

PRA Based Differential Charging between 4G and 5G NSA Subscriber

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Introduction

This document describes Presence Reporting Area (PRA) based Differential National Security Agency (NSA) online Charging Solution.

Prerequisites

Requirements

Cisco recommends that you have knowledge of these topics:

- PRA
- Mobility Management Entity (MME)
- Cisco Serving Gateway (SGW)/ Cisco Packet Data Network Gateway (PGW)
- Policy and Charging Rules Function (PCRF)

Also,

- MME to support PRA feature enhancement to map “S1-U IP Address” to “PRA ID”
- PGW supports PRA Trigger towards PCRF
- PCRF installs new pcc rulebase once it receives the presence-reporting-area-status as In area (0) or out of area (1) from GW

Components Used

The information in this document is based on StarOS : 21.28.mx.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Background Information

This feature is to support the requirement of differentiate the charging between 4G and 5G customers in the 5G NSA setup for Prepaid subscriber (online charging).

PRA is an area defined within 3GPP packet domain for reporting UE presence within that area for policy control and/or charging reasons.

For NSA Differential charging, PRA feature is used to report subscriber presence in 4G and 5G.

PRA ID Solution Overview

Expectation from/on MME:

- MME is expected to detect the UE movement from 4G to 5G coverage (gNB) and vice versa to build the logic to map this event with PRA reporting.
- PRA ID should be same as configured in PCRF for differential charging.
- Applicable to DCNR UE only.

PCRF subscribes to PRA Event trigger,

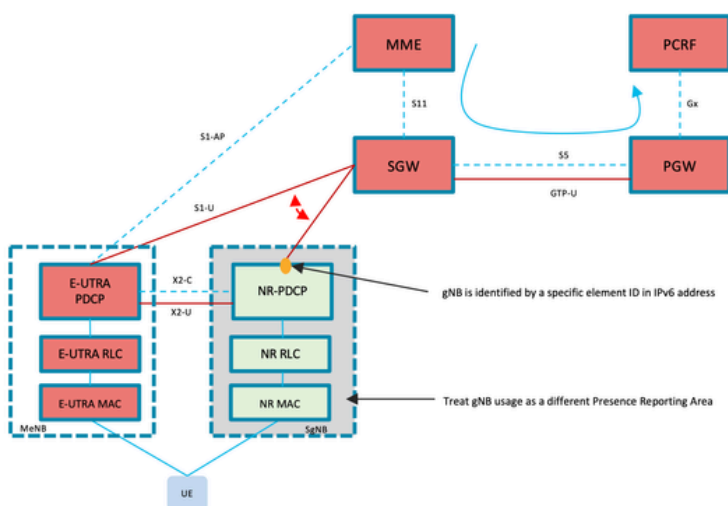
- PGW stores PRA action and forwards to SGW

When 4G to 5G transition happens (S1 tunnel switch):

- Based on gNB Transport Address, MME marks the PRA ID status as OPRA (out of 5G coverage)/IPRA (in 5G coverage)
- MME communicates PRA Information to SGW and SGW forwards to PGW

PGW receives PRA Information from SGW and forwards to PCRF

- PCRF changes rulebase based on PRA Information
- User-plane is communicated about change of rulebase



- MME identifies gNB vs. eNB usage.
- MME sends Modify Bearer Request with Presence Reporting Area to SPGW and then PCRF

Element	High Level Changes
MME	Vendor specific solution, needs to be consulted with the MME vendor. Identify UE movement to gNB coverage. Send MBRs to PGW.
PGW	Support Presence Reporting Area reports (standard feature) Inform PCRF
SGW	Support Presence Reporting Area reports (standard feature)
PCRF	Support Presence Reporting Area reports (standard feature) Implement policies based on reports

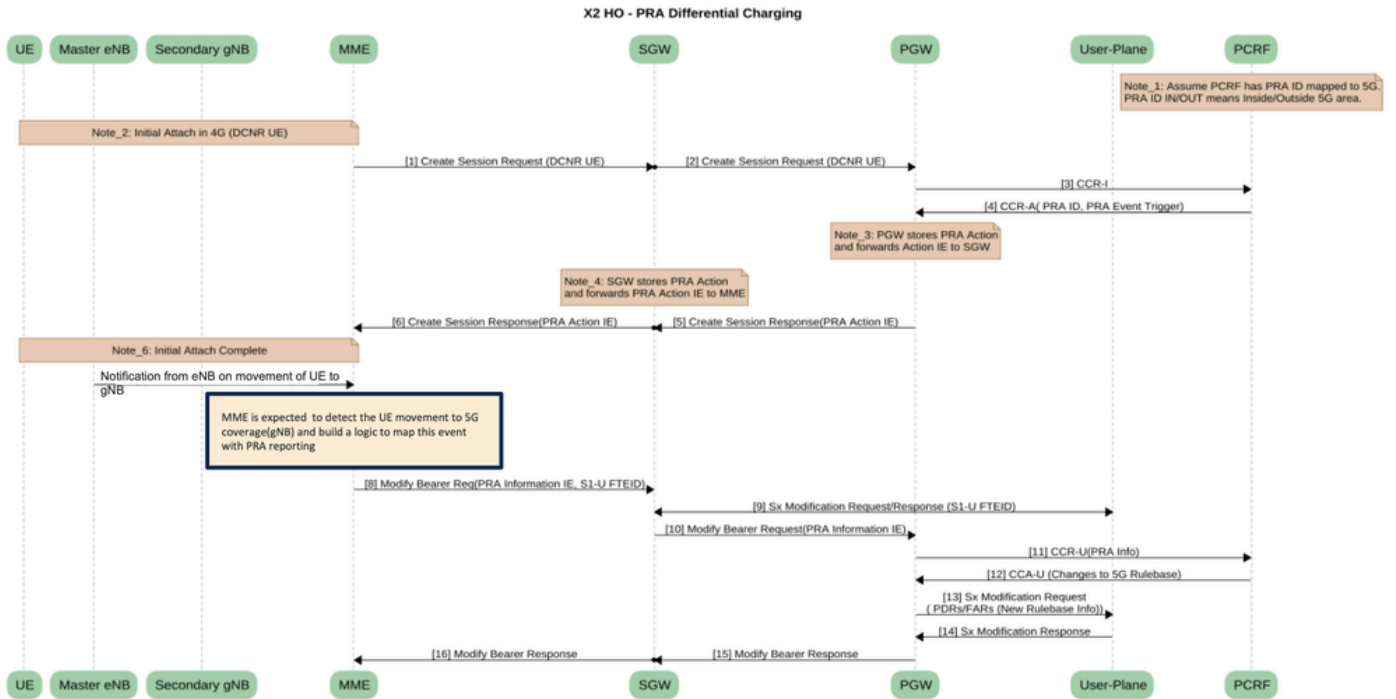
Abbreviations

PRA	Presence Reporting Area
OCS	Online Charging System
GW	Gateway (GGSN/PGW)
PCRF	Policy and Charging Rules Function
MOP	Method of Procedure
MME	Mobility Management Entity
SGW	Serving Gateway
PGW	Packet Gateway

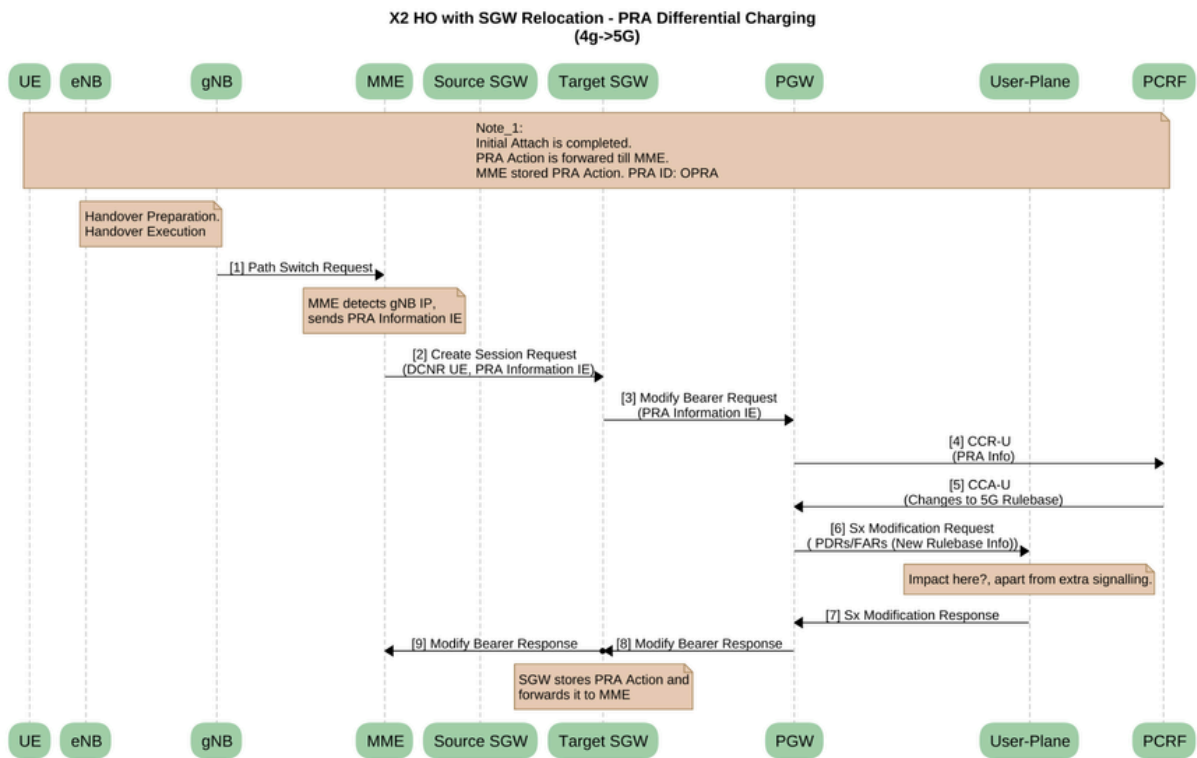
Possible Impacts and Considerations

- Solution proposed for Option3x mode of 5G NSA Deployment only.
- Since UE Movement is tracked from 4G to 5G and 5G to 4G, this tracking is inform to SGW/PGW, so high number CCR-U's are expected.
- Proposed solution is a customization and has not been implemented globally.
- End-to-end field testing required to be done in VI network
- CUPS UP/legacy SPGW Performance Impact due to extra signalling :
 - Throughput Impact (extra signalling on SPGW + increased Sx modifications in CUPS solution)
 - Frequent toggling of UE between 4G/5G will result in more signalling for PRA
 - Slowpath/Fastpath flow switches due to Rulebase changes
- Cisco PCRF supports PRA feature
- Enabling differential charging will cause additional signaling on Gx interface, which can impact PCRF performance.

Flow

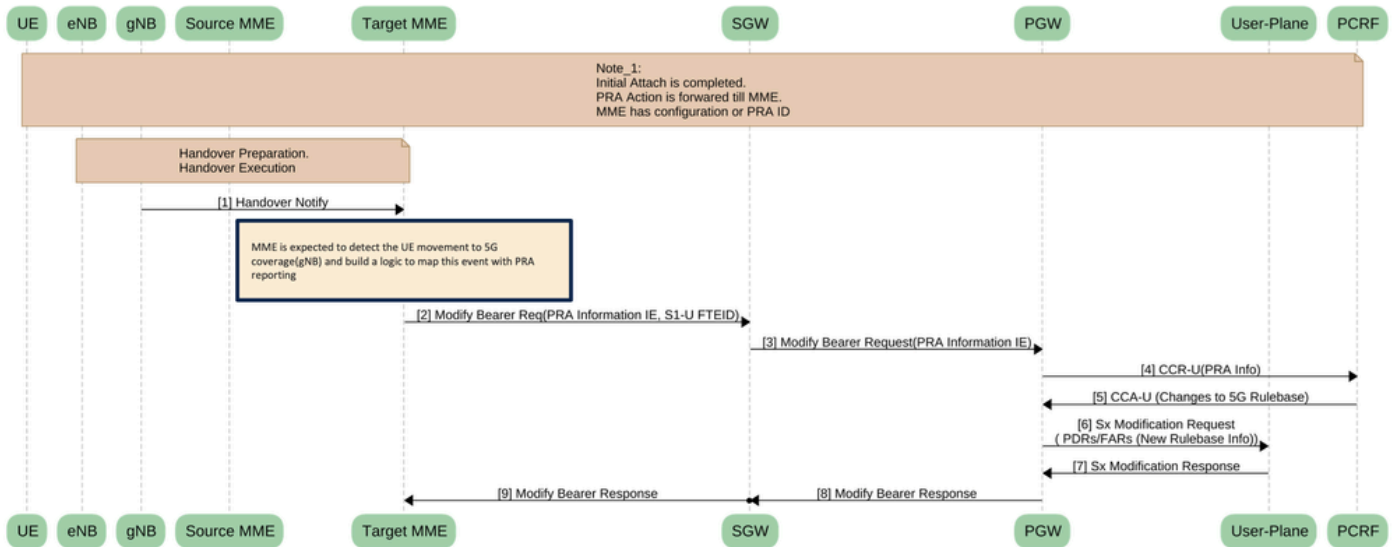


X2-HO – PRA Differential Charging



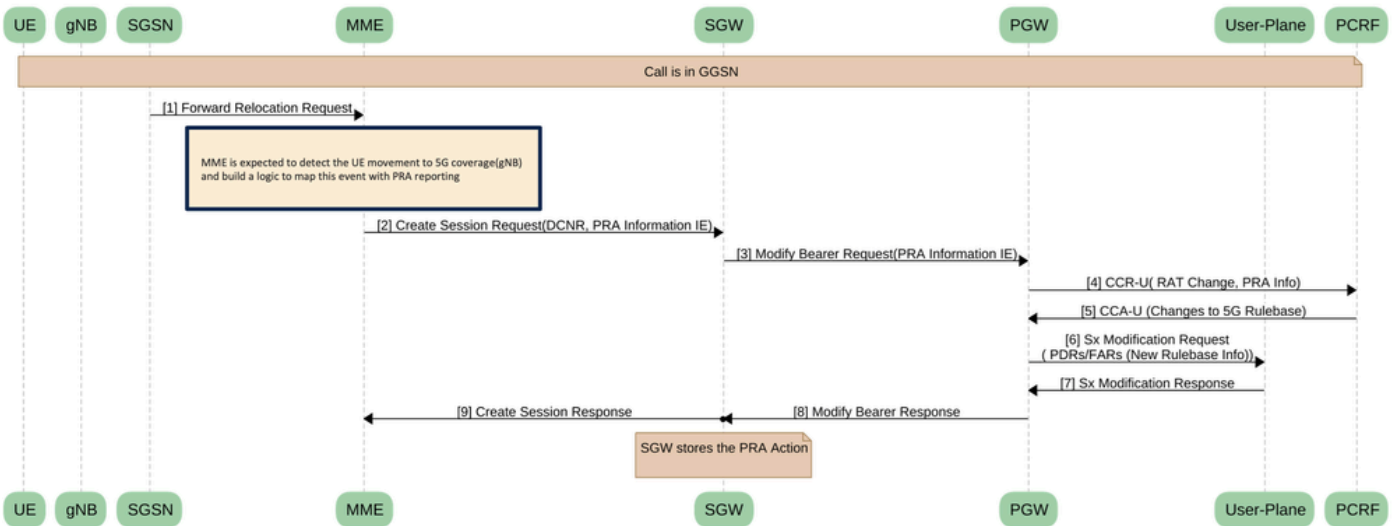
X2 HO with SGW Relocation - PRA Differential Charging (4g*□g)

S1 HO (No SGW Relocation) - PRA Differential Charging



S1 HO (No SGW Relocation) - PRA Differential Charging

GnGp (GGSN to PGW) HO - PRA Differential Charging (UE moving to 5g)



GnGp (GGSN to PGW) HO – PRA Differential Charging (UE Moving to 5g)

Procedure

MME End Configuration Changes

- Configure pra-profile and associate pra-profile in mme-service.
- Up to 50 IPv4 subnets and 50 IPv6 subnets can be added to pra-profile. As of now only pra-profile supported.
- At any point of time association or dissociation of pra-profile from mme-service doesn't give restart to mme-service.

```
config
lte-policy
pra-profile dcnr-5g-radio 5G-PRA
```

```

    gnb-s1u ipv6-prefix 2401:4900:4:84a4::/64
    gnb-s1u ipv6-prefix 2401:4900:2b::/48
    gnb-s1u ipv6-prefix 2401:4900:4:8601::2:540d
    exit
end
config
    context s1mme
        mme-service mme
            associate pra-profile dcnr-5g-radio 5G-PRA
    end
end

```

GW Configuration Changes

- Configure encode-supported-feature **cno-uli** under ims-auth-service.
- cno-uli Enables Presence Reporting Area Information Reporting Feature.
- Configure separate RG. RG will be used to report 5G usage.

```

configure
    context context_name
        ims-auth-service service_name
            policy-control
                diameter encode-supported-features cno-uli
                { default | no } diameter encode-supported-features
            end
        end
    end

```

```

config
    active-charging service ECS
    group-of-ruledefs NPR1_5G
    group-of-ruledefs-application gx-alias
    add-ruledef priority 2 ruledef RG_5G_default_IP_ANY_PrePaid
    add-ruledef priority 40 ruledef tethering_ip_ttl_RG
    exit

```

```

ruledef RG_5G_default_IP_ANY_PrePaid
    ip any-match = TRUE
    exit

```

```

rulebase <rulbase Name>
    action priority 702 static-and-dynamic ruledef RG_5G_default_IP_ANY_PrePaid charging-action 5G_IP_ANY_
    exit
end

```

Notes:

- **diameter encode-supported-features** : Enables or disables encoding and sending of Supported-Features AVP.
- **cno-uli** : Enables Presence Reporting Area Information Reporting feature.
- **no** : Removes the previously configured supported features.
- **default**: Applies the default setting for this command.

Verification

Wireshark Capture MME

Source	Destination	protocol	EPS Bearer ID	F-TEID IPv4	transportLayerAddress	Action	Inside Presence Reporting	AMBR	Info	UE Aggregate Maximum Bit Rate
SGW-S11	MME-S11	GTPv2	5	172.25.64.221		Start Reporting chan...		300000	Create Session Response	
MME-S11	SGW-S11	GTPv2	5	100.92.59.57				300000	Modify Bearer Request	
SGW-S11	MME-S11	GTPv2	5	10.1.159.103				300000	Modify Bearer Response	
ENB	S1-MME	S1AP			2401:4900:4:84a4::82				E-RABModificationIndication	
MME-S11	SGW-S11	GTPv2	5				True		Modify Bearer Request	
SGW-S11	MME-S11	GTPv2	5	10.1.159.103					Modify Bearer Response	
S1-MME	ENB	S1AP							E-RABModificationConfirm	
SGW-S11	MME-S11	GTPv2	5					2000000	Update Bearer Request	
S1-MME	ENB	S1AP							UEContextModificationRequest	2000000000bits/s
MME-S11	SGW-S11	GTPv2	5						Update Bearer Response	
ENB	S1-MME	S1AP							UEContextModificationResponse	
ENB	S1-MME	S1AP							UEContextReleaseRequest [RadioNetwork-cause=user-ina...	
MME-S11	SGW-S11	GTPv2	5	100.92.59.57			False		Modify Bearer Request	
SGW-S11	MME-S11	GTPv2	5					300000	Update Bearer Request	
MME-S11	SGW-S11	GTPv2	5						Update Bearer Response	
SGW-S11	MME-S11	GTPv2	5	10.1.159.103					Modify Bearer Response	
SGW-S11	MME-S11	GTPv2	5					300000	Update Bearer Request	
S1-MME	ENB	S1AP							UEContextModificationRequest	3000000000bits/s
ENB	S1-MME	S1AP							UEContextModificationResponse	
MME-S11	SGW-S11	GTPv2	5						Update Bearer Response	
ENB	S1-MME	S1AP			2401:4900:4:84a4::82				E-RABModificationIndication	
MME-S11	SGW-S11	GTPv2	5				True		Modify Bearer Request	
SGW-S11	MME-S11	GTPv2	5	10.1.159.103					Modify Bearer Response	
S1-MME	ENB	S1AP							E-RABModificationConfirm	
SGW-S11	MME-S11	GTPv2	5					2000000	Update Bearer Request	
S1-MME	ENB	S1AP							UEContextModificationRequest	2000000000bits/s

ENB-UE-S1AP-ID: 7992141

When UE moves to 5G, Inside Presence Reporting shows as True .

When UE moves to 4G, Inside Presence Reporting showing as False .

Wireshark Capture GW

Source	Destination	protocol	EPS Bearer ID	Action	Inside Pres	AMBR	Charging-Rule-Base-Name	Rating-Group	Info
GW	Gx	DIAMETER							cmd-Credit-Control Request(272) flags=RP-- appl=3GPP Gx(1)
Gx	GW	DIAMETER					BHARTI_VOLUME_PLAN		cmd-Credit-Control Answer(272) flags=-P-- appl=3GPP Gx(1)
PGW-OUT	SGW-IN	GTPv2	5	Start Reporting change		300000			Create Session Response
PGW-OUT	SGW-IN	GTPv2	5	Start Reporting change		300000			Create Session Response
SGW-S11	MME-S11	GTPv2	5	Start Reporting change		300000			Create Session Response
MME-S11	SGW-S11	GTPv2	5						Modify Bearer Request
SGW-S11	MME-S11	GTPv2	5						Modify Bearer Response
GW	Gy	DIAMETER					PostpaidAirtelgprs.com	403	cmd-Credit-Control Request(272) flags=RP-- appl=Diameter
Gy	GW	DIAMETER						403	cmd-Credit-Control Answer(272) flags=-P-- appl=Diameter
MME-S11	SGW-S11	GTPv2	5		True				Modify Bearer Request
SGW-IN	PGW-OUT	GTPv2			True				Modify Bearer Request
SGW-IN	PGW-OUT	GTPv2			True				Modify Bearer Request
GW	Gx	DIAMETER					BHARTI_VOLUME_PLAN,BHARTI_VOLUME_PLAN_5G		cmd-Credit-Control Request(272) flags=RP-- appl=3GPP Gx(1)
Gx	GW	DIAMETER							cmd-Credit-Control Answer(272) flags=-P-- appl=3GPP Gx(1)
PGW-OUT	SGW-IN	GTPv2	5			2000000			Modify Bearer Response
PGW-OUT	SGW-IN	GTPv2	5						Update Bearer Request
PGW-OUT	SGW-IN	GTPv2	5						Modify Bearer Response
SGW-S11	MME-S11	GTPv2	5						Modify Bearer Response
PGW-OUT	SGW-IN	GTPv2	5			2000000			Update Bearer Request
SGW-S11	MME-S11	GTPv2	5			2000000			Update Bearer Request
GW	Gy	DIAMETER					PostpaidAirtelgprs.com	623	cmd-Credit-Control Request(272) flags=RP-- appl=Diameter
MME-S11	SGW-S11	GTPv2	5						Update Bearer Response
SGW-IN	PGW-OUT	GTPv2	5						Update Bearer Response
SGW-IN	PGW-OUT	GTPv2	5						Update Bearer Response
Gy	GW	DIAMETER						623	cmd-Credit-Control Answer(272) flags=-P-- appl=Diameter
MME-S11	SGW-S11	GTPv2	5		False				Modify Bearer Request
SGW-IN	PGW-OUT	GTPv2	5		False				Modify Bearer Request
SGW-IN	PGW-OUT	GTPv2	5		False				Modify Bearer Request
GW	Gx	DIAMETER					BHARTI_VOLUME_PLAN_5G,BHARTI_VOLUME_PLAN		cmd-Credit-Control Request(272) flags=RP-- appl=3GPP Gx(1)
Gx	GW	DIAMETER							cmd-Credit-Control Answer(272) flags=-P-- appl=3GPP Gx(1)
PGW-OUT	SGW-IN	GTPv2	5			300000			Update Bearer Request
PGW-OUT	SGW-IN	GTPv2	5						Update Bearer Request

You can see when UE Moves to 5G Area Usage reported with RG: 623 while for 4G Usage reported with RG: 403.

DRA will receive presence-reporting-area-status as In area (0) when UE in 5G or out of area (1) when UE in 4G from GW,

```

  ✓ Supported-Features: 0000010a4000000c000028af0000027580000010000028af000000010000027680000010...
    > AVP: Vendor-Id(266) l=12 f=M- val=10415
    > AVP: Feature-List-ID(629) l=16 f=V-- vnd=TGPP val=1
    ✓ AVP: Feature-List(630) l=16 f=V-- vnd=TGPP val=8388609
      AVP Code: 630 Feature-List
      > AVP Flags: 0x80, Vendor-Specific: Set
      AVP Length: 16
      AVP Vendor Id: 3GPP (10415)
      ✓ GX Feature-List Flags: 0x00800001
        0... .. = CondPolicyInfo: Not supported
        .0.. .. = NetLoc-Untrusted-WLAN: Not supported
        ..0. .... = TSC: Not supported
        ...0 .... = NBIFOM: Not supported
        ....0... .. = ExUsage: Not supported
        .....0.. .. = ResShare: Not supported
        .....0. .... = Mission Critical QCI: Not supported
        .....0 .... = P-CSCF Restoration Enhancement: Not supported
        .....1... .. = Presence Reporting Area Information reporting: Supported
        .....0 ..... = DAN and/or MAF release cause: Not supported

```

CCR-I

When MME reports presence reporting area true, GW sends **CCR-I** to PCRF with **Presence Reporting Area Information : Supported**.

```

  ✓ AVP: Presence-Reporting-Area-Information(2822) l=44 f=V-- vnd=TGPP
    AVP Code: 2822 Presence-Reporting-Area-Information
    > AVP Flags: 0x80, Vendor-Specific: Set
    AVP Length: 44
    AVP Vendor Id: 3GPP (10415)
  ✓ Presence-Reporting-Area-Information: 00000b058000000f000028af800000000000b05800000f000028af80000000
    > AVP: Presence-Reporting-Area-Identifier(2821) l=15 f=V-- vnd=TGPP val=800000
    ✓ AVP: Presence-Reporting-Area-Identifier(2821) l=15 f=V-- vnd=TGPP val=800000
      AVP Code: 2821 Presence-Reporting-Area-Identifier
      > AVP Flags: 0x80, Vendor-Specific: Set
      AVP Length: 15
      AVP Vendor Id: 3GPP (10415)
      Presence-Reporting-Area-Identifier: 800000
      Padding: 00
  ✓ AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT (48)
    AVP Code: 1006 Event-Trigger
    > AVP Flags: 0xc0, Vendor-Specific: Set, Mandatory: Set
    AVP Length: 16
    AVP Vendor Id: 3GPP (10415)
    Event-Trigger: CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT (48)

```

CCA-I


```

> AVP: Session-Id(263) l=71 f=-M- val=0001-diamproxy.upe.pracups.gx;221084798;329321261;63a0c5ba-2d02
> AVP: Auth-Application-Id(258) l=12 f=-M- val=3GPP Gx (16777238)
> AVP: Origin-Host(264) l=37 f=-M- val=0001-diamproxy.upe.pracups.gx
> AVP: Origin-Realm(296) l=41 f=-M- val=pgw.mnc054.mcc405.3gppnetwork.org
> AVP: Destination-Realm(283) l=35 f=-M- val=delsdp85vip.airtelindia.com
> AVP: CC-Request-Type(416) l=12 f=-M- val=UPDATE_REQUEST (2)
> AVP: CC-Request-Number(415) l=12 f=-M- val=1
> AVP: Destination-Host(293) l=33 f=-M- val=delsdp85a.airtelindia.com
> AVP: Origin-State-Id(278) l=12 f=-M- val=1670878206
> AVP: Subscription-Id(443) l=40 f=-M-
> AVP: Subscription-Id(443) l=44 f=-M-
> AVP: Framed-IP-Address(8) l=12 f=-M- val=100.72.107.141 (100.72.107.141)
> AVP: Framed-IPv6-Prefix(97) l=18 f=-M- val=2401:4900:5db1:f7e7::/64
> AVP: User-Equipment-Info(458) l=44 f=-M-
> AVP: Called-Station-Id(30) l=22 f=-M- val=airtelgprs.com
> AVP: Event-Trigger(1006) l=16 f=VM- vnd=TGPP val=CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT (48)
> AVP: Access-Network-Charging-Address(501) l=18 f=VM- vnd=TGPP val=117.96.117.8 (117.96.117.8)
✓ AVP: Presence-Reporting-Area-Information(2822) l=44 f=V-- vnd=TGPP
  AVP Code: 2822 Presence-Reporting-Area-Information
  > AVP Flags: 0x80, Vendor-Specific: Set
  AVP Length: 44
  AVP Vendor Id: 3GPP (10415)
  ✓ Presence-Reporting-Area-Information: 00000b05800000f00028af80000000000b07800001000028af00000000
    > AVP: Presence-Reporting-Area-Identifier(2821) l=15 f=V-- vnd=TGPP val=800000
    ✓ AVP: Presence-Reporting-Area-Status(2823) l=16 f=V-- vnd=TGPP val=In area (0)
      AVP Code: 2823 Presence-Reporting-Area-Status
      > AVP Flags: 0x80, Vendor-Specific: Set
      AVP Length: 16
      AVP Vendor Id: 3GPP (10415)
      Presence-Reporting-Area-Status: In area (0)

```

CCR-U

Source	Destination	APN-Aggr	CC-Req	Prese	RAT	QoS-	Info	Charging-Rule-Ba	Event-Trigger
GW-GX	DRA-GX	2147484000	INITIAL_RE...		EUTRAN	QCI_9	cmd=Credit-Control Request(-		
DRA->PCRF	PCRF	2147484000	INITIAL_RE...		EUTRAN	QCI_9	cmd=Credit-Control Request(-		
PCRF	DRA->PCRF	3000000000	INITIAL_RE...			QCI_9	cmd=Credit-Control Answer(2-	BHARTI_NPRI	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT
DRA-GX	GW-GX	3000000000	INITIAL_RE...			QCI_9	cmd=Credit-Control Answer(2-	BHARTI_NPRI	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT,CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AR...
GW-GX	DRA-GX		UPDATE_REQ...	In area			cmd=Credit-Control Request(-		CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT
DRA->PCRF	PCRF		UPDATE_REQ...		GAN		cmd=Credit-Control Request(-		
PCRF	DRA->PCRF	2000000000	UPDATE_REQ...			QCI_6	cmd=Credit-Control Answer(2-	BHARTI_NPRI,BHARTI_NPRI_5G	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT
DRA-GX	GW-GX	2000000000	UPDATE_REQ...			QCI_6	cmd=Credit-Control Answer(2-	BHARTI_NPRI,BHARTI_NPRI_5G	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT,CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AR...
GW-GX	DRA-GX		UPDATE_REQ...	Out of...			cmd=Credit-Control Request(-		CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT
DRA->PCRF	PCRF		UPDATE_REQ...		EUTRAN		cmd=Credit-Control Request(-		
PCRF	DRA->PCRF	3000000000	UPDATE_REQ...			QCI_9	cmd=Credit-Control Answer(2-	BHARTI_NPRI_5G,BHARTI_NPRI	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT
DRA-GX	GW-GX	3000000000	UPDATE_REQ...			QCI_9	cmd=Credit-Control Answer(2-	BHARTI_NPRI_5G,BHARTI_NPRI	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT,CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AR...
GW-GX	DRA-GX		UPDATE_REQ...	In area			cmd=Credit-Control Request(-		CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AREA_REPORT
DRA->PCRF	PCRF		UPDATE_REQ...		GAN		cmd=Credit-Control Request(-		
PCRF	DRA->PCRF	2000000000	UPDATE_REQ...			QCI_6	cmd=Credit-Control Answer(2-	BHARTI_NPRI,BHARTI_NPRI_5G	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT
DRA-GX	GW-GX	2000000000	UPDATE_REQ...			QCI_6	cmd=Credit-Control Answer(2-	BHARTI_NPRI,BHARTI_NPRI_5G	QOS_CHANGE,RAT_CHANGE,PLMN_CHANGE,DEFAULT_EPS_BEARER_QOS_CHANGE,REVALIDATION_TIMEOUT,CHANGE_OF_UE_PRESENCE_IN_PRESENCE_REPORTING_AR...

GW - DRA - PCRF

Here, you can see that whenever DRA receives presence-reporting-area-status as In area (0) or out of area (1) from GW, it's sending rat type as a GAN and EUTRAN respectively towards PCRF. Basis on this rat type PCRF is changing rulebase and modifying QOS for 4G and 5G.