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Technical Specification

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LTE;
Policy and Charging Control (PCC) over S9 reference point
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Foreword

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1 Scope

The present document provides the stage 3 specification of the S9 reference point for the present release. The functional requirements of stage 2 specification for the S9 reference point are contained in 3GPP TS 23.203 [2]. The S9 reference point lies between the PCRF in the home PLMN (also known as H-PCRF) and the PCRF in the visited PLMN (also known as V-PCRF).

Whenever it is possible the present document specifies the requirements for the protocols by reference to specifications produced by the IETF within the scope of Diameter. Where this is not possible extensions to Diameter are defined within the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.203: "Policy and Charging Control Architecture"

[3] 3GPP TS 29.212: "Policy and charging control over Gx reference point"

[4] 3GPP TS 29.213: "Policy and charging control signalling flows and Quality of Service (QoS) parameter mapping"

[5] 3GPP TS 29.214: "Policy and charging control over Rx reference point"

[6] IETF RFC 3588: "Diameter Base Protocol".

[7] 3GPP TS 29.229: "Cx and Dx interfaces based on the Diameter protocol; Protocol details"

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Home Routed Access: Roaming scenario where the PCEF is located in the HPLMN. In a Home Routed roaming scenario, the UE obtains access to the packet data network from the HPLMN.

Visited Access (also known as local breakout): Roaming scenario where the PCEF is located in the VPLMN. In a Visited Access Roaming scenario, the UE obtains access to the packet data network from the VPLMN.

Editor"s Note: These definitions can be reformulated when they are included in stage 2 specifications.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

AF	Application Function
AN-Gateway	Access Network Gateway
AVP	Attribute-Value Pair
BBERF	Bearer Binding and Event Reporting Function
H-AF	Home AF
H-PCRF	Home PCRF
HPLMN	Home PLMN
OCS	Online charging system
OFCS	Offline charging system
PCC	Policy and Charging Control
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rule Function
S-GW	Serving Gateway
VA	Visited Access
V-AF	Visited AF
V-PCRF	Visited PCRF
VPLMN	Visited PLMN

4. S9 Reference Point

4.1 Overview

The S9 reference point is used in roaming scenarios involving a HPLMN and a VPLMN. Two main roaming scenarios are considered: visited access (PCEF in VPLMN and AF in VPLMN or HPLMN) and home-routed access (PCEF in HPLMN and AF in the HPLMN).

Two Diameter applications are used over the S9 reference point: S9 and Rx. The purpose of the S9 Diameter application is to install PCC rules or QoS rules generated in the HPLMN into the VPLMN and transport the events that may occur in the VPLMN to the HPLMN. When the AF is in the VPLMN, Rx is used over the S9 reference point to exchange service session information from the V-PCRF to the H-PCRF.

The AF exchanges session information with the H-PCRF or V-PCRF as specified in 3GPP TS 29.214[5]. The PCRF (H-PCRF and/or V-PCRF) exchanges PCC rules and QoS rules with the PCEF and BBERF respectively as specified in 3GPP TS 29.212[3].

Signalling flows related to all the PCC reference points (Gx, Gxx, Rx and S9) are specified in 3GPP TS 29.213[4].

4.2 Reference model

The S9 reference point is defined between the V-PCRF and the H-PCRF for home routed access and visited access.

NOTE 1: AN-Gateway refers to the S-GW when the Gxc applies and to a trusted non-3GPP access gateway when Gxa applies.

The relationships between the different functional entities involved in the home routed access are depicted in figure 4.2.1.

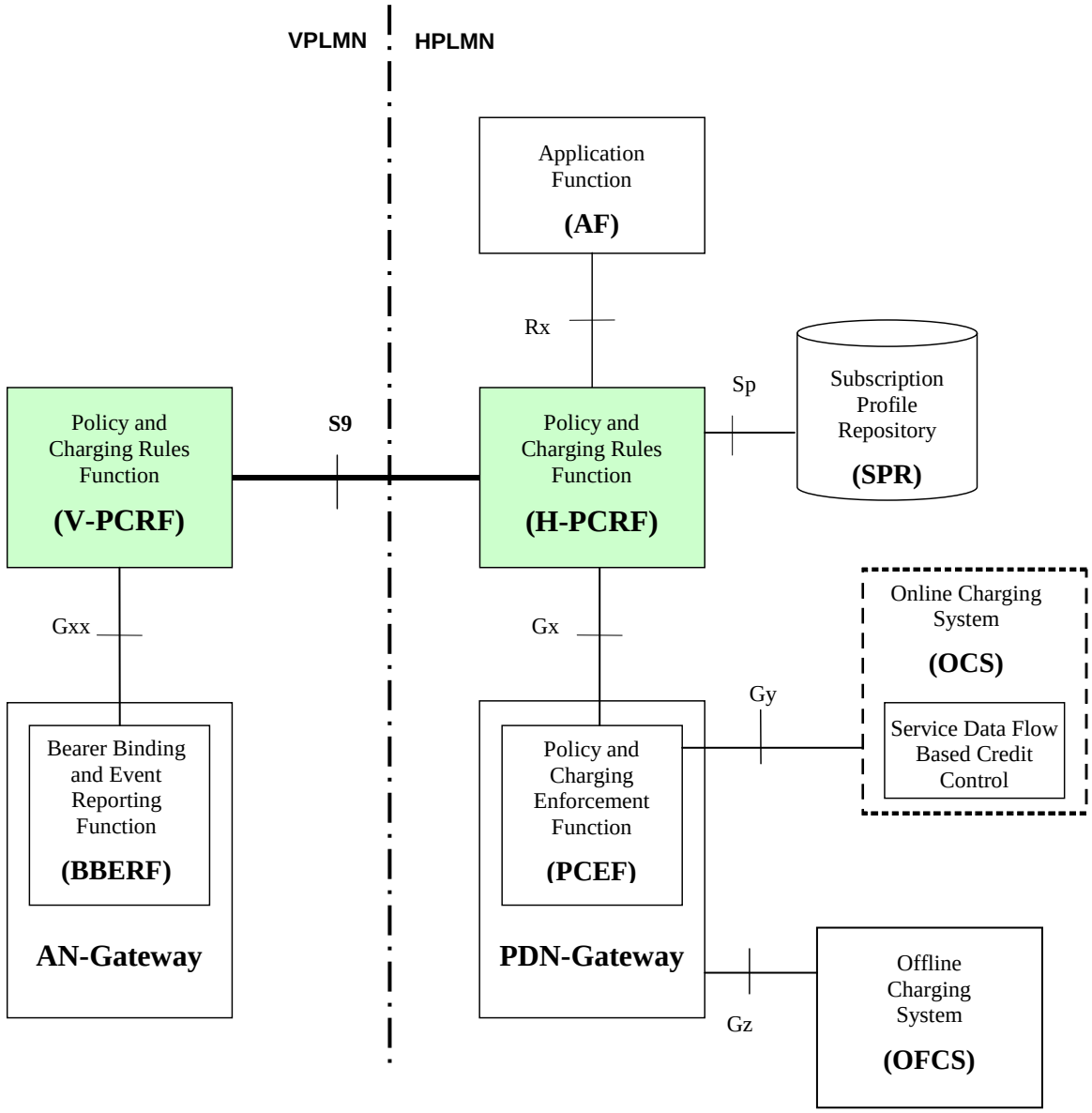

Figure 4.2.1: S9 reference point at the PCC architecture for roaming with home routed access

The relationships between the different functional entities involved in the visited access are depicted in figure 4.2.2.

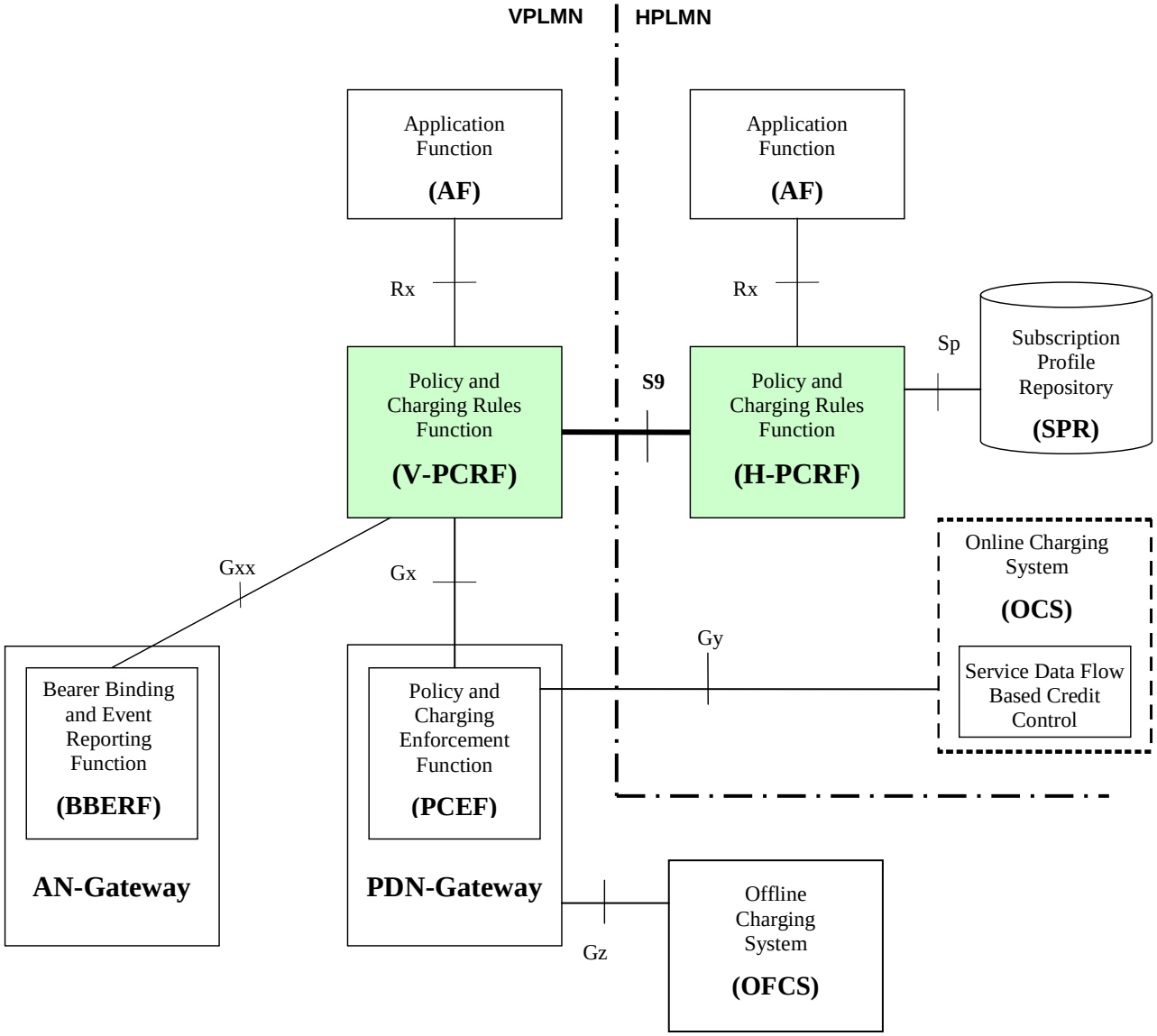

Figure 4.2.2: S9 reference point at the PCC architecture for roaming with visited access

NOTE 2: AF can be located in both VPLMN and HPLMN for the visited access.

For a visited access, the VPLMN may use an OCS proxy between the PCEF and the OCS.

NOTE 3: The H-PCRF can optionally send the addresses of the proxy/OCS to the V-PCRF.

4.3 Functional elements

4.3.1 H-PCRF

The H-PCRF (Home Policy and Charging Rules Function) is a functional element that encompasses policy control decision and flow based charging control functionalities in the HPLMN.

The H-PCRF provides functions for both home routed access and visited access.

4.3.1.1 Home routed access

The H-PCRF shall provision QoS Rules to the V-PCRF via the S9 reference point and PCC Rules to the PCEF via the Gx reference point. The H-PCRF ensures that the QoS Rules provisioned are aligned with the PCC Rules.

The H-PCRF PCC Rule decisions may be based on one or more of the following:

- Information obtained from the AF via the Rx reference point.
- Information obtained from the V-PCRF via the S9 reference point.

  NOTE: The above may include information obtained from the BBERF via the Gxx reference point.

- Information obtained from the PCEF via the Gx reference point
- Information obtained from the SPR via the Sp reference point.
- PCRF pre-configured information.

The H-PCRF provisions event triggers to the V-PCRF and PCEF.

4.3.1.2 Visited Access

The H-PCRF shall provision PCC Rules to the V-PCRF via the S9 reference point.

The H-PCRF PCC Rule decisions may be based on one or more of the following:

- Information obtained from the AF when located in the home network
- Information obtained from the V-PCRF via the S9 reference point.

  NOTE: The above may include information obtained from the AF when the AF is located in the VPLMN and information obtained from the PCEF or BBERF.

- Information obtained from the SPR via the Sp reference point.
- PCRF pre-configured information.

The H-PCRF provisions event triggers to the V-PCRF,

4.3.2 V-PCRF

The V-PCRF (Visited Policy and Charging Rules Function) is a functional element that encompasses policy control decision and flow based charging control functionalities in the VPLMN.

The V-PCRF provides functions for both home routed access and visited access.

4.3.2.1 Home routed access

The V-PCRF shall request QoS Rules and report events to the H-PCRF via the S9 interface.

The V-PCRF validates the QoS parameters received within the QoS Rules based on operator policies. The V-PCRF informs the H-PCRF if the QoS validation failed.

The V-PCRF shall provision QoS Rules to the BBERF via the Gxx reference point

4.3.2.2 Visited access

The V-PCRF shall request PCC Rules from and report events to the H-PCRF using the S9 reference point.

The V-PCRF extracts the QoS Rules from the PCC Rules, validates the former, and if QoS validation is successful, the V-PCRF shall provision the PCC Rules to the PCEF via the Gx reference point and the QoS Rules to the BBERF via the Gxx reference point. If the QoS validation fails the V-PCRF shall reject the request. For case 2a, there may be addicional specific rules to be installed at the BBERF for the sole purpose of allowing the tunnel between BBERF and P-GW not directly related with any service.

When the AF is located in the VPLMN, the V-PCRF shall exchange Rx messages with the H-PCRF over the S9 reference point.

4.4 PCC Rules and QoS Rules

4.4.1 PCC Rule definition

The purpose of the PCC Rule is defined in 3GPP TS 29.212 [3]. PCC Rules are sent over S9 interface for visited access.

There are two different types of PCC rules as defined in 3GPP TS 29.212 [3].:

- Dynamic PCC rules. Dynamically provisioned by the H-PCRF to the V-PCRF via the S9 interface. These PCC rules may be either predefined or dynamically generated in the H-PCRF. Dynamic PCC rules can be activated, modified and deactivated at any time.

- Predefined PCC rules. Preconfigured in the PCEF. Predefined PCC rules can be activated or deactivated by the H-PCRF at any time via the V-PCRF using S9 interface. Predefined PCC rules may be grouped allowing the H-PCRF to dynamically activate a set of PCC rules in the PCEF via the V-PCRF using S9 interface.

The content of a PCC Rule is the same as defined in 3GPP TS 29.212 [3]. The rule name within a PCC Rule shall be used to reference to a PCC Rule in the communication between the H-PCRF and the V-PCRF.

4.4.2 QoS Rule definition

The purpose of the QoS Rule is defined in 3GPP TS 29.212 [3]. QoS Rules are sent over S9 interface for home routed access and visited access.

The content of a QoS Rule is the same as defined in 3GPP TS 29.212 [3]. The rule name within a QoS Rule shall be used to reference to a QoS Rule in the communication between the H-PCRF and the V-PCRF.

4.4.3 Operations on PCC rules

PCC Rules operations are defined in 3GPP TS 29.212 [3]. This clause clarifies how those operations are implemented on the S9 interface.

For dynamic PCC rules, the V-PCRF validates the QoS parameters requested for the service identifier within the PCC Rules, before accepting the installation or modification of PCC Rules. If the QoS validation fails the V-PCRF rejects the installation or modification of the PCC Rule.

For the Visited Access case, the H-PCRF may activate predefined PCC rules in the V-PLMN"s PCEF. In that case, the V-PCRF shall validate, based on roaming agreements, that the H-PCRF is allowed to perform a particular operation on a particular PCC Rule.

4.4.4 Operations on QoS Rules

QoS Rules operations are defined in 3GPP TS 29.212 [3].

For QoS rules, the V-PCRF validates the QoS parameters requested within the QoS Rules, before accepting the installation or modification of QoS Rules. If the QoS validation fails the V-PCRF rejects the installation or modification of the QoS Rule.

4.5 PCC procedures over S9 Reference Point

4.5.1 General

In this release, there are two protocols running over the S9 interface: the S9 protocol and the Rx protocol.

- The Rx protocol is working as specified in 3GPP TS 29.214 [5]

- The S9 protocol is defined in clause 5 in this document. The S9 protocol allows establishment, modificationy and termination of Diameter S9 sessions. There is an S9 session per UE between each H-PCRF and V-PCRF pair. An S9 session can contain zero, one or several S9 subsessions. The S9 subsession scope is per PDN connection. An S9 subsession can be established, modified and terminated.

When the V-PCRF receives a request that should be sent to the HPLMN, the V-PCRF places the information within a S9 subsession level if it only applies to a particular PDN connection. Otherwise, the information is placed at S9 session level.

There are three distinct network scenarios for an IP-CAN as defined in 3GPP TS.29.213 [4]:

1. No Gateway Control session is needed. GTP is used for S5/S8 reference points.

2. Gateway Control session is needed. Two subcases can be distinguished:

    2a) S2c reference point (and then DSMIPv6 protocol) is used by a trusted non-3GPP access to access the EPC.

    2b) Trusted non-3GPP accesses that use 2a reference point (PMIPv6 or MIPv4 protocol are used) or 3GPP access that uses PMIPv6 over S5/S8 reference points.

The S9 reference point is used for case 1 in VA scenario and, for cases 2a and 2b for both HR and VA scenarios.

NOTE: The cases described above are oftenly referred through the document as cases 1, 2a or 2b.

4.5.1.1 S9 Session Establishment

When the V-PCRF receives a CCR command with CC-Request-type AVP set to the value "INITIAL_REQUEST" from the PCEF/BBERF that can not be associated with any existing S9 session to the H-PCRF for that UE (based on the Subscription-ID AVP), the V-PCRF shall establish a new S9 session according to the procedures specified in clause 4.5.2.1 or 4.5.3.1 for home-routed and visited access respectively.

NOTE: In a network scenario that deploys case 1 as defined in clause 4.5.1, S9 session is only needed in the visited access case and the procedures described in clause 4.5.3 apply.

4.5.1.2 S9 Session Termination

The V-PCRF shall initiate a termination of the S9 session when it receives a trigger that originates the removal of the last existing S9 subsession associated with the referred S9 session. The V-PCRF terminates the S9 session following the procedures described in clause 4.5.2.3 or clause 4.5.3.3.

When the H-PCRF determines that the S9 session shall be terminated, the procedures described in clause 4.5.2.4 and 4.5.3.4 apply.

NOTE: In a network scenario that deploys case 1 as defined in clause 4.5.1, only the procedures described in clause 4.5.3 apply.

4.5.1.3 Event Triggers

4.5.1.3.1 Provisioning of Event Triggers

Provisioning of event triggers may be performed by either the V-PCRF or the H-PCRF. The V-PCRF may receive requests to subscribe to event triggers from the H-PCRF, from the PCEF (VA case) or due to an internal or other external event. The H-PCRF may receive subscription request from the PCEF (HR case), or due to an internal or external event (e.g. due to an Rx interaction with the AF).

When the H-PCRF wants to subscribe or unsubscribe to event trigger(s) in the VPLMN, the H-PCRF shall provide to the V-PCRF one or several event triggers by including them within the Event-Trigger AVP. Event Triggers may apply to a specific S9 Subsession(s) or to a specific S9 session. Event Triggers provided for a specific S9 session apply to S9 Subsession(s) within the specified S9 session.

- When Event Triggers are provided for a specific S9 subsession(s), the H-PCRF includes Subsession-Decision-Information AVP for each of the affected S9 subsession. Each Subsession-Decision-Info AVP includes the Subsession-Id AVP and the list of event triggers within the Event-Trigger AVP.

- When Event Triggers are provided for a specific S9 session(s), the H-PCRF includes the list of event triggers within the Event-Trigger AVP at command level.

The H-PCRF adds new event triggers or removes previously provided event triggers to the V-PCRF by providing the new complete list of applicable event triggers.

The H-PCRF may provision event triggers to the V-PCRF using both a RAR and a CCA command.

When the V-PCRF receives event triggers from the H-PCRF, the V-PCRF stores them locally as S9-related and proceeds as follows:

- In both the Home-Routed and Visited Access cases, the V-PCRF shall provision the event triggers over the associated Gxx session to the BBERF using the Gateway Control and QoS Rules Provisioning or Gateway Control Session Establishment procedure described in 3GPP TS 29.212 [3] clauses 4a.5.1 and 4a.5.2.

- Additionally, in the Visited Access case, the V-PCRF may also provision the event triggers over the associated Gx session to the PCEF using the PCC Rule Provisioning procedure described in in 3GPP TS 29.212 [3] clause 4.5.3.

The H-PCRF may remove all previously provided event triggers by providing the Event-Trigger AVP set to the value NO_EVENT_TRIGGERS. The H-PCRF includes within the Subsession-Decision-Information AVP the affected Subsession-Id AVP and the list of event triggers within the Event-Trigger AVP. When an Event-Trigger AVP is provided with this value, no other Event-Trigger AVP shall be provided in the CCA or RAR command. Upon reception of an Event-Trigger AVP with this value from the H-PCRF, if there are no other locally handled event triggers, the V-PCRF shall provide the Event-Trigger AVP set to the value NO_EVENT_TRIGGERS to the BBERF and PCEF; if there are locally handled event triggers, the V-PCRF shall update the event triggers at the BBERF and the PCEF to remove those triggers previously installed based on requests from the H-PCRF. The V-PCRF shall not inform H-PCRF of any subsequent event except for those events that are always subscribed with no provision.

When the PCEF in the Visited Access case subscribes or unsubscribes to one or several event triggers with the V-PCRF, the V-PCRF stores them locally as Gx-related events and then provision them over the associated Gxx session (identified using the Gateway Control Session to IP-CAN session linking procedure described in 3GPP TS 29.212 [3] clause 4a.5.6) to the BBERF using the Gateway Control and QoS Rules Provisioning procedure described in 3GPP TS 29.212 [3] clause 4a.5.2.

The V-PCRF may also provision event triggers to the BBERF/PCEF due to an internal or external trigger or using the Provisioning of Event Triggers procedure as described in 3GPP TS 29.212 [3] clauses 4a.5.3. and clause 4.5.3.

4.5.1.3.2 Reporting of deployed Event Triggers

The V-PCRF may receive a report of an event trigger that is deployed at the BBERF or at the PCEF (VA case).

In the VA case, when the event trigger reported by the BBERF corresponds to a Gx-related event trigger (i.e. a subscription from the PCEF), the V-PCRF notifies the PCEF as described in 3GPP TS 29.212 [3] clause 4.5.2.1.

When the event trigger reported by the BBERF or the PCEF (in VA case) corresponds to a S9-related (i.e. a subscription from the H-PCRF) event trigger, the V-PCRF notifies the H-PCRF using the PCC Rule Request procedure as described in 4.5.3.1.

When the event trigger reported by the BBERF/PCEF corresponds to a V-AF-related event trigger, the V-PCRF shall inform the V-AF using the RAR command including the Specific-Action AVP as described in 3GPP TS 29.214 [5] clauses 4.4.6.1, 4.4.6.2 and 4.4.6.3.

4.5.1.4 Multiple BBERF scenarios

The multiple BBERF scenarios happen when there is a change of BBERF and the H-PCRF and the V-PCRF needs to handle more than one BBERF related with the same UE.

The V-PCRF shall follow the procedures defined in clauses 4.5.2.5 and 4.5.3.5 respectively for the home routed and visited access cases.

NOTE: For all cases the H-PCRF subscribes to IP-CAN_CHANGE events

4.5.2 Home-Routed access

4.5.2.1 S9 Session/Subsession session establishment/modification

The V-PCRF interacts with the H-PCRF in the following instances:

1) Upon Gateway Control Session establishment over Gxx:

   When the V-PCRF receives a CCR command with a CC-Request-Type AVP set to "INITIAL_REQUEST" from the BBERF over Gxx, the V-PCRF determines whether case 2a or case 2b applies as defined in 3GPP TS 29.213 [4] and applies the following procedures:

   - If case 2a applies,

     - If there is not an already established S9 session for this roaming user, the V-PCRF shall send to the H-PCRF a CCR command with the CC-Request-Type AVP set to the value "INITIAL_REQUEST" to establish a new S9 session. The CCR command from the V-PCRF to the H-PCRF shall include those attributes provided by the BBERF to the V-PCRF at the Diameter CCR command level.

     - Otherwise, if there is an already established S9 session for this roaming user, the procedures in clause 4.5.2.5 shall be applied.

   - If case 2b applies,

     - If an existing S9 session for the roaming user is already established with the H-PCRF, the V-PCRF shall update the existing session by sending a CCR with the CC-Request-Type AVP set to the value 'UPDATE_REQUEST' to the H-PCRF. Otherwise the V-PCRF shall establish a new S9 session as indicated in clause 4.5.1.1

     - If an S9 subsession does not exist for the PDN connection corresponding to the gateway control session establishment, the V-PCRF shall include the Subsession-Enforcement-Info AVP within the CCR command with a new S9 subsession identifier assigned by the V-PCRF within the Subsession-Id AVP, the Subsession-Operation AVP set to the value "ESTABLISHMENT". The V-PCRF shall map the Gxx session-id(s) to the corresponding subsession-id(s) in the S9 session. In addition, the V-PCRF shall include those attributes provided by the BBERF that allows the H-PCRF to identify the Subsession as defined in 3GPP TS 29.212 [3].

     - Otherwise, if an S9 subsession does exist for the PDN connection corresponding to the gateway control session establishment, the V-PCRF shall follow the procedures in clause 4.5.2.5.

2) Upon Gateway Control Session modification over Gxx by receiving a Gateway Control and QoS rules request

   When the V-PCRF receives a CCR command with a CC-Request-Type AVP set to "UPDATE_REQUEST" from the BBERF over Gxx, the V-PCRF shall send a CCR command with a CC-Request-Type AVP set to "UPDATE_REQUEST" to the H-PCRF including the changed information.

   In case 2a, The V-PCRF shall include any specific event within the Event-Trigger AVP, any affected previously provisioned QoS rule(s), sent by the BBERF, within the QoS-Rule-Report AVP.

   In case 2b, the V-PCRF shall modify the corresponding S9 subsession by including the Subsession-Enforcement-Info AVP within the CCR command that contains the allocated S9 subsession identifier within the Subsession-Id AVP, the Subsession-Operation AVP set to the value "MODIFICATION". In addition, the V-PCRF shall provide the Subsession-Id AVP to allow the H-PCRF to identify the Subsession for which QoS Rules are requested. The V-PCRF shall include any specific event (within the Event-Trigger AVP) and any affected previously provisioned QoS rule(s), sent by the BBERF, within the QoS-Rule-Report AVP within the Subsession-Enforcement-Info AVP.

The QoS rules are provisioned by the H-PCRF as follows:

- In case 2a, the H-PCRF shall provision QoS Rules in the CCA command by the QoS-Rule-Install AVP at the command level.

- In case 2b, the H-PCRF shall provision QoS Rules within the corresponding S9 subsession by issueing the CCA command by including the Subsession-Decision-Info AVP for the S9 subsession within the S9 session. Each S9 Subsession-Decision-Info AVP contains the QoS-Rule-Install AVP.

If the H-PCRF is, due to incomplete, erroneous or missing information (e.g. subscription related information not available or authorized QoS exceeding the subscribed bandwidth) not able to:

1) Provision a policy decision as response to the request sent by the V-PCRF, the H-PCRF shall send a CCA command including the Experimental-Result AVP at the command level with the Experimental-Result-Code AVP set to DIAMETER_ERROR_S9_SUBSESSION (5xxx), including the Subsession-Decision-Info AVP with the rejected Subsession-Id(s) within the Subsession-Id AVP and the appropriate error within either the Experimental-Result-Code AVP or Result-Code AVP.

2) Provision a policy decision to any of the S9 subsession(s) within the CCR command, the H-PCRF shall reject the request using a CCA command with the DIAMETER_ERROR_INITIAL_PARAMETERS (5140) within the Experimental-Result-Code AVP.

When the V-PCRF receives a CCA command where S9 specific subsession(s) contain with a specific Result-Code or Experimental-Result-Code AVP from the H-PCRF, the V-PCRF shall reply to the BBERF over the respective Gxx with a CCA command including the same result code.

When the V-PCRF receives a CCA command with an error code within the Experimental-Result-Code AVP or Result-Code AVP at the command level, the V-PCRF shall reply to the BBERF over the respective Gxx interface with a CCA command including the same result code.

The V-PCRF shall validate the QoS Rules contained in the CCA. If the QoS validation fails the V-PCRF shall perform the following:

1) Reply to the BBERF over Gxx with a CCA command including the Gx experimental result code DIAMETER_ERROR_INITIAL_PARAMETERS (5140).

2) In case 2a, send a CCR command to the H-PCRF including the QoS-Rule-Report AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

3) In case 2b, send a CCR command to the H-PCRF including the QoS-Rule-Report AVP within the Subsession-Enforcement-Info AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS. The V-PCRF shall include the S9 subsession specific information within the CCR command that includes the S9 subsession identifier within the Subsession-Id AVP. The Subsession-Operation AVP set to the value "TERMINATION" if the CCR used to request the rules was creating a new subsession.

Editor"s Note: For both cases, it is FFS what value to include in the CC-Request-Type AVP. The text in the bullets above shall be confirmed.

4.5.2.2 Provision of QoS Rules by the H-PCRF

The H-PCRF may decide to provision QoS Rules without obtaining a request from the V-PCRF, e.g. in response to information provided to the H-PCRF via the Rx reference point, or in response to an internal trigger within the H-PCRF, or from a trigger by the SPR. The H-PCRF may also decide to provision QoS rules in response to a request for PCC Rules received by the H-PCRF from the PCEF that is linked with a former Gateway Control session establishment.

To provision QoS Rules without a request from the V-PCRF, the H-PCRF shall do the following:

- In case 2a, send a RAR command including the QoS rules to be provisioned within the QoS-Rule-Install AVP at the command level.

- In case 2b, send a RAR command including the Subsession-Decision-Info AVP for each of the S9 subsessions within the S9 session. Each Subsession-Decision-Info AVP contains the QoS rules to be provisioned within the QoS-Rule-Install AVPs.

The V-PCRF shall validate the QoS Rules contained within each S9 subsession within the RAR command.

If the QoS validation fails the V-PCRF shall send a reject in the RAA command to the H-PCRF. The V-PCRF includes:

- In case 2a, a DIAMETER_PCC_RULE_EVENT (5142) experimental result code, the QoS-Rule-Report AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

- In case 2b, the Subsession-Enforcement-Info AVP for each rejected S9 subsession. The Subsession-Enforcement-Info AVP with the rejected Subsession-Id(s) and a DIAMETER_PCC_RULE_EVENT (5142) experimental result code, including the QoS-Rule-Report AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

If the QoS validation succeeds, the V-PCRF shall initiate the Gateway Control and QoS Rules Provision procedure over Gxx as defined in 3GPP TS 29.212 [3] by sending an RAR command to the BBERF including the parameters from the RAR command received from the H-PCRF. When the V-PCRF receives the RAA from the BBERF(s), the V-PCRF responds to the H-PCRF as follows:

- in case 2a, the V-PCRF shall send a corresponding RAA command to the H-PCRF including the corresponding result code.

- in case 2b, the V-PCRF shall send a corresponding RAA command to the H-PCRF including the S9-Subsession-Enforcement-Info AVP for each specific S9 subsession with the corresponding result code.

4.5.2.3 S9 Session/Subsession Termination Initiated by the V-PCRF

This procedure is triggered by a Gateway Control Session Termination procedure over Gxx interface. When the V-PCRF receives a CCR command with a CC-Request-Type AVP set to 'TERMINATION_REQUEST' from the BBERF over Gxx, it shall acknowledge this message by sending the CCA command to the BBERF as defined in 3GPP TS 29.212 [3]. In addition the V-PCRF shall do the following

1) Terminate the S9 session, if as a consequence of the Gateway Control Session Termination over Gxx, the last S9 subsession for that roaming user is terminated. In order to do that, the V-PCRF shall terminate the related S9 session by sending a CCR command with a CC-Request-Type AVP set to 'TERMINATE_REQUEST' to the H-PCRF.

   When the H-PCRF receives the CCR, it shall acknowledge this message by sending a CCA to the V-PCRF.

2) Update the S9 session, if there are remaining S9 subsessions for the roaming user. The V-PCRF shall modify the related S9 session by sending a CCR with a CC-Request-Type AVP set to 'UPDATE_REQUEST' to the H-PCRF. The V-PCRF shall include in the CCR the Subsession-Enforcement-Info and set the Subsession-Operation AVP to 'TERMINATION' for each S9 subsession of a particular UE that is terminated.

When the H-PCRF receives the CCR, it shall acknowledge this message by sending a CCA to the V-PCRF. The H-PCRF shall include the Subsession-Decision-Info AVP within the CCA command with the removed Subsession-Id AVP and the Result-Code AVP.

On receipt of the CCA command, the V-PCRF shall remove the session information stored for that Gateway Control Session.

4.5.2.4 S9 Session/Subsession Termination Initiated by the H-PCRF

The H-PCRF may request the termination of a S9 session/subsession to the V-PCRF.

The H-PCRF decides to terminate a S9 session/subsession due to an internal trigger or trigger from the SPR. The following cases can be distinguished:

- If the H-PCRF considers that the S9 session has to be terminated, the H-PCRF shall send an RAR command to the V-PCRF indicating the termination of the S9 subsession by including the Session-Release-Cause AVP. The V-PCRF shall send a corresponding RAA command to the H-PCRF.

- If the H-PCRF considers that the S9 subsession has to be terminated, the H-PCRF shall send an RAR command to the V-PCRF indicating the termination of the S9 subsession by including the Session-Release-Cause AVP within the Subsession-Decision AVP. When the V-PCRF receives the RAR command it shall answer it by issuing the corresponding RAA command.

The V-PCRF shall trigger the termination of the corresponding Gxx session(s) over Gxx interface by applying the Gateway Control session termination procedures as defined in 3GPP TS 29.212 [3] clause 4a.5.3.

4.5.2.5 Multiple BBERF Handling

The H-PCRF distinguishes two types of BBERFs: primary and non-primary according to 3GPP TS 29.212 [3].

When the V-PCRF has received a CCR for Gateway Control Session Establishment from a new BBERF that is related with an existing gateway control session, the V-PCRF modifies the S9 session by sending a CCR command. The V-PCRF shall include the AN-GW-Address AVP to distinguish the information from the new BBERF and to allow the H-PCRF operating on any of the BBERF separately. For case 2a, the AN-GW-Address AVP is included at the command level; for case 2b, the AN-GW-Address AVP is included at the subsession level.

When the H-PCRF receives the CCR command, the H-PCRF will apply the procedures defined in 3GPP TS 29.212 [3] to detect if the new BBERF is primary or not and will act accordingly by answering with a CCA command. Within the CCA command the H-PCRF may include new decisions at either the command level for case 2a or at the subsession level for case 2b for the affected BBERF.

If the same changes are applied to all BBERFs, the H-PCRF shall not include AN-GW-Address AVP within the CCA command. If different decisions are applied to different BBERFs, the H-PCRF shall include, in the CCA command, the AN-GW-Address AVP that was included in the CCR command and the associated QoS rules and event triggers for that BBERF. To provide the updated QoS rules and event triggers to the remaining BBERF(s), the H-PCRF initiates the QoS rule provision procedure with each of the remaining BBERF(s), the target BBERF identified by the AN-GW-Address AVP in the RAR command.

When the V-PCRF receives a CCR command from any of the BBERFs for Gateway Control Session modification, the V-PCRF shall follow the same procedures as described above for Gateway Control Session Establishment case and include AN-GW-Address AVP within the CCR command to the H-PCRF. The H-PCRF also follows the same procedures in determining whether to include AN-GW-Address AVP or not in the CCA command.

When provisioning different QoS rules, the H-PCRF shall include the different QoS rules within separate RAR commands, and shall also include the AN-GW-Address AVP with the value set to the BBERF address to indicate the actual BBERF where the rules are to be applied. The H-PCRF may also include subscription for any event trigger by including the Event-Trigger AVP with the corresponding value. For case 2a, the AN-GW-Address AVP is included at the command level; for case 2b, the AN-GW-Address AVP is included at the subsession level.

When provisioning the same QoS rules to the all BBERFs, the H-PCRF shall include the QoS rules within the same RAR command without including the AN-GW-Address AVP.

NOTE: For case 2b the old BBERF always initiates the termination of the Gateway Control Session.

4.5.3 Visited Access

4.5.3.1 Request PCC and QoS Rules

The V-PCRF shall request for PCC or QoS rules from the H-PCRF in the following instances:

1) A Diameter CCR command as defined in clause 4.5.1 of 3GPP TS 29.212 [3] is received by the V-PCRF from the PCEF requesting PCC Rules for a roaming user and/or informing that an installed event trigger has been detected in this case the affected PCC Rules are included by the PCEF.

2) A Diameter CCR command as defined in clause 4a.5.1 of 3GPP TS 29.212 [3] is received by the V-PCRF from the BBERF requesting QoS Rules for a roaming user and/or informing that an installed event trigger has been detected in this case the affected QoS Rules are included by the BBERF. If the request is coming from a non-primary BBERF during a multiple BBERF scenario as indicated in clause 4.5.3.5 the procedures outlined within that clause shall apply instead.

Editor"s Note: It is FFS if the V-PCRF stores the information received in the CCR from the BBERF and send a CCA back to the BBERF without QoS rules to acknowledge the reception of the related CCR command.

The V-PCRF shall store the information received in the CCR command from the BBERF/PCEF and send a new request over S9 as follows:

- If an existing S9 session for the roaming user does not already exist, the V-PCRF shall establish a new S9 session with the H-PCRF by sending a CCR command with the CC-Request-Type AVP set to the value 'INITIAL_REQUEST', to the H-PCRF.

- If an existing S9 session for the roaming user is already established with the H-PCRF, the V-PCRF shall update the existing session by sending a CCR command with the CC-Request-Type AVP set to the value "UPDATE_REQUEST" to the H-PCRF.

In case 2a and if the original CCR command is received from the BBERF, the V-PCRF shall include the attributes provided by the BBERF at the Diameter CCR command level.

In case 2b, the V-PCRF shall refer the request to the corresponding S9 subsession by including, the Subsession-Enforcement-Info AVP with the corresponding Subsession-Id AVP within the CCR command and shall also include those attributes provided by the BBERF/PCEF as defined in clause 4a.5.1 and 4.5.1 of 3GPP TS 29.212 [3] respectively.

- If new subsessions are created the V-PCRF shall include within the Subsession-Enforcement-Info AVP, the Subsession-Id AVP set to the value of a new subsession identifier, the Subsession-Operation AVP set to the value "ESTABLISHMENT". The V-PCRF shall map the Gxx or Gx session-id(s) to the corresponding subsession-id(s) in the S9 session.

NOTE: For case 2a, a new subsession will be created only when the original received Diameter CCR from the PCEF indicates an establishment request for a new Gx session. This is applicable also to case 2b although alternatively, the new subsession might be created upon the reception of the gateway control session establishment and be further modified when the corresponding IP-CAN session establishment arrives to the V-PCRF.

- If already existing subsessions are modified the V-PCRF shall set the Subsession-Operation AVP value within the Subsession-Enforcement-Info AVP to "MODIFICATION".

If the H-PCRF is, due to incomplete, erroneous or missing information (e.g. subscription related information not available or authorized QoS exceeding the subscribed bandwidth) not able to provision a policy decision to a particular subsession as response to the request sent by the V-PCRF, the H-PCRF may reject the request of the affected subsession(s) using a CCA command. To reject the QoS rule request for case 2a, the H-PCRF include the Experimental-Result-Code AVP or Result-Code AVP at the command level. For all other cases, the H-PCRF include the Subsession-Decision-Info AVP with the Subsession-Id AVP. For the rejected subsession(s) the Subsession-Decision-Info AVP shall also contain an appropriate result code within either the Experimental-Result-Code AVP or Result-Code AVP as defined in 3GPP TS 29.212 [3]. If the V-PCRF receives a CC Answer with this code, the V-PCRF shall send the CCA to the BBERF over Gxx and the PCEF over Gx.

Editor"s Note: The error handling needs to be clarified (similar to HR case) to clearly indicate what result codes are included at command level and subsession level and how V-PCRF handles each case, including the case where local authorization fails.

4.5.3.2 PCC and QoS Rules Provisioning

The H-PCRF shall provision, via the S9 reference point, PCC and QoS rules, using one of the following procedures:

- PULL procedure (Provisioning solicited by the V-PCRF): In response to a request for PCC rules being made by the V-PCRF, as described in the preceding section, to provide QoS rules for case 2a where no corresponding PCC rules are sent, the H-PCRF shall provision QoS rules in the CCA by including the QoS-Rule-Install AVP at the command level; for other cases, the H-PCRF shall provision PCC rules in the CCA command by including the Charging-Rule-Install AVP within the Subsession-Decision-Info AVP on the S9 subsession(s) that requested for PCC rules. or in response to a request for PCC Rules being made by the V-PCRF, as described in the preceding section instance

- PUSH procedure (Unsolicited provisioning from the H-PCRF). The H-PCRF may decide to provision (install, modify ore remove) PCC Rules without obtaining a request from the V-PCRF, e.g. in response to information provided to the H-PCRF from the AF (either in the visited or in the home network), or in response to an internal trigger within the H-PCRF, or from a trigger by the SPR. To install or modify PCC Rules without a request from the V-PCRF for case 2a when no corresponding PCC rules are sent, the H-PCRF shall provision QoS rules in the RAR by including the QoS-Rule-Install AVP at the command level; to provision PCC Rules without a request from the V-PCRF, the H-PCRF shall include these PCC Rules in an RAR command by including the Charging-Rule-Install AVP on the related S9 subsessions within the Subsession-Decision-Info AVP. To remove installed

PCC Rules without a request from the V-PCRF, the H-PCRF shall include these PCC Rules in a RAR command by including the Charging-Rule-Remove AVP on the related S9 subsessions within the Subsession-Decision-Info AVP.

The V-PCRF shall validate the QoS information contained within the PCC rules of the CCA/RAR command. If the QoS validation fails the V-PCRF shall reject the request using a CCR/RAA command respectively to the H-PCRF including the Subsession-Enforcement-Info AVP for each affected S9 subsession that includes the S9 subsession within the Subsession-Id AVP including the Charging-Rule-Report AVP to indicate the PCC Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

Editor"s Note: The CCA handling case is the same as previous subclause, so similar cleanup is needed; Another alternative is to structure the text similar as the HR case.

The V-PCRF shall validate the QoS information received from the H-PCRF in the RAR command. If the QoS validation fails the V-PCRF shall send a reject in the RAA command to the H-PCRF.

To reject QoS information provisioned at the command level, the V-PCRF includes, at the command level, the DIAMETER_PCC_RULE_EVENT (5142) experimental result code, the QoS-Rule-Report AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

To reject QoS information provisioned at the subsession level, the V-PCRF includes the Subsession-Enforcement-Info AVP for each rejected S9 subsession. Each Subsession-Enforcement-Info AVP includes the rejected Subsession-Id, a DIAMETER_PCC_RULE_EVENT (5142) experimental result code, the QoS-Rule-Report AVP to indicate the QoS Rules that were not accepted, the Event-Trigger AVP to indicate "UNSUCCESSFUL-QoS-VALIDATION" and the QoS-Information AVP to indicate the acceptable QoS.

The V-PCRF performs operations on a single PCC Rule or for a group of PCC Rules over S9 in the same way as described in clause 4.5.2 in 29.212 [3]. In addition, the V-PCRF generates QoS Rules based on the PCC Rules received over S9 interface to provision them in the BBERF.

If after provisioning the rules to the PCEF/BBERF, the V-PCRF receives a notification from either the PCEF (case 1, 2a, 2b) or the BBERF (case 2a and 2b) informing that an operation on a PCC/QoS rule has failed, the V-PCRF shall immediately inform to the H-PCRF. The V-PCRF shall send a CCR command with the CC-Request-Type AVP set to the value "UPDATE_REQUEST" (PULL procedure, i.e. initiating a new request) or send a RAA command (PUSH procedure, i.e. answering the RAR command) to the H-PCRF including the Experimental-Result-Code AVP received from the PCEF and the Charging-Rule-Report AVP to indicate the PCC Rules that were affected at either command level (case 2a) or subsession level (cases 1, 2a and 2b; by including the Subsession-Enforcement-Info AVP identifying the affected S9 subsession within Subsession-id AVP, the Subsession-Operation AVP set to the value 'MODIFICATION'). The H-PCRF may decide to reinstall, modify or remove the affected PCC Rules as described in this clause or terminate the S9 session/subsession as described in clause 4.5.3.4.

If the provisioning of the rules was successful, as part of the PUSH procedure, the V-PCRF will inform to the H-PCRF by sending a RAA command containing the information included in the notification received from the PCEF.

4.5.3.3 S9 Session/Subsession Termination Initiated by V-PCRF.

When the V-PCRF receives an indication of an IP-CAN Session Termination from the PCEF or an indication of Gxx session termination from the BBERF, the V-PCRF shall indicate to the H-PCRF one of the following actions:

1) Terminate the S9 session, if in case 2a, the Gxx session is removed or in case 2b, the last S9-subsession for the roaming user is removed. The V-PCRF shall terminate the S9 session with the H-PCRF by sending a CCR with the CC-Request-Type AVP set to the value "TERMINATION_REQUEST'.

2) Update the S9 session for the roaming user, if there are remaining S9 subsessions for the roaming user. The V-PCRF shall update the existing S9 session with the H-PCRF by sending a CCR command with CC-Request-type AVP set to value 'UPDATE-REQUEST' that includes the Subsession-Enforcement-Info AVP with the removed S9 subsession identifier within the Subsession-Id AVP, the Subsession-Operation AVP set to the value 'TERMINATION'.

NOTE: In case 2b, when the V-PCRF receives a Gxx session termination request from the BBERF (i.e. a CCR command with CC-Request-Type AVP set to value 'TERMINATION_REQUEST') , it handles it as specified in 3GPP TS 29.212 [3] without impacting S9.

When receiving the CCR command, the H-PCRF shall perform the following steps:

1) Identify the removed PCC Rules associated to the terminated S9 session or S9 subsession;

2) If an IP-CAN session is terminated, check whether the H-AF shall be informed and if the H-AF needs to be informed, send an ASR command as defined in clause 4.4.6.1 of 3GPP TS 29.214 [5]

The H-PCRF answers to the V-PCRF by issuing a CCA command. When receiving the CCR command, the V-PCRF shall send an acknowledgment to the PCEF as defined in 3GPP TS 29.212 [3].

4.5.3.4 S9 Session/Subsession Termination Initiated by the H-PCRF.

The H-PCRF may decide to terminate an S9 session or S9 subsession based on an internal trigger or a trigger from the SPR. When any of these triggers are met, the H-PCRF shall initiate a S9 session or S9 subsession termination by sending an RAR command to the V-PCRF as defined in clause 4.5.2.4.

4.5.3.5 Multiple BBERF Handling

The V-PCRF distinguishes two types of BBERF: primary and non-primary according to 3GPP TS 29.212 [3].

The V-PCRF shall ensure that the QoS rules are aligned with the PCC rules on all BBERFs as specified in TS 29.212 [3] clause 4a.5.7

The V-PCRF shall handle Gateway control session establishment and Gateway QoS request messages from a new BBERF locally.

When, due to handover, the V-PCRF receives an IP CAN session modification from the PCEF with the event trigger set to AN-GW-CHANGE(21) the V-PCRF shall send a CCR message to the H-PCRF with the Event-Trigger AVP at Subsession level set to AN-GW-CHANGE(21), provided the H-PCRF has subscribed to this event-trigger. If the CCR message from the PCEF also includes the IP-CAN_CHANGE(7) event-trigger, the V-PCRF shall reclassify the primary/ non-primary BBERFs and shall include this trigger as well in the CCR message sent to the H-PCRF, provided the H-PCRF has subscribed to it. If there is any subsequent request coming from the primary BBERF, the V-PCRF shall act according to the normal procedures specified in clause 4.5.3 and corresponding subclauses.

If the H-PCRF has not subscribed to either the AN_GW_CHANGE (21) or the IP-CAN_CHANGE event, the V-PCRF shall not inform the H-PCRF of this scenario and should solve it according to local policies and roaming agreements.

4.5.3.6 Rx Over S9

4.5.3.6.1 General

The interaction between the V-AF and the V-PCRF is in accordance with 3GPP TS 29.214 [5]. The V-PCRF may act as a Diameter Proxy or client/server to send the Rx messages between the V-AF and the H-PCRF except as noted below.

The V-PCRF may process the initial or modified Service Information received from the V-AF according to the operator policy to decide whether the request is accepted or not. If the service information provided by the V-AF is rejected, the V-PCRF shall send the AAA to reject the request with the Experimental-Result-Code AVP set to the value REQUESTED_SERVICE_NOT_AUTHORIZED. In this case, the V-PCRF shall not forward the AAR to the H-PCRF.

The V-PCRF shall not forward the AAR message from the V-AF to the H-PCRF if the processing of the request results in any of the specific values of the 'Rx specific Experimental-Result-Code' per clause. 5.5 of 3GPP TS 29.214 [5].

Editor"s Note: Optimization of the AF signalling channel and hadnding of the AF subscription events is FFS.

4.5.3.6.2 Event Handling

4.5.3.6.2.1 V-AF Subscription to Notification of Signalling Path Status

A V-AF may subscribe to notifications of the status of the AF Signalling transmission path by including the Specific-Action AVP with the corresponding value as described in section 4.4.5 of 3GPP TS 29.214 [9].

When the V-PCRF receives an AAR command for the establishment of the AF signalling session from the V-AF, the V-PCRF, depending on operator policy, may not forward the AAR message to the H-PCRF. In this case, the V-PCRF handles the AF signalling session locally and shall acknowledge the AAR command by sending an AAA command to the V-AF and follow the procedures described in clause 4.4.5 of 3GPP TS 29.212 [9]. Otherwise, the V-PCRF proxies the AAR to the H-PCRF.

Editor"s note: It is FFS how to handle the AF signalling transmission path locally if, for non-IMS V-AF, the AAR message from the V-AF includes both AF signalling and service information.

4.5.3.6.2.2 Reporting of Signalling Path Status

If the V-PCRF is handling the AF signalling session locally with the V-AF (i.e. the V-PCRF is not proxying the AF signalling session to the H-PCRF) and subscribed to the signalling path status specific actions ("INDICATION_OF_LOSS_OF_BEARER" and/or 'INDICATION_OF_RELEASE_OF_BEARER'), and the V-PCRF is notified of the loss or release of resources associated to the PCC Rules corresponding with V-AF Signalling IP Flows, the V-PCRF shall inform the V-AF about the Loss of the Signalling Transmission Path by sending a Re-Authorization Request (RAR) command to the V-AF per section 4.4.6.3 of TS 29.214 [9].

The V-PCRF shall send a CCR message to the H-PCRF over the S9 interface reporting this event trigger only if the H-PCRF has previously subscribed to the corresponding event trigger.

4.5.3.6.2.3 Reporting IP-CAN Type Change Notification

If the V-PCRF is handling the AF signalling session locally with the V-AF (i.e. the V-PCRF is not proxying the AF signalling session to the H-PCRF) and the V-AF has subscribed for change notification in UE's IP-CAN type, then the V-PCRF shall send a RAR command when there is a change in the UE's IP-CAN type per section 4.4.6.4 of TS 29.214 [9].

The V-PCRF shall send a CCR message to the H-PCRF over the S9 interface reporting this event trigger only if the H-PCRF has previously subscribed to the corresponding event trigger.

5. S9 Protocol

5.1 Protocol Support

The S9 application is defined as a vendor specific Diameter application, where the vendor is 3GPP and the Application-ID for the S9 Application in the present release is xxx. The vendor identifier assigned by IANA to 3GPP (http://www.iana.org/assignments/enterprise-numbers) is 10415.

Editor"s Note: A new Diameter application-id is required for S9 by IANA

NOTE: A route entry can have a different destination based on the application identification AVP of the message. Therefore, Diameter agents (relay, proxy, redirection, translation agents) must be configured appropriately to identify the 3GPP S9 application within the Auth-Application-Id AVP in order to create suitable routeing tables.

Due to the definition of the commands used in the S9 protocol, there is no possibility to skip the Auth-Application-Id AVP and use the Vendor-Specific-Application-Id AVP instead. Therefore the S9 application identification shall be included in the Auth-Application-Id AVP.

With regard to the Diameter protocol defined over the S9 interface, the H-PCRF acts as a Diameter server, in the sense that it is the network element that handles PCC/QoS rule requests for a particular realm. The V-PCRF acts as the Diameter client, in the sense that it is the network element requesting PCC/QoS rules to the H-PCRF

A Diameter S9 session used in the S9 protocol shall combine all Gx and Gxx Diameter sessions for a particular UE.

5.2 Initialization, maintenance and termination of connection and session

The initialization and maintenance of the connection between each V-PCRF/H-PCRF pair is defined by the underlying protocol. Establishment and maintenance of connections between Diameter nodes is described in IETF RFC 3588 [6].

After establishing the transport connection, the V-PCRF and the H-PCRF shall advertise the support of the S9 specific Application by including the value of the application identifier in the Auth-Application-Id AVP and the value of the 3GPP (10415) in the Vendor-Id AVP of the Vendor-Specific-Application-Id AVP contained in the Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands. The Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands are specified in the Diameter Base Protocol (RFC 3588 [6]).

The termination of the Diameter user session is specified in IETF RFC 3588 [6] in clauses 8.4 and 8.5. The description of how to use of these termination procedures in the normal cases is embedded in the procedures description (clause 4.5).

5.3 S9 specific AVPs

Table 5.3.1 describes the Diameter AVPs defined for the S9 reference point, their AVP Code values, types, possible flag values, whether or not the AVP may be encrypted and the applicability of the AVPs to charging control, policy control or both. The Vendor-Id header of all AVPs defined in the present document shall be set to 3GPP (10415).

Table 5.3.1: S9 specific Diameter AVPs

Attribute Name	AVP Code	Clause defined	Value Type (note 2)	AVP Flag rules (note 1)				May Encr.	Acc. type	Applicability (note 3)
				Must	May	Should not	Must not			
Subsession-Decision-Info	xxxx	5.3.1	Grouped	M,V	P			Y	All	Both
Subsession-Enforcement-Info	xxxx	5.3.2	Grouped	M,V	P			Y	All	Both
Subsession-Id	xxxx	5.3.3	Unsigned32	M,V	P			Y	All	Both
Subsession-Operation	xxxx	5.3.4	Enumerated	M,V	P			Y	All	Both

NOTE 1: The AVP header bit denoted as 'M', indicates whether support of the AVP is required. The AVP header bit denoted as 'V', indicates whether the optional Vendor-ID field is present in the AVP header. For further details, see RFC 3588 [4].
NOTE 2: The value types are defined in RFC 3588 [4].
NOTE 3: AVPs marked with 'CC' are applicable to charging control, AVPs marked with 'PC' are applicable to policy control and AVPs marked with 'Both' are applicable to both charging control and policy control.

5.3.1 Subsession-Decision-Info

The Subsession-Decision-Info AVP (AVP code xxxx) is of type Grouped, and it is used to manage PCC/QoS rules and event information within an S9 subsession from the H-PCRF to the V-PCRF.

The information contained within this grouped AVP pertains only to the subsession identified by the Subsession-Id AVP.

The Session-Release-Cause AVP and Event-Report-Indication AVP are only applicable when the Subsession-Decision-Info AVP is provided in a RAR.

The Result-Code AVP and Experimental-Result-Code AVP are only applicable when the Subsession-Decision-Info AVP is provided in a CCA. The Result-Code AVP or Experimental-Result-Code AVP may be provided to inform the V-PCRF of possible errors when processing subsession information that was provided in a corresponding CCR command.

AVP Format:

```
Subsession-Decision-Info ::= < AVP Header: xxxx >
                             { Subsession-Id }
                           0*2[ AN-GW-Address ]
                             [ Result-Code ]
                             [ Experimental-Result-Code ]
```

```
                    *[ Charging-Rule-Remove ]
                    *[ Charging-Rule-Install ]
                    *[ QoS-Rule-Install ]
                    *[ QoS-Rule-Remove ]
                     [ Session-Release-Cause ]
                    *[ Event-Trigger ]
                     [ Event-Report-Indication ]
                     [ Online ]
                     [ Offline ]
                    *[ QoS-Information ]
                    *[ AVP ]
```

5.3.2 Subsession-Enforcement-Info

The Subsession-Enforcement-Info AVP (AVP code xxxx) is of type Grouped, and it is used to set up and tear down subsessions, provide information about the subsession, request PCC/QoS rules and report on PCC/QoS rules and related events. This information is sent from the V-PCRF to the H-PCRF.The information contained within this grouped AVP pertains only to the subsession identified by the Subsession-Id AVP.

The following AVPs are only applicable when the Subsession-Enforcement-Info AVP is provided within a CCR: Subsession-Operation AVP, Bearer-Identifier AVP, Bearer-Operation AVP, QoS-Information AVP, Framed-IP-Address AVP, Framed-IPv6-Prefix AVP, Called-Station-ID AVP, Bearer-Usage AVP, TFT-Packet-Filter-Information AVP, Online AVP and Offline AVP.

The following AVPs are only applicable when the Subsession-Enforcement-Info AVP is provided within an RAA: Result-Code AVP and Experimental-Result-Code AVP.

The other AVPs are applicable when the Subsession-Enforcement-Info AVP is provided in either a CCR or RAA.

The Result-Code AVP or Experimental-Result-Code AVP may be provided to inform the H-PCRF of possible errors when processing subsession information that was provided in a corresponding RAR command.

```
Subsession-Enforcement-Info ::= < AVP Header: xxxx >
                                { Subsession-Id }
                                [ Subsession-Operation ]
                              0*2[ AN-GW-Address ]
                                [ Bearer-Identifier ]
                                [ Bearer-Operation ]
                                [ QoS-Information ]
                                [ Framed-IP-Address ]
                                [ Framed-IPv6-Prefix ]
                               *[ CoA-Information ]
                                [ Called-Station-ID ]
                                [ Bearer-Usage ]
                               *[ TFT-Packet-Filter-Information ]
                                [ Online ]
                                [ Offline ]
                                [ Result-Code ]
                                [ Experimental-Result-Code ]
                               *[ Charging-Rule-Report ]
                               *[ QoS-Rule-Report ]
                               *[ Event-Trigger ]
                               *[ Access-Network-Charging-Identifier-Gx ]
                               *[ AVP ]
```

Editor"s note: It is FFS which AVPs will be used to indicate UE requested resources (e.g. Resource-Identifier, Resource-Operation).

5.3.3 Subsession-Id

The Subsession-Id AVP (AVP code xxxx) is of type Unsigned32, and it is used to uniquely identify a subsession within the S9 session. The Subsession-Id AVP shall be selected by the V-PCRF.

5.3.4 Subsession-Operation

The Subsession-Operation AVP (AVP code xxxx) is of type of Enumerated, and it indicates the operation to be performed on the subsession.

The following values are defined:

TERMINATION (0)

This value is used to indicate that a subsession is being terminated.

ESTABLISHMENT (1)

This value is used to indicate that a new subsession is being established.

MODIFICATION (2)

This value is used to indicate that an existing subsession is being modified.

5.3.5 Void

5.4 S9 re-used AVPs

The S9 reference point re-uses all of the Gx and Gxx AVPs specified in 3GPP TS 29.212 [3], including the AVPs re-used by Gx and Gxx as specified in clauses 5.4 and 5a.4 of 3GPP TS 29.212 [3].

5.4.1 Use of the Supported-Features AVP on the S9 reference point

The Supported-Features AVP is used in S9 commands to inform the destination host about the features that the origin host requires to successfully complete a given command exchange. As described in section 7.2 of [7], a request command message shall always be compliant with the list of supported features indicated in the Supported-Features AVPs within that command message and features that are not indicated in the Supported-Features AVPs within a given application message shall not be used to construct that command message. Unless otherwise stated, the use of the Supported-Features AVP on the S9 reference point shall be compliant with the requirements for dynamic discovery of supported features on the Cx reference point as defined in section 7.2.1 of [7].

The base functionality for the S9 reference point is the 3GPP Rel-8 standard and a feature is an extension to that functionality. If the origin host does not support any features beyond the base functionality, the Supported-Features AVP may be absent from the S9 commands.

As defined in [7], the Supported-Features AVP is of type grouped and contains the Vendor-Id, Feature-List-ID and Feature-List AVPs. On the S9 reference point, the Supported-Features AVP is used to identify features that have been defined by 3GPP and hence the Vendor-Id AVP shall contain the vendor ID of 3GPP (10415). If there are multiple feature lists defined for the S9 reference point, the Feature-List-ID AVP shall differentiate those lists from one another.

5.5 S9 Messages

5.5.1 S9 Application

S9 Messages are carried within the Diameter Application(s) described in clause 5.1.

Existing Diameter command codes from the Diameter base protocol RFC 3588 [5] and the Diameter Credit Control Application RFC 4006 [9] are used with the S9 specific AVPs specified in clause 5.3. The Diameter Credit Control Application AVPs and AVPs from other Diameter applications that are re-used are defined in clause 5.4. Due to the definition of these commands there is no possibility to skip the Auth-Application-Id AVP and use the Vendor-Specific-Application-Id AVP instead. Therefore the S9 application identifier shall be included in the Auth-Application-Id AVP.

NOTE: Some of the AVPs included in the messages formats below are in bold to highlight that these AVPs are used by this specific protocol and do not belong to the original message definition in the DCC Application RFC 4006 [9] or Diameter Base Protocol RFC 3588 [5].

5.5.2 CC-Request (CCR) Command

The CCR command, indicated by the Command-Code field set to 272 and the 'R' bit set in the Command Flags field, is sent by the V-PCRF to the H-PCRF in order to request PCC or QoS rules. The CCR command is also sent by the V-PCRF to the H-PCRF in order to indicate bearer or PCC/QoS rule related events.

Message Format:

```
<CC-Request> ::= < Diameter Header: 272, REQ, PXY >
                 < Session-Id >
                 { Auth-Application-Id }
                 { Origin-Host }
                 { Origin-Realm }
                 { Destination-Realm }
                 { CC-Request-Type }
                 { CC-Request-Number }
                 [ Destination-Host ]
                 [ Origin-State-Id ]
                *[ Subscription-Id ]
                 [ Framed-IP-Address ]
                 [ Framed-IPv6-Prefix ]
                *[ Supported-Features ]
                 [ QoS-Information ]
                *[ TFT-Packet-Filter-Information ]
                *[ QoS-Rule-Report ]
              0*2 [ AN-GW-Address ]
                 [ Network-Request-Support ]
                *[ Subsession-Enforcement-Info ]
                 [ IP-CAN-Type ]
                 [ RAT-Type ]
                 [ Termination-Cause ]
                 [ User-Equipment-Info ]
                 [ QoS-Negotiation ]
                 [ QoS-Upgrade ]
                 [ 3GPP-SGSN-MCC-MNC ]
                 [ 3GPP-SGSN-Address ]
                 [ 3GPP-SGSN-IPv6-Address ]
                 [ RAI ]
                 [ 3GPP-User-Location-Info]
                 [ 3GPP2-BSID ]
                *[ Event-Trigger]
                *[ Proxy-Info ]
                *[ Route-Record ]
                *[ AVP ]
```

5.5.3 CC-Answer (CCA) Command

The CCA command, indicated by the Command-Code field set to 272 and the 'R' bit cleared in the Command Flags field, is sent by the H-PCRF to the V-PCRF in response to the CCR command. It is used to provision PCC/QoS rules and event triggers for the subsession/session

Message Format:

```
<CC-Answer> ::=  < Diameter Header: 272, PXY >
                 < Session-Id >
                 { Auth-Application-Id }
                 { Origin-Host }
                 { Origin-Realm }
                 [ Result-Code ]
                 [ Experimental-Result ]
                 { CC-Request-Type }
                 { CC-Request-Number }
                *[ Supported-Features]
                *[ QoS-Rule-Install ]
                *[ QoS-Rule-Remove ]
                *[ QoS-Information ]
                 [ Bearer-Control-Mode ]
                *[ Event-Trigger ]
                 [ Charging-Information ]
                *[ Subsession-Decision-Info ]
              0*2[ AN-GW-Address ]
                 [ Origin-State-Id ]
                 [ Error-Message ]
                 [ Error-Reporting-Host ]
                *[ Failed-AVP ]
```

```
                *[ Proxy-Info ]
                *[ Route-Record ]
                *[ AVP ]
```

5.5.4 Re-Auth-Request (RAR) Command

The RAR command, indicated by the Command-Code field set to 258 and the 'R' bit set in the Command Flags field, is sent by the H-PCRF to the V-PCRF in order to provision QoS/PCC rules, event triggers and event report indications for the subsession/session.

Message Format:

```
<RA-Request> ::= < Diameter Header: 258, REQ, PXY >
                  < Session-Id >
                  { Auth-Application-Id }
                  { Origin-Host }
                  { Origin-Realm }
                  { Destination-Realm }
                  { Destination-Host }
                  { Re-Auth-Request-Type }
                  [ Origin-State-Id ]
                 *[ Supported-Features]
                 *[ QoS-Rule-Install ]
                 *[ QoS-Rule-Remove ]
                 *[ QoS-Information ]
                 *[ Event-Trigger ]
                  [ Event-Report-Indication ]
                 *[ Subsession-Decision-Info ]
               0*2[ AN-GW-Address ]
                 *[ Proxy-Info ]
                 *[ Route-Record ]
                 *[ AVP]
```

5.5.5 Re-Auth-Answer (RAA) Command

The RAA command, indicated by the Command-Code field set to 258 and the 'R' bit cleared in the Command Flags field, is sent by the V-PCRF to the H-PCRF in response to the RAR command.

Message Format:

```
<RA-Answer> ::=  < Diameter Header: 258, PXY >
                 < Session-Id >
                 { Origin-Host }
                 { Origin-Realm }
                 [ Result-Code ]
                 [ Experimental-Result ]
                 [ Origin-State-Id ]
                 [ Framed-IP-Address ]
                 [ Framed-IPv6-Prefix ]
                *[ Supported-Features]
                 [ QoS-Information ]
                *[ TFT-Packet-Filter-Information ]
                *[ QoS-Rule-Report ]
              0*2[ AN-GW-Address ]
                *[ Subsession-Enforcement-Info ]
                 [ Error-Message ]
                 [ Error-Reporting-Host ]
                *[ Failed-AVP ]
                *[ Proxy-Info ]
                *[ AVP ]
```

5.6 S9 specific Experimental-Result-Code AVP values

5.6.1 General

RFC 3588 [6] specifies the Experimental-Result AVP containing Vendor-ID AVP and Experimental-Result-Code AVP. The Experimental-Result-Code AVP (AVP Code 298) is of type Unsigned32 and contains a vendor-assigned value representing the result of processing a request. The Vendor-ID AVP shall be set to 3GPP (10415).

5.6.2 Success

Result Codes that fall within the Success category are used to inform a peer that a request has been successfully completed.

The Result-Code AVP values defined in Diameter BASE RFC 3588 [6] shall be applied.

5.6.3 Permanent Failures

Errors that fall within the Permanent Failures category shall be used to inform the peer that the request failed, and should not be attempted again.

The Result-Code AVP values defined in Diameter BASE RFC 3588 [6] and 3GPP TS 29.212 [3] are applicable. Also the following specific S9 Experimental-Result-Codes values are defined:

DIAMETER_ERROR_S9_SUBSESSION (5xxx)

This error shall be used when one or more S9 subsessions within the answer contains an unsuccessful Result-Code or Experimental-Result-Code value. The Result Code specific to the request related to the subsession is specified within the corresponding Subsession-Decision-Info or Subsession-Enforcement-Info AVP.

Annex A (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
03/04/2008					Skeleton	-	0.0.0
21/05/2008					CRs implemented: C3-080704, C3-080761, C3-080763, C3-080839, C3-080840, C3-080841	0.0.0	0.1.0
30/06/2008					CRs implemented: C3-081113, C3-081183, C3-081114, C3-081184, C3-081153, C3-081172	0.1.0	0.2.0
27/08/2008					CRs implemented: C3-081515, C3-081526, C3-081540	0.2.0	0.3.0
01/09/2008					Version 1.0.0 created for presentation to TSG by MCC	0.3.0	1.0.0
14/10/2008					CRs implemented: C3-082100, C3-082082, C3-082068, C3-082025, C3-082101, C3-082027, C3-082083, C3-082114, C3-082030, C3-081983	1.0.0	1.1.0
19/11/2008					CRs implemented: C3-082213, C3-082379, C3-082382, C3-082383, C3-082384, C3-082460, C3-082595, C3-082599	1.1.0	1.2.0
01/12/2008					Correct implementation of C3-082595	1.2.0	1.2.1
26/11/2008					v 2.0.0 was produced by MCC for Approval in CT#42	1.2.1	2.0.0
13/12/2008	TSG#42				v 8.0.0 was produced by MCC	2.0.0	8.0.0
13/01/2009					V8.0.1 was produced by MCC due to editorial correction	8.0.0	8.0.1
13/01/2009					Further cosmetic corrections	8.0.1	8.0.2
03/2009	TSG#43	CP-090086	002	1	Event Trigger Clarifications	8.0.2	8.1.0
03/2009	TSG#43	CP-090086	003	1	Corrections on Session establishment for HR	8.0.2	8.1.0
03/2009	TSG#43	CP-090086	004	2	Handling of Proxy/OCS IP@ for Roaming VA	8.0.2	8.1.0
03/2009	TSG#43	CP-090083	006	5	Multiple BBERF Support Over S9 for VA	8.0.2	8.1.0
03/2009	TSG#43	CP-090082	007	1	Adding Supported-Features AVP to S9 commands	8.0.2	8.1.0
03/2009	TSG#43	CP-090083	008	2	Multiple BBERF handling in home routed case	8.0.2	8.1.0
03/2009	TSG#43	CP-090086	010	2	Break circular reference in S9 session establishment	8.0.2	8.1.0
03/2009	TSG#43	CP-090086	012	1	Experimental-Result-Code to indicate S9 subsession failure	8.0.2	8.1.0

History

Document history		
V8.0.2	January 2009	Publication
V8.1.0	April 2009	Publication