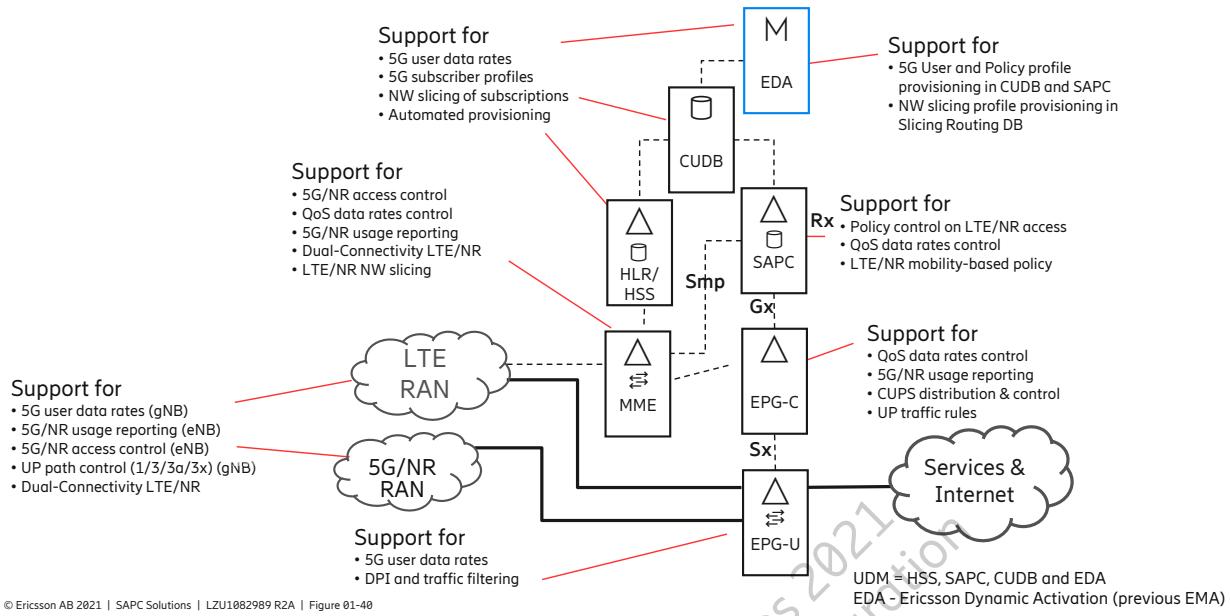


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5G EPC - Enhancements to Support the Option 3





New Use Cases Are Popping Up - New Policy Needs



Mission Critical

Remote Surgery
Securing QoS & latency to allow a real time experience in remote surgeries

Autonomous Driving Services
Securing QoS & latency to allow timely decisions in the driving sequence

Drone based surveillance
Securing QoS & latency to provide real time images of what is happening

Enhanced MBB

Fixed Wireless Access
Location based high bit rates

Augmented Reality
Low/Ultra low latency for reality impression and right gaming experience

QoE traffic routing
Dynamic traffic routing to automatically steer services to the optimal network instance

Massive IoT

Self-Adaptive Slice
Historical analysis of the device usage of the network (services, time) trigger policies to optimize the network resources within a slice in a proactive and automatic manner

Fraud Detection
With Close Loops including Policy and Analytics, operators can track the usage and location of the Smart Bus connected devices and detect when it diverges from normal usage

Industries

Remote control in constructions
Tailoring QoS and Data Security for their different types of devices

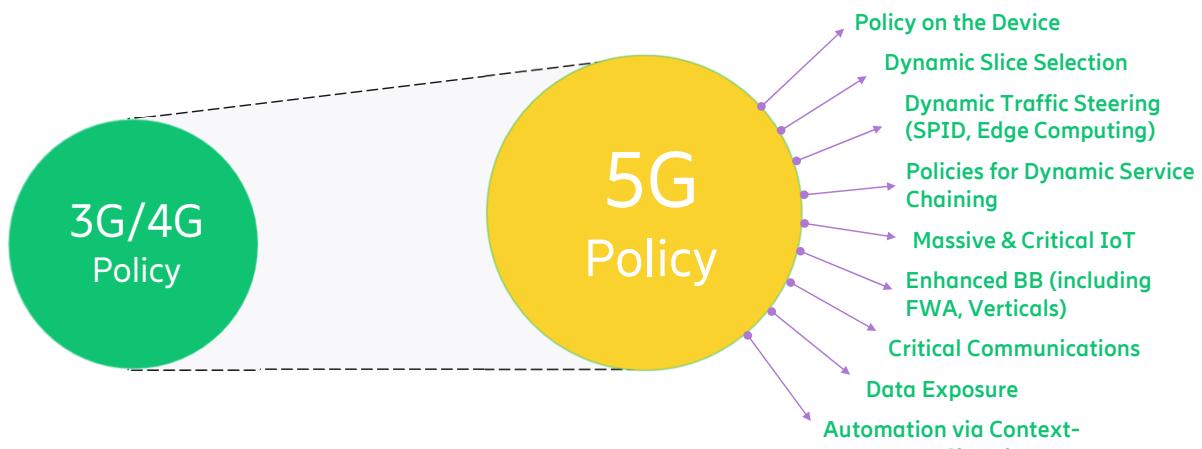
Car Infotainment and Monitoring Services
Securing QoS and charging levels in home and visited networks

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On the way to 5G Policy Management (1/3)

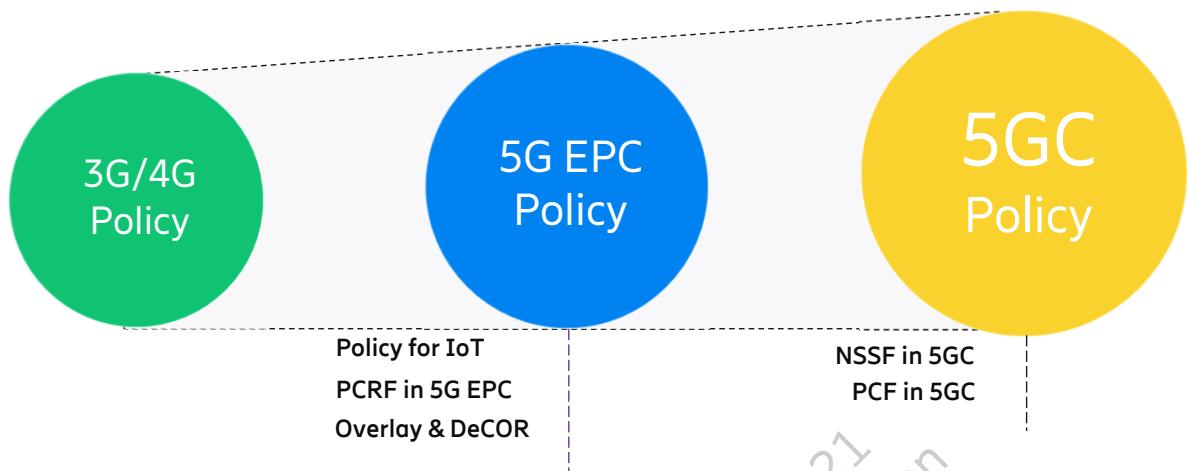


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On the way to 5G Policy Management (2/3)

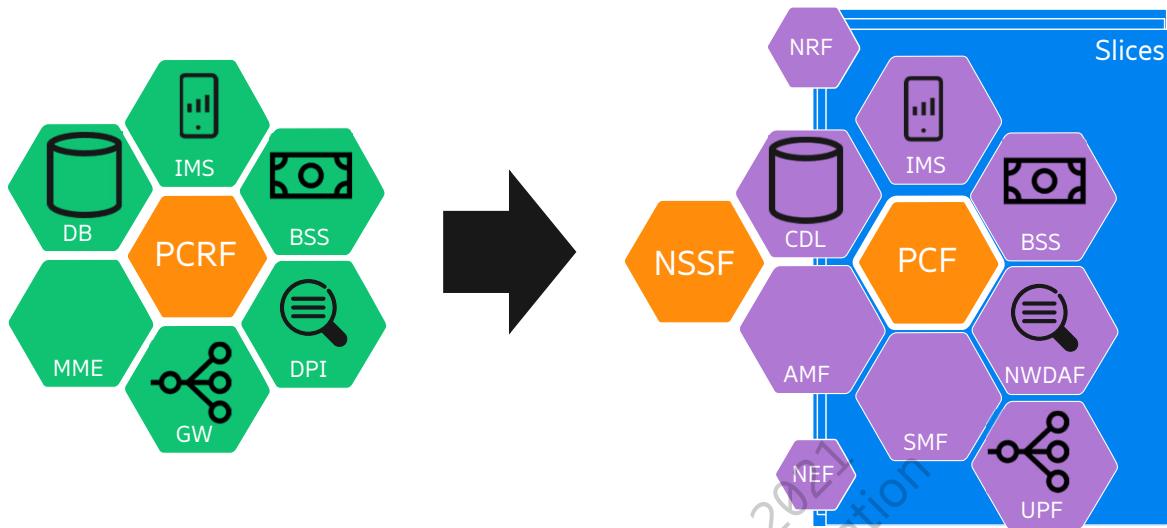


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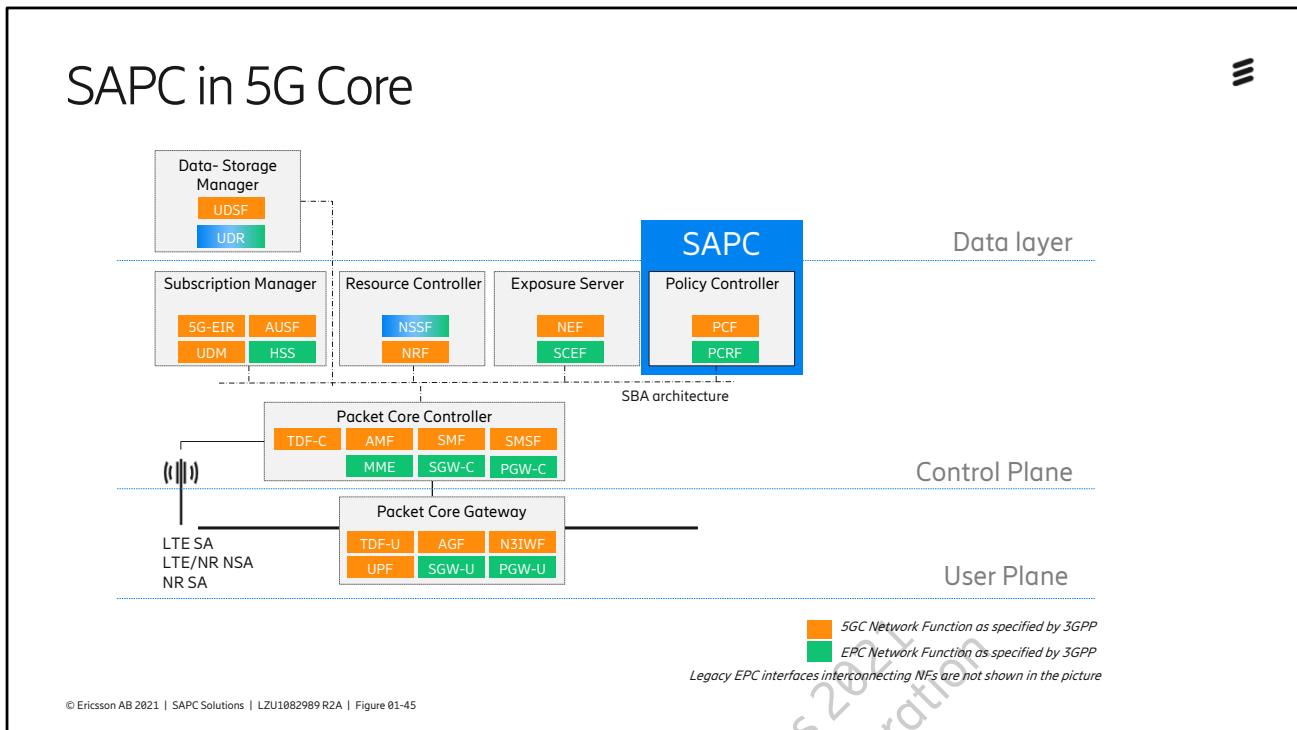
The slide features a title 'Overlay & DeCOR' at the top left. A vertical dashed blue line is positioned to the right of the title. A large, diagonal watermark is present across the slide, containing the text 'Do not copy', '© Ericsson Learning Services 2021', and 'SAPC 1 Operation and Configuration'. The background of the slide is white.



On the way to 5G Policy Management (3/3)



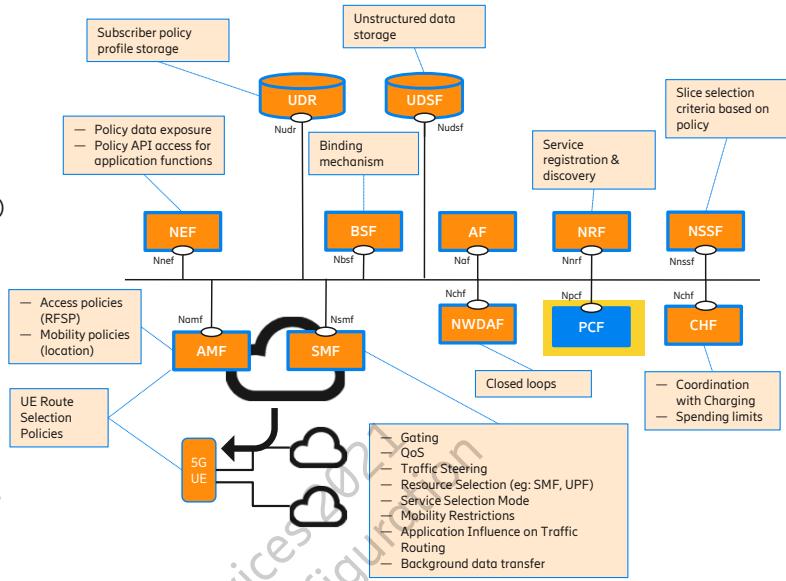
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3GPP PCF – Policy Control Function Ecosystem

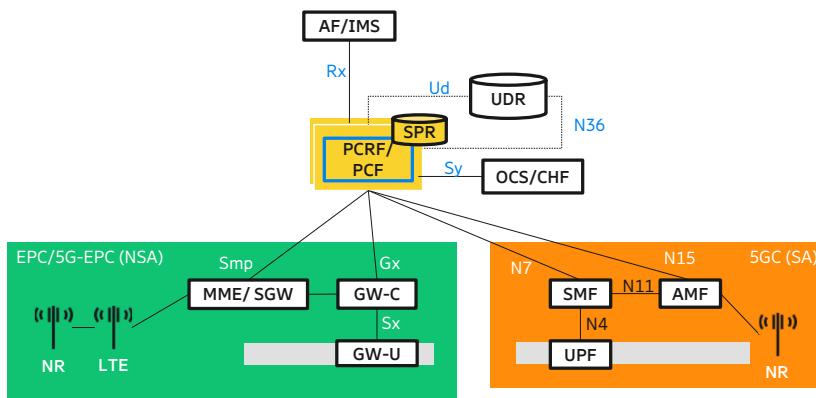
- Policy decisions to SMF and AMF
- Policy subscription profile in UDR
- Existing (PCRF-like) functionality in EPC
 - Usage monitoring, gating, traffic steering, spending limits
- New functionalities
 - Enhanced PCC rules for 5G (i.e. 5GC QoS framework)
 - New interface to the AMF for:
 - Access and Mobility Management policies (service area restrictions, RFSP index)
 - UE Route Selection Policies (Network Slice, SSC Mode...)
 - New interface with a Network Data Analytics Function (NWDAF) to
 - Receive network status analytics as input to policy decisions
 - Interface with NEF for exposure and new use cases (e.g. application influence on traffic routing)



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Expand to 5GC with SAPC 1



Leverage current policy controller towards 5GC (5G Stand-Alone – SA)

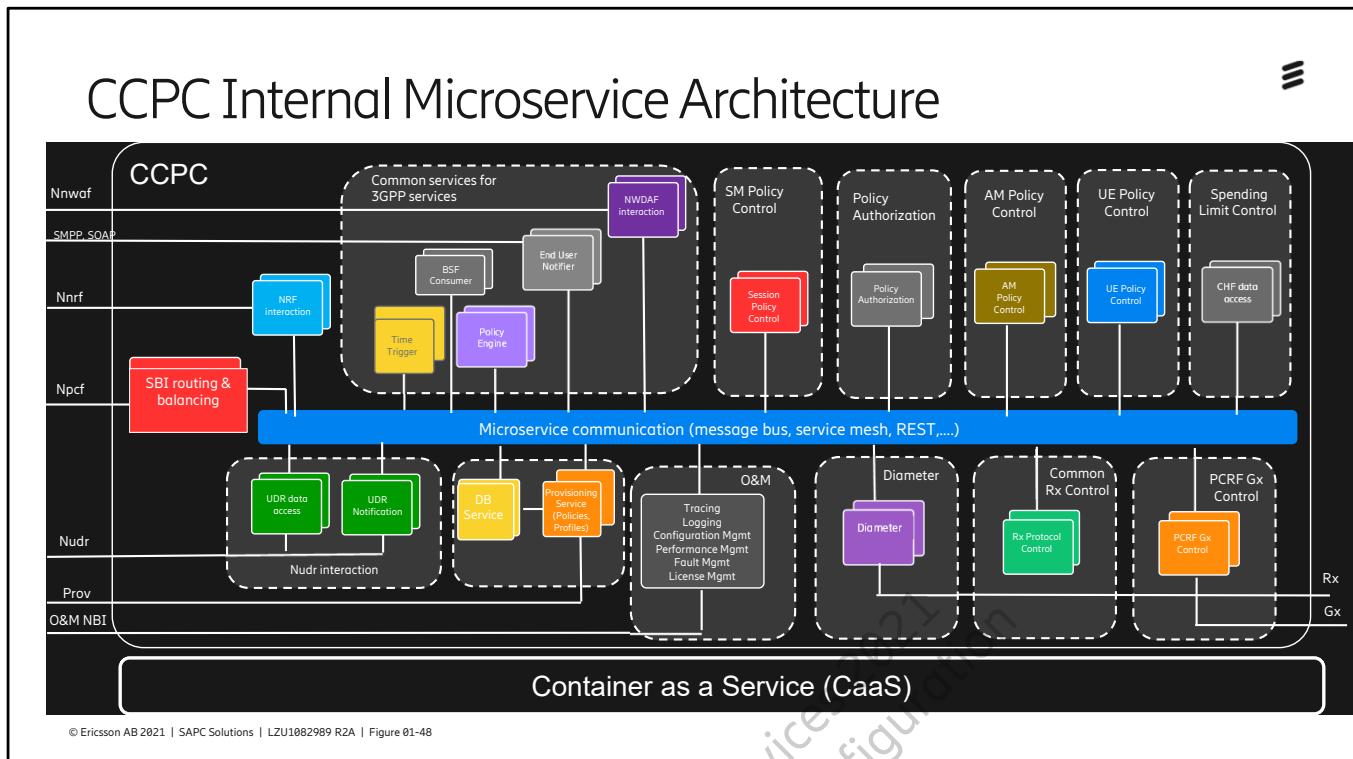
Activation of 5GCore VP

Cost effective. Total reuse of current infrastructure

Service parity in 5G

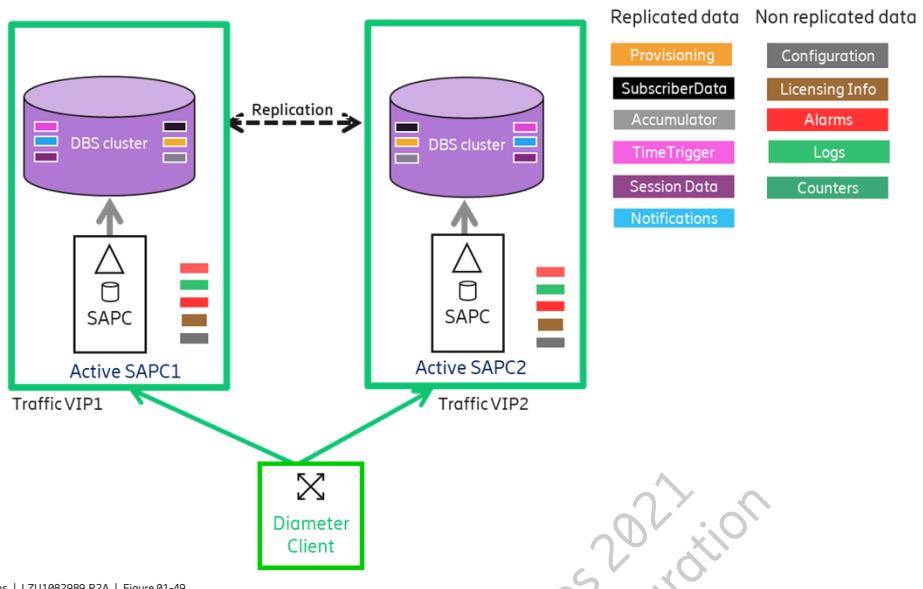
New interfaces to control 5GC nodes

- N7 to leverage from PCRF to SM-PCF (MBB, Voice)
- N15 to allow new 5GC access and mobility policies



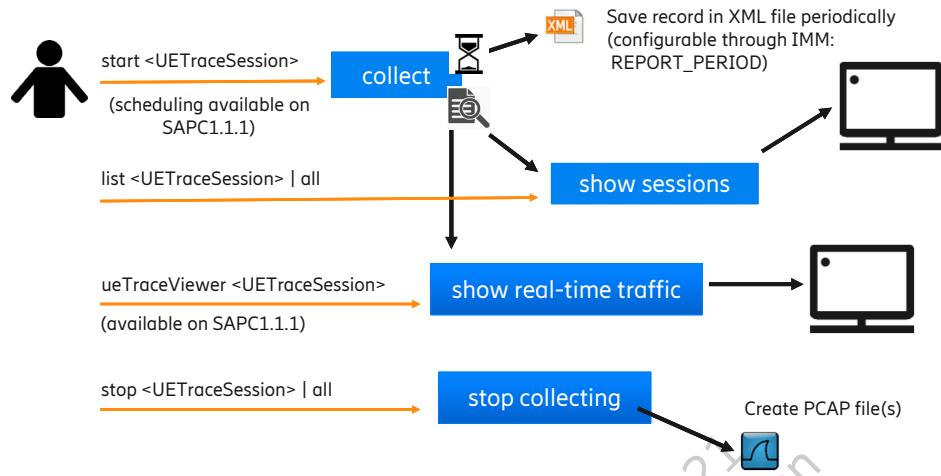


Geographical Redundancy





UE Trace



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Active Hanging Session Deletion Mechanism



What is in for the operator?

- Active cleanup mechanism to remove all the Gx inactive sessions: the obsolete sessions are periodically removed with low performance impact
- SAPC removes inactive sessions before either basic or massive clean-up takes place
- Minimal service impact: The execution time is configurable: It is also configurable
- Better memory management
- Better capacity license usage

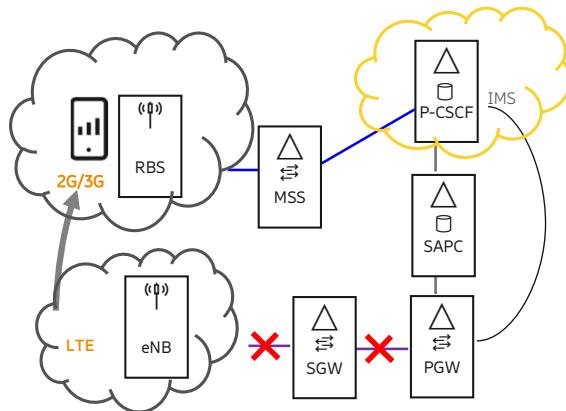
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Notification of AF Signaling Flow Status

- P-CSCF subscribes the AF signaling path status on Rx interface
- PGW reports the resource allocation failure for AF signaling bearer on Gx interface
- SAPC informs the release of resource associated AF signaling path to the P-CSCF on Rx interface



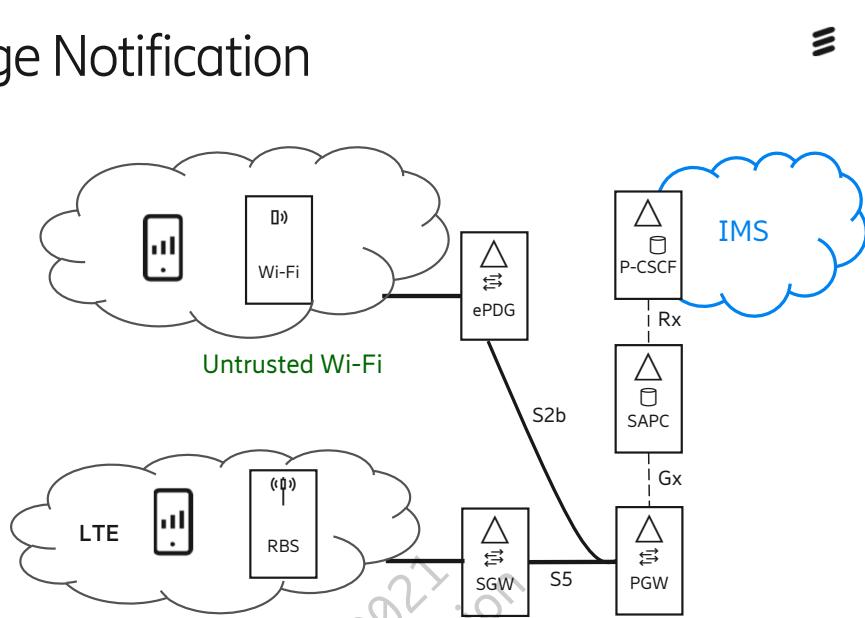
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IP-CAN Type Change Notification

- The AF is able to subscribe to IP-CAN Type Change notifications as a part of the IMS SIP registration or during the IMS SIP call negotiation
- When the SAPC receives the IP-CAN Type Change information from the PCEF, it sends a reauthorization request to the linked AF session



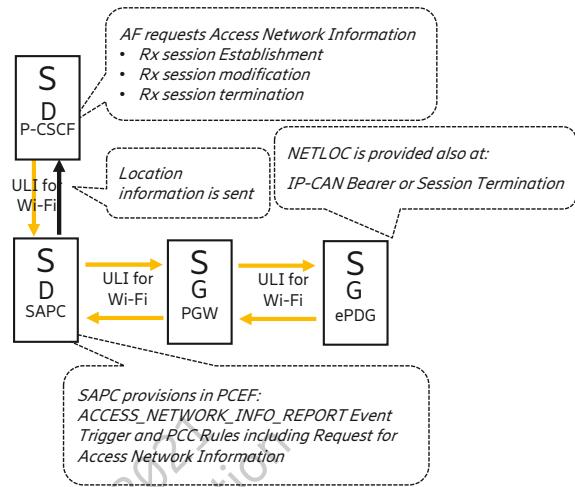
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NetLoc for Untrusted Wi-Fi

SAPC provides UE Network Location to the IMS domain when Wi-Fi access is used for the communication services

- When the Voice over Wi-Fi call starts/updates/terminates
- At IP-CAN Session termination
- SAPC provides to the IMS domain:
 - WLAN Location Information
 - WLAN Location Timestamp
 - UE Local IP Address
 - UDP or TCP Port Number
 - Timezone



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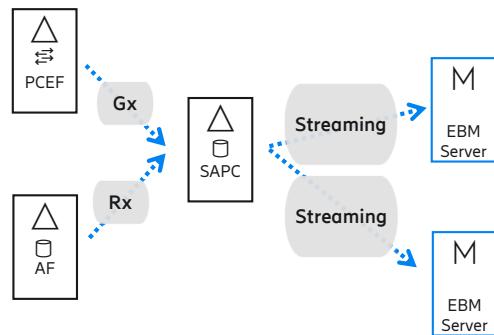


EBM – Rx and Gx Interfaces



EBM:

- Support of a Real-Time interface for event streaming
- Includes events triggered from the Gx and Rx interfaces (transactional and non transactional events).
- Includes the possibility to send events to several EBM Servers.



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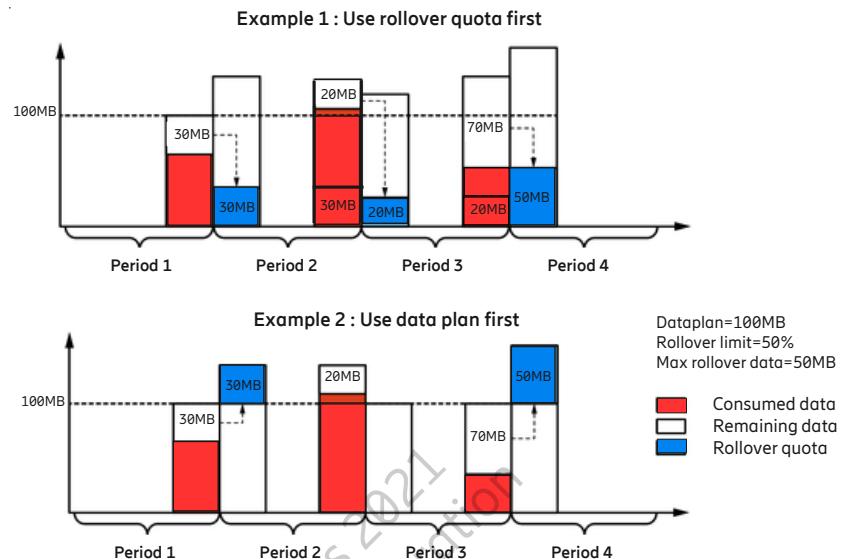
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Quota Rollover

The Quota Rollover feature enables subscribers and share dataplans members that have unconsumed volume or time quota at the end of a billing cycle, to transfer the remaining data to the next period

It does not apply to successive periods.



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Security Roles



Security Roles allows the SAPC Customers to define own O&M administrators with different access levels

Customers are to have a higher control over their O&M administrators with different access levels

Administrators defined in COM can have different roles to access to different domains:

- File System
- REST operations
- COM Tree

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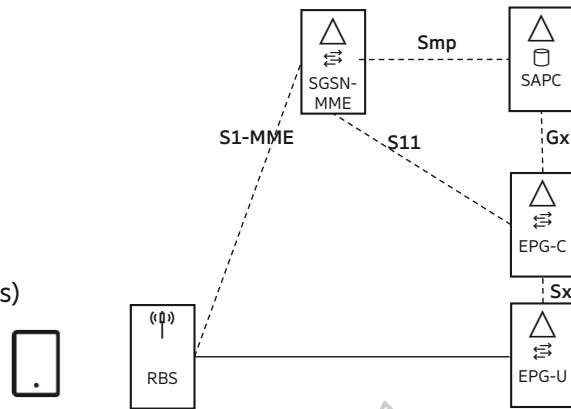


Smp Session Management



Smp interface related improvements:

- SPID Selection
(If cell is changed)
- Location Based Policies
(Location decision per cell)
- Smp-presence Report Area
(Policy decisions based on SRA status)
- Integration with OCS
(Quota in OCS)



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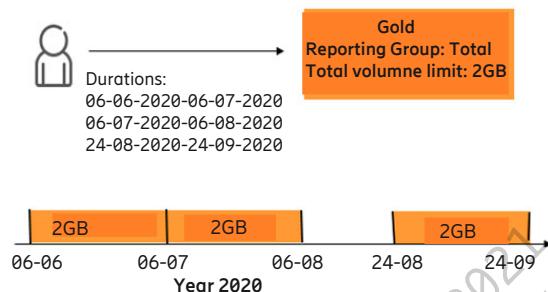
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Stackable Data Plans



- The SAPC enables the operator to activate automatically multiple vouchers with the same absolute volume or time limits for prepaid subscriptions.
- This is enabled by defining durations containing multiple sets of start date and end date of instances in the association of subscriber and subscriber group.



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Active Session Information Collection



The sapcadmin can use this command:

```
sapcadmin@SC-1:~> sudo sapcSessionCollector -h
```

This command collects session data from dynamic Persistent Object Types (POTs) and saves the output files in the /cluster/brf/backup/sessions folder.

The supported dynamic POTs are EPC_UeIpSessionPot, EPC_IpSessionPot, AfSessionPot, SubsChargingDataPot, SdSessionPot and SmpSessionPot.

Example 1 Collecting data from EPC_UeIpSessionPot

```
sudo sapcSessionCollector -i EPC_UeIpSessionPot
```

Example 2 Collecting data from all supported POTs

```
sudo sapcSessionCollector -a
```

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EBM Data Parsing Tools

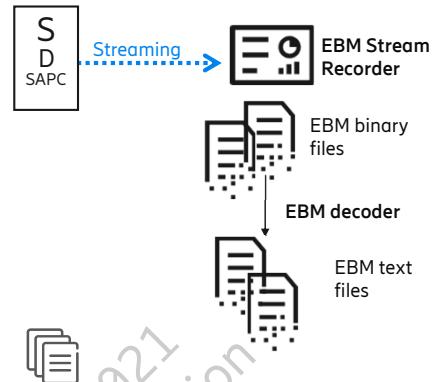


EBM Data Parsing Tools:

The SAPC provides tools that can be used on a remote platform for recording and parsing binary Event-Based Monitoring (EBM) data

The tools are:

- `ebm_stream_recorder` or `ebm_stream_recorder64`
- `parse_ebm_log.pl`



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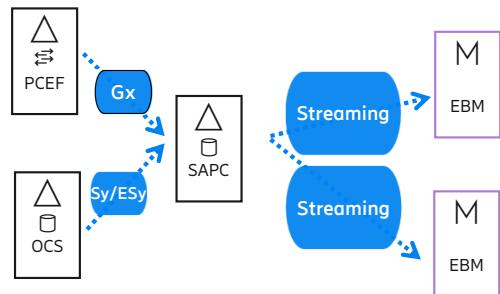


EBM for Sy Interface

EBM for Sy:

Includes events triggered from the 3GPP Sy or Ericsson Sy interfaces
(transactional events)

Provides highly valuable information to the operator that can be used for Business Intelligence and Network Assurance

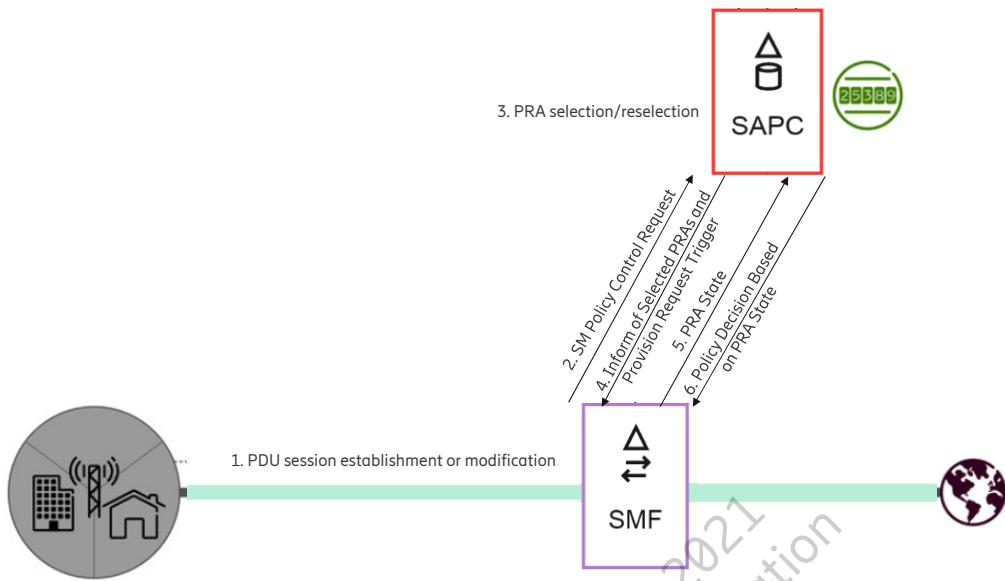


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PRA policy control over N7 interface



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Chapter Summary



On completion of this chapter, the participants should now be able to:

- Explain the 5G EPC SAPC PCF reference model
- Describe the SAPC main functions
- Explain the SAPC interfaces and their protocols
- Describe the SAPC in 5G EPC as well as Policy Controller in 5GC
- List the main features in SAPC 1

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SAPC 1 Architecture



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Chapter Objectives



On completion of this chapter, the participants will be able to:

- Describe the virtual SAPC 1 architecture.
- Outline the architecture of SAPC 1 on BSP 8100.
- Describe the architecture of SAPC 1 on NSP 6.1.

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SAPC 1 Architecture

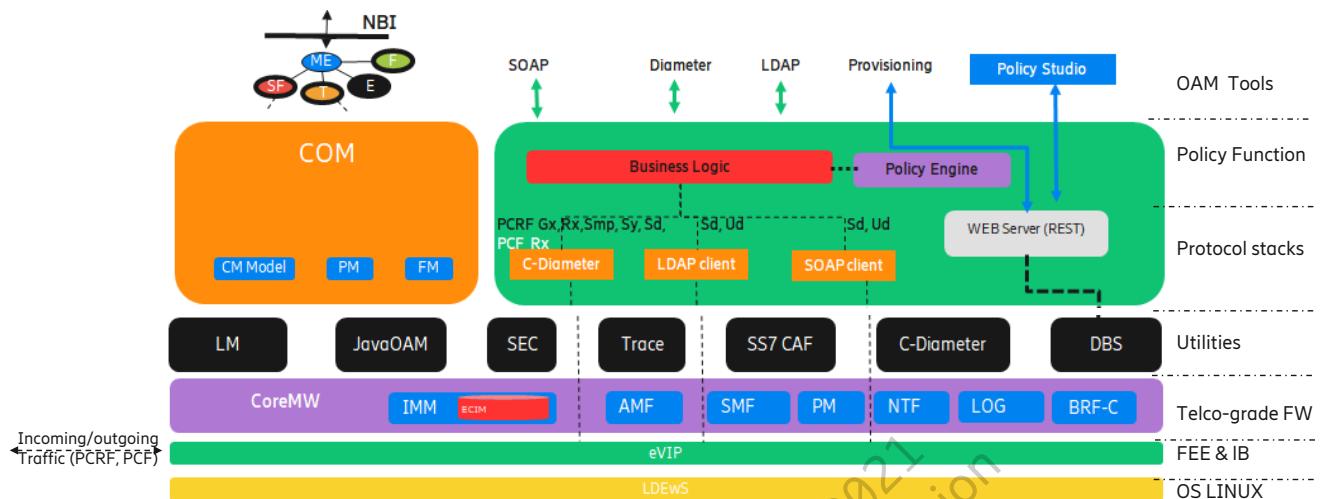


SAPC 1 architecture.

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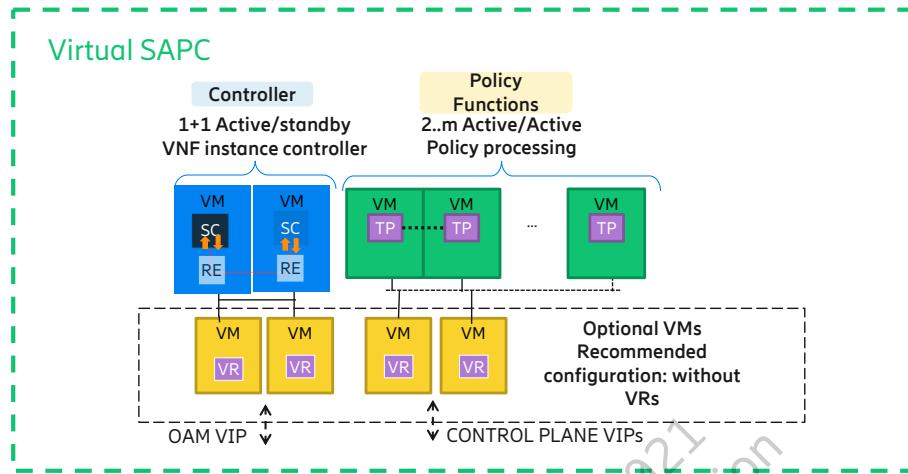


SAPC 1 on Linux Software Components





vSAPC – Traffic routing and packet flow

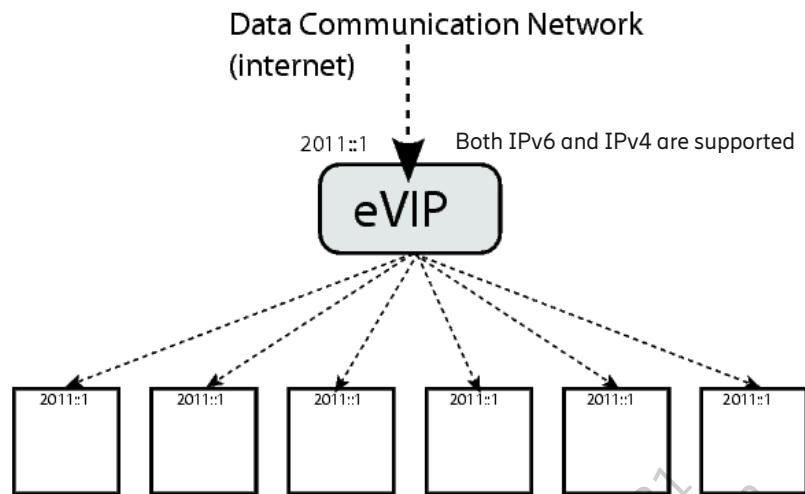


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eVIP Load Balancer

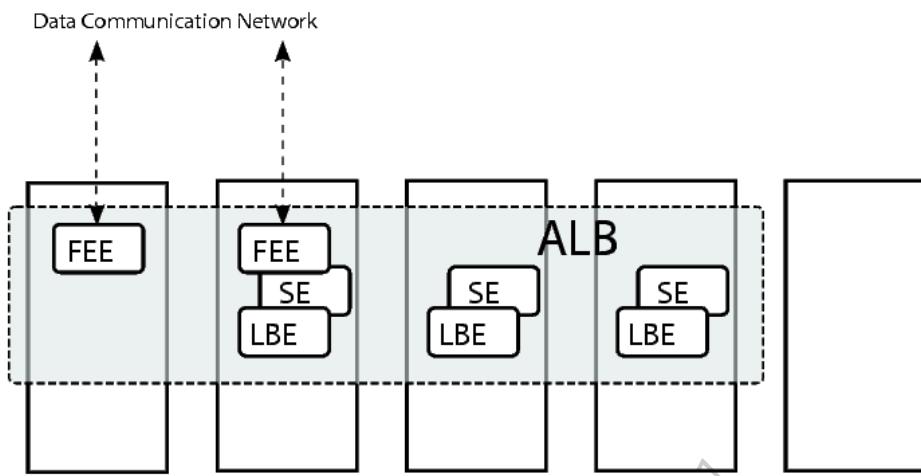


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eVIP Elements

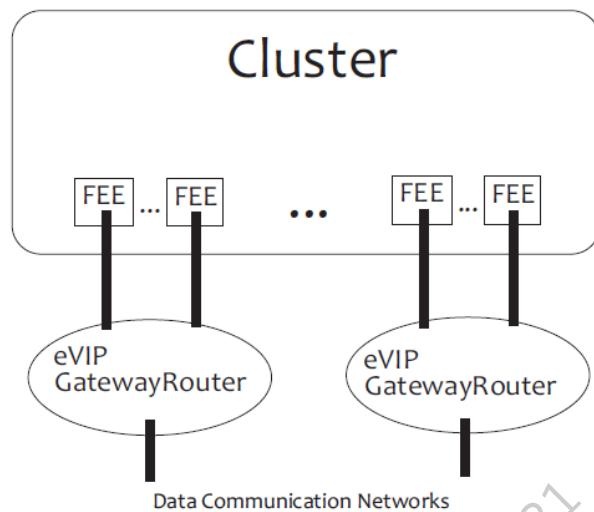


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External Connectivity

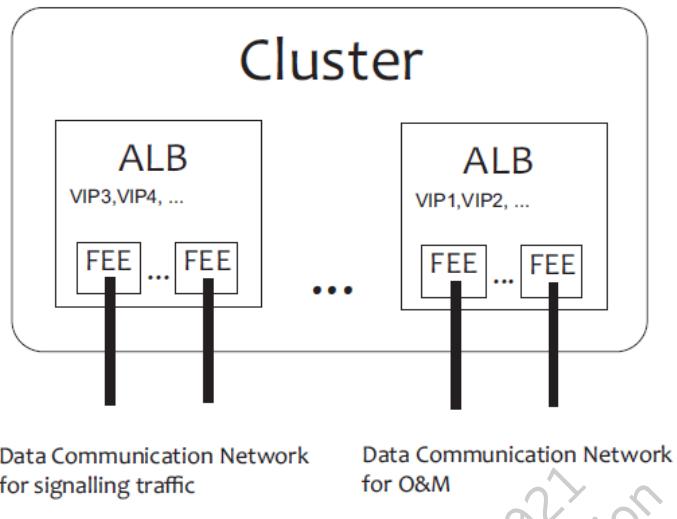


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Network Separation



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VIP Addresses

OAM VIP

- Mandatory address that corresponds to the VIP within the External OAM network used to communicate with the SAPC node for administration purposes.

Provisioning VIP

- Optional address for SAPC standalone deployments and mandatory for Geographical Redundancy.

Traffic VIPs

- Mandatory addresses that correspond to the VIPs within the External Traffic network that external traffic applications use to send/receive traffic to/from the SAPC node.

Replication VIP

- Only for Geographical Redundancy scenarios in which its presence is mandatory.

External Database VIP

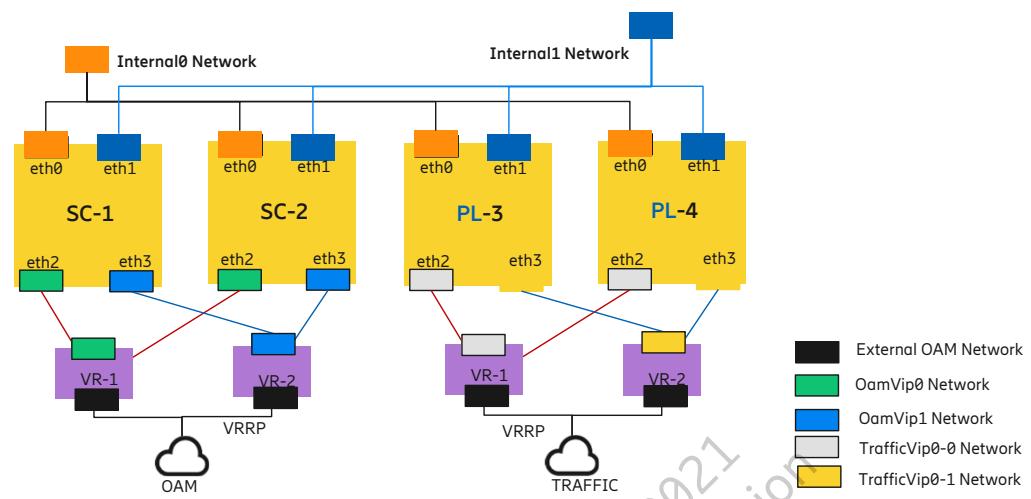
- Only for deployments with an External Database in which its presence is optional

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SAPC VNF Network Assignment



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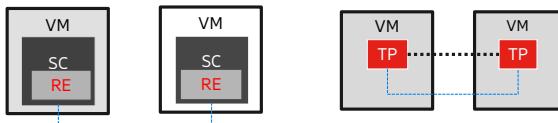


Failure Scenarios for SAPC



Failure of active VNF controller.

- No impact on subscriber traffic.
- Automatic switchover to standby controller.
- VM restarts and once VM is active again it is automatically brought into operation again as standby controller



Failure of PCRF policy processing VM

- The incoming traffic is distributed by LB among the available PCRF VMs while the failed VM is recovered.
- The requests that were being processed by the failed VM are lost.
- PCRF retries for these requests will be handled by any other of the available VMs.

Failure of standby VNF controller:

- No impact on subscribers traffic.
- VM restarts and once VM is back it is brought into operation again.

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SAPC 1 Architecture



Architecture of SAPC 1 on BSP 8100.

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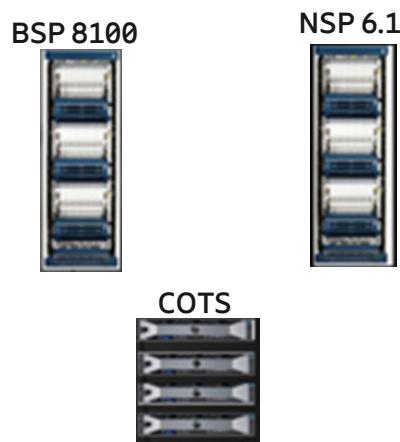


SAPC as PNF



SAPC is Ericsson hardware agnostic.
It supports the latest Ericsson hardware:
• BSP8100, recommended for best
customer experience in native.

It supports COTS hardware.

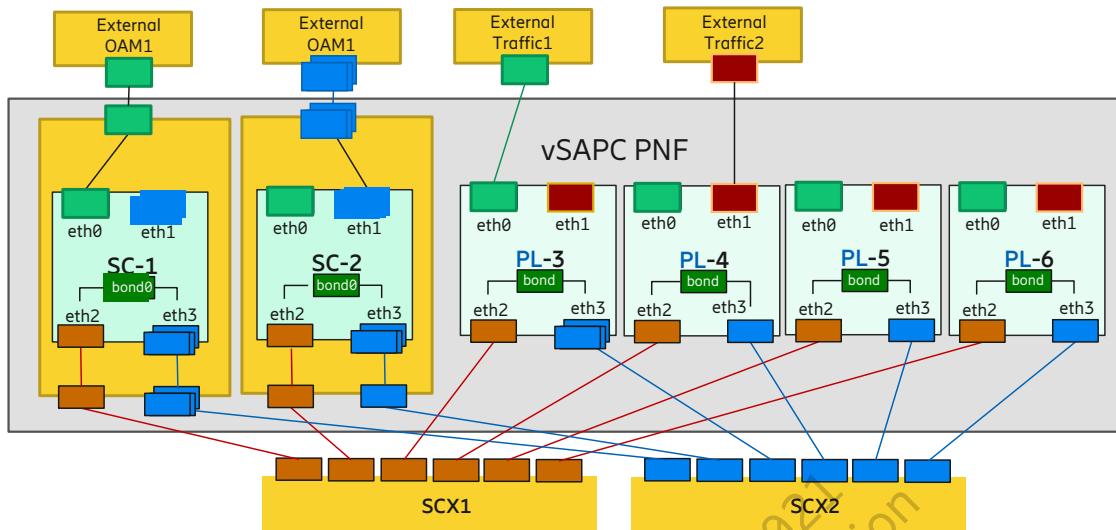


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SAPC PNF Architecture

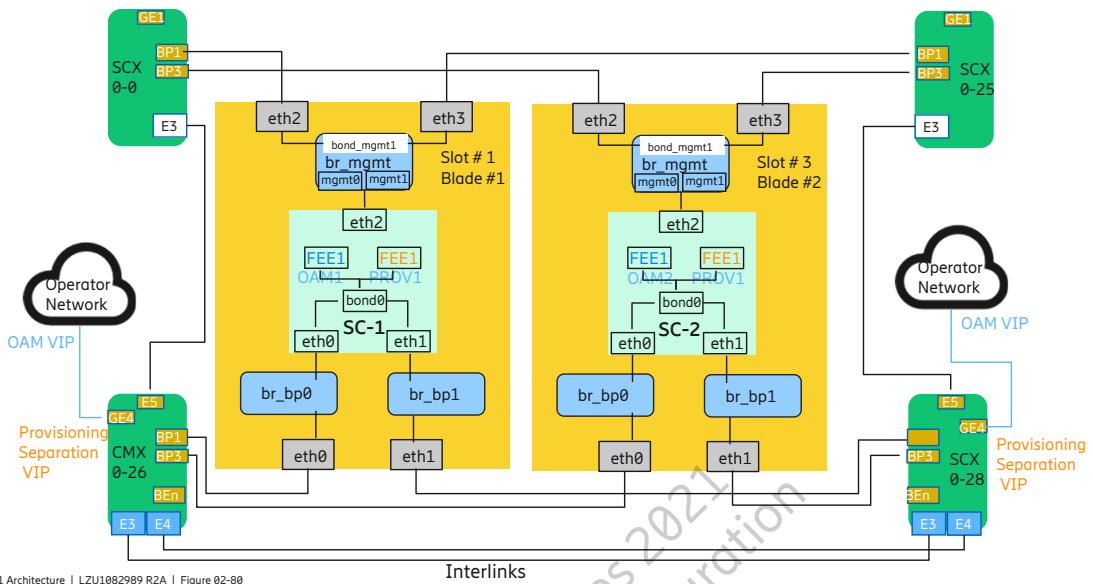


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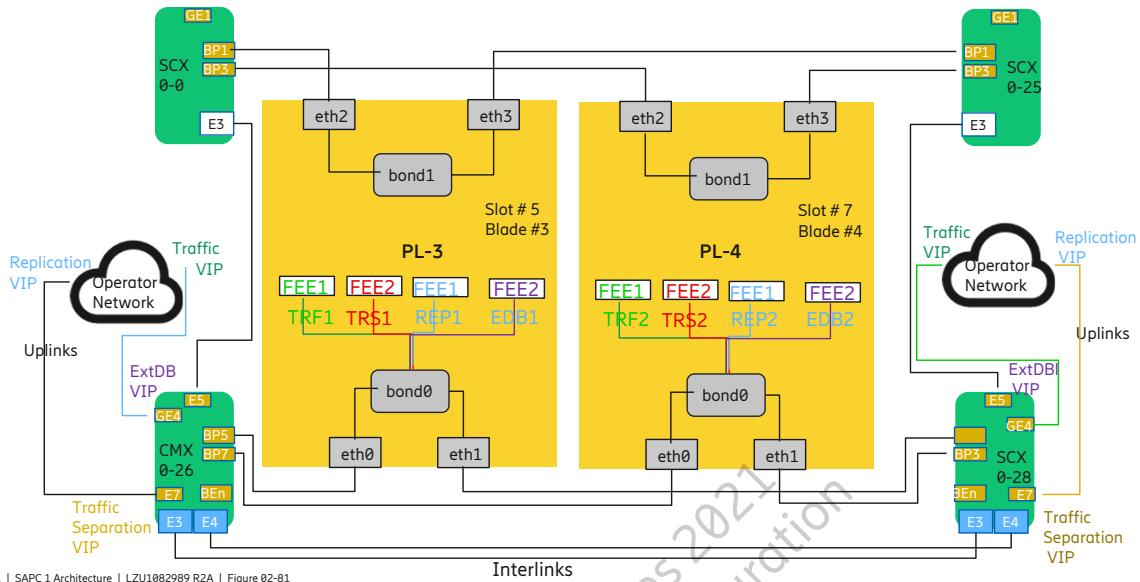
Minimum Configuration: SC-1, SC-2, PL-3, PL-4



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Minimum Configuration: SC-1, SC-2, PL-3, PL-4





12 Blades Configuration



- **PL-3 and PL-4** are used for traffic purposes in all scenarios. All external diameter traffic is received through these two.
- In case external database is configured, the next two PLs are used for this purpose. **PL-5 and PL-6** in this example scenario
- In case GeoRed is configured, the next two PLs are used for this purpose. **PL-7 and PL-8** in this example scenario
- In case traffic separation is configured, the next two PLs are used for this purpose. **PL-9 and PL-10** in this example scenario
- Rest of the PLs have no external communication

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SAPC 1 Architecture

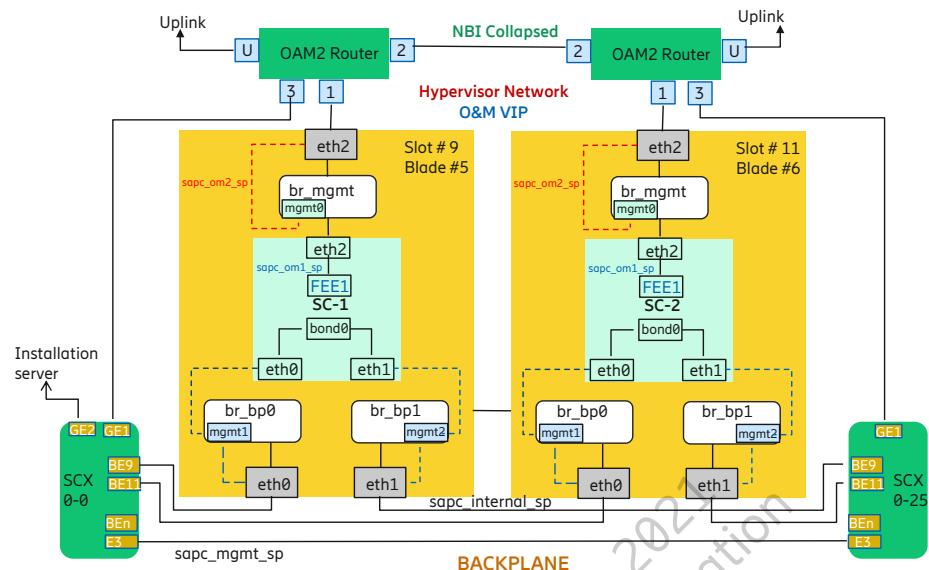


Architecture of SAPC 1 on NSP 6.1.

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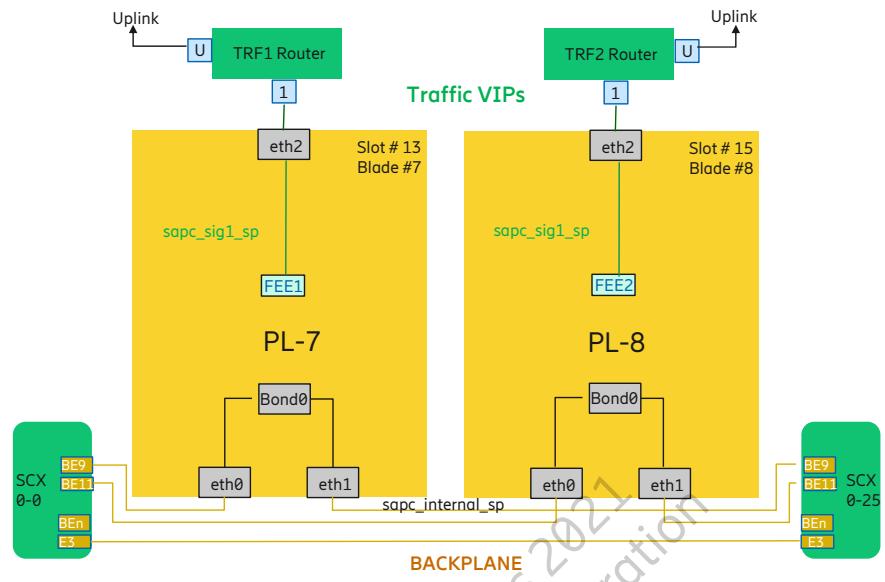
SC-1 and SC-2 (Slot 9 and Slot 11)



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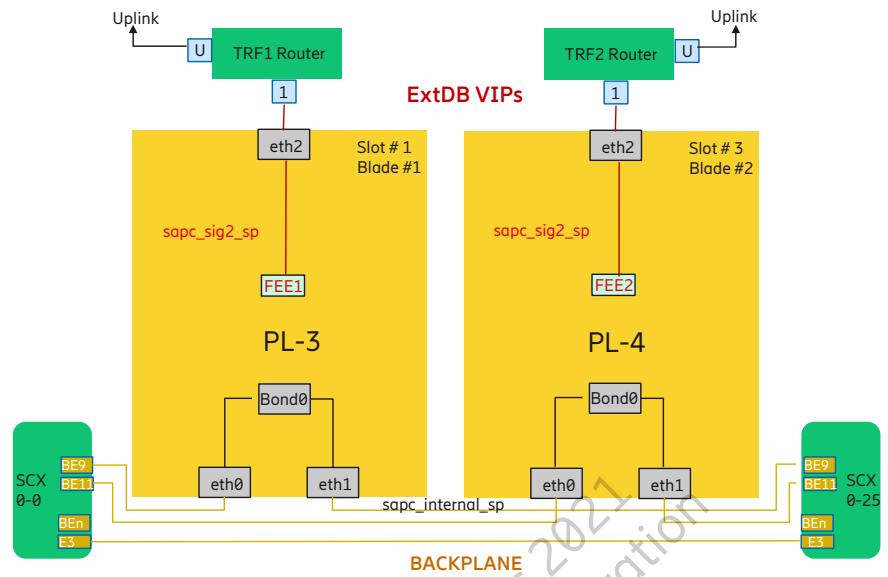
Traffic Payload Boards (Slot 13, Slot 15)



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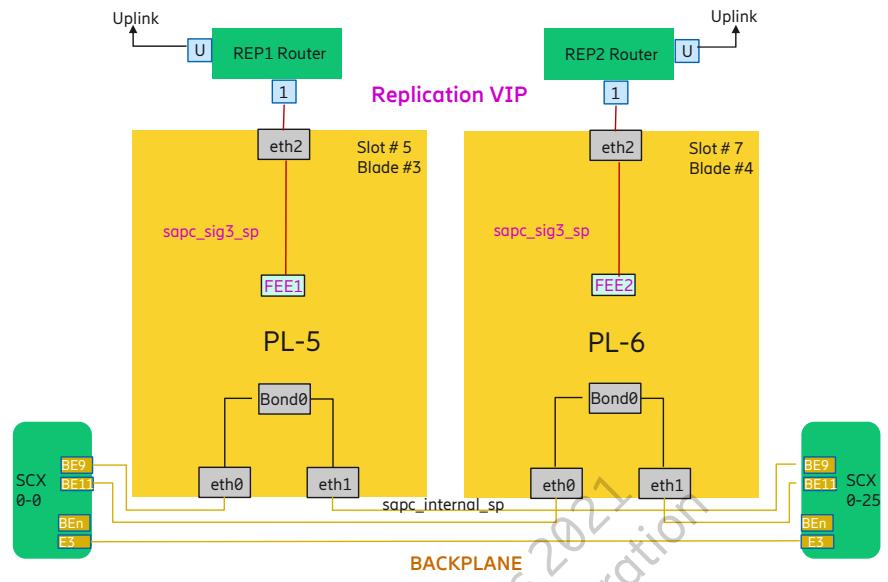
External Database Blades (Slot 1 and Slot 3)



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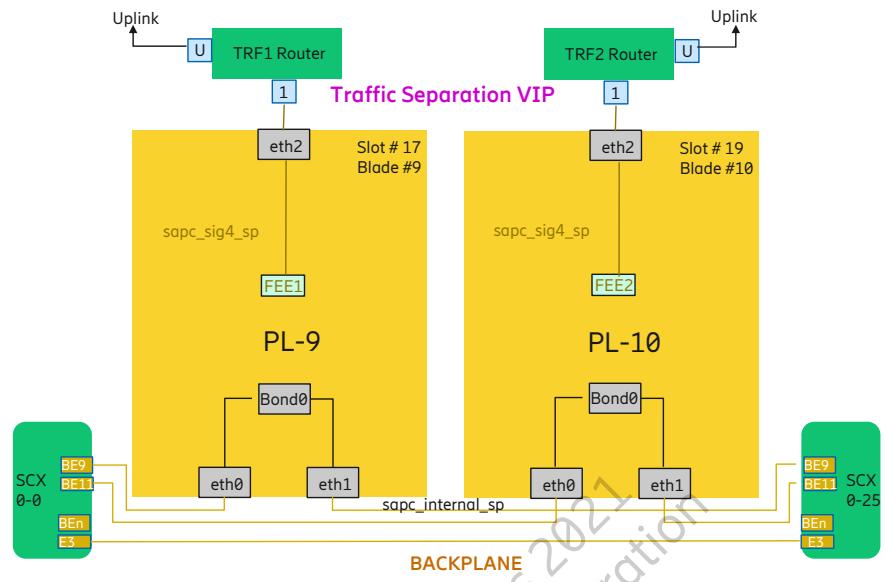
GeoRed Payload Blades (Slot 5 and Slot 7)



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Traffic Separation Blades (Slot 17 and Slot 19)



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Chapter Summary



After this chapter, the student should now be able to:

- Describe the virtual SAPC 1 architecture.
- Outline the architecture of SAPC 1 on BSP 8100.
- Describe the architecture of SAPC 1 on NSP 6.1.

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SAPC PCF



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Chapter 3 Objectives



After this chapter, the student will be able to:

- Explain the advantages of SAPC PCF
- Describe the Session Management Policy Control in SAPC-PCF and the main traffic cases
- Explain the N7 interface signaling messages
- Describe the N15 interface signaling messages
- Outline the Nnrf interface signaling messages
- Review the N36 interface signaling messages

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SAPC PCF



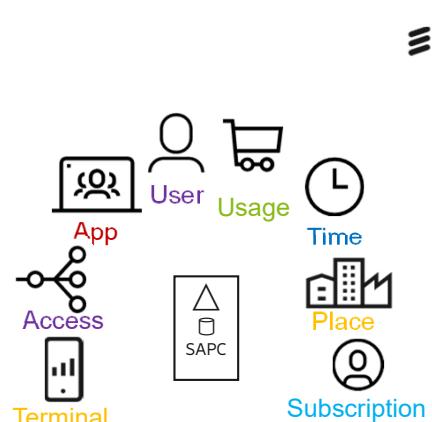
Advantages of SAPC PCF

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Ericsson SAPC:

- Dual-mode 3GPP PCRF & PCF
- Wide set of functions:
 - Flexible Rule Engine for dynamic differentiation
 - Differentiated control per subscriber and applications
 - Quota management including Shared Data Plans
 - Best-in-class PCRF for VoLTE and Wi-Fi calling support
 - Policies for IoT or Enterprise domains
 - New policies for 5G Core, incl. new 5GC QoS framework
 - Seamless evolution to 5G EPC & 5G Core
- Innovative solutions
 - Network Instance Slicing
 - Intelligent traffic steering
 - Real-time event streaming for analytics
 - Optimized Policy and Charging integration
- NFV Ready: Virtual SAPC



3GPP™

PCRF/PCF

broadband
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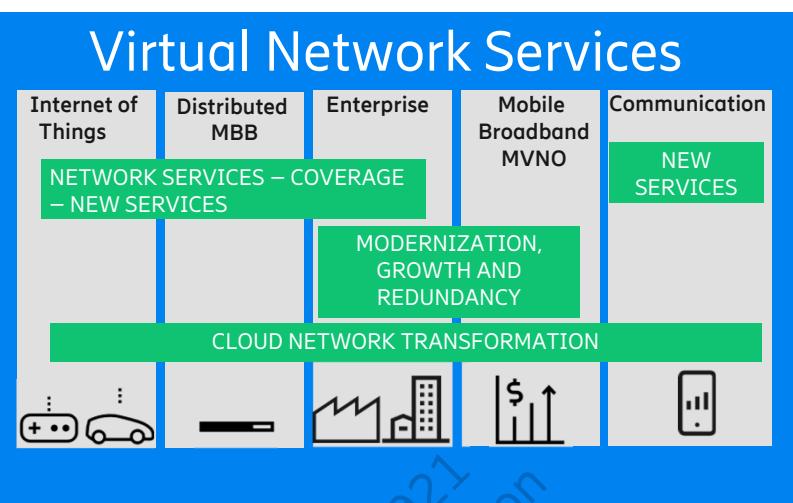
BPCF

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SAPC Growth Opportunities Within vEPC



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SAPC PCF



Session Management Policy Control in SAPC-PCF and the main traffic cases.

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PCC Rules Definition – Operation



The SM Policy Control service uses two different types of PCC rules:

- Static PCC rules: they are locally configured in the SMF and dynamically activated or deactivated from the SAPC PCF.
- Preconfigured PCC rules: they are configured in the SAPC PCF and dynamically sent to the SMF.

For static PCC rules, the SAPC PCF supports the following operations:

- Activation: to activate the PCC rule.
- Deactivation: to deactivate the PCC rule.

For preconfigured PCC rules, the SAPC PCF supports the following operations:

- Installation: to provision a PCC rule that has not been provisioned.
- Modification: to modify a PCC rule already installed.
- Removal: to remove a PCC rule already installed.

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PCC Rules



QoS Control for Static PCC Rules

- The SAPC PCF supports QoS control by installation or removal of static PCC rules. The SMF contains the mapping between the PCC rule names and their corresponding QoS information locally.

QoS Control for Preconfigured PCC Rules

- The SAPC PCF can send the authorized QoS for a PCC rule to the SMF, using the PCC rule installation or modification procedure.

The adjusted QoS information is based on the following information:

- Subscription information
- Network information received from the SMF

The SAPC PCF performs QoS Control for the preconfigured PCC rules at:

- SM Policy Association establishment.
- SM Policy Association modification because of:
 - PDU session update triggered by the SMF
 - PDU session-related subscription data update

The SAPC PCF can also assign and change the bandwidth limit for preconfigured PCC rules during the PDU session lifetime. It enables the SAPC PCF to control the peak uplink and downlink throughput of the services.

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PCC Rules (3/3)



Gating Control

- This is a user plane function, enabling or disabling the forwarding of data packets from service data flows.
- The SAPC PCF uses the flowStatus attribute within a PCC rule to indicate whether the possible uplink or downlink gate is opened or closed.
- If the gate is closed, the SAPC PCF drops all packets of related service data flows. If the gate is opened, the SAPC PCF forwards the packets of related service data flows.

The SAPC PCF uses the following values for gating:

- ENABLED-UPLINK (0)
Enables the associated uplink IP flows, and disables the associated downlink IP flows.
- ENABLED-DOWNLINK (1)
Enables the associated downlink IP flows, and disables the associated uplink IP flows.
- ENABLED (2)
Enables all associated IP flows in both directions.
- DISABLED (3)
Disables all associated IP flows in both directions.
- REMOVED
Removes all associated IP flows.

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SAPC PCF Functions



- SM policy association establishment, modification, and termination.
- QoS Control: The SAPC PCF supports the Session QoS control and QoS control to PCC rules.
- Gating Control: It is a user plane function, enabling or disabling the forwarding of data packets from service data flows.
- Policy control request trigger selection: Policy control request trigger is the condition when the SMF interacts again with the SAPC PCF for further policy decision of a PDU session.
- Dynamic Group Selection: Dynamic selection of subscriber groups is performed using group selection policies including operator configured conditions.
- Usage Monitoring Control: The Usage Monitoring Control enables the SAPC PCF to control the accumulated volume assumed at service level. Usage limits can be only applied to volume.

The SAPC PCF only supports Usage Monitoring Profiles at subscriber group level and does not support shared subscriber plans.

The SAPC PCF supports the accumulation of usage information only in the internal database. For subscribers capable in both 4G and 5G network, the SAPC PCF does not support the usage accumulators stored in the separated databases.

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QoS Control for the PDU Session



QoS Control for the PDU session decides the authorization and enforcement of the Session AMBR and default QoS combination.

The SAPC PCF evaluates QoS Control for the PDU session at:

- SM Policy Association establishment.
- SM Policy Association modification because of:
 - PDU session update triggered by the SMF.
 - PDU session related subscription data update.
 - Changes owing to time conditions.
- Events received from the Application Function.

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Policy Control Request Triggers Relevant to SMF



Policy control request triggers define events on which the SMF interacts again with the SAPC PCF. The SAPC PCF supports some of the possible request trigger values:

- SAREA_CH indicates that the serving area of the UE is changed.
- SE_AMBR_CH indicates that the session AMBR is changed.
- DEF_QOS_CH indicates that the default QoS is changed.
- US_RE indicates that the PDU session or the monitoring key specific resources consumed by a UE reach the threshold or need to be reported for other reasons.
- RAT_TY_CH indicates that the RAT type is changed.
- SUCC_RES_ALLO indicates that the SMF informs the SAPC PCF of the successful resource allocation for those rules that requires so.
- AN_INFO indicates Access Network Information report.

The SAPC PCF performs the policy control request trigger selection at:

- SM Policy Association establishment
- SM Policy Association modification because of:
 - PDU session update triggered by the SMF
 - PDU session related subscription data update

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Usage Monitoring Control



- This function enables the SAPC PCF to control the accumulated usage assumed by a subscriber at session level and service level. When the configured usage limits are surpassed, the SAPC PCF can take certain actions, such as QoS change to a service.
- Usage limits can be applied only to volume. For example, the SAPC PCF limits the accumulated volume usage to 1 GB. The operator can also define different volume limits for downlink, uplink, and for bidirectional traffic.
- The SAPC PCF supports the accumulation of usage information only in the internal database.
- The SAPC PCF does not support shared subscriber plans.

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SAPC PCF

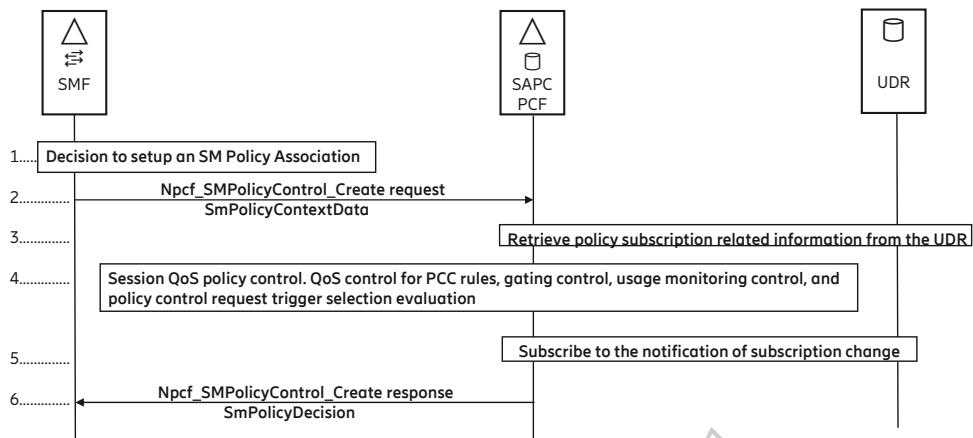


Session Management Policy Control Traffic Cases

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SM Policy Association Establishment (1/3)



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SM Policy Association Establishment (2/3)



1 The SMF decides to establish SM Policy Association with the SAPC PCF when a UE requests PDU session establishment.

2 The SAPC PCF receives a POST `Npcf_SMPolicyControl_Create` request with the `SmPolicyContextData` data structure including the following main attributes:

- supi: Subscription Permanent Identifier (SUPI) of the user
- pduSessionId: PDU session Id
- pduSessionType: the type of a PDU session
- dnn: the DNN of the PDU session
- notificationUri: identifies the recipient of SM policies update notifications sent by the SAPC PCF
- suppFeat: indicates the list of supported features
- Optional attributes:
 - ipv4Address or ipv6AddressPrefix: the Ipv4 Address or Ipv6 Prefix of the served UE
 - userLocationInfo: the location where the served UE is camping
 - subsSessAmbr: APN Maximum Bit Rate (AMBR) of the PDU session
 - subsDefQos: subscribed default QoS information

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SM Policy Association Establishment (3/3)



3 The SAPC PCF retrieves the SM policy data from the UDR.

4 The SAPC PCF performs policy control as follows:

- QoS control for the PDU session
- QoS control for PCC rules
- Gating control
- Usage monitoring control
- Policy control request trigger selection

5 The SAPC PCF subscribes to the notification of subscription change.

6 The SAPC PCF sends an **Npcf_SMPolicyControl_Create** reply with 201 Created and the **SmPolicyDecision** data structure. The **SmPolicyDecision** data structure includes the following information:

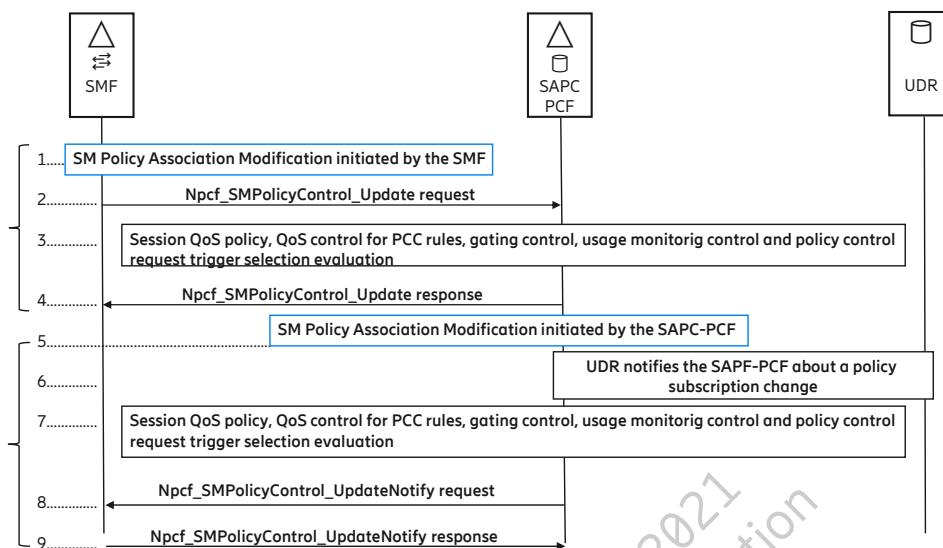
- Authorized Session AMBR, authorized default QoS information, and the QoS policy for PCC rules
- Gating control decisions
- Usage monitoring control decisions
- Policy control request triggers

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SM Policy Association Modification (1/3)



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SM Policy Association Modification (2/3)



SM Policy Association Modification Initiated by the SMF

2. The SAPC PCF receives a **POST Npcf_SMPolicyControl_Update request** from the SMF, when a policy control trigger condition is met. The trigger condition can be the serving area of the UE changed, session AMBR changed, default QoS changed, consumed usage volume changed, or the RAT type changed.
3. The SAPC PCF performs policy control as follows:
 - QoS control for the PDU session
 - QoS control for PCC rules
 - Gating control
 - Usage monitoring control
 - Policy control request trigger selection
4. The SAPC PCF sends an **Npcf_SMPolicyControl_Update response** with **200 OK** and updated policy information.

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SM Policy Association Modification (3/3)



SM Policy Association Modification Initiated by the SAPC PCF

6. The UDR notifies the SAPC PCF of subscription change related to SM policy.

7. The SAPC PCF performs policy control as follows:

- QoS control for the PDU session
- QoS control for PCC rules
- Gating control
- Usage monitoring control
- Policy control request trigger selection

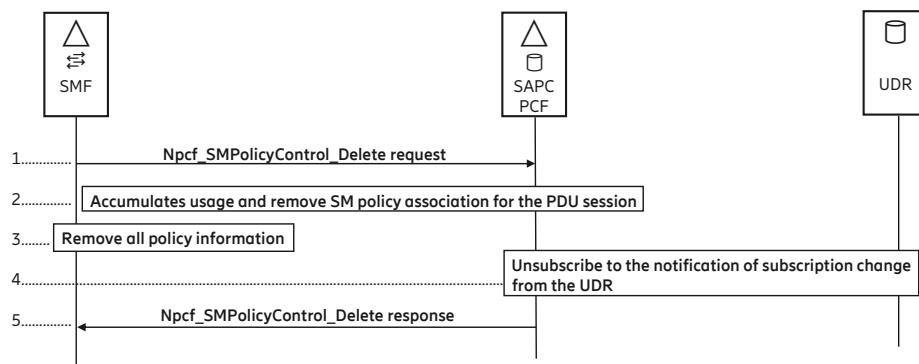
Then, the SAPC PCF determines the updated policy information.

8. The SAPC PCF sends a **POST Npcf_SMPolicyControl_UpdateNotify request** including the data structure **SmPolicyNotification** to the SMF. The **SmPolicyNotification** data structure includes the updated policy information.

9. The SMF accepts the policy update and returns **200 OK**.

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SM Policy Association Termination SMF Initiated (1/2) 

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SM Policy Association Termination SMF Initiated (2/2) ≡

1. The SAPC PCF receives a POST Npcf_SMPolicyControl_Delete request with the smPolicyId in the header and SmPolicyDeleteData data structure in the body.
2. The SAPC PCF performs usage update and removes the policy association related to the terminated PDU session.
3. The SMF removes all policy information about the PDU session.
4. The SAPC PCF unsubscribes to the data modification notification of the PDU Session from the UDR if it had subscribed such notification.
5. The SAPC PCF acknowledges to the SMF that the SAPC PCF handling of the PDU Session has terminated with 204 No Content.

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SM Policy Control Error Handling

Error Condition	Action	Code
The SAPC PCF receives a Npcf_SMPolicyControl_Create request specifying a subscriber not known by the SAPC PCF.	The SAPC PCF returns a Npcf_SMPolicyControl_Create response indicating an error and the session is not established.	USER_UNKNOWN (400 Bad Request)
The SAPC PCF receives a Npcf_SMPolicyControl_Update request with event trigger RAT_TY_CH, but the message does not include the RAT type attribute.	The SAPC PCF returns a Npcf_SMPolicyControl_Update response indicating an error and the session is not updated.	ERROR_INITIAL_PARAMETERS (400 Bad Request)
The SAPC PCF receives a Npcf_SMPolicyControl_Update request with event trigger RAT_TY_CH, but the value of RAT type is the same as previous one.	The SAPC PCF returns a Npcf_SMPolicyControl_Update response indicating an error and the session is not updated.	ERROR_TRIGGER_EVENT (400 Bad Request)
The SAPC PCF receives a request and the format of message is invalid.	The SAPC PCF returns a response indicating an error.	INVALID_MSG_FORMAT (400 Bad Request)
The SAPC PCF receives a request and the mandatory attributes are missing in the data structure of the request body.	The SAPC PCF returns a response indicating an error.	MANDATORY_IE_MISSING (400 Bad Request)
The SAPC PCF receives a Npcf_SMPolicyControl_Update or Npcf_SMPolicyControl_Delete request, but the SAPC PCF does not find the corresponding active PDU session in the database.	The SAPC PCF returns a response indicating an error.	404 Not Found
The SAPC PCF receives a request and there are some errors when building the response data.	The SAPC PCF returns a response indicating an error.	UNSPECIFIED_NF_FAILURE (500 Internal Server Error)
There are some internal errors during SAPC PCF handling the request such as DBN access error.	The SAPC PCF returns a response indicating an error.	SYSTEM_FAILURE (500 Internal Server Error)
The SAPC PCF receives a request and the system is overloaded.	The SAPC PCF returns a response indicating an error directly.	503 Service Unavailable

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SAPC PCF

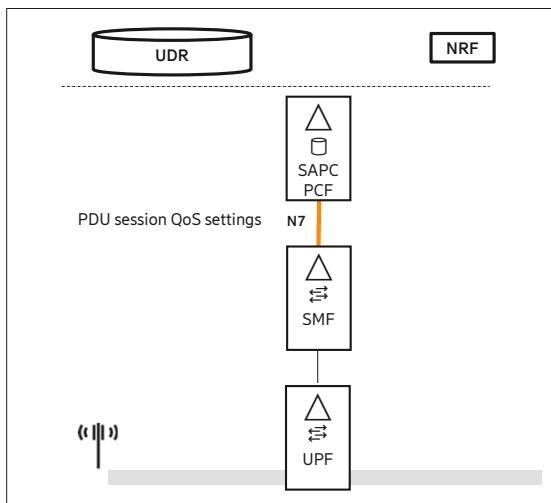


N7 interface.

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PDU session QoS Control (N7 Ref. Point; Npcf Service)



- Functionality that allows the application of the 5G QoS framework to the subscriber PDU session.
- PDU session 5G QoS framework includes parameters such as 5QI, ARP, Session-AMBR and Authorized default QoS.

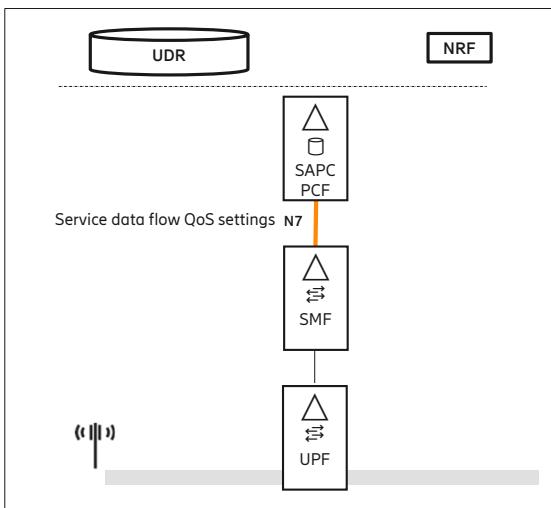
Benefits

- Allows the differentiation of different PDU sessions in terms of QoS limiting the number of resources used in accordance with the SLA.
- Allows subscriber differentiation what sets a framework to monetize the network according with different QoS levels.

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Service QoS Control (N7 Ref. Point; Npcf Service)



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- Functionality that allows the application of the 5G QoS framework per service data flow.
- GBR and Non-GBR QoS flows supported.
- 5G QoS framework includes QoS flows parameter such as 5QI and ARP, MFBR and GFBR.

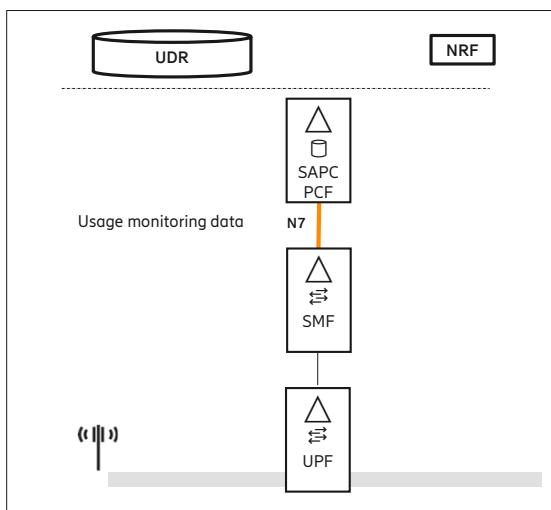
Benefits

- Allows the differentiation of services in terms of QoS enabling the fine-grained control of network resources used in accordance with each service SLA.
- Allows subscriber differentiation based on service QoS.

Monetize the network based on service QoS differentiation
Personalize the user QoE tailoring the service QoS level



PDU Session Usage Monitoring (N7; Npcf Service)



- Functionality that allows monitoring the volume of used data for the PDU session.
- Total, uplink and downlink volumes are supported.
- QoS settings can be modified when the configured usage limit is hit.

Benefits

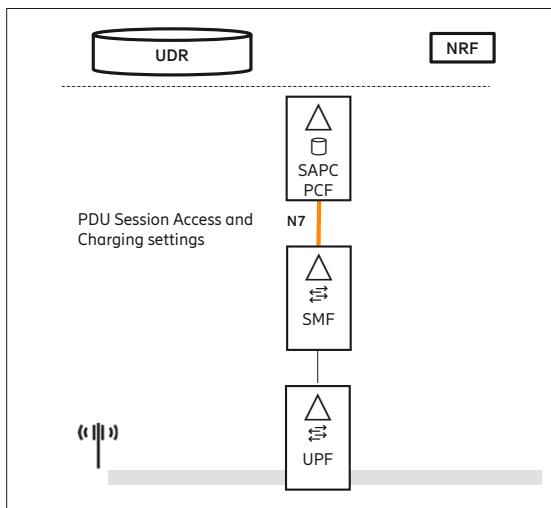
- Allows subscriber differentiation based on data usage.
- Allows network protection from heavy users.

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PDU Session Access and Charging Control



- Functionality that allows the application of access and charging control to the 5G subscriber at PDU session level.
- SAPC PCF decide which PDU sessions are authorized and the charging data applied to them making use of its **flexible rule engine** that evaluates operator configured conditions.

Benefits

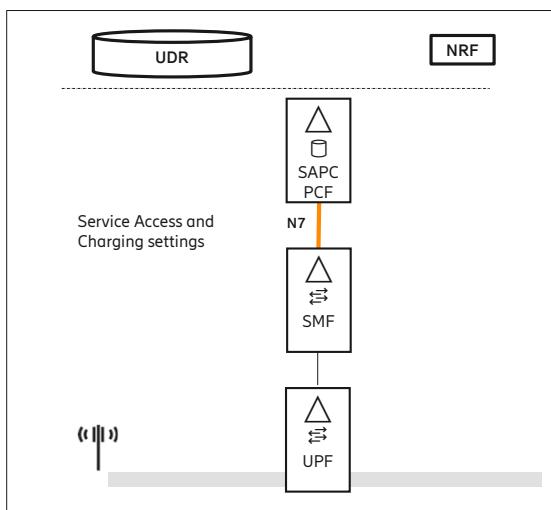
- Allows the differentiated Access and Charging Control of PDU sessions established by the subscriber
- Allows subscriber differentiation what sets a framework to monetize the network according with different Access and Charging levels.

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Service Access and Charging Control



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- Functionality that allows the application of access and charging control to the 5G subscriber at service level.
- SAPC PCF decide which Services are authorized and the charging data applied to them making use of its **flexible rule engine** that evaluates operator configured conditions.

Benefits

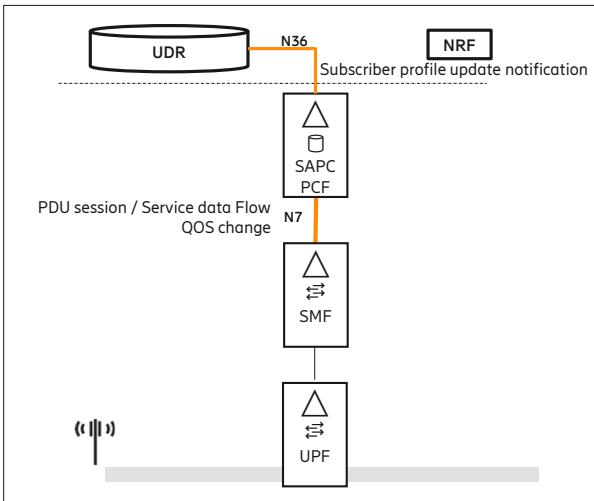
- Allows the differentiated Access Control of services accessed by the subscriber
- Allows the assignment of different Charging data based on services and subscriber
- Allows subscriber differentiation what sets a framework to monetize the network according with different Access and Charging levels.



QoS Policy Update



Trigger: Subscriber profile update (N7 reference point; N36 reference point)



- Functionality that allows updating the PDU session and/or service data flows QoS settings upon the reception of a subscriber profile update notification from UDR service.

Benefits

- Allows real time enforcement of subscriber profile updates differentiation based on data usage
- Allows network protection from heavy users

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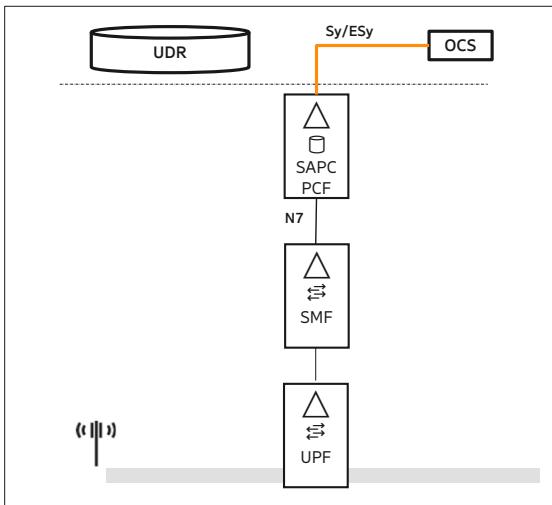
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Interaction with OCS



Sy or ESy interfaces support with N7



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- Two versions of the Sy Reference Point are supported: the Ericsson Sy - a pre-standard version of 3GPP Sy; and 3GPP Sy compliant version of the interface *Policy and Charging Control: Spending Limit Reporting over Sy Reference Point*.
- When the status of the subscriber account in OCS is changed, policy will be re-evaluated based on latest information and be sent to SMF.

Benefits

- Allows policy control decisions based on real-time information about the status of the monetary balance of a particular subscriber.

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HTTP/2 Protocol over N7 Interface



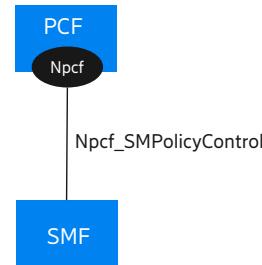
The Session Management Policy Control Service is provided by the SAPC PCF to the consumer shown in Figure below.

The Npcf is a service based interface.

The service-based interface uses HTTP/2 protocol with JSON as the application layer serialization protocol.

The service operations defined for Npcf_SMPolicyControl are:

- Npcf_SMPolicyControl_Create - Request to create an SM Policy association with the SAPC PCF to receive the policy for a PDU session. It is initiated by the SMF.
- Npcf_SMPolicyControl_Update - Request to update the SM Policy association with the SAPC PCF to receive the updated policy when Policy Control Request Trigger condition is met. It is initiated by the SMF.
- Npcf_SMPolicyControl_UpdateNotify - Request to update the Session Management related policies to the SMF. It is initiated by the SAPC PCF.
- Npcf_SMPolicyControl_Delete - Request to trigger the deletion of the context of SM related policies. It is initiated by the SAPC PCF.
- Npcf_SMPolicyControl_Delete - Request to delete the SM Policy Association and the associated resources.

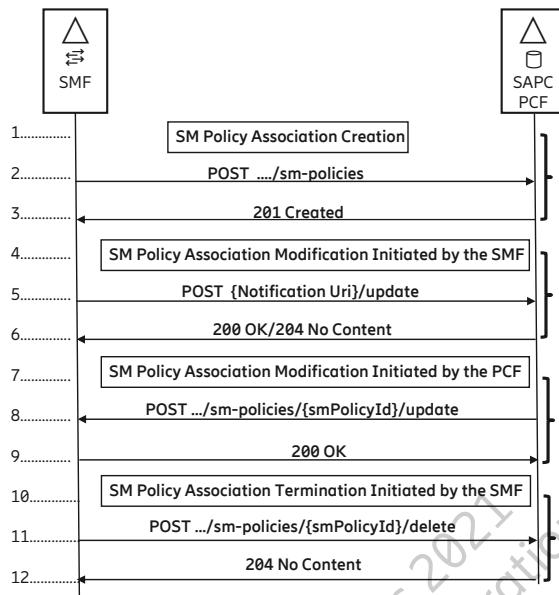


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HTTP/2 Protocol Message Exchange over N7



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SAPC PCF

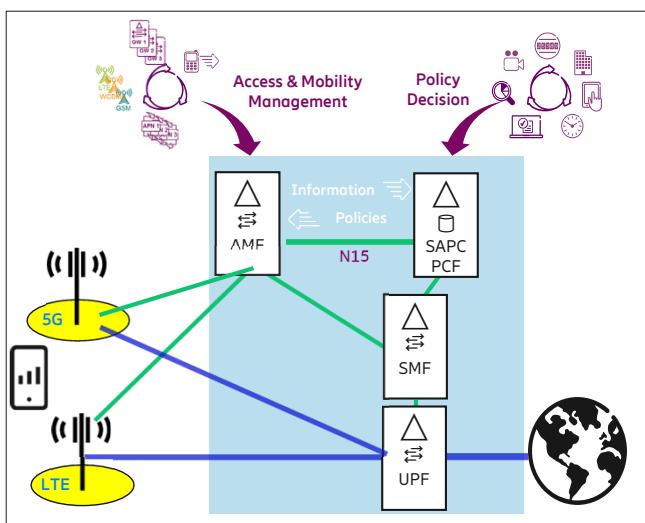


N15 interface.

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N15: Service Area Restriction (Npcf)



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Description

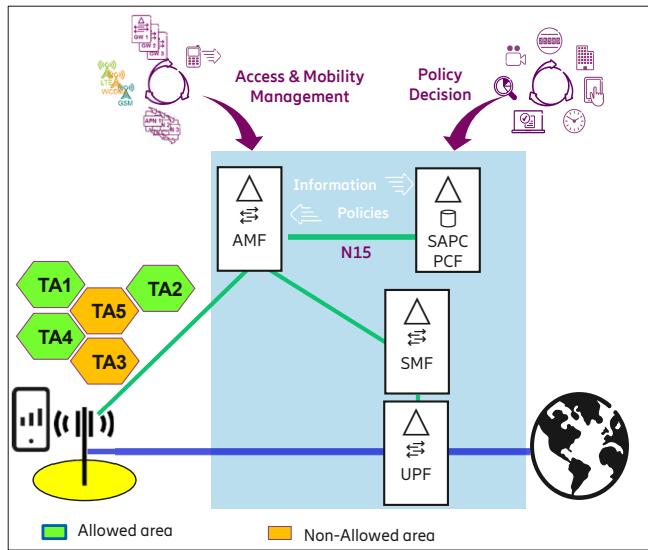
- Use case with AMF to allow service area restrictions using the new N15 reference point based on REST protocol as defined in the SBA.
- A service area restriction may contain either Allowed or Non-Allowed Areas—specified by using explicit tracking area identities.
- SAPC supports the dynamic selection of Non-Allowed Areas based on subscriber profile and dynamic network information.

Benefits

- **Steer devices or users to specific RAT/Frequency** based on the selected RFSP index.
- **Balance radio resource usage** according to device type, location, time of day and user profile information.



N15: Radio Frequency Selection Policies (RFSP) (Npcf)



Description

- Use case with AMF to dynamically select the Radio Frequency via N15 reference point based on REST protocol as defined in the SBA.
- SAPC, as PCF, performs radio frequency selection based on subscriber profile and dynamic network information

Benefits

- **Service restriction control** based on the allowed area or the non-allowed area customized by operator.
- **Balance radio and core network resource usage** by dynamic adapting the allowed/non-allowed area according to device type, location, time of day and user profile information.



SAPC PCF



Nnrf Interface.

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Functions of SAPC PCF Interaction with NRF



The interaction between the SAPC PCF and the NRF service supports the following functions:

- Allows the SAPC PCF to register, update or deregister its profile in the NRF.
- Allows the SAPC PCF to subscribe to be notified of target Network Function (NF) registering, updating, deregistering in the NRF.
- Allows the SAPC PCF to discover the service of target NF by querying the NRF.

Note:

The target NF here only includes the UDR.

Traffic Cases:

The NRF offers the following services for the SAPC PCF:

- Nnrf_NFManagement
- Nnrf_NFDiscovery

The following sections provide the traffic cases between the NRF and the SAPC PCF.

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Nnrf_NFManagement Service Operations



For the Nnrf_NFManagement service between the NRF and the SAPC PCF, the following service operations are supported:

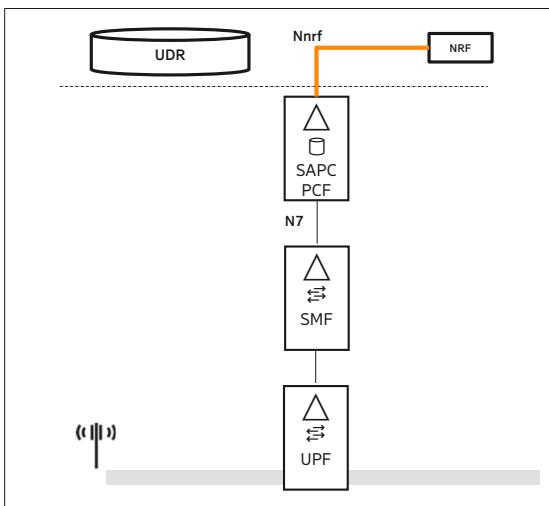
- NFRegister
- NFUpdate
- NFDeregister
- NFStatusSubscribe
- NFStatusNotify
- NFStatusUnsubscribe

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NRF registration (Nnrf service)



- Automatic registration of PCF function within the NRF following 3GPP procedures.
- Once the PCF is registered in the NRF, the NRF will allow the discovery of the PCF services to any other NF (e.g. AMF, SMF).

Benefits

- Allows automatic network configuration according to the SBA principles
- Allows automatic discovery of PCF services by other NFs.

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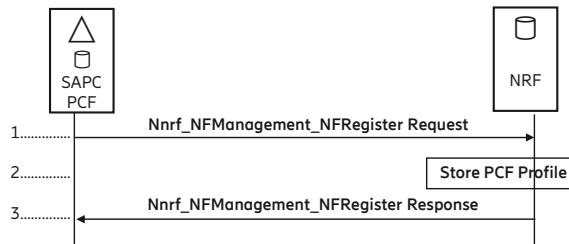
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NFRegister Operation (1/2)



This service operation allows the SAPC PCF to register its profile in the NRF.



1. The SAPC PCF sends a PUT `Nnrf_NFManagement_NFRegister Request` message to inform the NRF of its profile when this SAPC PCF is operative firstly. The main information that the SAPC PCF provides is:

- `nfInstanceID`
- `nfType`
- `nfStatus`
- `ipv4Addresses` or/and `ipv6Addresses`
- `pcfInfo`
- `nfServices`

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NFRegister Operation (2/2)



2.The NRF checks the request and stores the SAPC PCF profile. Additionally, the NRF returns a heart-beat timer containing the number of seconds expected between two consecutive heart-beat messages from an NF Instance to the NRF.

3.The SAPC PCF receives an Nnrf_NFManagement_NFRegister Response message indicating the operation result.

- If the request is successful, the value 201 Created is returned and a heart-beat timer is included. If the heart-beat timer is not returned in the response message, the default heart-beat timer "30s" is used
- If the request is invalid due to errors in the encoding of the SAPC PCF profile, the NRF returns 400 Bad Request with the problem details
- If the request is invalid due to NRF internal errors, the NRF returns 500 Internal Server Error with the problem details.

Note:

When the SAPC PCF registration fails, the automatic retry interval is 5 seconds until the SAPC PCF registration is successful.

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PCF Registration - Example



```
301 2020-05-14 04:16:35,... 192.168.12.40 192.168.14.42 SETTINGS[0], HEADERS[1]: PUT /nnrf-nfm/v1/nf-instances/de9f9fd9-ff3f-4255-a635-51f2e11c92fd  
302 2020-05-14 04:16:35,... 192.168.12.40 192.168.14.42 DATA[1] (application/json)
```

```
JavaScript Object Notation: application/json
Object
  Member Key: nfInstanceId
    String value: de9f9fd9-ff3f-4255-a635-51f2e11c92fd
    Key: nfInstanceId
  Member Key: nfType
    String value: PCF
    Key: nfType
  Member Key: nfStatus
    String value: REGISTERED
    Key: nfStatus
  Member Key: heartBeatTimer
  Member Key: plmnList
  Member Key: sNssais
  Member Key: fqdn
    String value: seliis03696.seli.gic.ericsson.se
    Key: fqdn
  Member Key: ipv4Addresses
  Member Key: capacity
  Member Key: pcfInfo
  Member Key: nfServices
```

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NFUpdate Operation



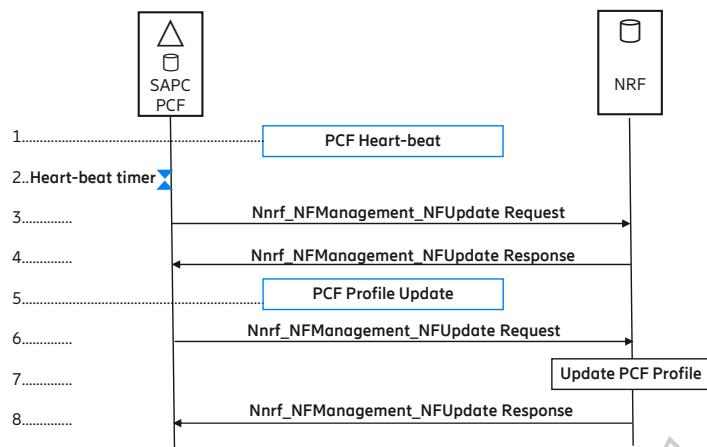
- This service operation allows the SAPC PCF to update the parameters of its profile in the NRF.
- The SAPC PCF profile contains general parameters of itself and parameters of the different services exposed by the SAPC PCF.
- The registered SAPC PCF contacts the NRF periodically (heart-beat), using the NFUpdate service operation, to show that the SAPC PCF is still operative.
- The time interval is returned by the NRF to the SAPC PCF as a result of a successful registration.
- If no heart-beat comes within the heart-beat interval, the SAPC PCF and its services can no longer be discovered by other NFs via NFDiscovey service.

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SAPC PCF Update (1/3)



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SAPC PCF Update (2/3)



SAPC PCF heart-beat

2. The SAPC PCF update can be triggered before the heart-beat timer expiration.
3. The SAPC PCF sends a PATCH Nnrf_NFManagement_NFUpdate Request message to inform the NRF of its active state.
4. The SAPC PCF receives an Nnrf_NFManagement_NFUpdate Response message indicating the operation result. If the request is successful, the value 200 OK is returned.

SAPC PCF profile update

- The SAPC PCF profile update procedure is triggered when one of the following conditions is met:
 - The SAPC PCF Profile is updated.
 - The status of the npcf-smpolicycontrol service is changed.
 - The status of the npcf-am-policy-control service is changed.

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SAPC PCF Update (3/3)



6. The SAPC PCF sends a PATCH Nnrf_NFManagement_NFUpdate Request message to the NRF to update the SAPC PCF profile.
7. The NRF checks the request, retrieves the original SAPC PCF profile, and updates the SAPC PCF profile according to the information provided by the SAPC PCF.
8. The SAPC PCF receives a Nnrf_NFManagement_NFUpdate Response message indicating the operation result.
 - If the request is successful, the value 200 OK is returned.
 - If the request is invalid, the error code 400 Bad Request is returned.
 - If the original SAPC PCF profile does not exist, the status code 404 Not Found is returned.
 - If the NRF fails to update the SAPC PCF profile due to internal errors, the error code 500 Internal Server Error is returned.

Note:

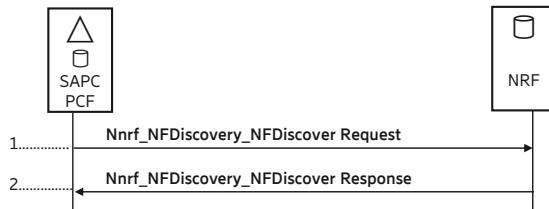
- For the error code 400 Bad Request, the SAPC PCF registration will be triggered.
- For the status code 404 Not Found and the error code 500 Internal Server Error, the retry for SAPC PCF profile update will happen after 5 seconds by default.



Nnrf_NFDiscovery Service Operations (1/2)



For the Nnrf_NFDiscovery service between the NRF and the SAPC PCF, the following service operation is supported:
NFDiscovers



1.The SAPC PCF sends a GET Nnrf_NFDiscovery_NFDiscover Request message to query the target NF in the NRF with the following parameters:

- target-nf-type: This attribute is mandatory and has a fixed value UDR.
- requester-nf-type: This attribute is mandatory and has a fixed value PCF.
- service-names: This attribute is optional and has a fixed value nudr-dr.
- requester-nf-instance-fqdn: This attribute is optional and has value of pcfFqdn defined in class PcfAppConfig.

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Nnrf_NFDiscovery Service Operations (2/2)



2.The NRF executes discovery operation, and returns a Nnrf_NFDiscovery_NFDiscover Response message indicating the operation result.

- If succeeded, the value 200 OK is returned. The response body contains a validity period. Only the information of the first UDR profile of the UDR profile list is stored in the response body. If the validity period is not returned in the response message, the default validity period "30s" is used. Before the validity period is expired, the UDR Discovery operation is triggered again to update the UDR profile. For more information about UDR profile, see Configuration Guide for SAPC PCF Interaction with UDR.
- If the SAPC PCF is not allowed to discover the target NF type provided in the query parameters, the NRF returns 403 Forbidden.
- If the request is invalid due to errors in the input data in the query parameters, the NRF returns 400 Bad Request with the problem details.
- If the request is invalid due to NRF internal errors, the NRF returns 500 Internal Server Error with the problem details.

Note:

If the UDR Discovery fails, the retry is expected until the UDR Discovery is successful.

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UDR Discovery - Example



Stream: HEADERS, Stream ID: 3, Length 116, GET /nnrf-disc/v1/nf-instances?target-nf-type=UDR&requester-nf-type=PCF&service-names=nudr-dr&requester-nf-instance-fqdn=selius03696.seli.gic.ericsson.se

```
306 2020-05-14 04:16:35,... 192.168.12.40 192.168.14.42 HEADERS[3]: GET /nnrf-disc/v1/nf-instances?target-nf-type=UDR&requester-nf-type=PCF&service-names=nudr-d...
307 2020-05-14 04:16:35,... 192.168.14.42 192.168.12.40 HEADERS[3]: 200 OK

HyperText Transfer Protocol 2
└ Stream: HEADERS, Stream ID: 3, Length 116, GET /nnrf-disc/v1/nf-instances?target-nf-type=UDR&requester-nf-type=PCF&service-names=nudr-dr&requester-nf-instance-fqdn=seli...
  Length: 116
  Type: HEADERS (1)
  Flags: 0x85
    0... .... .... .... .... .... = Reserved: 0x0
    .000 0000 0000 0000 0000 0000 0011 = Stream Identifier: 3
  [Pad Length: 0]
  Header Block Fragment: 8286c104ec62aac95690c8231dc2c552ac6a9091d442a3f...
  [Header Length: 335]
  [Header Count: 7]
  > Header: :method: GET
  > Header: :scheme: http
  > Header: :authority: 192.168.14.42:8080
  > Header: :path: /nnrf-disc/v1/nf-instances?target-nf-type=UDR&requester-nf-type=PCF&service-names=nudr-dr&requester-nf-instance-fqdn=selius03696.seli.gic.ericsson.se
  > Header: accept-encoding: gzip
  > Header: content-type: application/json
  > Header: user-agent: Go-http-client/2.0
```

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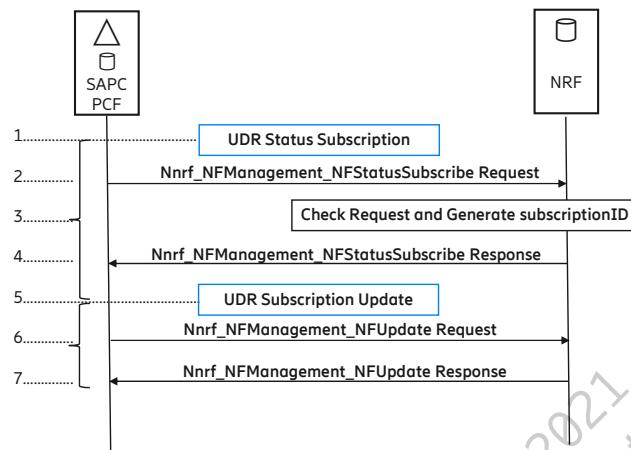
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NFStatusSubscribe Operation (1/4)



After the discovery operation is successfully executed, this service allows the SAPC PCF to subscribe to changes on the status of UDR registered in the NRF.



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NFStatusSubscribe Operation (2/4)



UDR Status Subscription

2. The SAPC PCF sends a POST Nnrf_NFManagement_NFStatusSubscribe Request message with the following information to subscribe to status changes of the target NF in the NRF. The below information in the POST Nnrf_NFManagement_NFStatusSubscribe Request message is retrieved from the udrSubProfile.

- nfStatusNotificationUri: This attribute is mandatory for SubscriptionData in request body.
- reqNfType: This attribute has a fixed value SAPC PCF.
- subscrCond
 - nfType: This attribute has a fixed value UDR.
 - serviceName: This attribute has a fixed value nudr-dr.

3. The NRF checks the request and generates subscriptionID for this subscription. The subscriptionID is a mandatory parameter in the response.

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NFStatusSubscribe Operation (3/4)



4. The SAPC PCF receives an Nnrf_NFManagement_NFStatusSubscribe Response message indicating the operation result.

- If the request is successful, the NRF returns 201 Created with subscriptionID and validity time. If the validity time is not returned in the response message, the default validity time "30s" is used. Before the validity time is expired, the UDR Subscription Update operation is triggered to update the status of UDR registered in the NRF.
- If the request is successful, the SAPC PCF updates the status change of the target NF in the NRF.
- If the request is invalid due to errors in the SubscriptionData in the request body, the NRF returns 400 Bad Request with the problem details.
- If the subscription fails due to NRF internal errors, the NRF returns 500 Internal Server Error with the problem details.

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NFStatusSubscribe Operation (4/4)



UDR Subscription Update

6. The SAPC PCF sends a PATCH Nnrf_NFManagement_NFSubscriptionUpdate Request message to the NRF.

7. The NRF returns an Nnrf_NFManagement_NFSubscriptionUpdate Response message to the SAPC PCF.

- If the request is successful, the NRF accepts the requested value for the validityTime attribute, and returns a 204 No Content status code.
- If the request is successful, the NRF assigns a different value from the requested value for the validityTime attribute, and returns a 200 OK response code.
- If the request is invalid due to errors in the SubscriptionData in the request body, the NRF returns 400 Bad Request with the problem details.
- If the subscription fails due to NRF internal errors, the NRF returns 500 Internal Server Error with the problem details.

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UDR Subscribe - Example

```
310 2020-05-14 04:16:35,... 192.168.12.40 192.168.14.42 HEADERS[5]: POST /nnrf-nfm/v1/subscriptions, DATA[5] (application/json)
> Header: :method: POST
> Header: :scheme: http
> Header: :authority: 192.168.14.42:8080
> Header: :path: /nnrf-nfm/v1/subscriptions
> Header: accept-encoding: gzip
> Header: content-length: 109
> Header: content-type: application/json
> Header: user-agent: Go-http-client/2.0
Stream: DATA, Stream ID: 5, Length 109
Length: 109
Type: DATA (0)
Flags: 0x01
0... .... .... .... .... .... = Reserved: 0x0
.000 0000 0000 0000 0000 0000 0101 = Stream Identifier: 5
[Pad Length: 0]
Data: 7b2022737562736372436f6e64223a207b226e6654797065...
JavaScript Object Notation: application/json
0 82 58 6a d2 63 d4 8f c0 0f 0d 82 08 1f bf be 00 .Xj.c.... .....
0 00 6d 00 01 00 00 00 05 7b 20 22 73 75 62 73 63 .m..... [ "subsc
0 72 43 6f 6e 64 22 3a 20 7b 22 6e 66 54 79 70 65 rCond": {"nfType
0 22 3a 20 22 55 44 52 22 7d 2c 20 22 6e 66 53 74
0 61 74 75 73 4e 6f 74 69 66 69 63 61 74 69 6f 6e
0 55 72 69 22 3a 20 22 68 74 74 70 3a 2f 2f 31 39
0 32 2e 31 36 38 2e 31 32 2e 34 30 3a 39 30 39 31
0 2f 6e 6e 72 66 2d 6e 6f 74 69 66 69 63 61 74 69
0 6f 6e 2f 22 7d atusNoti fication
Uri": "h ttp://19
2.168.12 .40:9091
/nnrf-no tificati
on/"]

```

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UDR Subscribe Response- Example



```
311 2020-05-14 04:16:35,... 192.168.14.42    192.168.12.40      WINDOW_UPDATE[0]
312 2020-05-14 04:16:35,... 192.168.14.42    192.168.12.40      HEADERS[5]: 201 Created
313 2020-05-14 04:16:35,... 192.168.14.42    192.168.12.40      DATA[5] (application/json)

<
  Data: 7b2022737562736372436f6e64223a207b226e6654797065...
  ▾ JavaScript Object Notation: application/json
  ▾ Object
    ▾ Member Key: subscrCond
      > Object
        Key: subscrCond
    ▾ Member Key: subscriptionId
      String value: 460001234567891
      Key: subscriptionId
    ▾ Member Key: validityTime
      String value: 2018-12-30T23:20:50Z
      Key: validityTime
    ▾ Member Key: nfstatusNotificationUri
      String value: http://192.168.12.40:9091/nnrf-notification/
      Key: nfStatusNotificationUri

0040 48 84 00 de 3c 76 00 00 b6 00 01 00 00 00 05 7b H..<v... ....-{ 
0050 20 22 73 75 62 73 63 72 43 6f 6a 64 22 3a 20 7b "subscr Cond": { 
0060 22 6e 6a 54 79 70 65 22 3a 20 22 55 44 52 22 7d "nfType" : "UDR"} 
0070 2c 22 73 75 62 73 63 72 69 70 74 69 6f 6e 49 64 , "subscr optionId 
0080 22 3a 22 34 36 30 30 30 31 32 33 34 35 36 37 38 ":"46000 12345678 
0090 39 31 22 2c 22 76 61 6e 69 64 69 74 79 54 69 6d 91","val idityin 
00a0 65 22 3a 22 33 30 31 38 2d 31 32 2d 33 30 54 32 e":"2018 -12-30T2 
00b0 33 3a 32 30 3a 35 30 5a 22 2c 20 22 6e 66 53 74 3:20:50Z ", "nfSt 
00c0 61 74 75 73 4e 6f 74 69 66 69 63 61 74 69 6f 6e atusNoti fication 
00d0 55 72 69 22 3a 20 22 68 74 74 70 3a 2f 2f 31 39 Uri": "http://19 
00e0 32 2e 31 36 38 2e 31 32 2e 34 30 3a 39 30 39 31 2.168.12 .40:9091 
00f0 2f 6e 6e 72 66 2d 6e 6f 74 69 66 69 63 61 74 69 /nnrf-no tificati 
0100 6f 6e 2f 22 7d on/") 

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```

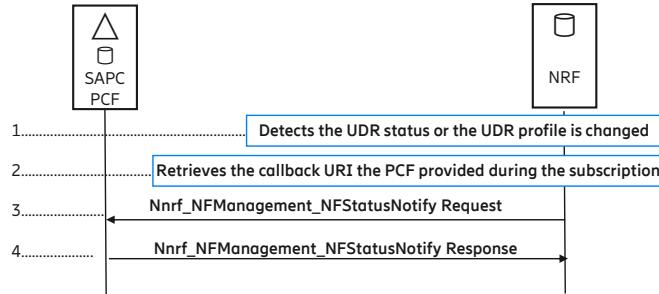
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NFStatusNotify Operation (1/2)



This service allows the NRF to notify the previously subscribed SAPC PCF of changes on the status of UDR.



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NFStatusNotify Operation (2/2)



3. The NRF sends a POST Nnrf_NFManagement_NFStatusNotify Request message with the following information to the nfStatusNotificationUri:

- If the event type is NF_Registered, the request body includes eventType, nfInstanceUri, and the new NF profile.
- If the event type is NF_Profile_Changed, the request body can include either combination of the followings: -
 - eventType, nfInstanceUri, and complete change of the NF profile
 - eventType, nfInstanceUri, and partial change of the NF profile
- If the event type is NF_Deregistered, the request body includes eventType, and nfInstanceUri.

4. The SAPC PCF returns an Nnrf_NFManagement_NFStatusNotify Response message indicating the operation result.

- If the request is successful, the value 204 No content is returned. Meanwhile, the SAPC PCF stores or updates the UDR profile.
- If the request fails due to invalid notification URI, the SAPC PCF returns 404 Not Found with the problem details.

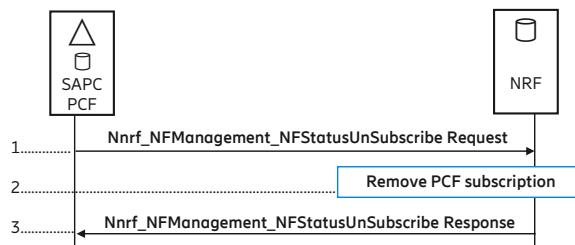
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NFStatusUnsubscribe Operation (1/2)



This service allows the SAPC PCF to remove an existing subscription.



Preconditions

- There is (existed) a successful subscription.

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NFStatusUnsubscribe Operation (2/2)



Trigger Conditions

- The subscriber profile is removed.
 - The SAPC PCF deregistration is removed.
 - If the udrSubProfile is modified in or deleted from the POST Nnrf_NFManagement_NFStatusSubscribe Request message from the UDR Status Subscription operation, the UDR Status Unsubscription operation is triggered.
1. The NRF receives a DELETE Nnrf_NFManagement_NFStatusUnsubscribe Request message from the SAPC PCF including a subscriptionID to unsubscribe to status changes of the target NF.
 2. The NRF removes the correlation subscriptionID.
 3. The SAPC PCF receives a Nnrf_NFManagement_NFStatusUnsubscribe Response message indicating the operation result. If the request is successful, the value 204 No content is returned.

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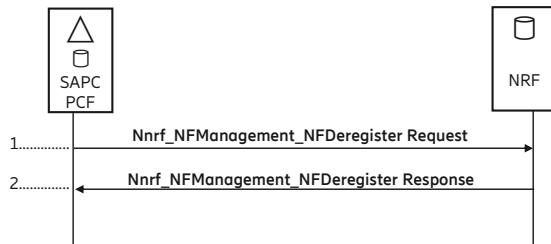
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NFDeregister Operation (1/2)



This service operation allows the previously registered SAPC PCF to remove its profile in the NRF.



The SAPC PCF Deregistration is triggered when one of the following conditions is met:

- License is changed from available to not available.
- The configuration of the pcfPeerNode for NRF is changed or deleted.
- When the pcfID is changed.
- When the pcfAdminStatus is changed to ADMIN_DEREGISTERED.
- When the pcfRegProfile is removed from PcfMsgTemplate.

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NFDeregister Operation (2/2)



1. The SAPC PCF sends a DELETE Nnrf_NFManagement_NFDeregister Request message to NRF, when one of the following conditions is met:
 2. The SAPC PCF receives an Nnrf_NFManagement_NFDeregister Response message indicating the operation result.
 - If the request is successful, the value 204 No Content is returned.
 - If the nfInstanceId is not found in the list of registered SAPC PCF profile in the NRF database, the error code 404 Not Found is returned with the problem details
 - If the NRF fails to delete the SAPC PCF profiles due to internal errors, the error code 500 Internal Server Error is returned with the problem details.

Note:

If the SAPC PCF deregistration fails, no retry is expected.

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UDR Unsubscribe and PCF Deregistration



415.....HEADERS[9]:DELETE /nrf-nfm/v1/subscriptions/460001234567891 UDR Unsubscribe
HEADERS[11]:DELETE /nrf-nfm/v1/nf-instances/de9f9fd9-ff3f-4255-a635-51f2e11c92fd HTTP2 186

↑ PCF Deregistration

```
415 2020-05-14 04:16:40,... 192.168.12.40 192.168.14.42 HEADERS[9]: DELETE /nrf-nfm/v1/subscriptions/460001234567891, HEADERS[11]: DELETE /nrf-nfm/v1/nf-insta...>
Stream: HEADERS, Stream ID: 9, Length 45, DELETE /nrf-nfm/v1/subscriptions/460001234567891
Length: 45
Type: HEADERS (1)
> Flags: 0x05
0... .... .... .... .... = Reserved: 0x0
.000 0000 0000 0000 0000 0000 1001 = Stream Identifier: 9
[Pad Length: 0]
Header Block Fragment: 420644454c45544586c2049e62aaac956aa5a58ee16116c6...
[Header Length: 238]
[Header Count: 7]
> Header: :method: DELETE
> Header: :scheme: http
> Header: :authority: 192.168.14.42:8080
> Header: :path: /nrf-nfm/v1/subscriptions/460001234567891
> Header: accept-encoding: gzip
> Header: content-type: application/json
> Header: user-agent: Go-http-client/2.0
Stream: HEADERS, Stream ID: 11, Length 53, DELETE /nrf-nfm/v1/nf-instances/de9f9fd9-ff3f-4255-a635-51f2e11c92fd
Length: 53
Type: HEADERS (1)
> Flags: 0x05
0... .... .... .... .... = Reserved: 0x0
.000 0000 0000 0000 0000 0000 1011 = Stream Identifier: 11
[Pad Length: 0]
Header Block Fragment: be86c204ad62aaac956aa5a58ee162a956354848ea2150c4...
[Header Length: 258]
[Header Count: 7]
> Header: :method: DELETE
> Header: :scheme: http
> Header: :authority: 192.168.14.42:8080
> Header: :path: /nrf-nfm/v1/nf-instances/de9f9fd9-ff3f-4255-a635-51f2e11c92fd
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```

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NRF Policy Control Error Handling (1/2)



The SAPC PCF answers with the following error codes:

Error Condition	Action	Code
The SAPC PCF sends an invalid PUT Nnrf_NFManagement_NFRegister Request message to the NRF due to errors in the encoding of the SAPC PCF profile, and the SAPC PCF Registration fails.	The SAPC PCF retries to send the NFRegister Request to the NRF.	400 Bad Request
The SAPC PCF sends an invalid PUT Nnrf_NFManagement_NFRegister Request message to the NRF due to NRF internal errors, and the SAPC PCF Registration fails.	The SAPC PCF retries to send the NFRegister Request to the NRF.	500 Internal Server Error
The SAPC PCF sends an invalid PATCH Nnrf_NFManagement_NFUpdate Request message to the NRF, and the SAPC PCF Profile Update fails.	The SAPC PCF retries to send the NFUpdate Request to the NRF.	400 Bad Request
The SAPC PCF sends a PATCH Nnrf_NFManagement_NFUpdate Request message to the NRF, but the original SAPC PCF profile does not exist. The SAPC PCF Profile Update fails.	The SAPC PCF retries to send the NFUpdate Request to the NRF.	404 Not Found
The SAPC PCF sends a PATCH Nnrf_NFManagement_NFUpdate Request message to the NRF, but the NRF fails to update the SAPC PCF profile due to internal errors. The SAPC PCF Profile Update fails.	The SAPC PCF retries to send the NFUpdate Request to the NRF.	500 Internal Server Error
The SAPC PCF sends a DELETE Nnrf_NFManagement_NFDeregister Request message to the NRF, but the nInstanceId is not found in the list of registered SAPC PCF profiles in the NRF database. The SAPC PCF Deregistration fails.	No specific action.	404 Not Found
The SAPC PCF sends a DELETE Nnrf_NFManagement_NFDeregister Request message to the NRF, but the NRF fails to delete the SAPC PCF profiles due to internal errors. The SAPC PCF Deregistration fails.	No specific action.	500 Internal Server Error
The SAPC PCF sends an invalid POST Nnrf_NFManagement_NFStatusSubscribe Request message to the NRF due to errors in the SubscriptionData in the request body. The UDR Status Subscription fails.	The SAPC PCF retries to send the NFStatusSubscribe Request to the NRF.	400 Bad Request
The SAPC PCF sends a POST Nnrf_NFManagement_NFStatusSubscribe Request message to the NRF, but the NRF has internal errors. The UDR Status Subscription fails.	The SAPC PCF retries to send the NFStatusSubscribe Request to the NRF.	500 Internal Server Error

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NRF Policy Control Error Handling (2/2)



The SAPC PCF answers with the following error codes:

Error Condition	Action	Code
The SAPC PCF sends an invalid PATCH <code>Nnrf_NFManagement_NFSubscriptionUpdate</code> Request message to the NRF due to errors in the SubscriptionData in the request body. The UDR Status Subscription fails.	The SAPC PCF retries to send the NFStatusSubscribe Request to the NRF.	400 Bad Request
The SAPC PCF sends a PATCH <code>Nnrf_NFManagement_NFSubscriptionUpdate</code> Request message to the NRF, but the NRF has internal errors. The UDR Status Subscription fails.	The SAPC PCF retries to send the NFStatusSubscribe Request to the NRF.	500 Internal Server Error
The SAPC PCF receives a POST <code>Nnrf_NFManagement_NFStatusNotify</code> Request message, but the request sent from the NRF has invalid notification URI.	The SAPC PCF returns an <code>Nnrf_NFManagement_NFStatusNotify</code> Response message indicating the problem details, and the UDR Status Notification fails.	404 Not Found
The SAPC PCF sends an invalid DELETE <code>Nnrf_NFManagement_NFStatusUnsubscribe</code> Request message to the NRF due to errors in the UnsubscriptionData in the request body. The UDR Status Unsubscription fails.	No specific action.	400 Bad Request
The SAPC PCF sends a DELETE <code>Nnrf_NFManagement_NFStatusUnsubscribe</code> Request message to the NRF, but the NRF has internal errors. The UDR Status Unsubscription fails.	No specific action.	500 Internal Server Error
The SAPC PCF sends a GET <code>Nnrf_NFDiscovery_NFDiscover</code> Request message to the NRF, but the SAPC PCF is not allowed to discover the target NF type provided in the query parameters. The UDR Discovery fails.	The SAPC PCF retries to send the NFDiscover Request to the NRF.	403 Forbidden
The SAPC PCF sends an invalid GET <code>Nnrf_NFDiscovery_NFDiscover</code> Request message to the NRF due to errors in the input data in the query parameters. The UDR Discovery fails.	The SAPC PCF retries to send the NFDiscover Request to the NRF.	400 Bad Request
The SAPC PCF sends an invalid GET <code>Nnrf_NFDiscovery_NFDiscover</code> Request message to the NRF due to NRF internal errors. The UDR Discovery fails.	The SAPC PCF retries to send the NFDiscover Request to the NRF.	500 Internal Server Error

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SAPC PCF

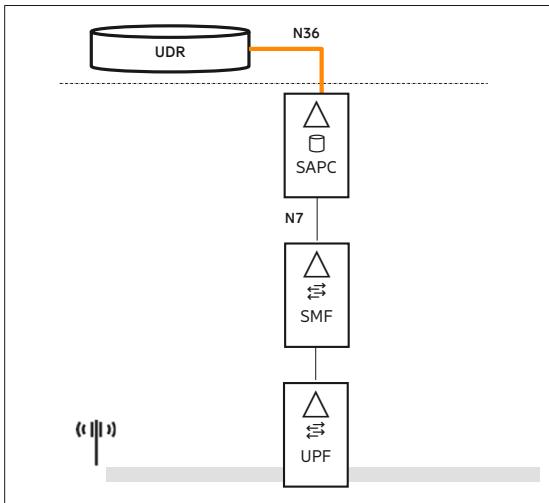


SAPC PCF Interaction with UDR

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Interaction with UDR (N36 Ref. Point; Nudr Service)



- Allows the connection with an external DB to get the subscriber profile following 3GPP for fully multivendor interoperability
- The subscriber profile data is used to determine the actions to take and enforce in the PDU session
- If UDR is not available, unknown subscriber profile applies
- UDR profile can be configured locally or discovered via NRF

Benefits

- Interoperable with any DB vendor that follows 3GPP standard

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SAPC PCF Interaction with UDR Function



The SAPC PCF provides the following functionalities, supported by the UDR:

- Retrieval of Session Management Policy Data needed to handle a PDU session.
- Subscription to data change notifications and cancellation of the subscription.
- Reception of data change notifications.
- UDR geographical redundancy (1+1)

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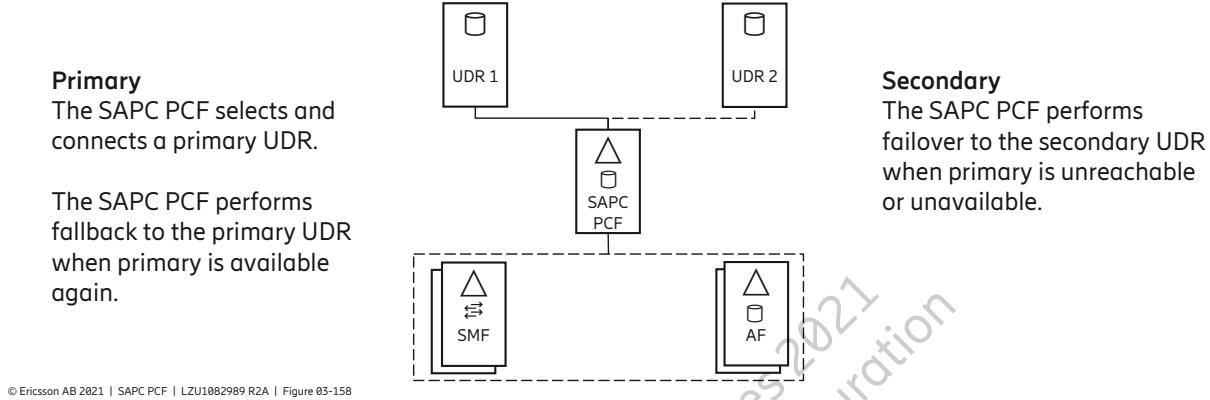
UDR Geographical Redundancy (1+1) Support



The UDR provides a redundancy configuration where the data can be replicated in two geographically distributed UDRs (1+1 geographical redundancy).

The SAPC PCF selects a primary UDR for traffic after UDR discovery if NRF is configured in the network. Otherwise, the SAPC PCF selects a primary UDR from the locally configured UDRs.

The following figure shows the scenario where the SAPC PCF leverages 1+1 redundancy in UDR.





UDR Selection



The SAPC PCF selects primary UDR according to the order:

1. Select the one with higher priority. A lower value indicates a higher priority.
2. If both UDRs have the same priority or no priority is provided, the SAPC PCF selects the one with locality same to pcfLocality configured in the SAPC PCF.
Locality is geographic location or data center. The values are case insensitive.
3. If both UDRs have or neither UDR has the same locality or no locality is provided, SAPC PCF selects the primary UDR by ASCII code order of instance IDs.

For example, if discovering both UDR1 and UDR2, the SAPC PCF takes UDR1 as primary UDR.

The SAPC PCF reselects the primary UDR when a more suitable UDR instance becomes available. For example, the new instance has same locality with SAPC PCF while the initially selected one does not. The SAPC PCF takes the new UDR as primary UDR.

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Failover



- Failover is the mechanism that allows the SAPC PCF to route the traffic to the secondary UDR. The failover takes place when the primary UDR is unreachable or unavailable to serve traffic.
- The SAPC PCF detects UDR failure by connection failure, HTTP message timeouts, or HTTP 5XX (except 503) errors. When detecting a UDR failure, the SAPC PCF performs the following steps:
 1. Route the traffic to the secondary UDR.
 2. Raise a failover alarm. If the failure is because of connection failure, the SAPC PCF also raises a connection failure alarm.

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Fallback



The SAPC PCF monitors the failed primary UDR as follows:

- If the UDR failure is because of connection failure, the SAPC PCF attempts TCP connections periodically. If connected, the SAPC PCF sends HTTP GET messages to the UDR to confirm that the UDR is active.
- If the UDR failure is because of HTTP message timeouts or HTTP 5XX (except 503) errors, the SAPC PCF periodically sends HTTP GET messages to the UDR.

If the primary UDR is active, the SAPC PCF performs the following steps:

1. Route the traffic back to the primary UDR.
2. Clear the failover alarm. Clear the connection failure alarm if raised.

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Traffic Cases



For the Nudr_DataRepository service provided by the UDR, the SAPC PCF supports the following service operations:

- Query: The SAPC PCF requests policy data from the UDR.
- Subscribe: The SAPC PCF subscribes to data change notifications from the UDR.
- Notify: The UDR notifies the SAPC PCF of modification of data, when data in the UDR is added, modified, or deleted.
- Unsubscribe: The SAPC PCF unsubscribes to data change notifications from the UDR.

The following sections provide the traffic cases between the SAPC PCF and the UDR.

The precondition is that UDR discovery is done previously or the UDR is preconfigured in the SAPC PCF.

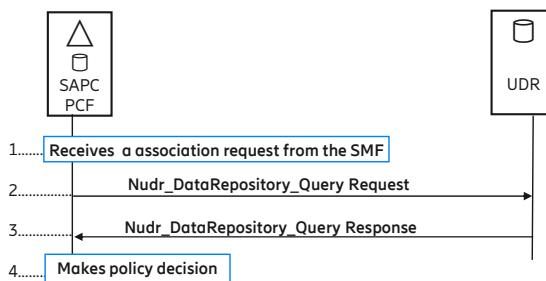
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Query Operation (1/2)



This service operation allows the SAPC PCF to retrieve the policy data stored in the UDR. The data records can be a data set, a data subset, a group of data in one data subset, or a specific data.



1. The SAPC PCF receives a policy association request from the SMF.
2. The SAPC PCF sends a GET Nudr_DataRepository_Query request with the ueId to retrieve required data from the UDR.
If the SAPC PCF gets no response within 5 seconds, the SAPC PCF looks for UnknownSubscriber in internal database. If getting no information, the SAPC PCF returns 400 Bad Request with HTTP cause USER_UNKNOWN to the SMF.

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Query Operation (2/2)



3. The UDR returns an Nudr_DataRepository_Query response with the data structures and attributes corresponding to the requests:

- SessionManagementPolicyData
- SmPolicyData data structure including the smPolicySnssaiData attribute (map(SmPolicySnssaiData) datatype).
The SmPolicySnssaiData data structure includes the following attributes:
 - snssai: S-NSSAI associated with the data. The Snssai data structure contains the following attributes:
 - sst: represents the Slice/Service Type
 - sd: represents the Slice Differentiator
 - smPolicyDnnData (SmPolicyDnnData data type): SM policy data per DNN for all the DNNs of the indicated S-NSSAI. The SmPolicyDnnData data structure includes the following attribute:
 - dnn: DNN associated with the data

Note: If receiving policy data of multiple of SNSSAI and DNN combination, the SAPC PCF only handles the policy data of last SNSSAI and DNN combination.

4. The SAPC PCF makes policy decision based on the received policy data.

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SMF Session Create Request - (SMF>PCF)



```
201 2020-05-14 04:19:59,... 192.168.14.42 192.168.12.40 HEADERS[3]: POST /npcf-smpolicycontrol/v1/sm-policies
<
  HyperText Transfer Protocol 2
    Stream: HEADERS, Stream ID: 3, Length 90, POST /npcf-smpolicycontrol/v1/sm-policies
      Length: 90
      Type: HEADERS (1)
    Flags: 0x04
      0... .... .... .... .... .... = Reserved: 0x0
      .000 0000 0000 0000 0000 0000 0011 = Stream Identifier: 3
      [Pad Length: 0]
      Header Block Fragment: 418d0be25c2e3cb844bb40b8f81f0f83459a62aac92ac8a6...
      [Header Length: 274]
      [Header Count: 9]
    Header: :authority: 192.168.12.40:9091
    Header: :method: POST
    Header: :path: /npcf-smpolicycontrol/v1/sm-policies
    Header: :scheme: http
    Header: content-type: application/json
    Header: accept-charset: UTF-8
    Header: content-length: 561
    Header: accept-encoding: gzip
    Header: user-agent: Go-http-client/2.0
```

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SMF Session Create Request - (SMF>PCF)



```
{"supi":"imsi460001234567891",
 "pduSessionId":123,
 "pduSessionType":"IPV4",
 "dnn":"dnn_mbb.com",
 "ipv4Address":"1.1.1.1",
 "userLocationInfo":{"nrLocation":{"tai":{"plmnId":{"mcc":"460","mnc":"00"}, "tac":"0064"}, "ngi":{"plmnId":{"mcc":"460","mnc":"00"}, "nrCellId":"010203061"}}, "subsSessAmbr":{"uplink":"2 Gbps", "downlink":"2 Gbps"}, "subsDefQos":{"5qi":6, "arp":{"priorityLevel":9, "preemptCap":"MAY_PREEMPT", "preemptVuln":"PREEMPTABLE"}}, "notificationUrl": "http://192.168.14.42:7071/policy/notification/imsi-460001234567891;123", "sliceInfo":{"sst":2, "sd":"000002"}}
```

No.	Time	Source	Destination	Info
202	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	DATA[3]

▼ HyperText Transfer Protocol 2
 ▼ Stream: DATA, Stream ID: 3, Length 561 (partial entity body)
 Length: 561
 Type: DATA (0)
 Flags: 0x00
 0... = Reserved: 0x0
 .000 0000 0000 0000 0000 0000 0000 0011 = Stream Identifier: 3
 [Pad Length: 0]
 Reassembled body in frame: 203

```
0040 0f d5 00 df 03 c6 00 02 31 00 00 00 00 00 03 7b  ..... 1.....
0050 22 73 75 70 69 22 3a 22 69 6d 73 69 2d 34 36 30  "supi" "imsi-460
0060 30 30 31 32 33 34 35 36 37 38 39 31 22 2c 22 70  00123456 7891" "p
0070 64 75 53 65 73 73 69 6f 6e 49 64 22 3a 31 32 33  ,pduSessionId":123
0080 2c 22 70 64 75 53 65 73 73 69 6f 6e 54 79 70 65 ,pduSessionType
```

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Nudr_DataRepository_Query Request - (PCF>UDR)



No.	Time	Source	Destination	Info
211	2020-05-14 04:19:59,...	192.168.12.40	192.168.14.42	SETTINGS[0], HEADERS[1]: GET /nudr-dr/v2/policy-data/ues/imsi-460001234567891/sm-data?snssai=%7b%22sst%22:2,%22sd%22:%22000002%22%7d&dnn=dnn_mbb.com

HyperText Transfer Protocol 2

- Stream: SETTINGS, Stream ID: 0, Length 0
 - Length: 0
 - Type: SETTINGS (4)
 - Flags: 0x01
 - 0... = Reserved: 0x0
 - .000 0000 0000 0000 0000 0000 = Stream Identifier: 0
- Stream: HEADERS, Stream ID: 1, Length 104, GET /nudr-dr/v2/policy-data/ues/imsi-460001234567891/sm-data?snssai=%7b%22sst%22:2,%22sd%22:%22000002%22%7d&dnn=dnn_mbb.com
 - Length: 104
 - Type: HEADERS (1)
 - Flags: 0x05
 - 0... = Reserved: 0x0
 - .000 0000 0000 0000 0000 0000 0001 = Stream Identifier: 1
 - [Pad Length: 0]
 - Header Block Fragment: 8286418d0be25c2e3cb85a5da15c780f3904d562ab64b169...
 - [Header Length: 205]
 - [Header Count: 4]
 - Header: :method: GET
 - Header: :scheme: http
 - Header: :authority: 192.168.14.42:8086
 - Header: :path: /nudr-dr/v2/policy-data/ues/imsi-460001234567891/sm-data?snssai=%7b%22sst%22:2,%22sd%22:%22000002%22%7d&dnn=dnn_mbb.com

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Nudr_DataRepository_Query Response - (UDR>PCF)

No.	Time	Source	Destination	Info
212	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	HEADERS[1]: 200 OK

<

▼ HyperText Transfer Protocol 2

 ▼ Stream: HEADERS, Stream ID: 1, Length 43, 200 OK

 Length: 43

 Type: HEADERS (1)

 > Flags: 0x04

 0.... = Reserved: 0x0

 .000 0000 0000 0000 0000 0000 0001 = Stream Identifier: 1

 [Pad Length: 0]

 Header Block Fragment: 885f8b1d75d0620d263d4c7441ea5c033134396196df3dbf...

 [Header Length: 120]

 [Header Count: 4]

 > Header: :status: 200 OK

 > Header: content-type: application/json

 > Header: content-length: 149

 > Header: date: Thu, 14 May 2020 02:19:59 GMT

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Nudr_DataRepository_Query response - (UDR>PCF)



```
{"smPolicySnssaiData":{"2-000002":{"snssai":{"sst":2,"sd":"000002"},"smPolicyDnnData":{"dnn_mbb.com":{"dnn":"dnn_mbb.com","subscCats":["Bronze"]}}}}}
```

No.	Time	Source	Destination	Info
	213 2020-05-14 04:19:59...	192.168.14.42	192.168.12.40	DATA[1] (application/json)
<				
HyperText Transfer Protocol 2				
Stream: DATA, Stream ID: 1, Length 149				
Length: 149				
Type: DATA (0)				
Flags: 0x01				
0... = Reserved: 0x0				
.000 0000 0000 0000 0000 0001 = Stream Identifier: 1				
[Pad Length: 0]				
Data: 7b22736d506f6c696379536e7373616944617461223a7b22...				
> JavaScript Object Notation: application/json				
0000	02 00 00 01 00 1a 52 54 00 07 00 20 81 00 00 65		 RT e
0010	08 00 45 00 00 d2 0c 58 40 00 3f 06 93 2b c0 a8			..E....X @ ?...+..
0020	00 2a c8 a8 0c 28 1f 96 80 8d 0f f5 02 85 86 1a			.*....(.....
0030	9f 9d 80 18 00 e3 92 9c 00 00 01 01 08 0a c8 34		 4
0040	0f d7 00 df 04 ab 00 00 95 00 01 00 00 00 01 7b		 {
0050	22 73 6d 50 6f 6c 69 63 79 53 6e 73 73 61 69 44			"smPolicySnssaiD
0060	61 74 61 22 3a 7b 22 32 2d 30 30 30 30 32 22			ata":{"2-000002"
0070	3a 7b 22 73 6d 73 73 61 69 22 3a 7b 22 73 73 74			:{"snssai": {"sst
0080	22 3a 32 2c 22 73 64 22 3a 22 30 30 30 30 32			":2,"sd": "000002"
0090	0090 22 7d 2c 22 73 6d 50 ef 6c 69 63 79 44 6e 6e 44			"},"smPolicyDnnD
00a0	61 74 61 22 3a 7b 22 64 6e 22 3a 22 64 6e 6e 63			ata":{"dnn_mbb.c
00b0	6f 6d 22 3a 7b 22 64 6e 22 3a 22 64 6e 6e 63			om":{"dnn_mbb.com", "subscC
00c0	6d 62 62 2e 63 6f 6d 22 2c 22 73 75 62 73 63 43			ats":["Bronze"]}}
00d0	61 74 73 22 3a 5b 22 42 72 6f 6a 7a 65 22 5d 7d			
00e0	7d 7d 7d 7d			

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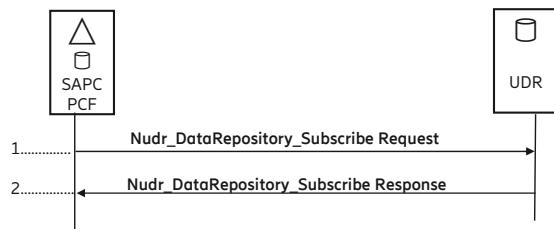
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SAPC 1 Operation and Configuration



Subscribe Operation (1/2)



- This service operation allows the SAPC PCF to subscribe to data change notifications, so that the SAPC PCF can receive notifications of data changes from the UDR.
- The precondition is that the PDU session or policy association has been already established for the subscriber.



1.The SAPC PCF sends a POST Nudr_DataRepository_Subscribe request with the PolicyDataSubscription data structure including the following attributes:

- notificationUri: URI provided by the SAPC PCF indicating where to receive the subscribed notification from the UDR
- monitoredResourceUris: a set of URIs that identifies the resources for which a modification triggers a notification

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Subscribe Operation (2/2)



2. The UDR returns an Nudr_DataRepository_Subscribe response with value 201Created with the message header containing the subsId.

Note:

If multiple PDU sessions are established between the SAPC PCF and SMFs for a subscriber, the SAPC PCF only performs the Subscribe operation once, corresponding to the first request



Nudr_DataRepository_Subscribe Request (PCF>UDR)

No.	Time	Source	Destination	Info
218	2020-05-14 04:19:59,...	192.168.12.40	192.168.14.42	HEADERS[5]: POST /nudr-dr/v2/policy-data/subs-to-notify, DATA[5] (application/json)
<				
> Header: :method: POST				
> Header: :scheme: http				
> Header: :authority: 192.168.14.42:8086				
> Header: :path: /nudr-dr/v2/policy-data/subs-to-notify				
> Header: content-length: 244				
> Header: content-type: application/json				
> Header: x-eric-u eid: imsi-460001234567891				
> Stream: DATA, Stream ID: 5, Length 244				
Length: 244				
Type: DATA (0)				
> Flags: 0x01				
0... = Reserved: 0x0				
.000 0000 0000 0000 0000 0000 0001 Stream Identifier: 5				
[Pad Length: 0]				
Data: 7b226e6f74696669636174696f6e557269223a2268747470...				
0099 32 cd 38 00 00 22 65 a6 dc 75 e7 c3 00 00 f4 00 2 8 - "e -u -----				
00a0 01 00 00 00 05 7b 22 6e 6f 74 69 66 69 63 61 74{'n otificat				
00b0 69 6f 60 55 72 69 22 3a 22 68 74 74 70 3a 2f 2f ionUri": "http://				
00c0 31 39 32 2e 31 36 38 2e 31 32 2e 34 30 3a 39 30 192.168. 12.40:90				
00d0 39 31 2f 6e 70 63 66 2d 73 6d 70 6f 6e 69 63 79 91/npcf- smpolicy				
00e0 63 6f 6a 74 72 6f 6c 2f 76 31 2f 63 61 6c 6c 62 control/ v1/callb				
00f0 61 63 6b 2f 6e 75 64 72 22 2c 22 6d 6f 6e 69 74 ack/nudr ", "monit				
0100 6f 72 65 64 52 65 73 6f 75 72 63 65 55 72 69 73 oredReso urceUris				
0110 22 3a 5b 22 2f 6e 75 64 72 2d 64 72 2f 76 32 2f ":"["/nud r-dr/v2/				
0120 70 6f 62 69 63 79 2d 64 61 74 61 2f 75 65 73 2f policy-d ata/ues/				
0130 69 6d 73 69 2d 34 36 30 30 30 31 32 33 34 35 36 imsi-460 00123456				
0140 37 38 39 31 2f 73 6d 2d 64 61 74 61 22 2c 22 2f 7891/sm- data", "				
0150 66 75 6d 72 2d 64 72 2f 76 32 2f 70 6f 6c 69 63 nudr-dr/ v2/polic				
0160 79 2d 64 61 74 61 2f 75 65 73 2f 69 6d 73 69 2d y-data/u es/imsi-				
0170 34 36 30 30 31 32 33 34 35 36 37 38 39 31 2f 46000123 4567891/				
0180 6f 70 65 72 61 74 6f 72 2d 73 70 65 63 69 66 69 operator -specifi				
0190 63 2d 64 61 74 61 22 5d 7d c-data"] }				

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Nudr_DataRepository_Subscribe Response (UDR>PCF) ≡

No.	Time	Source	Destination	Info
219	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	WINDOW_UPDATE[0]
220	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	HEADERS[5]: 201 Created
221	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	DATA[5] (application/json)

<

```
HyperText Transfer Protocol 2
Stream: HEADERS, Stream ID: 5, Length 55, 201 Created
Length: 55
Type: HEADERS (1)
Flags: 0x04
0.... .... .... .... .... .... = Reserved: 0x0
.000 0000 0000 0000 0000 0000 0101 = Stream Identifier: 5
[Pad Length: 0]
Header Block Fragment: 4e821003c26eaa62ab64b1692c63b898acf4189e9690691b...
[Header Length: 195]
[Header Count: 5]
Header: :status: 201 Created
Header: content-type: application/json
Header: location: /nudr-dr/v2/policy-data/subs-to-notify/imsi-460001234567891
Header: content-length: 244
Header: date: Thu, 14 May 2020 02:19:59 GMT
```

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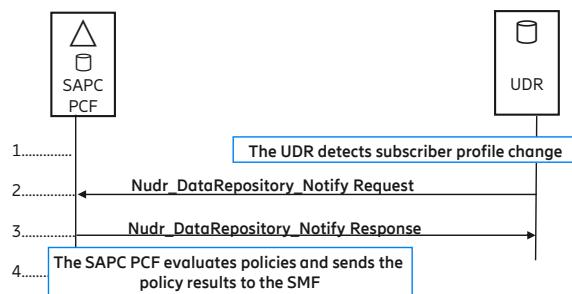
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Notify Operation (1/2)



- This service operation allows the UDR to send the data change notifications to the SAPC PCF when the UDR detects subscriber data changes.
- The precondition is that the SAPC PCF has subscribed to data change notifications from the UDR.



1. The UDR detects changes of the subscribed data.

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Notify Operation (2/2)



2. The UDR sends a POST Nudr_DataRepository_Notify message to the SAPC PCF with the PolicyDataChangeNotification data structure including the following attributes:

- smPolicyData: SM policy data, if changed
- ueId: represents the UE subscription identifier SUPI

3. The SAPC PCF returns an Nudr_DataRepository_Notify response with value 204 NoContent.

4. The SAPC PCF evaluates policies and sends the policy results to the SMF.

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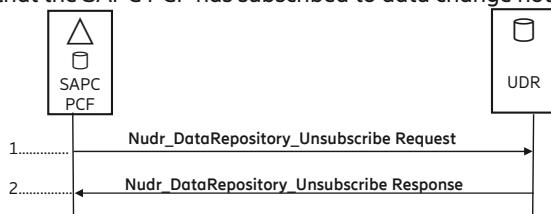
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Unsubscribe Operation



- This service operation allows the SAPC PCF to unsubscribe to the data change notifications, so that the SAPC PCF does not receive the notifications of data changes from the UDR.
- The precondition is that the SAPC PCF has subscribed to data change notifications from the UDR.



1. The SAPC PCF sends a DELETE Nudr_DataRepository_UnSubscribe request with the subsId to unsubscribe to data change notifications.

2. The UDR deletes the Subscription Correlation ID and returns an Nudr_DataRepository_UnSubscribe response with value 204 NoContent.

Note:

If multiple PDU sessions exist between the SAPC PCF and SMFs for a subscriber, the SAPC PCF only performs the Unsubscribe operation once, corresponding to the last terminationrequest.

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Nudr_DataRepository_Unsubscribe Request(PCF>UDR)≡

No.	Time	Source	Destination	Info
228	2020-05-14 04:19:59,...	192.168.12.40	192.168.14.42	SETTINGS[0], HEADERS[1]: DELETE /nudr-dr/v2/policy-data/subs-to-notify/imsi-460001234567891

<

```
✓ HyperText Transfer Protocol 2
  > Stream: SETTINGS, Stream ID: 0, Length 0
  ✓ Stream: HEADERS, Stream ID: 1, Length 68, DELETE /nudr-dr/v2/policy-data/subs-to-notify/imsi-460001234567891
    Length: 68
    Type: HEADERS (1)
  > Flags: 0x05
    0... .... .... .... .... .... = Reserved: 0x0
    .000 0000 0000 0000 0000 0000 0001 = Stream Identifier: 1
    [Pad Length: 0]
    Header Block Fragment: 420644454c45544586418d0be25c2e3cb85a5da15c780f39...
    [Header Length: 148]
    [Header Count: 4]
  > Header: :method: DELETE
  > Header: :scheme: http
  > Header: :authority: 192.168.14.42:8086
  > Header: :path: /nudr-dr/v2/policy-data/subs-to-notify/imsi-460001234567891
```

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Nudr_DataRepository_Unsubscribe Response(UDR>PCF)

No.	Time	Source	Destination	Info
229	2020-05-14 04:19:59,...	192.168.14.42	192.168.12.40	HEADERS[1]: 204 No Content

<

✓ HyperText Transfer Protocol 2
 ✗ Stream: HEADERS, Stream ID: 1, Length 38, 204 No Content
 Length: 38
 Type: HEADERS (1)
 > Flags: 0x05
 0... = Reserved: 0x0
 .000 0000 0000 0000 0000 0000 0001 = Stream Identifier: 1
 [Pad Length: 0]
 Header Block Fragment: 895f8b1d75d0620d263d4c7441ea6196df3dbf4a05a5340f...
 [Header Length: 95]
 [Header Count: 3]
 > Header: :status: 204 No Content
 > Header: content-type: application/json
 > Header: date: Thu, 14 May 2020 02:19:59 GMT

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UDR Error Handling



The SAPC PCF can answer with the following error code:

Error Condition	Action	Code
The SAPC PCF receives a request and the system is overloaded.	The SAPC PCF returns a response indicating an error directly.	503 Service Unavailable

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Chapter 3 Summary



After this chapter, the student should now be able to:

- Explain the advantages of SAPC PCF
- Describe the Session Management Policy Control in SAPC-PCF and the main traffic cases
- Explain the N7 interface signaling messages
- Describe the N15 interface signaling messages
- Outline the Nnrf interface signaling messages
- Review the N36 interface signaling messages

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Chapter 4 Objectives



On completion of this chapter, the participants will be able to:

- Understand the Policy Design functionality related to the SAPC application
- Explain the REST API interface and outline the REST API commands
- Describe the static and dynamic configuration categories
- Work with use cases related to Policy QoS & Charging Control
- Describe the provision of services in SAPC PCF
- Familiarize with the Policy Studio GUI
- Comprehend the monitoring key for Fair Usage Control

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Policy & Control Design Introduction



- The SAPC, as Policy Server gives network control regarding the SDF detection, gating, QoS, and flow-based charging towards the Policy and Charging Enforcement Function (PCEF) and/or Traffic Detection Function (TDF)
- Such policy control decision can be based on dynamic service input provided by the Application Function (AF), subscriber profile data managed by the Subscription Profile Repository (SPR), IP-CAN Session data reported by the PCEF, subscriber spending limits reported by the Online Charging System (OCS), or internal PCRF events (for example, timers)
- With the policy control management we can design use cases like the following and many more:
 - Bearer QoS Management
 - Access Control
 - Application Detection and Control (ADC)
 - Dynamic Policy Control for IMS Services (VoWifi, VoLTE) or non-IMS services (e.g. IPTV)
 - Policy Control Based on Spending Limits or Mobility

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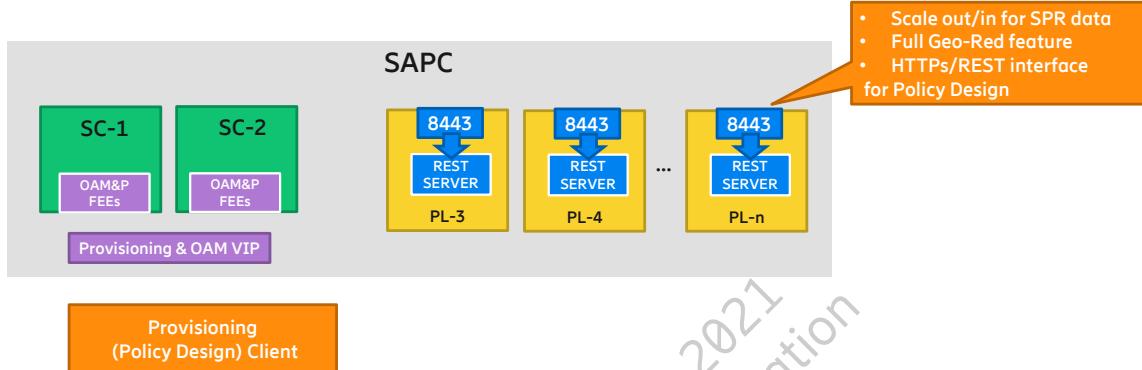
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REST Interface



- New provisioning interface for the Policy design configuration and provisioning
- LDAP provisioning interface has been replaced by REST API interface
- The SAPC uses REST API for provisioning of subscriber/policy design and service-related data. This interface handles the creation, retrieval, update, and deletion of the SAPC subscribers, subscriber groups, services, and policies information.



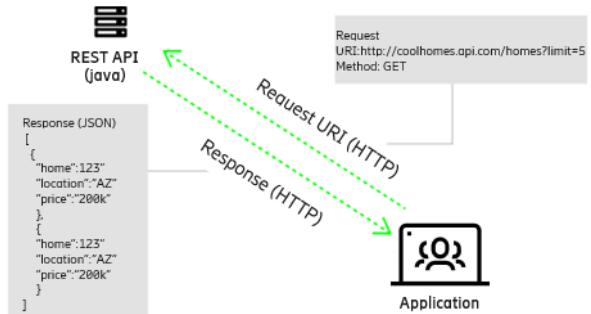
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What is REST?

- REST uses HTTP(S)
- There's a request and a response between a client to the API server
- The client and server can be based in any language (XML, JSON, Atom, RSS, CSV, HTML and more)
- REST APIs focus on resources (that is, things, rather than actions), and ways to access the resources. You access the resources through URLs (Uniform Resource Locations)
- The URLs are accompanied by a method that specifies how you want to interact with the resource
- Common methods include GET (read), POST (create), PUT (update), and DELETE (remove)



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Provisioning – RESTY



- A REST client, RESTY, is provided to perform the following operations:
 - GET (ldapsearch in LDAP)
 - PUT (ldapadd/ldapmodify in LDAP)
 - DELETE (ldapdelete in LDAP)
- RESTY is provided within SAPC installation and must be executed in a SC.
- It is used to make HTTPS requests based in URIs. There is no rollback operation upon the executed actions

How to connect:

```
sapcadmin@SC-1:~> resty https://$VIPP:$PORTP/provisioning/v1 -H "Content-Type: application/json" -k -u sapcprov:<password>
```

- Once logout from the SC, RESTY will disconnect.
- Detailed information about RESTY can be found in: Provisioning Tools CPI document

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Access to Provisioning Tools



```
SC-1:~ # ssh sapcadmin@10.57.156.195 (DefaultPassword: pokeMON123)
Last login: Wed Feb  8 10:51:25 2017 from 10.57.156.197
sapcadmin@SC-2:~>
sapcadmin@SC-2:~> resty https://10.57.156.196:8443/provisioning/v1 -H "Content-Type: application/json" -k -u sapcprov:pokeMON123
https://10.57.156.196:8443/provisioning/v1*
```

Example:

```
sapcadmin@SC-2:~> GET /rules
{"ids": ["r_Home_Access_only", "r_Vilte_Service", "r_Volte_Service"] }
sapcadmin@SC-2:~>
sapcadmin@SC-2:~> GET /subscribers/1111162000000
```

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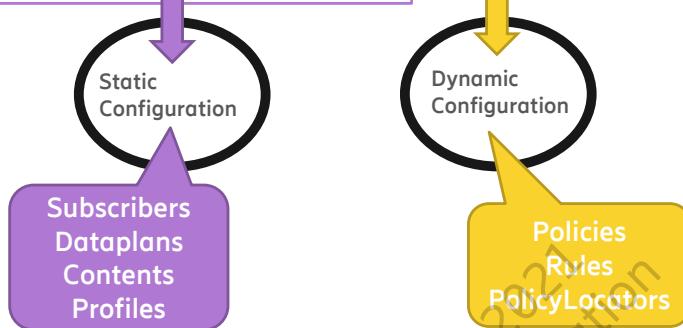
Configuration Concepts: Static – Dynamic



Objects that do not change dynamically like ex. ToD, location, RAT, Rx, deviceID etc.

- Subscriber is related to a provisioned ID
- Content describes an IP service flow (ex, dest IP/port etc.)
- Dataplan is a collection of subscribers with assigned allowed/disallowed Contents
- Profile is a template (Charging, QoS etc.)

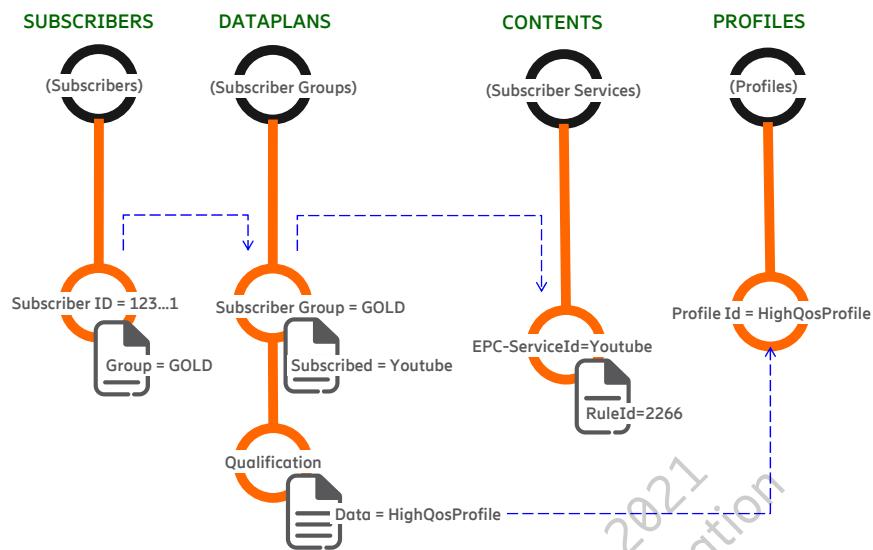
- Rule evaluates dynamic conditions (ex. is subscriber's access RAT 3GPP EPS?)
- Profile evaluates Rules (ex. If at least one rule is FALSE then disallow service)
- Locator correlates Static and Dynamic objects



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Static Configuration Overview



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Dynamic Configuration



Who?

One user, a group...

What?

The bearer, one service ...

When?

After 6pm,
roaming, ...

WHO is going to be
affected by the SAPC
defined dynamic
behavior

WHAT is going to be
affected by the SAPC
defined dynamic
behavior

WHEN is going to
take place the SAPC
defined dynamic
behavior

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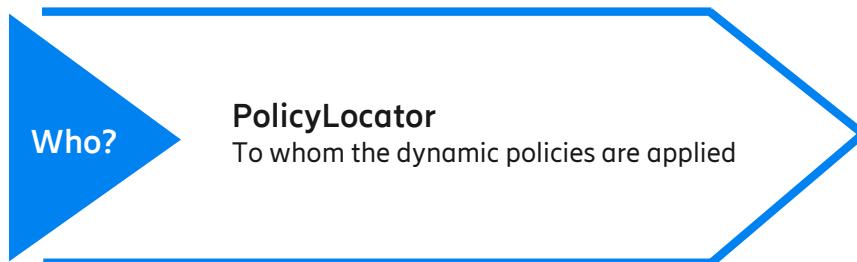


Dynamic Configuration - Who?



Policies on:

- Specific user
- Group of users
- All users



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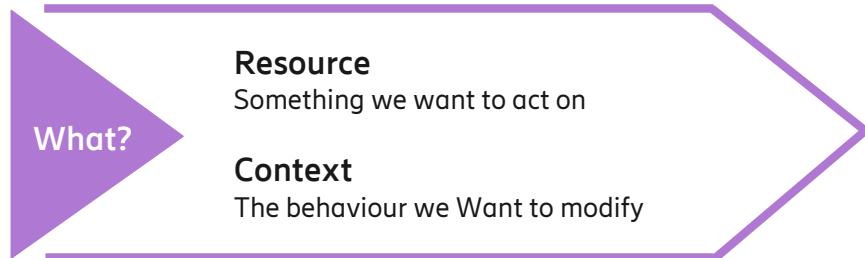
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Dynamic Configuration - What?

Resource Id Context Name

Any → event-triggers
any → location
any → charging
<contentId> → charging
<contentId> → static-access
<contentId> → access
ip-can-session → qos
ip-can-session → access

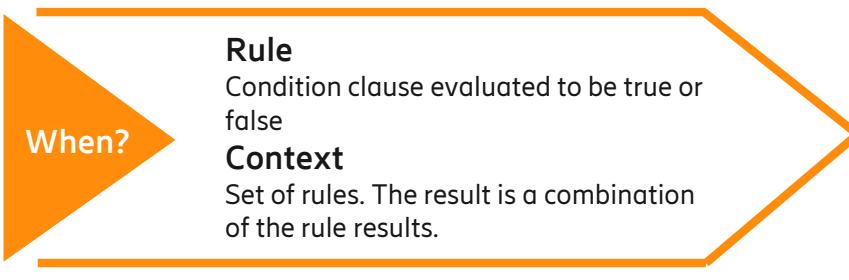


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Dynamic Configuration - When?



"now.time>18:00" \iff Rule: After6pm

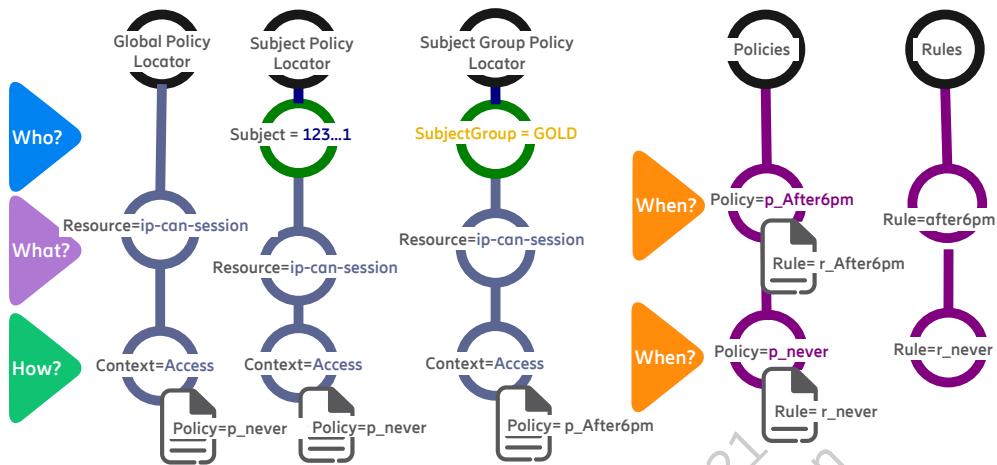
Rule Not Roaming
Rule After6pm
Rule UsingIPv6 } Policy: GoldGroupPolicy

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Dynamic Configuration Overview example



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Condition Formula Language examples



- The result is true if the subscriber ID is equal to 12345678 and has subscribed "service1" or "service2"
`(Subscriber.id == 12345678) && (Subscriber.subscribedServices[0] == "service1" ||
Subscriber.subscribedServices[1] == "service2")`
- The result is true if the current day is equal to 3 and the subscriber IP Address received in the service control request message is equal to 10.21.164.146
`(now.day == 3) && (AccessData.subscriber.ueIpAddress == "10.21.164.146")`
- The condition formula evaluation result is true if the string returned by the function is equal to "subs"
`StrDRight(Subscriber.id, AccessData.subscriber.id)== "subs"`
 - Regarding string values, the SAPC is case sensitive
- This condition formula evaluates to true from 17:30:01, until 18:29:59
`(now.time > "17:30") && (now.time < "18:30")`
- Next condition formula evaluates to true on weekends (Monday is 1, ..., Saturday is 6, Sunday is 7)
`(now.dayOfWeek == 6) || (now.dayOfWeek == 7)`

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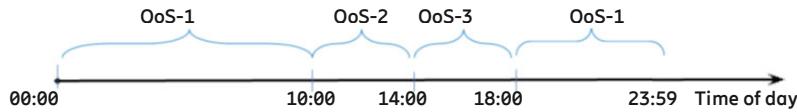
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Configuring Time of Day Conditions



- Here is provided an example of assigning 3 different QoS Profiles at different time periods:



- The following example shows (schematically) the contents of condition formula of 3 different rules for the different time periods:

Rule1 (QoS-1): `((now.time < "10:00") || (now.time > "17:59:59"))`

Rule2 (QoS-2): `((now.time > "09:59:59") && (now.time < "14:00"))`

Rule3 (QoS-3): `((now.time > "13:59:59") && (now.time < "18:00"))`

Note:

This example considers that Permit Overrides algorithm is used. The example has to be completed with the proper output attributes (for example to apply for Bearer QoS Control or another function), depending on the policy type used.



JSON data “Pretty Print”



The output of a resty command is a raw JSON. For example:

```
sapcprov@SC-1:~> GET /contents/100_http
{"contentName": "100_http", "pccRuleId": 100, "pccRuleType": 0}
```

SAPC provides an alias called pp that eases reading the JSON output

The alias pp, short for "pretty-print", indents and prettifies JSON data. For example:

```
sapcprov@SC-1:~> GET /contents/100_http | pp
{
    "contentName": "100_http",
    "pccRuleId": 100,
    "pccRuleType": 0
}
```

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Check Operation Results



Successful operation:

```
sapcprov@SC-1:~> GET /contents/100_http
{"contentName":"100_http","pccRuleId":100,"pccRuleType":0}
sapcprov@SC-1:~> echo $?
0
```

Non successful operation:

In this case the first digit of the response status is returned (that is, 4 for 4xx, 5 for 5xx, and so on)

```
sapcprov@SC-1:~> GET /contents/missing
{"error":{"code":404,"description":"Not found."}}
sapcprov@SC-1:~> echo $?
4
```

Status code	Description	Example
0	Success	N/A
4	Client Error	400 - Bad Request. The input JSON data is not valid
5	Server Error	500 - Internal Server Error. The server encountered an unexpected condition which prevented it from fulfilling the request

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Contents and pccRule types



- A Content describes a service IP flow. Those services are controlled by SAPC
- Those services can be
 - Static: Already known by the network (PCEF or SMF) and activated by SAPC, identified by the Charging-Rule-Name AVP or the Charging-Rule-Base-Name AVP
 - Charging-Rule-Base-Name AVP indicates the name of a predefined group of PCC rules residing at the PCEF
 - Charging-Rule-Name defines a name for PCC rule residing at the PCEF
 - Preconfigured: Locally set in the SAPC by the operator, downloaded from the SAPC towards the PCEF via Gx using the Charging-Rule-Definition AVP
 - Dynamic: Dynamically generated (and modified) in the SAPC from information coming from Rx Interface and the Application Function (AF) and also downloaded to PCEF using the Charging-Rule-Definition AVP
- Inside a content definition
 - pccRuleType 0 means Charging-Rule-Name, pccRuleType 1 means Charging-Rule-Base-Name
 - pccRuleType 2 means Preconfigured

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Contents and pccRules – Examples

```
PUT /contents/Streaming
{
    "contentName" : "Streaming",
    "flows" :
    [
        {
            "destIpAddr" : "any",
            "destPort" : "",
            "direction" : "dl",
            "flowName" : "1",
            "protocol" : "ip",
            "sourceIpAddr" : "192.168.1.2",
            "sourcePort" : "5001-5050"
        },
        {
            "destIpAddr" : "any",
            "destPort" : "",
            "direction" : "dl",
            "flowName" : "2",
            "protocol" : "ip",
            "sourceIpAddr" : "192.168.1.2",
            "sourcePort" : "5101-5150"
        }
    ],
    "pccRuleName" : "4033",
    "pccRuleType" : 2,
    "staticQualification" :
    [
        {
            "contentChargingProfileId" : "cp_streaming"
        }
    ]
}

PUT /contents/Chat
{
    "contentName" : "Chat",
    "pccRuleName" : "1000",
    "pccRuleType" : 0
}

PUT /contents/Internet
{
    "contentName" : "Internet",
    "pccRuleName" : "2000",
    "pccRuleType" : 1
}
```

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PCC Rule Types 0 or 1 – Example in Policy Studio

Contents > Chat > edit

Chat

Basic information

Description

Add a brief description of the content

PCC Rules

PCC Rule Name: 1000

PCC Rule Type:

- Static using name
- Static using basename

View code

Chat

PUT: /contents/Chat

```
1 ~ [ "contentName": "Chat",  
2   "pccRuleName": "1000",  
3   "pccRuleType": 0  
4 ]
```

Contents > create

Internet

Basic information

Description

Add a brief description of the content

PCC Rules

PCC Rule Name: 2000

PCC Rule Type:

- Static using name
- Static using basename

View code

Internet

PUT: /contents/Internet

```
1 ~ [ "contentName": "Internet",  
2   "pccRuleName": "2000",  
3   "pccRuleType": 1  
4 ]
```

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PCC Rule Type 2 example in Policy Studio

The screenshot shows the Policy Studio interface for a PCC Rule named 'Streaming2'. The rule is of type '(2) Other'. It includes a 'Content charging profile' section with a single entry for 'cp.streaming'. This profile has a 'Charging control' section with a 'Rating Group' set to '3'. Under 'Reporting Level', it shows '(0) Charging Rule level' and '(0) Duration'. The 'Charging Method' section indicates both 'Online Enabling' and 'Offline Enabling' are disabled. On the right, a 'View code' panel displays the JSON configuration for the rule:

```
1 {  
2   "contentName": "Streaming2",  
3   "pccRuleName": "4033",  
4   "pccRuleType": "(2) Other",  
5   "staticClassification": [  
6     {"contentchargingProfileId": "cp.streaming"}  
7   ],  
8   "flows": [  
9     {  
10       "flowName": "1",  
11       "sourceIpAddress": "192.168.1.2",  
12       "destIpAddress": "any",  
13       "protocol": "ip",  
14       "direction": "dl",  
15       "sourcePort": "5001-5050"  
16     },  
17     {  
18       "flowName": "2",  
19       "sourceIpAddress": "192.168.1.2",  
20       "destIpAddress": "any",  
21       "protocol": "ip",  
22       "direction": "ul",  
23       "sourcePort": "5101-5150"  
24     }  
25   ]  
26 }
```

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Dynamic Rules Trace example



```
29 13.630085 10.0.1.20      10.0.1.6      DIAMETER      698 cmd=Re-Auth Request(258) flags=RP-- appl=3GPP Gx|  
  < AVP: Charging-Rule-Definition(1003) l=396 f=VM- vnd=TGPP  
    AVP Code: 1003 Charging-Rule-Definition  
    > AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set  
    AVP Length: 396  
    AVP Vendor Id: 3GPP (10415)  
  < Charging-Rule-Definition: 000003edc00000f000028af3130300000001ff00000010...  
    > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=100  
    > AVP: Flow-Status(511) l=16 f=VM- vnd=TGPP val=ENABLED (2)  
    > AVP: Precedence(1010) l=16 f=VM- vnd=TGPP val=250  
  < AVP: Flow-Description(507) l=55 f=VM- vnd=TGPP val=permit in ip from 10.1.1.27 to 10.0.4.22 80  
    AVP Description: permit in ip from 10.1.1.27 to 10.0.4.22 80  
    AVP Padding: 00  
  < AVP: Flow-Description(507) l=56 f=VM- vnd=TGPP val=permit out ip from 10.0.4.22 80 to 10.1.1.27  
    AVP Code: 507 Flow-Description  
    > AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set  
    AVP Length: 56  
    AVP Vendor Id: 3GPP (10415)  
    Flow-Description: permit out ip from 10.0.4.22 80 to 10.1.1.27  
  < AVP: QoS-Information(1016) l=88 f=VM- vnd=TGPP  
    AVP Code: 1016 QoS-Information  
    > AVP Flags: 0xc0, Vendor-Specific: Set, Mandatory: Set  
    AVP Length: 88  
    AVP Vendor Id: 3GPP (10415)  
  < QoS-Information: 00000404.0000010000028af0000000600000203c0000010...  
    > AVP: QoS-Class-Identifier(1028) l=16 f=VM- vnd=TGPP val=QCI_6 (6)  
    > AVP: Max-Requested-Bandwidth-DL(515) l=16 f=VM- vnd=TGPP val=5000000  
    > AVP: Max-Requested-Bandwidth-UL(516) l=16 f=VM- vnd=TGPP val=5000000  
    > AVP: Allocation-Retention-Priority(1034) l=28 f=VM- vnd=TGPP  
  < AVP: Flow-Information(1058) l=68 f=VM- vnd=TGPP  
    AVP Code: 1058 Flow-Information  
    > AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set  
    AVP Length: 68  
    AVP Vendor Id: 3GPP (10415)  
  < Flow-Information: 000001fb0000037000028af7065726d697420696e206970...
```

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Gx Interface Description

Ericsson Service-Aware Policy Controller

AVP Name	AVP Code	Comment	Reference
[AF-Charging-Identifier]	995	-	3GPP TS 29.212
[AF-Signalling-Protocol]	529	-	3GPP TS 29.212
[Charging-Rule-Name]	1005	-	3GPP TS 29.212
The SAPC sends the following AVPs:			
*[Flow-Information]	1058	- [Flow-Description] - [Flow-Direction]	3GPP TS 29.212
[Flow-Status]	511	The SAPC sets it to ENABLED for preconfigured PCC rules. The SAPC sends the value received from Rx interface for dynamic PCC rules.	3GPP TS 29.212
*[Flows]	510	-	3GPP TS 29.212
[Metering-Method]	1007	It is configured in the SAPC at service level.	3GPP TS 29.212
[Monitoring-Key]	1004	The specific value "\x32\x0f" (non-printable characters) indicates to the PCRF to remove the association of the monitoring key and the service (Charging Rule).	3GPP TS 29.212
[Mute-Notification]	2809	-	3GPP TS 29.212
[Offline]	1008	It is set in the SAPC at service level.	3GPP TS 29.212
[Online]	1009	It is set in the SAPC at service level.	3GPP TS 29.212
[Precedence]	1010	See Precedence AVP.	3GPP TS 29.212
[QoS-Information]	1016	It can be set in the SAPC at service level or derived from AF information.	3GPP TS 29.212
[Rating-Group]	452	It is set in the SAPC at service level.	RFC 4006
The SAPC sends the following AVPs:			
[Redirect-Information]	1065	- [Redirect-Address-Type] - [Redirect-Gateway-Address]	3GPP TS 29.212
*[Required-Access-Info]	536	The SAPC sends this AVP only when the AF requests the SAPC to report Access Network Information.	3GPP TS 29.212
[Reporting-Level]	1011	The SAPC supports the following values: - SERVICE_IDENTIFIER_LEVEL (0) - RATING_GROUP_LEVEL (1)	3GPP TS 29.212
[Service-Identifier]	499	It is configured in the SAPC at service level.	RFC 4006
[TDF-Application-Identifier]	1088	It is configured in the SAPC at service level.	3GPP TS 29.212

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Policy Design example Use Case



Let's create a subscriber and a dataplan

```
PUT /subscribers/34600000001
{
    "subscriberId" : "34600000001"
    "dataplans": [ { "dataplanName": "Gold" } ]
}
```

```
PUT /dataplans/Gold
{
    "dataplanName" : "Gold"
}
```

And a content (a service identifier)

```
PUT /contents/Streaming
{
    "contentName" : "Streaming",
    "pccRuleName" : "500",
    "pccRuleType" : 0
}
```

The use case is:

- The "Streaming" service is authorized dynamically for Dataplan if access is through EPS Radio Access
- If the condition is not fulfilled, the service is not authorized (and the SAPC includes the non-authorization code 6 (Operator reason 1) in the answer in case of Gx+)

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Policy Design Use Case – Dataplan/Content/Access



Rule:

```
PUT /rules/SAuth_Streaming_AccessBased
{
    "condition" : "#( (AccessData.bearer.accessType==1004) , 6 )",
    "ruleName" : "SAuth_Streaming_AccessBased"
}
```

Policy:

```
PUT /policies/SAuth_Streaming_Policy
{
    "policyName" : "SAuth_Streaming_Policy",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "SAuth_Streaming_AccessBased" ]
}
```

Relate the Dataplan to Content and Access policy, using a locator:

```
PUT /dataplans/Gold/locators/resources/Streamingcontexts/access
{
    "policies" : [ " SAuth_Streaming_Policy " ]
}
```

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Policy Studio example for the same Use Case



The screenshot shows the Policy Studio interface for a Dataplan named "Gold". The "Information" tab is selected. In the "Dataplan summary" section, the "Policies (1)" checkbox is checked. The "Policies by locator" table shows one policy for the locator "access.Streaming" with context "access", resource "Streaming", and algorithm "Permit overrides or Deny overrides". The "Expected output" is "No return value". The "List of policies" section shows a single policy named "SAuth_Streaming_Policy". This policy has one rule named "SAuth_Streaming_AccessBased". The rule information shows the condition: `1 #((AccessData.bearer.accessType == 1004), 6)`.

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Also verify with Resty

```
sapcadmin@SC-1:~> GET /dataplans/Gold/locators/resources/Streaming-contexts/access
{"policies":["SAuth_Streaming_Policy"]}
sapcadmin@SC-1:~> GET /policies/SAuth_Streaming_Policy | pp
{
    "policyName": "SAuth_Streaming_Policy",
    "ruleCombiningAlgorithm": "permit-overrides",
    "rules": [
        "SAuth_Streaming_AccessBased"
    ]
}
sapcadmin@SC-1:~> GET /rules/SAuth_Streaming_AccessBased
{"ruleName":"SAuth_Streaming_AccessBased","condition":"#((AccessData.bearer.accessType==1004),6)"}
sapcadmin@SC-1:~> GET /dataplans/Gold
{"dataplanName":"Gold","globalScope":false}

sapcadmin@SC-1:~> GET /subscribers/34600000001
{"subscriberId":"34600000001"}
sapcadmin@SC-1:~> GET /subscribers/34600000001
{"subscriberId":"34600000001","dataplans":[{"dataplanName":"Gold"}]}
sapcadmin@SC-1:~> GET /subscribers/34600000001|pp
{
    "dataplans": [
        {
            "dataplanName": "Gold"
        }
    ],
    "subscriberId": "34600000001"
}
sapcadmin@SC-1:~> GET /dataplans/Gold
{"dataplanName":"Gold","globalScope":false}
sapcadmin@SC-1:~>
```

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Another Use Case – QoS Control for a Service

```
PUT /rules/QoS_Streaming_OTHER
{
  "condition" : "AccessData.bearer.accessType!=1000",
  "outputAttributes" :
  [
    {
      "attrName" : "qos",
      "attrValue" :
      "ServiceQosProfile[\"QosProfile_Streaming_OTHER\"],
      "result" : "permit" }],
    "ruleName" : "QoS_Streaming_OTHER"
  }

PUT /rules/QoS_Streaming_UTRAN
{
  "condition" :
  "AccessData.bearer.accessType==1000",
  "outputAttributes" :
  [
    {
      "attrName" : "qos",
      "attrValue" :
      "ServiceQosProfile[\"QosProfile_Streaming_UTRAN\"],
      "result" : "permit" }],
    "ruleName" : "QoS_Streaming_UTRAN"
  }

PUT /policies/QoS_Streaming
{
  "policyName" : "QoS_Streaming",
  "ruleCombiningAlgorithm" : "permit-
overrides",
  "rules" : [ "QoS_Streaming_UTRAN",
  "QoS_Streaming_OTHER" ]
}

PUT
/dataplans/Gold/locators/resources/Streaming/context
s/qos
{
  "policies" : [ "QoS_Streaming" ]
}

PUT /dataplans/Gold
{
  "dataplanName" : "Gold",
  "subscribedContents" :
  [
    {
      "contentName" : "Streaming",
      "redirect" : false
    }
  ]
}
```

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Use Case in Policy Studio sample

The screenshot shows two windows from the Policy Studio interface:

- Policies > QoS_Streaming**: This window displays a policy named "QoS_Streaming". It includes sections for "Information" and "Schema (beta)". Under "Policy information", it shows "Rule evaluation: Permit overrides" and "Output type: Profile / Content QoS". The "Rules" section contains two entries:
 1. **QoS_Streaming_UTRAN**: Rule information: `AccessData.bearer.accessType == 1000`. Output: Profile / Content QoS. QoSProfile_Streaming_UTRAN: Guaranteed Bit Rate (GBR) - Downlink: 3.67 Mbit/s, Uplink: 1.54 Mbit/s; Maximum Bit Rate (MBR) - Downlink: 4.10 Mbit/s, Uplink: 2.05 Mbit/s.
 2. **QoS_Streaming_OTHER**: Rule information: `AccessData.bearer.accessType != 1000`.
- Dotaplays > Gold > edit**: This window shows a policy named "Gold". It has tabs for "Locator", "Context", "Resource", "Expected rule combining algorithm", and "Expected output". The "List of policies" section shows the "QoS_Streaming" policy under "1".

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Permit – Deny Overrides in a Policy



- How to select the result of the rules associated to one policy?
- The output attributes returned are the ones associated to the rule that determined the result
- Algorithms for decision:
 - Single result: when only one result of all the rules within the policy is returned, and there are results contradictory for a resource:
 - Permit overrides: the result is "permit", if any rule evaluates to permit
 - Deny overrides: the result is "deny" if any rule evaluates to deny
 - Multiple result: when it is wanted that all the rules of a policy are evaluated, use all permit algorithm. In that case, the output attributes of all the rules that evaluates to permit are returned
 - This could be used for example in a notification related policy
- For example, if we want to allow a service only if SGSN IP is 1.2.3.4 AND TerminalModel is "X123", then we use a "deny-overrides" which means that if any of the conditions is not fulfilled, the service is not authorized

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Multimedia Telephony IMS – Dynamic Policy Control



- Standard requirements for IMS conversational voice or video
- The conversational video service is an extra complement to a conversational voice service in IMS
- It can be added or removed by the end user during an ongoing session or can be established together with voice media at initial call establishment
- Ericsson recommends to provision two different dynamic services (VoLTE and ViLTE) that are activated according to the media component information received from the AF
- A dedicated bearer is set up for audio with QCI=1 and another dedicated bearer for video with QCI=2
- This example is useful to understand the dynamic policy control part, i.e. how contents (services) are dynamically assigned based on dynamic conditions, in this case a call coming from the IMS

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Multimedia Telephony IMS – Dynamic Policy Control

```
PUT /contents/service_ViLTE
{
    "contentName" : "service_ViLTE",
    "staticQualification" :
    {
        "contentQosProfileId" :
    "QoS_ViLTE"
    }
}

PUT /contents/service_VoLTE
{
    "contentName" : "service_VoLTE",
    "staticQualification" :
    {
        "contentQosProfileId" :
    "QoS_VoLTE"
    }
}

PUT /profiles/content-qos/QoS_ViLTE
{
    "arpPriorityLevel" : 7,
    "profileId" : "QoS_ViLTE",
    "qci" : 2
}

PUT /profiles/content-qos/QoS_VoLTE
{
    "arpPriorityLevel" : 6,
    "profileId" : "QoS_VoLTE",
    "qci" : 1
}

PUT /rules/rule_ViLTE
{
    "condition" : "((AfData.appId ==\"%3A3gpp-
service.ims.icsi.mmtel\") &&
&&(AfData.media.type==\"video\"))",
    "outputAttributes" : [
        {
            "attrName" : "service",
            "attrValue" : "\"service_ViLTE\"",
            "result" : "permit"
        }],
    "ruleName" : "rule_ViLTE"
}
```

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Multimedia Telephony IMS – Dynamic Policy Control

```
PUT /policies/policy_ViLTE
{
    "policyName" : "policy_ViLTE",
    "ruleCombiningAlgorithm" : "single-match",
    "rules" : [ "rule_ViLTE" ]
}

PUT /rules/rule_VoLTE
{
    "condition" : "((AfData.appId == \"%3A3gpp-
service.ims.icsci.mmtel\") && (AfData.media.type==\"audio\"))",
    "outputAttributes" : [
        {
            "attrName" : "service",
            "attrValue" : "\"service_VoLTE\"",
            "result" : "permit"
        }
    ],
    "ruleName" : "rule_VoLTE"
}

PUT /policies/policy_VoLTE
{
    "policyName" : "policy_VoLTE",
    "ruleCombiningAlgorithm" : "single-match",
    "rules" : [ "rule_VoLTE" ]
}

PUT /policies/policy_VoLTE_ViLTE
{
    "policyName" : "policy_VoLTE_ViLTE",
    "ruleCombiningAlgorithm" : "single-match",
    "rules" : [ "rule_VoLTE", "rule_ViLTE" ]
}

PUT
/locators/resources/application/contexts/service-
classification
{
    "policies" : [ "policy_VoLTE", "policy_ViLTE",
    "policy_VoLTE_ViLTE" ]
}
```

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Call from IMS – Policy Control in SAPC

- Note the AF-AppID that was configured in the rules previously
- Also the Media-Type
- This comes from IMS (SBC)
- Note also immediately after the AA request/answer from Rx: the RAR towards the PCEF requesting for the dedicated bearer for this call

The Wireshark capture shows the following sequence of messages:

- 16. 15.558... 10.248.59.17 10.248.143.132 DIAMETER 330 cmd=Credit-Control Answer(272) flags=-P-- appl=3GPP Gx(16777236) h2h=100...
- 17. 26.999... 10.248.143.36 10.248.59.17 DIAMETER 938 cmd=AA Request(265) flags=R-- appl=3GPP Rx(16777236) h2h=100...
- 18. 27.005... 10.248.59.17 10.248.143.36 DIAMETER 286 cmd=AA Answer(265) flags=-P-- appl=3GPP Rx(16777236) h2h=100...
- 19. 27.010... 10.248.59.17 10.248.143.132 DIAMETER 12... cmd=Re-Auth Request(258) flags=R-- appl=3GPP Gx(16777238) h2h=...
- 20. 27.024... 10.248.143.1... 10.248.59.17 DIAMETER 322 cmd=Re-Auth Answer(258) flags=-P-- appl=3GPP Gx(16777238) h2h=...
- 21. 28.151... 10.248.143.36 10.248.59.17 DIAMETER 990 cmd=AA Request(265) flags=R-- appl=3GPP Rx(16777236) h2h=200...

Details of the AA Request message (Message 17):

- > AVP: Session-Id(263) l=77 f=M val=r...
- > AVP: Auth-Application-Id(258) l=12 f=M- val=3GPP Rx (16777236)
- > AVP: Origin-Host(264) l=43 f=M- val=rx.test-sbg01
- > AVP: Origin-Realm(296) l=29 f=M- val=test.ims2
- > AVP: Destination-Realm(283) l=41 f=M- val=epc.mnc01.mcc01.3gppnetwork.org
- > AVP: Media-Component-Description(517) l=532 f=VM- vnd=TGPP
AVP Code: 517 Media-Component-Description
AVP Flags: 0x0, Vendor-Specific: Set, Mandatory: Set
AVP Length: 532
AVP Vendor Id: 3GPP (10415)
- > AVP: Media-Component-Description: 00000206c0000010000028af0000000100000207c00000c0...
- > AVP: Media-Component-Number(518) l=16 f=VM- vnd=TGPP val=1
- > AVP: Media-Sub-Component(519) l=192 f=VM- vnd=TGPP
- > AVP: Media-Sub-Component(519) l=192 f=VM- vnd=TGPP
- > AVP: AF-Application-Identifier(504) l=70 f=VM- vnd=TGPP val=g.3gpp.icsi-ref=urn:n3gpp-service.ims.icsi.mmTEL
- > AVP: Media-Type(520) l=16 f=VM- vnd=TGPP val=AUDIO (0)
- > AVP: Max-Requested-Bandwidth-UL(516) l=16 f=VM- vnd=TGPP val=41000
- > AVP: Max-Requested-Bandwidth-DL(515) l=16 f=VM- vnd=TGPP val=41000
- > AVP: AF-Charging-Identifier(505) l=63 f=VM- vnd=TGPP val=test-sbg01.test.ims2
- > AVP: Framed-IP-Address(8) l=12 f=M- val=10.248.5.34
- > AVP: Route-Record(282) l=43 f=M- val=...

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Import JSON to Policy Studio

The screenshot illustrates the steps to import a JSON configuration file into Policy Studio:

1. The JSON file 'newrule.json' is selected in a file explorer window.
2. The 'Import' button is clicked in the Policy Studio interface.
3. A file selection dialog shows the path 'This PC' and the file 'newrule.json'.
4. The 'Import' button is clicked in the dialog.
5. A confirmation message 'newrule.json has been successfully imported' is displayed.

On the left, the Policy Studio interface shows the 'TestRule2' rule configuration, including its conditions, output attributes, and QoS settings.

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CPI library examples easy implementation!

1. Configuration Guide for Access and Charging Control (Gx)

```
dynamic_event_trigger.json
{
    "rules": [
        {
            "condition": "(AccessData.bearer.accessType==1000)",
            "outputAttributes": [
                {
                    "attrName": "event-triggers",
                    "attrValue": "\\"13,48\\",
                    "result": "permit"
                }
            ],
            "ruleName": "DynamicEventTriggersSubscriber"
        }
    ]
}
```

2. Policy Studio

3. DynamicEventTriggersSubscriber

Rule information

```
1 { AccessData.bearer.accessType == 1000 }
```

Output: Event triggers

(13) User location change | Service area location change, (48) Change of UE presence reporting area report

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Policy Studio – Commit / Workspace mode

The screenshot shows the SAPC Policy Studio interface. At the top, there's a toolbar with icons for file operations and a dropdown for 'SAPC05'. Below the toolbar, a message box titled 'Changing mode to Commit' appears, stating 'Changes in this mode will be directly committed to SAPC05'. There are 'Cancel' and 'Continue' buttons. The main area shows a table of policy objects with columns for Type, Last modified by, and Last modified time. The table includes rows for 'Content charging', 'Content', and 'Content'. The bottom of the screen shows a navigation bar with 'Policies > testPolicy' and a toolbar with icons for edit, commit, and search.

- You can work in workspace mode where you can fully control which changes will be committed
- You press commit after creating/importing when you are sure that you want to apply your object
- Only when you change the mode to "commit mode" the changes will be directly committed to the SAPC after every import or creation/modification etc. !
- So you can easily import and work with any configuration before applying any changes !

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Usage help

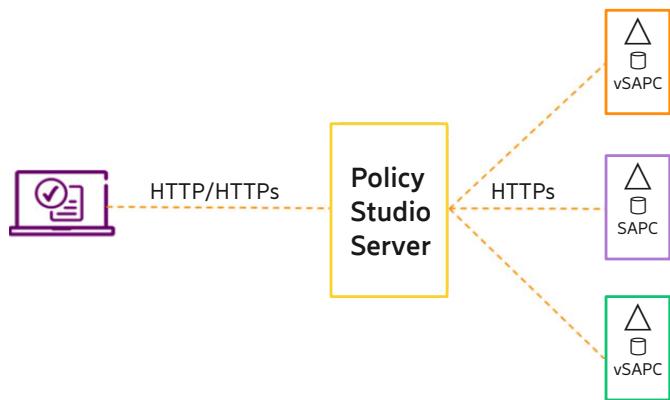
The screenshot shows the Policy Studio Help Center interface. It includes several sections:

- Workspace and Commit modes guide:** Explains the two modes: Workspace mode (a draft environment) and Commit mode (directly applying changes). It also details how to switch between modes.
- What is Policy Studio?**: Describes Policy Studio as a graphical user interface for provisioning SAPC in a graphical, intuitive, and easy way. It mentions it is the main client of the SAPC provisioning REST API.
- Policy Studio key icons:** A legend mapping icons to object types: Dataplans, Policies, Contents, Profiles, Rules, Locators, Global policies, Subscribers, Shared dataplans, Rule spaces, and Operator specific infos.
- Validation status guide:** Lists validation indicators:
 - 5G_Bronze3 Item with problems**: The object with this indicator has problems.
 - 5G_Bronze3 Not in use**: The object is not in use in this configuration.
 - 5G_Bronze3 Not found**: This object does not exist in this configuration.
- Workspace and Commit modes guide**, **What is a local change?**, **How do I compare what I have in Workspace and Commit mode?**, and **Do you need more help?** are also visible.

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Policy Studio works with multiple SAPC instances



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Settings and Node Administration



The screenshot shows two windows from the Policy Studio application. The top window is titled 'Node administration' and displays a list of nodes. It shows one node named 'SAPC05' selected, with its details: Domain/IP address '10.36.187.169' and Port '8443'. Below the list are buttons for 'Edit', 'Delete', and 'Test connectivity'. The bottom window is a 'Create Node' dialog box. It has fields for 'Node Name' (set to 'SAPC05'), 'Provisioning username' (set to 'Admin'), 'Domain/IP address' (empty), 'Provisioning password' (empty), 'Port' (empty), and 'Server certificate' (with 'Choose file' and 'Add certificate' buttons). A 'Test connectivity' button is also present. Both windows have a header bar with the SAPC logo, version 'v2.0.0', and user 'Admin'.

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Monitoring Key – Fair Usage Overview



- This feature enables the SAPC to monitor usage for preconfigured and dynamic services by associating with the Monitoring Key (3GPP TS 29.212)
- Each Service that is to be monitored has an associated monitoring “key”
- The SAPC specifies the data to be reported by including the usage monitoring key for each set of data being monitored within a Monitoring-Key AVP within the Usage-Monitoring-Information AVP
- The operator can provision Monitoring Keys unconditionally or configure Monitoring Key Selection policies to associate the Monitoring Keys with services
- Monitoring key can be selected dynamically at IP-CAN session establishment, modification and reauthorization and AF session establishment and modification (CCA, RAR, or RAA messages)
- Fair usage related policy tags can be used at reporting group level for service authorization, qualification, QoS control and bandwidth management

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Statically associated monitoring key to service



```
PUT /contents/108
{
    "contentName" : "108",
    "flows" :
    [
        {
            "destIpAddr" : "any",
            "destPort" : "",
            "direction" : "dl",
            "flowName" : "1",
            "protocol" : "ip",
            "sourceIpAddr" : "10.220.100.1",
            "sourcePort" : "1000"
        },
        "pccRuleName" : "108",
        "pccRuleType" : 2,
        "staticQualification" :
        {
            "contentChargingProfileId" : "charg_prof_preconf_group3",
            "contentMonitoringKey": "home_chat"
        }
    }
}
```

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Dynamically associated monitoring key to service



```
PUT /dataplans/VoLTE_ims_group/locators/resources/MMTel_audio/contextes/monitoring-key
{
    "policies" : [ "pMK_HomeChat" ]
}
PUT /policies/pMK_HomeChat
{
    "policyName" : "pMK_HomeChat",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "rMK_HomeChat" ]
}
PUT /rules/rMK_HomeChat
{
    "condition" : "((StrDRight(AfData.appId,\\"urn%3Aurn-7\\")=="%3A3gpp-service.ims.icsi.mmtel\")
    ||(StrDRight(AfData.appId,\\"urn%3Aurn-7\\")=="3gppservice.ims.icsi.mmtel \")
    ||(substr(AfData.appId,29,30)=="%3A3gpp-service.ims.icsi.mmtel\") ||(substr(AfData.appId,29,28)=="3gpp-
    service.ims.icsi.mmtel\")) &&(AfData.media.type=="audio\""),
        "outputAttributes" :
        [
            {
                "attrName" : "monitoring-key",
                "attrValue" : "\"home_chat\"",
                "result" : "permit"
            }
        ],
    "ruleName" : "rMK_HomeChat"
}
```

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Chapter 4 Summary



After this chapter, the student should now be able to:

- Understand the Policy Design functionality related to the SAPC application
- Explain the REST API interface and outline the REST API commands
- Describe the static and dynamic configuration categories
- Work with use cases related to Policy QoS & Charging Control
- Describe the provision of services in SAPC PCF
- Familiarize with the Policy Studio GUI
- Comprehend the monitoring key for Fair Usage Control

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SAPC Configuration



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Chapter 5 Objectives



On completion of this chapter, the participants will be able to:

- Understand basic configuration and Managed Object Model object hierarchy and relationships
- Outline the security management and user authentication and authorization
- Comprehend the Geo-Redundancy active/standby and active/active scenarios
- Explore the configuration parameters for Geo Redundancy

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SAPC Definition (1/6)



The purpose of those SAPC definition slides is to understand better the class OAM CLI tool, the MOM object relationships, as well as the basic functions and how they are configured using the CLI

STEP 1:

A new SAPC is going to be deployed. The first step is to take a blank backup:

```
ManagedElement=1, SystemFunctions=1, BrM=1, BrmBackupManager=SYSTEM_DATA  
createBackup PCRF_BLANK_10122017  
show progressReport
```

STEP 2:

```
ManagedElement=SAPC1) >show  
ManagedElement=SAPC1  
    networkManagedElementId="SAPC1"  
    siteLocation="Kista"  
    userLabel="SAPC1"  
    Equipment=1  
    JavaCaf=1  
    PolicyControlFunction=1  
    SystemFunctions=1  
    Transport=1  
(ManagedElement=SAPC1) >
```

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SAPC Definition (2/6)



STEP 3: Configure NTP , if not configured via adapt_cluster.cfg file (for SAPC deployment)

```
ManagedElement=SAPC1, SystemFunctions=1, SysM=1, TimeM=1, Ntp=1  
(Ntp=1)>show -r  
Ntp=1  
    NtpServer=0  
        administrativeState=UNLOCKED  
        serverAddress="10.1.25.10"  
    NtpServer=NTPServer1  
        administrativeState=UNLOCKED  
        serverAddress="10.253.2.5"  
        userLabel="Primary NTP server for SAPC1"  
    NtpServer=NTPServer2  
        administrativeState=UNLOCKED  
        serverAddress="10.253.2.6"  
        userLabel="Secondary NTP server for SAPC1"  
(Ntp=1)>
```

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SAPC Definition (3/6)



STEP 4:

SNMP config is autopushed by ENM as below , nothing needs to be done for that except reachability to ENM server

```
ManagedElement=SAPC1, SystemFunctions=1, SysM=1, Snmp=1  
(Snmp=1)>show -r  
Snmp=1  
    operationalState=ENABLED  
    agentAddress  
        host="0.0.0.0"  
        port=161  
    SnmpTargetV3=ENMFM  
        address="10.30.14.7"  
        authKey="1:2j6IsaLLp+qfAhixgArB2g7fvIshciUB"  
        operationalState=ENABLED  
        privKey="1:2j6IsaLLp+qfAhixgArB2g7fvIshciUB"  
        user="ENMFM"  
(Snmp=1)>
```

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SAPC Definition (4/6)



STEP 5: Configure Event Trigger

```
ManagedElement=SAPC1,PolicyControlFunction=1,AppConfig=1  
(AppConfig=1)>show -r  
AppConfig=1  
  PccConfig=1  
    eventTriggers  
      SUCCESSFUL_RESOURCE_ALLOCATION  
      SGSN_CHANGE  
      PLMN_CHANGE  
      RAT_CHANGE  
      IP_CAN_CHANGE  
      AN_GW_CHANGE  
      ACCESS_NETWORK_INFO_REPORT  
      RAI_CHANGE  
      DEFAULT_EPS_BEARER_QOS_CHANGE  
SessionInactivityConfig=1  
SessionInfoPublicationConfig=1  
SubscriberSessionCleanupConfig=1  
(AppConfig=1)>
```

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SAPC Definition (5/6)



STEP 6:

This step is valid if:

If no cluster or individual diameter node is not defined.

If there are all common controls then we can define a default profile, which would be applied to all peer PCEF.

```
ManagedElement=SAPC1,PolicyControlFunction=1,Network=1,DiameterNodes=1  
(DiameterNodes=1)>show -r  
DiameterNodes=1  
DiameterNode=default  
controls  
    IP_CAN_SESSION_ACCESS  
    SERVICE_ACCESS_PCRF_TOD  
    BEARER_QOS  
    SERVICE_CHARGING  
    dynamicServiceSupport=true  
Tdfs=1  
(DiameterNodes=1)>
```

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SAPC Definition (6/6)



STEP 7: Start GEO-RED

```
ManagedElementId=1,PolicyControlFunction=1,GeoRedManager=1
start
(GeoRedManager=1)>show-config
GeoRedManager=1
lastOperationDetailedInfo=""
lastOperationExecuted=START
lastOperationStatus=ACTION_RESULT_OK
up
```

Check in the pl-x if you can see port 8443

```
SC-1:~ # ssh pl-3
Last login: Sun Oct 14 02:11:59 2018 from sc-1
PL-3:~ # netstat -an | grep 8443
tcp        0      0 10.5.116.220:8443          0.0.0.0:*           LISTEN
```

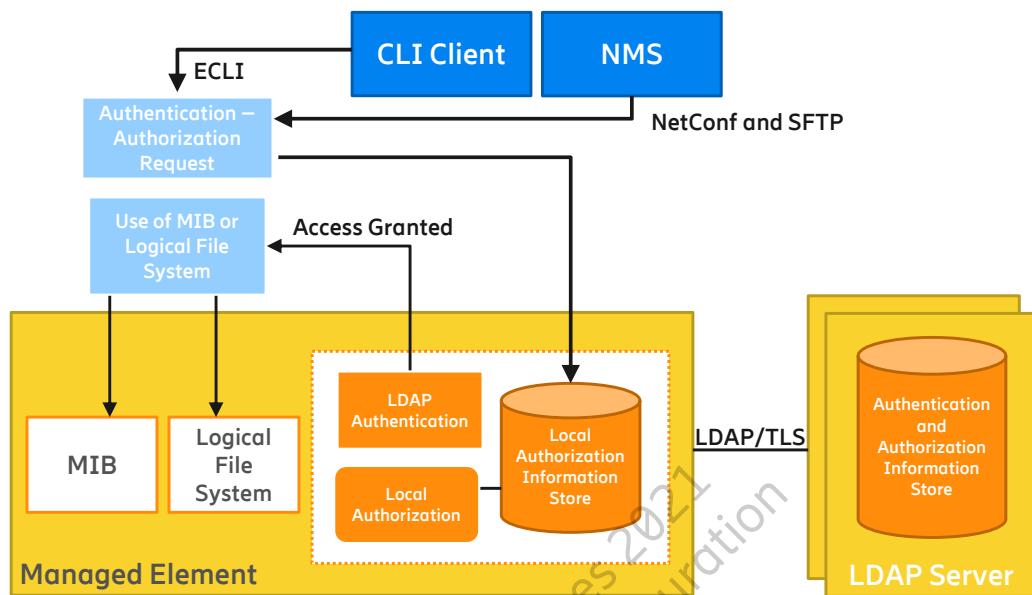
Now you can check if the provisioning part is working (RESTY commands).

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Security – User Management



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Overview-Benefit



- Security Roles functionality allows the SAPC to define its own O&M administrators with different access/privilege levels
- The operator can have a better control over their O&M administrators with those different access levels
- Administrators defined in COM can have different roles to access to different domains:
 - File System
 - REST operations
 - COM Tree

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User Authentication



- The first part related to User Management is the User Authentication
- The user needs authentication access to the ME through a username and password
- There are two possibilities:
 - Local
 - Remote (LDAP) centralized authentication
- By using username and password, LDAP authentication executes the following operations in succession:
- An LDAP bind to identify the ME to the LDAP server with the configured bind Distinguished Name (DN) and bind password
- An LDAP search, based on an LDAP filter to locate the user in the LDAP server
- An LDAP bind to authenticate the user to the LDAP server with the username and user-provided password before returning the authentication result

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User Authorization



- After the user has been authorized to enter the ME, the authorization part follows
- Relates to the privileges and the things the user is allowed to perform on the node
- Authorization rules specify the permissions to a set of resources within the ME
- The authorization rules are grouped into roles
- Roles are either retrieved from the LDAP server or are custom roles defined locally on the ME.
- The authorization rules are all defined locally on the ME
- Custom rules corresponding to customer roles can be configured over the NBI
- Authorization rules provide different access levels to the MIB and the ECLI commands
- Authorization is enabled when administrativeState is set as UNLOCKED in CLI:

```
>configure  
(config)>ManagedElement=1, SystemFunctions=1, SecM=1, UserManagement=1, LocalAuthorizationMet  
hod=1, administrativeState=UNLOCKED  
(config)>commit
```

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Permission Types



Permission	Description
No access (NO_ACCESS)	The user has no read, write, or execute rights to the MOs, attributes, or actions
Execute (X)	The user can execute all actions in the MOM
Read (R)	The user can read MOs and get attribute values
Read and execute (RX)	The user can read MOs, get attribute values, and execute all actions in the MOM
Read and write (RW)	The user can create and delete MOs as well as get and set attribute values
Read, write, and execute (RWX)	The user can create and delete MOs, set and get attribute values, as well as execute all actions in the MOM

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Predefined Default Roles



Default Role	Description
System Administrator	Responsible for the administration of all non-security-related attributes and capabilities of an ME, including features, configuration parameters, and monitoring
System Security Administrator	Responsible for the administration of all security-related attributes and capabilities of an ME, including user accounts and authorizations
System Read Only	Can view most non-security-related attributes and capabilities of an ME, including features, configuration parameters, and monitoring.
Managed Function Application Administrator	Responsible for the administration of all non-security-related attributes and capabilities of the Managed Function, including features, configuration parameters, and monitoring
Managed Function Application Security Administrator	Responsible for the administration of all security-related attributes and capabilities of the Managed Function, including user accounts and authorizations.
Managed Function Application Operator	Can view some non-security-related attributes and capabilities of the Managed Function, including features, configuration parameters, and monitoring

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SAPC default users



These are the administrators created by default in SAPC

User	Role	Description
sapcadmin	SuperUser	Complete access
sapcsystemadmin	SapcSystemAdministrator	Administrates all non-security-related attributes and capabilities
sapcsystemseccadmin	SapcSystemSecurityAdministrator	Administrates attributes and capabilities of an application system related to security
sapctroubleshooter	SapcTroubleshooter	Resolves application system instabilities and accesses to traces.
systemreadonly	SapcSystemReadOnly	Monitorizes the configuration of non-security-related attributes
sapcooperator	SapcOperator	Manages elements that are administrative in nature (e.g. backups)
sapcprov	SapcProvisioningAdministrators	Only for provisioning.
authadmin	LocalAuthenticacionAdministrator	Administrates local user accounts at initial or recovery scenarios.

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View Roles and Rules



```
>dn  
ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1, LocalAuthorizationMethod  
  
LocalAuthorizationMethod=1) >show -r -v Role=SystemAdministrator  
Role=SystemAdministrator  
  roleId="SystemAdministrator"  
  roleName="SystemAdministrator" <read-only>  
  userLabel="System Administrator Role"  
  Rule=FaultManagement_1 permission=RWX <read-only>  
  ruleData="ManagedElement, SystemFunctions, Fm, *" <read-only> ruleId="FaultManagement_1"  
  ruleName="FaultManagement_1" <read-only>  
  Rule=SystemManagement_1 permission=RWX <read-only>  
  ruleData="ManagedElement, SystemFunctions, SysM, *" <read-only> ruleId="SystemManagement_1"  
  ruleName="SystemManagement_1" <read-only> userLabel="RWX Rule for SysM" Rule=Top_1  
  permission=RWX <read-only> ruleData="ManagedElement" <read-only> ruleId="Top_1"  
  ruleName="Top_1" <read-only> userLabel="RWX Rule for ME"  
  [...]
```

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MOM for Local Authentication



```
ManagedElement
  +-SystemFunctions
  +-SecM
    +-UserManagement
      +-LocalAuthenticationMethod
        +-AccountPolicy
        +-AdministratorAccount
        +-PasswordPolicy
        +-PasswordQuality
        +-UserAccountM
          +-UserAccount
```

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Managed Object Class	Description
LocalAuthenticationMethod	The root MOC of Local Authentication.
AccountPolicy	Handles properties of account policy.
AdministratorAccount	Used for initial and recovery scenarios when authentication to regular O&M accounts is inaccessible.
PasswordPolicy	Handles properties of password policy.
PasswordQuality	Handles the criteria of password quality checking.
UserAccountM	Defines and handles the management of O&M user accounts.
UserAccount	Represents a user account. The O&M users must authenticate to a UserAccount MO to access the ME.



User Account



```
>dn  
ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1, LocalAuthenticati  
onMethod=1, UserAccountM=1  
(UserAccountM=1) >configure  
(config-UserAccountM=1) >UserAccount=joedoe  
(config-  
UserAccount=joedoe) >accountPolicy="ManagedElement=NODE06ST, SystemFunctions=1, SecM=1  
, UserManagement=1, LocalAuthenticationMethod=1, AccountPolicy=1"  
(config-  
UserAccount=joedoe) >passwordPolicy="ManagedElement=NODE06ST, SystemFunctions=1, SecM=1  
, UserManagement=1, LocalAuthenticationMethod=1, PasswordPolicy=1"  
(config-UserAccount=joedoe) >userName="John M. Doe"  
8. Commit the settings:  
(config-UserAccount=joedoe) >commit
```

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Account Policy



```
>dn ManagedElement=<Node  
Name>,SystemFunctions=1,SecM=1,UserManagement=1,LocalAuthenticationMethod=1  
(LocalAuthenticationMethod=1)>configure  
(config-LocalAuthenticationMethod=1)>AccountPolicy=1  
(config-AccountPolicy=1)>dormantTimer=360  
(config-AccountPolicy=1)>commit  
(AccountPolicy=1)>show -v  
AccountPolicy=1  
accountPolicyId="1"  
dormantTimer=360  
reservedByAccount=[] <empty> <read-only>  
userLabel=[] <empty>
```

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Password Policy



```
(config-LocalAuthenticationMethod=1)>PasswordPolicy=1
(config-PasswordPolicy=1)>minLength=12
(config-
PasswordPolicy=1)>passwordQuality="ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1, LocalAu
thenticationMethod=1, PasswordQuality=1"
(config-PasswordPolicy=1)>commit
(PasswordPolicy=1)>show -v
PasswordPolicy=1
  expireWarning=7 <default>
  failureCountInterval=1800 <default>
  historyLength=12 <default>
  lockoutDuration=[] <empty>
  maxAge=90 <default>
  maxFailure=3 <default>
  minAge=15 <default>
  minLength=12
  passwordPolicyId="1"
  passwordQuality="ManagedElement=1, ⇒
SystemFunctions=1, SecM=1, UserManagement=1, ⇒
LocalAuthenticationMethod=1, PasswordQuality=1"
  reservedByAccount=[] <empty> <read-only>
  userLabel=[] <empty>
```

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User Roles



```
>dn  
ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1, LocalAuthorizationMethod=1  
(LocalAuthorizationMethod=1) >show  
LocalAuthorizationMethod=1  
    administrativeState=UNLOCKED  
    CustomRole=Custom_UserAdministrator  
    Role=SystemAdministrator  
    Role=SystemSecurityAdministrator  
    Role=LocalAuthenticationAdministrator  
>dn  
ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1, LocalAuthenticationMethod=1  
, UserAccountM=1, UserAccount=joedoe  
(UserAccount=joedoe) >configure  
(config-UserAccount=joedoe) >roles="SystemAdministrator", "EricssonSupport"  
(config-UserAccount=joedoe) >commit
```

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Verify Account Setting

```
(UserAccount=joedoe) >show -v
UserAccount=joedoe
  accountPolicy="ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, ⇒
UserManagement=1, LocalAuthenticationMethod=1, AccountPolicy=1"
  accountState=LOCKED <read-only>
  accountUsageState=UNUSED <read-only>
  administrativeState=LOCKED <default>
  lastLoginTime="" <read-only>
  lockedTime="2015-11-13T11:20:24Z" <read-only>
  passwordChangedTime="" <read-only>
  passwordFailureTimes=[] <empty> <read-only>
  passwordPolicy="ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, ⇒
UserManagement=1, LocalAuthenticationMethod=1, PasswordPolicy=1"
  passwordState=[] <empty> <read-only>
  roles
    "SystemAdministrator"
    "EricssonSupport"
  userAccountId="joedoe"
  userLabel=[] <empty>
  userName="John M. Doe"
```

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SAPC 1 Operation and Configuration



Active-Standby Geographical Redundancy



- The geographical network redundancy function provides an extra level of redundancy at network level
- The solution is based on a hot-standby system (1+1 redundancy), composed of two SAPC peers and network connection allowing communication between them
- The active SAPC, processes the incoming traffic and provisioning operations
- The standby SAPC, replicates the state from the active one, and it is ready to process the incoming traffic and provisioning when the active SAPC cannot handle it
- Enables a seamless service continuation in case of failover
 - Based on the replication capability provided by the DBS Common Component
- SAPC traffic handling is adapted to follow the hot standby principles, by always attempting to route traffic to the correct peer
- Node configuration, operation and maintenance procedures are performed in each SAPC individually

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SAPC 1 Operation and Configuration



Feature Description – Active/Standy redundancy



- There is only one connection point to the redundant SAPC pair seen from the external network independently of the peer that is handling traffic and provisioning
- The redundant SAPC solution exposes by default one VIP address for traffic and another VIP address for provisioning
- The active SAPC notifies, through Open Shortest Path First (OSPF) mechanism, that it is the one that is processing traffic and provisioning, while the standby SAPC does not.
- One of the SAPC must be configured as preferred and the other as non-preferred
- This is used when resolving faulty situations where it is not possible to know which SAPC has the most up-to-date database:
 - After recovery of the network connectivity between both SAPCs (split-brain), the database from the preferred SAPC is maintained
 - When both SAPC reload and come up nearly at the same time, the preferred SAPC provides data to the non preferred one

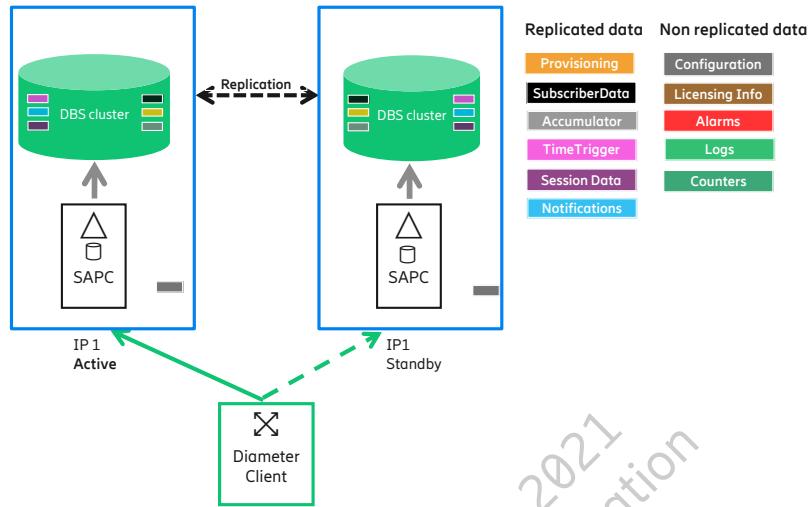
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Replication between GeoRed SAPCs – Active/Standby

The standby SAPC replicates the state from the active one, acting as hot-standby

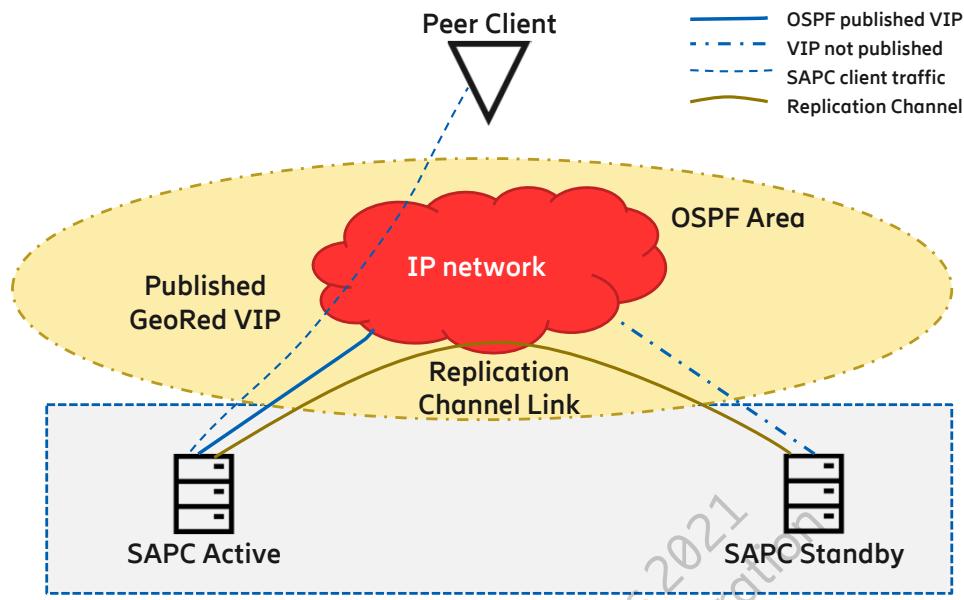


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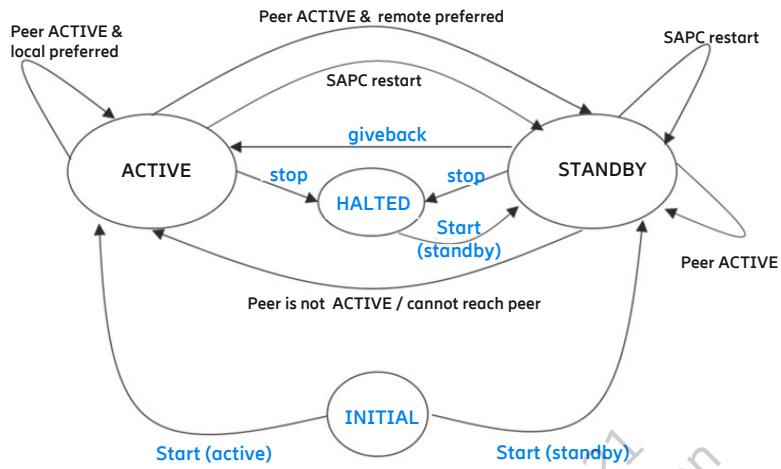


Active-Standby scheme – IP connectivity





Active-Standby – Redundancy States



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Geo-Red configuration objects and attributes



GeoRedManager object:

Attributes:

```
currentState: INITIAL, ACTIVE, STANDBY, HALTED
previousState: INITIAL, ACTIVE, STANDBY, HALTED
lastOperationExecuted: START, STOP, SET, SHOW_CONFIGURATION, GIVEBACK
lastOperationStatus : ACTION_RESULT_OK, ACTION_RESULT_NOT_OK, ACTION_ONGOING
lastOperationDetailedInfo: Add more information when status is failed
    Already in Active state
    Already in Standby state
    Already in Halted state
    Already configured as Preferred / Non-Preferred
    Not possible to execute start/set/stop/giveback action from
    INITIAL/HALTED/ACTIVE/STANDBY state
    Parameter state not valid
    Parameter state missing
    Not possible to execute stop action when peer is initial or halted
    Not possible to execute giveback action from non-preferred SAPC
    Internal error updating preferred value
lastTransitionState (timestamp)
```

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Start Geographical Redundancy (1/2)



Precondition: both SAPCs are in Initial state. Procedure steps:

1. Start Preferred as Active

Connect to the Preferred SAPC, open a CLI session and navigate to class GeoRedManager object:

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Execute start action:

```
(GeoRedManager=1)>start --state ACTIVE  
Start operation ongoing...
```

Verify the result:

```
(GeoRedManager=1)>show  
GeoRedManager=1  
  currentState=ACTIVE  
  lastOperationDetailedInfo=""  
  lastOperationExecuted=START  
  lastOperationStatus=ACTION_RESULT_OK  
  lastTransitionState="1479226642"  
  previousState=INITIAL
```

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Start Geographical Redundancy (2/2)



2. Start Non-Preferred as Standby

Connect to the Non-Preferred SAPC, open a CLI session and navigate to class GeoRedManager object:

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Execute start action:

```
(GeoRedManager=1)>start --state STANDBY  
Start operation ongoing...
```

Verify the result:

```
(GeoRedManager=1)>show  
GeoRedManager=1  
  currentState=STANDBY  
  lastOperationDetailedInfo=""  
  lastOperationExecuted=START  
  lastOperationStatus=ACTION_RESULT_OK  
  lastTransitionState="1479226651"  
  previousState=INITIAL
```

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Monitor Geographical Redundancy State



This procedure retrieves the geographical redundancy state of the node. During normal operation, it's expected that the node is either in Active or Standby State

Procedure steps:

Connect to the SAPC, open a CLI session and navigate to class GeoRedManager object:

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Execute show action:

```
(GeoRedManager=1)>show  
GeoRedManager=1  
  currentState=ACTIVE  
  lastOperationDetailedInfo=""  
  lastOperationExecuted=START  
  lastOperationStatus=ACTION_RESULT_OK  
  lastTransitionState="1479226642"  
  previousState=INITIAL
```

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Check Geographical Redundancy Configuration



Check Geographical Redundancy Configuration

This procedure retrieves the geographical redundancy configuration of the node, so the user can verify the values for Local IP, Peer IP and Role attributes

Procedure steps:

Connect to the SAPC, open a CLI session and navigate to class GeoRedManager object:

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Execute showConfiguration action:

```
(GeoRedManager=1)>showConfiguration  
Configuration:  
    Local IP: 192.168.12.41  
    Peer IP: 192.168.12.42  
    Role: Preferred
```

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Active-Active Geographical Redundancy



- The geographical network redundancy function provides an extra level of redundancy on network level
 - Operators may also require the possibility to shut down clusters completely for planned or unplanned maintenance
 - complete power failure, natural disasters
- The solution is based on a 1+1 redundancy, where both SAPC peers are active
- Both SAPC peers can process the incoming traffic and provisioning operations
- Each SAPC keeps the state of the mated peer, and is ready to process the incoming traffic and provisioning when the mated peer cannot handle it
- The replication capability is provided by the Database Service (DBS) of the Ericsson Common Component Based Architecture (CBA)
- The Diameter clients or the Diameter Routing Agent (DRA) nodes must support subscriber and session stickiness

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SAPC 1 Operation and Configuration



Active-Active – Preferred SAPC



- One of the SAPC applications in active-active scheme must be configured as preferred
- This is used when resolving faulty situations where it is not possible to know which SAPC has the most up-to-date database:
 - After recovery of the network connectivity between both SAPCs (split-brain), the database from the preferred SAPC application is maintained
 - When both SAPC applications reload and come up nearly at the same time, the preferred SAPC application provides data to the non preferred one
- When the Replication Channel is down but the Application Channel is available, the preferred SAPC takes the role of the active node and the non-preferred one goes to standby, to prevent loss of data after the recovery of the Replication Channel

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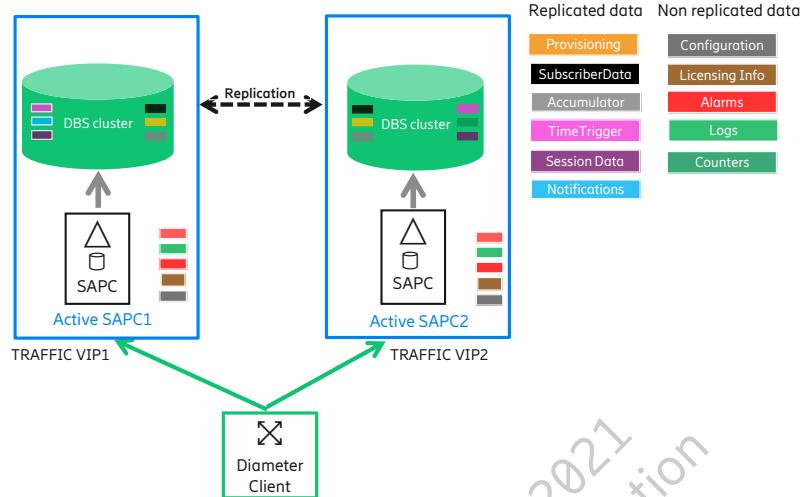
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Replication between GeoRed SAPCs – Active/Active



Data Mirroring

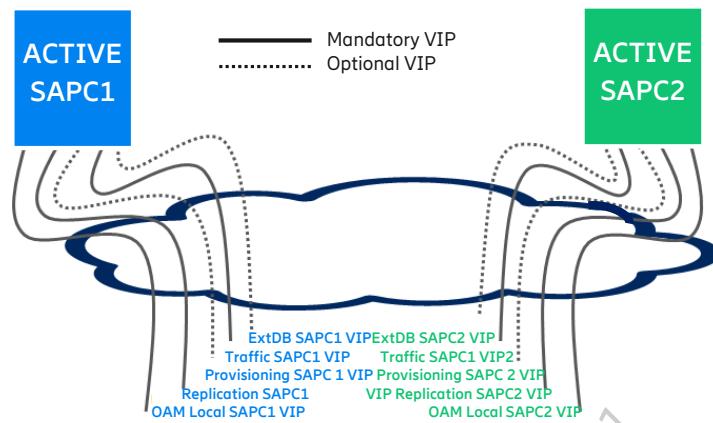


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Active/Active scheme – VIP addressing

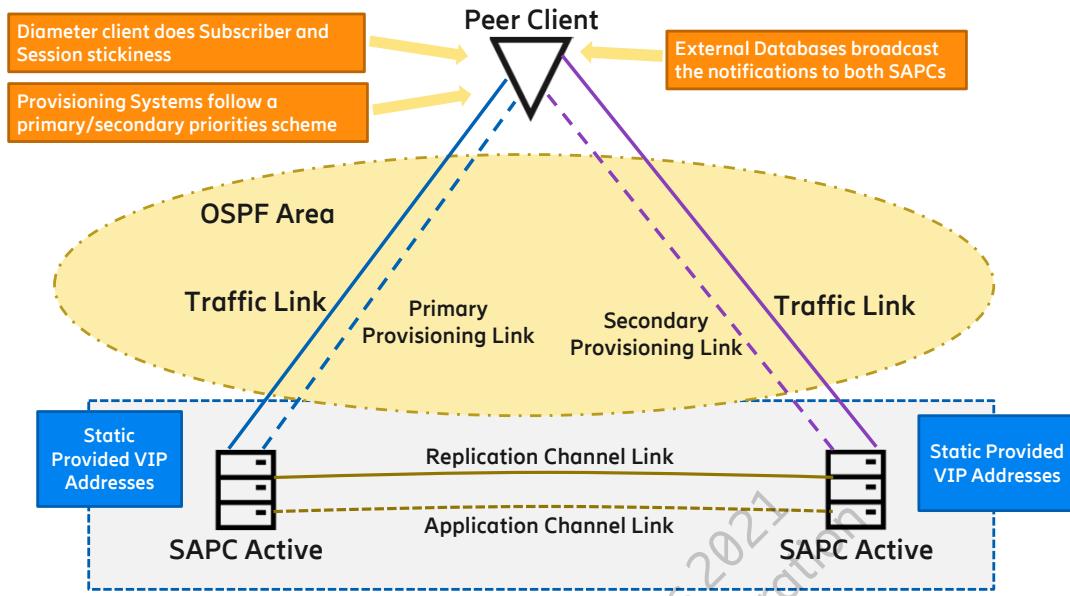


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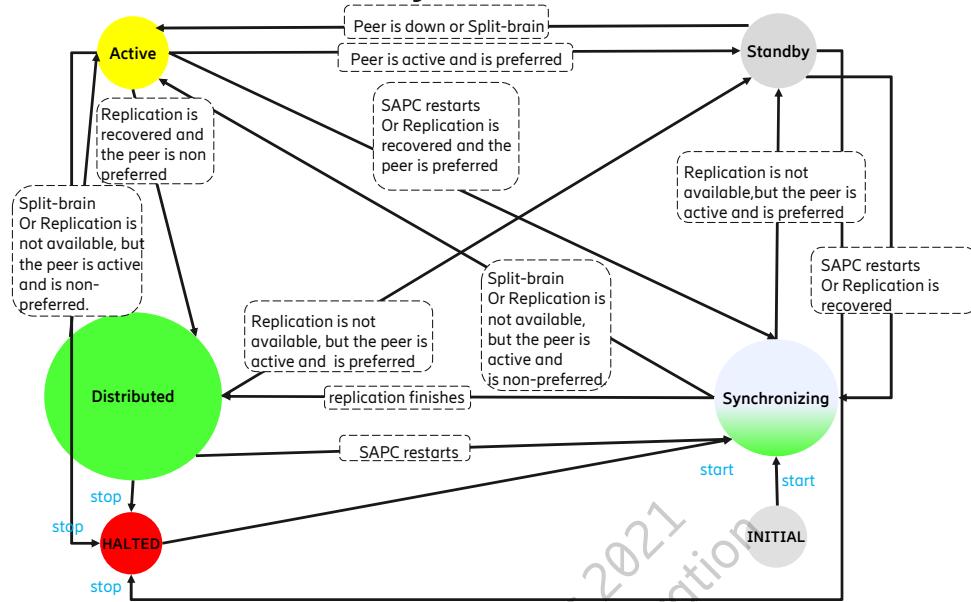


Active/Active scheme – IP connectivity





Active/Active – Redundancy States





Active/Active Geographical Redundancy Traffic Cases

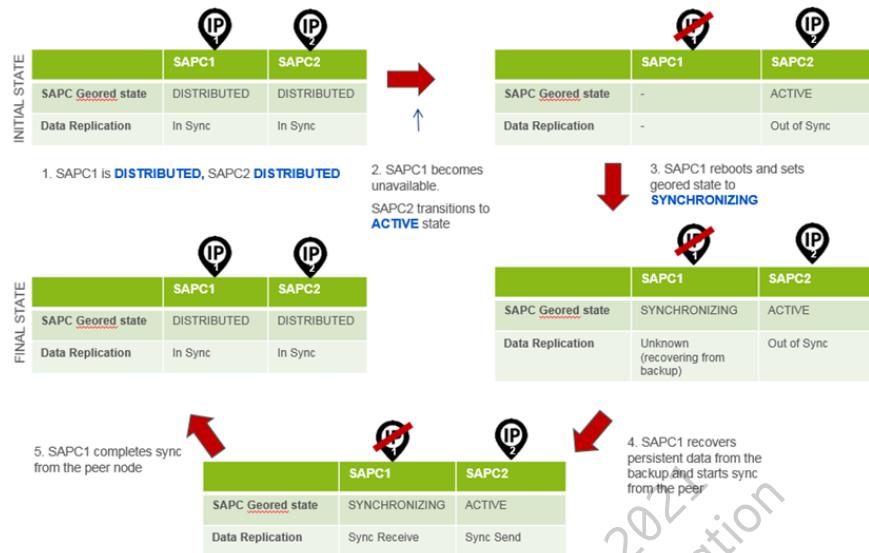
Replication Heartbeat / Traffic Heartbeat	SAPC1 state	SAPC2 state
Available / Available	DISTRIBUTED	DISTRIBUTED
Available / Unavailable	DISTRIBUTED	DISTRIBUTED
Unavailable / Available	ACTIVE (preferred)	STANDBY (non-preferred)
Unavailable / Unavailable	ACTIVE	ACTIVE

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Use Case: SAPC in DISTRIBUTED state restarts

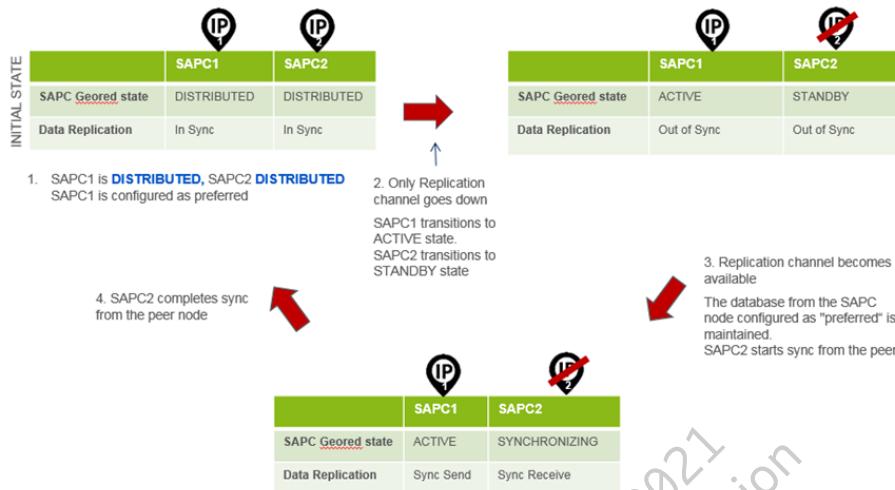


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SAPC 1 Operation and Configuration



Use case: Replication channel unavailable but traffic channel available

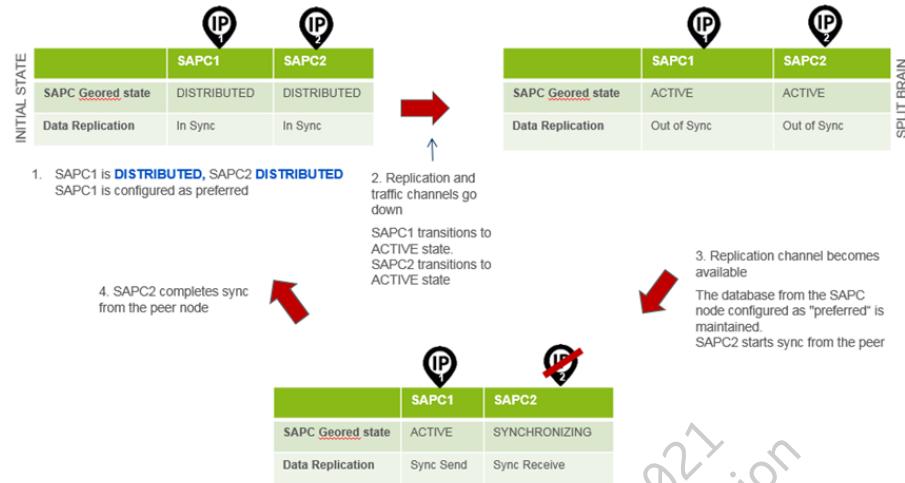


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Use Case: Both Replication & Traffic Channel Unavailable



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Geo-Red Configuration



GeoRedManager object:

Attributes:

```
currentState: INITIAL, ACTIVE, STANDBY, HALTED
previousState: INITIAL, ACTIVE, STANDBY, HALTED
lastOperationExecuted: START, STOP, SET, SHOW_CONFIGURATION, GIVEBACK
lastOperationStatus : ACTION_RESULT_OK, ACTION_RESULT_NOT_OK, ACTION_ONGOING
lastOperationDetailedInfo: Add more information when status is failed
    Already in Active state
    Already in Standby state
    Already in Halted state
    Already configured as Preferred / Non-Preferred
    Not possible to execute start/set/stop/giveback action from
    INITIAL/HALTED/ACTIVE/STANDBY state
    Parameter state not valid
    Parameter state missing
    Not possible to execute stop action when peer is initial or halted
    Not possible to execute giveback action from non-preferred SAPC
    Internal error updating preferred value
lastTransitionState (timestamp)
```

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Monitor Geographical Redundancy State



This procedure retrieves the geographical redundancy state of the application

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Procedure steps:

Connect to the SAPC, open a CLI session and navigate to class GeoRedManager object:

Execute show action:

```
(GeoRedManager=1) >show  
GeoRedManager=1  
    currentState=DISTRIBUTED  
    lastOperationDetailedInfo=""  
    lastOperationExecuted=START  
    lastOperationStatus=ACTION_RESULT_OK  
    lastTransitionState="1479226642"  
    previousState=SYNCHRONIZING
```

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Check Geographical Redundancy Configuration



This procedure retrieves the geographical redundancy configuration of the SAPC, so the user can verify the values for Local IP, Peer IP and Role attributes

```
#/opt/com/bin/cliss  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
```

Procedure steps:

Connect to the SAPC, open a CLI session and navigate to class GeoRedManager object:

Execute showConfiguration action:

```
(GeoRedManager=1)>showConfiguration  
Configuration:  
    Local Replication IP: 192.168.12.61  
    Peer Replication IP: 192.168.12.62  
    Role: Preferred  
    Local Application IP: 192.168.12.41  
    Peer Application IP: 192.168.12.42  
    Geored Mode: Active-Active
```

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Verify both SAPC peers synchronized



Verify the result in Preferred SAPC:

```
(GeoRedManager=1)>show  
GeoRedManager=1  
    currentState=DISTRIBUTED  
    lastOperationDetailedInfo=""  
    lastOperationExecuted=START  
    lastOperationStatus=ACTION_RESULT_OK  
    lastTransitionState="1479226651"  
    previousState=ACTIVE
```

Verify the result in Non-Preferred SAPC:

```
(GeoRedManager=1)>show  
GeoRedManager=1  
    currentState=DISTRIBUTED  
    lastOperationDetailedInfo=""  
    lastOperationExecuted=START  
    lastOperationStatus=ACTION_RESULT_OK  
    lastTransitionState="1479226651"  
    previousState=SYNCHRONIZING
```

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Chapter 5 Summary



After this chapter, the student should now be able to:

- Understand the basic configuration and Managed Object Model object hierarchy and relationships
- Outline the security management and user authentication and authorization
- Comprehend the Geo-Redundancy active/standby and active/active scenarios
- Explore the configuration parameters for Geo Redundancy

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SAPC operation



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Chapter 6 Objectives



On completion of this chapter, the participants will be able to:

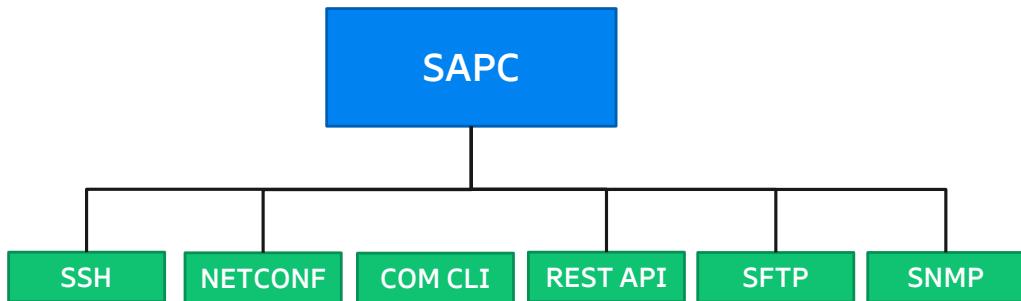
- Understand the SAPC OAM tools
- Comprehend the cluster platform configuration file
- Describe the main log files and the logging enhancements
- Work with the fault management part
- Understand measurements and the performance management
- Perform the SAPC backup and restore procedures

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Interfaces and Tools

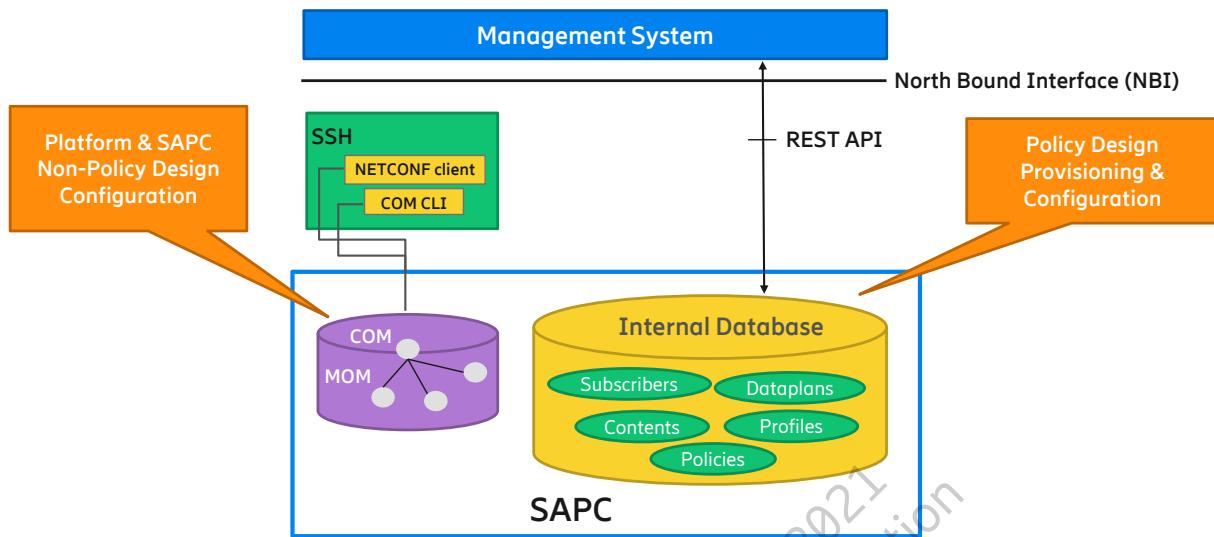


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SAPC Configuration & Provisioning



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Configuration through COM CLI



The SAPC uses the COM CBA component to configure System Functions and standard SAPC application settings like Diameter, VIP addresses etc.

Its heart is the Managed Object Model (MOM), a tree configuration represented in Object classes

There are two ways of accessing to the COM MOM:

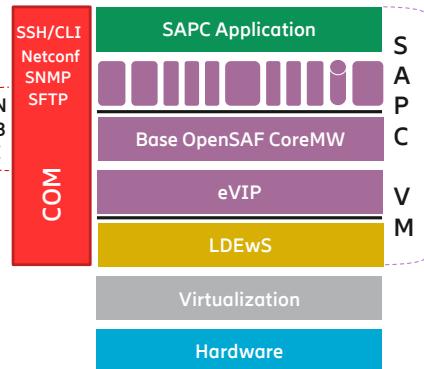
1. NETCONF interface

An example NETCONF command to configure an object included in the file "filename.xml" is the following:

```
netconf-console -u sapcadmin -p <password> --proto=ssh -  
-port=830 --host=<OAM VIP> -s raw --rpc=RPC filename.xml
```

- Note: netconf-console is an example client used. The vSAPC is providing NETCONF service not providing any client

2. COM CLI (cliss)

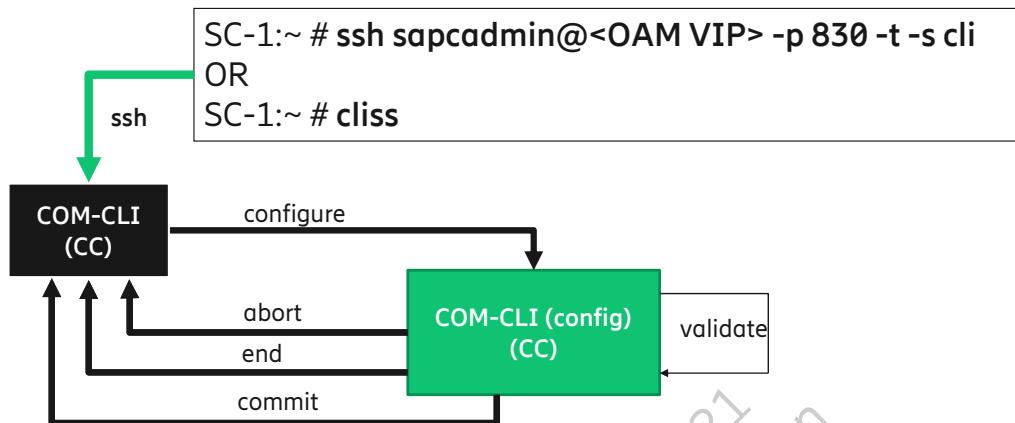


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OAM Node Access – COM CLI



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NETCONF



- The Network Configuration Protocol (NETCONF) is a network management protocol developed and standardized by the IETF (RFC 6241)
- Used as machine-to-machine interface for configuration management of the Managed Element (ME) over the Secure Shell (SSH) or the Transport Layer Security (TLS)
- The NETCONF protocol provides mechanisms to change the configuration of network devices, and monitor status and statistics
- The NETCONF uses an Extensible Markup Language (XML) based data encoding for the configuration data and the protocol messages
- The NETCONF protocol operations are realized as Remote Procedure Calls (RPCs) and can be useful also for bulk configurations some times
- To start a NETCONF session over SSH :

```
ssh sapcadmin@<OAM-VIP> -p 830 -s netconf
```

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Connecting NETCONF to SAPC

The screenshot shows the Ericsson NETCONF Browser interface. At the top, there's a toolbar with icons for New connection, Local configuration, and Connect. Below the toolbar, the title bar says "Ericsson NETCONF Browser" and "Connections SAPC1". On the right side of the title bar are links for Support, About, and Help. The main window has a sidebar on the left labeled "Connections" with "SAPC1" selected. A central modal dialog titled "Connection" is open, containing fields for "Name" (set to "SAPC1"), "Netconf Interface", "Schema Retrieval", and "Netconf Filter". Under the "Tunneling" section, "Connect directly" is selected. In the "SSH" section, a checkbox for "Use NETCONF subsystem (e.g. ssh -p 830 user@host-s netconf)" is checked. The "Host" field is set to "10.95.127.129", "Netconf port" to "830", "User name" to "sapcadmin", and "Password" to "*****". Under the "NETCONF" section, the "Fetch method" is set to "get" (radio button selected). At the bottom of the dialog are "Fetch", "Save", and "Cancel" buttons. A watermark reading "Do not copy © Ericsson Learning Services 2021 SAPC 1 Operation and Configuration" is diagonally across the screen.

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NETCONF Browser Sample outputs

The screenshot shows the Ericsson NETCONF Browser interface with two main panes. The left pane displays a hierarchical tree of managed elements under the 'SAPC' connection. The tree includes nodes such as ManagedElement, Equipment, JavaConfig, PolicyControlFunction, AppConfig, BusinessEvents, EntityData, EventBasedMonitoring, FlexibleDiameter, GeoRedManager, Network, DiameterNode, and various service endpoints like Tdbshts, EhrnSever, SmcCenter, and WebServiceEndPoints. The right pane shows a table of alarms for the 'diameterNodesId' node, with one entry listed:

Name	Value
diameterNodesId	1

Below this table, another table lists specific alarm details:

Name	Value
activeSeverity	MAJOR
additionalText	Observed value: 80; Threshold level: 8...
eventType	QUALITYOFSERVICEALARM
fmAlarmId	9
lastEventTime	2021-04-21T07:17:01.000+02:00
majorType	193
minorType	65538
originalAdditionalText	Observed value: 80; Threshold level: 8...
originalEventTime	2021-04-21T07:17:01.000+02:00
originalSeverity	MAJOR
probableCause	351
sequenceNumber	17
source	ManagedElements>1.SystemFunctions...
specificProblem	Performance Management Threshold...

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Platform cluster configuration file: cluster.conf



The CBA cluster platform parameters (not SAPC application) like interfaces, OAM NTP, internal networking, scaling, virtual MAC address mappings, syslog settings, TIPC etc. are configured in the global cluster platform specific file:

/cluster/etc/cluster.conf

After updating any parameter values in the configuration file cluster.conf:

- Validate the configuration: SC-1:~ # lde-config -v
- Reload the updated configuration: SC-1:~ # lde-config --reload
- The command lde-config -p prints the contents: SC-1:~ # lde-config -p
- According to the change type cluster reboot might be needed for changes to take effect

SC-1:~ # lde-reboot <reboot only OAM VMs or -a (all)>

- Note: rebooting all VMs will affect traffic (-a means all nodes, SC's and PL's)

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Example of a cluster.conf file

```
SC-1:~ # lde-config -p
# -----
# Start of site specific configuration
# -----
# Define NTP servers
# The internal ntp server first to speed up the query
#ntp ${@CUSTOMER__NTP_SERVER_IP@}

# Define time zone
# See /usr/share/zoneinfo/ for supported time zones
timezone Europe/Madrid
# -----
# End of site specific configuration
# -----


# -----
# Start of hardware specific configuration
# -----


# Define nodes. Id, type and name are fixed.
# sc01-02
node 1 control SC-1
node 2 control SC-2
node 3 payload PL-3
node 4 payload PL-4
# Define the scaling-template node/s
nodegroup scaling-template payload

# Define node interfaces
# SC-1
interface 1 eth0 ethernet 02:10:20:3C:01:03
interface 1 eth1 ethernet 02:10:20:3C:01:04
interface 1 eth2 ethernet 02:10:20:3C:01:05
interface 1 eth3 ethernet 02:10:20:3C:01:06

# SC-2
interface 2 eth0 ethernet 02:10:20:3C:02:03
interface 2 eth1 ethernet 02:10:20:3C:02:04
interface 2 eth2 ethernet 02:10:20:3C:02:05
interface 2 eth3 ethernet 02:10:20:3C:02:06
# PL-3
interface 3 eth0 ethernet 02:10:40:3C:03:03
interface 3 eth1 ethernet 02:10:40:3C:03:04
interface 3 eth2 ethernet 02:10:40:3C:03:05
interface 3 eth3 ethernet 02:10:40:3C:03:06
# PL-4
interface 4 eth0 ethernet 02:10:40:3C:04:03
interface 4 eth1 ethernet 02:10:40:3C:04:04
interface 4 eth2 ethernet 02:10:40:3C:04:05
interface 4 eth3 ethernet 02:10:40:3C:04:06
# -----
# End of hardware specific configuration
# -----


# Start of cluster internal configuration
# -----


# Define cluster internal networks
network internal 172.16.100.0/24
network default 0.0.0.0/0
network multicast 224.0.0.0/4
# Define alias interfaces
interface control eth0:1 alias
interface control eth0:2 alias
# SS7CAF CPM Address alias interface
interface payload eth0:1 alias
# Define internal IP address
ip all eth0 internal dynamic
# Define scaling temporary IP address pool
scaling 172.16.100.245 172.16.100.254

# Define movable IP addresses
mip control nfs eth0:1 internal 172.16.100.100
mip control boot eth0:2 internal 172.16.100.200
# SS7CAF MIP for CPM Address
mip payload ss7cfcpmaddress eth0:1 internal 172.16.100.244

# Define TIPCs service addresses
tipc all dynamic eth1
tipc all link_tolerance 9000
# Define internal NFS server IP address
nfs 172.16.100.100
# Define boot server IP address
boot 172.16.100.200
# Deactivates the quick-reboot feature for the PLs
# to avoid a kernel-panic situation
quick-reboot payload off

# Payload RAM disc size
ram-rootsfs-size control 4096
ram-rootsfs-size payload 4096
# Type of console output
default-output serial
# Storage size
enable-storage-resize on
# -----
# End of cluster internal configuration
# -----


# End of file
SC-1:~
```

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Logging Management – Severity Levels



To configure the logging level, set the attribute of BusinessEvents to proper value in COM CLI

- by default set to 4 (WARNING)

```
> ManagedElement=1,PolicyControlFunction=1,BusinessEvents=1  
(BusinessEvents=1)>configure  
(config-BusinessEvents=1)>loggingLevel=?  
Indicates the system logging level.  
Values:  
 0: EMERGENCY  
 1: ALERT  
 2: CRITICAL  
 3: ERROR  
 4: WARNING  
 5: NOTICE  
 6: INFORMATIONAL
```

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Log Events Table Contents



Event Name	Slogan of the event
Description	The explanation of the cause event
Severity	One of the following level values: 0: EMERGENCY. System is unusable 1: ALERT. Action must be taken immediately 2: CRITICAL. Critical conditions. If no action is taken, the system may not run properly 3: ERROR. Error conditions 4: WARNING. Warning conditions 5: NOTICE. Advise 6: INFORMATIONAL. Informational
Source	Subsystem originating the event: Access and Charging Control QoS Control Dynamic Policy Control Policy Engine Subscription Fair Usage Time Trigger End User Notifications Geographical Redundancy External Database Sy Subscriber Charging SOAP Notification Obsolete Sessions Notifier Sd Application Detection and Control REST Web Service
Additional Info	Any other relevant information.

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Events related to the SAPC REST API Logged by SAPC

Event Name	REST Operation Req failed
Description	A REST operation request has failed.
Severity	3: ERROR
Source	REST Web Service
Additional Info	HostIpAddr: <Host IP address that requests the operation>, User: <The user id who sends the command>, Method: <GET/PUT/POST/DELETE>, RestUri: <REST URI>, Duration: <The duration of operation in milliseconds>, Error: <Error message>, RequestJson: <Serialized JSON body of the HTTP message>
Event Name	REST Operation Req answered
Description	A REST operation request received and responded successfully.
Severity	6:INFO
Source	REST Web Service
Additional Info	HostIpAddr: <Host IP address that requests the operation>, User: <The user id who sends the command>, Method: <GET/PUT/POST/DELETE>, RestUri: <REST URI>, Duration: <The duration of operation in milliseconds>, StatusCode: <HTTP status code>, RequestJson: <Serialized JSON body of the HTTP message>, ResponseJson: <Serialized JSON body of the HTTP message>

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Example of Application Events Logged by SAPC



Event Name	AF Emergency Session established.		
Description	The SAPC has received and authorized a new request for IMS emergency service		
Severity	6: INFORMATIONAL		
Source	Dynamic Policy Control		
Additional Info	SessionId: <Session ID>, IpAddr: <UE IP Address>, ServiceUrn: <Service URN>, IMEISV: <IMEISV>, SubsId: <Subscriber ID>		
Event Name	Error sending CCA.	Event Name	Error sending RAR.
Description	The SAPC failed to send a CCA message.	Description	The SAPC failed to send a RAR message.
Severity	3: ERROR	Severity	4: WARNING
Source	Access and Charging Control QoS Control Sd Application Detection and Control	Source	Access and Charging Control QoS Control Dynamic Policy Control Sd Application Detection and Control
Additional Info	SessionId: <Session ID>, Protocol: <Gx Smp Sd>	Additional Info	SessionId: <Session ID>, Protocol: <Gx Rx Sd Smp>

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Log Files



The files related to the northbound interface (NBI) are stored in /cluster/storage/no-backup/nbi_root

```
SC-1:/cluster/storage/no-backup/nbi_root # ls -l
total 20
lrwxrwxrwx 1 com-core com-core      65 Apr 13 15:44 AlarmLogs -> /storage/no-backup/coremw/var/log/saflog/FaultManagementLog/alarm
lrwxrwxrwx 1 com-core com-core      65 Apr 13 15:44 AlertLogs -> /storage/no-backup/coremw/var/log/saflog/FaultManagementLog/alert
lrwxrwxrwx 1 root    root          66 Apr 13 15:41 BackupAndRestoreManagementFiles -> /storage/no-backup/brfc-apr010485/BackupAndRestoreManagementFiles
lrwxrwxrwx 1 root    root          36 Apr 13 15:54 ConfigurationFiles -> /cluster/storage/system/config/sapc/
lrwxrwxrwx 1 root    root          46 Apr 13 15:55 InServicePerformance -> /storage/no-backup/coremw/InServicePerformance
lrwxrwxrwx 1 root    root          49 Apr 13 15:54 LogFiles -> /cluster/storage/no-backup/coremw/var/log/syslog/
lrwxrwxrwx 1 com-core com-core      66 Apr 13 15:44 PerformanceManagementReportFiles -> /storage/no-backup/com-apr010443/PerformanceManagementReportFiles
lrwxrwxrwx 1 root    root          46 Apr 13 15:46 PolicyControlPdcFiles -> /storage/no-backup/sapc/PolicyControlPdcFiles/
lrwxrwxrwx 1 root    root          56 Apr 13 15:46 PolicyControlRestGetCollections -> /storage/no-backup/sapc/PolicyControlRestGetCollections/
lrwxrwxrwx 1 cmw-swm cmw-swm       44 Apr 13 15:55 SoftwareManagement -> /storage/no-backup/coremw/SoftwareManagement
lrwxrwxrwx 1 root    root          49 Apr 13 15:54 Tracesfiles -> /cluster/storage/no-backup/coremw/var/log/saflog/
drwxr-x--- 2 com-core system-nbi-data 4096 Apr 13 15:44 dev
lrwxrwxrwx 1 root    root          37 Apr 13 15:46 uetracefiles -> /storage/no-backup/sapc/uetracefiles/
SC-1:/cluster/storage/no-backup/nbi_root #
```

Use SFTP to connect to OAM VIP, port 115, user sapcadmin. This is the root SFTP folder to transfer easily those files remotely if needed

The screenshot shows an SFTP session window with the following details:

- Session Title:** sapcadmin@10.36.197.169
- Address:** 10.36.197.169
- Port:** 115
- User:** sapcadmin
- File List:** The root directory contains several subfolders:
 - AlarmLogs
 - AlertLogs
 - BackupAndRestoreM...
 - ConfigurationFiles
 - InServicePerformance
 - LogFiles
 - PerformanceManage...
 - PolicyControlPdcFiles
 - PolicyControlRestGet...
 - SoftwareManagement
 - Tracesfiles
 - uetracefiles
- File Details:** A table provides file metadata for each item in the list.

Name	Size	Changed	Rights	Owner
AlarmLogs	4/13/2021 3:55:56 PM	rw-rwx---	0	
AlertLogs	4/29/2021 8:00:10 AM	rw-rwx---	305	
BackupAndRestoreM...	4/20/2021 3:01:11 AM	rw-rwx---	304	
ConfigurationFiles	4/13/2021 3:41:09 PM	rw-rwx---	0	
InServicePerformance	4/13/2021 3:54:51 PM	rw-rwx---	311	
LogFiles	4/13/2021 3:34:44 PM	rw-rwx---	320	
PerformanceManage...	4/19/2021 3:32:47 PM	rw-rwx---	0	
PolicyControlPdcFiles	5/2/2021 5:10:50 PM	rw-rws---	311	
PolicyControlRestGet...	4/13/2021 3:33:09 PM	rw-rwx---	0	
SoftwareManagement	4/13/2021 3:34:44 PM	rw-rwx---	307	
Tracesfiles	5/2/2021 3:04:10 PM	rw-rwx---	305	
uetracefiles	4/13/2021 3:40:25 PM	rw-rwx---	0	

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SAPC Log Files



The actual log files can be found as the table summary shows below.

The folder **/cluster/storage/no-backup/nbi_root** contains symbolic links for all the main log & events

Logs	File
SAPC Application Logs	/cluster/storage/no-backup/coremw/var/log/saflog/sapc/sapc_<createdate>_<createtime>[_<closedate>_<closetime>].log
Alarm Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogAlarm_<createdate>_<createtime>[_<closedate>_<closetime>].log
Notification Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogNotification_<createdate>_<createtime>[_<closedate>_<closetime>].log
System Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogSystem_<createdate>_<createtime>[_<closedate>_<closetime>].log

Logs	File
SAPC Java Application Logs (external database and end user notifications)	/cluster/storage/no-backup/coremw/var/log/saflog/sapc/sapcJava_<createdate>_<createtime>[_<closedate>_<closetime>].log
SAPC Emergency Calls Logs	/cluster/storage/no-backup/coremw/var/log/saflog/sapc/emergencyCalls_<createdate>_<createtime>[_<closedate>_<closetime>].log
SAPC REST Logs	/cluster/storage/no-backup/coremw/var/log/saflog/sapc/rest_<createdate>_<createtime>[_<closedate>_<closetime>].log

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Path to SAPC Log Files



There are different logs to store different types of events:

Logs	File
SAPC Application Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/sapc_<createdate>_<createtime>[_<closedate>_<closetime>].log
Alarm Logs(1)	/cluster/storage/no-backup/coremw/var/log/saflog/saLogAlarm_<createdate>_<createtime>[_<closedate>_<closetime>].log
Notification Logs(2)	/cluster/storage/no-backup/coremw/var/log/saflog/saLogNotification_<createdate>_<createtime>[_<closedate>_<closetime>].log
System Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogSystem_<createdate>_<createtime>[_<closedate>_<closetime>].log
SAPC Emergency Calls Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/emergencyCalls_<createdate>_<createtime>[_<closedate>_<closetime>].log
REST Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/rest_<createdate>_<createtime>[_<closedate>_<closetime>].log
Campaign Generation Logs (tcg)	/storage/no-backup/coremw/var/log/tcglog/tcg.log
Diameter logs	/storage/no-backup/diacc/log/

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SAPC Logging Events Sample Tables



AF Emergency Session established
AF Emergency Session terminated
Autoprovisioned subscriber
Configuration error
Diameter incoming message discarded
Diameter peer node restarted
Discarded received usage
EBM Mandatory Parameter Missed
End Deleting Inactive Sessions
End deleting old sessions
End sessions emergency removal
End User Notification discarded
Error fetching data from external DB
Error Sending ASR
Error sending CCA
Error sending RAR
Error sending SLR

Error sending SNA
Error sending STR
Error sending ASR
Error storing data into external DB
Existing IP Session removed
Geographical redundancy state changed
Internal error
IP-CAN session exists
License error
IMS Multimedia Priority Service
Notification Server Communication Error
Protocol error
Reset of accumulated usage data

REST Operation Req failed
REST Operation Req answered
Rollover Limit Surpassed
Rule Installation Failure
SOAP external DB notification not matching object for DN
SOAP external DB notification event not supported
Start Deleting Inactive Sessions
Start deleting old sessions
Start sessions emergency removal
Timeout receiving RAA
Timeout receiving STA
Unable to deliver End User Notification
Unsuccessful RAA Received
Unsuccessful SLA Received
Unsuccessful SNA sent
Unsuccessful STA received
Update Accumulated Usage Failed
Usage Limit Surpassed

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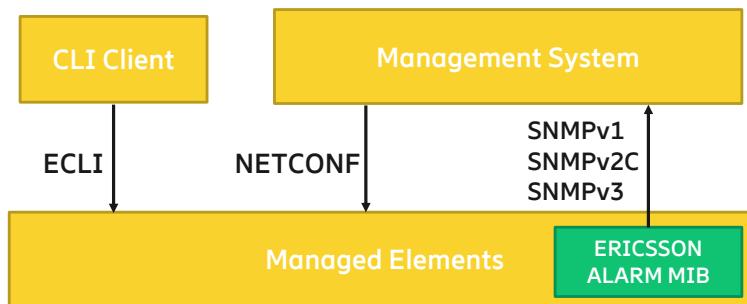


Fault Management



FM detects unexpected Managed Element (ME) behaviors and malfunctions requiring corrective actions that cannot be performed by the ME. FM raises alarms in such situations to get the user attention

The FM interfaces are as follows:



Alarm information is available in the ECLI, NETCONF, and SNMP interfaces and in log files.

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View Alarms – FMAlarm class object

FmAlarm instance represents an active alarm

ManagedObjectModel representation is used for alarm display

```
>ManagedElement=1, SystemFunctions=1, Fm=1
(Fm=1)>show
Fm=1
  lastChanged="2021-04-27T15:42:17.016+02:00"
  sumCritical=0
  sumMajor=29
  sumMinor=0
  sumWarning=0
  totalActive=29
FmAlarm=9
FmAlarm=14
FmAlarm=15
FmAlarm=16
FmAlarm=17
FmAlarm=18
FmAlarm=19
FmAlarm=20
FmAlarm=21
FmAlarm=22
FmAlarm=23
FmAlarm=24
FmAlarm=25
FmAlarm=26
FmAlarm=27
FmAlarm=28
FmAlarm=29
FmAlarm=30
```

```
(Fm=1)>show FmAlarm=9
FmAlarm=9
  activeSeverity=MAJOR
  additionalText="Observed value: 80; Threshold level : 80; MeasurementType: ManagedElement=1, SystemFunction s=1, Pm=1, PmGroup=0$ProcessingUnit, MeasurementType=Mem. PercentUsed; Threshold Direction: INCREASING; MO instance: 0$ProcessingUnit=PL-4"
    eventType=QUALITYOFSERVICEALARM
    lastEventTime="2021-04-21T07:17:01.000+02:00"
    majorType=193
    minorType=65538
    originalAdditionalText="Observed value: 80; Threshold level : 80; MeasurementType: ManagedElement=1, System Functions=1, Pm=1, PmGroup=0$ProcessingUnit, MeasurementType=Mem. PercentUsed; Threshold Direction: INCREASING; MO instance: 0$ProcessingUnit=PL-4"
    originalEventTime="2021-04-21T07:17:01.000+02:00"
    originalSeverity=MAJOR
    probableCause=351
    sequenceNumber=17
    source="ManagedElement=1, SystemFunctions=1, Pm=1, PmJ ob=memoryLoadThresholdJob, MeasurementReader=memoryLoad _mr=0$ProcessingUnit=PL-4"
    specificProblem="Performance Management Threshold c rossed or Reached"
(Fm=1)>
```

class FmAlarm	
ManagedObject	SystemFunctions
Fm	FmAlarm
An FmAlarm instance represents an active alarm. An alarm is a persistent indication of a fault that clears only when the triggering condition has been resolved.	
This MO is created by the system.	
Attributes	
SeverityLevel[0..1]	activeSeverity The perceived severity of the alarm. It may change during the alarm's lifetime.
Notification[0..1]	additionalInfo The information represented as a set of data structures with two items of information, an identifier and a value. It may change during the alarm's lifetime.
lastEventTime[0..1]	additionalInfo Extra information about the problem. The information is represented as a set of data structures with two items of information, an identifier and a value. It may change during the alarm's lifetime.
majorType[0..1]	additionalInfo Extra information about the alarm. It may change during the alarm's lifetime.
minorType[0..1]	eventType General category for the alarm.
originalAdditionalText[0..1]	Specification: ITU-T X.733 X.736 fmalarmId Holds the name used when identifying the MO.
originalEventTime[0..1]	lastEventTime The timestamp of when the alarm was last updated. This is a set of alarm information change or severity change.
originalSeverity[0..1]	majorType The attributes majorType and minorType are the two key attributes used to identify the alarm type.
probableCause[0..1]	minorType The attributes majorType and minorType are the two key attributes used to identify the alarm type.
sequenceNumber[0..1]	originalAdditionalText The additional text set when the alarm was raised. This is a set of alarm information change or severity change.
source[0..1]	originalEventTime The timestamp when the alarm was raised. This is a set of alarm information change or severity change.
specificProblem[0..1]	originalSeverity The perceived severity of the alarm. It may change during the alarm's lifetime.

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View Alarms – show-table



To verify Alarm through COM-CLI, execute the following command :

```
show-table ManagedElement=1, SystemFunctions=1, Fm=1 -m FmAlarm -p fmAlarmId, specificProblem
>show-table ManagedElement=1, SystemFunctions=1, Fm=1 -m FmAlarm -p fmAlarmId, specificProblem
=====
| fmAlarmId | specificProblem
=====
| 74       | License Management, Capacity Usage Threshold Reached |
=====
>
>ManagedElement=NLHRL1PCRF98, SystemFunctions=1, Fm=1
(Fm=1)>
(Fm=1)>show-table -m FmAlarm -p fmAlarmId, specificProblem
=====
| fmAlarmId | specificProblem
=====
| 74       | License Management, Capacity Usage Threshold Reached |
=====
(Fm=1)>
```

The alarm and alert is also available in file /cluster/storage/no-backup/nbi_root/FaultManagementLog

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Log Records in Alarm Log – Sample



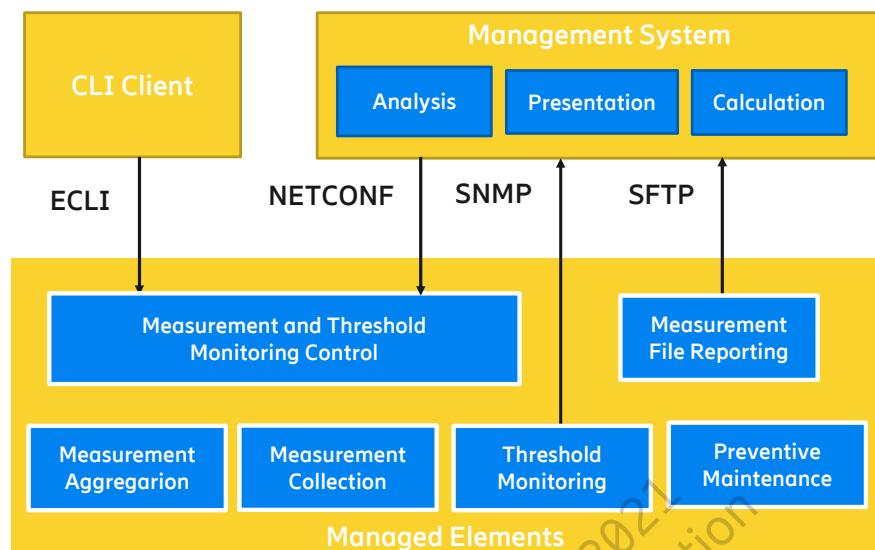
```
.....  
<FmLogRecord>  
<LogTimestamp>2014-03-27T10:53:55+01:00</LogTimestamp>  
<Alarm>1;2014-03-27T10:53:55+01:00;ManagedElement=1,Equipment=1,⇒  
PluginUnit=13;123;429876;HW Fault;418;CRITICAL;Overheated;3;⇒  
EQUIPMENTALARM;2014-03-27T10:53:49+01:00;MAJOR;Overheated;1;2;⇒  
core1 temp;87;core2temp;93</Alarm>  
</FmLogRecord>  
<FmLogRecord>  
<LogTimestamp>2014-03-27T10:53:55+01:00</LogTimestamp>  
<Alarm>1;2014-03-27T10:53:55+01:00;ManagedElement=1,Transport=1,⇒  
Atm=1;421;792134;Link Overload;613;MAJOR;;5;COMMUNICATIONSALARM;⇒  
2014-03-27T10:53:49+01:00;MINOR;Link Overload;2;1;overload;130</Alarm>  
</FmLogRecord>  
<FmLogRecord>  
<LogTimestamp>2014-03-27T10:53:55+01:00</LogTimestamp>  
<Alarm>1;2014-03-27T10:53:55+01:00;ManagedElement=1,Transport=1,⇒  
Atm=1;421;792134;Link overload;613;CLEARED;;5;COMMUNICATIONSALARM;⇒  
2014-03-27T10:53:49+01:00;MINOR;Link Overload;2;0</Alarm>  
</FmLogRecord>  
.....
```

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Performance Management Interfaces



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PM: Managed Object Model



```
ManagedElement
  +-SystemFunctions
    +-Pm
      +-PmGroup
        +-MeasurementType
      +-PmJob
        +-MeasurementReader
          +-PmThresholdMonitoring
        +-PmMeasurementCapabilities
```

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Performance Management XML Files



- Performance measurement XML files are compliant with 3GPP® TS 32.435. The files are of type "A", which means that the file contains results of measurements collected from a single ME during a single GP, according to the 3GPP TS 32.432 V10.0.0 standard. The performance measurement XML files also handle multi-value counters, which are an addition to the 3GPP standard.
- The performance XML file can optionally be compressed using GZIP to reduce the amount of disk space used
- A report file contains results of measurements collected from a single Managed Element (ME) during a single Granularity Period (GP) by all active measurement jobs
- The PM report file format is according to 3GPP TS 32.432 type A and is built on the example in 3GPP TS 32.435 Annex A.2
- In addition, multi-value counters, also known as Probability Density Function (PDF) measurements, are supported but are not part of the 3GPP specification

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Performance Management Report File



The performance management report file can be retrieved through SFTP:

SFTP port 22 (normal port) with directory path :

/cluster/storage/no-backup/nbi_root

SFTP port 115 : get a direct access to the report files

```
group01@jh-sapc-hot:~$ sftp -P 115 sapcadmin@10.11.1.24
Password:
Connected to 10.11.1.24.
sftp> pwd
Remote working directory: /
sftp> ls -ltr
drwxr-xr-x    2 320      cmw-ispl     4096 Dec 17 18:19 InServicePerformance
drwxrwxrwx    2 307      cmw-swml     4096 Dec 17 18:19 SoftwareManagement
drwxrwx---    2 304      system-nbi-data 4096 Dec 17 18:28
BackupAndRestoreManagementFiles
drwxrwx---    2 cmw-core   system-nbi-data 4096 Feb 27 13:59 AlertLogs
drwxrwx---    2 cmw-core   system-nbi-data 4096 Feb 27 14:03 AlarmLogs
drwxrws---    2 311      system-nbi-data 77824 Mar  2 16:25
PerformanceManagementReportFiles
```

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Performance Management – Job Types



- The execution of measurement data collection, aggregation, and reporting is performed by **measurement jobs**
- A measurement job applies to one or more measurement types or to an entire PM group
- The Measurement reader defines the measurement being counted in a particular measurement job and ties it to the specific measurement types (counters) or a PM group (counter group)
- A measurement job executes the measurement types respective collection method and aggregation method at regular time intervals as defined by its granularity period (default 15 minutes) and exports XML
 - ❖ A **threshold job** monitors measurement data and raises an alarm when a threshold is crossed, but do not collect measurement data (does not export XML files)
 - ❖ A threshold job raises or clears an alarm based on a comparison of the counter value with the configured high and low threshold values
 - ❖ At the end of the GP, if the counter value is higher than the high threshold value and no alarm is active, then an alarm is raised.
 - ❖ If the counter value is lower than the low threshold value and if an alarm is active, then the alarm is cleared

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Measurement counters – PM Groups



The SAPC provides statistic measures in groups related to several interface protocol messages and functions:

- Gx Protocol Measures
- Rx Protocol Measures
- Sy Protocol Measures
- Smp Protocol Measures
- Protocol Measures
- NpcfSm Protocol Measures
- Nnrf Protocol Measures
- Nudr Protocol Measures
- Fair Usage Control Measure
- Notification Measures
- Notification Measures
- Capacity Measures
- Resource Measures
- DBS Measures
- External Database Measures
- EBM Measures
- Optional Measures
- REST Measures
- Other Measures

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Examples of Gx SAPC Measurements



- gxCcasSuccess: The number CCAs sent indicating success (Result-Code AVP set to 2001). Cumulative Counter This counter is related to the messages on the Gx interface.
- gxCcasRejected: The number of CCAs sent indicating authorization rejected (Result-Code AVP set to 5003). Cumulative Counter This counter is related to the messages on the Gx interface
- gxCcasInitTooBusy: The number of CCAs initial sent indicating too busy (Result-Code AVP set to 3004)
- gxCcasUpdateSuccess: The number of CCAs sent indicating successful (Result-Code AVP set to 2001) IP-CAN session modification
- gxCcrCcaLatencyBetween101_120: The number of Gx transactions that latency between receiving a Gx CCR (including CCR-I, CCR-U, and CCR-T) and sending a corresponding Gx CCA is between 101 to 120 ms
- gxCrsInit: The number of initial CCRs received (CC-Request-Type AVP set to value INITIAL)

For the full available measurements list in SAPC for all interfaces: "Measurements User Guide" in CPI library

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Example of Gx SAPC Measure - gxCcassSuccess



Under PmGroup MO you can find all the available performance management group counters

```
ManagedElement=1, SystemFunctions=1, Pm=1, PmGroup=policyControlFunctionGxMeasuresGro  
up, MeasurementType=gxCcassSuccess  
(MeasurementType=gxCcassSuccess) >show  
MeasurementType=gxCcassSuccess  
aggregation=SUM collectionMethod=CC  
derSampleRate=1 description="The number CCAs sent indicating success (Result-Code  
AVP set to 2001)."  
initialValue=0  
measurementName="gxCcassSuccess"  
measurementResult="1"  
measurementStatus=USED  
multiplicity=1  
resetAtGranPeriod=true  
size=1  
thresholdDirection=INCREASING  
(MeasurementType=gxCcassSuccess) >
```

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Measurement Job example creation



Navigate to the Pm MO, for example: >ManagedElement=NODE06ST, SystemFunctions=1, Pm=1

Enter Config mode: (Pm=1)>configure

Create a measurement collection job: (config-Pm=1)>PmJob=test_15min_Job

Set the PmJob initial state to ACTIVE: (config-PmJob=test_15min_Job)>requestedJobState=ACTIVE

Perform one of the following options:

Create one or more MeasurementReader MOs with references to PmGroup MOs, for example

```
(config-PmJob=test_15min_Job)>MeasurementReader=testjob_mr  
(config-MeasurementReader=testjob_mr)>measurementSpecification  
(config-measurementSpecification)>groupRef="ManagedElement=NODE06ST, SystemFunctions=1, Pm=1, PmGroup=policyControlFunctionGxMeasuresGroup"
```

Create one or more MeasurementReader MOs with references to measurementType MOs, for example:

```
(config-PmJob=test_15min_Job)>MeasurementReader=testjob_inst_mr  
(config-MeasurementReader=testjob_inst_mr)>measurementSpecification  
(config-measurementSpecification)>measurementTypeRef="ManagedElement=NODE06ST, SystemFunctions=1, Pm=1, PmGroup=policyControlFunctionGxMeasuresGroup, MeasurementType=gxCcasSuccess"
```

Commit the changes: (config-measurementSpecification)>commit

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Backup & Restore



- SAPC database is based on DBS (Database Service solution)
- The DBS Solution is an in-memory, object-oriented, cluster-wide distributed database system falling into the NoSQL class of database management systems
- Because of its in-memory characteristic, it is very important to do backup regularly
- System data backup is used to do a system data fallback to recover to a former version of the whole system with consistency

Path / File	Description
/cluster/brf/backup/<backup-name>/	<ul style="list-style-type: none">• Software installed• Node configuration• Static Subscriber information• Dynamic Subscriber information

- The following data is lost during SAPC restore (restart)
- IP-CAN sessions
- Time Trigger events

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Managed Object Model

BRM MOM class is accessed using NETCONF or ECLI:

```
ManagedElement
+-SystemFunctions
+-BrM
+-BrmBackupManager
+-BrmBackup
+-BrmBackupHousekeeping
+-BrmBackupLabelStore
+-BrmBackupScheduler
+-BrmCalendarBasedPeriodicEvent
+-BrmPeriodicEvent
+-BrmSingleEvent
```

Managed Object Class	Description
BrmBackupManager	Handles backups of System Data. Provides actions for creating new backups and deleting backups of the corresponding type.
BrmBackup	Describes a backup of the type specified by the BrmBackupManager MO.
BrmBackupHousekeeping	Handles preventive maintenance of manually created backups.
BrmBackupLabelStore	Describes labeled backups for the type specified by MO BrmBackupManager.
BrmBackupScheduler	Handles scheduling of a backup.
BrmCalendarBasedPeriodicEvent	Handles periodic scheduled backup events using a calendar-based interval.
BrmPeriodicEvent	Handles periodic scheduled backup events.
BrmSingleEvent	Handles single scheduled backup events.

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Creating a Backup



- Navigate to the BrmBackupManager managed object:

```
> ManagedElement=NODE06ST, SystemFunctions=1, BrM=1, BrmBackupManager=SYSTEM_DATA
```

- Start the backup operation:

```
(BrmBackupManager=SYSTEM_DATA) >createBackup PERF_BACKUP_NAME1_20140428_175907
```

- Note: If needed, To cancel the creation of a manual backup, type in cancelCurrentAction

- Verify that the backup was created:

```
(BrmBackupManager=SYSTEM_DATA) >show progressReport
```

- If an error occurs during the execution of the operation, attribute reportProgress shows result=FAILURE and resultInfo shows the failure cause.

- Backup files can be found in /cluster/brf/backup:

```
SC-1:/cluster/brf/backup # ll  
drwxr-xr-x 2 root root 4096 Jan 12 14:57 NLAHM1PCRF01_TEST_20160112_1455  
drwxr-xr-x 2 root root 4096 Nov 4 14:08 SMF-BACKUP_2015-11-04T14-07-10
```

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Restore a Backup



To perform the SAPC System Data restore, execute the following steps:

1. Access to the SAPC, using ECLI, according to System Administrator Guide.
2. Verify that the SAPC status is correct following the procedure described in Preventive Maintenance
3. In Geographical Redundancy, stop the data replication between zones, following the procedure explained in Temporarily Disable Geographical Redundancy
4. Follow the procedure explained in Restore Backup, using BrmBackupManager=SYSTEM_DATA

At this step, the SAPC is restarted automatically.

Wait until the system is operational again. Check the restore operation result, following the procedure described in View Progress Report, and check the SAPC Status following the procedure described in Preventive Maintenance.

Check IMM Persistent Back End, following the procedure described in Preventive Maintenance. At this stage, the SAPC is ready to process traffic, and configuration and provisioning operations can be executed.

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Chapter 6 Summary



After this chapter, the student should now be able to:

- Understand the SAPC OAM tools
- Comprehend the cluster platform configuration file
- Describe the main log files and the logging enhancements
- Work with the fault management part
- Understand measurements and the performance management
- Perform the SAPC backup and restore procedures

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SAPC Basic Troubleshooting



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Chapter 7 Objectives



On completion of this chapter, the participants will be able to:

- Explain the tools available for troubleshooting including sapcCaptureTool and session-handler
- Describe the recommended maintenance activities and intervals
- List the GeoRed troubleshooting activities
- Understand the license function
- Explain the UE trace for SAPC including the Sd and Sy interfaces.
- Describe the EBM function

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Troubleshooting Tools: forall



```
SC-2:~ # forall AllNodes hostname
PL-3
PL-4
SC-1
SC-2
SC-2:~ # forall cluster hostname
SC-1
SC-2
PL-3
PL-4
SC-2:~ # forall control hostname
SC-1
SC-2
SC-2:~ # forall payload hostname
PL-3
PL-4
```

The command below obtains the number of connections in port 3868 for all PLs:

```
forall PLs 'hostname; netstat -anp | grep -c 3868'
PL-3
1
PL-4
1
```

The command below executes the uptime command in all nodes of the cluster:

```
forall cluster 'hostname ; uptime'
```

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Troubleshooting Tools: immHelper



```
SC-2:~ # immHelper ng
[Node Group] [Node List or empty data if missing]
sapc_all PL-3 PL-4 SC-1 SC-2
sapc_pls PL-3 PL-4
sapc_scs SC-1 SC-2
Done!

SC-2:~ #
```

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Toolbox: amfHelper



This command executes actions on Service Units.

Example:

```
SC-2:~ # amfHelper -f 'pcrf|CDiameter'  
Missing action parameter, specify now:  
  (1: stop, 2: start, 3: restart, 4: repair, q: quit)  
3  
Perform service unit operations:  
  Executing amf-adm lock safSu=PL-4,safSg=NWA,safApp=ERIC-sapc.pcrfProc.payload ... done!  
  Executing amf-adm unlock safSu=PL-4,safSg=NWA,safApp=ERIC-sapc.pcrfProc.payload ... done!  
  Executing amf-adm lock safSu=PL-3,safSg=NWA,safApp=ERIC-sapc.pcrfProc.payload ... done!  
  Executing amf-adm unlock safSu=PL-3,safSg=NWA,safApp=ERIC-sapc.pcrfProc.payload ... done!  
  Executing amf-adm lock safSu=PL-4,safSg=NWA,safApp=ERIC-sv.SVCDiameter ... done!  
  Executing amf-adm unlock safSu=PL-4,safSg=NWA,safApp=ERIC-sv.SVCDiameter ... done!  
  Executing amf-adm lock safSu=PL-3,safSg=NWA,safApp=ERIC-sv.SVCDiameter ... done!  
  Executing amf-adm unlock safSu=PL-3,safSg=NWA,safApp=ERIC-sv.SVCDiameter ... done! Done!  
SC-2:~ #
```

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OpenSAF CoreMW IMM – AMF



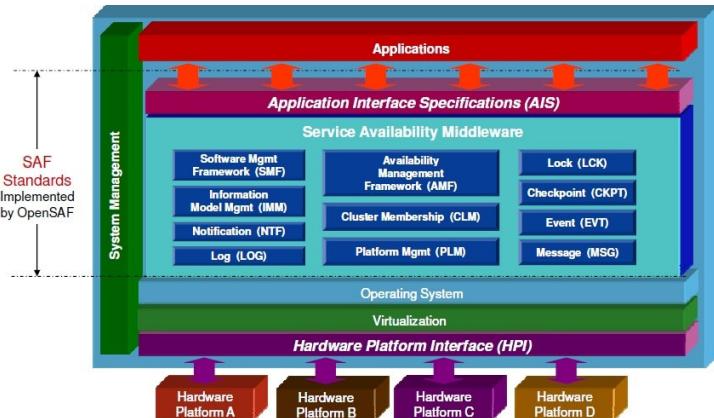
From OpenSAF's web page:

IMM

- Defines and manages middleware and application's configuration and state information in the form of managed objects and their attributes
- Configuration changes are handled as transactions to ensure consistency of configuration data

AMF

- High availability and workload management framework
- Supports the Active/Standby and Active/Active models for the applications' LCM



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Toolbox: pot-utility



Displays information about Persistent Object Type (POT) status and management. This tool accesses to DBS and retrieves information related to POTs

This tool runs in any traffic payload where DBS is installed. The sapcadmin can run this command.

Example:

```
PL-3:~ # pot-utility select ContentPot
Initializing DBN API
Waiting for DBN (false)...
Pots to select: ContentPot. Filter: <not provided>

TABLE ContentPot: id(key) | pccRuleId | pccRuleName | tdfAppId | pccRuleType | precedence |
flows | qosProfileId | chargingProfileId | adcRedirectProfileId | adcMuteNotification |
adcRuleName | adcRuleType | description | flowStatus | defQosFlowIndication | monitoringKey
ContentPot: Internet | | test | | 1 | | | | | | | | | | | |
ContentPot: HTTP | 300 | 300 | | 0 | | | | | | | | | | |
ContentPot: Default | 999 | 999 | | 0 | | | | | | | | | |
ContentPot: Chat | 1000 | 1000 | | 0 | | | | | | | | | |
ContentPot: FTP | 200 | 200 | | 0 | | | | | | | | | |
PL-3:~ #
```

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Troubleshooting Tools: sapcHealthCheck



```
sapcadmin@SC-X:~> sudo sapcHealthCheck
=====
HEALTH CHECK REPORT =====
(provide -h to get help)

Checking the SAPC is installed...
SAPC installation --> OK --> All the 17 ERIC-SAPC SDPs installed are used [main version: ERIC-SAPC-CXP9030138_6-R2B28].
Checking TIPC communication...
TIPC --> OK --> All the 12 available nodes at TIPC level are up.
Checking DRBD devices...
DRBD device --> OK
Checking CMW status...
CMW status --> OK --> All the "node comp app su si sg siass csiass pm" are OK.
Checking AMF status...
AMF status --> OK --> All the AMF entities are OK.
Checking active FM alarms...
Alarms --> OK --> There are no active FM Alarms.
Checking existing coredumps...
Coredumps --> OK --> There are no core dumps.
Checking Diameter daemon status...
Diameter stack --> OK --> The stack is alive in every running PL.
Checking Data Base...
All Data Base agents working normally --> OK
Checking error logs in the system...
No errors in the system --> OK
*** SAPC HEALTH CHECK SUMMARY ***
WARNINGS: 0
CRITICAL ERRORS: 0
*****
SAPC Health Check finished: OK
```

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Check the Processor Load

```
PL-3:~ # top
top - 13:46:39 up 17 days, 6 min,  2 users,  load average: 0.54, 0.43, 0.36
Tasks: 249 total,   1 running, 248 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.1 us,  0.8 sy,  5.3 ni, 92.6 id,  0.0 wa,  0.0 hi,  0.2 si,  0.0 st
KiB Mem: 7159032 total, 4986460 used, 2172572 free,          0 buffers
KiB Swap:      0 total,       0 used,       0 free. 2925592 cached Mem
Unknown command - try 'h' for help
      PID USER      PR  NI      VIRT      RES      SHR S %CPU %MEM     TIME+ COMMAND
    481 root      20   0 10.866g 242500  8160 S 1.329 3.387 40:04.16 Dbn
13414 root      20   0 1431864 216564  4920 S 0.997 3.025 421:32.18 beam.smp
14820 root      20   0 409504 70424  1772 S 0.664 0.984 17:17.52 logd
10943 root      20   0 109256 1788  1364 S 0.332 0.025 16:21.48 lbeagent
11075 root      20   0 256736 3976  1428 S 0.332 0.056 16:57.57 lbeagent
12044 root      30  10 2523296 207004 13908 S 0.332 2.892 72:33.93 java
12050 root      30  10 2544212 215688 14460 S 0.332 3.013 76:52.38 java
```

- To verify that the node is correct and prevent any unexpected situation, the values for the CPULoad
 - Total must be less than 75% and Mem.PercentUsed must be less than 80%.
 - If any of these indicators are not correct, contact Ericsson personnel before free any memory or reduce the CPU load.

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Check the Alarms



Example:

```
>show-table ManagedElement=SAPC1, SystemFunctions=1, Fm=1 -m FmAlarm -p fmAlarmId,  
specificProblem  
=====| fmAlarmId | specificProblem |  
=====| 16 | Policy Control, Connection to UDR Failed for SM Policy Control. |  
| 17 | Policy Control, Connection to UDR Failed for SM Policy Control. |  
| 19 | LOTC Time Synchronization |  
| 21 | LOTC Time Synchronization |  
| 23 | License Management, Emergency Unlock Reset Key Required |  
=====|  
>
```

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Check the Logs



Logs	File
SAPC Application Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/sapc_<createdate>_<createtime>[_<closedate>_<closetime>].log
Alarm Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogAlarm_<createdate>_<createtime>[_<closedate>_<closetime>].log
Notification Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogNotification_<createdate>_<createtime>[_<closedate>_<closetime>].log
System Logs	/cluster/storage/no-backup/coremw/var/log/saflog/saLogSystem_<createdate>_<createtime>[_<closedate>_<closetime>].log
SAPC Emergency Calls Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/emergencyCalls_<createdate>_<createtime>[_<closedate>_<closetime>].log
REST Logs	/cluster/storage/no-backup/coremw/var/log/syslog/sapc/rest_<createdate>_<createtime>[_<closedate>_<closetime>].log
Campaign Generation Logs (tcg)	/storage/no-backup/coremw/var/log/tcglog/tcg.log
Diameter logs	/storage/no-backup/diacc/log/

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Traffic Measurements



- Gx Protocol Measures
- Rx Protocol Measures
- Sy Protocol Measures
- Smp Protocol Measures
- Sd Protocol Measures
- NpcfSm Protocol Measures
- Nnrf Protocol Measures
- Nudr Protocol Measures
- Fair Usage Control Measures
- Notification Measures
- Capacity Measures
- Resource Measures
- DBS Measures
- External Database Measures
- EBM Measures
- Optional Measures
- REST Measures

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Check the Traffic Measurements



Measure Name	Name (identification) of the measure type. Indicates what is measured.
Measure Meaning	It explains the data collected in this measure.
Measured Object Instance	String key identifying the measured object (MOID). For example, a measure can be collected for a specific network element (Peer) that communicates to or from the SAPC using an external interface. Its corresponding MOID is the network identifier of the peer. For those cases, this document states <Network Peer>, for example <PcefDN PeerDN>. In other cases, the measure is collected in general for a concept in the SAPC, and in this case its MOID takes a fixed string value, for example "Sessions".
Alarm Id	For Fault Detection related measures, identifier of the associated alarm. A dash means that there is not any alarm related to it.
Measurement Type	It indicates the collection method for the measure: Cumulative Counter. Gauge. Status Inspection. Discrete Event Registration.

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Check the Traffic Measurements - Examples



Measure Name	gxCcrsInit
Measure Meaning	The number of initial CCRs received (CC-Request-Type AVP set to value INITIAL).
Measured Object Instance	<Pcef Peer>
Alarm Id	-
Measurement Type	Cumulative Counter
Measure Name	rxAasFailed
Measure Meaning	The number of AAAs sent indicating not success (Result-Code AVP set to a value different than 2001)
Measured Object Instance	<Pcef Peer>
Alarm Id	Major Type: 193 Minor Type: 7077894
Measurement Type	Cumulative Counter
Measure Name	gxRars
Measure Meaning	The number of RARs sent.
Measured Object Instance	<Pcef Peer>
Alarm Id	-
Measurement Type	Cumulative Counter

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Check the Core Files



Check the Core Dump existence by following these steps:

1. Access to the SAPC.
2. Run `sapcadmin@SC-X>ls -la /cluster/dumps`

If there are many core files, <filename>.core, contact Ericsson personnel

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Check the System Messages



Important information about the general status of the different processors can be found as root user in the following files found in any SC processor:

```
root@<SC-X>:/var/log/<node-id>/auth*
root@<SC-X>:/var/log/<node-id>/kernel*
root@<SC-X>:/var/log/<node-id>/messages*
```

Note: Where <SC-X> is SC-1 or SC-2

Where <node-id> is SC-1, SC-2, PL-3, PL-4 or PL-n

```
SC-1:/var/log/SC-1 # ls
auth auth.3 auth.6 auth.9 messages.1 messages.4 messages.7
auth.1 auth.4 auth.7 kernel messages.2 messages.5 messages.8
auth.2 auth.5 auth.8 messages messages.3 messages.6 messages.9
SC-1:/var/log/SC-1 #
```

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EVIP Quick Checks



```
sapcadmin@SC-1:~> telnet `/opt/vip/bin/getactivecontrol` 25190
Trying fe80::1234%evip_macvlan0...
Connected to fe80::1234%evip_macvlan0.

.....
* All rights reserved.

EVIP> show albs
0 : 'alb_trf' : ACTIVE
1 : 'alb_oam' : ACTIVE
OK

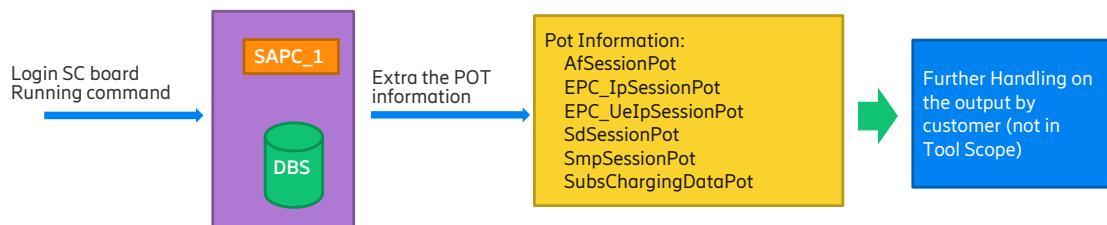
EVIP> show status
EVIP> show agents
EVIP> show hosts
EVIP> show evip-status
EVIP> show floating-config
```

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sapcSessionCollector tool – Workflow



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sapcSessionCollector usage details help



Login one of SCs as user **sapcadmin**.

```
# sapcSessionCollector -h
usage: sapcSessionCollector [-h] [-i POTs name list [POTs name list ...]]
                             [--all] [-s size]

Collects active sessions information from the related POTs in DBS and save to
files. Different types of POT data will be written into different files.

Optional arguments:
  -h, --help            show this help message and exit
  -i                   POTs name list [POTs name list ...]
                      The supported types of POT include AfSessionPot,
                      EPC_IpSessionPot, EPC_UeIpSessionPot, SdSessionPot,
                      SmpSessionPot and SubsChargingDataPot.
  --all                Collects all supported POTs.
  -s size              Maximum size for each file, data will be split into
                      several files if it is too large. (default=10M)
```

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sapcSessionCollector sample output



Example for tools running:

- When started, the time will be estimated. "?" used before estimation done
- The elapsed time and remained time, the velocity of the session reading.
- The progress is shown in percentage and progress bar

```
sapcadm@SC-2:~$ sudo sapcSessionCollector -i EPC_UeIpSessionPot -s 100m
PL-3 will be used to retrieve the session information:
EPC_UeIpSessionPot: 0%| [00:00 - ?, ?Session/s]

sapcadm@SC-2:~$ sudo sapcSessionCollector -i EPC_UeIpSessionPot -s 100m
PL-3 will be used to retrieve the session information:
EPC_UeIpSessionPot: 1%[#####
sapcadm@SC-2:~$ sudo sapcSessionCollector -i EPC_UeIpSessionPot -s 100m
PL-3 will be used to retrieve the session information:
EPC_UeIpSessionPot: 56%[#####
sapcadm@SC-2:~$ [00:06 - 00:22, 1843.69Session/s]
[s00:17 - 00:11, 1871.82Session/s]

• The output file will be prompted when finished:
[s/cluster/brf/backup/sessions/EPC_UeIpSessionPot_20181116-092141_?.txt]
```

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Startup and Shutdown



Note: Before performing any of these actions, it is recommended to perform a backup.

To restart the SAPC, execute the following steps:

```
sapcadmin@SC-X> sudo sapcApplication -a restart  
sapcadmin@SC-X> sudo sapcApplication -a status
```

To stop the SAPC, execute the following steps:

```
sapcadmin@SC-X> sudo sapcApplication -a stop  
sapcadmin@SC-X> sudo sapcApplication -a status
```

To start the SAPC, execute the following steps:

```
sapcadmin@SC-X> sudo sapcApplication -a start  
sapcadmin@SC-X> sudo sapcApplication -a status
```

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Processor Restart



If a fault is confirmed, check if there is a node locked:

```
sapcadmin@SC-n:~ #cmw-status node
```

If the active System Controller is locked, do one of the following:

Unlock the System Controller:

```
sapcadmin@SC-n:~> cmw-node-unlock <locked-processor>
```

Perform a reload of the recently unlocked System Controller:

```
sapcadmin@SC-n:~> sudo cmw-node-reboot <locked-processor>
```

Wait until the processor is back, then check the SAPC status:

```
sapcadmin@SC-X>sudo sapcApplication -a status
```

The commands cmw-node-lock SC-2 and cmw-node-unlock SC-2 applies to a processor (SC-1, SC-2 or any PL), while the command sapcApplication -a restart applies to the SAPC application (no matter the number of processors).

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Cluster Reboot (cmw-cluster-reboot)



- The cluster reboot command re-initiates all the guest operating system and all the PLs.
- The cluster reboot implies a backup is read.
- A complete system reload is ordered, if faults are confirmed, typing the following command:
 - cmw-cluster-reboot

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Preventive Maintenance – Health Check Commands



Check the status of the DRBD mirrored /cluster partition

```
sapcadmin@SC-1> drbdadm status
drbd0 role:Secondary
disk:UpToDate
SC-2 role:Primary
peer-disk:UpToDate
```

Check Core Dump existence:

```
sapcadmin@SC-<X>> ls -la /cluster/dumps
```

Check CPU Load and Memory Usage using the Linux *top* and *free* commands

CBA quick check. Check the status of the essential core middleware components

```
SC-2:~ # cmw-status node
Status OK
SC-2:~ # cmw-status comp su si
: Status OK
```

Check status of all the nodes in the cluster (all neighbors expected in UP state)

```
SC-1:~ # tipc-config -n
```

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Preventive Maintenance – Health Check Commands



The **sapcHealthCheck** script performs several checkups to verify the status of the system: TIPC communication, DRBD devices, CMW status, active FM alarms, existing core dumps, DB and error logs

It also provides an overall status in function of checkups results

According to the activity (installation, upgrade, O&M or scaling workflow), this script applies different checkups and uses different criteria for overall status

```
sapcadmin@SC-1:~> sudo sapcHealthCheck -h
Usage: sapcHealthCheck [-t <seconds>] [-p CHECKUP ]
                      sapcHealthCheck [-t <seconds>] [BATCH]
OPTIONS:
  -h, --help           help
  -t, --timeout        timeout seconds for checking platform commands. Set on 300 sg by default.
  -p, --param          specific checkup
CHECKUP:
  SAPCInstallation
  Connectivity
  DRBD
  CoreMiddleware
  :Alarms
  CoreDumps
  SystemOperative
  DataBase
  ErrorLogs
```

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CBA Status Commands



CBA quick check. Check the status of the linux nodes

```
SC-2:~ # cmw-status node  
Status OK  
SC-2:~ # cmw-status comp su si  
Status OK
```

Check status of all the nodes in the cluster (can be given on any node in the cluster)

```
SC-1:~ # tipc-config -n  
Neighbors:  
<1.1.2>: up  
<1.1.3>: up  
<1.1.4>: up  
:
```

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CBA Status Commands



```
SC-1:~ # amf-state
Service Instances UNLOCKED and UNASSIGNED:
Service Units UNLOCKED and DISABLED:
Nodes UNLOCKED and DISABLED:
SC-1:~ #
```

} Expected result

immHelper

This command helps to know the current SAPC components state, according to the following use:

```
SC-1:~ # immHelper ng2
[Node Group] [Node List or empty data if missing]
  spc_all PL-3 PL-4 SC-1 SC-2
  spc_all[U] PL-3 PL-4 SC-1 SC-2
  spc_all[L] PL-3 PL-4
  spc_pls PL-3 PL-4
  spc_pls[U] PL-3 PL-4
  spc_pls[L] PL-3 PL-4
  spc_scs SC-1 SC-2
  spc_scs[U] SC-1 SC-2
  spc_scs[L] SC-1 SC-2
Done!
SC-1:~ #
```

} L: Locked state
U: Unlocked state

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CBA Status Commands



Clurun.sh is an internal database CLI tool that provides useful information about database status

To verify that all the database cluster components are working properly, get_node_state tool is used as detailed below

Each node status may be Disabled, Starting or Started

Everything normal when every node is 'Started'

```
SC-2:~ # clurun.sh get_node_state
Result from [.cdsv.director]:
safAmfNode=PL-3,safAmfCluster=myAmfCluster is Started
safAmfNode=PL-4,safAmfCluster=myAmfCluster is Started
safAmfNode=PL-5,safAmfCluster=myAmfCluster is Started

Result from [PL-3.cdsv.director]:
safAmfNode=PL-3,safAmfCluster=myAmfCluster is Started
safAmfNode=PL-4,safAmfCluster=myAmfCluster is Started
safAmfNode=PL-5,safAmfCluster=myAmfCluster is Started
.....
```

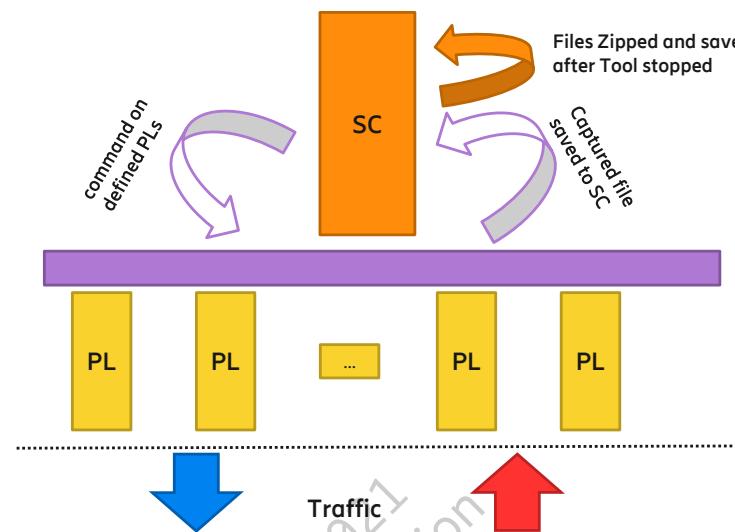
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sapcCapture Tool Overview

- Tool to capture the message on live PLs
- The collected data can be used for maintenance
- The generated capture files are saved in a standard PCAP format file and stored in the SC node



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sapcCaptureTool Usage



Login on one of SCs as user **sapcadmin**

```
SC-1:~ # sapcCaptureTool -h
Parameters for Capture Tool:
  -h or --help      : Show this help message and exit
  -PL <PL list>    : PL name, support multi-value.
                      [Example: -PL PL-3,PL-4]
  -g percentage     : Percentage, limit of the used disk storage of capture files. Default: no limit.
                      [Example: -g 50]
  -m time           : Time limit for the duration of capturing in seconds, if the time is reached, exit.
Default: no limit.
  -b                : true or false. Define if stop when one or several PLs acting abnormal.
  -f                : Force exit command from other terminal, which should graceful terminate.

Parameters for Tcpdump:
  [-aAbdDefhHIJKLnNOpqStuUvxX#] [ -B size ] [ -c count ]
  [ -C file_size ] [ -E algo:secret ] [ -F file ] [ -G seconds ]
  [ -i interface ] [ -j tstamptype ] [ -M secret ] [ --number ]
  [ -Q in|out|inout ]
  [ -R file ] [ -s snaplen ] [ --time-stamp-precision precision ]
  [ --immediate-mode ] [ -T type ] [ --version ] [ -V file ]
  [ -W filecount ] [ -y datalinktype ] [ -z postrotate-command ]
  [ -Z user ] [ expression ]
```

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sapcCaptureTool sample usage output

```
SC-1:~ # sudo sapcCaptureTool -m 100 -PL pl-3,pl-4
2019-06-04 07:51:14,781 - INFO - 560 - sapcCaptureTool - ===== sapcCaptureTool starts =====
2019-06-04 07:51:14,781 - INFO - 561 - sapcCaptureTool - Warning: Please pay attention to Disk Usage!
2019-06-04 07:51:14,782 - INFO - 562 - sapcCaptureTool - Make sure that before and after sapcCaptureTool starts
2019-06-04 07:51:14,782 - INFO - 563 - sapcCaptureTool - there is sufficient disk space to store pcap files!!!
2019-06-04 07:51:14,782 - INFO - 566 - sapcCaptureTool - Pre check capture tool instance...
2019-06-04 07:51:16,637 - INFO - 259 - sapcCaptureTool - ===== Capture Tool initialisation =====
2019-06-04 07:51:16,674 - INFO - 426 - sapcCaptureTool - Start to run tcpdump command...
2019-06-04 07:51:16,674 - INFO - 461 - sapcCaptureTool - Start to get diameter traffic interface...
2019-06-04 07:51:16,777 - INFO - 457 - sapcCaptureTool - Tcpdump starts in PL-3.
2019-06-04 07:51:16,784 - INFO - 457 - sapcCaptureTool - Tcpdump starts in PL-4.
uname: invalid option -- #
Try 'uname --help' for more information.
uname: invalid option -- #
Try 'uname --help' for more information. Traffic ALB will be the default interface to dump diameter message.
tcpdump: listening on alb_tr, link-type LINUX_SLL (Linux cooked), capture size 262144 bytes
tcpdump: listening on alb_tr, link-type LINUX_SLL (Linux cooked), capture size 262144 bytes
^C
Graceful exit when received "^\c"
2019-06-04 07:51:31,837 - INFO - 315 - sapcCaptureTool - Signal is received, Capture Tool will stop to run!
2019-06-04 07:51:31,837 - INFO - 525 - sapcCaptureTool - Graceful Termination starts...
2019-06-04 07:51:32,934 - INFO - 377 - sapcCaptureTool - The timer to check PLs status is completed...
2019-06-04 07:51:33,585 - INFO - 501 - sapcCaptureTool - Forced to quit due to all tcpdumps stop running...
2019-06-04 07:51:34,443 - INFO - 542 - sapcCaptureTool - All tcpdumps stop to run, time to Compress files.
2019-06-04 07:51:36,837 - INFO - 335 - sapcCaptureTool - The timer to check disk usage is completed...
2019-06-04 07:51:41,477 - WARNING - 193 - sapcCaptureTool - Capture tool is compressing pcap files, please do not use 'ctrl + c' to stop Capture Tool.
Otherwise, the compression will stop either.
2019-06-04 07:51:41,495 - INFO - 196 - sapcCaptureTool - Compress result: 20190604_075114/
20190604_075114/PL-3_alb_tr.pcap
20190604_075114/PL-4_alb_tr.pcap
The captured files will be compressed saved to dedicated path.
2019-06-04 07:51:41,495 - INFO - 197 - sapcCaptureTool - Compress successfully in /cluster/storage/captureTool/ with name: 20190604_075114.tar.gz
SC-1:~ #
```

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Session-handler Tool



Tool to show or delete ongoing sessions for a specific subscriber. On any PL:

```
session-handler --trafficId <trafficId> --action <action> [--  
sessionType< <sessionType>>] [--onlyAF] [--noConfirm] [--cfg <configFile>] | --help
```

Parameters	Description
--help	This help message.
--trafficId <trafficId>	The traffic ID value (IMSI, MSISDN, or SIP-URI value) identifying the subscriber whose sessions are going to be shown or deleted. Note: <SIP-URI> is not supported by the SAPC PCF.
--action <action>	Action to be executed. The valid values are: show, delete.
--sessionType <sessionType>	This option is applied only for the delete action. It indicates the session type to be deleted. The valid values are: Gx N7 N15_AMPC. If Gx is specified, the Gx sessions and their dependent Rx, Sy, and Sd sessions will be deleted. If N7 is specified, the N7 sessions and their dependent Rx sessions will be deleted. If this option is omitted, all the sessions (Gx, N7, N15_AMPC, Rx, Sy, and Sd) will be deleted.
--onlyAF	Apply the requested action only to AF sessions (Rx).
--noConfirm	Do not ask for confirmation in case of a delete action request.
--cfg <configFile>	A specific configuration file to replace the default configuration file and to override the default configuration values.

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Usage Example 1 (1/2)



Session-handler usage example 1: Showing the Session Model of the Subscriber Identified by the "460001234567891" Traffic ID:

```
sudo session-handler --trafficId 460001234567891 --action show
Initializing DBN API
Waiting for DBN (false)...
INFO: trafficId [460001234567891] -> adminSubsId [460001234567891]
-----
Session data model corresponding to trafficId -> [460001234567891]
-----
Gx sessions:
IP session (Gx):
  ipAddr (IP@APN@PCEF) = [223.136.18.23@Default@ggsnNodeHostname.nodeHostRealm.com]
  diamSessionId (Gx) = [ggsnNodeHostname.nodeHostRealm.com;460001234567891;1578019891134198647]
  creationTime = [Jan 03, 2020; 03:51:37]
  modificationTime = [Jan 03, 2020; 03:51:37]
  peerId = [ggsnNodeHostname.nodeHostRealm.com@nodeHostRealm.com]
  pccRules = { [MMTel_Service_audio], [MMTel_Service_audio], [MMTel_Service_video], [MMTel_Service_video],
[StaticInternet] }

Af sessions:
Af session (Rx):
  afSessionId (IP@diamSessionId) =
[223.136.18.23@afNodeHostname.afNodeHostRealm.com;460001234567891;1578019891147754547]
  creationTime = [Jan 03, 2020; 03:51:37]
  peerId = [afNodeHostname.afNodeHostRealm.com@afNodeHostRealm.com]
  state = [0]
```

... to be continued in next slide

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Usage Example 1 (2/2)



... continued from previous slide

```
N7 sessions:  
  IP session (N7):  
    ipAddr (IP@DNN@SMF) = [223.136.18.24@dnn_mbb.com@http://192.168.14.42:7071/]  
    PDUSessionId (N7) = [imsi-460001234567891;123]  
    creationTime = [Jan 03, 2020; 03:51:37]  
    modificationTime = [Jan 03, 2020; 03:51:37]  
    peerId = [http://192.168.14.42:7071/@5G]  
    pccRules = { [MMTel_Service_audio], [MMTel_Service_audio], [MMTel_Service_video],  
      [MMTel_Service_video] }  
  
  Af sessions:  
    Af session (Rx):  
      afSessionId (IP@diamSessionId) =  
      [223.136.18.24@afNodeHostname.afNodeHostRealm.com;imsi-460001234567891;1578019891147756882]  
      creationTime = [Jan 03, 2020; 03:51:37]  
      peerId = [afNodeHostname.afNodeHostRealm.com@afNodeHostRealm.com]  
      state = [0]  
  
  Sy sessions:  
  
  Sd sessions:  
  
#####
```

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Usage Example 2



Session-handler usage example 2: Showing Only the AF Sessions (Rx Protocol) for the Subscriber Identified by the "34600001401" Traffic ID:

```
sudo session-handler --trafficId 34600001401 --action show --onlyAF
Initializing DBN API
Waiting for DBN (false)...
INFO: trafficId [34600001401] -> adminSubsId [admin_subscriber_1]
-----
Session data model corresponding to trafficId -> [34600001401]
-----

Af sessions:
Af session (Rx):
afSessionId (IP@diamSessionId) =
[224.236.110.211@tc_14_01_Rx_Sy_simpleCase;afNodeHostname.nodeHostRealm.com;2;5260810]
creationTime = [May 07, 2018; 15:06:31]
peerId = [afNodeHostname.nodeHostRealm.com@nodeHostRealm.com]
state = [0]

#####
#####
```

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Usage Example 3 (1/3)



Session-handler usage example 3: Deleting the Whole Session Model of the Subscriber Identified by the "460001234567891" Traffic ID, after the Required Confirmation:

```
sudo session-handler --trafficId 460001234567891 --action delete
Initializing DBN API
Waiting for DBN (false)...
INFO: trafficId [460001234567891] -> adminSubsId [460001234567891]
-----
Session data model corresponding to trafficId -> [460001234567891]
-----
Gx sessions:
  IP session (Gx):
  ... omitted for Gx sessions print out
  Af sessions:
    Af session (Rx):
    ... omitted for Rx sessions depending on Gx sessions print out

N7 sessions:
  IP session (N7):
  ... omitted for N7 sessions print out

  Af sessions:
    Af session (Rx):
    ... omitted for Rx sessions depending on N7 sessions print out
  Sy sessions:
  ... to be continued in next slide
```

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Usage Example 3 (2/3)



... continued from previous slide

Sd sessions:

```
# # # # # # # # # # # # # # # # #
```

Deletion requires confirmation...

Current deletion with no specific option(s).

Do you want to proceed with the deletion? [y/n]

Y

Deleted N7 session corresponding to:

```
ipAddr (IP@DNN@PCEF) = [223.136.18.24@dnn_mbb.com@http://192.168.14.42:7071/]
PDUSessionId (N7) = [imsi-460001234567891;123]
creationTime = [Jan 03, 2020; 03:51:37]
peerId = [http://192.168.14.42:7071/@5G]
```

Deleted Af session corresponding to:

```
id (IP@diamSessionId) = [223.136.18.24@afNodeHostname.afNodeHostRealm.com;imsi-
460001234567891;1578019891147756882]
creationTime = [Jan 03, 2020; 03:51:37]
peerId = [afNodeHostname.afNodeHostRealm.com@afNodeHostRealm.com]
```

Deleted Gx session corresponding to:

```
ipAddr (IP@APN@PCEF) = [223.136.18.23@Default@ggsnNodeHostname.nodeHostRealm.com]
diamSessionId (Gx) = [ggsnNodeHostname.nodeHostRealm.com;460001234567891;1578019891134198647]
creationTime = [Jan 03, 2020; 03:51:37]
peerId = [ggsnNodeHostname.nodeHostRealm.com@nodeHostRealm.com]
```

... to be continued in next slide

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Usage Example 3 (3/3)



... continued from previous slide

Deleted Af session corresponding to:

```
id (IP@diamSessionId) =  
[223.136.18.23@afNodeHostname.afNodeHostRealm.com;460001234567891;1578019891147754547]  
creationTime = [Jan 03, 2020; 03:51:37]  
peerId = [afNodeHostname.afNodeHostRealm.com@afNodeHostRealm.com]
```

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Usage Example 4 (1/2)



Session-handler usage example 4: Deleting Only the N7 Sessions of the Subscriber Identified by the "460001234567891" Traffic ID, without Requiring Any Confirmation from the User:

```
sudo session-handler --trafficId 460001234567891 --action delete --sessionType N7 --noConfirm
Initializing DBN API
Waiting for DBN (false)...
INFO: trafficId [460001234567891] -> adminSubsId [460001234567891]
-----
Session data model corresponding to trafficId -> [460001234567891]
-----
Gx sessions:
  IP session (Gx):
  ... omitted for Gx sessions print out
    Af sessions:
      Af session (Rx):
      ... omitted for Rx sessions depending on Gx sessions print out

  N7 sessions:
    IP session (N7):
    ... omitted for N7 sessions print out

    Af sessions:
      Af session (Rx):
      ... omitted for Rx sessions depending on N7 sessions print out

  Sy sessions:
  ... to be continued in next page
```

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Usage Example 4 (2/2)



... continued from previous page

Sd sessions:

```
# # # # # # # # # # # # # # # # # #
```

Deleted N7 session corresponding to:

```
ipAddr (IP@DNN@PCEF) = [223.136.18.24@dnn_mbb.com@http://192.168.14.42:7071/]
PDUSessionId (N7) = [imsi-460001234567891;123]
creationTime = [Jan 03, 2020; 03:51:37]
peerId = [http://192.168.14.42:7071/@5G]
```

Deleted Af session corresponding to:

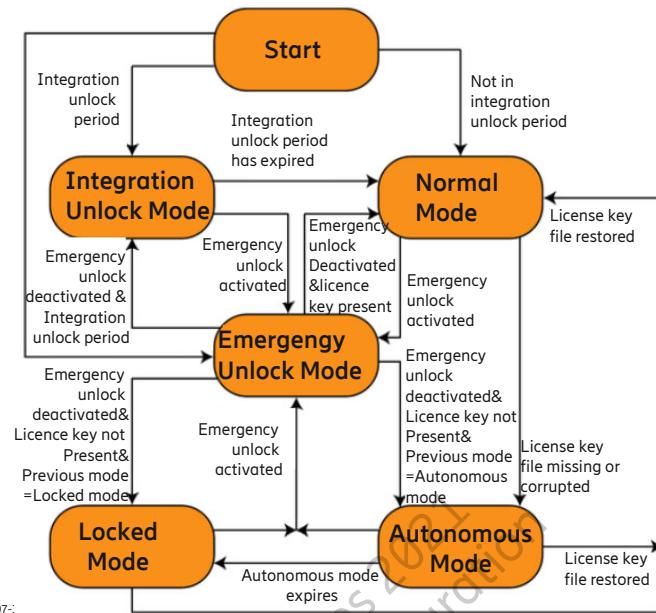
```
id (IP@diamSessionId) =
[223.136.18.24@afNodeHostname.afNodeHostRealm.com;imsi-
460001234567891;1578019891147756882]
creationTime = [Jan 03, 2020; 03:51:37]
peerId = [afNodeHostname.afNodeHostRealm.com@afNodeHostRealm.com]
```

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License Management State Transitions



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License – Integration Unlock Mode status check



1. Check the activation state of Integration Unlock mode:

```
show ManagedElement=1, SystemFunctions=1, Lm=1, IntegrationUnlock=1,  
activationState
```

- activationState=ACTIVATED indicates that the system is currently operating in Integration Unlock mode.

2. If the system is currently operating in Integration Unlock mode, check the expiration date and time:

```
show ManagedElement=1, SystemFunctions=1, Lm=1, IntegrationUnlock=1,  
expiration
```

- The expiration date and time is displayed in the following format: YYYY-MM-DDThh:mm:ss

3. Exit the COM CLI: exit

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License – Emergency Unlock Mode Activation



1. Navigate to the EmergencyUnlock managed object, for example:

```
>ManagedElement=NODE06ST, SystemFunctions=1, Lm=1, EmergencyUnlock=1
```

2. Activate the Emergency Unlock mode: (EmergencyUnlock=1)>activate

- The system returns true if the operation is successful.

3. Verify that the Emergency Unlock mode was activated correctly:

```
(EmergencyUnlock=1) >show activationState
```

- The system returns activationState=ACTIVATED if the system now operates in Emergency Unlock mode.

4. View the expiration date of the Emergency Unlock period:

```
(EmergencyUnlock=1) >show expiration
```

The following is an example output: expiration=2014-05-25T00:00:00

Note: Emergency Unlock automatically ceases at the end of the seven-day emergency unlock window.

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Gx Diameter Hanging Sessions



As a consequence of wrong configurations or erroneous situations in the SAPC, it is possible that obsolete sessions remain inside the SAPC database. This circumstance leads to two main problems:

- Unnecessary occupation of memory
- The SAPC increases the number of Diameter error code 5012 (Unable To Comply) answers to the PCEF

When an abnormal number of these error codes are observed, check configuration first (specially for clustered systems). If the configuration is correct, verify the existing sessions in the SAPC:

Check the number of EPC_IpSessionPot POTs:

```
PL-5:~ # pot-utility count EPC_IpSessionPot
```

Verify if there are obsolete sessions:

```
PL-5:~ # pot-utility select EPC_IpSessionPot
```

If the number of obsolete sessions is high, it is recommended to clean up them of the DBS, following the procedure in SAPC Emergency Recovery Procedure.

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Removing Rx/Sd Hanging Sessions



- In Rx Diameter scenarios, when the SAPC sends an ASR message to the AF, this session is marked as "obsolete", and it is removed from the database when the AF sends an STR message to the SAPC.

— If this STR message never comes to the SAPC, there will be unnecessary information in the SAPC DB

- To remove these sessions from DBS, in real time, without affecting the ongoing Rx traffic, use the pot-utility tool

```
PL-5:~ # pot-utility remove AfSessionPot obsolete
```

- In Sd Diameter scenarios, when the SAPC sends a RAR message containing the Session-Release-Cause AVP with IP_CAN_SESSION_TERMINATION value towards the TDF, this session is marked as "obsolete", and it is removed from the database when the TDF sends a CCR-T message to the SAPC afterwards.

— If this CCR-T message never comes to the SAPC, there will be unnecessary information in the SAPC DB

- To remove these sessions from DBS, in real time, without affecting the ongoing Sd traffic, use the pot-utility tool.

```
PL-5:~ # pot-utility remove SdSessionPot obsolete
```

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Removing Smp/N7 Hanging Sessions



Smp Diameter Hanging Sessions

- Check the number of SmpSessionPot: PL-5:~# pot-utility countSmpSessionPot
- Verify if there are obsolete sessions: PL-5:~# pot-utility selectSmpSessionPot

N7 Hanging Sessions

- Because of wrong configurations or erroneous situations in the SAPC PCF, it is possible that obsolete sessions remain inside the SAPC database. This circumstance produces two main problems:
 - Unnecessary occupation of memory.
 - Error codes that the SAPC PCF answers to the SMF are increased.
- Count the number of EPC_IpSessionPot POTs:

```
PL-5:~ # pot-utility count EPC_IpSessionPot
```

- List all sessions to check if the obsolete session exists (shows both Gx Diameter and N7 sessions):

```
PL-5:~ # pot-utility select EPC_IpSessionPot
```

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Maintenance Intervals



Task	Daily	Weekly	Monthly
Check active alarms	X		
Check the SAPC status	X		
Check PMF Measures	X		
Check Core Dumps existence	X		
Check CPU and Memory Load	X(1)		
Check IMM Persistent Back End		X	
Check Disk Space		X	
Make a System Data Backup when significant changes are done and the SAPC is working properly according to such configuration.			X

(1) Check these values during the busy hour

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Status Commands: GEO-RED DBS Replication Status



```
SC-1:~ # clurun.sh netshared_state_dump  
Result from [.dbsvdirector]:
```

		Local Node	State	Channel state
safAmfNode=PL-10,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-11,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-12,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-3,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-4,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-5,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-6,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-7,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-8,safAmfCluster=myAmfCluster	Idle	Connected		
safAmfNode=PL-9,safAmfCluster=myAmfCluster	Idle	Connected		
StartupTime	StateId ClusterId	Remote Node	State	Preferred
safAmfNode=PL-10,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-11,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-12,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-3,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-4,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-5,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-6,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-7,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-8,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1
safAmfNode=PL-9,safAmfCluster=myAmfCluster	Idle	False	1544433201851684	12 1

In normal operation,
the state must be "Idle"
and the Channel state
"Connected"

SC-1:~ #

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GEORED Troubleshooting



- Geored – control process:
- The process runs only in one PL. Check using amf the PL where it is running

```
amfHelper -f GeoRed -a status
```

- Where is n in the output, the PL where it is running, check that the process is not being restarted
- Check that the process is not paused

```
gdb --batch attach $(pgrep geo) | grep -c pause
```

- (the result must be 0. Otherwise, the process is paused (probably due to wrong cfg, explained in the next page)).

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GEORED Troubleshooting



Geored-control process (II)

Confirm that the geored-control.cfg has all the mandatory information:

```
/storage/system/config/sapc/geored-control.cfg
  heartbeat_timer=<value in seconds>
  heartbeat_retries=<number of retries>
  managed_vips=<vipp>@alb_oam,<vip_tr1>@alb_tr...
  replication_vips=<local replication vip>@local,<peer_replication_vip>@peer
  - heartbeat_port=<tcp port>

heartbeat_timer=5
heartbeat_retries=3
managed_vips=10.51.89.126@alb_oam,10.65.112.52@alb_trf_1,10.65.112.53@alb_trf_2
replication_vips=200.200.200.201@local,200.200.200.202@peer
heartbeat_port=9981
```

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GEORED Troubleshooting – DBS backlog



- Database changes in the active node are temporarily stored in memory while they are sent to the standby node. They are stored in a memory buffer known as sender backlog
- Next, the received changes are saved in the standby node and a confirmation is sent back to the active node, releasing the sender backlog
- The standby node uses the receiver backlog while applying the received changes in the local database
- There are situations when some transactions in the backlog cannot be processed immediately, for example, due to overload in either the sender or the receiver side, or disturbances in the replication channel
- To check the current occupation of these backlogs and that the database storage capacity limit is not reached:
 - Sender backlog (KB): clurun.sh collect_stats -d dbn
 - Receiver backlog (KB): clurun.sh collect_stats -d dbn

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GEORED Troubleshooting commands summary



Start replication:

```
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1,start --state "active"  
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1,start --state "standby"
```

Start from halted:

```
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1, start
```

Give control back to the preferred node (executed from preferred):

```
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1,giveback
```

Set preferred:

```
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1,set --preferred=true
```

Stop replication:

Set halted state to a node for OAM

```
>ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1,stop
```

If any of these commands fail, check:

- lastOperationDetailedInfo
 - >ManagedElement=1,PolicyControlFunction=1,GeoRedManager=1
(GeoRedManager=1)>show
- Geored-control process status
- Collect traces: tracecc-profile-create GeoredTraces -t "com_ericsson_sapc_geored* 7" -n "128" -s "128"

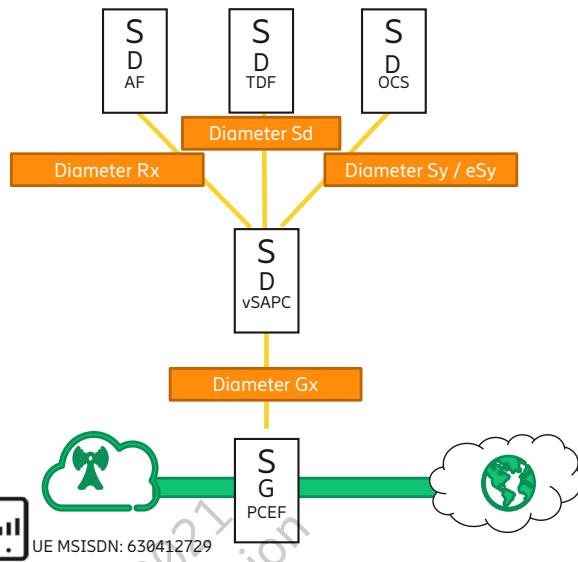
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UE Trace overview

- SAPC gives the operator the opportunity of collecting subscriber information in a readable format for Sd, Sy and ESy interfaces in addition to Gx and Rx
- The operator may quickly identify and understand network behavior caused by specific subscribers
- Improves O&M activities:
 - Troubleshooting of network problems.
 - Network analyses and optimization
 - Take corrective or preventive actions based on accurate and detailed information.



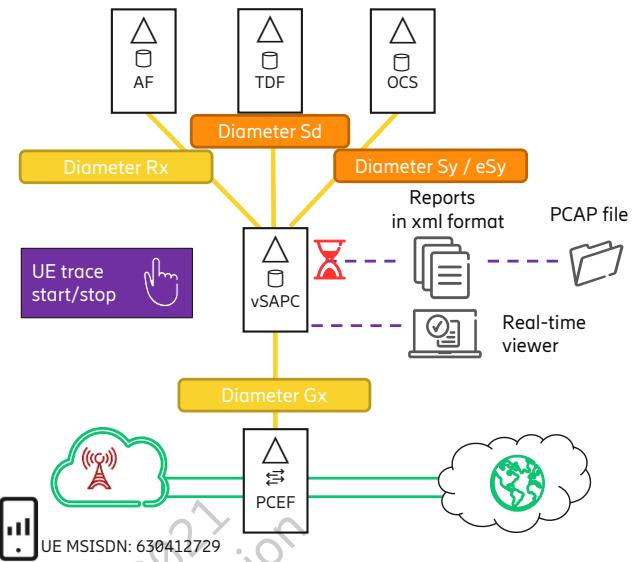
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UE Trace functionality

1. The UE trace session is configured and started in cliss (NBI) for a particular User Equipment (MSISDN or IMSI)
2. The SC communicates to the PLs the session to be traced.
3. The PLs are sniffing all the packets in the ports configured for the Sd / Sy interfaces using libtiny C++ library. The port configuration is taken directly without any cfg file.
4. The packets corresponding to the UE to be traced are propagated back to the SC
5. The SC periodically writes the captured messages to the XML and PCAP files (default is 15 minutes), or displays them to the console immediately if the real-time viewer is used



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UE Trace CLI



From SAPC 1.14 supports N7

To start or schedule a trace session, follow the instructions below after starting CLI session:

Navigate to the UeTrace class.

- >dn ManagedElement=1,PolicyControlFunction=1,UeTrace=1

Execute the start command (operational mode):

- (ManagedElement=1,PolicyControlFunction=1,UeTrace=1)> start [--traceSessionRef <sessionRef>] [--interfaces <interfaces>] [--imsis <subscriberIds>] [--msisdns <subscriberIds>] [--sipuris <subscriberIds>] [--timeStart <YYYY-MM-DD-THH:MM:SS>] [--timeEnd <YYYY-MM-DD-THH:MM:SS>] [--duration <minutes>]

Example: Trace two subscribers by IMSI and two subscribers by MSISDN over the Gx interface

- (UeTrace=1)\>start --traceSessionRef 1234 --interfaces Gx --imsis "460020292059900,460020292059901" --msisdns "341591010201,341591010202"

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UE Trace Actions – CPI library



Actions	
string	<code>list ()</code> Lists the UE trace sessions to be traced.
string	<code>start (string imsis , string msisdns , string sipuris , string traceSessionRef , string interfaces , DateTime timeStart , DateTime timeEnd , int32 duration)</code> Orders the start of a UE trace session. Parameters [.] Name: interfaces Default value: Gx,Rx,Sd,Sy,N7 Description: The interfaces over which the messages are traced. interface values = [Gx, Rx, Sd, Sy, N7] Required: optional. [.]
string	<code>stop (EcimEmpty all , string traceSessionRef , EcimEmpty nonPcapFile)</code> Stops the specified UE trace sessions.

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UE Trace information



The XML and PCAP storage directories are:

/storage/no-backup/sapc/uetracefiles/uetraceXMLfiles/

/storage/no-backup/sapc/uetracefiles/uetracePCAPfiles/

The XML File name syntax is:

```
<Type><Startdate>.<Starttime>-<Enddate>.<Endtime>-
<SenderType>.<SenderName>_ue_trace.<Fileindex>
```

Example: A20180205.0930+0100-20180205.0945+0100-PCRF.1_ue_trace.1

The PCAP File name syntax is:

```
<Type><Startdate>_<Starttime>-
<Enddate>_<Endtime>_<traceSessionRef>_ue_trace.<Fileindex>.pcap
```

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UE Trace sample

The following example shows an TDF-Session-Request message recorded for the traced UE:

```
<traceRecSession traceSessionRef="tc600000001" traceRecSessionRef="3">
  <ue idType="MSISDN" idValue="346001560201"/>
  <msg function="Sd" name="TDF-Session-Request" changeTime="183.386" vendorSpecific="false">
    <initiator type="PCRF"/>
    <target type="TDF"/>
    <rawMsg protocol="Diameter" version="1">01000198c080001d0100057000000204f0dcda000001074000048736
170634f776e486f737449642e6f70657261746f725265616c6d2e636f6d3b31353393534383433323b38323839343032363b3334
363030313536303230310000001e4000001464656661756c7441706e49640000006140000012004057fadf42c9423258000000000
104400000200000102400000c01000570000010a400000c000028af000001084000027736170634f776e486f737449642e6f
70657261746f725265616c6d2e636f6d000000116400000c5cf4d25c0000011b40000018746466336770707265616c6d2e636f6
d0000012540000285444464e6f6465486f73746e616d652e746466336770707265616c6d2e636f6d00000128400000196f706572
61746f725265616c6d2e636f6d000000000001bb40000028000001bc40000014333436303031353630323031000001c24000000c0
000000000003eec0000010000028af00000027000003eec00000010000028af0000002800000444c000001c0000028af00000448c0
000010000028af31303031</rawMsg>
  </msg>
</traceRecSession>
```

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UE Trace viewer



SAPC provides a real-time viewer to see the most important information for each Sd and Sy incoming/outgoing message (in addition to Gx and Rx messages).

```
sapcadmin@SC-X> uetraceViewer --traceSessionRef <traceSessionRefId>
```

Example: Output example in real-time view:

```
Mon Jan 22 11:23:42.268475 TraceSessionRef: "tc159010116", SubsId:  
"3461591010116,460020292059016", Event: "TSR", SessionId:  
"tc_01_01_16_Session_Multiple_SubscriptionIds_UeTrace_Msisdn_Imsi;  
ggsn2NodeHostname.nodeHostRealm.com;2;1297280", Protocol: "Sd", SubsType:  
"MSISDN", "IMSI", IpAddr: "153.104.100.156"
```

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Event Based Monitoring



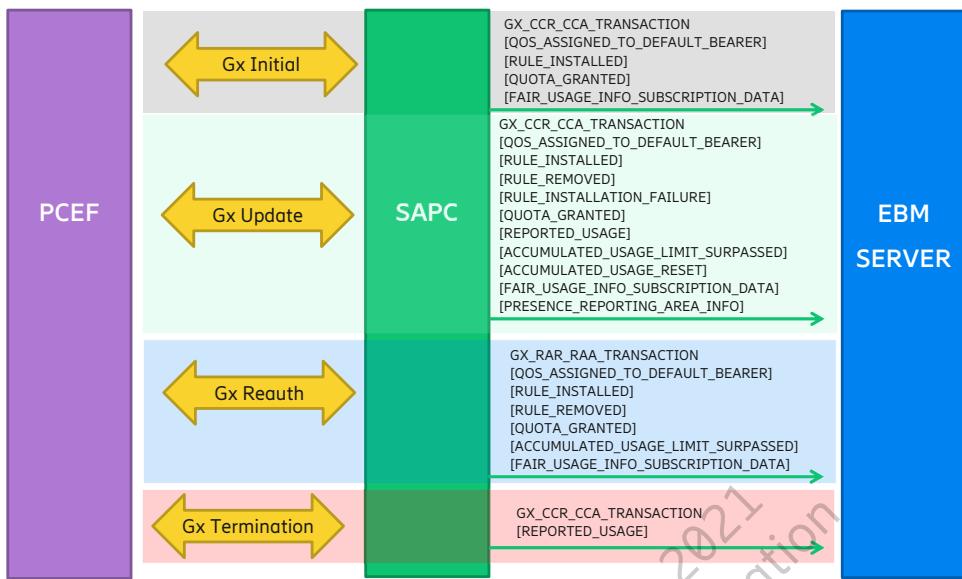
- Event Based Monitoring enables the SAPC to report events in near-real time in the form of a TCP connection stream to external EBM servers
- EBM provides an additional source of business and operational intelligence based on subscriber and service events in real time
- EBM complements other existing performance management counters and logs
- SAPC also stores internally the EBM event records
- Used for reporting in near-real time and post-processing analysis of events like Installation of a PCC Rule, Granted quota, Accumulated usage limit surpassed, Gx and Rx related transactions
- The availability of this function in the SAPC is under license control and is supported in mobile deployments for Gx, Gx+, Rx Release 9 onwards, 3GPP Sy Release 11 onwards, and Ericsson Sy related events

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EBM feature – Supported Messages (Gx Interface)

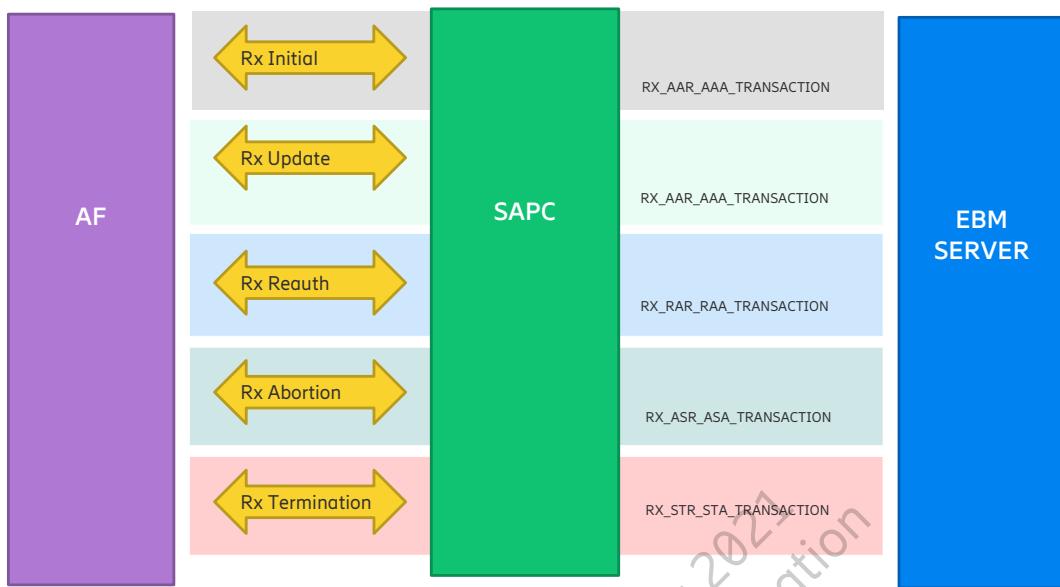


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Technical Details – Supported Messages (Gx Interface) ≡



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EBM – example configurations



Example in Netconf showing the configuration of an external EBM server (SAPC acts as the client)

```
<edit-config>
  <target>
    <running />
  </target>
  <config>
    <ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
      <managedElementId>1</managedElementId>
      <dnPrefix>dc=ManagedElement</dnPrefix>
      <networkManagedElementId>1</networkManagedElementId>
      <userLabel>Managed Element</userLabel>
      <PolicyControlFunction xmlns="urn:com:ericsson:ecim:sopcmon">
        <policyControlFunctionId>1</policyControlFunctionId>
        <Network xmlns="urn:com:ericsson:ecim:networkmom">
          <networkId>1</networkId>
          <EbmServers>
            <ebmServersId>1</ebmServersId>
            <EbmServer>
              <ebmServerId>EBM_Server1</ebmServerId>
              <ipAddress>10.5.6.34</ipAddress>
              <port>32010</port>
            </EbmServer>
          </EbmServers>
        </Network>
      </PolicyControlFunction>
    </ManagedElement>
  </config>
</edit-config>
```

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EBM – example configurations



Business events that can be reported to the external EBM server

```
<edit-config>
  <target>
    <running />
  /<target>
  <config>
<ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
  <managedElementId>1</managedElementId>
  <dnPrefix><!--ManagedElement--></dnPrefix>
  <networkManagedElementId>1</networkManagedElementId>
  <userLabel>Managed Element</userLabel>
<PolicyControlFunction xmlns="urn:com:ericsson:ecim:sopcmom">
  <policyControlFunctionId>1</policyControlFunctionId>
<EventBasedMonitoring xmlns="urn:com:ericsson:ecim:eventbasedmonitoringmom">
  <eventBasedMonitoringId>1</eventBasedMonitoringId>
  <enable>true</enable>
<EbmBusinessEvents xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
  <ebmBusinessEventsId>1</ebmBusinessEventsId>
  <EbmBusinessEvent>
    <ebmBusinessEventId>GK_CCR_CCA_TRANSACTION</ebmBusinessEventId>
    <enable>true</enable> Enable
    <ebmServerIds>EBM_Server1</ebmServerIds>
  </EbmBusinessEvent>
  <EbmBusinessEvent>
    <ebmBusinessEventId>RULE_INSTALLED</ebmBusinessEventId>
    <enable>true</enable> Enable
    <ebmServerIds>EBM_Server1</ebmServerIds>
  </EbmBusinessEvent>
</EbmBusinessEvents>
</EventBasedMonitoring>
</PolicyControlFunction>
</ManagedElement>
</config>
</edit-config>
```

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EBM – example configurations



For each enabled EBM event, include the server identifier that SAPC will send this type of events (If empty, is sent to all EBM servers configured):

```
<edit-config>
  <target>
    <running />
  </target>
  <config>
    <managedElement xmlns="urn:com:ericsson:ecim:ComTop">
      <managedElementId>1</managedElementId>
      <dnPrefix>dc=ManagedElement</dnPrefix>
      <networkManagedElementId>1</networkManagedElementId>
      <userLabel>Managed Element</userLabel>
      <PolicyControlFunction xmlns="urn:com:ericsson:ecim:sopcmom">
        <policyControlFunctionId>1</policyControlFunctionId>
        <EventBasedMonitoring xmlns="urn:com:ericsson:ecim:eventbasedmonitoringmom">
          <eventBasedMonitoringId>1</eventBasedMonitoringId>
          <EbmBusinessEvents xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
            <ebmBusinessEventsId>1</ebmBusinessEventsId>
            <EbmBusinessEvent>
              <ebmBusinessEventId>GX_CCR_CCA_TRANSACTION</ebmBusinessEventId>
              <enable>true</enable>
              <ebmServerIds>EBM_Server1</ebmServerIds> ← Server Id to send GX_CCR_CCA_TRANSACTION events
            </EbmBusinessEvent>
            <EbmBusinessEvent>
              <ebmBusinessEventId>RULE_INSTALLED</ebmBusinessEventId>
              <enable>true</enable>
              <ebmServerIds>EBM_Server1</ebmServerIds> ← Server Id to send RULE_INSTALLED events
            </EbmBusinessEvent>
          </EbmBusinessEvents>
        </EventBasedMonitoring>
      </PolicyControlFunction>
    </managedElement>
  </config>
</edit-config>
```

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EBM – example configurations



Enable EBM functionality:

```
<edit-config>
  <target>
    <running />
  </target>
  <config>
    <ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
      <managedElementId>1</managedElementId>
      <dnPrefix>dc=ManagedElement</dnPrefix>
      <networkManagedElementId>1</networkManagedElementId>
      <userLabel>Managed Element</userLabel>
    </ManagedElement>
    <PolicyControlFunction xmlns="urn:com:ericsson:ecim:sopcmon">
      <policyControlFunctionId>1</policyControlFunctionId>
      <EventBasedMonitoring xmlns="urn:com:ericsson:ecim:eventbasedmonitoringmom">
        <eventBasedMonitoringId>1</eventBasedMonitoringId>
        <enable>true</enable>
        General enable
        <ebmBusinessEvents xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
          <ebmBusinessEventsId>1</ebmBusinessEventsId>
          <EbBusinessEvent>
            <ebmBusinessEventId>GX_CCR_CCA_TRANSACTION</ebmBusinessEventId>
            <enable>true</enable>
            <ebmServerIds>EBM_Server1</ebmServerIds>
          </EbBusinessEvent>
          <EbBusinessEvent>
            <ebmBusinessEventId>RULE_INSTALLED</ebmBusinessEventId>
            <enable>true</enable>
            <ebmServerIds>EBM_Server1</ebmServerIds>
          </EbBusinessEvent>
        </EbmBusinessEvents>
      </EventBasedMonitoring>
    </PolicyControlFunction>
  </ManagedElement>
  </config>
</edit-config>
```

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Chapter 7 Summary



After this chapter, the student should now be able to:

- Explain the tools available for troubleshooting including sapcCaptureTool and session-handler
- Describe the recommended maintenance activities and intervals
- List the GeoRed troubleshooting activities
- Understand the license function
- Explain the UE trace for SAPC including the Sd and Sy interfaces.
- Describe the EBM function

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Appendix



SAPC 1 Operation and Configuration

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SAPC 1 Operation and Configuration



SAPC Operation

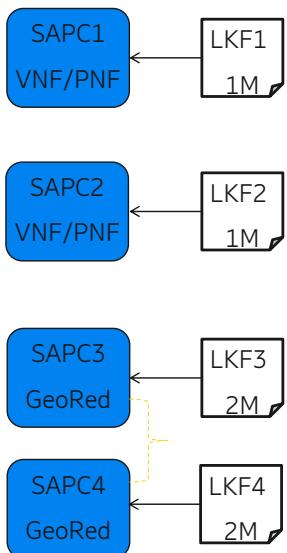


Network license server (NeLS).

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ELIM Mode License System



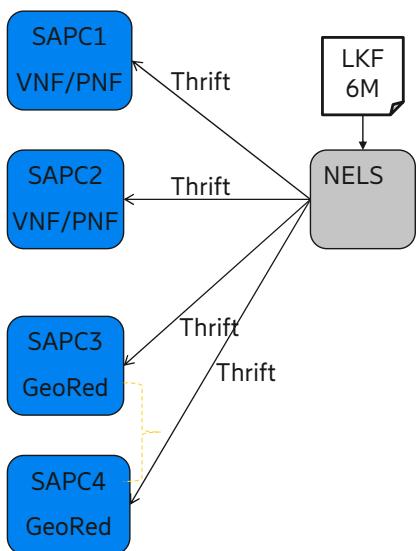
- Every node requires individual license key file tied to the SAPC's figure print.
- Capacities are not shared between nodes in one network

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ELIM Mode License System



- Only one license is needed for the whole network
- License is shared between multiple nodes, which request features and capacities from the NELS server
- When one node is put out of service (e.g. for software upgrade), it automatically releases the capacities that can be reused by other nodes

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Technical Details (1/2)



- Network license server (NeLS) is supported since SAPC1.7.
- Both ELIM (local license file) and NeLS (online or offline) are supported.
 - ELIM or NELS mode can be selected during deployment by modifying adapt_cluster.cfg.
 - The default mode is ELIM.
- NeLS sever can be Native Deployments or VNF Online/Offline.
- Migration from ELIM mode to NELS mode is supported from SAPC application point of view.
 - The switch is unidirectional.
 - The license key file should be installed in NELS or in a remote license repository, the capacity should be the sum of nodes capacities in the network.
 - Migration of HW Resources to the network HW Resources is required in ELIS. For details please check ELIS Activation Guide
- To use NELS, the VNF/PNF must be connected to NeLS server.
 - If the link breaks or if NELS server failure, autonomous mode is entered for 24 hours.

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Technical Details (2/2)



- Emergency unlock is still maintained in VNF/PNF
- Integration unlock is supported
 - After deployment, integration unlock mode is entered. If LKFs are available license control will be done based on the LKFs, otherwise all the requests are allowed in this mode.
 - The duration of integration unlock is 21 days.
 - Integration unlock is applicable to both ELIM and NeLS mode.

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SAPC 1 Operation and Configuration



Operation and Maintenance (1/4)



License Key File for NeLS

- To deploy SAPC in Network License Server (NeLS) mode, new license key files must be ordered and installed on NeLS locally or active in Ericsson License gateway using NeLS online.

Install License Key File in NeLS

- LKFs can be installed on NeLS using the File or SFTP protocols. The File protocol is used to install an LKF that is already stored in a NeLS local directory. The SFTP protocol is used to install an LKF in NeLS from a remote server.
- For information on how to install an LKF , refer to following sections in CPI for NeLS.
 - [Install License Key File Using File Protocol](#)
 - [Install License Key File Using SFTP Protocol](#)

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Operation and Maintenance (2/4)



Deploy SAPC in NeLS mode

- The following parameters are added in the adapt_cluster.cfg file:
 - LKF_FORMAT
 - NELS_HOST
 - NELS_PORT

To deploy SAPC in NeLS mode, set the value of LKF_FORMAT to 4, the address and port of Nels server should be set in NELS_HOST and NELS_PORT. Refer to [Adapt Cluster Tool](#).

'Check Deployment Instructions for both VNF and PNF deployments for further steps



Operation and Maintenance (3/4)



Migration from ELIM to NeLS

- The SAPC also supports migration from ELIM deployment to NeLS deployment from implementation point of view. If the original SAPC is ELIM LM deployment, after upgrade to SAPC 1.7.0 or later version, you can switch the license management to NeLS mode by running switch command as below(Refer to SAPC Upgrade Instruction for further info.):

```
SC-1:~ # cliss
>ManagedElement=1,SystemFunctions=1,Lm=1,KeyFileManagement=1
ManagedElement=1,SystemFunctions=1,Lm=1,KeyFileManagement=1
(KeyFileManagement=1)>switchToNeLS --prepare true
(KeyFileManagement=1)>up
(Lm=1)>NeLSConfiguration=1
(NeLSConfiguration=1)> configure
(config-NeLSConfiguration=1)>host=10.35.22.xxx
(config-NeLSConfiguration=1)>port=9095
(config-NeLSConfiguration=1)>commit
(NeLSConfiguration=1)>up
ManagedElement=1,SystemFunctions=1,Lm=1,KeyFileManagement=1
(KeyFileManagement=1)>switchToNeLS
```

Note:

migration of HW Resources to the network HW Resources is required in ELIS. For details please check ELIS Activation Guide.

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Operation and Maintenance (4/4)



Relevant alarms

- Besides legacy alarms, the following alarms for NeLS are added:
 - [License Management, Autonomous Mode Activated](#)
 - [License Management, Emergency Unlock Reset Key Required](#)
 - [License Management, Key File Fault](#)

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SAPC Operation



Logging enhancements.

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Operation and Maintenance (1/4)



class BusinessEvents Service-Aware Policy Controller

ManagedElement
PolicyControlFunction
BusinessEvents
BusinessEvent [0..]

Holds the SAPC logging events configuration data.

This MO is created by the system.

Attributes

string key mandatory noNotification restricted	businessEventsId Identifies the instance of this class. Forced value=1.
int32 noNotification	loggingLevel = 3 <default> Indicates the system logging level. Values: 0: EMERGENCY 1: ALERT 2: CRITICAL 3: ERROR 4: WARNING 5: NOTICE 6: INFORMATIONAL
uint32	maxFilesRotated = 99 <default> Maximum number of rotated files.
uint64	maxLogFileSize = 20971520 <default> Max file size (in bytes) rotated for each instance.

Logging level default value changed from 6 to 3, for SAPC Maiden installations

File rotation parameters changes will take effect when next rotation occurs

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Operation and Maintenance (2/4)



class RestEvents Service-Aware Policy Controller

ManagedElement
PolicyControlFunction
RestEvents
RestEvent [0..]

Holds the SAPC REST logging events configuration data.

This MO is created by the system.

Attributes

int32 noNotification	loggingLevel = 3 <default> Indicates the REST logging level. Values: 0: EMERGENCY 1: ALERT 2: CRITICAL 3: ERROR 4: WARNING 5: NOTICE 6: INFORMATIONAL
uint32	maxFilesRotated = 99 Maximum number of rotated files.
uint64	maxLogFileSize = 20971520 Max file size (in bytes) rotated for each instance.
string key mandatory noNotification restricted	restEventsId Identifies the instance of this class. Forced value=1.

File rotation parameters
changes will take effect when
next rotation occurs

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Operation and Maintenance (3/4)



class BusinessEvent Service-Aware Policy Controller

ManagedElement
PolicyControlFunction
BusinessEvents
BusinessEvent

Individual log parameters
changes could take effect up
to 30 seconds later (for java
logs)

It represents a Log Business Event.

Attributes

string key mandatory noNotification restricted	businessEventId Identifier of the log event. It corresponds with the log slogan event name, without blanks.
boolean	enable = true Enables or disables the log. If empty, the log is enabled.
int32[0..1]	severity { 0..6 } Indicates the individual log severity. Values: 0: EMERGENCY 1: ALERT 2: CRITICAL 3: ERROR 4: WARNING 5: NOTICE 6: INFORMATIONAL If empty, the default log severity is used.

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Operation and Maintenance (4/4)



class RestEvent Service-Aware Policy Controller

ManagedElement
PolicyControlFunction
RestEvents
RestEvent

It represents a Log Rest Event.

Attributes

boolean	<code>enable</code> = true Enables or disables the log. If empty, the log is enabled.
string key mandatory noNotification restricted	<code>restEventId</code> Identifier of the log event. It corresponds with the log slogan event name, without blanks.
int32[0..1]	<code>severity</code> { 0..6 } Indicates the individual log severity. Values: 0: EMERGENCY 1: ALERT 2: CRITICAL 3: ERROR 4: WARNING 5: NOTICE 6: INFORMATIONAL If empty, the default log severity is used.

Individual log parameters changes could take effect up to 30 seconds later (for java logs)

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Network Impact



- As there are now several informational logs per each traffic message, setting the logging level to 6 implies a performance impact: +10% CPU load and +10% memory usage in PLs, approximately, depending on the traffic model in use
- This is to be taken into account during the upgrades from SAPC < 1.6 to SAPC >= 1.6:
- Upgrade Instruction document recommends setting the logging level to 3 to avoid any issues.

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SAPC Operation



Overload control.

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SAPC 1 Operation and Configuration



Load Regulation Troubleshooting (1/2)



Check resources counters

Access the SAPC and list the reporting files with the following command:

```
SC-1:~ # ls -la /storage/no-backup/com-apr9010443/PerformanceManagementReportFiles
```

A list of log files is presented with the following format:

Ayyyymmdd.hhmm±hhmm-hhmm±hhmm_1.xml

Verify the values within the time frame by reading the desired file. The output is similar to the following:

```
<measInfo measInfoId="OSProcessingUnit">
<job jobId="ResourcesCountersJob"/> -> New PmJob to monitor resources
<granPeriod duration="PT300S" endTime="yyyy-mm-ddThh:mm:ss±hhmm"/>
<repPeriod duration="PT300S"/>
<measType p="1">CPULoad.TotalmeasType p="1">CPULoad.Total</measType>
<granPeriod duration="PT300S" endTime="yyyy-mm-ddThh:mm:ss±hhmm"/>
<measType p="2">Mem.PercentUsedmeasType p="2">Mem.PercentUsed</measType>
<measValue measObjLdn="OSProcessingUnit=PL-X"
<r p="1">CPULoad.Total Value</r> -> This is the value for CPU in the granularity period
<r p="2">Mem.PercentUsed value</r> -> This is the value for Memory in the granularity period
</measValue>
....</measInfo>
```

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Load Regulation Troubleshooting (2/2)



In an overload scenario, the SAPC can trigger the following alarms:

- Policy Control, Number of CCAs Initial Sent Indicating Too Busy Reached
- Policy Control, Number of AAAs Initial Sent Indicating Too Busy Reached

If any of these alarms is active, it means that the SAPC has rejected CCAs or AAAs respectively during a granularity period. To verify the amount of messages sent by the SAPC indicating "DIAMETER_TOOBUSY", verify the following measurements:

- gxCcasInitTooBusy: The number of CCAs initial sent indicating too busy (Result-Code AVP set to 3004)
- rxAaasInitTooBusy: The number of AAAs initial sent indicating too busy (Result-Code AVP set to 3004)



Performance Measurements – Overload Control



The number of Gx CCAs initial sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs initial for emergency services sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs initial for multimedia priority services sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs update sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs update for emergency services sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs update for multimedia priority services sent indicating too busy (Result-Code AVP set to 3004).
The number of Gx CCAs terminate sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs initial sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs initial for emergency services sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs initial for multimedia priority services sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs update sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs update for emergency services sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx AAAs update for multimedia priority services sent indicating too busy (Result-Code AVP set to 3004).
The number of Rx STAs sent indicating too busy (Result-Code AVP set to 3004).
The number of Sd CCAs update sent indicating too busy (Result-Code AVP set to 3004).
The number of Smp CCAs initial sent indicating too busy (Result-Code AVP set to 3004).
The number of Smp CCAs update sent indicating too busy (Result-Code AVP set to 3004).
The number of Smp CCAs terminate sent indicating too busy (Result-Code AVP set to 3004).
The number of Sy SNAs update sent indicating too busy (Result-Code AVP set to 3004).
The number of SOAP notifications not processed due to overload protection.
The number of REST provisioning messages indicating too busy (HTTP status code set to 503).
The number of Time of Day reauthorizations not processed due to overload protection.
The number of Npcf_SMPolicyControl_Create responses sent indicating too busy (HTTP StatusCode set to value 503).
The number of Npcf_SMPolicyControl_Update responses sent indicating too busy (HTTP StatusCode set to value 503).

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SAPC Operation

Load regulation for N7 and NRF

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Technical Details



- The SAPC PCF provides different mechanisms to control overload situations on N7 and Nnrf interfaces.
- The SAPC PCF detects that it is working in overload situation, then it prioritizes the events handled with higher priority and rejects or discards events handled with lower priority:
 - Disabling N7 session massive reauthorizations due to UDR notifications or ToD using configuration parameters
 - Rejecting incoming N7 and NRF messages and UDR notifications to reduce its load answering with 503 Service Unavailable
 - Skipping N7 session reauthorizations due to UDR notifications or ToD even if massive reauthorizations are not disabled by parameters
 - Not sending requests to the NRF

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Operation and Maintenance - Counters



Disable Massive Reauthorizations Based on Subscriber Update or Removal

To prevent the SAPC overload in case of massive reauthorizations messages based on subscriber profile change or removal, set attribute enableReauthsOnSubsChange to false.

Disable Massive Reauthorizations Associated to Time Conditions

To prevent the SAPC overload in case of massive reauthorization messages associated to time conditions, set enableReauthsOnToD attribute to false.

```
>show ManagedElement=1,PolicyControlFunction=1,AppConfig=1  
...  
  enableReauthsOnSubsChange=true <default>  
  enableReauthsOnToD=true <default>  
...
```

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Operation and Maintenance - Counters



Counters relevant to SMF

NpcfSmCreateTooBusy : The number of NpcfSmCreate responses sent indicating toobusy

NpcfSmUpdateTooBusy: The number of NpcfSmUpdate responses sent indicating toobusy

NpcfSmDeleteTooBusy: The number of NpcfSmDelete responses sent indicating toobusy

```
>show
ManagedElement=1, SystemFunctions=1, Pm=1, PmGroup=policyControlFunctionNpcfSmMeasuresGroup
PmGroup=policyControlFunctionNpcfSmMeasuresGroup
...
MeasurementType=NpcfSmCreateTooBusy
MeasurementType=NpcfSmDeleteTooBusy
MeasurementType=NpcfSmUpdateTooBusy
...
```

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SAPC 1 Operation and Configuration



Operation and Maintenance - Counters



Counter relevant to UDR: NudrDataRepositoryNotifyTooBusy : The number of UDR notifications not processed due to overload protection.

```
>show ManagedElement=1,SystemFunctions=1,Pm=1,PmGroup=policyControlFunctionNudrMeasuresGroup  
PmGroup=policyControlFunctionNudrMeasuresGroup  
...  
MeasurementType=NudrDataRepositoryNotifyTooBusy
```

Counters relevant to ToD: notificationsOnToDTooBusy : The number of Time of Day reauthorizations for 5G not processed due to overload protection.

```
>show ManagedElement=1,SystemFunctions=1,Pm=1,PmGroup=policyControlFunctionOtherMeasurGroup  
...  
MeasurementType=notificationsOnToDTooBusy
```



Operation and Maintenance - Counters



Counters relevant to NRF

- NnrfNfRegisterTooBusy: The number of NRF register not processed due to overload protection.
- NnrfNfDeregisterTooBusy: The number of NRF deregister not processed due to overload protection.
- NnrfNfUpdateTooBusy: The number of NRF update not processed due to overload protection.
- NnrfNfStatusSubscribeTooBusy: The number of NRF status subscribe not processed due to overload protection.
- NnrfNfStatusUnsubscribeTooBusy: The number of NRF status unsubscribe not processed due to overload protection.
- NnrfNfStatusNotifyTooBusy: The number of NRF status Notify not processed due to overload protection.
- NnrfNfSubscribeUpdateTooBusy: The number of NRF subscribe update not processed due to overload protection.
- nrfNfDiscoverTooBusy: The number of NRF discover not processed due to overload protection.

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SAPC 1 Operation and Configuration



Operation and Maintenance - Counters



Counters relevant to NRF

```
>show ManagedElement=1,SystemFunctions=1,Pm=1,PmGroup=policyControlFunctionNnrfMeasuresGroup
...
MeasurementType=NnrfNfDeregisterTooBusy
MeasurementType=NnrfNfDiscoverTooBusy
MeasurementType=NnrfNfRegisterTooBusy
MeasurementType=NnrfNfStatusNotifyTooBusy
MeasurementType=NnrfNfStatusSubscribeTooBusy
MeasurementType=NnrfNfStatusUnsubscribeTooBusy
MeasurementType=NnrfNfSubscribeUpdateTooBusy
MeasurementType=NnrfNfUpdateTooBusy
...
```

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Operation and Maintenance - Alarms



NpcfSmCreateTooBusyReached

The Alarms indicates the number of NpcfSmCreate response indicating too busy (Respond-Code to 503) in a specific given granularity period exceeds the configured threshold value

NnrfNFStatusNotifyTooBusyReached

The number of NnrfNfStatusNotify response indicating too busy (Respond-Code to 503) in a specific given granularity period exceeds the configured threshold value

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SAPC Configuration



Dynamic cluster size.

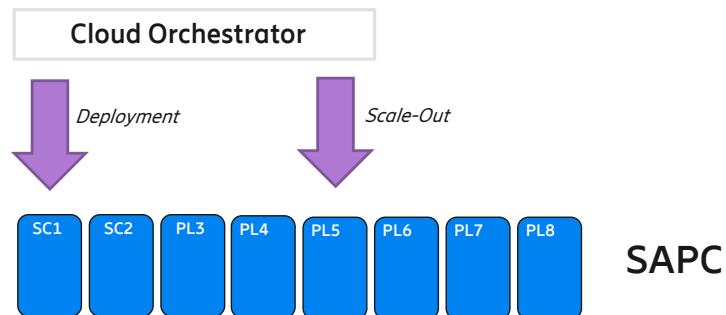
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SAPC 1 Operation and Configuration



Overview



Previously, SAPC could be only deployed with 2 payloads. In case the customer requires a higher number, a scale-out procedure was needed.



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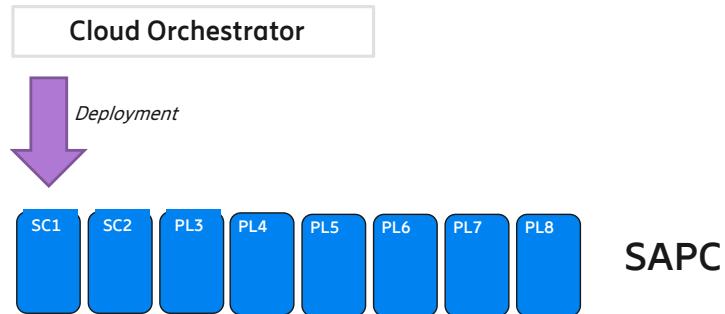
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SAPC 1 Operation and Configuration



Overview



With Dynamic Cluster Size, SAPC can be deployed with the number of payloads required by the customer from the initial deployment, no need of later scale-out procedure



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Overview - Benefit



- Due to the scale-out procedure is no longer necessary to provide the initial SAPC size, the time for deployments is improved for medium/large sizes.
- For small sizes (2+2) is slightly increased.
- Further information on Instantiation times to be found in Dimensioning Guidelines.

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SAPC 1 Operation and Configuration



Technical Details



- With previous releases, SAPC images were delivered with a default size of 2 payloads and a scale-out procedure was needed to obtain a larger size. These images contained an already installed SAPC.
- SAPC images supporting Dynamic Cluster Size are generated offline (there is no installed SAPC) which enables the definition of any cluster size during the first deployment
- The installation of software is now performed as part of the deployment.
- Configuration parameters related with cluster size (PL nodes, interfaces definition) are automatically injected during deployment within the ovf-env.xml file.
- This file is automatically generated as part of the deployment procedure
- The SAPC takes the parameters injected during the start-up and use them to adapt the configuration to the size requested. This method is common for both VNF and PNF deployments.

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SAPC 1 Operation and Configuration



Operation and Maintenance



VNF:

- Attribute initial_pls in SAPC.cfg file ([sapc] section): Previous limitation for the parameter to be set to value 2 is removed. Now, the total number of PLs required by the customer can be configured. Default value is 2 PLs. File adapt_cluster.cfg is overwritten with value from SAPC.cfg.

PNF

- Attribute initial_pls in adapt_cluster.cfg file ([sapc] section): Previous limitation for the parameter to be set to value 2 is removed. Now, the total number of PLs required by the customer can be configured. Default value for VNF is 2 and default value for PNF is 10.
- File adapt_cluster.iso contains now adapt_cluster.cfg + ovf-env info. The adapt_cluster.cfg is also used as input for building correct ovf-env, depending on environment.
- Automatic detection of BSP/NSP environment and handling of Blade MAC addresses in adapt_cluster.iso

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (1/6)



Ericsson NETCONF Browser

Connections SAPC1 * SAPC1 *

Support | About

Fetch Push Save... Compare with Validate Search

Edit View Info

ManagedElement[managedElementId=1]
Equipment[equipmentId=1]
JavaCat[javaCatId=1]
PolicyControlFunction[policyControlFunctionId=1]
AppConfig[appConfigId=1]
PccConfig[pccConfigId=1]
BusinessEvents[businessEventsId=1]
EntityDataIdentityData[id=1]
FlexibleDiameter[flexibleDiameterId=1]
GeoRedManager[geoRedManagerId=1]
Network[networkId=1]
DiameterNodes[diameterNodesId=1]
DiameterNode[diameterNodeId=dpiHostname.operator.com]
DiameterNode[diameterNodeId=ggsnHostname.operator.com]
DiameterNode[diameterNodeId=pcefCluster]
SmsCenter[smsCenterId=1]
WebServiceEndPoints[webServiceEndPointsId=1]
NotificationConfig[notificationConfigId=1]
SystemFunctions[systemFunctionsId=1]

Name	Value
enableEmergenciesWithIMEI	true
eventTriggers	RAT_CHANGE
eventTriggers	QOS_CHANGE
pccConfigId	1

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (2/6)



Ericsson NETCONF Browser

Connections SAPC1 SAPC1

Fetch Push Save... Compare with Validate Search

Edit View Info

Add parameter group Add parameter struct Delete parameter group Add parameter

Delete parameter Revert changed value Revert all value changes

GeoRedManager[geoRedManagerId=1] Network[networkId=1]

DiameterNodes[diameterNodeId=1]

- DiameterNode[diameterNodeId=dpiHostname.operator.com]
- DiameterNode[diameterNodeId=gsmHostname.operator.com]
- DiameterNode[diameterNodeId=pcefCluster]

SmsCenter[smsCenterId=1] WebServiceEndPoints[webServiceEndPointsId=1] NotificationConfig[notificationConfigId=1] SystemFunctions[systemFunctionsId=1]

Name	Value
enableEmergenciesWithImei	true
eventTriggers	RAT_CHANGE
eventTriggers	QOS_CHANGE
pccConfigId	1

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (3/6)



The screenshot shows the Ericsson NETCONF Browser interface. The left pane displays a hierarchical tree of managed elements under 'SAPC1'. The 'eventTriggers' node under 'PolicyControlFunction' is selected. A modal dialog titled 'Add New Parameter Instance' is open, showing a table with two rows:

Name	Value
enableEmergenciesWithImei	true
eventTriggers	RAT_CHANGE QOS_CHANGE

The 'Name' column has dropdown menus for 'Name' and 'Value'. The 'Value' column contains the trigger names 'RAT_CHANGE' and 'QOS_CHANGE'. A numeric input field with the value '1' is also visible. The 'OK' and 'Cancel' buttons are at the bottom of the dialog.

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (4/6)



The screenshot shows the NETCONF GUI interface. On the left, there is a tree view of managed elements, including ManagedElement, Equipment, JavaConfig, PolicyControlFunction, AppConfig, PccConfig, BusinessEvents, EntityData, FlexibleDiameter, GeoRedManager, Network, DiameterNodes, DiameterNode, SmsCenter, WebServiceEndPoints, and NotificationConfig. The PccConfig node is selected. On the right, there is a table with columns 'Name' and 'Value'. A modal dialog titled 'Add New Parameter Instance' is open, showing 'Name: eventTriggers' and 'Value: Value'. A large list of trigger names is displayed below the modal, including: ACCESS_NETWORK_INFO_REPORT, AN_GW_CHANGE, APPLICATION_STOP, CHANGE_OF UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT, DEFAULT_EPS_BEARER_QOS_CHANGE, ECGI_CHANGE, IP_CAN_CHANGE, OUT_OF_CREDIT, PLMN_CHANGE, QOS_CHANGE, RAJ_CHANGE, RAT_CHANGE, REVALIDATION_OF_CREDIT, REVALIDATION_TIMEOUT, SGSN_CHANGE, SUCCESSFUL_RESOURCE_ALLOCATION, TAI_CHANGE, UI_TIME_ZONE_CHANGE, USAGE_REPORT, and USER_LOCATION_CHANGE.

Name	Value
enableEmergenciesWithImei	true
eventTriggers	RAT_CHANGE QOS_CHANGE

Add New Parameter Instance

Name: eventTriggers

Value: Value

ACCESS_NETWORK_INFO_REPORT
AN_GW_CHANGE
APPLICATION_STOP
CHANGE_OF UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT
DEFAULT_EPS_BEARER_QOS_CHANGE
ECGI_CHANGE
IP_CAN_CHANGE
OUT_OF_CREDIT
PLMN_CHANGE
QOS_CHANGE
RAJ_CHANGE
RAT_CHANGE
REVALIDATION_OF_CREDIT
REVALIDATION_TIMEOUT
SGSN_CHANGE
SUCCESSFUL_RESOURCE_ALLOCATION
TAI_CHANGE
UI_TIME_ZONE_CHANGE
USAGE_REPORT
USER_LOCATION_CHANGE

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (5/6)



The screenshot shows the Ericsson NETCONF Browser interface. The left pane displays a hierarchical tree of configuration nodes under 'SAPC1'. The 'eventTriggers' node under 'PolicyControlFunction[...]' is selected. A modal dialog titled 'Add New Parameter Instance' is open, showing a table with two rows:

Name	Value
enableEmergenciesWithImei	true
eventTriggers	RAT_CHANGE QOS_CHANGE PLMN_CHANGE

The 'Value' column for 'eventTriggers' contains three entries: 'RAT_CHANGE', 'QOS_CHANGE', and 'PLMN_CHANGE'. The 'PLMN_CHANGE' entry is currently selected. The bottom right of the dialog has 'OK' and 'Cancel' buttons.

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SAPC 1 Operation and Configuration



Defining Event Trigger Using NETCONF GUI (6/6)



Ericsson NETCONF Browser

Connections SAPC1 SAPC1

Support About

Fetch Push Save... Compare with Validate Search

Edit View Info

ManagedElement[managedElementId=1]
Equipment[equipmentId=1]
JavaCaffJavaCaffId=1
PolicyControlFunction[policyControlFunctionId=1]
AppConfig[appConfigId=1]
PccConfig[pccConfigId=1]
BusinessEvents[businessEventsId=1]
EntityData[entityDataId=1]
FlexibleDiameter[flexibleDiameterId=1]
GeoRedManager[geoRedManagerId=1]
Network[networkId=1]
DiameterNodes[diameterNodesId=1]
DiameterNode[diameterNodeId=dpiHostname.operator.com]
DiameterNode[diameterNodeId=ggsnHostname.operator.com]
DiameterNode[diameterNodeId=pcefCluster]
SmsCenter[smsCenterId=1]
WebServiceEndPoints[webServiceEndPointsId=1]
NotificationConfig[notificationConfigId=1]
SystemFunctions[systemFunctionsId=1]

Name	Value
enableEmergenciesWithImei	true
eventTriggers	RAT_CHANGE
eventTriggers	QOS_CHANGE
eventTriggers	PLMN_CHANGE
eventTriggers	SUCCESSFUL_RESOURCE_ALLOCATION
pccConfigId	1

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SAPC 1 Operation and Configuration



Verifying the changes added by NETCONF GUI.



```
> ManagedElement=1, PolicyControlFunction=1, AppConfig=1, PccConfig=1  
(PccConfig=1)>show configuration  
PccConfig=1  
  eventTriggers=SGSN_CHANGE  
  eventTriggers=RAT_CHANGE  
  eventTriggers=PLMN_CHANGE  
  eventTriggers=SUCCESSFUL_RESOURCE_ALLOCATION  
    up  
(PccConfig=1)>
```

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SAPC 1 Operation and Configuration



Configure PCEF in SAPC (1/4)



1. Open the NETCONF Session :

```
ssh sapcadmin@<OAM-VIP> -p 830 -s netconf
```

2. Send the capability request like below :

```
<?xml version="1.0" encoding="UTF-8" ?>
<hello xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
<capabilities>
<capability>urn:ietf:params:netconf:base:1.0</capability>
</capabilities>
</hello>]]>]]>
```

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SAPC 1 Operation and Configuration



Configure PCEFs in SAPC (2/4)



3. Copy the "Example 2 PCEF in cluster Configuration" taken from "Configuration Guide for Access and Charging Control (Gx)" chapter "3.2 Configure PCEFs for Interworking with Clustered Diameter Systems" to a notepad.

4. Modify the cluster pattern, use below information :

```
<clusterPattern>GcdMadrid.com</clusterPattern>
```

5. Add the following controls in to the template :

```
<controls>SERVICE_CHARGING</controls>
```

```
<controls>USAGE_REPORTING</controls>
```

6. Add the green font below to the command in notepad :

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
```

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="0">
```

```
<edit-config>
```

```
...
```

```
</edit-config>
```

```
</rpc>]]>]]>
```

7. Send the command in the NETCONF Session

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SAPC 1 Operation and Configuration



Configure PCEF in SAPC (3/4)



7. Send the command in the NETCONF Session:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="0">
<edit-config>
<target>
  <running/>
</target>
<config>
<ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
<managedElementId>1</managedElementId>
<PolicyControlFunction xmlns="urn:com:ericsson:ecim:sapcmom">
<policyControlFunctionId>1</policyControlFunctionId>
<Network xmlns="urn:com:ericsson:ecim:networkmom">
<networkId>1</networkId>
<DiameterNodes>
<diameterNodesId>1</diameterNodesId>
<diameterNode xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
<diameterNodeId>poecluster</diameterNodeId>
<control>IP_CAN_SESSION_ACCESS</controls>
<control>SERVICE_ACCESS_PCEF_TOD</controls>
<control>REARER_QoS</controls>
<control>SERVICE_CHANGING</controls>
<control>USAGE_REPORTING</controls>
<clusterPattern>G00Madrid.com</clusterPattern>
</diameterNode>
</DiameterNodes>
</Network>
</PolicyControlFunction>
</ManagedElement>
</config>
</edit-config>
</rpc>]]>]]>
```

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SAPC 1 Operation and Configuration



Configure PCEF in SAPC (4/4)



8. End the session and commit :

```
<rpc message-id="1" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
<close-session/>
</rpc>]]>]]>
```

9. Check and verify with COM CLI :

```
>show -r ManagedElement=1,PolicyControlFunction=1,Network=1,DiameterNodes=1
```

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SAPC 1 Operation and Configuration



SAPC Configuration



Configuration file **adapt_cluster.cfg**

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SAPC 1 Operation and Configuration



Configuration File adapt_cluster.cfg

```
SC-2:/cluster/storage/system/config/sapc # cat
adapt_cluster.cfg
[Customer]
TIMEZONE = Europe/Madrid

[Cluster]
PAYLOADS = 3 4

[Interface]
NAME = eth0 eth1
SC_IFZ_INDEX = 0 1
PL_IFZ_INDEX = 0
SC_MAC_PREFIX = 02:10:20:3C
PL_MAC_PREFIX = 02:10:40:3C
MAC_SUFFIX = 03 04

[Network]
SAPC_OM_SC_SH3_NETWORK = 192.168.100.0/24
SAPC_INT_SH_NETWORK = 172.16.100.0/24
TIPC_TAG = 4004

OAM_FEE_NODE = 1 2
OAM_FEE_IFZ_INDEX = 1 1
OAM_FEE_VLAN_TAG = 130 131
OAM_FEE_NETWORK = 192.168.218.0/29
192.168.218.8/29
OAM OSPF AREA = 0.1.1.1
OAM OSPF DEAD = 7

TRF_FEE_NODE = 3 4
TRF_FEE_IFZ_INDEX = 0 0
TRF_FEE_VLAN_TAG = 120 121
TRF_FEE_NETWORK = 192.168.216.0/28
192.168.216.16/28
TRF OSPF AREA = 0.0.1.1
TRF OSPF DEAD = 7

OAM_VIP = 10.95.74.1 ALB_OAM
GX_VIP = 10.95.74.21 ALB_TRF
SC-2:/cluster/storage/system/config/sapc #
```

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SAPC 1 Operation and Configuration



SAPC Configuration



Dual-stack for external networks for PNF deployments.

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SAPC 1 Operation and Configuration



Overview – Benefit Dual-stack for external networks

- Dual-Stack for External Networks allows SAPC to interact with the surrounding network elements using IPv4 and IPv6 traffic simultaneously.
- All external interfaces provided by SAPC in the PCC/BBF architectures to communicate with neighbours nodes support Dual-Stack configuration.
- Geored replication channel is considered internal traffic, so, this interface is configured as IPv4-only/IPv6-only.
- Dual-Stack configuration helps operators during the transitional period between IPv4 and IPv6.

- Technical Details:
- It is now possible to choose to configure IPv4, IPv6 or both of them at same time, for VIP addresses and external networks.

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SAPC 1 Operation and Configuration



Operation and Maintenance



adapt_cluster.cfg:

Examples of dual-stack parameters.

- OAM_FEE_NETWORK = 10.144.30.224/29 2001:1b74:20:be00:fc00::c0/123
- TRF_1_FEE_NETWORK = 10.144.70.224/28 2001:1b74:20:bf00:fc00::c0/123
- OAM_VIP = 10.200.64.177 2001:1b74:0020:be80:fc00:0000:0000:03e7 ALB_OAM
- GX_VIP = 10.200.65.141 2001:1b74:0020:bf80:fc00:0000:0000:03e7 ALB_TRF_1

Templates provided for dual-stack use cases.

- adapt_cluster_PNF_BSP_dualstack.cfg
- adapt_cluster_PNF_NSP_dualstack.cfg
- BSP templates: For BSP deployments a new set of templates is provided to configure BSP with Dual-Stack:
BSP_templates_dualstack.tar.gz

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SAPC 1 Operation and Configuration



SAPC Configuration

SCTP Multi-homing.

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Overview – Benefits (1/2)



SCTP Multi Homed With Path Diversity

Legacy SCTP support in previous SAPC releases:

- Single-Homed SCTP: SCTP endpoints handling a single IP address are supported but only to be configured for one external traffic network (ALB).
- Multi-Homed with Single Path: SCTP endpoints handling two IP addresses, so the session can persist during a network failure by redundant LAN, are supported but they must be manually configured and both VIPs are only supported to be published through the same external network (Single Path).

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SAPC 1 Operation and Configuration



Overview – Benefits (2/2)



SCTP Multi Homed With Path Diversity

SCTP support in SAPC1.7(*):

- Single-Homed: SCTP may be configured for as many external networks (ALBs) as needed, so, in traffic separation scenarios the different diameter applications running in different external networks may use Single-Homed SCTP (or any other SCTP configuration mode) as Transport Protocol configuration.
- Multi-Homed with Single Path: SCTP handling two IP addresses may be configured automatically during deployment based on adapt_cluster configuration reducing later manual intervention (*).
- Multi-Homed with Path Diversity: New configuration for SCTP is supported to provide different paths between SCTP endpoints, so at least two IP paths with no common equipment are available. SCTP transports supporting Path Diversity may be configured automatically during deployment based on adapt_cluster configuration file. Limited to VNF deployments without Virtual Routers.

(*) For payload traffic where SAPC acts as client (Sy/Sd), the specific transports and otpdiaHost objects in CDiameter are configured manually as part of the provisioning in the customer. Configuration Guide for Diameter in SAPC1.7 is updated to consider the SCTP configuration scenarios supported.

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SAPC 1 Operation and Configuration



Overview – Benefit



Dual-Stack for External Networks

Dual-Stack for External Networks allows SAPC to interact with the surrounding network elements using IPv4 and IPv6 traffic simultaneously.

All external interfaces provided by SAPC in the PCC/BBF architectures to communicate with neighbours nodes support Dual-Stack configuration.

Geored replication channel is considered internal traffic, so, this interface is configured as IPv4-only/IPv6-only.

Dual-Stack configuration helps operators during the transitional period between IPv4 and IPv6.

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SAPC 1 Operation and Configuration



Technical Details



SCTP transport can be configured in three different modes:

- Single homed
- Multi-homed with Single Path
- Multi-homed with Path Diversity

Configuration of SCTP is done per traffic type (Gx, Rx, Sd, Sx, Sy)

Regarding Dual-Stack, it is now possible to choose to configure IPv4, IPv6 or both of them at same time, for VIP addresses and external networks.

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SAPC 1 Operation and Configuration



Operation and Maintenance (1/2)



adapt_cluster.cfg:

- Variable XX_ALT_VIP (where XX can be traffic type, GX, RX, SX, SD, SY) to set additional VIP address for multihomed SCTP.
 - GX_VIP = 10.200.65.150 ALB_TRF1
 - GX_ALT_VIP = 10.200.79.39 ALB_TRF1
- If ALB for XX_VIP is different than ALB for XX_ALT_VIP, Path Diversity is desired.
 - GX_VIP = 10.200.65.150 ALB_TRF1
 - GX_ALT_VIP = 10.200.79.39 ALB_TRF3
- Variable SINGLEHOMED_SCTP to set what types of traffic shall use this transport protocol with single VIP.
 - SINGLEHOMED_SCTP = RX SX SD

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SAPC 1 Operation and Configuration



Operation and Maintenance (2/2)



adapt_cluster.cfg:

- Variable SCTP_ALB deprecated.
- Additional templates provided with different SCTP configurations
- Templates and examples also provided for dual-stack use cases.
 - OAM_FEE_NETWORK = 10.144.30.224/29 2001:1b74:20:be00:fc00::c0/123
 - TRF_1_FEE_NETWORK = 10.144.70.224/28 2001:1b74:20:bf00:fc00::c0/123
 - OAM_VIP = 10.200.64.177 2001:1b74:0020:be80:fc00:0000:0000:03e7 ALB_OAM
 - GX_VIP = 10.200.65.141 2001:1b74:0020:bf80:fc00:0000:0000:03e7 ALB_TRF_1

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SAPC Configuration



LDAP Authentication

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SAPC 1 Operation and Configuration



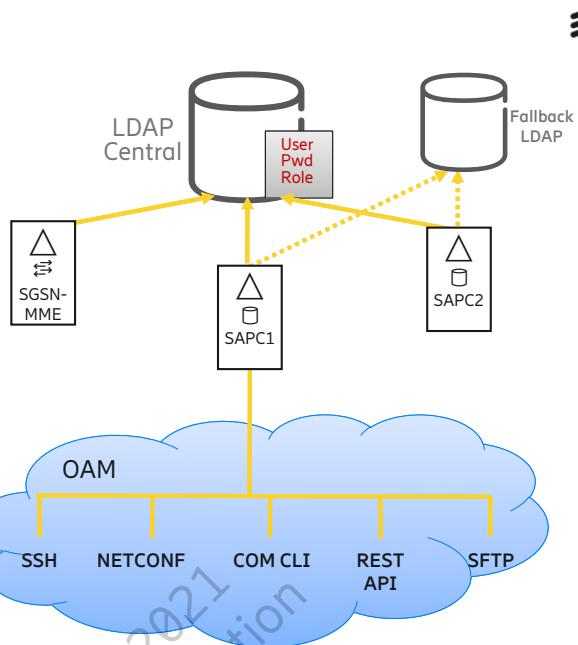
Overview- Benefit

LDAP Central Authentication/Authorization allows SAPC customers to authenticate and authorize O&M administrators based on the configuration provided in a customer centralized LDAP server.

Customers will be able to share O&M administrators between different nodes.

SAPC provides user authentication and authorization through centralized LDAP server for next OAM Interfaces:

- NETCONF/COM CLI
- REST API
- SSH
- SFTP



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Technical Details (1/2)



SAPC supports authentication and authorization based on the POSIX® account and the POSIX group schemas, according to RFC 2307.

SAPC supports a standard POSIX account schema extended with the following attributes:

- ericssonUserAuthenticationScope
- ericssonUserAuthorizationScope
- ericssonRoleAlias

These extensions are used to provide extended capabilities such as:

- Target-Based Access Control (different management roles for an O&M user depending on the node).
- Role aliases (different nodes have their own set of roles, because definition of roles is done locally on the individual node)

For example, the role administrator can be specified as admin on one node and adm on another.

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Technical Details (2/2)



SAPC supports LDAP over TLS

- LDAPS protocol
- StartTLS operation according to RFC 4515

SAPC supports the configuration of a primary and a fallback LDAP servers.

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LDAP Authentication

```
>dn ManagedElement=NODE06ST, SystemFunctions=1, SecM=1, UserManagement=1  
(UserManagement=1) >show -r  
UserManagement=1  
targetType="ims.kista.se"  
userLabel="Selective authentication for Kista site"  
LdapAuthenticationMethod=1  
administrativeState=UNLOCKED  
Ldap=1  
baseDn="dc=my-domain,dc=com"  
bindDn="cn=proxyaccount,dc=ericsson,dc=com"  
bindPassword="1:XUC+jE8QV05dG570uv7hWi1s/wa+uWi0"  
fallbackLdapIpAddress="192.0.2.11"  
ldapIpAddress="192.0.2.10"  
nodeCredential="ManagedElement=NODE06ST, SystemFunctions=1,=>  
SecM=1,CertM=1,NodeCredential=1"  
serverPort=636  
tlsMode=LDAPS  
...  
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```



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Operation and Maintenance (1/10)



What is configurable (`LdapAuthenticationMethod` in the `SecM` class):

`administrativeState` in the `LdapAuthenticationMethod` :

- LOCKED
- UNLOCKED (Enable feature)

`profileFilter` in the `LdapAuthenticationMethod` :

- `POSIX_GROUPS`
- `ERICSSON_FILTER`
- `FLEXIBLE`

Network configuration in the `LdapAuthenticationMethod` :

- `ldapIpAddress` (Primary LDAP Server)
- `fallbackLdapIpAddress` (Secondary LDAP Server)

`useTLS` in the `LdapAuthenticationMethod` :

- false
- true -> `tlsMode=LDAPS` (Secured port of LDAP Server)
- true -> `tlsMode=STARTTLS` (Default port of LDAP Server)

How to configure :

- In IMM, via netconf or cliss.

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Operation and Maintenance (2/10)



How to configure POSIX_GROUPS - Example of configuration via netconf

```
<edit-config>
  <target>
    <running/>
  </target>
<config>
  <ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
    <managedElementId>1</managedElementId>
    <SystemFunctions>
      <systemFunctionsId>1</systemFunctionsId>
      <SecM>
        <secMid>1</secMid>
        <UserManagement>
          <userManagementId>1</userManagementId>
          <LdapAuthenticationMethod>
            <ldapAuthenticationMethodId>1</ldapAuthenticationMethodId>
            <administrativeState>UNLOCKED</administrativeState> ← UNLOCKED
            <Ldap>
              <ldapId>1</ldapId>
              <ldapIpAddress>$TTCN_HOSTIP_ETH1</ldapIpAddress> ← LDAP SERVER IP ADDRESS
              <baseDn>dc=example,dc=com</baseDn>
              <serverPort>50090</serverPort> ← PORT
              <useTls>false</useTls>
              <profileFilter>POSIX_GROUPS</profileFilter> ← FILTER PROFILE
            </Ldap>
          </LdapAuthenticationMethod>
        </UserManagement>
      </SecM>
    </SystemFunctions>
  </ManagedElement>
</config>
</edit-config>
```

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SAPC 1 Operation and Configuration



Operation and Maintenance (3/10)



How to configure POSIX_GROUPS - Example of user in LDAP SERVER:

```
# POSIX User Account Entry
dn: uid=ldapsapcadmin,ou=people,dc=example,dc=com
objectClass: account
objectClass: posixAccount
objectClass: top
cn: SuperUser
uid: ldapsapcadmin ← LDAP User
uidNumber: 1011
gidNumber: 1011
userPassword: madrid13UCL ← Password
homeDirectory: /home/system-oam/ldapsapcadmin

# POSIX Group Entry
dn: cn=SuperUser,ou=group,dc=example,dc=com
objectClass: posixGroup
objectClass: top
cn: SuperUser ← ROLE
memberUid: ldapsapcadmin ← LDAP User assigned to Role
gidNumber: 1011
```

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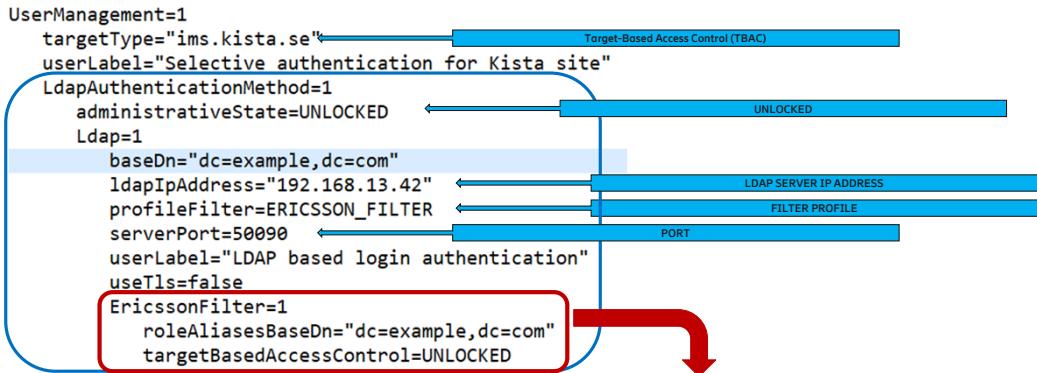
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Operation and Maintenance (4/10)



How to configure ERICSSON_FILTER - Example of configuration via CLISS



Example:

```
ericssonUserAuthenticationScope: ims.kista.se
ericssonUserAuthenticationScope: cscf.ims.malmo
ericssonUserAuthorizationScope: ims.kista.se:SystemAdministrator
ericssonUserAuthorizationScope: cscf.ims.malmo:SystemSecurityAdministrator
ericssonUserAuthorizationScope: *:ApplicationOperator.
```

Entry	TBAC OFF	TBAC ON EricssonFilter version 1	TBAC ON EricssonFilter version 2
<target> ":" <role>	Not Accepted	Accepted when the target matches.	Accepted
<target> ":" <role alias>	Not Accepted	Accepted when the target matches.	Accepted
<role>	Accepted	Accepted	Accepted
<role alias>	Accepted	Accepted	Accepted
">" ":" <role>	Accepted	Accepted	Accepted
">" ":" <role alias>	Accepted	Accepted	Accepted

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Operation and Maintenance (5/10)



How to configure ERICSSON_FILTER - Example of user in LDAP SERVER

```
# User account entry
dn: uid=lars, ou=people, dc=alvsjö, dc=telco, dc=com
objectClass: account
objectClass: posixAccount
objectClass: ericssonUserAuthentication
objectClass: ericssonUserAuthorization
objectClass: top
uid: lars
uidNumber: 1000
gidNumber=1000
userPassword: e1NTDSEldksflksdjflksdjflksdjflk
ericssonUserAuthorizationScope: SystemAdministrator
ericssonUserAuthorizationScope: secAdminRoleAlias
```

```
# Role alias entry
dn: role=secAdminRoleAlias, dc=roleAliases, dc=telco, dc=com
objectClass: ericssonRoleAlias
ericssonUserAuthorizationScope: SystemSecurityAdministrator
```

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Operation and Maintenance (6/10)



How to configure TLS - Install certificate following Install Trusted Certificate (CPI document)

```
>ManagedElement=1, SystemFunctions=1, SecM=1, CertM=1
(CertM=1)>installTrustedCertFromUri --uri sftp://xalealo@192.168.13.42/tmp/xalealo
/esapc/allInOne/server.pem --uriPassword XXXXXXXX --fingerprint
50:73:3a:7b:ca:96:31:01:0a:74:b6:f4:49:15:16:92:3c:e8:4e:67:a9:83:46:49:6f:f8:4f
true
(CertM=1)>show reportProgress
reportProgress
  actionPerformed=0
  actionName="installTrustedCertFromUri"
  additionalInfo
    "TrustedCertificate=1"
  progressInfo=""
  progressPercentage=100
  result=SUCCESS
  resultInfo="installed from the certificate file"
  state=FINISHED
  timeActionCompleted="2019-01-18T11:02:44Z"
  timeActionStarted="2019-01-18T11:02:43Z"
  timeOfLastStatusUpdate="2019-01-18T11:02:44Z"
(CertM=1)>
```

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Operation and Maintenance (7/10)



How to configure TLS

Create Trust Category following **Create Trust Category (CPI document)**:

```
(CertM=1)>configure  
(config-CertM=1)>TrustCategory=1  
(config-  
TrustCategory=1)>trustedCertificates="ManagedElement=1, SystemFunctions=1, SecM=1, CertM=1  
(config-TrustCategory=1)>commit  
(TrustCategory=1)>show  
TrustCategory=1  
trustedCertificates  
"ManagedElement=1, SystemFunctions=1, SecM=1, CertM=1, TrustedCertificate=1"  
(TrustCategory=1)>
```

Enabled Trusted Certificate following **Enable Trusted Certificate (CPI document)**:

```
(CertM=1)>configure  
(config-CertM=1)>TrustedCertificate=1  
(config-TrustedCertificate=1)>managedState=ENABLED  
(config-TrustedCertificate=1)>commit  
(TrustedCertificate=1)>show -v managedState  
managedState=ENABLED <default>
```

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Operation and Maintenance (8/10)



How to configure TLS - Example of configuration via netconf (LDAPS)

```
<edit-config>
  <target>
    <running/>
  </target>
  <config>
    <ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
      <managedElementId>1</managedElementId>
      <SystemFunctions>
        <systemFunctionsId>1</systemFunctionsId>
        <SecM>
          <secMid>1</secMid>
          <UserManagement>
            <userManagementId>1</userManagementId>
            <LdapAuthenticationMethod>
              <ldapAuthenticationMethodId>1</ldapAuthenticationMethodId>
              <administrativeState>UNLOCKED</administrativeState>
              <Ldap>
                <ldapId>1</ldapId>
                <ldapIpAddress>$TCN_HOSTIP_ETH1</ldapIpAddress>
                <baseDn>dc=example,dc=com</baseDn>
                <serverPort>50001</serverPort>
                <useTls>true</useTls> ← Set to true
                <tlsMode>LDAPS</tlsMode> ← LDAPS
                <trustCategory>ManagedElement=1,SystemFunctions=1,SecM=1,CertM=1,TrustCategory=1</trustCategory> ← trustCategory with TLS certificate
                <profileFilter>POSIX_GROUPS</profileFilter>
              </Ldap>
            </LdapAuthenticationMethod>
          </UserManagement>
        </SecM>
      <SystemFunctions>
    </ManagedElement>
  </config>
</edit-config>
```

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Operation and Maintenance (9/10)



How to configure TLS - Example of configuration via netconf (STARTTLS)

```
<edit-config>
  <target>
    <running/>
  </target>
  <config>
    <ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
      <managedElementId>1</managedElementId>
      <SystemFunctions>
        <systemFunctionsId>1</systemFunctionsId>
        <SecM>
          <secMId>1</secMId>
          <UserManagement>
            <userManagementId>1</userManagementId>
            <LdapAuthenticationMethod>
              <ldapAuthenticationMethodId>1</ldapAuthenticationMethodId>
              <administrativeState>UNLOCKED</administrativeState>
              <Ldap>
                <ldapId>1</ldapId>
                <ldapIpAddress>$TCN_HOSTIP_ETH1</ldapIpAddress>
                <baseDn>dc=example,dc=com</baseDn>
                <serverPort>50009</serverPort>
                <useTls>true</useTls>
                <tlsMode>STARTTLS</tlsMode> Set to true
                <trustCategory>ManagedElement=1, SystemFunctions=1, SecM=1, CertM=1, TrustCategory=1</trustCategory>
                <profileFilter>POSIX_GROUPS</profileFilter>
              </Ldap>
            </LdapAuthenticationMethod>
          </UserManagement>
        </SecM>
      </SystemFunctions>
    </ManagedElement>
  </config>
</edit-config>
```

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Operation and Maintenance (10/10)



What is configurable:

- ldap_user_cache_timeout: Time in seconds for ldap user cached in rest-server.
- clean_ldap_cache_timer: Time in hours between executions of the cache cleaner that ensures that old residual user sessions are cleared from the rest-server cache.

How to configure:

- Command line.

```
# All the process will need a config file in order to allow to some automatic  
# tool (like tcmalloc) checks the SAPC code  
# For FT the following variable must be set to -1 meaning the permanent cache will be inactive  
central-cache-invalidator-timeout=-1  
##central-cache-invalidator-timeout=300000  
# 300000 = 5 minutes  
# default nuThreads for session reauth async pool  
num-threads-session-reauth=10  
ldap user cache timeout=0
```

Example of configuration:

- SC-1:~ # vi /cluster/storage/system/config/sapc/rest-server.cfg
- SC-1:~ # sapcRestServer -a restart

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SAPC 1 Operation and Configuration



SAPC Configuration

Configuration of SAPC interaction with NRF and UDR.

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SAPC 1 Operation and Configuration



SAPC Configuration



SAPC interaction with NRF.

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SAPC 1 Operation and Configuration



NRF Server Configuration



To configure NRF Server data in MOM, follow these steps:

```
ManagedElement=1,PolicyControlFunction=1,PcfConfig=1,PcfNetwork=1,PcfPeerNodes=1  
(PcfPeerNodes=1)> configure  
(PcfPeerNodes=1)> PcfPeerNode=nrf1  
(config-PcfPeerNode=nrf1)> ipv4=<Ip address>          (For IPv4 traffic)  
(config-PcfPeerNode=nrf1)> ipv6=<Ip address>          (For IPv6 traffic)  
(config-PcfPeerNode=nrf1)> port=<Port number>  
(config-PcfPeerNode=nrf1)> type=NRF  
(config-PcfPeerNode=nrf1)> commit
```

Note:

Configure either IPv4 or IPv6 address, SAPC PCF is not allowed IPv4 and IPv6 traffic at the same time.

It is recommended to take a data backup after modifying the configuration of the NRF server.

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Configure the pcfAppConfig



To configure the attributes in the pcfAppConfig MO, use the following attributes:

- The pcfID parameter is mandatory.
- The pcfAdminStatus parameter is set as ADMIN_REGISTERED.
- The pcfFqdn parameter is optional.
- The pcfLocality parameter is used by other network functions to select PCF.
- The pcfPriority parameter is used for UDR geographical redundancy.

For example:

```
(PcfAppConfig=1)>show -v
PcfAppConfig=1
checkFor5gSessionAlive=true <default>
pcfAdminStatus=ADMIN_REGISTERED <default>
pcfAppConfigId="1"
pcfFqdn="selius03696.seli.gic.ericsson.se"
pcfID="de9f9fd9-ff3f-4255-a635-51f2e11c92fd"
pcfLocality=[] <empty>
pcfPriority=[] <empty>
PcfMsgTemplates=1
```

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SAPC 1 Operation and Configuration



Configure the SAPC PCF Registration Profile



```
ManagedElement=1, PolicyControlFunction=1, PcfConfig=1, PcfAppConfig=1, PcfMsg  
Templates=1  
(PcfMsgTemplates=1)> configure  
(config-PcfMsgTemplates=1)> PcfMsgTemplate=pcfRegProfile  
(config-PcfMsgTemplate=pcfRegProfile)>
```

Configure the value of the PCF message template depending on your needs.

The tags listed in the next slide can be used in the template. When SAPC PCF interaction with NRF, the tags are going to be replaced with real value according to the operator environment.

In this example is created a PCF message template with name pcfRegProfile.

(An example of the PcfMsg Template is provided in slide 5-46).

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Corresponding value of the Tag in Message Template



{PCF_ID}: The value of pcfID

{PCF_HB_TIMER}

{PCF_STATUS}: When the value of {smpc_status} or {ampc_status} or {uepc_status} is REGISTERED, the value of {PCF_STATUS} is REGISTERED. When the value of {smpc_status}, {ampc_status}, and {uepc_status} are SUSPENDED, the value of {PCF_STATUS} is SUSPENDED.

{PCF_FQDN}: the value of pcfFqdn.

{PCF_VIP}: the evip of Nnrf traffic. If the NRF_VIP is not configured in adapt_cluster.cfg, the default value is GX_VIP.

{N15_VIP}: the evip of N15 traffic. If the N15_VIP is not configured in adapt_cluster.cfg, the default value is GX_VIP.

{N7_VIP}: the evip of N7 traffic. If the N7_VIP is not configured in adapt_cluster.cfg, the default value is GX_VIP.

{CONNECT}: if enableTLS is true, it's https, else it's http

{smpc_status}: If the SM policy control service is available, the value is REGISTERED, otherwise the value is SUSPENDED.

{ampc_status}: If the AM policy control service is available, the value is REGISTERED, otherwise the value is SUSPENDED.

{uepc_status}: If the UE policy control service is available, the value is REGISTERED, otherwise the value is SUSPENDED.

{n15_port}: port defined in openapi_gateway for AMF.

{n7_port}: port defined in openapi_gateway for SMF.

{uepc_port}: port defined in openapi_gateway

The **openapi_gateway** is an evip flow policy.

The following tags are fixed for corresponding keys:

{PCF_ID}, {PCF_HB_TIMER}, {PCF_STATUS}, {PCF_FQDN}, {PCF_VIP}, {CONNECT}

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SAPC 1 Operation and Configuration



Entity Data Source

- To de-couple the SAPC application objects or policy data used in policy conditions and the physical database, the SAPC uses the Entity Data Source concept
- It is a representation of the mapping between application objects and the physical storage
- “from where and how to access data”
- An Entity Data Source definition is composed of a set of elements (using a language specified in Entity Data Definition Language)
- This defines how to access the repository, where the data is stored, which attributes are obtained, how to obtain them
- Used for LDAP interaction, possibly to build more complex policies etc.

```
>ManagedElement=1,PolicyControlFunction=1  
,EntityData=1,EDSources=1  
(EDSources=1)>show  
EDSources=1  
EDSource=AdcRedirectProfile  
EDSource=PolicyLocator  
EDSource=PraProfile  
EDSource=SubscriberGroup  
EDSource=AccumulatedUsage  
EDSource=BearerQosProfile  
  
EDSource=AccumulatedUsageSharedDataplan  
EDSource=ChargingSystem  
EDSource=GroupsToSharedDataplan  
EDSource=GroupsToSubscriber  
EDSource=OnlineChargingSystemProfile  
EDSource=Policy  
EDSource=Rule  
EDSource=RuleSpace  
EDSource=Service  
EDSource=ServiceChargingProfile  
EDSource=ServiceQosProfile  
EDSource=SharedDataplan  
EDSource=SubsChargingProfile  
EDSource=Subscriber
```

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SAPC Configuration

SAPC interaction with UDR.

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Configuration of UDR Node Information



```
ManagedElement=1,PolicyControlFunction=1,PcfConfig=1,PcfNetwork=1,PcfPeerNodes=1  
(PcfPeerNodes=1)>configure  
(PcfPeerNodes=1)> PcfPeerNode=udr1  
(config-PcfPeerNode=udr1)>type=UDR  
(config-PcfPeerNode=udr1)>ipv4=<Ip address>  
(config-PcfPeerNode=udr1)>ipv6=<Ip address>  
(config-PcfPeerNode=udr1)>port=<Port number>  
(config-PcfPeerNode=udr1)>nodeStatus=REGISTERED
```

The mandatory attributes were configured above. If needed define the optional attributes are as follows:

fqdn Fully Qualified Domain Name (FQDN) of the NF node.

priority Priority of peer node. A lower value indicates a higher priority.

locality Locality of peer node: geographic location or data center. The values are case insensitive.

Commit the settings:

```
(config-PcfPeerNode=udr1)>commit
```

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Configuration of UDR Node Information - Example



```
>ManagedElement=1,PolicyControlFunction=1,PcfConfig=1,PcfNetwork=1,PcfPeerNodes=1
(PcfPeerNodes=1)>configure
(config-PcfPeerNodes=1)>PcfPeerNode=UDR1
(config-PcfPeerNode=UDR1)>type=?
NRF      NRF.
UDR      UDR.
(config-PcfPeerNode=UDR1)>type=UDR
(config-PcfPeerNode=UDR1)>ipv4=10.10.10.0
(config-PcfPeerNode=UDR1)>port=8443
(config-PcfPeerNode=UDR1)>nodeStatus=?
REGISTERED   REGISTERED.
SUSPENDED    SUSPENDED.
(config-PcfPeerNode=UDR1)>nodeStatus=REGISTERED
(config-PcfPeerNode=UDR1)>commit
(PcfPeerNode=UDR1)>show
PcfPeerNode=UDR1
  ipv4="10.10.10.0"
  nodeStatus=REGISTERED
  port=8443
  type=UDR
(PcfPeerNode=UDR1)>
```

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SAPC Configuration



SAPC PCF interaction with SMF.

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SAPC PCF Interaction with SMF



This section is explaining in three parts:

- Controls in SAPC PCF
- Triggers in SAPC PCF

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SAPC Configuration



Controls in SAPC PCF

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SMF Configuration



The controls (for example, PDU Session Access Control and Service Access Control) that the SAPC PCF executes when receiving N7 traffic, are configured at the SMF level.

To define an SMF, create a `PcfPeerNodes` instance using the value of `smfid` sent by the SMF in `Npcf_SMPolicyControl_Create` request as `pcfNetworkId`.

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Example of SMF Configuration



```
<edit-config>
<target>
<running/>
</target>
<config>
<ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
<managedElementId>1</managedElementId>
<PolicyControlFunction xmlns="urn:com:ericsson:ecim:sapcmom">
<policyControlFunctionId>1</policyControlFunctionId>
<PcfConfig xmlns="urn:com:ericsson:ecim:pcfconfigmom">
<pcfConfigId>1</pcfConfigId>
<PcfNetwork>
<pcfNetworkId>1</pcfNetworkId>
<PcfPeerNodes>
<pcfPeerNodesId>1</pcfPeerNodesId>
<PcfPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
<pcfPeerNodeId>09c45809-5f33-428c-b9e0-229dca1585e6</pcfPeerNodeId>
<controls>PDU_SESSION_ACCESS</controls>
<controls>SERVICE_ACCESS_PCF_TOD</controls>
<controls>SUBSCRIBER_CHARGING</controls>
<controls>SERVICE_CHARGING</controls>
<type>SMF</type>
</PcfPeerNode>
</PcfPeerNodes>
</PcfNetwork>
</PcfConfig>
</PolicyControlFunction>
</ManagedElement>
</config>
</edit-config>
```

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SAPC 1 Operation and Configuration



Configure a Default SMF



- The SAPC PCF supports the definition of the Default SMF to avoid adding each SMF configuration individually. The Default SMF is compatible with particular SMF configuration.
- To add the Default SMF in the SAPC PCF the operator has to create a PcfPeerNodes with the pcfPeerNodesId equal to the case sensitive value Default.
- The Default SMF in the SAPC PCF is unique but it is configurable, so the SAPC PCF configures controls and has the ability to support dynamic services or not. In addition, the configuration is modifiable at any moment.
- When an incoming Gx message arrives to the SAPC PCF from an SMF, the SAPC PCF searches first for the particular configuration for the SMF. If no configuration found and the Default SMF exists, the SAPC PCF applies the Default configuration for the unknown SMF.

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SAPC 1 Operation and Configuration



Example of a Default SMF Configuration



```
<edit-config>
<target>
<running/>
</target>
<config>
<ManagedElement xmlns="urn:com:ericsson:ecim:ComTop">
<managedElementId>1</managedElementId>
<PolicyControlFunction xmlns="urn:com:ericsson:ecim:sapcmom">
<policyControlFunctionId>1</policyControlFunctionId>
<PcfConfig xmlns="urn:com:ericsson:ecim:pcfconfigmom">
<pcfConfigId>1</pcfConfigId>
<PcfNetwork>
<pcfNetworkId>1</pcfNetworkId>
<PcfPeerNodes>
<pcfPeerNodesId>1</pcfPeerNodesId>
<PcfPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
<pfcPeerNodeId>Default</pfcPeerNodeId>
<controls>PDU_SESSION_ACCESS</controls>
<controls>SERVICE_ACCESS_PCF_TOD</controls>
<controls>SUBSCRIBER_CHARGING</controls>
<controls>SERVICE_CHARGING</controls>
<type>SMF</type>
</PcfPeerNode>
</PcfPeerNodes>
</PcfNetwork>
</PcfConfig>
</PolicyControlFunction>
</ManagedElement>
</config>
</edit-config>
```

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SAPC Configuration

Triggers in SAPC PCF

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Policy Control Request Trigger Selection Configuration



Unconditional Policy Control Request Trigger Selection

The SAPC PCF notifies the SMF of the policy control request trigger that the SAPC PCF is interested in the receiving POST request. To use the policy control request triggers:

1. Find the value of the event triggers that matches the required Policy Control Request Trigger in the event trigger mapping table in the document: N7 Interface Description.
2. Set the eventTriggers attribute of dataplans or global dataplans URI in the provisioning REST API.
3. Configuring the location change related event triggers (for example RAI change, TAI change, and ECGI change) at the subscriber group level can minimize the network signaling compared to configuring them at the SAPC PCF level.

In this example, the SAPC PCF subscribes to the location change trigger for subscriber group Silver. The configuration of the Policy Control Request Trigger is performed at Subscriber Group Level:

```
PUT /dataplans/Silver'{  
    "dataplanName": "Silver",  
    "eventTriggers": [13]  
}'
```

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Policy Control Request Trigger Selection Configuration



Conditional Policy Control Request Trigger Selection

To configure policy control request triggers at subscriber group level depending on conditions, create the required policies using:

- For Global Policy locator:
`/locators/resources/any/contexts/event-triggers`
- For Subscriber Group locator:
`/dataplans/<dataplanName>/locators/resources/any/contexts/event-triggers`
- For Subscriber locator:
`/subscribers/<subscriberId>/locators/resources/any/contexts/event-triggers`

Within the outputAttributes object in the rule, set:

- attrName attribute to event-triggers
- attrValue attribute to the value of the Policy control request triggers.

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Policy Control Request Trigger Selection Configuration

Conditional Policy Control Request Trigger Selection - Example

```
PUT /rules/DynamicEventTriggersDataplan '{  
    "ruleName":"DynamicEventTriggersDataplan",  
    "condition":"(AccessData.subscriber.locationInfo.routingAreaCode==676)",  
    "outputAttributes": [  
        {  
            "attrName":"event-triggers",  
            "attrValue":"202",  
            "result":"permit"  
        }]  
    }  
  
PUT /policies/DynamicEventTriggersPolicy '{  
    "policyName":"DynamicEventTriggersPolicy",  
    "ruleCombiningAlgorithm":"permit-overrides",  
    "rules":["DynamicEventTriggersDataplan"]  
}  
  
PUT /dataplans/Silver/locators/resources/any/contexts/event-triggers '{  
    "policies":["DynamicEventTriggersPolicy"]  
}'
```

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SAPC 1 Operation and Configuration



SAPC Configuration



Traffic separation and dual stack in SAPC PCF

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Technical Details



Traffic Separation:

Physical traffic separation is supported for HTTP/2 interface, including N7, N15, N36 and Nnrf.

Dual Stack:

- The interfaces N15, N36, Nnrf can be configured in dual stack.
- All configured IPs (including IPv4 and IPv6) will be informed to NRF.
- For incoming message, the response is sent by using IPV4 or IPV6 accordingly.
- For outgoing message: If peer is in dual stack mode, IPV6 IP will be used firstly.

Note:

- Traffic Separation on N7, N36 and Nnrf is supported in 1.10.
- Traffic Separation on N15 is supported in 1.11.
- Dual Stack is supported in 1.11

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Configurations (1/2)



Configuration changes in Adapt Cluster Tool:

Following VIPs and Ports supported in case Traffic separation and Dual Stack:

- N7_VIP with Dual Stack
- N15_VIP with Dual Stack
- N36_VIP with Dual Stack
- NRF_VIP with Dual Stack
- HTTP2_N7_PORT
- HTTP2_N15_PORT
- HTTP2_N36_PORT
- HTTP2_NRF_PORT

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Configurations (2/2)



Configuration change on PcfMsgTemplate:

- The configuration segment N7 and N15 is added to support Traffic Separation, including:
 - ipv4Address
 - ipv6 address in dual stack scenario.
 - port
 - apiPrefix
 - allowedPlmnns
 - allowedNfTypes

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Example of the adapt_cluster_tool.cfg



```
[Customer]
TIMEZONE = Europe/Madrid
NTP_SERVER_IP = 10.221.17.38

[Cluster]
INITIAL_PLS = 2

[Interface]
SC_MAC_PREFIX = 02:10:20:3C
PL_MAC_PREFIX = 02:10:40:3C
PL_IFACE_COUNT = 4
SC_IFACE_COUNT = 7

[Network]
SAPC_INT_SH_NETWORK = 172.16.100.0/24

OAM_FEE_NODE = 1 2
OAM_FEE_IFZ_INDEX = 2
OAM_FEE_NETWORK = 10.90.30.224/29 2001:1c74:10:be00:0918::/123

PROV_FEE_NODE = 1 2
PROV_FEE_IFZ_INDEX = 3
PROV_FEE_NETWORK = 10.90.40.224/29 2001:1c74:10:be00:0918::/123

TRF_1_FEE_NODE = 3 4
TRF_1_FEE_IFZ_INDEX = 2
TRF_1_FEE_NETWORK = 10.90.70.224/29 2001:1c74:10:bf00:0918::/123

TRF_2_FEE_NODE = 3 4
TRF_2_FEE_IFZ_INDEX = 3
TRF_2_FEE_NETWORK = 10.90.80.224/29 2001:1c74:10:bf00:0918::/20/123

TRF_3_FEE_NODE = 3 4
TRF_3_FEE_IFZ_INDEX = 4
TRF_3_FEE_NETWORK = 10.90.90.224/29 2001:1c74:10:bf00:0918::40/123

TRF_4_FEE_NODE = 3 4
TRF_4_FEE_IFZ_INDEX = 5
TRF_4_FEE_NETWORK = 10.90.100.224/29 2001:1c74:10:bf00:0918::60/123

TRF_5_FEE_NODE = 3 4
TRF_5_FEE_IFZ_INDEX = 6
TRF_5_FEE_NETWORK = 10.90.110.224/29 2001:1c74:10:bf00:0918::80/123

OAM_VIP = 10.200.64.203 2001:1b74:88:c830::228 ALB_OAM
PROV_VIP = 10.200.81.66 2001:1b74:88:c830::229 ALB_PROV
GX_VIP = 10.200.65.203 2001:1b74:88:c430::228 ALB_TRF_1
NRF_VIP = 10.200.79.52 2001:1b74:88:c430::229 ALB_TRF_2
N7_VIP = 10.200.79.53 2001:1b74:88:c430::22a ALB_TRF_3
N15_VIP = 10.200.79.54 2001:1b74:88:c430::22b ALB_TRF_4
N36_VIP = 10.200.79.55 2001:1b74:88:c430::22c ALB_TRF_5

[BusinessEvents]
EBM_VIP = 10.200.65.203 2001:1b74:88:c430::228 ALB_TRF_1
```

Note: The ALB definition should follow the suggestion from eVIP System Architecture description.

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Example of the PcfMsg Template

```
{  
    "nfInstanceId": "{PCF_ID}",  
    "nfType": "PCF",  
    "heartBeatTimer": {PCF_HB_TIMER},  
    "nfStatus": "{PCF_STATUS}",  
    "plmnList": [{"mcc": "240", "mnc": "81"}],  
    "sNsais": [{"st": 1, "sd": "000002"}, {"st": 1, "sd": "000003"}, {"st": 2, "sd": "000001"}, {"st": 2, "sd": "000002"}, {"st": 2, "sd": "000003"}, {"st": 3, "sd": "000001"}, {"st": 3, "sd": "000002"}, {"st": 3, "sd": "000003"}, {"st": 4, "sd": "000001"}, {"st": 4, "sd": "000002"}, {"st": 4, "sd": "000003"}, {"st": 4, "sd": "000004"}, {"st": 1, "sd": "000001"}, {"st": 2, "sd": "000002"}, {"st": 3, "sd": "000003"}],  
    "fqdn": "{PCF_FQDN}",  
    "ipv4Addresses": "{PCF_VIP}",  
    "capacity": 100,  
    "priority": 1,  
    "pcfInfo": {"dnList": ["Internet", "Internet1", "Internet2", "Internet3", "cups1", "cups2", "cups3", "apn0", "apn1", "apn2", "apn3"], "supiRanges": [{"start": "240810000000001", "end": "24081999999999"}]},  
    "rxDiamHost": "rxDiam-Host.com", "rxDiamRealm": "rxDiam-Realm.com"},  
    "nfServices": [  
        {  
            "serviceInstanceId": "npcf-smpc-0001",  
            "serviceName": "npcf-smpolicycontrol",  
            "versions": [{"apiVersionInUri": "v1", "apiFullVersion": "1.R15.2.0"}],  
            "scheme": "(CONNECT)",  
            "nfServiceStatus": "{smpc_status}",  
            "ipEndPoints": [{"ipv4Address": "[N7_VIP]", "ipv6Address": "[N7_VIP_IPV6]", "port": "(n7_port)"},  
                {"ipPrefix": "npcf-smpolicycontrol", "allowedPlmns": [{"mcc": "240", "mnc": "81"}], "allowedNfTypes": ["SMF"]}],  
        },  
        {  
            "serviceInstanceId": "npcf-ampc-0001",  
            "serviceName": "npcf-am-policy-control",  
            "versions": [{"apiVersionInUri": "v1", "apiFullVersion": "1.R15.2.0"}],  
            "scheme": "(CONNECT)",  
            "nfServiceStatus": "{ampc_status}",  
            "ipEndPoints": [{"ipv4Address": "[N15_VIP]", "ipv6Address": "[N15_VIP_IPV6]", "port": "(n15_port)"},  
                {"ipPrefix": "npcf-am-policy-control", "allowedPlmns": [{"mcc": "240", "mnc": "81"}], "allowedNfTypes": ["AMF"]}],  
        }  
    ]  
}
```

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SAPC 1 Operation and Configuration



SAPC Provisioning



Image based Policy Studio deployment.

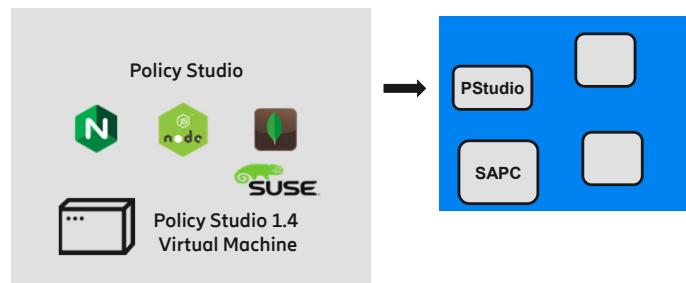
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Overview – Benefit (1/2)



This is a new delivery flavor of Policy Studio, comprising a Virtual Machine with all requirements already installed and configured



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Overview – Benefit (2/2)



Operators consistently reported the difficulty of the installation of Policy Studio with software version before 1.4

- needed to install an operating system
- needed to download and install the rest of the software requirements:
 - MongoDB
 - NodeJs
 - Nginx
- needed to have internet access to complete the installation process

This feature provides a solution to these problems

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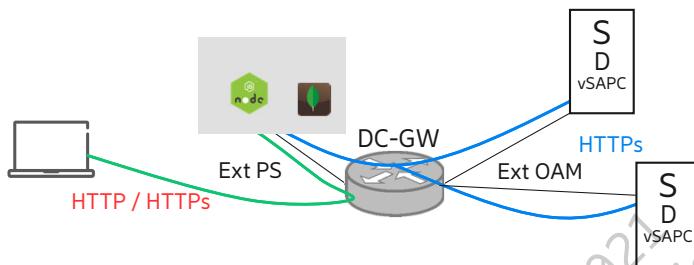
Technical Details (1/2)



The environment needs to define a flavor with the minimum requirements

- CPU: 2 vCPUs
- RAM: 4 GB
- Hard Disk Space: 100 GB

And a network should be available with connectivity to the SAPCs



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Technical Details (2/2)



Configuration Item	Area	Comments
ps_ipaddr ps_netmask ps_gateway	Networking	
this_hostname ntp_server_ip ps_vm_user_auth_method ps_vm_user_passwd	Host	Select the configuration method either: • password : then provide the ps_vm_user_passwd • public_key : then provide the certificate /ericsson/ps/data/authorized_keys
ps_mongo_port ps_mongo_user ps_mongo_passwd	Mongo DB	
ps_port ps_log_max_size ps_log_max_files ps_log_files_level	Express server configuration	ps_log_files_level= Number to enable different logging levels: 0 - No logs 1 - Errors 2 - Errors and auth 3 - Errors, auth and sapc requests
ps_nginx_port ps_nginx_http	Nginx configuration (external server)	This is real service port When ps_nginx_http is configured with https be sure to provide the SSL certificates /etc/ssl/server.crt /etc/ssl/server.key

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SAPC 1 Operation and Configuration



Operation and Maintenance



The O&M user is **pstadmin**.

The access mode to **pstadmin** is configured with `ps_vm_user_auth_method`.

- Password
- Certificate

The **O&M operations described in 1.3** can be performed with this user:

- Configuration
- Log management
- Troubleshooting
- Backup and restore
- Upgrade
- Rollback

The virtual machine provides an additional O&M feature: **start and stop scripts**:

- `sudo /usr/local/bin/stop_PS`
- `sudo /usr/local/bin/start_PS`

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SAPC 1 Operation and Configuration



SAPC Provisioning



Outline the QoS enhancement handling mechanism.

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SAPC 1 Operation and Configuration



Overview



Enhancement on QoS handling

- The SAPC provide the new functionality consist of the enhancement about Bearer QoS control.

Benefit for the operator:

- More flexible on Bearer QoS Control mechanism.
- Option to control the functionality.
- Following information (AVPs) will be stored if available:
- QoS-Information
- Default-EPS-Bearer-QoS

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SAPC 1 Operation and Configuration



User Case



Two dataplans are defined: Dataplan 1 and Dataplan 2.

- Dataplan 1 (DT1):
- Dataplan used as no limitation.
- There's no QoS control in this Dataplan.

Dataplan 2 (DT2):

- Dataplan with higher priority.
- QoS set to low.

Scenario:

- When the sub quota in DT1 exhausted, DT2 is active, and QoS limited.
- When the Quota reset or DT2 invalid, and QoS should back to high QoS, however there's no QoS defined, UE will still using low QoS.

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SAPC 1 Operation and Configuration



Technical Details - Description



New configuration in appConfig to control the function

Store the QoS information when:

- CCR-I received with it's RAT Type.
- CCR-U received:
 - Check if it's due to event RAT_Change.
 - If it's RAT Change, check if the QoS information stored previous for the new RAT Type:
 - If QoS Information stored, then exit.
 - If QoS Information not stored, store the QoS information with RAT Type.

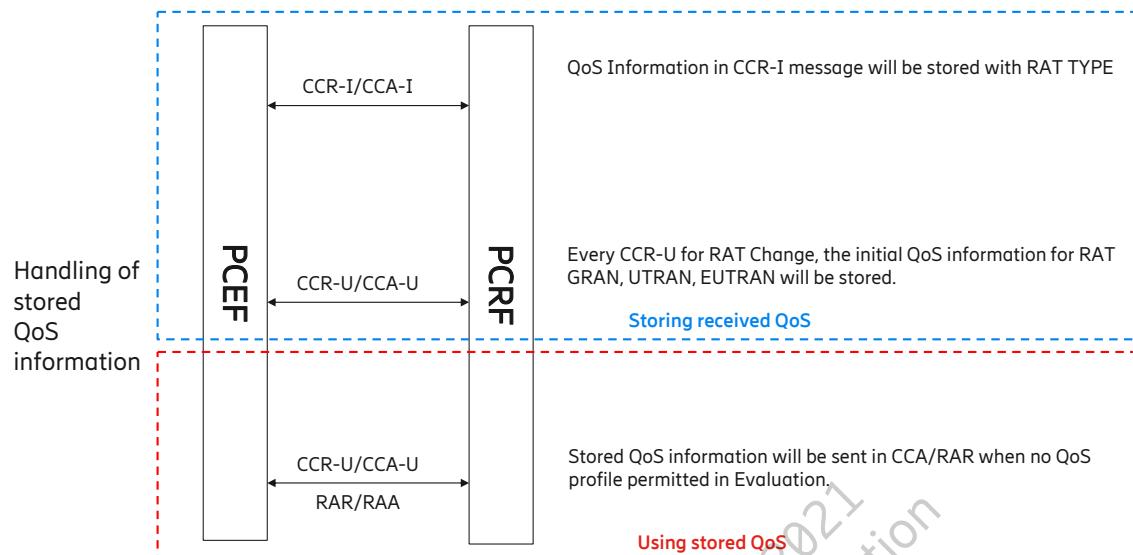
When no QoS profile permitted from policy engine to message to PCEF, the stored QoS information will be sent to PCEF.

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SAPC 1 Operation and Configuration



Technical Details - Description



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SAPC 1 Operation and Configuration



Operation and Maintenance



To configure/enable behavior:

- Set the parameter enableQosEnhancements in appConfig to True.
- The modification will be effective immediately.

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SAPC 1 Operation and Configuration



Example: Restart sapcPcrfProc



- The Diameter proxy is an optional feature that resides with CBA diameter service to achieve diameter connectivity redundancy
- When the SAPC detects that the Diameter connectivity to a specific host is broken, it forwards request messages to the mated peer. The messages are sent through the diameter stack of the counterpart.
- In the SAPC, the different processes serve different protocols. For example, pcrfProc process serves Gx and Rx protocol
- The diameter proxyfunction for each protocol can be configured in separate process config files. Forexample, to changethediameter proxy for Gx and Rx, update the /cluster/storage/system/config/sapc/pcrf-proc.cfg.
- In most of the scenarios the default configurations above are enough.
- To make the change effective, it is necessary to edit the file and restart the process with the following command:
 >sapcPcrfProc -a restart -f
- The Diameter proxy for other protocols can be configured in similar way.

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SAPC 1 Operation and Configuration



System Admin – CFG Files Configuration



SAPC use several static configuration files to adjust its environmental parameters

These CFG files found in /cluster/storage/system/config/sapc/ are :

- timetriggereventnotifierproc.cfg
 - Maximum number of reauthorizations due to the time of day that the SAPC sends per second
- java.cfg End User Notification Function
 - Maximum number of connections that a notification server supports, Connection inactivity time, Time period to check a connection state
- extDBProc.cfg External Database Access Function
 - Related to parameters tuned by the Ericsson Staff for the dimensioning of the External Database Access
- pcrf-proc.cfg Network Location Information Function
 - parameters related to Network Location Information, like for ex. the time (in ms) that the SAPC waits between the Rx STR command received and the CCR-U received from the PCEF, before sending the Rx STA

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SAPC 1 Operation and Configuration



System Admin – CFG Files Configuration



The parameters can be changed in : /cluster/storage/system/config/sapc/<config_file>.cfg

To apply any changes issue the following command:

Note:

Only the name of the file is necessary. Do not prefix with the path of the file.

```
SC-1:~ # sudo sapcReloadConfig -f <config_file>.cfg
```

Warning note!

Any change in the value of these parameters must be carefully done by Ericsson personnel.

Caution!

The SAPC internally uses many other parameters in .cfg files. DO NOT change any other parameter than the ones appearing in this section, as it can lead to an undesired behavior or malfunctioning of the SAPC.

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SAPC 1 Operation and Configuration



SAPC Configuration

UDR: 1+1 Geo-red support

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SAPC 1 Operation and Configuration



Overview



Main Functionalities:

- SAPC PCF is able to support 2 UDRs discovering from NRF or configuring locally in without NRF deployment.
- SAPC PCF supports the primary UDR selection based on the priority (UDR with lower value will be selected) and locality (UDR with same locality as PCF will be selected).
- If the primary UDR is unavailable, SAPC PCF should failover to the secondary one.
- When the primary UDR is recovered, SAPC PCF should fallback to this one.

Benefits for the operator:

- Enhance system robustness by supporting UDR 1+1, SAPC PCF can select the available UDR dynamically according to network status
- Enhance system stability by supporting UDR 1+1, user data are synchronized between two UDRs, user data consistence is guaranteed
- Enrich deployment variety by supporting UDR 1+1, customer can select network deployment according to their requirements

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Technical Details – UDR Selection



- PCF uses the UDR priority as the first judgement condition
- Priority: the UDR with lower value is the preferred one
- Locality: the UDR with the same value (case insensitive) as PCF is the preferred one
 - Example1:
 - PCF: pcfLocality=Shanghai
 - UDR1: priority=1, locality= Beijing
 - UDR2: priority=2, locality= Shanghai
 - Conclusion: PCF selects UDR1 as the primary one.
 - Example2:
 - PCF: pcfLocality=Shanghai
 - UDR1: priority=1, locality= Beijing
 - UDR2: priority=1, locality= Shanghai
 - Conclusion: PCF selects UDR2 as the primary one.

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Technical Details – Failover and Fallback



Connection failure triggered failover and fallback

- Failover when the primary UDR connection failed. Following are some possible cases:
 - TCP RST or FIN received
 - TCP connection timeout
 - PING frame timeout
 - HTTP request/response timeout
 - Failback when the primary UDR connection recovered from failure status.

HTTP response 5xx triggered failover and fallback

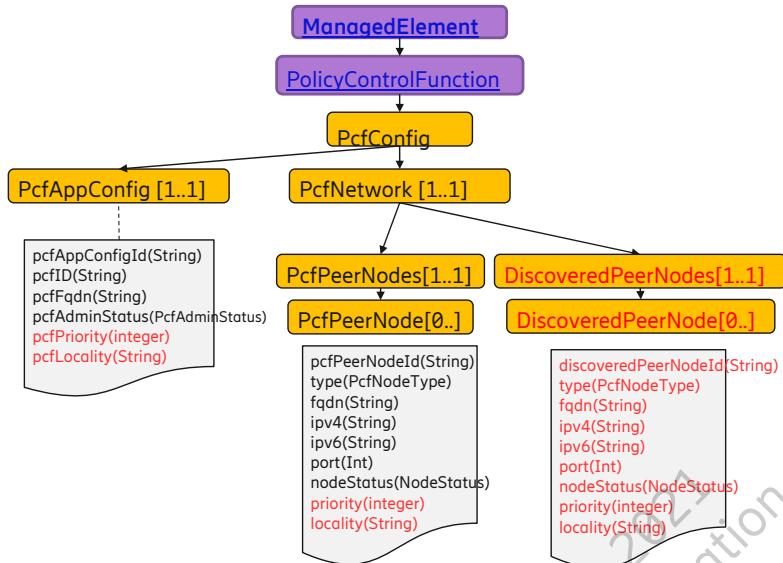
- Failover when the primary UDR responds HTTP 5xx (except 503) for 3 consecutive times.
- Failback when the primary UDR responds HTTP non-5xx (including 503) for 3 consecutive times.

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Operation and Maintenance – CDM Definition



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Operation and Maintenance



XML example for pcfLocality configuration:

For the same priority UDRs, PCF will select the UDR which has the same locality with PCF as the primary UDR.

```
<PcfConfig xmlns="urn:com:ericsson:ecim:pcfconfigmom">
<pcfConfigId>1</pcfConfigId>
    <PcfAppConfig>
        <pcfAppConfigId>1</pcfAppConfigId>
            <pcfLocality>ShangHai</pcfLocality>
        </PcfAppConfig>
        .....
    </PcfConfig>
```

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Operation and Maintenance



XML example for local UDRs configuration

UDR local configuration only is available when there is no NRF server configuration.

```
<PcfPeerNodes>
<pcfPeerNodesId>1</pcfPeerNodesId>
    <PcfPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
        <pcfPeerNodeId>udr1</pcfPeerNodeId>
            <ipv4>@TTCN_HOSTIP@</ipv4>
            <ipv6>FE80:1234::0000</ipv6>
            <port>8086</port>
            <type>UDR</type>
            <locality>ShangHai</locality>
            <priority>1</priority>
            <nodeStatus>REGISTERED</nodeStatus>
    </PcfPeerNode>
    <PcfPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
        <pcfPeerNodeId>udr2</pcfPeerNodeId>
        ....
    </PcfPeerNode>
</PcfPeerNodes>
```

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SAPC 1 Operation and Configuration



Operation and Maintenance



XML example for discovered UDRs from NRF

SAPC PCF supports to discover UDR list (2 UDRs) from NRF, and saves the results into the COM configuration.

Note: It's just for the awareness of the discovery results. Forbit operator to change them manually.

```
<DiscoveredPeerNodes>
<discoveredPeerNodesId>1</discoveredPeerNodesId>
    <DiscoveredPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
        <discoveredPeerNodeId>udr1</discoveredPeerNodeId>
            <ipv4>@TTCN_HOSTIP@</ipv4>
            <ipv6>FE80:1234::0000</ipv6>
            <port>8086</port>
            <type>UDR</type>
            <locality>ShangHai</locality>
            <priority>1</priority>
            <nodeStatus>REGISTERED</nodeStatus>
    </DiscoveredPeerNode>
    <DiscoveredPeerNode xmlns="urn:com:ericsson:ecim:pcfconfigmom" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0" nc:operation="merge">
        <discoveredPeerNodeId>udr2</discoveredPeerNodeId>
        .....
    </DiscoveredPeerNode>
</DiscoveredPeerNodes>
```

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Operation and Maintenance



Alarm for UDR connection failure

- NpcfSmPolicycontrolFailedToConnectToUdr
- The SAPC-PCF shall raise this alarm when a connectivity issue (request timeout/TCP reset) is detected for a UDR.
- The SAPC-PCF shall monitor the connectivity periodically.
- The SAPC-PCF shall clear the alarm when the connection to a UDR is recovered.

Attribute Name	Attribute Value
Alarm Type Id	NpcfSmPolicycontrolFailedToConnectToUdr
Major Type	193
Minor Type	7078014
Specific Problem	Policy Control, Connection to UDR Failed for SM Policy Control.
Severity	Major
Source	ManagedElement=1,PolicyControlFunction=1,PcfConfig=1,PcfNetwork=1,PeerNode=<nfInstID>, PL=<PayloadBoardID>
Event Type	Communications
Additional Text	Connection to UDR failed: <nfInstanceID>, <nfType>, <ip>, <port>, <locality>
Last Event Time	YYYY-MM-DDTHH:mm:ss<time zone>

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Operation and Maintenance



Alarm for UDR failover:

- NpcfSmPolicyControlUdrFailover
- The SAPC-PCF shall raise this alarm when it initiates a UDR failover as failover condition match (connection failure or 5xx failure).
- The SAPC-PCF shall clear this alarm when failback to the primary UDR.

Attribute Name	Attribute Value
Alarm Type Id	NpcfSmPolicyControlUdrFailover
Major Type	193
Minor Type	7078016
Specific Problem	Policy Control, Failover Caused by Failure on UDR Connection for SM Policy Control
Severity	Major
Source	ManagedElement=1, PolicyControlFunction=1, PcfConfig=1, PcfNetwork=1, PL=<PayloadBoardID>
Event Type	Communications
Additional Text	One or more failures in connections to the UDR in the primary site have triggered a failover towards lower priority site(s)
Last Event Time	YYYY-MM-DDTTHH:mm:ss<time zone>

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SAPC Provisioning

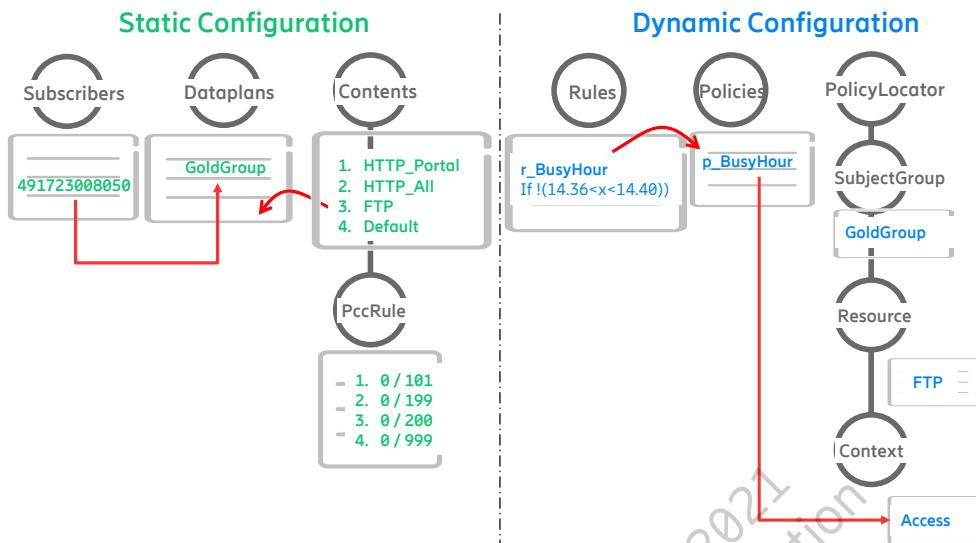


Access Control Service Authorization from SAPC to EPG - Example

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Static and Dynamic Configuration Complete Solution



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RESTY Commands – Static Configuration



```
PUT /contents/HTTP-Portal  
{  
    "contentName" : "HTTP-Portal",  
    "pccRuleId" : 101,  
    "pccRuleType" : 0  
}'
```

```
PUT /contents/HTTP_ALL  
{  
    "contentName" : "HTTP-All",  
    "pccRuleId" : 199,  
    "pccRuleType" : 0  
}'
```

```
PUT /contents/Default  
{  
    "contentName" : "Default",  
    "pccRuleId" : 999,  
    "pccRuleType" : 0  
}'
```

```
PUT /contents/FTP  
{  
    "contentName" : "FTP",  
    "pccRuleId" : 200,  
    "pccRuleType" : 0  
}'
```

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RESTY Commands – Static Configuration



```
PUT /dataplans/Gold '  
{  
    "dataplanName" : "Gold",  
    "subscribedContents" :  
    [  
        {  
            "contentName" : "HTTP-Portal",  
            "redirect" : false},  
        {  
            "contentName" : "Default",  
            "redirect" : false},  
        {  
            "contentName" : "HTTP-All",  
            "redirect" : false},  
        {  
            "contentName" : "FTP",  
            "redirect" : false}  
    ]  
}'
```

```
PUT /subscribers/491723008050 '  
{  
    "dataplans" :  
    [  
        {"dataplanName" : "Gold"}  
    ],  
    "subscriberId" : "491723008050"  
}'
```

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RESTY Commands – Dynamic Configuration



```
PUT /rules/r_BusyHour'  
{  
    "condition" : "!((now.time > 14:36) && (now.time < 14:40))",  
    "ruleName" : "r_BusyHour"  
}'  
  
PUT /policies/p_BusyHourEPG '  
{  
    "policyName" : "p_BusyHour",  
    "ruleCombiningAlgorithm" : "permit-overrides",  
    "rules" : [ "r_BusyHour" ]  
}'  
  
PUT /dataplans/Gold/locators/resources/FTP/contexts/access '  
{  
    "policies" : [ "p_BusyHour" ]  
}'
```

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Use Case Description

All off the following customer services are controlled (authorized/not authorized) by SAPC:

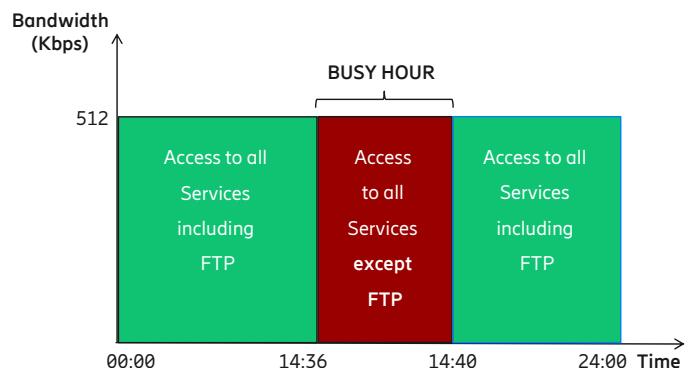
- HTTP-All > Authorized
- HTTP-Portal > Authorized
- FTP > Authorized
- Other data traffic > Authorized

Authorization during normal hours:

- Access to all services allowed.

Authorization during busy hours:

- Busy hour: 14:36 – 14:40
- FTP traffic is denied.
- All other services are allowed.

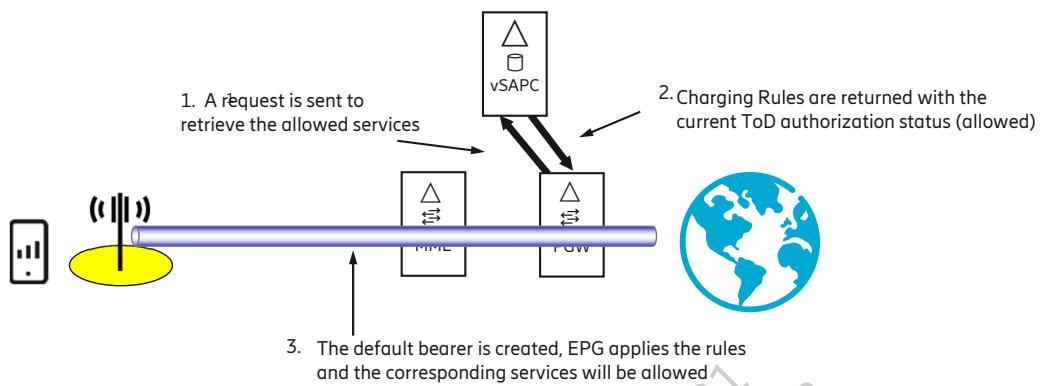


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Access Control Based on Time of Day - 1/2

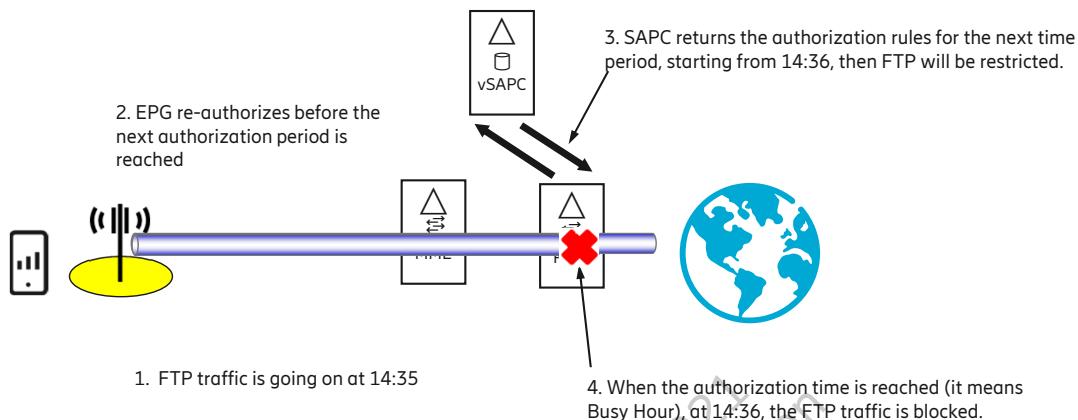


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Access Control Based on Time of Day - 2/2



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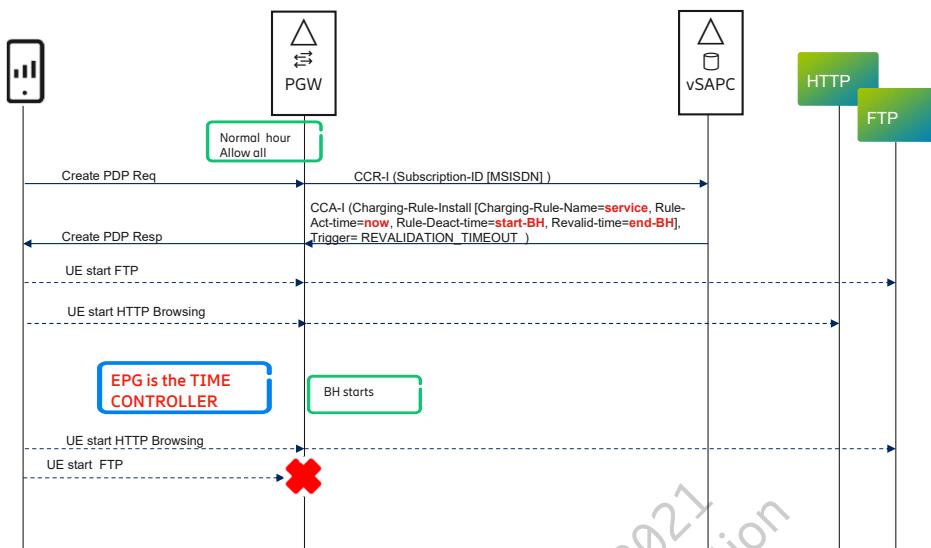


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Flow Diagram

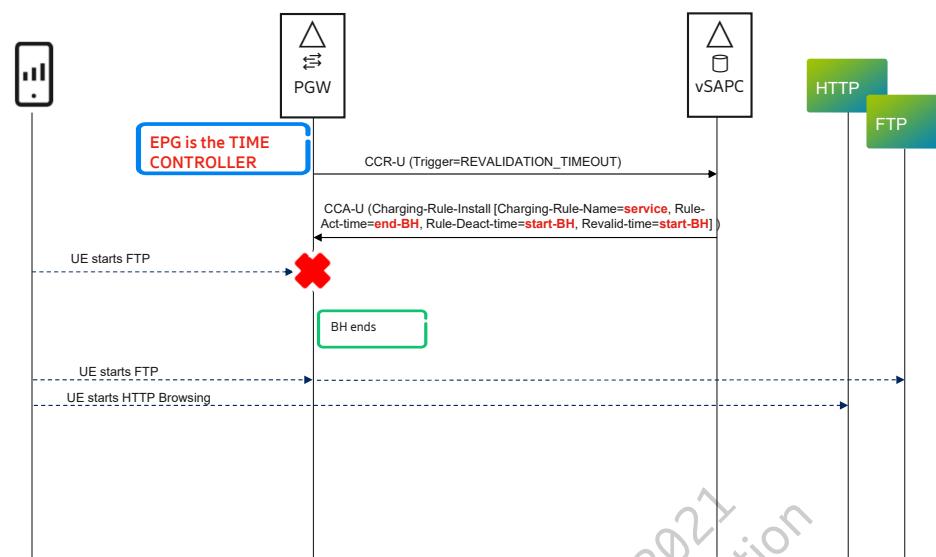


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Flow Diagram



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SAPC 1 Operation and Configuration



Credit Control Request – Initial Request



No.	Time	Source	Destination	Info
1	2013-04-12 14:35:04,218045	10.37.151.146	10.42.83.245	cmd=Credit-Control Request(272) flags=RP-- appl=3GPP Gx(16777238)

<

▼ Diameter Protocol

- Version: 0x01
- Length: 712
- Flags: 0x00, Request, Proxyable
- Command Code: 272 Credit-Control
- ApplicationId: 3GPP Gx (16777238)
- Hop-by-Hop Identifier: 0x69943337
- End-to-End Identifier: 0x9b617a7e
- [Answer In: 2]
- > AVP: Session-Id(263) l=65 f=M- val=c6-10-37-151-146-selnwe005epg01.ericsson.se;1365404086;28
- > AVP: Auth-Application-Id(258) l=12 f=-MP val=3GPP Gx (16777238)
- > AVP: Origin-Host(264) l=51 f=M- val=c6-10-37-151-146-selnwe005epg01.ericsson.se
- > AVP: Origin-Realm(296) l=24 f=M- val=ggssn.ericsson.se
- > AVP: Destination-Realm(283) l=20 f=-MP val=ericsson.com
- > AVP: CC-Request-Type(416) l=12 f=-MP val=INITIAL_REQUEST (1)
- > AVP: CC-Request-Number(415) l=12 f=-MP val=0
- > AVP: Gx-Capability-List(1060) l=16 f=V- vnd=Ericsson val=1
- > AVP: 3GPP-MS-TimeZone(23) l=14 f=M- vnd=TGPP val=Timezone: GMT + 2 hours 0 minutes +1 hour adjustment for Daylight Saving Time
- > AVP: Origin-State-Id(278) l=12 f=-MP val=0
- ▼ AVP: Subscription-Id(443) l=40 f=-MP
 - AVP Code: 443 Subscription-Id
 - > AVP Flags: 0x60, Mandatory: Set, Protected: Set
 - AVP Length: 40
- ▼ Subscription-Id: 000001c26000000c0000000000001bc6000001434393137...
 - > AVP: Subscription-Id-Type(450) l=12 f=-MP val=END_USER_E164 (0)
 - > AVP: Subscription-Id-Data(444) l=20 f=-MP val=491723008050
- > AVP: Framed-IP-Address(8) l=12 f=-MP val=10.41.145.194
- > AVP: IP-CAN-Type(1027) l=16 f=VM- vnd=TGPP val=3GPP-EPS (5)
- > AVP: RAT-Type(1032) l=16 f=V-- vnd=GPP val=UTRAN (1000)
- > AVP: QoS-Information(1016) l=44 f=VM- vnd=TGPP
- > AVP: Default-EPS-Bearer-QoS(1049) l=88 f=V-- vnd=TGPP

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Credit Control Answer – Initial Request

No.	Time	Source	Destination	Info
+	2 2013-04-12 14:35:04,292562	10.42.83.245	10.37.151.146	cmd=Credit-Control Answer(272)
<				

```
> AVP: CC-Request-Type(416) l=12 f=-MP val=INITIAL_REQUEST (1)
> AVP: CC-Request-Number(415) l=12 f=-MP val=0
> AVP: Gx-Capability-List(1060) l=16 f=V-- vnd=Ericsson val=1
> AVP: Event-Trigger(1066) l=16 f=VM- vnd=TGPP val=QOS_CHANGE (1)
> AVP: Event-Trigger(1066) l=16 f=VM- vnd=TGPP val=TAI_CHANGE (26)
> AVP: Event-Trigger(1066) l=16 f=VM- vnd=TGPP val=REVALIDATION_TIMEOUT (17)
> AVP: Charging-Rule-Install(1001) l=76 f=VM- vnd=TGPP
    AVP Code: 1001 Charging-Rule-Install
    AVP Flags: 0xc0, Vendor-Specific: Set, Mandatory: Set
    AVP Length: 76
    AVP Vendor Id: 3GPP (10415)
    < Charging-Rule-Install: 000003edc00000f000028af39393900000003edc000000f...
        > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=999
        > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=199
        > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=101
        > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=100
    < AVP: Charging-Rule-Install(1001) l=60 f=VM- vnd=TGPP
        AVP Code: 1001 Charging-Rule-Install
        AVP Flags: 0xc0, Vendor-Specific: Set, Mandatory: Set
        AVP Length: 60
        AVP Vendor Id: 3GPP (10415)
        < Charging-Rule-Install: 000003edc00000f000028af323030000000413c0000010...
            > AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=200
            > AVP: Rule-Activation-Time(1043) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:35:04.000000000 UTC
            > AVP: Rule-Deactivation-Time(1044) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:36:01.000000000 UTC
        < AVP: Revalidation-Time(1045) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:40:00.000000000 UTC
    < AVP: QoS-Information(1016) l=44 f=VM- vnd=TGPP
        > AVP: Default-EPS-Bearer-QoS(1049) l=88 f=VM- vnd=TGPP
        > AVP: Supported-Features(628) l=56 f=V- vnd=TGPP
        > AVP: Bearer-Control-Mode(1023) l=16 f=VM- vnd=TGPP val=UE_ONLY (0)
        > AVP: Origin-State-Id(278) l=12 f=-M- val=7
```

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SAPC 1 Operation and Configuration



Credit Control Request – Update Request



No.	Time	Source	Destination	Info
3	2013-04-12 14:36:04,323499	10.37.151.146	10.42.83.245	[TCP ACKed unseen segment] [TCP Previous segment not captured] cmd=Credit-Control Request(272)
<				
> Frame 3: 358 bytes on wire (2864 bits), 358 bytes captured (2864 bits)				
> Ethernet II, Src: Juniper_N_49:c3:fc (00:1d:b5:49:c3:fc), Dst: Ericsson_19:e1:a7 (00:30:88:19:e1:a7)				
> Internet Protocol Version 4, Src: 10.37.151.146, Dst: 10.42.83.245				
> Transmission Control Protocol, Src Port: 54451, Dst Port: 3868, Seq: 929, Ack: 765, Len: 292				
Diameter Protocol				
Version: 0x01				
Length: 292				
Flags: 0xc0, Request, Proxyable				
Command Code: 272 Credit-Control				
ApplicationId: 3GPP Gx (16777238)				
Hop-by-Hop Identifier: 0x6994333d				
End-to-End Identifier: 0xb617a84				
[Answer In: 4]				
> AVP: Session-Id(263) l=65 f=-M val=c6-10-37-151-146-selnwe005epg01.ericsson.se;1365404086;28				
> AVP: Auth-Application-Id(258) l=12 f=-MP val=3GPP Gx (16777238)				
> AVP: Origin-Host(264) l=51 f=-M val=c6-10-37-151-146-selnwe005epg01.ericsson.se				
> AVP: Origin-Realm(296) l=24 f=-M val=ggsn.ericsson.se				
> AVP: Destination-Realm(283) l=20 f=-MP val=ericsson.com				
> AVP: CC-Request-Type(416) l=12 f=-MP val=UPDATE_REQUEST (2)				
> AVP: CC-Request-Number(415) l=12 f=-MP val=1				
> AVP: Destination-Host(293) l=29 f=-MP val=tsp6115m.epcrealm.com				
> AVP: Origin-State-Id(278) l=12 f=-MP val=0				
> AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=REVALIDATION_TIMEOUT (17)				
AVP Code: 1006 Event-Trigger				
> AVP Flags: 0xc0, Vendor-Specific: Set, Mandatory: Set				
AVP Length: 16				
AVP Vendor Id: 3GPP (10415)				
Event-Trigger: REVALIDATION_TIMEOUT (17)				
> AVP: Framed-IP-Address(8) l=12 f=-MP val=10.41.145.194				

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SAPC 1 Operation and Configuration



Credit Control Answer – Update Request



No.	Time	Source	Destination	Info
4	2013-04-12 14:36:04,396613	10.42.83.245	10.37.151.146	[TCP ACKed unseen segment] [TCP Previous segment not captured] cmd=Credit-Control Answer(272)
<				
>	Ethernet II, Src: Ericsson_19:e1:a7 (00:30:88:19:e1:a7), Dst: JuniperN_49:c3:fd (00:1d:b5:49:c3:fd)			
>	Internet Protocol Version 4, Src: 10.42.83.245, Dst: 10.37.151.146			
>	Transmission Control Protocol, Src Port: 3868, Dst Port: 54451, Seq: 765, Ack: 1221, Len: 276			
>	Diameter Protocol			
>	Version: 0x01			
>	Length: 276			
>	Flags: 0x40, Proxyable			
>	Command Code: 272 Credit-Control			
>	ApplicationId: 3GPP Gx (16777238)			
>	Hop-by-Hop Identifier: 0x6994333d			
>	End-to-End Identifier: 0x9b617a84			
>	[Request In: 3]			
>	[Response Time: 0.073114000 seconds]			
>	AVP: Session-Id(263) l=65 f=-M- val=c6-10-37-151-146-selnwe005epg01.ericsson.se;1365404086;28			
>	AVP: Result-Code(268) l=12 f=-M- val=DIAMETER_SUCCESS (2001)			
>	AVP: Origin-Host(264) l=29 f=-M- val=tsp6115m.epcrealm.com			
>	AVP: Origin-Realm(296) l=20 f=-M- val=ericsson.com			
>	AVP: Auth-Application-Id(258) l=12 f=-MP val=3GPP Gx (16777238)			
>	AVP: CC-Request-Type(416) l=12 f=-MP val=UPDATE_REQUEST (2)			
>	AVP: CC-Request-Number(415) l=12 f=-MP val=			
>	AVP: Charging-Rule-Install(1001) l=60 f=VM- vnd=TGPP			
>	AVP Code: 1001 Charging-Rule-Install			
>	AVP Flags: 0xc8, Vendor-Specific: Set, Mandatory: Set			
>	AVP Length: 60			
>	AVP Vendor Id: 3GPP (10415)			
>	Charging-Rule-Install: 000003edc00000f000028af3230300000000413c0000010...			
>	AVP: Charging-Rule-Name(1005) l=15 f=VM- vnd=TGPP val=200			
>	AVP: Rule-Activation-Time(1043) l=16 f=VM- vnd=TGPP val=Apr 12, 2013 12:40:00.000000000 UTC			
>	AVP: Rule-Deactivation-Time(1044) l=16 f=VM- vnd=TGPP val=Apr 13, 2013 12:36:01.000000000 UTC			
>	AVP: Revalidation-Time(1042) l=16 f=VM- vnd=TGPP val=Apr 13, 2013 12:36:01.000000000 UTC			
>	AVP: Origin-State-Id(278) l=12 f=-M- val=7			

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SAPC Provisioning



REST API commands and Examples

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Provisioning REST API Commands:



GET /subscribers
GET /dataplans
GET /contents
GET /profiles/content-charging
GET /profiles/content-qos
GET /locators
GET /policies
GET /rules
GET /operator-specific-infos
GET /shared-dataplans

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SAPC REST Resources for Subscriber Provisioning



```
/subscribers/  
/subscribers/{subscriberId}  
/subscribers/{subscriberId}/locators  
/subscribers/{subscriberId}/locators/resources/{resourceId}/contexts/{contextId}  
/subscribers/{subscriberId}/usage-accumulators  
/subscribers/{subscriberId}/static-qualification  
/subscribers/{subscriberId}/dataplans  
/subscribers/{subscriberId}/dataplans/{dataplanName}  
/subscribers/{subscriberId}/usage-limits  
/subscribers/{subscriberId}/operator-specific-infos
```

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Provisioning Subscribers

```
PUT /subscribers/34600000001  
{  
    "dataplans" :  
    [  
        {  
            "dataplanName" : "Gold"  
        }  
    ],  
    "deniedContents" : [ "Chat" ],  
    "subscriberId" : "34600000001"  
}  
  
GET /subscribers/ 34600000001  
  
GET /subscribers/ 34600000001 | pp  
  
DELETE /subscribers/ 34600000001
```

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SAPC REST Resources for Provisioning Contents



/contents
/contents/{contentName}
/contents/{contentName}/static-qualification

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Provisioning Contents

```
PUT /contents/Chat  
{  
    "contentName" : "Chat",  
    "pccRuleId" : 1000,  
    "pccRuleType" : 0  
}  
GET /contents/Chat  
PUT /contents/MMTel_video  
{  
    "contentName" : "MMTel_video",  
    "staticQualification" :  
    {  
        "contentChargingProfileId" : "Char_MMTel_video",  
        "contentQosProfileId" : "QoS_MMTel_video"  
    }  
}  
GET /contents/MMTel_video  
DELETE /contents/MMTel_video
```

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Provisioning Contents



```
PUT /contents/Streaming
{
    "contentName" : "Streaming",
    "flows" :
    [
        {
            "destIpAddr" : "any",
            "destPort" : "",
            "direction" : "dl",
            "flowName" : "1",
            "protocol" : "ip",
            "sourceIpAddr" : "192.168.1.2",
            "sourcePort" : "5001-5050"
        },
        {
            "destIpAddr" : "any",
            "destPort" : "",
            "direction" : "dl",
            "flowName" : "2",
            "protocol" : "ip",
            "sourceIpAddr" : "192.168.1.2",
            "sourcePort" : "5101-5150"
        }
    ],
    "pccRuleName" : "4033",
    "pccRuleType" : 2,
    "staticQualification" :
    {
        "contentChargingProfileId" : "cp_streaming"
    }
}
```

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SAPC REST Resources for Provisioning Dataplans



```
/dataplans  
/dataplans/{dataplanId}  
/dataplans/{dataplanId}/locators  
/dataplans/{dataplanId}/locators/resources/{resourceId}/contexts/{contextId}  
/dataplans/{dataplanId}/static-qualification  
/dataplans/{dataplanId}/usage-limits  
/dataplans/{dataplanId}/notification  
/dataplans/{dataplanId}/subscribed-contents  
/dataplans/{dataplanId}/subscribed-contents/{contentName}  
/dataplans/{dataplanId}/denied-contents
```

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Provisioning Dataplans

```
PUT /dataplans/Bronze '  
{  
    "dataplanName" : "Bronze",  
    "subscribedContents" :  
    [  
        {  
            "contentName" : "Chat",  
            "redirect" : false  
        }  
    ]  
}'  
  
GET /dataplans/Bronze  
  
DELETE /dataplans/Bronze
```

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Provisioning Dataplans



```
PUT /dataplans/Gold  
{  
    "dataplanName" : "Gold",  
    "subscribedContents" :  
    [  
        {  
            "contentName" : "Streaming",  
            "redirect" : false  
        },  
        {  
            "contentName" : "Video",  
            "redirect" : false  
        },  
        {  
            "contentName" : "Chat",  
            "redirect" : false  
        }  
    ]  
}
```

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SAPC REST Resources for Provisioning Profiles



/profiles/ip-can-session-qos
/profiles/ip-can-session-qos/{profileId}
/profiles/subscriber-charging
/profiles/subscriber-charging/{profileId}
/profiles/charging-system
/profiles/charging-system/{profileId}
/profiles/online-charging-system
/profiles/online-charging-system/{profileId}
/profiles/content-qos
/profiles/content-qos/{profileId}
/profiles/content-charging
/profiles/content-charging/{profileId}

/profiles/content-adc-redirect-profile
/profiles/content-adc-redirect-profile/{profileId}
/profiles/presence-reporting-area
/profiles/presence-reporting-area/{profileId}
/profiles/pdn-gw
/profiles/pdn-gw/{profileId}
/profiles/pdn-gw-list
/profiles/pdn-gw-list/{profileId}
/profiles/af-signalling-paths
/profiles/af-signalling-paths/{profileId}
/profiles/multimedia-priority-services
/profiles/multimedia-priority-services/{profileId}

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Provisioning Profiles



```
PUT /profiles/content-qos/QoS_MMTEL_video  
{  
    "arpPriorityLevel" : 7,  
    "profileId" : "QoS_MMTEL_video",  
    "qci" : 2  
}  
  
PUT /profiles/content-charging/Char_MMTEL_video  
{  
    "chargingServiceId" : 301,  
    "profileId" : "Char_MMTEL_video",  
    "ratingGroup" : 301,  
    "reportingLevel" : 1  
}  
  
PUT /contents/MMTEL_video  
{  
    "contentName": "MMTEL_video ",  
    "staticQualification": {  
        "contentQosProfileId": "QoS_MMTEL_video ",  
        "contentChargingProfileId": "Char_MMTEL_video "  
    }  
}
```

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SAPC REST Resources for Provisioning Rules



```
/rules  
/rules/{ruleId}
```

Example:

```
PUT /rules/RSubsc2  
{  
    "condition" : "(AccessData.subscriber.id==\"34600702041\"),  
    "ruleName" : "RSubsc2"  
}
```

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SAPC REST Resources for Provisioning Policies



```
/policies  
/policies/{policyId}
```

Example:

```
PUT /policies/PSubsc2  
{  
    "policyName" : "PSubsc2",  
    "ruleCombiningAlgorithm" : "permit-overrides",  
    "rules" : [ "RSubsc2" ]  
}
```

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Provisioning Global Locators



```
/locators  
/locators/resources/{resourceId}/contexts{contextId}
```

Example:

```
#Global Policy Locator  
PUT /locators/resources/application/contexts/service-classification '  
{  
    "policies": [  
        "p_IMS_Service",  
        "p_Volte_Service",  
        "p_Vilte_Service"  
    ]  
}'
```

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Provisioning non-Global Locators



```
/dataplans/{dataplanId}/locators/resources/{resourceId}/contexts/{contextId}
```

Example:

#Subject Group Policy Locator

```
PUT /dataplans/Gold_HPLMN/locators/resources/ip-can-session/contexts/access  
{  
    "policies": [  
        "p_HPLMN"  
    ]  
}'
```

```
/subscribers/{subscriberId}/locators/resources/{resourceId}/contexts/{contextId}
```

Example:

#Subject Policy Locator

```
PUT /subscribers/Joe/locators/resources/reporting-group/contexts/accumulation  
{  
    "policies" : [ "p_accumulation" ]  
}'
```

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Accumulation Example –Subscribers (1/4)



```
PUT /subscribers/subs0208
{
    "dataplans" :
    [
        {
            "dataplanName" : "Premium",
            "priority" : 1
        }
    ],
    "subscriberId" : "subs0208",
    "trafficIds" : [ "mary@ericsson.com" ]
}
```

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Accumulation Example –Dataplan (2/4)



```
PUT /dataplans/Premium
{
    "dataplanName" : "Premium",
    "usageLimits" :
    [
        {
            "absoluteLimits" :
            {
                "conditionalLimits" :
                [
                    {
                        "dlVolume" : 1024,
                        "name" : "NotFlatRateHours"
                    },
                    {
                        "dlVolume" : 2048,
                        "name" : "FlatRateHours"
                    }
                ],
                "resetPeriod" :
                {
                    "volume" : "monthly"
                }
            },
            "description" : "Total traffic",
            "subscriptionDate" : "25-12-2020T08:00:00"
        }
    ]
}
```

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Accumulation Example – Locators (3/4)



```
PUT  
/dataplans/Premium/locators/resources/total.FlatRateHours/co  
ntexts/accumulation  
{  
    "policies" : [ "pAccumFlatRateHours" ]  
}  
  
PUT  
/dataplans/Premium/locators/resources/total.NotFlatRateHours  
/contexts/accumulation  
{  
    "policies" : [ "pAccumNotFlatRateHours" ]  
}
```

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Accumulation Example – Policies and Rules (4/4)



```
PUT /rules/rAcumFlatRateHours
{
    "condition" : "((now.time>\\"00:00\\")&&(now.time<\\"08:00\\")) || ((now.time>\\"17:00\\")
&&(now.time<\\"23:59\\")),
    "ruleName" : "rAcumFlatRateHours"
}

PUT /rules/rAcumNotFlatRateHours
{
    "condition" : "((now.time>\\"08:00\\")&&(now.time<\\"17:00\\"))",
    "ruleName" : "rAcumNotFlatRateHours"
}

PUT /policies/pAccumFlatRateHours
{
    "policyName" : "pAccumFlatRateHours",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "rAcumFlatRateHours" ]
}

PUT /policies/pAccumNotFlatRateHours
{
    "policyName" : "pAccumNotFlatRateHours",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "rAcumNotFlatRateHours" ]
}
```

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Static Association of subscriber to Groups (1/2)



```
PUT /subscribers/562500100200
{
    "dataplans" :
    [
        {
            "dataplanName" : "RusticGroup"
        },
        {
            "dataplanName" : "CitiGroup"
        }
    ],
    "subscriberId" : "562500100200"
}
```

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Static Association of subscriber to Groups (2/2)



```
PUT /locators/resources/CityGroup-contexts/subscription '
{
    "policies" : [ "pCityCells" ]
}

PUT /policies/pCityCells '
{
    "policyName" : "pCityCells",
    "ruleCombiningAlgorithm" : "permit-overrides",
    "rules" : [ "rCityCells" ]
}

#Rustic Areas
PUT /rules/rCityCells '
{
    "condition" : "not( inRange(AccessData.subscriber.locationInfo.cellIdentity,
\"1000,2000\" ))",
    "ruleName" : "rCityCells"
}'
```

In the example, the subscriber is statically associated with "RusticGroup" and "CityGroup". However, "CityGroup" is only selected for the subscriber in case their location does not belong to the cell identifiers (1000-2000) belonging to the rustic area.

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Dynamic association of Dataplans to Subscribers (1/2)

```
PUT /subscribers/Joe '
{
    "dataplans" :
    [
        {
            "dataplanName" : "Basic"
        },
        {
            "dataplanName" : "Gold",
            "priority" : 1
        }
    ],
    "subscriberId" : "Joe"
}

PUT /subscribers/Joe/locators/resources/Gold/contexts/subscription '
{
    "policies" : [ "pDynamicGroupSelection" ]
}
```

In addition to the static association of a Subscriber to a Group, it is possible to determine it **dynamically**, using Group Selection policies.

The SAPC evaluates these policies are evaluated for the list of groups statically associated with the subscriber.

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Dynamic association of Dataplans to Subscribers (2/2) ≡

```
PUT /policies/pDynamicGroupSelection'  
{  
    "policyName" :  
    "pDynamicGroupSelection",  
    "ruleCombiningAlgorithm" : "permit-  
overrides",  
    "rules" : [ "rDynamicGroupSelection" ]  
}'
```

```
PUT /rules/rDynamicGroupSelection'  
{  
    "condition" : "((now.time > \"18:00\")  
&& (now.time < \"20:00\")),  
    "ruleName" : "rDynamicGroupSelection"  
}'
```

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In the example above, the subscriber "Joe" is statically associated with "Basic" and "Gold" groups. However, "Gold" group is only selected from 18:00 until 20:00.

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SAPC Provisioning

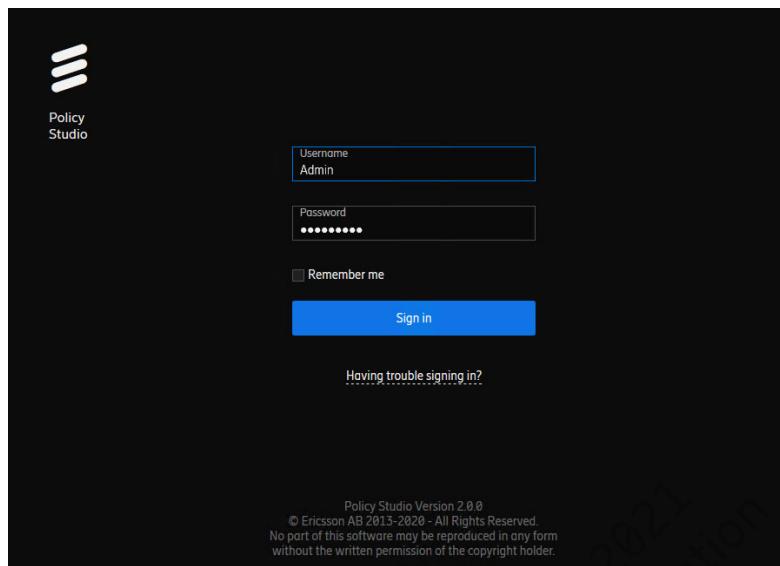


Policy Studio - Sample Screenshots

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Policy Studio – Login



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Policy Studio – First landing page initially



The screenshot shows the Policy Studio interface version 2.0.0. The left sidebar contains a menu with the following items and counts: Dataplans - 0, Contents - 0, Global policies - 0, Operator specific infos - 0, Policies - 0, Profiles - 0, Rules - 0, Rule spaces - 0, and Subscribers - 0 (SAPC). The main content area is titled "All elements" and displays a message: "No data entries to show here. There is no data to show. Use the 'Create' button to make the first item for this section". Below the message are four large, semi-transparent icons: a document with a gear, a cube, a circle with a cross, and a question mark.

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Policy Studio – Workspace mode



The screenshot shows the Policy Studio interface in workspace mode. The top navigation bar includes 'Menu', 'Subscribers > 12345678' (with a note 'Changes saved correctly'), 'Information' (selected), 'Schema', and 'Edit' buttons. A status bar at the bottom indicates 'v2.0.0' and 'Admin'. The left sidebar lists categories: 'Dataplans - 1', 'Contents - 1', 'Global policies - 0', 'Operator specific infos - 0', 'Policies - 0', 'Profiles - 2', 'Rules - 0', 'Rule spaces - 0', and 'Subscribers - 0 (SAPC)'. The main content area displays a 'Subscriber summary' section with checkboxes for 'Basic information' (unchecked), 'Dataplans (1)' (checked), 'Static qualification' (unchecked), 'Contents' (unchecked), 'Usage limits' (unchecked), and 'Operator specific infos' (unchecked). Below this is a 'Dataplans' section containing a table:

Dataplan name	Start date and time	Stop date and time
Test1Dataplan		

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Policy Studio – All elements list

Name	Type	Last modified by	Last modified time
session_testprofile2	Ip can session QoS	Admin	2021-04-29 14:29:49
streaming_qos_profile	Content QoS	Admin	2021-04-29 14:28:52
StreamingService	Content	Admin	2021-04-29 14:28:52
Silver_Dataplan	Dataplan	Admin	2021-04-29 14:28:52

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Policy Studio – Not used highlight

The screenshot shows the Policy Studio interface version 2.0.0. The left sidebar lists categories like Dataplans, Contents, Global policies, Operator specific infos, Policies, Profiles, Rules, Rule spaces, and Subscribers. The main area displays a table of elements with columns for Name, Type, Last modified by, and Last modified time. A filter bar at the top includes checkboxes for 'unused', 'with problems', and 'with changes'. A tooltip 'Not in use' is shown over the 'session_testprofile2' row. The table contains the following data:

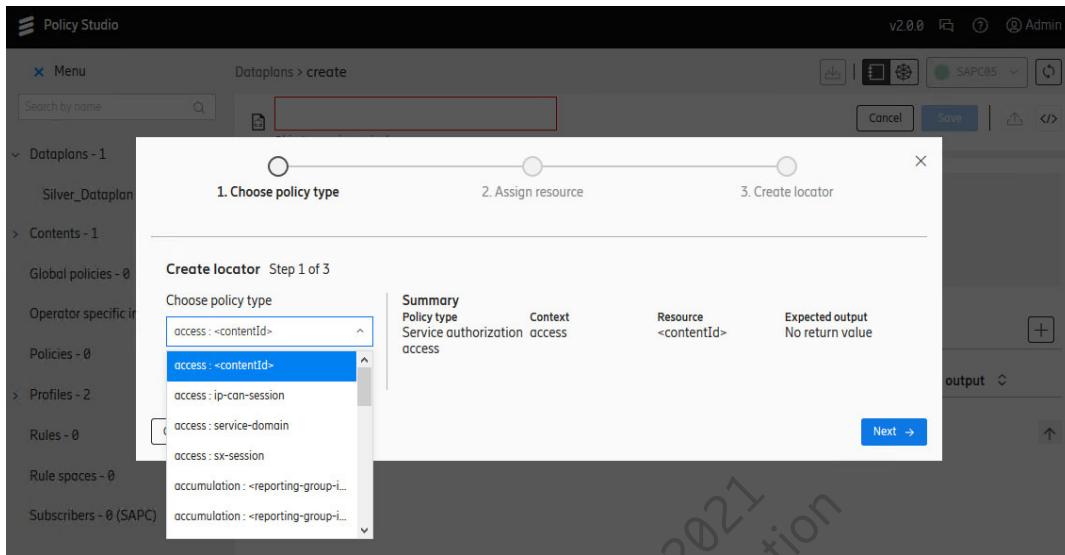
	Name	Type	Last modified by	Last modified time
<input type="checkbox"/>	session_testprofile2	ip can session QoS	Admin	2021-04-29 14:29:49
<input type="checkbox"/>	streaming_qos_profile	Content QoS	Admin	2021-04-29 14:28:52
<input type="checkbox"/>	StreamingService	Content	Admin	2021-04-29 14:28:52
<input type="checkbox"/>	Silver_Dataplan	Dataplan	Admin	2021-04-29 14:28:52

At the bottom, there are navigation buttons (←, →), a page number (1), and a 'Show 10' dropdown.

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Policy Studio – Assign policy type



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Policy Studio – Assign resource

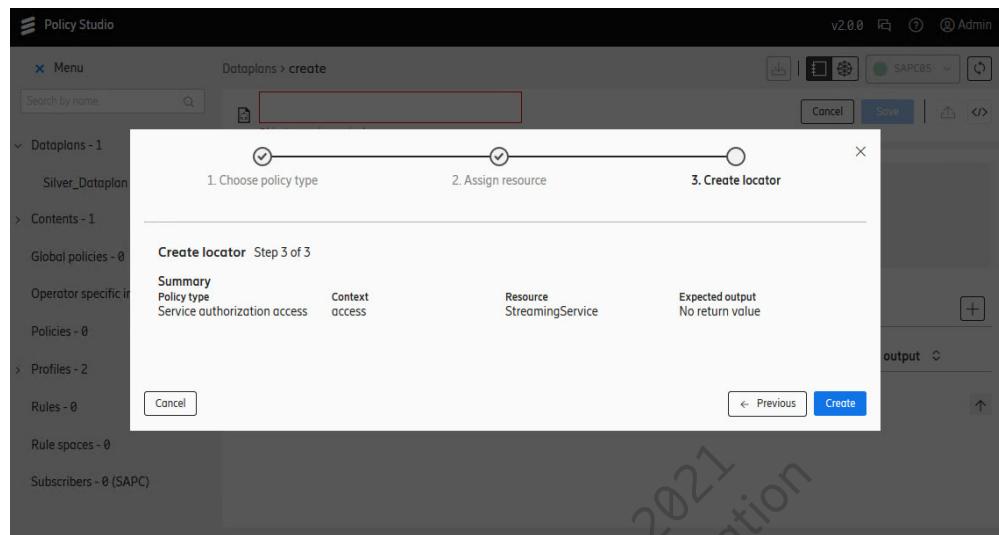
The screenshot shows the Policy Studio interface with the title 'Policy Studio' and version 'v2.0.0'. On the left, there's a sidebar with navigation links like 'Dataplans - 1', 'Contents - 1', 'Global policies - 0', etc. The main area is titled 'Create locator Step 2 of 3' with the sub-step '2. Assign resource' highlighted. A table lists a single object: 'StreamingService' with Content Monitoring Key '14', last modified by 'Admin' on '2021-04-29 14:28:52'. There are buttons for 'Cancel', 'Next >', and 'Previous <'.

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Policy Studio – Locator



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Policy Studio – Dataplans



Policy Studio

Dataplans > create

Bronze_dataplan

Policies by locator

Locator	Context	Resource	Expected rule combining algorithm	Expected output
access:StreamingService	access	StreamingService	Permit overrides or Deny overrides	No return value

List of policies

1 Policy

Define this object using the add button

v2.0.0 Admin

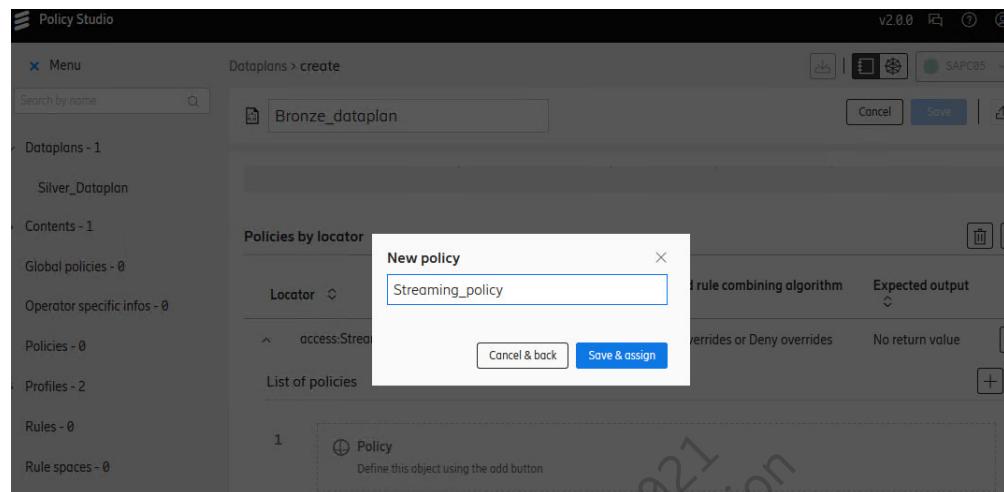
SAPC05

Cancel Save

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Policy Studio – new policy



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Policy Studio – Dataplan policies



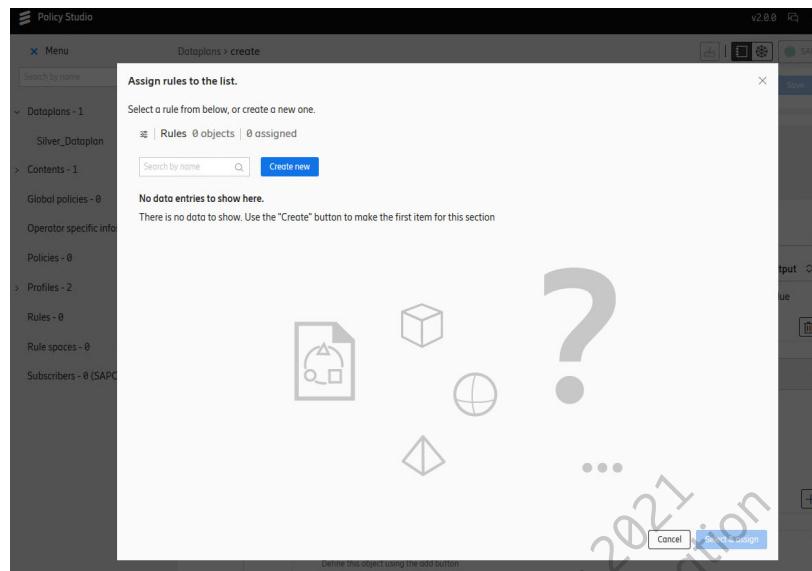
The screenshot shows the Policy Studio interface for creating a new Dataplan. The left sidebar lists various policy-related categories. The main area is titled 'Dataplans > create' and shows a search bar with 'Bronze_dataplan'. Below the search bar is a 'Dataplan summary' section with several tabs: 'Basic information' (selected), 'Static qualification', 'Contents', 'Usage limits', and 'Policies (1)' (selected). The 'Policies by locator' section displays a table with one row for 'access:StreamingService'. The 'Policy information' section for 'Streaming_policy' shows 'Rule evaluation: Permit overrides' and 'Output type: No return value'. A 'Rules' section contains a single rule entry.

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Policy Studio – Rules to a policy



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Policy Studio – Rule Output assignment



The screenshot shows the Policy Studio interface for creating a new Dataplan. The left sidebar lists various policy components: Dataplans (1), Contents (1), Global policies (0), Operator specific infos (0), Policies (0), Profiles (2), Rules (0), Rule spaces (0), and Subscribers (0) (SAPC). The main panel shows the creation of a Dataplan named 'Bronze_dataplan'. The 'Policy information' section includes 'Rule evaluation' (Permit overrides) and 'Output type' (Profile / Content QoS). The 'Rules' section contains one rule named 'Streaming_rule'. The 'Rule information' for this rule shows the 'Output' is set to 'Profile / Content QoS'. A large watermark with the text 'Do not copy © Ericsson Learning Services 2021 SAPC 1 Operation and Configuration' is diagonally across the screenshot.

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Policy Studio – Rule information auto-completion



The screenshot shows the Policy Studio interface for creating a Dataplan named 'Bronze_dataplan'. In the 'List of policies' section, there is one policy named 'Streaming_policy'. Under 'Rules *', there is one rule named 'Streaming_rule'. The 'Rule information' panel for 'Streaming_rule' is open, showing a dropdown menu with several options. One option, 'AccessData.bearer.accessPoint', is highlighted with a blue selection bar. A tooltip for this option provides the following details:

AccessData.bearer.accessPoint
AccessData.bearer.accessType
AccessData.bearer.eventTypes
AccessData.bearer.isAntennae
AccessData.bearer.isAntTrusted
AccessData.bearer.controlMode
AccessData.bearer.accessControl.ChargingChars
AccessData.bearer.accessControl.Ip

AccessData.bearer.accessPoint
The Called Station ID. Address where the user is connected to.
Network ID + Operator ID
-> is type (String)

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Policy Studio – Policies / Rules relationship



The screenshot shows the Policy Studio interface for creating a Dataplan. The left sidebar shows a tree structure with 'Dataplans - 1' (Silver_Dataplan), 'Contents - 1', 'Global policies - 0', 'Operator specific infos - 0', 'Policies - 0', 'Profiles - 2', 'Rules - 0', 'Rule spaces - 0', and 'Subscribers - 0 (SAPC)'. The main area shows 'Dataplans > create' for 'Bronze_dataplan'. It lists a policy 'Streaming_policy' under 'access-StreamingService' with 'access' and 'StreamingService' as conditions, and 'Permit overrides or Deny overrides' as the return value. Below it is a rule 'Streaming_rule' under 'AccessData.bronze.accessType'. The rule's 'Output' field is set to 'Profile / Content QoS' and contains a list of RAN values:

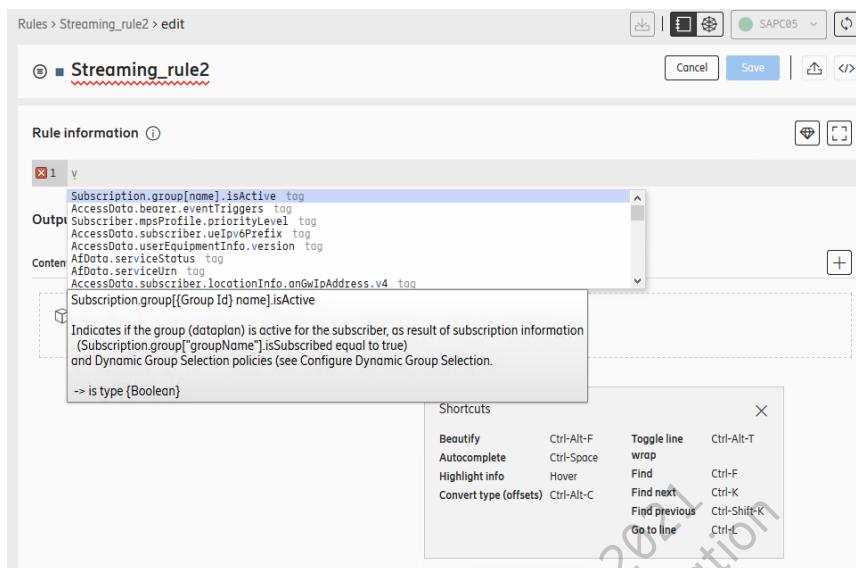
Value
1000 "UTRAN" [Radio Access Technology] value
1001 "GERAN" [Radio Access Technology] value
1002 "GSM" [Radio Access Technology] value
1003 "UMTS" [Radio Access Technology] value
1004 "E-UTRAN" [Radio Access Technology] value
1005 "E-UTRAN-NB-IoT" [Radio Access Technology] value
1006 "NR" [Radio Access Technology] value
2001 "HSDPA" [Radio Access Technology] value

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Policy Studio – Rule development assistance



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Policy Studio – Assign profile



Profile name	Last modified by
streaming_qos_profile	Admin

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Policy Studio - Data plan Summary



The screenshot shows the Policy Studio interface with the following details:

- Left sidebar:** Shows the navigation tree with sections like Datasplans, Contents, Global policies, Operator specific infos, Policies, Profiles, Rules, Rule spaces, and Subscribers.
- Main area:** The title is "Datasplans > create" and the sub-section is "Datasplan summary".
 - Policies by locator:** A table with columns: Locator, Context, Resource, Expected rule combining algorithm, and Expected output. One row is expanded for "access.StreamingService" with "access" as the context, "StreamingService" as the resource, "Permit overrides or Deny overrides" as the algorithm, and "No return value" as the output.
 - Policy information:** A detailed view of the "Streaming_policy" for "access.StreamingService". It shows the rule evaluation ("Permit overrides") and output type ("Profile / Content QoS").
 - Rule information:** Contains a single rule: "AccessType_bearer.accessType == 1000".
 - Output:** Set to "Profile / Content QoS".
 - Profile / Content QoS:** Expanded to show "streaming_qos_profile".
 - QoS Class Identifier (QCI):** Qci
 - Guaranteed Bit Rate (GBR):** 100 kbit/s

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Policy Studio Rule example – View code



The screenshot shows the Policy Studio interface version 2.8.0. The left sidebar lists categories like Dataplans, Contents, Global policies, Operator specific infos, Policies, Profiles, Rules, and Subscribers. The 'Rules' category is expanded, and 'Streaming_rule' is selected, which is highlighted with a blue background. The main panel displays a 'Streaming_rule' configuration with sections for 'Rule information' (containing a condition: 'AccessData.bezier.accessType == 1000') and 'Output: Profile / Content QoS' (listing 'streaming_qos_profile', 'Qos Class Identifier (OCI)', and 'Qos Class Identifier (QCI)'). Below this is a 'Guaranteed Bit Rate (GBR)' section with 'Downlink' and '100 kbit/s'. On the right, a 'View code' window is open, showing the generated JSON code:

```
PUT: /rules/Streaming_rule
1: [
2:   "ruleName": "Streaming_rule",
3:   "condition": "AccessData.bezier.accessType == 1000",
4:   "outputAttributes": [
5:     {
6:       "attrValue": "ServiceQoSProfile\\\"streaming_qos_p",
7:       "attrName": "qos",
8:       "result": "permit"
9:     }
10:   ]
11: ]
```

A 'Copy to clipboard' button is located at the bottom right of the code window.

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Policy Studio Event Triggers

The screenshot shows two windows from the Policy Studio interface. The left window is titled 'Silver_Dataplan' under 'Dataplans > Silver_Dataplan > edit'. It displays a 'Basic information' section with fields for 'Description' (containing 'Add a brief description of the dataplan'), 'Scope' (set to 'Not global'), 'Default priority' (set to '0-2147483647'), and 'Notifications' (set to 'Not defined'). Below this is an 'Event triggers' section with a 'Edit' button. The right window is titled 'Choose event trigger' and lists various event types with their descriptions and N7/N15 session identifiers. Some entries are collapsed, indicated by a minus sign.

#	Event Type	N7	N15
(8)	SGSN change	Session AMBR change	
(1)	QoS change	RAT change	
(2)	RAT change		
(4)	PLMN change	Access type change	
(7)	IPCon change		
(12)	RAI change		
(13)	User location change	Service area location change	
(15)	Out of credit		
(16)	Reallocation of credit		
(17)	Revolution timeout		
(20)	Default EPS bearer QoS change	Default EPS bearer QoS change	
(21)	AN GW change		
(22)	Successful resource allocation	Successful resource allocation	
(25)	UE time zone change		
(26)	TAI change		
(27)	ECGI change		

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Policy Studio Export example

The screenshot shows the Policy Studio interface version 2.0.0. The left sidebar lists categories like Dataplans, Contents, Global policies, Policies, Profiles, Rules, Rule spaces, and Subscribers. The 'Rules' category is expanded, and 'Streaming_rule' is selected. The main panel displays a 'Streaming_rule' configuration with a condition 'AccessData.bearer.accessType == 1000' and an output 'Profile / Content QoS'. A 'streaming_qos_profile' is defined under it, specifying a QoS Class Identifier (QCI) of 3. The right side shows an 'Export' dialog box with a JSON tab containing the following code:

```
{ "rules": [ { "ruleName": "Streaming_rule", "condition": "AccessData.bearer.accessType == 1000", "outputAttributes": [ { "attribute": "ServiceQosProfile[\"streaming_qos_profile\"]", "atName": "qos", "result": "permit" } ] } ] }
```

The 'Export' button is highlighted in blue.

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Policy Studio Commit mode



The screenshot shows the Policy Studio interface with the following details:

- Header:** Policy Studio v2.0.0, Admin.
- Left Sidebar:** Menu, Home, Search by name, Dataplans - 2, Contents - 1, Global policies - 0, Policies - 1, Profiles - 2, Rules - 2, Rule spaces - 0, Subscribers - 0 (SAPC).
- Center Content:** All elements, 8 items, 0 selected. Filters: unused, with problems, with changes. A table lists the following items:

Name	Type	Last modified by	Last modified time
Bronze_dataplan	Dataplan	Admin	2021-04-29 14:55:46
Streaming_policy	Policy	Admin	2021-04-29 14:55:46
Streaming_rule	Rule	Admin	2021-04-29 14:55:46
Streaming_rule2	Rule	Admin	2021-04-29 14:55:46
session_testprofile2	Ip can session QoS	Admin	2021-04-29 14:29:49
streaming_gos_profile	Content QoS	Admin	2021-04-29 14:28:52
StreamingService	Content	Admin	2021-04-29 14:28:52
Silver_Dataplan	Dataplan	Admin	2021-04-29 14:28:52
- Right Panel:** Workspace mode, showing a preview of the commit mode interface with a search bar and a green SAPC05 icon.

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Policy Studio Export



The screenshot shows the Policy Studio interface with the following details:

- Left Sidebar:** Shows navigation categories like Dataplans, Contents, Policies, Profiles, Rules, Rule spaces, and Subscribers.
- Top Bar:** Version v2.0.0, Admin user, and a search bar.
- Center Content:** A table listing selected policy elements:

Name	Type	Last modified by	Last modified time
Bronze_datoplan	Dataplan	Admin	2021-04-29 14:55:46
Streaming_policy	Policy	Admin	2021-04-29 14:55:46
Streaming_rule	Rule	Admin	2021-04-29 14:55:46
Streaming_rule2	Rule	Admin	2021-04-29 14:55:46
session_testprofile2	Ip can session QoS	Admin	2021-04-29 14:29:49
streaming_qos_profile	Content QoS	Admin	2021-04-29 14:28:52
StreamingService	Content	Admin	2021-04-29 14:28:52
Silver_Dataplan	Dataplan	Admin	2021-04-29 14:28:52
- Bottom:** Pagination (1), Show (10), Go to (1).

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Policy Studio Nodes administration



The screenshot shows the Policy Studio application interface. On the left, there is a list of nodes with columns for Name, Type, Last modified by, and Last modified time. The nodes listed are:

Name	Type	Last modified by	Last modified time
Bronze_dataplan	Dataplan	Admin	2021-04-29 14:55:46
Streaming_policy	Policy	Admin	2021-04-29 14:55:46
Streaming_rule	Rule	Admin	2021-04-29 14:55:46
Streaming_rule2	Rule	Admin	2021-04-29 14:55:46
session_testprofile2	Ip can session QoS	Admin	2021-04-29 14:29:49
streaming_qos_profile	Content QoS	Admin	2021-04-29 14:28:52
StreamingService	Content	Admin	2021-04-29 14:28:52
Silver_Dataplan	Dataplan	Admin	2021-04-29 14:28:52

On the right, there is a sidebar titled "My Settings" with options for User administration, Nodes administration, and Change password. It also displays the last sign-in date (29/4/2021 12:54:10) and password expiration information (Your password will expire in: 119 days). A "Sign out" button is at the bottom.

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Policy Studio Add Nodes

The screenshot shows two windows of the Policy Studio Node administration interface.

The top window displays a list of nodes with one item selected: SAPC05. The node details show a Domain/IP address of 10.36.187.169 and Port 8443. A success message "Connection sucessful to node SAPC05" is visible. Action buttons include Delete, Edit node, and Test connectivity.

The bottom window shows a "Create Node" dialog. It includes fields for Node Name (SAPC05), Provisioning username (Admin), Provisioning password, Domain/IP address, Port, Server certificate (Choose file, Add certificate), and Test connectivity. Buttons for Cancel and Save are at the bottom.

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Acronyms & Abbreviations



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