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Policy and Charging Control (PCC) over Gx/Sd 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:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document provides the stage 3 specification of the Gx reference point for the present release. The functional requirements and the stage 2 specifications of the Gx refernce point are contained in 3GPP TS 23.203 [7]. The Gx reference point lies between the Policy and Charging Rule Function and the Policy and Charging Enforcement Function.

Whenever it is possible the present document specifies the requirements for the protocol 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 and/or edition number or version number) 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 29.210: "Charging Rule Provisioning over Gx Interface".

[3] 3GPP TS 29.207: "Policy control over Go interface".

[4] 3GPP TS 29.208: "End-to-end Quality of Service (QoS) signalling flows".

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

[6] IETF RFC 3556: "Session Description Protocol (SDP) Bandwidth Modifiers for RTP Control Protocol (RTCP) Bandwidth".

[7] 3GPP TS 23.203: "Policy Control and Charging architecture".

[8] 3GPP TS 29.213: "Policy and charging control signalling flows and Quality of Service (QoS) parameter mapping".

[9] IETF RFC 4006: "Diameter Credit Control Application".

[10] 3GPP TS 29.214: "Policy and Charging Control over Rx reference point".

[11] 3GPP TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".

[12] IETF RFC 4005: "Diameter Network Access Server Application".

[13] 3GPP TS 24.008: "Mobile radio interface Layer 3 specification".

[14] 3GPP TS 29.229: "Cx and Dx interfaces based on Diameter protocol; Protocol details".

[15] IETF RFC 3162: "Radius and IPv6".

[16] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".

[17] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[18] 3GPP TS 29.060: "General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface".

[19] 3GPP TS 32.299: "Telecommunication management; Charging management; Diameter charging applications".

[20] 3GPP TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply:

IP-CAN bearer: IP transmission path of defined capacity, delay and bit error rate, etc.
See 3GPP TS 21.905 [1] for the definition of bearer.

IP-CAN session: association between a UE and an IP network
The association is identified by a UE IPv4 address or IPv6 prefix together with a UE identity information, if available. An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as the UE IPv4 address or IPv6 prefix are established and announced to the IP network.

IP flow: unidirectional flow of IP packets with the same source IP address and port number and the same destination IP address and port number and the same transport protocol.
Port numbers are only applicable if used by the transport protocol.

3.2 Abbreviations

For the purpose of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply:

AF	Application Function
OCS	Online charging system
OFCS	Offline charging system
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rule Function

4 Gx reference point

4.1 Overview

The Gx reference point is located between the Policy and Charging Rules Function (PCRF) and the Policy and Charging Enforcement Function (PCEF). The Gx reference point is used for provisioning and removal of PCC rules from the PCRF to the PCEF and the transmission of traffic plane events from the PCEF to the PCRF. The Gx reference point can be used for charging control, policy control or both by applying AVPs relevant to the application.

The stage 2 level requirements for the Gx reference point are defined in 3GPP TS 23.203 [7].

Signalling flows related to the both Rx and Gx interfaces are specified in 3GPP TS 29.213 [8].

4.2 Gx Reference model

The Gx reference point is defined between the PCRF and the PCEF. The relationships between the different functional entities involved are depicted in figure 4.1.

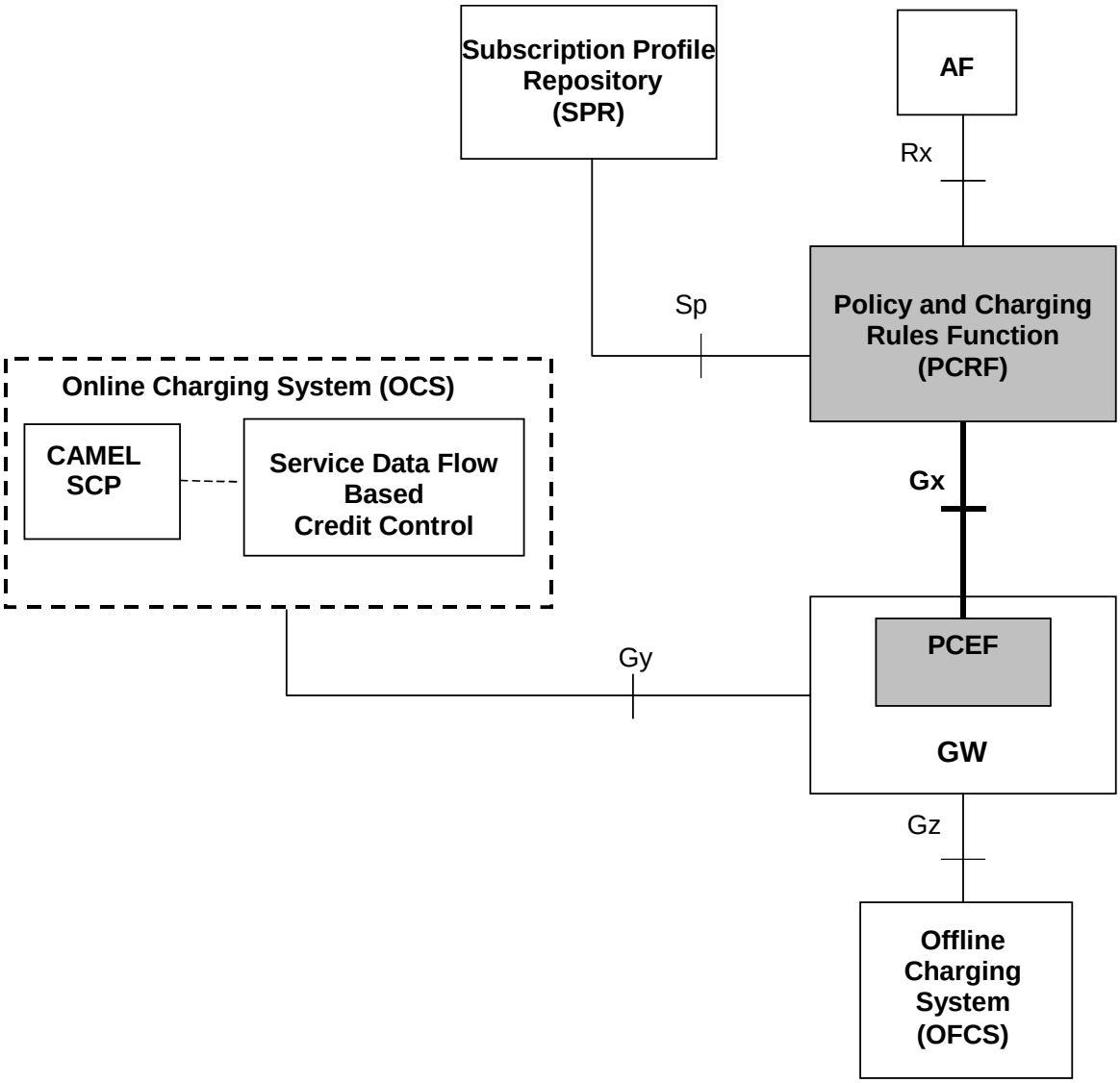

Figure 4.1: Gx reference point at the Policy and Charging Control (PCC) architecture

NOTE: The details associated with the Sp reference point are not specified in this Release. The SPR"s relation to existing subscriber databases is not specified in this Release.

4.3 PCC Rules

4.3.1 PCC Rule Definition

The purpose of the PCC rule is to:

- Detect a packet belonging to a service data flow.
  - The service data flow filters within the PCC rule are used for the selection of downlink IP CAN bearers.
  - The service data flow filters within the PCC rule are used for the enforcement that uplink IP flows are transported in the correct IP CAN bearer.

- Identify the service the service data flow contributes to.
- Provide applicable charging parameters for a service data flow.
- Provide policy control for a service data flow.

The PCEF shall select a PCC rule for each received packet by evaluating received packets against service data flow filters of PCC rules in the order of the precedence of the PCC rules. When a packet matches a service data flow filter, the packet matching process for that packet is completed, and the PCC rule for that filter shall be applied.

There are two different types of PCC rules as defined in [7]:

- Dynamic PCC rules. Dynamically provisioned by the PCRF to the PCEF via the Gx interface. These PCC rules may be either predefined or dynamically generated in the PCRF. Dynamic PCC rules can be installed, modified and removed at any time.
- Predefined PCC rules. Preconfigured in the PCEF. Predefined PCC rules can be activated or deactivated by the PCRF at any time. Predefined PCC rules within the PCEF may be grouped allowing the PCRF to dynamically activate a set of PCC rules over the Gx reference point.

NOTE: The operator may define a predefined PCC rule, to be activated by the PCEF. Such a predefined rule is not explicitly known in the PCRF.

A PCC rule consists of:

- a rule name;
- service identifier;
- service data flow filter(s);
- precedence;
- gate status;
- QoS parameters;
- charging key (i.e. rating group);
- other charging parameters.

The rule name shall be used to reference a PCC rule in the communication between the PCEF and the PCRF.

The service identifier shall be used to identify the service or the service component the service data flow relates to.

The service flow filter(s) shall be used to select the traffic for which the rule applies. It shall be possible to define wildcarded service data flow filter(s), both for the dynamic and predefined PCC rules.

The gate status indicates whether the service data flow, detected by the service data flow filter(s), may pass (gate is open) or shall be discarded (gate is closed) in uplink and/or in downlink direction.

The QoS information includes the QoS class identifier (authorized QoS class for the service data flow) and authorized bitrates for uplink and downlink.

The charging parameters define whether online and offline charging interfaces are used, what is to be metered in offline charging, on what level the PCEF shall report the usage related to the rule, etc.

For different PCC rules with overlapping service data flow filter, the precedence of the rule determines which of these rules is applicable. When a dynamic PCC rule and a predefined PCC rule have the same precedence, the dynamic PCC rule takes precedence.

PCC rule also includes Application Function record information for enabling charging correlation between the application and bearer layer if the AF has provided this information via the Rx interface. For IMS this includes the IMS Charging Identifier (ICID) and flow identifiers.

4.3.2 Operations on PCC Rules

For dynamic PCC rules, the following operations are available:

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

For predefined PCC rules, the following operations are available:

- Activation: to allow the PCC rule being active.
- Deactivation: to disallow the PCC rule.

The procedures to perform these operations are further described in clause 4.5.2.

4.4 Functional elements

4.4.1 PCRF

The PCRF (Policy Control and Charging Rules Function) is a functional element that encompasses policy control decision and flow based charging control functionalities. These 2 functionalities are the heritage of the release 6 logical entities PDF and CRF respectively. The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF. The PCRF receives session and media related information from the AF and informs AF of traffic plane events.

The PCRF shall provision PCC Rules to the PCEF via the Gx reference point.

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

- Information obtained from the AF via the Rx reference point, e.g. the session, media and subscriber related information.
- Information obtained from the PCEF via the Gx reference point, e.g. IP-CAN bearer attributes, request type and subscriber related information.
- Information obtained from the SPR via the Sp reference point, e.g. subscriber and service related data.

NOTE: The details associated with the Sp reference point are not specified in this Release. The SPR"s relation to existing subscriber databases is not specified in this Release.

- Own PCRF pre-configured information.

If the information from the PCEF contains traffic mapping information not matching any service data flow filter known to the PCRF, and the PCRF allows the UE to request enhanced QoS for services not known to the PCRF, the PCRF shall add this traffic mapping information as service data flow filters to the corresponding authorized PCC Rule. The PCRF may wildcard missing filter parameters, e.g. missing uplink TFT address and port information in case of GPRS.

The PCRF shall report events to the AF via the Rx reference point.

The PCRF shall inform the PCEF through the use of PCC rules on the treatment of each service data flow that is under PCC control, in accordance with the PCRF policy decision(s). For GPRS it shall be possible to support policy control, i.e. access control and QoS control, on a per PDP context basis for the UE initiated case.

The PCRF shall be able to select the bearer control mode that will apply for the IP-CAN session and provide it to the PCEF via the Gx reference point.

Upon subscription to loss of AF signalling bearer notifications by the AF, the PCRF shall request the PCEF to notify the PCRF of the loss of resources associated to the PCC Rules corresponding with AF Signalling IP Flows, if this has not been requested previously.

4.4.2 PCEF

The PCEF (Policy and Charging Enforcement Function) is the functional element that encompasses policy enforcement and flow based charging functionalities. These 2 functionalities are the heritage of the release 6 logical entities PEP and TPF respectively. This functional entity is located at the Gateway (e.g. GGSN in the GPRS case, and PDG in the WLAN case). It provides control over the user plane traffic handling at the Gateway and its QoS, and provides service data flow detection and counting as well as online and offline charging interactions.

For a service data flow that is under policy control the PCEF shall allow the service data flow to pass through the Gateway if and only if the corresponding gate is open.

For a service data flow that is under charging control the PCEF shall allow the service data flow to pass through the Gateway if and only if there is a corresponding active PCC rule and, for online charging, the OCS has authorized the applicable credit with that Charging key. The PCEF may let a service data flow pass through the Gateway during the course of the credit re-authorization procedure.

If requested by the PCRF, the PCEF shall report to the PCRF when the status of the related service data flow changes. This procedure can be used to monitor an IP-CAN bearer dedicated for AF signalling traffic.

4.5 PCC procedures over Gx reference point

4.5.1 Request for PCC rules

The PCEF shall indicate, via the Gx reference point, a request for PCC rules in the following instances.

1) At IP-CAN session establishment:

   - The PCEF shall send a CC-Request with CC-Request-Type AVP set to the value "INITIAL_REQUEST". The PCEF shall supply user identification and other attributes to allow the PCRF to identify the rules to be applied. The other attributes shall include the type of IP-CAN, the type of the radio access technology (e.g. UTRAN, GERAN, WLAN), the UE IPv4 address or IPv6 prefix. The PCEF may also include the Access-Network-Charging-Address and Access-Network-Charging-Identifier-Gx AVPs in the CC-Request. For GPRS, information about the user equipment (e.g. IMEISV), QoS negotiated and further QoS related information as detailed in Clause 4.5.5.0a, user location information (e.g. RAI, CGI/SAI) SGSN Address, SGSN country and network codes, APN and indication if the bearer is used as IMS signalling PDP context shall be provided. Furthermore, if the UE and the network support the network network-initiated bearer request procedure, the PCEF shall indicate this by supplying the Network Request Support AVP. If the UE indicated a preferred bearer control mode, the PCEF shall indicate this mode within the Bearer-Control Mode AVP.

NOTE: 3GPP TS 29.060 [18] appears to define the RAT type as optional over Gn/Gp interface. In fact the optionality is introduced solely for maintaining backwards compatibility at the protocol level between different versions of the protocol. It is mandatory for the RAT Type IE to be sent from the SGSN to the GGSN, as this is only for compatibility and it is also mandatory to be sent by the SGSN to the GGSN for Flow Based Charging as defined in 3GPP TS 23.060 [17]. For these reasons RAT Type is also mandatory to be included in the initial CC-Request as described above.

   For IP-CAN types that support multiple IP-CAN bearers (as in the case of GPRS), the PCEF shall provide the Bearer-Identifier AVP at the IP-CAN session establishment. In this case, the PCEF shall also include the Bearer-Operation AVP set to the value "Establishment".

2) At IP-CAN session modification:

   IP-CAN session modification with PCEF-requested rules can occur in the following cases:

   - For GPRS, when a new PDP Context is being established by the UE in an already existing IP-CAN Session.

   - For GPRS, when a PDP context is being modified and an Event trigger is met.

   - For GPRS, when a PDP context is being terminated.

The PCEF shall send a CC-Request with CC-Request-Type AVP set to the value "UPDATE_REQUEST". The PCEF may include the Access-Network-Charging-Address and Access-Network-Charging-Identifier-Gx AVPs in the CC-Request. For an IP-CAN Session modification where an existing IP-CAN Bearer is modified, the PCEF shall supply within the PCC rule request the specific event which caused the IP-CAN session modification (within the Event-Trigger AVP) and any previously provisioned PCC rule(s) affected by the IP-CAN session modification. The PCC rules and their status shall be supplied to PCRF within the Charging-Rule-Report AVP.

In the case the PCRF performs the bearer binding and:

- a new IP-CAN bearer is being established, the PCEF shall assign a new bearer identifier to this IP-CAN bearer, include this identifier within the Bearer-Identifier AVP, and include the Bearer-Operation AVP set to the value "Establishment", and supply QoS related information as detailed in Clause 4.5.5.0a;

- an existing IP-CAN bearer is being modified, the PCEF shall include the Bearer-Identifier AVP and the Bearer-Operation AVP set to the value "Modification", and supply QoS related information as detailed in Clause 4.5.5.0a. If the Event trigger that caused the IP-CAN bearer modification applies at session level (i.e. it is common to all the bearers belonging to that IP-CAN session), PCEF shall send a single CC-Request for all the affected bearers. In this case, the Bearer-Identifier AVP shall not be included to indicate that it applies to all the IP-CAN bearers in the IP-CAN session.

In the case both the PCRF and the PCEF may performs the bearer binding:
For GPRS, this applies for the mixed UE/network bearer control mode:

- If the UE request the establishment of a new IP-CAN bearer, the PCEF shall assign a new bearer identifier to this IP-CAN bearer, include this identifier within the Bearer-Identifier AVP, and include the Bearer-Operation AVP set to the value "Establishment", the UE-provided TFT filters and the requested QoS of the new IP-CAN bearer and further QoS related information as detailed in Clause 4.5.5.0a.

- If an existing IP-CAN bearer is being modified:

  - If the PCEF has not yet notified the PCRF about this IP CAN bearer and the UE assigns one or more Traffic Flow template(s) within an IP CAN Bearer modification request, the PCEF shall assign a new bearer identifier to this IP-CAN bearer, and shall include the Bearer-Identifier AVP and the Bearer-Operation AVP set to the value "Establishment", the UE-provided TFT filters and the requested QoS of the new IP-CAN bearer and further QoS related information as detailed in Clause 4.5.5.0a. The PCEF shall modify the received requested QoS by removing the bandwidth required for PCC rules the PCEF has previously bound to this IP CAN bearer and indicate this modified requested QoS to the PCRF.

NOTE: The details how the bandwidth required for PCC rules the PCEF has previously bound to this IP CAN bearer are calculated are ffs, e.g. the significance of the maximum and guaranteed bandwidth per PCC rule in this calculation.

  - If the PCEF has already notified the PCRF about this IP CAN bearer, the PCEF shall include the Bearer-Identifier AVP and the Bearer-Operation AVP set to the value "Modification" and QoS related information as detailed in Clause 4.5.5.0a. If the PCEF has received a new requested QoS as part of an IP CAN bearer modification request, the PCEF shall modify this received requested QoS by removing the bandwidth required for PCC rules the PCEF has previously bound to this IP CAN bearer and indicate this modified requested QoS to the PCRF.

NOTE: The details how the bandwidth required for PCC rules the PCEF has previously bound to this IP CAN bearer are calculated are ffs, e.g. the significance of the maximum and guaranteed bandwidth per PCC rule in this calculation.

If the Event trigger that caused the IP-CAN bearer modification applies at session level (i.e. it is common to all the bearers belonging to that IP-CAN session), PCEF shall send a single CC-Request for all the affected bearers. In this case, the Bearer-Identifier AVP shall not be included to indicate that it applies to all the IP-CAN bearers in the IP-CAN session. If the Event trigger that caused the IP CAN bearer modification applies at bearer level, the Charging-Rule-Report AVP shall include all the affected PCC rules.

PCC rules can also be requested as a consequence of a failure in the PCC rule installation/activation or enforcement without requiring an Event-Trigger. See clause 4.5.11.

If the PCRF is, due to incomplete, erroneous or missing information (e.g. QoS, SGSN address, RAT type, TFT, subscriber information) not able to provision a policy decision as response to the request for PCC rules by the PCEF, the PCRF may reject the request using a CC Answer with the Gx experimental result code DIAMETER_ERROR_INITIAL_PARAMETERS (5140). If the PCEF receives a CC Answer with this code, the PCEF shall reject the IP-CAN session establishment or modification that initiated the CC Request.

If the PCRF does not accept one or more of the traffic mapping filters (e.g. TFT filters for GPRS) provided by the PCEF in a CC Request (e.g. because the PCRF does not allow the UE to request enhanced QoS for services not known to the PCRF), the PCRF shall reject the request using a CC Answer with the Gx experimental result code DIAMETER_ERROR_TRAFFIC_MAPPING_INFO_REJECTED (5144). If the PCEF receives a CC Answer with this code, the PCEF shall reject the IP-CAN session establishment or modification that initiated the CC Request, e.g. for GPRS applying a proper cause code and other parameters as per 3GPP TS 29.060 [18]).

4.5.2 Provisioning of PCC rules

The PCRF shall indicate, via the Gx reference point, PCC rules to be applied at the PCEF. This may be using one of the following procedures:

- PULL procedure (Provisioning solicited by the PCEF): In response to a request for PCC rules being made by the PCEF, as described in the preceding section, the PCRF shall provision PCC rules in the CC-Answer; or

- PUSH procedure (Unsolicited provisioning): The PCRF may decide to provision PCC rules without obtaining a request from the PCEF, e.g. in response to information provided to the PCRF via the Rx reference point, or in response to an internal trigger within the PCRF. To provision PCC rules without a request from the PCEF, the PCRF shall include these PCC rules in an RA-Request message. No CCR/CCA messages are triggered by this RA-Request.

For each request from the PCEF or upon the unsolicited provision the PCRF shall provision zero or more PCC rules. The PCRF may perform an operation on a single PCC rule by one of the following means:

- To activate or deactivate a PCC rule that is predefined at the PCEF, the PCRF shall provision a reference to this PCC rule within a Charging-Rule-Name AVP and indicate the required action by choosing either the Charging-Rule-Install AVP or the Charging-Rule-Remove AVP.

- To install or modify a PCRF-provisioned PCC rule, the PCRF shall provision a corresponding Charging-Rule-Definition AVP within a Charging-Rule-Install AVP.

- To remove a PCC rule which has previously been provisioned by .the PCRF, the PCRF shall provision the name of this rule as value of a Charging-Rule-Name AVP within a Charging-Rule-Remove AVP.

- If the PCRF performs the bearer binding, the PCRF may move previously installed or activated PCC rules from one IP CAN bearer to another IP CAN bearer, as described further down.

As an alternative to providing a single PCC rule, the PCRF may provide a Charging-Rule-Base-Name AVP within a Charging-Rule-Install AVP or the Charging-Rule-Remove AVP as a reference to a group of PCC rules predefined at the PCEF. With a Charging-Rule-Install AVP, a predefined group of PCC rules is activated or moved. With a Charging-Rule-Remove AVP, a predefined group of PCC rules is deactivated.

The PCRF may combine multiple of the above PCC rule operations in a single command.

To activate a predefined PCC rule at the PCEF, the rule name within a Charging-Rule-Name AVP shall be supplied within a Charging-Rule-Install AVP as a reference to the predefined rule. To activate a group of predefined PCC rules within the PCEF (e.g. gold users or gaming services) the PCC rule base name within a Charging-Rule-Base-Name AVP shall be supplied within a Charging-Rule-Install AVP as a reference to the group of predefined PCC rules. If the PCRF performs the bearer binding, the PCRF shall indicate the IP CAN bearer where the PCC rules shall be activated using a Bearer-Identifier AVP within the Charging-Rule-Install AVP.

To install a new or modify an already installed PCRF defined PCC rule, the Charging-Rule-Definition AVP shall be used. If a PCC rule with the same rule name, as supplied in the Charging-Rule-Name AVP within the Charging-Rule-Definition AVP, already exists at the PCEF, the new PCC rule shall update the currently installed rule. If the existing PCC rule already has attributes also included in the new PCC rule definition, the existing attributes shall be overwritten. Any attribute in the existing PCC rule not included in the new PCC rule definition shall remain valid.

If the PCRF performs the bearer binding (for GPRS for "UE only" or mixed "UE/network" bearer control mode) and installs or activates a new PCC rule, the PCRF shall indicate the IP CAN bearer where the new rule shall be installed using a Bearer-Identifier AVP within the Charging-Rule-Install AVP. If the PCRF modifies an already installed PCC rule, the PCRF does not need to indicate the bearer. If the PCEF obtains an updated definition of a PCC rule within a Charging-Rule-Install AVP without a Bearer-Identifier AVP, the PCEF shall continue to apply the PCC rule to the IP CAN bearer that has previously been indicated.

If the PCRF does not perform the bearer binding and installs or activates a new PCC rule, the PCRF does not indicate the bearer within the Charging-Rule-Install AVP. The PCEF shall then perform the bearer binding and select the IP CAN bearer where the provisioned new PCC rule is applied.

If the PCRF performs the bearer binding, the PCRF may move previously installed or activated PCC rule(s) from one IP CAN bearer to another IP CAN bearer. To move such PCC rule(s), the PCRF shall indicate the new bearer using the Bearer-Identifier AVP within a Charging-Rule-Install AVP and shall indicate the charging rules(s) to be moved using Charging-Rule name AVP(s), and/or a Charging-Rule-Base-Name AVP(s), and/or Charging-Rule-Definition AVP(s) (for PCC rule(s) that are modified at the same time). The PCEF shall then apply these PCC rules at the new indicated IP CAN bearer and shall remove them from the IP CAN bearer where the rules previously had been applied.

Further details of the binding mechanism can be found in 3GPP TS 29.213 [8].

For deactivating single predefined or removing PCRF-provided PCC rules, the Charging-Rule-Name AVP shall be supplied within a Charging-Rule-Remove AVP. For deactivating a group of predefined PCC rules, the Charging-Rule-Base-Name AVP shall be supplied within a Charging-Rule-Remove AVP.

NOTE: When deactivating a predefined PCC rule that is activated in more than one IP-CAN bearers, the predefined PCC rule is deactivated simultaneously in all the IP-CAN bearers where it was previously activated.

If the provisioning of PCC rules fails, the PCEF informs the PCRF as described in Clause 4.5.11 PCC Rule Error Handling. If network initiated procedures apply for the PCC rule and the corresponding IP-CAN bearer can not be established or modified to satisfy the bearer binding, then the PCEF shall reject the activation of a PCC rule using the Gx experimental result code DIAMETER_PCC_BEARER_EVENT and a proper Rule Failure Code. Depending on the cause, PCRF can decide if re-installation, modification, removal of PCC rules or any other action apply.

If the PCRF is unable to create a PCC rule for the response to the CC Request by the PCEF, the PCRF may reject the request as described in subclause 4.5.1.

If the PCRF receives a request for PCC rules for an IP CAN session from the PCEF while no suitable authorized PCC rules are configured in the PCRF or can be derived from service information provisioned by an AF, the PCRF shall check the set of services the user is allowed to access.

If the user is not allowed to access AF session based services, the PCRF shall check whether the user is allowed to request resources for services not known to the PCRF and whether the requested QoS can be authorized. If this is the case, the PCRF shall provide a PCC rule to authorize the UE requested QoS and TFT that were received as part of the request for PCC rules. The service data flow description shall be derived from the TFT. The bitrate parameters and the QCI may be downgraded according to PCC internal policies. If the user is not allowed to request resources for services not known to the PCRF, the PCRF shall reject the request.

If the user is allowed to access AF session based services, the PCRF may, depending e.g. on the user"s subscription details or operator policy, authorise the requested QoS for a timer supervised grace period to wait for AF service information. If an AF session bound to the same IP CAN session is ongoing and only preliminary service information was received within this AF session, the PCRF shall base the authorization of the requested QoS on the preliminary service information.

NOTE: This scenario may for instance be encountered for a UE terminated IMS session establishment or modification with UE initiated resource reservation, refer to 3GPP TS 29.214 [10]. If the PCRF does not authorize a request for PCC rules in this scenario, the IMS session setup may fail.

NOTE: During the grace period, the QoS requested by the UE needs to be authorized even if the user is not allowed to request for resources for services not known to the PCRF or if the requested QCI is not allowed for services not known to the PCRF as it is not clear at this point in time whether the UE resource request belongs to an AF session or to a service not known to the PCRF.

If the preliminary service information is insufficient to construct appropriate PCC rules or no preliminary service information is available, the PCRF shall provide preliminary PCC rules to authorize the UE requested QoS and TFT. Therefore, the preliminary PCC rules shall contain wildcarded flow description or flow description derived from possible TFTs received as part of the request for PCC rules. The PCRF may apply a dedicated charging key value to indicate to the charging subsystem that the charging key is preliminary and may be corrected later on.

NOTE: With the dedicated charging key, the PCRF instructs the charging subsystem to recalculate the applicable charge for the time when the dedicated charging key value was applied once the dedicated charging key value is replaced with some other value in a new provisioning of PCC rules. For example, if online charging applies, Session Charging with Unit Reservation (SCUR) can be used .When the charging key changes, the PCEF will return initially reserved credit units and the OCS then can recalculate the consumed credit units applying the rate derived from the new other charging key value and update the users credit accordingly.

NOTE: A preliminary PCC rule is a normal PCC rule containing preliminary information.

If the PCRF receives AF service information while the timer-supervised grace period is running, the PCRF shall stop the timer and may derive authorized PCC rules from this service information and update or replace the preliminary PCC rules that were previously provided for the UE requested QoS and TFT, for instance by choosing service specific QoS parameters and charging keys.

NOTE: The dedicated preliminary charging key value that was previously provided by the PCRF instructs the charging subsystem to recalculate the applicable charge when the new service specific charging key is provided. The recalculation covers the time when the previous dedicated charging key value was active. The new service specific charging key is applied from that time onwards.

If the timer expires and the PCRF has not received any AF service information, the PCRF should apply the policy for services not known to the PCRF and may downgrade or revoke the authorization for the preliminary PCC rules (previously provided for the UE requested QoS and TFT) in accordance with the policy for services not known to the PCRF. The PCRF should adjust the charging keys within the PCC rules and should downgrade the authorized QoS to the allowed value for the services not known to the PCRF, if required. The PCRF should also adjust or revoke the authorization for a corresponding dedicated IP CAN bearer.

4.5.2.1 Selecting a PCC rule for Uplink IP packets

If PCC is enabled, the PCEF shall select the applicable PCC rule for each received uplink IP packet within an IP CAN bearer (for GPRS, PDP context) by evaluating the packet against uplink service data flow filters of PCRF-provided or predefined active PCC rules of this IP CAN bearer in the order of the precedence of the PCC rules. When a PCRF-provided PCC rule and a predefined PCC rule have the same precedence, the uplink service data flow filters of the PCRF-provided PCC rule shall be applied first. When a packet matches a service data flow filter, the packet matching process for that packet is completed, and the PCC rule for that filter shall be applied. Uplink IP packets which do not match any PCC rule of the corresponding IP CAN bearer shall be silently discarded.

4.5.2.2 Selecting a PCC rule and IP CAN Bearer for Downlink IP packets

If PCC is enabled, the PCEF shall select a PCC rule for each received downlink IP packet within an IP CAN session by evaluating the packet against downlink service data flow filters of PCRF-provided or predefined active PCC rules of all IP CAN bearers of the IP CAN session in the order of the precedence of the PCC rules. When a PCRF-provided PCC rule and a predefined PCC rule have the same precedence, the downlink service data flow filters of the PCRF-provided PCC rule shall be applied first. When a packet matches a service data flow filter, the packet matching process for that packet is completed, and the PCC rule for that filter shall be applied. The Downlink IP Packet shall be transported within the IP CAN bearer where the selected PCC rule is mapped. Downlink IP packets which do not match any PCC rule of the IP CAN session shall be silently discarded.

For GPRS, TFT filters shall not be applied to assign downlink IP packets to PDP contexts if PCC is enabled for an APN.

4.5.2.3 Gate function

The Gate Function represents a user plane function enabling or disabling the forwarding of service flow packets. A gate is described within a PCC rule. If the PCC rule contains Flow-Description AVP(s) or Flow-Information AVP(s) applicable for uplink IP flows, it shall describe a gate for the corresponding uplink IP flows. If the PCC rule contains

Flow-Description or Flow-Information AVP(s) applicable for downlink IP flows, it shall describe a gate for the corresponding downlink IP flows. The Flow Status AVP of the PCC rule shall describe if the possible uplink and possible downlink gate is opened or closed.

The commands to open or close the gate shall lead to the enabling or disabling of the passage for corresponding IP packets. If the gate is closed all packets of the related IP flows shall be dropped. If the gate is opened the packets of the related IP flows are allowed to be forwarded.

4.5.2.4 Policy enforcement for "Authorized QoS" per PCC Rule

The PCRF can provide the authorized QoS for a PCC rule to the PCEF. The Provisioning of authorized QoS per PCC Rule shall be performed using the PCC rule provisioning procedure. For a PCRF-provided PCC rule, the "Authorized QoS" shall be encoded using a QoS-Information AVP within the Charging-Rule-Definition AVP of the PCC rule. If "Authorized QoS" is provided for a PCC rule, the PCEF shall enforce the corresponding policy.

See also Clause 4.5.5.

4.5.3 Provisioning of Event Triggers

The PCRF may provide one or several event triggers within one or several Event-Trigger AVP to the PCEF using the PCC rule provision procedure. Event triggers may be used to determine which IP-CAN session modification or specific event causes the PCEF to re-request PCC rules. Although event trigger reporting from PCEF to PCRF can apply for an IP CAN session or bearer depending on the particular event, provisioning of event triggers will be done at session level. The Event-Trigger AVP may be provided in combination with the initial or subsequent PCC rule provisioning.

The PCRF may add new event triggers or remove the already provided ones at each request from the PCEF or upon the unsolicited provision from the PCRF. In order to do so, the PCRF shall provide the new complete list of applicable event triggers including the needed provisioned Event-Trigger AVPs in the CCA or RAR commands.

The PCRF may remove all previously provided event triggers by providing the Event-Trigger AVP set to the value NO_EVENT_TRIGGERS. 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, the PCEF shall not inform PCRF of any event.

If no Event-Trigger AVP is included in a CCA or RAR operation, any previously provisioned event trigger will be still applicable.

4.5.4 Provisioning of charging related information for the IP-CAN session

4.5.4.1 Provisioning of Charging Addresses

In combination with the initial PCC rule provisioning only, the PCRF may provide OFCS and/or OCS addresses within a Charging-Information AVP to the PCEF defining the offline and online charging system addresses respectively. These shall overwrite any predefined addresses at the PCEF. Both primary and secondary addresses for OFCS and/or OCS shall be provided simultaneously. Provisioning OFCS or OCS addresses without PCC rules for offline or online charged service data flows, respectively, shall not be considered as an error since such PCC rules may be provided in later provisioning.

4.5.4.2 Provisioning of Default Charging Method

The default charging method indicates what charging method shall be used for every PCC rule where the charging method is omitted. The PCEF may have a pre-configured Default charging method.

Upon the initial interaction with the PCRF, the PCEF shall provide the pre-configured Default charging method if available within the Online AVP and/or Offline AVP embedded directly within the CCR command to the PCRF.

Upon the initial interaction with the PCEF, the PCRF may provide default charging method within the Online AVP or Offline AVP embedded directly within the CCA command to the PCEF. The default charging method provided by the PCRF shall overwrite any predefined default charging method at the PCEF.

4.5.5 Provisioning and Policy Enforcement of Authorized QoS

4.5.5.0 Overview

The PCRF may provide authorized QoS to the PCEF.

The authorized QoS shall be provisioned within a CCA or RAR Diameter message as QoS-Information AVP. The provisioning of the authorized QoS (which is composed of QCI and bitrates) is performed from the PCRF to the PCEF. The authorized QoS can refer to a PCC rule, to an IP CAN bearer or to QCI.

- When the authorized QoS applies to an IP CAN bearer, it shall be provisioned outside a Charging-Rule-Definition AVP and it shall also include the Bearer-Identifier AVP to indicate what bearer it applies to.

- When the authorized QoS applies to a PCC rule, it shall be provisioned within the corresponding PCC rule by including the QoS-Information AVP within the Charging-Rule-Definition AVP. The QoS-Information AVP shall not contain a Bearer-Identifier AVP.

- When the authorized QoS applies to QCI, authorised MBR per QCI is supplied. In such a case the authorized QoS shall be provisioned outside a Charging-Rule-Definition AVP at the command level.

The authorized QoS provides appropriate values for the resources to be enforced.

If the PCEF performs the bearer binding, the authorized QoS for a PCC rule is a request for allocating the corresponding resources, and the authorized QoS for a QCI is a request for an upper limit for the MBR that the PCEF assigns to non-GBR bearers with that QCI. The authorized QoS per IP CAN bearer is not applicable.

If the PCRF performs the bearer binding, the authorized QoS per IP CAN bearer presents the QoS for this IP CAN bearer. Authorized QoS per QCI is not applicable.

The Provisioning of authorized QoS per IP CAN bearer may be performed separate or in combination with the PCC rule provisioning procedure in Clause 4.5.2. The Provisioning of authorized QoS per PCC rule is a part of PCC rule provisioning procedure.

If the PCEF cannot allocate any of the resources as authorized by the PCRF, the PCEF should inform the PCRF as described in Clause 4.5.11 PCC Rule Error Handling.

The PCEF is responsible for enforcing the policy based authorization.

QoS authorization information may be dynamically provisioned by the PCRF or it can be a pre-defined PCC rule in the PCEF. In case the PCRF provides PCC rules dynamically, authorised QoS information for the IP-CAN bearer (combined QoS) may be provided. For a predefined PCC rule within the PCEF the authorized QoS information shall take affect when the PCC rule is activated.

The PCEF shall make sure that the total QoS information of the PCC rules for one IP-CAN bearer does not exceed the authorized QoS information, i.e. the information received from the PCRF.

If the PCRF is unable to make a decision for the response to the CC-Request by the PCEF, the PCRF may reject the request as described in subclause 4.5.1.

4.5.5.0a Provisioning of authorized QoS per IP CAN bearer

The authorized QoS per IP-CAN bearer is used if the bearer binding is performed by the PCRF (as defined in [8]).

The PCEF will request the authorization of an IP CAN bearer establishment or modification by the PCRF using the "Request for PCC rules" procedure if the related conditions outlined in Clause 4.5.1 apply. While executing this procedure, the PCEF shall apply the following QoS related procedures:

- When the UE request the establishment of a new IP-CAN bearer, the PCEF shall derive the requested QoS information and shall request a new PCC decisions using a CCR command including the requested QoS information within the QoS-Information AVP, in the CCR command to be sent to the PCRF.
  For GPRS, the PCEF shall use Table 5.3.17 to map the requested QoS within the IP CAN bearer establishment request to the QoS-Information AVP. If the GGSN receives the 'upgrade QoS Supported' flag set to '1' in the Common Flag Information element within the corresponding Create PDP context request (3GPP TS 29.060[18]), the GGSN shall supply the QoS-Upgrade AVP with value QoS_UPGRADE_SUPPORTED.

The PCEF shall then wait for the corresponding CCA before replying to the IP-CAN bearer establishment request.

- If at any point of time the PCEF receives a request for a modification of an already existing IP-CAN bearer that matches event triggers supplied by the PCRF for the IP CAN session, the PCEF shall also request a new PCC decisions using a CCR command including the corresponding event triggers in the Event-Trigger AVP. If a QoS change for the existing IP-CAN bearer is requested the PCEF shall include the requested QoS information within the QoS-Information AVP in the CCR.
  For GPRS, the PCEF shall use Table 5.3.17 to map the requested QoS within the IP CAN bearer modification request to the QoS-Information AVP. If the GGSN receives within the corresponding Update PDP context request the 'upgrade QoS Supported' flag in the Common Flag Information element (3GPP TS 29.060[18]) set to a different value than previously communicated to the PCRF, the GGSN shall supply the QoS-Upgrade AVP indicating the new value. If the GGSN receives within the Update PDP context request the 'No QoS negotiation' flag set to '1' in the Common Flag Information element (3GPP TS 29.060[18]), the GGSN shall supply the QoS-Negotiation AVP with the value NO_QoS_NEGOTIATION.
  The PCEF shall wait for the corresponding CCA before replying to the IP-CAN bearer modification request.

When receiving a CCR with a QoS-Information AVP, the PCRF shall decide upon the requested QoS information within the CCR command.

- For GPRS, the following restrictions apply to the PCRF QoS authorization process defined in this clause:

  - If the QoS-Negotiation AVP is received by the PCRF indicating that QoS negotiation is not allowed, the PCRF shall provision the requested QoS as authorized QoS.

  - If the QoS-Upgrade AVP has been received by the PCRF indicating that QoS upgrade is not supported, the PCRF shall not provision an authorized QoS that is higher than the requested QoS.

- The PCRF may compare the authorized QoS derived according to Clause 6.3 of 3GPP TS 29.213 with the requested QoS. If the requested QoS is less than the authorised QoS, the PCRF may either request to upgrade the IP CAN QoS by supplying that authorised QoS in the QoS-Information AVP to the PCEF (e.g. if the PCRF has exact knowledge of the required QoS for the corresponding service), or the PCRF may only authorise the requested QoS by supplying the requested QoS in the QoS-Information AVP to the PCEF (e.g. if the PCRF only derives upper limits for the authorized QoS for the corresponding service). If the requested QoS is higher than the authorised QoS, the PCRF shall downgrade the IP CAN QoS by supplying the authorised QoS in the QoS-Information AVP to the PCEF.

If for any reason the PCRF cannot authorize the requested QoS (e.g. authorized QoS would exceed the subscribed QoS), the PCRF shall indicate to the PCEF that the request is rejected by answering with a CCA command including the Experimental-Result-Code AVP set to the value DIAMETER_ERROR_BEARER_NOT_AUTHORIZED (5143) together with the bearer-identifier AVP. Otherwise, the PCRF shall provide a response for the CCR to the PCEF by issuing a CCA command without this experimental result code. The PCRF may use this CCA at the same time for the solicited PCC rule provisioning procedure in Clause 4.5.2. The CCA command shall include a QoS-Information AVP at command level including the Bearer-Identifier AVP used in the corresponding CCR and the authorized QCI and bitrates. If PCRF decides to move rules between bearers, the CCA command shall also include the QoS-Information AVP(s) for the impacted bearers.

The PCRF may also decide to modify the authorized QoS per IP CAN bearer if it receives a CCR with other event triggers, for instance if the PCRF moves PCC rules from one IP-CAN bearer to another (e.g. in GPRS due to a TFT change). The PCRF shall then provision the updated authorized QoS per IP CAN bearer in the CCA within a QoS-Information AVP at command level including the corresponding Bearer-Identifier AVP.

The PCRF may decide to modify the authorized QoS per IP CAN bearer at any time. However, if the QoS-Upgrade AVP has been received by the PCRF indicating that QoS upgrade is not supported, the PCRF shall not upgrade the authorized QoS. To modify the authorized QoS per IP CAN bearer, The PCRF shall send an unsolicited authorization to the PCEF. The unsolicited authorization shall be performed by sending a RAR command to the PCEF and including the QoS-Information AVP(s) with the new authorized values per IP CAN bearer. The PCRF may use this RAR at the same time for the unsolicited PCC rule provisioning procedure in Clause 4.5.2. If the trigger to modify the authorized QoS comes from the AF, before starting an unsolicited provisioning, the PCRF may start a timer to wait for a UE requested corresponding PDP context modification. At the expiry of the timer, if no PCC rule request has previously been received by the PCRF, the PCRF should go on with the unsolicited authorization as explained above.

In addition to a provisioning of the "Authorized QoS" per IP CAN Bearer, the PCRF may also provide an authorized QoS per PCC rule.

4.5.5.1 Policy enforcement for authorized QoS per IP CAN bearer

The PCEF is responsible for enforcing the policy based authorization, i.e. to ensure that the requested QoS is in-line with the "Authorized QoS" per IP CAN Bearer.

For GPRS, upon reception of an authorized QoS per IP-CAN bearer within a CCA or RAR command, the PCEF shall perform the mapping from that "Authorised QoS" information for the IP-CAN bearer into authorised UMTS QoS information according to Table 5.3.17.1. The authorised UMTS QoS information is further processed by the UMTS BS Manager within the GGSN.

If the PCEF receives a solicited authorization decision from the PCRF (i.e. a decision within a CCA) and the requested QoS received within the IP-CAN bearer establishment or modification request that triggered the corresponding request for the authorization decision does not match the authorised QoS, the PCEF shall adjust the requested QoS information to the authorised QoS information within the IP-CAN bearer establishment or modification response.

The PCEF may store the authorized QoS of an active IP-CAN bearer in order to be able to make local decisions, when the UE requests for an IP-CAN bearer modification.

When the PCEF receives an unsolicited authorisation decision from the PCRF (i.e. a decision within a RAR) with updated QoS information for an IP-CAN bearer, the PCEF shall update the stored authorised QoS. If the existing QoS of the IP-CAN bearer does not match the updated authorised QoS the PCEF shall perform a network initiated IP-CAN bearer modification to adjust the QoS to the authorised level.

If the PCEF provide authorized QoS for both, the IP-CAN bearer and PCC rule(s), the enforcement of authorized QoS of the individual PCC rules shall take place first.

4.5.5.2 Policy provisioning for authorized QoS per service data flow

The Provisioning of authorized QoS per service data flow is a part of PCC rule provisioning procedure, as described in Clause 4.5.2.

If the PCRF performs the bearer binding for a service data flow, the PCRF may optionally provision an authorized QoS for that service data flow. If the PCEF performs the bearer binding for a service data flow, the PCRF shall provision an authorized QoS for that service data flow.

The authorized QoS per service data flow shall be provisioned within the corresponding PCC rule by including the QoS-Information AVP within the Charging-Rule-Definition AVP in the CCA or RAR commands. This QoS-Information AVP shall not contain a Bearer-Identifier AVP.

4.5.5.3 Policy enforcement for authorized QoS per service data flow

If an authorized QoS is defined for a PCC rule, the PCEF shall limit the data rate of the service data flow corresponding to that PCC rule not to exceed the maximum authorized bandwidth for the PCC rule by discarding packets exceeding the limit.

If the PCEF performs the bearer binding, the PCEF shall reserve the resources necessary for the guaranteed bitrate for the PCC rule upon receipt of a PCC rule provisioning including QoS information. For GBR bearers the PCEF should set the bearer"s GBR to the sum of the GBRs of all PCC rules that are active/installed and bound to that GBR bearer. For GBR bearers the PCEF should set the bearer"s MBR to the sum of the MBRs of all PCC rules that are active/installed and bound to that GBR bearer. For non-GBR bearers the PCEF may also set the bearer"s MBR to the sum of the MBRs of all PCC rules that are active and bound to that non-GBR bearer unless that sum exceeds a possibly provisioned authorized QoS per QCI for the beareren´s QCI (see Clause 4.5.5.6). If an authorized QoS per QCI has been provisioned for the bearer´s QCI, the PCEF should set the bearer"s MBR to the corresponding MBR. The access-specific BS Manager (as included in [8]) within the PCEF receives the authorised access-specific QoS information from the Translation/mapping function. For GPRS, the mapping from the authorized QoS parameters to the UMTS QoS parameters shall be performed according to Table 5.3.17. Then the PCEF shall start the needed procedures to ensure that the provisioned resources are according to the authorized values. This may imply e.g. for GPRS that the PCEF needs to request the establishment of new IP CAN bearer(s) or the modification of existing IP CAN bearer(s). If the enforcement is not successful, the PCEF shall inform the PCRF as described in subclause 4.5.5.0.

Upon deactivation or removal of a PCC rule, the PCEF shall free the resources reserved for that PCC rule.

If the PCRF provides authorized QoS for both, the IP-CAN bearer and PCC rule(s), the enforcement of authorized QoS of the individual PCC rules shall take place first.

4.5.5.4 Coordination of authorized QoS scopes in mixed mode

For mixed mode the PCEF will request the authorization of an IP CAN bearer establishment or modification by the PCRF using the "Request for PCC rules" procedure if the related conditions outlined in Clause 4.5.1 apply. The PCEF shall then substract the guaranteed bitrate for the PCC rule it has bound to that IP CAN bearer from the requested QoS of that IP CAN bearer and request the authorization of the remaining QoS from the PCRF within the within the QoS-Information AVP.

The PCRF shall authorize the bandwidth for an IP CAN bearer which is required for the PCC rules it has bound to this IP CAN bearer. The PCEF shall add to the PCRF-provisioned authorized bandwidth of an IP CAN bearer the required bandwidth of all PCC rules it has bound to that IP CAN bearer unless the derived MBR value exceeds a possibly provisioned authorized QoS per QCI for the bearerer´s QCI (see Clause 4.5.5.6).

4.5.5.5 Provisioning of authorized QoS per QCI

If the PCEF performs the bearer binding, the PCRF may provision an authorized QoS per QCI for non-GBR bearer QCI values. If the PCRF performs the bearer binding the PCRF shall not provision an authorized QoS per QCI. The PCRF shall not provision an authorized QoS per QCI for GBR bearer QCI values.

The authorized QoS per QCI shall be provisioned at RAR or CCA command level using the QoS-Information AVP with the QoS-Class-Identifier AVP and the Maximum-Requested-Bandwidth-UL AVP and/or the Maximum-Requested-Bandwidth-DL AVP. The Guaranteed Bitrate values shall not be filled up. Multiple QoS-Information AVPs can be used for assigning authorized QoS for several QCIs with one command. The authorized QoS per QCI may be provisioned before or in connection with the activation of the first PCC rule with a certain QCI. The PCRF may also provision a changed authorized QoS per QCI at any time.

4.5.5.6 Policy enforcement for authorized QoS per QCI

The PCEF can receive an authorized QoS per QCI for non GBR-bearer QCI values. It sets an upper limit for the MBR that the PCEF may assign to a non-GBR bearer with that QCI. If the PCEF receives an authorized QoS per QCI for a non-GBR bearer QCI value, it shall not set a higher MBR for that bearer than the provisioned MBR. The PCEF should assign the authorized MBR per QCI to a non-GBR bearer with that QCI to avoid frequent IP-CAN bearer modifications as PCC rules can be dynamically activated and deactivated.

If multiple IP-CAN bearers within the same IP-CAN session are assigned the same QCI, the authorized MBR per QCI applies independently to each of those IP-CAN bearers.

The access-specific BS Manager (as included in [8]) within the PCEF receives the authorized access-specific QoS information from the Translation/mapping function. For GPRS, the mapping from the authorized QoS parameters to the UMTS QoS parameters shall be performed according to Table 5.3.17.

4.5.6 Indication of IP-CAN Bearer Termination Implications

If the last IP CAN bearer within an IP CAN session is being terminated, the PCEF shall apply the procedures in clause 4.5.7 to indicate the IP CAN session termination.

Otherwise, the PCEF shall apply the "Indication of IP CAN Bearer Termination Implications" procedure to inform the PCRF about implications of this bearer termination if any of the following conditions apply while the IP-CAN Session remains active:

- For GPRS, a PDP context is terminated, which has been initiated by the UE.
- PCC rule(s) are disabled due to the termination of the IP CAN bearer.

The "Indication of IP-CAN Bearer Termination Implications" procedure shall be carried out as part of a Request for PCC rules at IP-CAN session modification. The PCEF shall send a CC-Request with CC-Request-Type AVP set to the value "UPDATE_REQUEST" and shall include the following additional information:

- The PCEF shall include the Charging-Rule-Report AVP with the PCC-Rule-Status set to inactive for the affected PCC rules.

- For GPRS, when the PCRF performs bearer binding, the PCEF shall also supply the Bearer-Identifier and Bearer-Operation AVPs to indicate "Termination" of a specific bearer.

When the PCRF receives the CC-Request indicating the implications of a bearer termination, it shall acknowledge the message by sending a CC-Answer to the PCEF. The PCRF has the option to make a new PCC decision for the affected PCC Rules. Within the CC-Answer, the PCRF may provision PCC rules as detailed in clause 4.5.2, e.g. to move PCC rules previously applied to the terminated IP CAN bearer to any of the remaining IP CAN bearer(s).

The PCEF shall remove all PCC rules previously applied to the terminated IP CAN bearer, which have not been moved.

Signalling flows for the IP-CAN bearer termination and details of the binding mechanism are presented in 3GPP TS 29.213 [8].

4.5.7 Indication of IP-CAN Session Termination

The PCEF shall contact the PCRF when the IP-CAN session is being terminated (e.g. for GPRS when the last PDP Context within the IP-CAN session is being terminated). The PCEF shall send a CC-Request with CC-Request-Type AVP set to the value "TERMINATION_REQUEST".

When the PCRF receives the CC-Request, it shall acknowledge this message by sending a CC-Answer to the PCEF.

NOTE: According to DCC procedures, the Diameter Credit Control session is being terminated with this message exchange.

Signalling flows for the IP-CAN session termination are presented in 3GPP TS 29.213 [8].

4.5.8 Request of IP-CAN Bearer Termination

If the termination of the last IP CAN bearer within an IP CAN session is requested, the PCRF and PCEF shall apply the procedures in clause 4.5.9.

Otherwise, the PCRF may request the termination of an existing IP CAN bearer within an IP CAN session by using the PCC rule provisioning procedures in clause 4.5.2 to remove all PCRF-provisioned PCC rules and/or deactivate all PCC rules predefined within the PCEF, which have been applied to this IP CAN bearer. The PCRF may either completely remove these PCC rules from the IP CAN session or move them to another IP CAN bearer within the IP CAN session.

If the selected Bearer Control Mode (BCM) is UE-only, and the PCRF receives a trigger for the removal of all PCC rules bound to an IP CAN bearer from the AF, the following steps apply. In order to avoid race conditions, the PCRF should start a timer to wait for the UE-initiated termination message. If a UE-initiated termination of an IP CAN bearer is performed before timer expiry, the PCRF will receive an Indication of IP-CAN Bearer Termination Implications according to Clause 4.5.6 and shall then not perform the network-initiated termination of that IP CAN bearer. Otherwise, if the timer expires, the PCRF shall remove/deactivate all the PCC rules that have been previously installed/activated for that IP-CAN bearer.

If the selected BCM is UE-only, and the PCRF decides to remove all PCC rules bound to an IP CAN bearer due to an internal trigger or trigger from the SPR, the PCRF shall instantly remove/deactivate all the PCC rules that have been previously installed/activated on that IP-CAN bearer.

If the selected BCM is UE/NW, the PCEF performs the binding and the PCRF removes/deactivates at the PCEF, all PCC rules bound to an IP CAN bearer (due to any trigger), the PCEF shall instantly start the procedures to terminate the related IP-CAN bearer.

NOTE: If the PCEF performs the IP CAN bearer binding, the PCRF may not be aware that it requests the termination of an IP CAN bearer by removing certain PCC rules. Further details of the binding mechanism can be found in 3GPP TS 29.213 [8].

If no more PCC rules are applied to an IP CAN bearer, the PCEF shall apply IP CAN specific procedures to terminate the IP CAN bearer, if such procedures exist for this IP CAN type. For GPRS, the GGSN shall send a PDP context deactivation request. Furthermore, the PCEF shall apply the indication of IP CAN Bearer Termination procedure in clause 4.5.6.

4.5.9 Request of IP-CAN Session Termination

If the PCRF decides to terminate an IP CAN session due to an internal trigger or trigger from the SPR, the PCRF shall send an RAR command including the Session-Release-Cause AVP to the PCEF. The PCEF shall acknowledge the command by sending an RAA command to the PCRF and instantly remove/deactivate all the PCC rules that have been previously installed or activated on that IP-CAN session.

The PCEF shall apply IP CAN specific procedures to terminate the IP CAN session. For GPRS, the GGSN shall send a PDP context deactivation request with the teardown indicator set to indicate that the termination of the entire IP-CAN session is requested. Furthermore, the PCEF shall apply the indication of IP CAN Session Termination procedure in clause 4.5.7.

4.5.10 Bearer Control Mode Selection

The PCEF may indicate, via the Gx reference point, a request for Bearer Control Mode (BCM) selection at IP-CAN session establishment or IP-CAN session modification (as a consequence of an SGSN change). It will be done using the PCC rule request procedure.

The PCEF will supply, if available, the Network-Request-Support AVP in the CC-Request with a CC-Request-Type AVP set to the value 'INITIAL_REQUEST'. The Network-Request-Support AVP indicates the access network support of the network requested bearer control.

For GPRS, the GGSN shall only include the Network-Request-Support AVP if it supports this procedure and both the UE and the SGSN have previously indicated to the GGSN (refer to 3GPP TS 23.060 [17] and 29.060 [18]) that they also support it.

The PCRF derives the Selected Bearer-Control-Mode AVP based on the received Network-Request-Support AVP, the Bearer-Control-Mode AVP, access network information, subscriber information and operator policy. The Selected Bearer-Control-Mode AVP shall be provided to the PCEF using the PCC Rules provision procedure at IP-CAN session establishment. The PCEF should forward it to the UE. The selected value will be applicable for the whole IP-CAN session (in GPRS, it is applicable to all PDP Contexts within the activated PDP Address/APN pair).

The BCM selection procedure can also be triggered as a consequence of a change of SGSN.

NOTE: This scenario will likely happen when there is PLMN change that force a BCM change to UE-only due to the lack of support of network initiated procedures. There are several valid solutions such as enforcing the IP-CAN termination, or retaining the IP-CAN session with either all the bearers or only with the bearers with bearer binding related to UE-only procedures. A preferred solution is not specified in Rel-7 and is left as an implementation choice.

4.5.11 PCC Rule Error Handling

If the installation/activation of one or more PCC rules fails, the PCEF shall include one or more Charging-Rule-Report AVP(s) in either a CCR or an RAA command as described below for the affected PCC rules. Within each Charging-Rule-Report AVP, the PCEF shall identify the failed PCC rule(s) by including the Charging-Rule-Name AVP(s) or Charging-Rule-Base-Name AVP(s), shall identify the failed reason code by including a Rule-Failure-Code AVP, and shall include the PCC-Rule-Status AVP as described below:

- If the installation/activation of one or more PCC rules fails using a PUSH mode (i.e., the PCRF installs/activates a rule using RAR command), the PCEF shall communicate the failure to the PCRF in the RAA response to the RAR.

  If the PCRF performs the bearer binding, for predefined PCC rules that contain only uplink service data flow filters which are known to the PCRF, the PCEF may include the Bearer-Identifier AVP within the Charging-Rule-Report AVP to indicate the affected IP-CAN bearer from a failed PCC rule activation. If no Bearer-Identifier is provided then the PCRF shall assume that PCC rule failed to activate to all assigned IP-CAN bearers.

NOTE: In such a case the same PCC rule can be activated to multiple IP-CAN bearers of the same IP-CAN session.

- If the installation/activation of one or more PCC rules fails using a PULL mode (i.e., the PCRF installs/activates a rule using a CCA command) the PCEF shall send the PCRF a new CCR command and include the Rule-Failure-Code AVP.

If the installation/activation of one or more new PCC rules (i.e., rules which were not previously successfully installed) fails, the PCEF shall set the PCC-Rule-Status to INACTIVE for both the PUSH and the PULL modes.

If a PCC rule was successfully installed/activated, but can no longer be enforced by the PCEF, the PCEF shall send the PCRF a new CCR command and include a Charging-Rule-Report AVP. The PCEF shall include the Rule-Failure-Code AVP within the Charging-Rule-Report AVP and shall set the PCC-Rule-Status to INACTIVE.

NOTE: The status of the rule must be INACTIVE when reporting an error in a new CCR command since the new CCR/CCA transaction contains no previous state information regarding the definition and status of the rule.

4.5.12 Time of the day procedures

PCEF shall be able to perform PCC rule request as instructed by the PCRF. Revalidation-Time when set by the PCRF, shall cause the PCEF to trigger a PCRF interaction to request PCC rules from the PCRF for an established IP CAN session. The PCEF shall stop the timer once the PCEF triggers an REVALIDATION_TIMEOUT event.

PCRF shall be able to provide a new value for the revalidation timeout by including Revalidation-Time in CCA or RAR.

PCRF shall be able to stop the revalidation timer by disabling the REVALIDATION_TIMEOUT event trigger.

The PCRF may control at what time the status of a PCC rule changes.

1) If Rule-Activation-Time is specified only and has not yet occurred, then the PCEF shall set the PCC rule inactive and make it active at that time. If Rule-Activation-Time has passed, then the PCEF shall immediately set the PCC rule active.

2) If Rule-Deactivation-Time is specified only and has not yet occurred, then the PCEF shall set the PCC rule active and make it inactive at that time. If Rule-Deactivation-Time has passed, then the PCEF shall immediately set the PCC rule inactive.

3) If both Rule-Activation-Time and Rule-Deactivation-Time are specified, and the Rule-Activation-Time occurs before the Rule-Deactivation-Time, and also when the PCC rule is provided before or at the time specified in the Rule-Deactivation-Time the PCEF shall handle the rule as defined in 1) and then as defined in 2).

4) If both Rule-Activation-Time and Rule-Deactivation-Time are specified, and the Rule-Deactivation-Time occurs before the Rule-Activation-Time, and also when the PCC rule is provided before or at the time specified in the Rule-Activation-Time, the PCEF shall handle the rule as defined in 2) and then as defined in 1).

5) If both Rule-Activation-Time and Rule-Deactivation-Time are specified but time has passed for both, and the Rule-Activation-Time occurs before the Rule-Deactivation-Time, then the PCEF shall immediately set the PCC rule inactive.

6) If both Rule-Activation-Time and Rule-Deactivation-Time are specified but time has passed for both, and the Rule-Deactivation-Time occurs before the Rule-Activation-Time, then the PCEF shall immediately set the PCC rule active.

PCC Rule Activation or Deactivation will not generate any CCR commands with Charging-Rule-Report since PCRF is already aware of the state of the rules.

If Rule-Activation-Time or Rule-Deactivation-Time is specified in the Charging-Rule-Install then it will replace the previously set values for the specified PCC rules. If Rule-Activation-Time AVP, Rule-Deactivation-Time AVP or both AVPs are omitted, then any previous value for the omitted AVP is no longer valid.

The 3GPP-MS-TimeZone AVP, if available, may be used for the PCRF to derive the Rule-Activation-Time and Rule-Deactivation-Time.

5 Gx protocol

5.1 Protocol support

The Gx protocol in the present release is based on Gx protocol defined for Release 6 as specified in 3GPP TS 29.210 [2]. However, due to a new paradigm (DCC session for an IP-CAN session) between Release 6 and the present release, the Gx application in the present release has an own vendor specific Diameter application.

The Gx application is defined as a vendor specific Diameter application, where the vendor is 3GPP and the Application-ID for the Gx Application in the present release is 16777238. The vendor identifier assigned by IANA to 3GPP (http://www.iana.org/assignments/enterprise-numbers) is 10415.

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 Gx application within the Auth-Application-Id AVP in order to create suitable routeing tables.

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

With regard to the Diameter protocol defined over the Gx interface, the PCRF acts as a Diameter server, in the sense that it is the network element that handles PCC Rule requests for a particular realm. The PCEF acts as the Diameter client, in the sense that is the network element requesting PCC rules in the transport plane network resources.

5.2 Initialization, maintenance and termination of connection and session

The initialization and maintenance of the connection between each PCRF and PCEF pair is defined by the underlying protocol. Establishment and maintenance of connections between Diameter nodes is described in RFC 3588 [5].

After establishing the transport connection, the PCRF and the PCEF shall advertise the support of the Gx 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 [5]).

The termination of the Diameter user session is specified in RFC 3588 [5] 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.

5.3 Gx specific AVPs

Table 5.3.1 describes the Diameter AVPs defined for the Gx 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: Gx specific Diameter AVPs

Attribute Name	AVP Code	Clause defined	Value Type (note 2)	AVP Flag rules (note 1)					Acc. type	Applicability (note 3)
				Must	May	Should not	Must not	May Encr.		
Access-Network-Charging-Identifier-Gx	1022	5.3.22	Grouped	M,V	P			Y	All	CC
Bearer-Control-Mode	1023	5.3.23	Enumerated	M,V	P			Y	All	PC
Bearer-Identifier	1020	5.3.20	OctetString	M,V	P			Y	GPRS	Both
Bearer-Operation	1021	5.3.21	Enumerated	M,V	P			Y	GPRS	Both
Bearer-Usage	1000	5.3.1	Enumerated	M,V	P			Y	GPRS	Both
Charging-Rule-Install	1001	5.3.2	Grouped	M,V	P			Y	All	Both
Charging-Rule-Remove	1002	5.3.3	Grouped	M,V	P			Y	All	Both
Charging-Rule-Definition	1003	5.3.4	Grouped	M,V	P			Y	All	Both
Charging-Rule-Base-Name	1004	5.3.5	UTF8String	M,V	P			Y	All	Both
Charging-Rule-Name	1005	5.3.6	OctetString	M,V	P			Y	All	Both
Charging-Rule-Report	1018	5.3.18	Grouped	M,V	P			Y	All	Both
Event-Trigger	1006	5.3.7	Enumerated	M,V	P			Y	All	Both
Flow-Information	1058	5.3.37	Grouped	V	P		M	Y	All	Both
Flow-Label	1057	5.3.36	OctetString	V	P		M	Y	All	Both
IP-CAN-Type	1027	5.3.27	Enumerated	M, V	P			Y	All	Both
Guaranteed-Bitrate-DL	1025	5.3.25	Unsigned32	M,V	P			Y	All	PC
Guaranteed-Bitrate-UL	1026	5.3.26	Unsigned32	M,V	P			Y	All	PC
Metering-Method	1007	5.3.8	Enumerated	M,V	P			Y	All	CC
Network-Request-Support	1024	5.3.24	Enumerated	M,V	P			Y	All	PC
Offline	1008	5.3.9	Enumerated	M,V	P			Y	All	CC
Online	1009	5.3.10	Enumerated	M,V	P			Y	All	CC
Precedence	1010	5.3.11	Unsigned32	M,V	P			Y	All	Both
Reporting-Level	1011	5.3.12	Enumerated	M,V	P			Y	All	CC
PCC-Rule-Status	1019	5.3.19	Enumerated	M,V	P			Y	All	Both
Session-Release-Cause	1045	5.3.34	Enumerated	M,V	P			Y	All	Both
QoS-Class-Identifier	1028	5.3.17	Enumerated	M,V	P			Y	All	Both
QoS-Information	1016	5.3.16	Grouped	M.V	P			Y	All	Both
QoS-Negotiation	1029	5.3.28	Enumerated	M,V	P			Y	GPRS	PC
Qos-Upgrade	1030	5.3.29	Enumerated	M.V	P			Y	GPRS	PC
Rule-Failure-Code	1031	5.3.30	Enumerated	M.V	P			Y	All	Both
Security-Parameter-Index	1056	5.3.35	OctetString	V	P		M	Y	All	Both
TFT-Filter	1012	5.3.13	IPFilterRule	M,V	P			Y	GPRS	Both
TFT-Packet-Filter-Information	1013	5.3.14	Grouped	M,V	P			Y	GPRS	Both
ToS-Traffic-Class	1014	5.3.15	OctetString	M,V	P			Y	All	Both
Revalidation-Time	1042	5.3.31	Time	M,V	P			Y	All	Both
Rule-Activation-Time	1043	5.3.32	Time	M,V	P			Y	All	Both
Rule-Deactivation-Time	1044	5.3.33	Time	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 Bearer-Usage AVP (GPRS access type only)

The Bearer-Usage AVP (AVP code 1000) is of type Enumerated, and it shall indicate how the bearer is being used. If the Bearer-Usage AVP has not been previously provided, its absence shall indicate that no specific information is available. If the Bearer-Usage AVP has been provided, its value shall remain valid until it is provided the next time. The following values are defined:

GENERAL (0)

This value shall indicate no specific bearer usage information is available.

IMS_SIGNALLING (1)

This value shall indicate that the bearer is used for IMS signalling only.

Editor's Note: It is for further study whether this AVP applies to I-WLAN or not.

5.3.2 Charging-Rule-Install AVP (All access types)

The Charging-Rule-Install AVP (AVP code 1001) is of type Grouped, and it is used to activate, install or modify PCC rules as instructed from the PCRF to the PCEF.

For installing a new PCC rule or modifying a PCC rule already installed, Charging-Rule-Definition AVP shall be used.

For activating a specific PCC rule predefined at the PCEF, Charging-Rule-Name AVP shall be used as a reference for that PCC rule. The Charging-Rule-Base-Name AVP is a reference that may be used for activating a group of PCC rules predefined at the PCEF.

For GPRS scenarios where the bearer binding is performed by the PCRF, the Bearer Identifier AVP shall be included as part of Charging-Rule-Install AVP.

If present within Charging-Rule-Install AVP, the Bearer-Identifier AVP indicates that the PCC rules within this Charging-Rule-Install AVP shall be installed or activated within the IP CAN bearer identified by the Bearer-Identifier AVP.

If no Bearer-Identifier AVP is included within the Charging-Rule-Install AVP, the PCEF shall select an IP CAN bearer for each of the PCC rules within this Charging-Rule-Install AVP, were the PCC rule is installed or activated.

If Rule-Activation-Time or Rule-Deactivation-Time is specified then it applies to all the PCC rules within the Charging-Rule-Install

AVP Format:

```
Charging-Rule-Install ::=   < AVP Header: 1001 >
                            *[ Charging-Rule-Definition ]
                            *[ Charging-Rule-Name ]
                            *[ Charging-Rule-Base-Name ]
                             [ Bearer-Identifier ]
                             [ Rule-Activation-Time ]
                             [ Rule-Deactivation-Time ]
                            *[ AVP ]
```

5.3.3 Charging-Rule-Remove AVP (All access types)

The Charging-Rule-Remove AVP (AVP code 1002) is of type Grouped, and it is used to deactivate or remove PCC rules from an IP CAN session.

Charging-Rule-Name AVP is a reference for a specific PCC rule at the PCEF to be removed or for a specific PCC rule predefined at the PCEF to be deactivated. The Charging-Rule-Base-Name AVP is a reference for a group of PCC rules predefined at the PCEF to be deactivated.

AVP Format:

```
Charging-Rule-Remove ::= < AVP Header: 1002 >
                          *[ Charging-Rule-Name ]
                          *[ Charging-Rule-Base-Name ]
                          *[ AVP ]
```

5.3.4 Charging-Rule-Definition AVP (All access types)

The Charging-Rule-Definition AVP (AVP code 1003) is of type Grouped, and it defines the PCC rule for a service flow sent by the PCRF to the PCEF. The Charging-Rule-Name AVP uniquely identifies the PCC rule and it is used to reference to a PCC rule in communication between the PCEF and the PCRF within one IP CAN session. The Flow-Description or Flow-Information AVP(s) determines the traffic that belongs to the service flow.

If the PCRF has not received any of the IPSec SPI or the Flow Label in the TFT-Packet-Filter-Information AVP from the PCEF, the Flow-Description AVP shall be used, otherwise, the Flow-Information AVP may be used.

If optional AVP(s) within a Charging-Rule-Definition AVP are omitted, but corresponding information has been provided in previous Gx messages, the previous information remains valid. If Flow-Description or Flow-Information

AVP(s) are supplied, they replace all previous Flow-Description or Flow-Information AVP(s). If Flows AVP(s) are supplied, they replace all previous Flows AVP(s).

Flows AVP may appear if and only if AF-Charging-Identifier AVP is also present.

AVP Format:

```
Charging-Rule-Definition ::= < AVP Header: 1003 >
                              { Charging-Rule-Name }
                              [ Service-Identifier ]
                              [ Rating-Group ]
                             *[ Flow-Description ]
                             *[ Flow-Information ]
                              [ Flow-Status ]
                              [ QoS-Information ]
                              [ Reporting-Level ]
                              [ Online ]
                              [ Offline ]
                              [ Metering-Method ]
                              [ Precedence ]
                              [ AF-Charging-Identifier ]
                             *[ Flows ]
                             *[ AVP ]
```

5.3.5 Charging-Rule-Base-Name AVP (All access types)

The Charging-Rule-Base-Name AVP (AVP code 1004) is of type UTF8String, and it indicates the name of a pre-defined group of PCC rules residing at the PCEF.

5.3.6 Charging-Rule-Name AVP (All access types)

The Charging-Rule-Name AVP (AVP code 1005) is of type OctetString, and it defines a name for PCC rule. For PCC rules provided by the PCRF it uniquely identifies a PCC rule within one IP CAN session. For PCC rules pre-defined at the PCEF it uniquely identifies a PCC rule within the PCEF.

5.3.7 Event-Trigger AVP (All access types)

The Event-Trigger AVP (AVP code 1006) is of type Enumerated. When sent from the PCRF to the PCEF the Event-Trigger AVP indicates an event that shall cause a re-request of PCC rules. When sent from the PCEF to the PCRF the Event-Trigger AVP indicates that the corresponding event has occurred at the gateway.

NOTE: An exception to the above is the Event Trigger AVP set to NO_EVENT_TRIGGERS that indicates that PCEF shall not notify PCRF of any event.

Whenever the PCRF subscribes to one or more event triggers by using the RAR command, the PCEF shall send the corresponding currently applicable values (e.g. 3GPP-SGSN-Address AVP or 3GPP-SGSN-IPv6-Address AVP, 3GPP-RAT-Type, 3GPP-User-Location-Info, etc.) to the PCRF in the RAA if available, and in this case, the Event-Trigger AVPs shall not be included.

Whenever one of these events occurs, the PCEF shall send the related AVP that has changed together with the event trigger indication.

Unless stated for a specific value, the Event-Trigger AVP applies to all access types.

The values 8, 9, and 10 are obsolete and shall not be used, values 18 to 24 are reserved in this Release.

The following values are defined:

SGSN_CHANGE (0)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon the change of the serving SGSN PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because the serving SGSN changed. The new value of the serving SGSN shall be indicated in either 3GPP-SGSN-Address AVP or 3GPP-SGSN-IPv6-Address AVP. Applicable only to GPRS.

QOS_CHANGE (1)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon any QoS change (even within the limits of the current authorization) at bearer level PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because there has been a change in the requested QoS for a specific bearer (e.g. the previously maximum authorized QoS has been exceeded). The Bearer-Identifier AVP shall be provided to indicate the affected bearer. QoS-Information AVP is required to be provided in the same request with the new value.

RAT_CHANGE (2)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a RAT change PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because of a RAT change. The new RAT type shall be provided in the 3GPP-RAT-Type AVP. Applicable only to GPRS.

TFT_CHANGE (3)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a TFT change at bearer level PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because of a change in the TFT. The Bearer-Identifier AVP shall be provided to indicate the affected bearer. All the TFT values for this bearer shall be provided in TFT-Packet-Filter-Information AVP. Applicable only to GPRS.

PLMN_CHANGE (4)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a PLMN change PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because there was a change of PLMN. 3GPP-SGSN-MCC-MNC AVP shall be provided in the same request with the new value. Applicable only to GPRS.

LOSS_OF_BEARER (5)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon loss of bearer, GW should inform PCRF. When used in a CCR command, this value indicates that the PCEF generated the request because the bearer associated with the PCC rules indicated by the corresponding Charging-Rule-Report AVP was lost. The PCC-Rule-Status AVP within the Charging-Rule-Report AVP shall indicate that these PCC rules are temporarily inactive. Applicable to those access-types that handle multiple bearers within one single IP-CAN session (e.g. GPRS).
The mechanism of indicating loss of bearer to the GW is IP-CAN access type specific. For GPRS, this is indicated by a PDP context modification request with Maximum Bit Rate (MBR) in QoS profile changed to 0 kbps.
When the PCRF performs the bearer binding, the PCEF shall provide the Bearer-Identifier AVP to indicate the bearer that has been lost.

RECOVERY_OF_BEARER (6)

This value shall be in CCA and RAR commands by the PCRF used to indicate that upon recovery of bearer, GW should inform PCRF. When used in a CCR command, this value indicates that the PCEF generated the request because the bearer associated with the PCC rules indicated by the corresponding Charging-Rule-Report AVP was recovered. The PCC-Rule-Status AVP within the Charging-Rule-Report AVP shall indicate that these rules are active again. Applicable to those access-types that handle multiple bearers within one single IP-CAN session (e.g. GPRS).
The mechanism for indicating recovery of bearer to the GW is IP-CAN access type specific. For GPRS, this is indicated by a PDP context modification request with Maximum Bit Rate (MBR) in QoS profile changed from 0 kbps to a valid value.
When the PCRF performs the bearer binding, the PCEF shall provide the Bearer-Identifier AVP to indicate the bearer that has been recovered.

IP-CAN_CHANGE (7)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a change in the IP-CAN type PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because there was a change of IP-CAN type. IP-CAN-Type AVP shall be provided in the same request with the new value. For 3GPP IP-CAN type value, 3GPP-RAT-Type AVP shall also be provided.

QOS_CHANGE_EXCEEDING_AUTHORIZATION (11)

This value shall be used in CCA and RAR commands by the PCRF to indicate that only upon a requested QoS change beyond the current authorized value(s) at bearer level PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because there has been a change in the requested QoS beyond the authorized value(s) for a specific bearer. The Bearer-Identifier AVP shall be provided to indicate the affected bearer. QoS-Information AVP is required to be provided in the same request with the new value.

RAI_CHANGE (12)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a change in the RAI, PCEF shall inform the PCRF. When used in a CCR command, this value indicates that the PCEF generated the request because there has been a change in the RAI. The new RAI value shall be provided in the RAI AVP. If the user location has been changed but the PCEF can not get the detail location information for some reasons (e.g. handover from 3G to 2G network), the PCEF shall send the RAI AVP to the PCRF by setting the LAC of the RAI to value 0x0000. Applicable only to GPRS.

USER_LOCATION_CHANGE (13)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a change in the user location, PCEF shall inform the PCRF. When used in a CCR command, this value indicates that the PCEF generated the request because there has been a change in the user location. The new location value shall be provided in the 3GPP-User-Location-Info AVP. If the user location has been changed but the PCEF can not get the detail location information for some reasons (e.g. handover from 3G to 2G network), the PCEF shall send the 3GPP-User-Location-Info AVP to the PCRF by setting the LAC of the CGI/SAI to value 0x0000. Applicable only to GPRS.

NO_EVENT_TRIGGERS (14)

This value shall be used in CCA and RAR commands by the PCRF to indicate that PCRF does not require any Event Trigger notification.

OUT_OF_CREDIT (15)

This value shall be used in CCA and RAR commands by the PCRF to indicate that the PCEF shall inform the PCRF about the PCC rules for which credit is no longer available, together with the applied termination action. When used in a CCR command, this value indicates that the PCEF generated the request because the PCC rules indicated by the corresponding Charging-Rule-Report AVP have run out of credit, and that the termination action indicated by the corresponding Final-Unit-Indication AVP applies (3GPP TS 32.240 [20] and 3GPP TS 32.299 [19]).

REALLOCATION_OF_CREDIT (16)

This value shall be used in CCA and RAR commands by the PCRF to indicate that the PCEF shall inform the PCRF about the PCC rules for which credit has been reallocated after the former out of credit indication. When used in a CCR command, this value indicates that the PCEF generated the request because the PCC rules indicated by the corresponding Charging-Rule-Report AVP have been reallocated credit after the former out of credit indication (3GPP TS 32.240 [20] and 3GPP TS 32.299 [19]).

REVALIDATION_TIMEOUT(17)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon revalidation timeout, PCEF shall inform the PCRF. When used in a CCR command, this value indicates that the PCEF generated the request because there has been a PCC revalidation timeout.

UE_TIME_ZONE_CHANGE (25)

This value shall be used in CCA and RAR commands by the PCRF to indicate that upon a change to the time zone the UE is currently located in, PCC rules shall be requested. When used in a CCR command, this value indicates that the PCEF generated the request because the time zone the UE is currently located in has changed. The new value of the UE"s time zone shall be indicated in the 3GPP-MS-TimeZone AVP.

5.3.8 Metering-Method AVP (All access types)

The Metering-Method AVP (AVP code 1007) is of type Enumerated, and it defines what parameters shall be metered for offline charging. The PCEF may use the AVP for online charging in case of decentralized unit determination, refer to 3GPP TS 32.299 [19].

The following values are defined:

DURATION (0)

This value shall be used to indicate that the duration of the service flow shall be metered.

VOLUME (1)

This value shall be used to indicate that volume of the service flow traffic shall be metered.

DURATION_VOLUME (2)

This value shall be used to indicate that the duration and the volume of the service flow traffic shall be metered.

If the Metering-Method AVP is omitted but has been supplied previously, the previous information remains valid. If the Metering-Method AVP is omitted and has not been supplied previously, the metering method pre-configured at the PCEF is applicable as default metering method.

5.3.9 Offline AVP (All access types)

The Offline AVP (AVP code 1008) is of type Enumerated.

If the Offline AVP is embedded within a Charging-Rule-Definition AVP it defines whether the offline charging interface from the PCEF for the associated PCC rule shall be enabled. The absence of this AVP within the first provisioning of the Charging-Rule-definition AVP of a new PCC rule indicates that the default charging method for offline shall be used.

If the Offline AVP is embedded within the initial CCR on command level, it indicates the default charging method for offline pre-configured at the PCEF is applicable as default charging method for offline. The absence of this AVP within the initial CCR indicates that the charging method for offline pre-configured at the PCEF is not available.

If the Offline AVP is embedded within the initial CCA on command level, it indicates the default charging method for offline. The absence of this AVP within the initial CCA indicates that the charging method for offline pre-configured at the PCEF is applicable as default charging method for offline.

The default charging method provided by the PCRF shall take precedence over any pre-configured default charging method at the PCEF.

The following values are defined:

DISABLE_OFFLINE (0)

This value shall be used to indicate that the offline charging interface for the associated PCC rule shall be disabled.

ENABLE_OFFLINE (1)

This value shall be used to indicate that the offline charging interface for the associated PCC rule shall be enabled.

5.3.10 Online AVP (All access types)

The Online AVP (AVP code 1009) is of type Enumerated.

If the Online AVP is embedded within a Charging-Rule-Definition AVP, it defines whether the online charging interface from the PCEF for the associated PCC rule shall be enabled. The absence of this AVP within the first provisioning of the Charging-Rule-Definition AVP of a new PCC rule indicates that the default charging method for online shall be used.

If the Online AVP is embedded within the initial CCR on command level, it indicates the default charging method for online pre-configured at the PCEF is applicable as default charging method for online. The absence of this AVP within the initial CCR indicates that the charging method for online pre-configured at the PCEF is not available.

If the Online AVP is embedded within the initial CCA on command level, it indicates the default charging method for online. The absence of this AVP within the initial CCA indicates that the charging method for online pre-configured at the PCEF is applicable as default charging method for online.

The default charging method provided by the PCRF shall take precedence over any pre-configured default charging method at the PCEF.

The following values are defined:

DISABLE_ONLINE (0)

This value shall be used to indicate that the online charging interface for the associated PCC rule shall be disabled.

ENABLE_ONLINE (1)

This value shall be used to indicate that the online charging interface for the associated PCC rule shall be enabled.

5.3.11 Precedence AVP (All access types)

The Precedence AVP (AVP code 1010) is of type Unsigned32.

Within the Charging Rule Definition AVP, the Precedence AVP determines the order, in which the service data flow templates are applied at service data flow detection at the PCEF. A PCC rule with the Precedence AVP with lower value shall be applied before a PCC rule with the Precedence AVP with higher value.

NOTE 1: For PCRF-initiated IP-CAN session modification cases where the PCEF creates new service data flow filters (e.g. new TFT-UL filters), the PCEF need to make an appropriate mapping between the value of the Precedence AVP from the PCC rule and the precedence information of the service data flow filter. The PCEF have to maintain the order of the precedence information provided by the PCRF with the precedence information of the new service data flow filters. For UE-initiated IP-CAN session modification cases, according to 3GPP TS 23.060 [17], the precedence of the service data flow filter provided by the UE is not modified by the PCEF.

NOTE 2: The precedence value range defined within the PCC rule is operator configurable and can be set based on the IP-CAN type.

The Precedence AVP is also used within the TFT-Packet-Filter-Information AVP to indicate the evaluation precedence of the Traffic Mapping Information filters (for GPRS the TFT packet filters) as received from the UE. The PCEF shall assign a lower value in the corresponding Precedence AVP to a Traffic Mapping Information filter with a higher evaluation precedence than to a Traffic Mapping Information filter with a lower evaluation precedence.

5.3.12 Reporting-Level AVP (All access types)

The Reporting-Level AVP (AVP code 1011) is of type Enumerated, and it defines on what level the PCEF reports the usage for the related PCC rule. The following values are defined:

SERVICE_IDENTIFIER_LEVEL (0)

This value shall be used to indicate that the usage shall be reported on service id and rating group combination level, and is applicable when the Service-Identifier and Rating-Group have been provisioned within the Charging-Rule-Definition AVP.

RATING_GROUP_LEVEL (1)

This value shall be used to indicate that the usage shall be reported on rating group level, and is applicable when the Rating-Group has been provisioned within the Charging-Rule-Definition AVP.

If the Reporting-Level AVP is omitted but has been supplied previously, the previous information remains valid. If the Reporting-Level AVP is omitted and has not been supplied previously, the reporting level pre-configured at the PCEF is applicable as default reporting level.

5.3.13 TFT-Filter AVP (GPRS access type only)

The TFT-Filter AVP (AVP code 1012) is of type IPFilterRule, and it contains the flow filter for one TFT packet filter. The TFT-Filter AVP is derived from the Traffic Flow Template (TFT) defined in 3GPP TS 24.008 [13]. The following information shall be sent:

- Action shall be set to "permit".
- Direction shall be set to "out".
- Protocol shall be set to the value provided within the TFT packet filter parameter "Protocol Identifier/Next Header Type". If the TFT packet filter parameter "Protocol Identifier/Next Header Type" is not provided within the TFT packet filter, Protocol shall be set to "ip".
- Source IP address (possibly masked). The source IP address shall be derived from TFT packet filter parameters "Source address" and "Subnet Mask". The source IP address shall be set to "any", if no such information is provided in the TFT packet filter.
- Source and destination port (single value, list or ranges). The information shall be derived from the corresponding TFT packet filter parameters. Source and/or destination port(s) shall be omitted if such information is not provided in the TFT packet filter.
- The Destination IP address shall be set to "assigned".

The IPFilterRule type shall be used with the following restrictions:

- No options shall be used.
- The invert modifier "!" for addresses shall not be used.

The direction "out" refers to downlink direction.

5.3.14 TFT-Packet-Filter-Information AVP (GPRS access type only)

The TFT-Packet-Filter-Information AVP (AVP code 1013) is of type Grouped, and it contains the information from a single TFT packet filter including the evaluation precedence, the filter and the Type-of-Service/Traffic Class sent from the PCEF to the PCRF. The PCEF shall include one TFT-Packet-Filter-Information AVP for each TFT packet filters applicable at a PDP context in separate TFT-Packet-Filter-Information AVPs within each PCC rule request corresponding to that PDP context. TFT-Packet-Filter-Information AVPs are derived from the Traffic Flow Template (TFT) defined in 3GPP TS 24.008 [13].

AVP Format:

```
TFT-Packet-Filter-Information ::= < AVP Header: 1013 >
                              [ Precedence ]
                              [ TFT-Filter ]
                              [ ToS-Traffic-Class ]
                              [ Security-Parameter-Index ]
                              [ Flow-Label ]
                             *[ AVP ]
```

5.3.15 ToS-Traffic-Class AVP (All access types)

The ToS-Traffic-Class AVP (AVP code 1014) is of type OctetString, and is encoded on two octets. The first octet contains the IPv4 Type-of-Service or the IPv6 Traffic-Class field and the second octet contains the ToS/Traffic Class mask field. One example is that of a TFT packet filter as defined in 3GPP TS 24.008 [13].

5.3.16 QoS-Information AVP (All access types)

The QoS-Information AVP (AVP code 1016) is of type Grouped, and it defines the QoS information for an IP-CAN bearer, PCC rule or QCI. When this AVP is sent from the PCEF to the PCRF, it indicates the requested QoS information for an IP CAN bearer. When this AVP is sent from the PCRF to the PCEF, it indicates the authorized QoS for an IP CAN bearer (when appearing at CCA or RAR command level or a service flow (when included within the PCC rule) or a QCI (when appearing at CCA or RAR command level with the QoS-Class-Identifier AVP and the Maximum-Requested-Bandwidth-UL AVP and/or the Maximum-Requested-Bandwidth-DL AVP).

The QoS class identifier identifies a set of IP-CAN specific QoS parameters that define QoS, excluding the applicable bitrates. It is applicable both for uplink and downlink direction.

The Max-Requested-Bandwidth-UL defines the maximum bit rate allowed for the uplink direction.

The Max-Requested-Bandwidth-DL defines the maximum bit rate allowed for the downlink direction.

The Guaranteed-Bitrate-UL defines the guaranteed bit rate allowed for the uplink direction.

The Guaranteed-Bitrate-DL defines the guaranteed bit rate allowed for the downlink direction.

The Bearer Identifier AVP shall be included as part of the QoS-Information AVP if the QoS information refers to an IP CAN bearer initiated by the UE and the PCRF performs the bearer binding. The Bearer Identifier AVP identifies this bearer. Several QoS-Information AVPs for different Bearer Identifiers may be provided per command.

If the QoS-Information AVP has been supplied previously but is omitted in a Diameter message or AVP, the previous information remains valid. If the QoS-Information AVP has not been supplied from the PCRF to the PCEF previously and is omitted in a Diameter message or AVP, no enforcement of the authorized QoS shall be performed.

AVP Format:

```
QoS-Information ::=     < AVP Header: 1016 >
                      [ QoS-Class-Identifier ]
                      [ Max-Requested-Bandwidth-UL ]
                      [ Max-Requested-Bandwidth-DL ]
                      [ Guaranteed-Bitrate-UL ]
                      [ Guaranteed-Bitrate-DL ]
                      [ Bearer-Identifier ]
```

5.3.17 QoS-Class-Identifier AVP (All access types)

QoS-Class-Identifier AVP (AVP code 1028) is of type Enumerated, and it identifies a set of IP-CAN specific QoS parameters that define the authorized QoS, excluding the applicable bitrates for the IP-CAN bearer or service flow. The following values are defined:

The mapping of QCI to UMTS QoS parameters for GPRS is shown in the following table (coming from TS 23.203 [7] Annex A table A.3):

Table 5.3.17.1: Mapping for QoS Class Identifier to/from QoS parameters

QoS-Class-Identifier AVP Value	UMTS QoS parameters			
	Traffic Class	THP	Signalling Indication	Source Statistics Descriptor
1	Conversational	n/a	n/a	speech (NOTE)
2	Conversational	n/a	n/a	unknown
3	Streaming	n/a	n/a	speech (NOTE)
4	Streaming	n/a	n/a	unknown
5	Interactive	1	Yes	n/a
6	Interactive	1	No	n/a
7	Interactive	2	No	n/a
8	Interactive	3	No	n/a
9	Background	n/a	n/a	n/a
NOTE: The QCI values that map to "speech" should be selected for service data flows consisting of speech (and the associated RTCP) only.				

5.3.18 Charging-Rule-Report AVP (All access types)

The Charging-Rule-Report AVP (AVP code 1018) is of types Grouped, and it is used to report the status of PCC rules.

Charging-Rule-Name AVP is a reference for a specific PCC rule at the PCEF that has been successfully installed, modified or removed (for dynamic PCC rules), or activated or deactivated (for predefined PCC rules) because of trigger from the MS. Charging-Rule-Base-Name AVP is a reference for a group of PCC rules predefined at the PCEF that has been successfully activated or deactivated because of trigger from the MS.

The Charging-Rule-Report AVP can also be used to report the status of the PCC rules which cannot be installed/activated or enforced at the PCEF. In this condition, the Charging-Rule-Name AVP is used to indicate a specific PCC rule which cannot be installed/activated or enforced, and the Charging-Rule-Base-Name AVP is used to indicate a group of PCC rules which cannot be activated. The Rule-Failure-Code indicates the reason that the PCC rules cannot be successfully installed/activated or enforced.

The Charging-Rule-Report AVP can also be used to report the status of the PCC rules for which credit is no longer available or credit has been reallocated after the former out of credit indication. When reporting an out of credit condition, the Final-Unit-Indication AVP indicates the termination action the PCEF applies to the PCC rules as instructed by the OCS.

If the PCRF performs the bearer binding and the PCRF activates a pre-defined rule the PCEF may include the Bearer-Identifier AVP within the Charging-Rule-Report AVP in order to indicate to the PCRF the IP-CAN bearer affected by the failed PCC rule activation.

NOTE: Applicable only for predefined PCC rules that contain only uplink service data flow filters. In such case the same PCC rule can be activated to multiple IP-CAN bearers of the same IP-CAN session

AVP Format:

```
Charging-Rule-Report ::= < AVP Header: 1018 >
                       *[Charging-Rule-Name]
                       *[Charging-Rule-Base-Name]
                        [Bearer-Identifier]
                        [PCC-Rule-Status]
                        [Rule-Failure-Code]
                        [Final-Unit-Indication]
                       *[AVP]
```

Multiple instances of Charging-Rule-Report AVPs shall be used in the case it is required to report different PCC-Rule-Status or Rule-Failure-Code values for different groups of rules within the same Diameter command.

5.3.19 PCC-Rule-Status AVP (All access types)

The PCC-Rule-Status AVP (AVP code 1019) is of type Enumerated, and describes the status of one or a group of PCC Rules.

The following values are defined:

ACTIVE (0)

This value is used to indicate that the PCC rule(s) are successfully installed (for those provisioned from PCRF) or activated (for those pre-provisioned in PCEF)

INACTIVE (1)

This value is used to indicate that the PCC rule(s) are removed (for those provisioned from PCRF) or inactive (for those pre-provisioned in PCEF)

TEMPORARILY INACTIVE (2)

This value is used to indicate that, for some reason (e.g. loss of bearer), already installed or activated PCC rules are temporarily disabled.

5.3.20 Bearer-Identifier AVP (Applicable access type GPRS)

The Bearer-Identifier AVP (AVP code 1020) is of type OctetString, and it indicates the bearer to which specific information refers.

When present within a CC-Request Diameter command, subsequent AVPs within the CC-Request refer to the specific bearer identified by this AVP.

The bearer identifier of an IP CAN bearer shall be unique within the corresponding IP CAN session. The bearer identifier shall be selected by the PCEF.

5.3.21 Bearer-Operation AVP (Applicable access type GPRS)

The Bearer-Operation AVP (AVP code 1021) is of type of Enumerated, and it indicates the bearer event that causes a request for PCC rules. This AVP shall be supplied if the bearer event relates to an IP CAN bearer initiated by the UE.

The following values are defined:

TERMINATION (0)

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

ESTABLISHMENT (1)

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

MODIFICATION (2)

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

5.3.22 Access-Network-Charging-Identifier-Gx AVP (All access types)

The Access-Network-Charging-Identifier-Gx AVP (AVP code 1022) is of type Grouped. It contains a charging identifier (e.g. GCID) within the Access-Network-Charging-Identifier-Value AVP and the related PCC rule name(s) within the Charging-Rule-Name AVP(s) and/or within the Charging-Rule-Base-Name AVP(s). If the IP CAN session contains only a single IP CAN bearer, no Charging-Rule-Name AVPs or Charging-Rule-Base-Name AVPs need to be provided. Otherwise, all the Charging-Rule-Name AVPs or Charging-Rule-Base-Name AVPs corresponding to PCC rules activated or installed within the IP CAN bearer corresponding to the provided Access-Network-Charging-Identifier-Value shall be included.

The Access-Network-Charging-Identifier-Gx AVP can be sent from the PCEF to the PCRF. The PCRF may use this information for charging correlation towards the AF.

AVP Format:

```
Access-Network-Charging-Identifier-Gx ::=   < AVP Header: 1022 >
                                             { Access-Network-Charging-Identifier-Value}
                                            *[ Charging-Rule-Base-Name ]
                                            *[ Charging-Rule-Name ]
```

5.3.23 Bearer-Control Mode-AVP

The Bearer-Control-Mode AVP (AVP code 1023) is of type of Enumerated. It is sent from PCRF to PCEF and indicates the PCRF selected bearer control mode.

The following values are defined:

UE_ONLY (0)

This value is used to indicate that the UE shall request any additional bearer establishment.

RESERVED (1)

This value is not used in this Release.

UE_NW (2)

This value is used to indicate that both the UE and PCEF may request any additional bearer establishment and add own traffic mapping information to an IP-CAN bearer.

5.3.24 Network Request Support AVP

The Network-Request-Support AVP (AVP code 1024) is of type of Enumerated and indicates the UE and network support of the network initiated procedures.

If the Network Request Support AVP has not been previously provided, its absence shall indicate the value NETWORK_REQUEST NOT SUPPORTED. If the Network Request Support AVP has been provided, its value shall remain valid until it is provided the next time.

The following values are defined:

NETWORK_REQUEST NOT SUPPORTED (0)

This value is used to indicate that the UE and the access network do not support the bearer establishment request procedure.

NETWORK_REQUEST SUPPORTED (1)

This value is used to indicate that the UE and the access network support the bearer establishment request procedure.

5.3.25 Guaranteed-Bitrate-DL AVP

The Guaranteed-Bitrate-DL AVP (AVP code 1025) is of type Unsigned32, and it indicates the guaranteed bitrate in bits per second for a downlink service data flow. The bandwidth contains all the overhead coming from the IP-layer and the layers above, e.g. IP, UDP, RTP and RTP payload.

5.3.26 Guaranteed-Bitrate-UL AVP

The Guaranteed –Bitrate-UL AVP (AVP code 1026) is of type Unsigned32, and it indicates the guaranteed bitrate in bits per second for an uplink service data flow. The bandwidth contains all the overhead coming from the IP-layer and the layers above, e.g. IP, UDP, RTP and RTP payload.

5.3.27 IP-CAN-Type AVP (All access types)

The IP-CAN-Type AVP (AVP code 1027) is of type Enumerated, and it shall indicate the type of Connectivity Access Network in which the user is connected.

The IP-CAN-Type AVP shall always be present during the IP-CAN session establishment. During an IP-CAN session modification, this AVP shall be present when there has been a change in the IP-CAN type and the PCRF requested to be informed of this event. The Event-Trigger AVP with value IP-CAN CHANGE shall be provided together with the IP-CAN-Type AVP.

The following values are defined:

3GPP (0)

This value shall be used to indicate that the IP-CAN is associated with a 3GPP access and is further detailed by the 3GPP-RAT-Type AVP.

DOCSIS (1)

This value shall be used to indicate that the IP-CAN is associated with a DOCSIS access.

xDSL (2)

This value shall be used to indicate that the IP-CAN is associated with an xDSL access.

WiMAX (3)

This value shall be used to indicate that the IP-CAN is associated with a WiMAX access (IEEE 802.16).

3GPP2 (4)

This value shall be used to indicate that the IP-CAN is associated with a 3GPP2 access.

5.3.28 QoS-Negotiation AVP (GPRS Access Type only)

The QoS-Negotiation AVP (AVP code 1029) is of type Enumerated. The value of the AVP indicates for a single PCC rule request if the PCRF is allowed to negotiate the QoS by supplying in the answer to this request an authorized QoS different from the requested QoS.

The following values are defined:

NO_QoS_NEGOTIATION (0)

This value indicates that a QoS negotiation is not allowed for the corresponding PCC rule request.

QoS_NEGOTIATION_SUPPORTED (1)

This value indicates that a QoS negotiation is allowed for the corresponding PCC rule request. This is the default value applicable if this AVP is not supplied

5.3.29 QoS-Upgrade AVP (GPRS Access Type only)

The QoS-Upgrade AVP (AVP code 1030) is of type Enumerated. The value of the AVP indicates whether the SGSN supports that the GGSN upgrades the QoS in a Create PDP context response or Update PDP context response. If the SGSN does not support a QoS upgrade, the PCRF shall not provision an authorized QoS which is higher than the requested QoS for this IP CAN bearer. The setting is applicable to the bearer indicated in the request within the Bearer-Identifier AVP.

If no QoS-Upgrade AVP has been supplied for an IP CAN bearer, the default value QoS_UPGRADE_NOT_SUPPORTED is applicable. If the QoS-Upgrade AVP has previously been supplied for an IP CAN bearer but is not supplied in a new PCC rule request, the previously supplied value remains applicable.

The following values are defined:

QoS_UPGRADE_NOT_SUPPORTED (0)

This value indicates that the IP-CAN bearer does not support the upgrading of the requested QoS. This is the default value applicable if no QoS-Upgrade AVP has been supplied for an IP CAN bearer.

QoS_UPGRADE_SUPPORTED (1)

This value indicates that the IP-CAN bearer supports the upgrading of the requested QoS.

5.3.30 Rule-Failure-Code AVP (All access types)

The Rule-Failure-Code AVP (AVP code 1031) is of type Enumerated. It is sent by the PCEF to the PCRF within a Charging-Rule-Report AVP to identify the reason a PCC Rule is being reported.

The following values are defined:

UNKNOWN_RULE_NAME (1)

This value is used to indicate that the pre-provisioned PCC rule could not be successfully activated because the Charging-Rule-Name or Charging-Rule-Base-Name is unknown to the PCEF.

RATING_GROUP_ERROR (2)

This value is used to indicate that the PCC rule could not be successfully installed or enforced because the Rating-Group specified within the Charging-Rule-Definition AVP by the PCRF is unknown or, invalid.

SERVICE_IDENTIFIER_ERROR (3)

This value is used to indicate that the PCC rule could not be successfully installed or enforced because the Service-Identifier specified within the Charging-Rule-Definition AVP by the PCRF is invalid, unknown, or not applicable to the service being charged.

GW/PCEF_MALFUNCTION (4)

This value is used to indicate that the PCC rule could not be successfully installed (for those provisioned from the PCRF) or activated (for those pre-provisioned in PCEF) or enforced (for those already successfully installed) due to GW/PCEF malfunction.

RESOURCES_LIMITATION (5)

This value is used to indicate that the PCC rule could not be successfully installed (for those provisioned from PCRF) or activated (for those pre-provisioned in PCEF) or enforced (for those already successfully installed) due to a limitation of resources at the PCEF.

MAX_NR_BEARERS_REACHED (6)

This value is used to indicate that the PCC rule could not be successfully installed (for those provisioned from PCRF) or activated (for those pre-provisioned in PCEF) or enforced (for those already successfully installed) due to the fact that the maximum number of bearers has been reached for the IP-CAN session.

UNKNOWN_BEARER_ID (7)

This value is used only in the case the PCRF is performing bearer binding to indicate that the PCC rule could not be successfully installed or enforced at the PCEF because the Bearer-Id specified within the Charging-Rule-Install AVP by the PCRF is unknown or invalid.

MISSING_BEARER_ID (8)

This value is used only in the case the PCRF is performing bearer binding to indicate that the PCC rule could not be successfully installed or enforced at the PCEF because the Bearer-Id is not specified within the Charging-Rule-Install AVP by the PCRF.

MISSING_FLOW_DESCRIPTION (9)

This value is used to indicate that the PCC rule could not be successfully installed or enforced because the Flow-Description or Flow-Information AVP is not specified within the Charging-Rule-Definition AVP by the PCRF during the first install request of the PCC rule.

5.3.31 Revalidation-Time (ALL Access Types)

The Revalidation-Time AVP (AVP code 1042) is of type Time. This value indicates the NTP time before which the PCEF will have to re-request PCC rules. This value shall be provided with the event trigger when REVALIDATION_TIMEOUT is provisioned via CCA or RAR.

5.3.32 Rule-Activation-Time (ALL Access Types)

The Rule-Activation-Time AVP (AVP code 1043) is of type Time. This value indicates the NTP time at which the PCC rule has to be enforced. The AVP is included in Charging-Rule-Install AVP and is applicable for all the PCC rules included within the Charging-Rule-Install AVP.

5.3.33 Rule-Deactivation-Time (ALL Access Types)

The Rule-Deactivation-Time AVP (AVP code 1044) is of type Time. This value indicates the NTP time at which the PCEF has to stop enforcing the PCC rule . The AVP is included in Charging-Rule-Install AVP and is applicable for all the PCC rules included within the Charging-Rule-Install AVP.

5.3.34 Session-Release-Cause (All access types)

Session-Release-Cause AVP (AVP code 1045) is of type Enumerated, and determines the cause of release the IP-CAN session by the PCRF. The following values are defined:

UNSPECIFIED_REASONS (0)

This value is used for unspecified reasons.

UE_SUBSCRIPTION_REASON (1)

This value is used to indicate that the subscription of UE has changed (e.g. removed) and the session needs to be terminated.

INSUFFICIENT_SERVER_RESOURCES (2)

This value is used to indicate that the server is overloaded and needs to abort the session.

5.3.35 Security-Parameter-Index AVP (All access types)

The Security-Parameter-Index AVP (AVP code 1056) is of type OctetString, and it contains the security parameter index of the IPSec packet. One example is that of a TFT packet filter as defined in 3GPP TS 24.008 [13].

5.3.36 Flow-Label AVP (All access types)

The Flow-Label AVP (AVP code 1057) is of type OctetString, and it contains the IPv6 flow label header field. One example is that of a TFT packet filter as defined in 3GPP TS 24.008 [13].

5.3.37 Flow-Information AVP (All access types)

The Flow-Information AVP (AVP code 1058) is of type Grouped, and it is sent from the PCRF to the PCEF and contains the information from a single IP flow packet filter including the flow description.

The Flow-Information AVP may also include the Type-of-Service/Traffic Class, the IPSec SPI, and the Flow Label. The values of these AVPs are obtained from the packet filter information provided by the PCEF.

AVP Format:

```
Flow-Information ::= < AVP Header: 1058 >
                            { Flow-Description }
                            [ ToS-Traffic-Class ]
                            [ Security-Parameter-Index ]
                            [ Flow-Label ]
                           *[ AVP ]
```

5.4 Gx re-used AVPs

Table 5.4 lists the Diameter AVPs re-used by the Gx reference point from existing Diameter Applications, reference to their respective specifications, short description of their usage within the Gx reference point and the applicability of the AVPs to charging control, policy control or both. Other AVPs from existing Diameter Applications, except for the AVPs from Diameter base protocol, do not need to be supported. The AVPs from Diameter base protocol are not included in table 5.4, but they are re-used for the Gx reference point. Where 3GPP Radius VSAs are re-used, they shall be translated to Diameter AVPs as described in RFC 4005 [12] with the exception that the 'M' flag shall be set and the 'P' flag may be set.

Table 5.4: Gx re-used Diameter AVPs

Attribute Name	Reference	Description	Acc. type	Applicability (note 1)
3GPP-RAT-Type	3GPP TS 29.061 [11]	Indicate which Radio Access Technology is currently serving the UE.	GPRS	Both
3GPP-SGSN-Address	3GPP TS 29.061 [11]	For GPRS the IPv4 address of the SGSN	GPRS	Both
3GPP-SGSN-IPv6-Address	3GPP TS 29.061 [11]	For GPRS the IPv6 address of the SGSN	GPRS	Both
3GPP-SGSN-MCC-MNC	3GPP TS 29.061 [11]	For GPRS the MCC and the MNC of the SGSN	GPRS	Both
3GPP-User-Location-Info	3GPP TS 29.061 [11]	For GPRS indicates details of where the UE is currently located (e.g. SAI or CGI)	GPRS	Both
Access-Network-Charging-Address	3GPP TS 29.214 [10]	Indicates the IP Address of the network entity within the access network performing charging (e.g. the GGSN IP address).	All	CC
Access-Network-Charging-Identifier-Value	3GPP TS 29.214 [10]	Contains a charging identifier (e.g. GCID).	All	CC
AF-Charging-Identifier	3GPP TS 29.214 [10]	The AF charging identifier that may be used in charging correlation. For IMS the ICID. This AVP may only be included in a Charging-Rule-Definition AVP if the SERVICE_IDENTIFIER_LEVEL reporting is being selected with the Reporting-Level AVP.	All	CC
Called-Station-ID	IETF RFC 4005 [12]	The address the user is connected to. For GPRS the APN.	All	Both
CC-Request-Number	IETF RFC 4006 [9]	The number of the request for mapping requests and answers	All	Both
CC-Request-Type	IETF RFC 4006 [9]	The type of the request (initial, update, termination)	All	Both
Charging-Information	3GPP TS 29.229 [14]	The Charging-Information AVP is of type Grouped, and contains the addresses of the charging functions in the following AVPs: • Primary-Event-Charging-Function-Name is of type DiameterURI and defines the address of the primary online charging system. The protocol definition in the DiameterURI shall be either omitted or supplied with value "Diameter". • Secondary-Event-Charging-Function-Name is of type DiameterURI and defines the address of the secondary online charging system for the bearer. The protocol definition in the DiameterURI shall be either omitted or supplied with value "Diameter". • Primary-Charging-Collection-Function-Name is of type DiameterURI and defines the address of the primary offline charging system for the bearer. If the GTP' protocol is applied on the Gz interface as specified in 3GPP TS 32.295 [16], the protocol definition in the DiameterURI shall be omitted. If Diameter is applied on the Gz interface, the protocol definition in DiameterURI shall be either omitted or supplied with value "Diameter". The choice of the applied protocol on the Gz interface depends upon configuration in the PCEF. • Secondary-Charging-Collection-Function-Name is of type DiameterURI and defines the address of the secondary offline charging system for the bearer. If the GTP' protocol is applied on the Gz interface as specified in 3GPP TS 32.295 [16], the protocol definition in the DiameterURI shall be omitted. If Diameter is applied on the Gz interface, the protocol definition in DiameterURI shall be either omitted or	All	CC

Attribute Name	Reference	Description	Acc. type	Applicability (note 1)
		supplied with value "Diameter". The choice of the applied protocol on the Gz interface depends upon configuration in the PCEF.		
Final-Unit-Indication	IETF RFC 4006 [9]	The action applied by the PCEF, and the related filter parameters and redirect address parameters (if available), when the user's account cannot cover the service cost.	All	CC
Flow-Description	3GPP TS 29.214 [10]	Defines the service flow filter parameters for a PCC rule	All	Both
Flows	3GPP TS 29.214 [10]	The flow identifiers of the IP flows related to a PCC rule as provided by the AF. May be only used in charging correlation together with AF-Charging-Identifier AVP.	All	CC
Flow-Status	3GPP TS 29.214 [10]	Defines whether the service flow is enabled or disabled. The value "REMOVED" is not applicable to Gx.	All	Both
Framed-IP-Address	IETF RFC 4005 [12]	The IPv4 address allocated for the user.	All	Both
Framed-IPv6-Prefix	IETF RFC 4005 [12]	The IPv6 prefix allocated for the user. The encoding of the value within this Octet String type AVP shall be as defined in IETF RFC 3162 [15], Clause 2.3. The "Reserved", "Prefix-Length" and "Prefix" fields shall be included in this order.	All	Both
Max-Requested-Bandwidth-UL (note 2)	3GPP TS 29.214 [10]	Defines the maximum authorized bandwidth for uplink.	All	PC
Max-Requested-Bandwidth-DL (note 2)	3GPP TS 29.214 [10]	Defines the maximum authorized bandwidth for downlink.	All	PC
RAI	3GPP TS 29.061 [11]	Contains the Routing Area Identity of the SGSN where the UE is registered	GPRS	Both
Rating-Group	IETF RFC 4006 [9]	The charging key for the PCC rule used for rating purposes	All	CC
Service-Identifier	IETF RFC 4006 [9]	The identity of the service or service component the service data flow in a PCC rule relates to.	All	CC
Subscription-Id	IETF RFC 4006 [9]	The identification of the subscription (IMSI, MSISDN, etc)	All	Both
User-Equipment-Info	IETF RFC 4006 [9]	The identification and capabilities of the terminal (IMEISV, etc.) When the User-Equipment-Info-Type is set to IMEISV(0), the value within the User-Equipment-Info-Value shall be a UTF-8 encoded decimal.	All	Both
3GPP-MS-TimeZone	3GPP TS 29.061 [11]	Indicate the offset between universal time and local time in steps of 15 minutes of where the MS currently resides.	All	Both

NOTE 1: 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.
NOTE 2: When sending from the PCRF to the PCEF, the Max-Requested-Bandwidth-UL/DL AVP indicate the maximum allowed bit rate for the uplink/downlink direction; when sending from the PCEF to the PCRF, the Max-Requested-Bandwidth-UL/DL AVP indicate the maximum requested bit rate for the uplink/downlink direction.

5.5 Gx specific Experimental-Result-Code AVP values

5.5.1 General

RFC 3588 [5] 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).

5.5.2 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 [5] shall be applied.

5.5.3 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 [5] are applicable. Also the following specific Gx Experimental-Result-Codes values are defined:

DIAMETER_ERROR_INITIAL_PARAMETERS (5140)

This error shall be used when the set of bearer or session or subscriber information needed by the PCRF for rule selection is incomplete or erroneous or not available for the decision to be made. (e.g. QoS, SGSN address, RAT type, TFT, subscriber information)

DIAMETER_ERROR_TRIGGER_EVENT (5141)

This error shall be used when the set of bearer/session information sent in a CCR originated due to a trigger event been met is incoherent with the previous set of bearer/session information for the same bearer/session. (e.g. event trigger met was RAT changed, and the RAT notified is the same as before)

DIAMETER_PCC_RULE_EVENT (5142)

This error shall be used when the PCC rules cannot be installed/activated. Affected PCC-Rules will be provided in the Charging-Rule-Report AVP including the reason and status as described in Clause 4.5.11. Absence of the Charging-Rule-Report means that all provided PCC rules for that specific bearer/session are affected.

DIAMETER_ERROR_BEARER_NOT_AUTHORIZED (5143)

This error shall be used when the PCRF cannot authorize an IP-CAN bearer (e.g. the authorized QoS would exceed the subscribed QoS) upon the reception of an IP-CAN bearer authorization request coming from the PCEF. The affected IP-CAN bearer is the one that triggered the corresponding CCR. The PCEF shall reject the attempt to initiate or modify the bearer indicated in the related CCR command.

DIAMETER_ERROR_TRAFFIC_MAPPING_INFO_REJECTED (5144)

This error shall be used when the PCRF does not accept one or more of the traffic mapping filters (e.g. TFT filters for GPRS) provided by the PCEF in a CC Request.

5.5.4 Transient Failures

Errors that fall within the transient failures category are used to inform a peer that the request could not be satisfied at the time it was received, but may be able to satisfy the request in the future.

The Result-Code AVP values defined in Diameter Base RFC 3588 [5] are applicable. Also the following specific Gx Experimental-Result-Code value is defined for transient failures:

DIAMETER_PCC_BEARER_EVENT (4141)

This error shall be used when for some reason a PCC rule cannot be enforced or modified successfully in a network initiated procedure. Affected PCC-Rules will be provided in the Charging-Rule-Report AVP including the reason and status as described in Clause 4.5.11.

5.6 Gx Messages

5.6.1 Gx Application

Gx 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 Gx 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 Gx application identifier shall be included in the Auth-Application-Id AVP.

In order to support both PULL and PUSH procedures, a diameter session needs to be established for each IP-CAN session. For IP-CAN types that support multiple IP-CAN bearers (as in the case of GPRS), the diameter session is established when the very first IP-CAN bearer for the IP-CAN session is established.

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].

5.6.2 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 PCEF to the PCRF in order to request PCC rules for a bearer. The CCR command is also sent by the PCEF to the PCRF in order to indicate bearer or PCC rule related events or the termination of the IP CAN bearer and/or session.

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 ]
                 [ Network-Request-Support ]
                 [ Bearer-Identifier ]
                 [ Bearer-Operation ]
                 [ Framed-IP-Address ]
                 [ Framed-IPv6-Prefix ]
                 [ IP-CAN-Type ]
                 [ 3GPP-RAT-Type ]
                 [ Termination-Cause ]
                 [ User-Equipment-Info ]
                 [ QoS-Information ]
                 [ QoS-Negotiation ]
                 [ QoS-Upgrade ]
                  [ 3GPP-SGSN-MCC-MNC ]
                 [ 3GPP-SGSN-Address ]
                 [ 3GPP-SGSN-IPv6-Address ]
                 [ RAI ]
                 [ 3GPP-User-Location-Info]
                 [ 3GPP-MS-TimeZone ]
                 [ Called-Station-ID ]
                 [ Bearer-Usage ]
                 [ Online ]
                 [ Offline ]
                *[ TFT-Packet-Filter-Information ]
                *[ Charging-Rule-Report]
                *[ Event-Trigger]
                 [ Access-Network-Charging-Address ]
                *[ Access-Network-Charging-Identifier-Gx ]
                *[ Proxy-Info ]
                *[ Route-Record ]
                *[ AVP ]
```

5.6.3 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 PCRF to the PCEF in response to the CCR command. It is used to provision PCC rules and event triggers for the bearer/session and to provide the selected bearer control mode for the IP-CAN session. If the PCRF performs the bearer binding, PCC rules will be provisioned at bearer level. The primary and secondary CCF and/or primary and secondary OCS addresses may be included in the initial provisioning.

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 }
                 [ Bearer-Control-Mode ]
                *[ Event-Trigger ]
                 [ Origin-State-Id ]
                *[ Charging-Rule-Remove ]
                *[ Charging-Rule-Install ]
                 [ Charging-Information ]
                 [ Online ]
                 [ Offline ]
                *[ QoS-Information ]
                 [ Revalidation-Time ]
                 [ Error-Message ]
                 [ Error-Reporting-Host ]
                *[ Failed-AVP ]
                *[ Proxy-Info ]
                *[ Route-Record ]
                *[ AVP ]
```

5.6.4 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 PCRF to the PCEF in order to provision PCC rules using the PUSH procedure initiate the provision of unsolicited PCC rules. It is used to provision PCC rules and event triggers for the session. If the PCRF performs the bearer binding, PCC rules will be provisioned at bearer level.

NOTE: If the RAR command is received by the PCEF without providing any operation on PCC rules or any QoS information, the PCEF will respond with a CCR command requesting PCC rules.

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 }
                 [ Session-Release-Cause ]
                 [ Origin-State-Id ]
                *[ Event-Trigger ]
                *[ Charging-Rule-Remove ]
                *[ Charging-Rule-Install ]
                *[ QoS-Information ]
                 [ Revalidation-Time ]
                *[ Proxy-Info ]
                *[ Route-Record ]
                *[ AVP]
```

5.6.5 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 PCEF to the 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 ]
                  * [ Charging-Rule-Report]
                   [ IP-CAN-Type ]
                   [ 3GPP-RAT-Type ]
                   [ 3GPP-SGSN-MCC-MNC ]
                   [ 3GPP-SGSN-Address ]
                   [ 3GPP-SGSN-IPv6-Address ]
                   [ RAI ]
                   [ 3GPP-User-Location-Info ]
                   [ 3GPP-MS-TimeZone ]
                   [ Access-Network-Charging-Address ]
                  * [ Access-Network-Charging-Identifier-Gx ]
                   [ Error-Message ]
                   [ Error-Reporting-Host ]
                  * [ Failed-AVP ]
                  * [ Proxy-Info ]
                  * [ AVP ]
```

Annex A (informative): Change history

Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
11/11/2005					Includes the following TDOCs agreed at CT3#38: C3-050692, C3-050834, C3-050835, C3-050843, C3-050846	0.0.0	0.1.0
17/02/2006					Includes the following TDOCs agreed at CT3#39: C3-060130, C3-060131, C3-060132, C3-060140	0.1.0	0.2.0
12/05/2006					Includes the following TDOCs agreed at CT3#40: C3-060199, C3-060200, C3-060255, C3-060259, C3-060260	0.2.0	0.3.0
13/09/2006					Includes the following TDOCs agreed at CT3#41: C3-060378, C3-060379, C3-060382, C3-060434, C3-060438, C3-060439, C3-060441, C3-060443, C3-060445, C3-060536, C3-060551	0.3.0	0.4.0
09/11/2006					Includes the following TDOCs agreed at CT3#42: C3-060786, C3-060854, C3-060750, C3-060595, C3-060848, C3-060753, C3-060630, C3-060755, C3-060849, C3-060829, C3-060866, C3-060756, C3-060700, C3-060851	0.4.0	0.5.0
01/12/2006	TSG#33	CP-060636			Editorial update by MCC for presentation to TSG CT for information	0.3.0	1.0.0
22/02/2007					Includes the following TDOCs agreed at CT3#43: C3-070050, C3-070084, C3-070137, C3-070166, C3-070175, C3-070212, C3-070239, C3-070244, C3-070245, C3-070246, C3-070268	1.0.0	1.1.0
28/02/2007	TSG#35	CP-060097			Editorial update by MCC for presentation to TSG CT for approval	1.1.0	2.0.0
03-2007					MCC update to version 7.0.0 after approval at TSG CT#35	2.0.0	7.0.0
06-2007	TSG#36	CP-070419	001	1	IP-CAN session specific charging	7.0.0	7.1.0
06-2007	TSG#36	CP-070420	004	11	Handling of Authorized QoS	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	005	2	Subscription to notification of Loss of AF signalling	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	006	1	Routeing of Diameter commands - Gx	7.0.0	7.1.0
06-2007	TSG#36	CP-070420	007	5	QoS change event	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	008		PCC rule without Flow-Description AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	009	1	Addition and removal of event triggers	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	010	2	Metering-Method AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	011	2	Reporting-Level AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	012	1	PCC-Rule-Status AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	013		Charging-Information AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	014	1	PCC-Rule-Event AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	015		Corrections to Reused AVPs	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	016	4	Precedence AVP	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	017	6	Mixed Mode	7.0.0	7.1.0
06-2007	TSG#36	CP-070419	018	2	Correction to where binding should be	7.0.0	7.1.0
06-2007	TSG#36	CP-070420	024	1	Alignment of the QoS information	7.0.0	7.1.0
09-2007	TSG#37	CP-070555	025		Usage of Event-Trigger AVP in RAA	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	027		Correct inconsistent name of re-used AVPs	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	031	2	Combine different sets of authorized QoS information	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	033	1	Precedence of the PCC rule	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	034	3	Experimental-Result-Code for the IP-CAN session rejection	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	036	1	Several bearer QoS-Authorization AVP(s) in the same command	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	037	2	Bearer Identifier handling in Event Trigger reporting	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	039	2	Removal of Editor"s Notes	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	041	2	Location based PCC decisions and Event Triggers	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	042		IP-CAN Type AVP missing in commands	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	043	1	BCM change due to handover	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	048		Support of Authorisation Token in Gx	7.1.0	7.2.0
09-2007	TSG#37	CP-070556	049	3	Extension of IP-CAN-Type AVP to specify non-3GPP IP-CANs	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	051	1	Authorized QoS per QCI	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	052		Applicability to charging or policy control	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	053	2	IP-CAN bearer operation failure	7.1.0	7.2.0
09-2007	TSG#37	CP-070555	054		Gx Application Id	7.1.0	7.2.0
12-2007	TSG#38	CP-070726	056		Add Bearer-Identifier AVP in RAA message	7.2.0	7.3.0
12-2007	TSG#38	CP-070726	057		Alignment for the Indication of IP-CAN Bearer Termination Implications	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	058	5	Correction of default charging method over Gx interface	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	061	2	Clarify the ambiguous name of Max-Requested-Bandwidth-UL/DL AVPs	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	062	2	Authorized QoS per QCI provisioned in CCA	7.3.0	7.4.0

12-2007	TSG#38	CP-070726	064	3	Modify the description of Charging-Rule-Report AVP	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	067	2	Adding 3GPP-User-Location-Info AVP in CCR message	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	068	1	Removing unnecessary and ambiguous text from the Charging-Rule-Install section	7.3.0	7.4.0
12-2007	TSG#38	CP-070726	069		AVP applicability to charging or policy control	7.3.0	7.4.0
03-2008	TSG#39	CP-080040	071		Adding clarification around the encoding of the IMEISV	7.3.0	7.4.0
03-2008	TSG#39	CP-080040	072	1	Reporting the current event related value by the event trigger	7.3.0	7.4.0
03-2008	TSG#39	CP-080040	073	1	PDP Session	7.3.0	7.4.0
03-2008	TSG#39	CP-080040	074		Metering method for online charging	7.3.0	7.4.0
03-2008	TSG#39	CP-080040	077	4	Support of access capabilities for QoS control in PCC	7.3.0	7.4.0
05-2008	TSG#40	CP-080292	100	2	Binding of PCC rules having no AF session	7.4.0	7.5.0
05-2008	TSG#40	CP-080292	101	2	Rejection of traffic mapping information	7.4.0	7.5.0
05-2008	TSG#40	CP-080292	102	1	Downgrading of QoS request	7.4.0	7.5.0
09-2008	TSG#41	CP-080553	105	1	Removal of BCM=Nw-Only	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	113		Error code misalignments	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	123	3	PCC Error Handling Procedures	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	134	1	Missing AVP codes	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	144	2	Setting of Precedence in PCRF-initiated IP-CAN session modifcation	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	148	1	Correction of RAA command	7.5.0	7.6.0
09-2008	TSG#41	CP-080553	150	4	Out of credit indication	7.5.0	7.6.0
12-2008	TSG#42	CP-080952	160	8	Time zone for Time Of Day	7.6.0	7.7.0
12-2008	TSG#42	CP-080751	164	3	IP-CAN session termination initiated by PCRF	7.6.0	7.7.0
12-2008	TSG#42	CP-080751	196	1	Additional failure codes in Rule-Failure-Code AVP	7.6.0	7.7.0
12-2008	TSG#42	CP-080751	200	3	IMS session setup with UE initiated resource reservation	7.6.0	7.7.0
03-2009	TSG#43	CP-090074	211	3	Clarification for TFT operations	7.7.0	7.8.0
03-2009	TSG#43	CP-090074	213		Correction of the Diameter AVP codes	7.7.0	7.8.0
03-2009	TSG#43	CP-090074	215	1	Correction of Policy enforcement for authorized QoS per service data flow	7.7.0	7.8.0
03-2009	TSG#43	CP-090074	234	2	Correction on Charging-Rule-Report AVP	7.7.0	7.8.0
03-2009	TSG#43	CP-090074	243		TFT at initial CC Request	7.7.0	7.8.0
03-2009	TSG#43	CP-090074	250		Indication of IP-CAN bearer termination	7.7.0	7.8.0
05-2009	TSG#44	CP-090334	269	2	Precedence based on IP-CAN type	7.8.0	7.9.0
05-2009	TSG#44	CP-090334	277	4	Clarification of Precedence relation for UE-initiated IP-CAN session modification(R7 29.212)	7.8.0	7.9.0
05-2009	TSG#44	CP-090334	286		Correction to the operation on dynamic PCC rules	7.8.0	7.9.0
05-2009	TSG#44	CP-090334	287	2	IP Packets matching procedures handling	7.8.0	7.9.0
09-2009	TSG#45	CP-090569	302	2	Alignment of TFT and PCC packet filters	7.9.0	7.10.0
09-2009	TSG#45	CP-090569	304	1	Adding the missed AVP in the RAA	7.9.0	7.10.0
09-2009	TSG#45	CP-090569	320	1	Error handling in authorized QoS enforcement	7.9.0	7.10.0
12-2009	TSG#46	CP-090836	334	2	RAT type in the initial CCR	7.10.0	7.11.0
12-2009	TSG#46	CP-090836	367	1	Clarification and correction of IPv6 procedures over Gx	7.10.0	7.11.0
12-2009	TSG#46	CP-090836	372		Corrections to PCC rule provisioning	7.10.0	7.11.0
12-2009	TSG#46	CP-090836	373	2	Report the UE time zone information to the PCRF	7.10.0	7.11.0
12-2009	TSG#46	CP-090836	375	1	Correction for the missing Charging-Rule-Base-Name	7.10.0	7.11.0
03-2010	TSG#47	CP-100070	399	1	Usage reporting	7.11.0	7.12.0
03-2012	TSG#55	CP-120056	766	1	Correction to deferred rules	7.12.0	7.13.0

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