Chapter 3

Online Charging for MTC Events

In Evolved Packet Core (EPC) network, flow based online charging is performed by the PCEF in the PDN-GW. The PCEF interacts with OCS using the Diameter Credit Control (DCC) protocol. The OCS provides the Event Based Charging Function (EBCF) responsible for event-based service such as SMS delivery ,and content downloading (e.g., for music or ring tones) [21].

In the OCS (see Figure 3.1), the Rating Function (RF) handle a wide variety of rateable instances such as data volume, connection time, event-based service (e.g. for content downloading or message delivery). The Account Balance Management Function (ABMF) maintains user balances and other account data. When a user's credit depletes, the ABMF connects the Recharge Server to trigger the recharge account function. The EBCF interacts with ABMF by Rc interface to query and update user's account. The CDRs generated by the EBCF are transferred to Charging Gateway Function (CGF) at once. The CGF collects CDRs through the Ga interface and act as gateway between the 3GPP network and the Billing System [22, 23].

3.1 3GPP Diameter Credit Reservation Procedure

In online charging service, the Diameter Credit Control (DCC) protocol applies for Gy interface that allows online credit control for flow based charging. The OCS play the role of DCC server and PCEF play the role of DCC client. The OCS credit

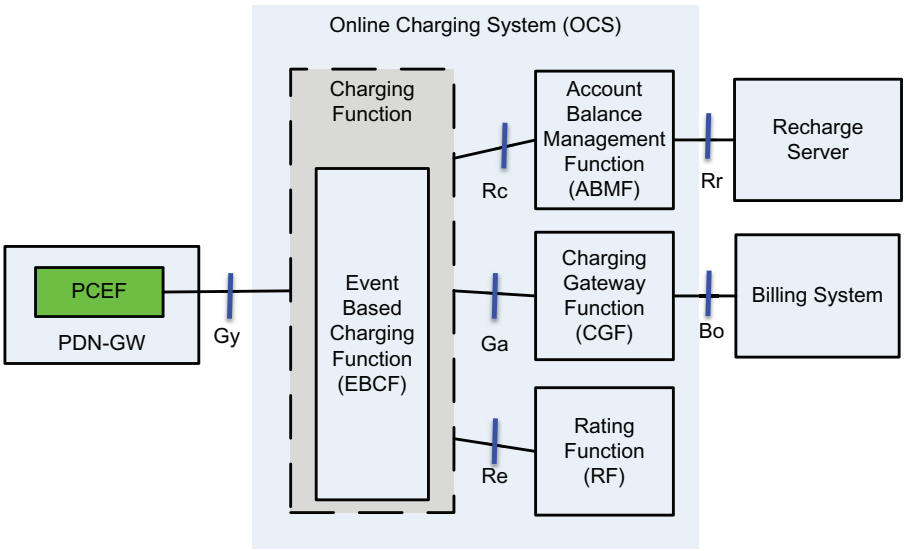

Figure 3.1: Online Charging System and PCEF.

control is completed by exchanging the Credit Control Request (CCR) and the Credit Control Answer (CCA) messages [24]. There are three kind of online charging control procedures: Immediate Event Charging (IEC), Event Charging with Unit Reservation (ECUR), Session Charging with Unit Reservation (SCUR). A credit control message type can be any one or more of the following credit control procedures [18]:

- In the case of IEC, the credit control process for event-based service is controlled by the corresponding CC-Requested-Type "EVENT-REQUEST" that is sent with CCR message for a given credit control event.
- In the case of ECUR, the credit control process for event-based service is controlled by the corresponding CC-Request-Type "INITIAL-REQUEST" and "TERMINATION-REQUEST" are used for charging for a given credit control event. A reservation is made prior to service delivery and committed on execution of a successful delivery.
- In the case of SCUR, the credit control process for session-based service is controlled by the corresponding CC-Request-Type "INITIAL-REQUEST": initiates a credit control session,"UPDATE-REQUEST": contains update credit control information for an in-progress session and "TERMINATION-REQUEST": terminates an in-progress credit control session.

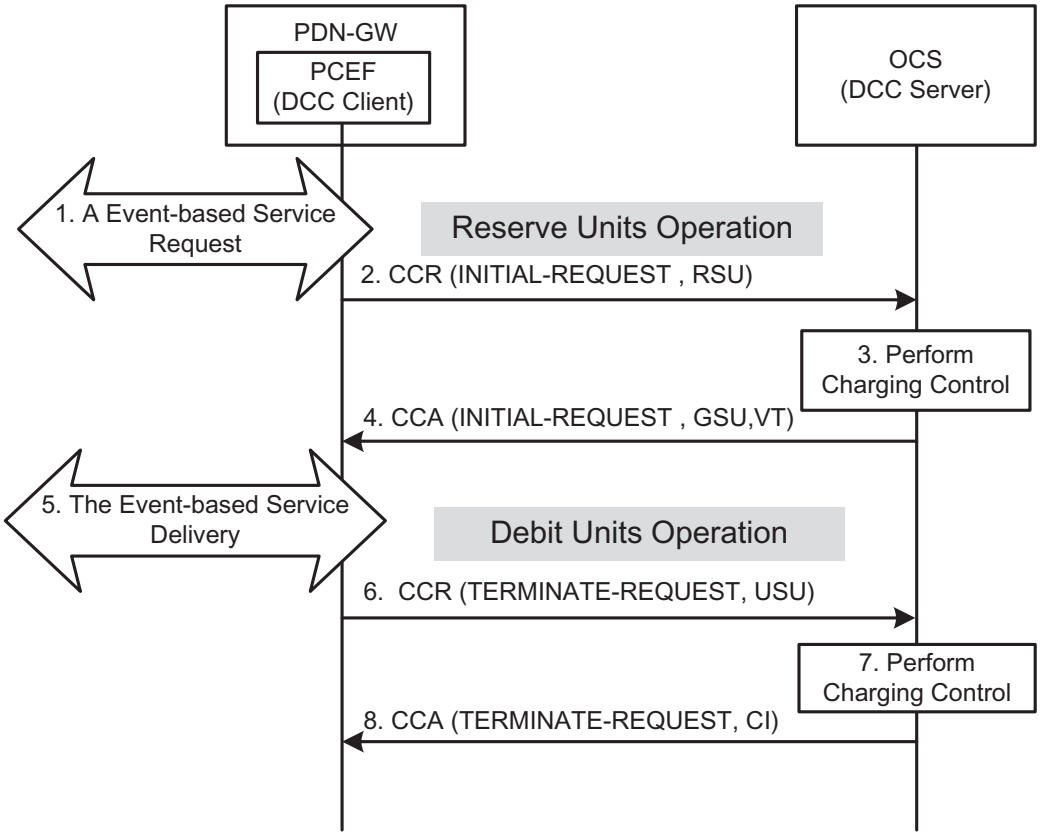

Figure 3.2: ECUR for Diameter Credit Control message flow.

In the session charging with unit reservation, the unit credits are reserved by the OCS from the users account mainly because, in this situation, the OCS does not know how many units are needed to provide the service. Upon the service termination, the amount of used credit is deducted from the users account, and eventually any units reserved and not used are released and added back to the users account.

In Immediate Event Charging, the unit credits are immediately deducted from user account in one single transaction. It is apply to when the price for event-based service is clearly defined. To avoid failure handling for event-based service, it is more appropriate to use Event Charging with Unit Reservation. Event charging with unit reservation conducts reserving credit and returning unused credit for event-based service. The credit reservation procedure for ECUR include two types of credit control operations: Reserve Units operation (Steps 2 and 4 in Figure 3.2) and Debit Units operation (Steps 6 and 8 in Figure 3.2). Consider the scenario where a user or network element request

a transmission from the PDN-GW. The following operations are executed.

Step 1. The PDN-GW receives a event-based service request. This service request may be initiated either by the user or the other network element.

Step 2. [Reserve Units(request)] The PCEF sends a CCR message with CC-Request-Type "INITIAL-REQUEST" to the OCS. If known, the PCEF may include Requested-Service-Unit (RSU) AVP in the request message.

Step 3. Upon receipt of CCR message, the OCS performs charging control and then reserves the equivalent amount of requested credit θ which $\theta = 1 * c_{\texttt{mtc}}$ [1] from the users account.

Step 4. [Reserve Units(response)] Once the reservation has been made, the OCS replies with the CCA message to authorize the event-based service delivery to the network node. This message indicates Granted-Service-Unit (GSU) AVP and Validity-Time (VT) AVP.

Step 5. The PDN-GW starts to deliver the event-based service.

Step 6. [Debit Units(request)] When the event-based service delivery is completed, the PCEF sends a CCR message with CC-Request-Type "TERMINATION-REQUEST" to the OCS. This message terminates the credit control session and indicates Used-Service-Unit (USU) AVP.

Step 7. The OCS debits the consumed credit units from the subscriber's account. Unused reserved credit units are released, if the event-based service delivery fails.

Step 8. [Debit Units(response)] The OCS acknowledges the PCEF with CCA message. This message contains the Cost-Information (CI) AVP indicating the cost of the requested event-based service.

However, there is a potential problem when ECUR credit control procedure is used for charging the MTC events. MTC events are usually trigger by the environment or external factor (e.g., earth quake, change of temperature , timer expires...) and then

[1] $c_{\texttt{mtc}}$: Credit units cost per MTC record.

MTC device will record them becoming the MTC records. The MTC device sends these MTC records to the MTC server periodically or randomly by way of PDN-GW. These MTC records' size usually are only few bytes and the number of MTC records may be extremely large. For example, the power or gas company will deploy a lot of smart meters in a wide area. These smart meters will record the metering data which become the MTC records and transfer to the company's server periodically or randomly. If we create CDR for each MTC record, it will generates a bulk of CDRs. Charging for each MTC record not only generates a bulk of CDRs but also leads to the signals overhead between the OCS and PCEF (i.e.,the OCS will executed the ECUR credit control procedure many times result in CCR and CCA message overhead). To solve this potential problem for OCS, we propose a new credit control procedure, called Multiple-Event-based Charging Reservation (MECR) for handling multiple-events in the next section.

3.2 Multiple-Event-based Charging Reservation Procedure

The reason for signal overhead between the OCS and PCEF is Reserve Units operation (Step 4 in Figure 3.2) in ECUR credit control procedure. Because the OCS reserves credit units that only can support one MTC record. It means that if lots of MTC records arrive, the OCS need to carry out the ECUR credit control procedure for each MTC record in short time period. It will be inefficiency. In order to reduce the ECUR credit control procedure, we propose increasing the reserved credit units at each Reserve Units operation (see Figure 3.3). Each Reserve Units operation will reserves the θ credit units which can support m MTC records, θ denotes the number of credit units and m denotes the number of MTC records. The following operations are the MECR credit control procedure.

Step 1. The PDN-GW receives the first MTC service record transmission request. This request may be initiated either by the machine or the other network element.

Step 2. [Reserve Units(request)] The PCEF sends a CCR message with CC-Request-

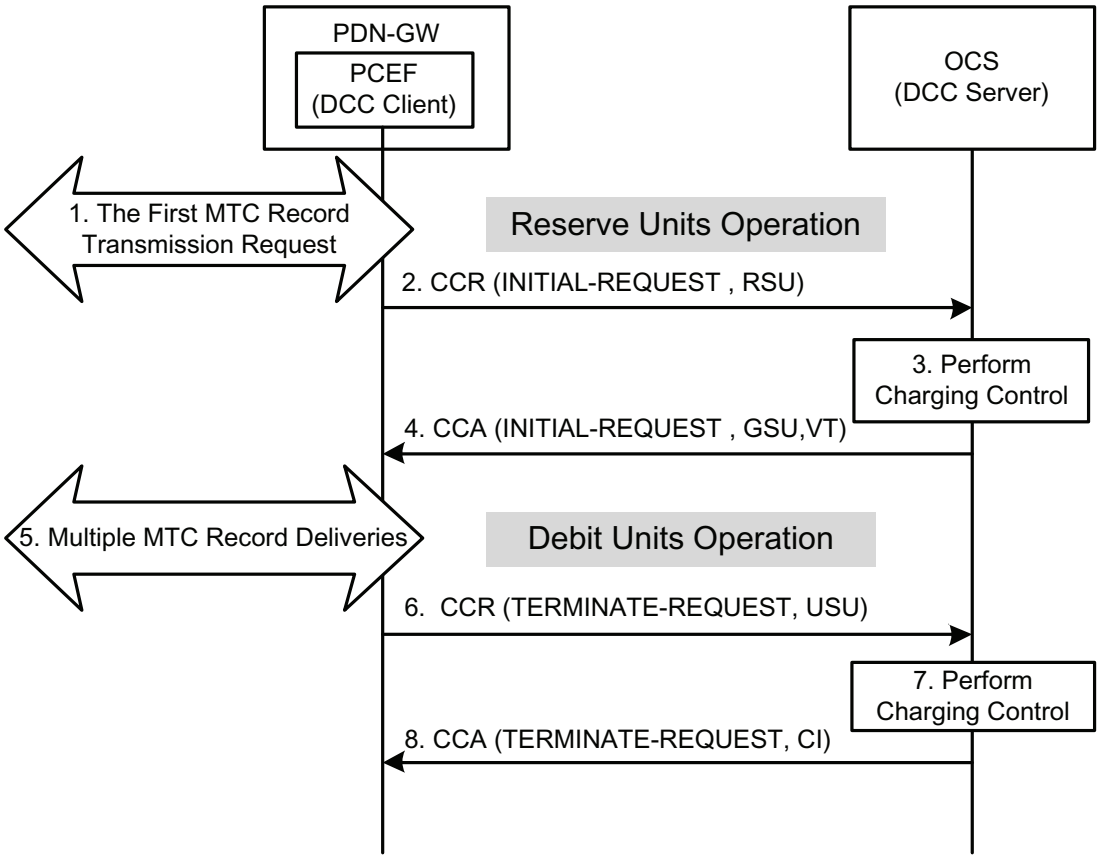

Figure 3.3: MECR for Diameter Credit Control message flow.

Type "INITIAL-REQUEST" to the OCS. If known, the PCEF may include Requested-Service-Unit (RSU) AVP in the request message.

Step 3. Upon receipt of CCR message, the OCS performs charging control and then reserves the equivalent amount of requested credit θ which $\theta = m * c_{\texttt{mtc}}$ and $m \geq 1$ from the subscriber's account.

Step 4. [Reserve Units(response)] Once the reservation has been made, the OCS replies with the CCA message to authorize multiple MTC records delivery to the network node. This message indicates Granted-Service-Unit (GSU) AVP and Validity-Time (VT) AVP.

Step 5. The PDN-GW starts to deliver the MTC records and the reserved credit units are concurrently controlled.

Step 6. [Debit Units(request)] When the θ credit units are consumed or timer expires, the PCEF sends a CCR message with CC-Request-Type "TERMINATION-REQUEST" to the OCS. This message terminates the credit control session and indicates Used-Service-Unit (USU) AVP.

Step 7. The OCS debits the consumed credit units from the subscriber's account. Unused reserved credit units are released.

Step 8. [Debit Units(response)] The OCS acknowledges the PCEF with CCA message. This message contains the Cost-Information (CI) AVP indicating the cumulative cost of the requested MTC records.

If the MECR credit control procedure is used for Gy interface , there is no need to execute the credit control procedure for each MTC record arrives. It is trivial that the MECR credit control procedure not only reduce signal overhead between OCS and PCEF but also decrease the CDRs which are generated by EBCF. However, the MECR procedure brings a issue. To avoid quite a lot of unused reserved credit units, it is cautious to reserve credit units for the MTC services. For example, let θ be the amount of reserved credit units which can support m MTC record events. Under the same MTC record arrival rate, if θ is too large, it will generate lots of unused

reserved credit units and then may result in insufficient credit units reserved for the other prepaid service. In the next chapter, an analytical model is proposed to study the impact of OCS on the MECR credit control procedure.