International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.2233

(06/2010)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Service aspects: Service capabilities and service architecture

Requirements and framework allowing accounting and charging capabilities in NGN

Recommendation ITU-T Y.2233

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	**Y.2200–Y.2249**
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Numbering, naming and addressing	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Future networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.2233

Requirements and framework allowing accounting and charging capabilities in NGN

Summary

Recommendation ITU-T Y.2233 specifies the technical requirements and framework which allow for accounting and charging capabilities in NGN. It is intended to aid in standardizing protocols and mechanisms to enable accounting and charging for NGN.

In order to support advanced accounting and charging capabilities in NGN, it is important to support policy-based accounting and charging and its associated extensions in terms of requirements, architecture, scenarios and capabilities. Extensions are also needed in other areas in order to support advanced requirements such as dynamic rating, supporting hierarchy of customer accounts, and online and offline inter-provider settlements. This Recommendation provides such extensions to the previous ITU-T Y.2233 (2008) version.

Non-technical aspects of charging in NGN and management aspects of accounting and charging in NGN are out of the scope of this Recommendation.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y.2233	2008-01-25	13
2.0	ITU-T Y.2233	2010-06-13	13

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

Recommendation ITU-T Y.2233

Requirements and framework allowing accounting and charging capabilities in NGN

1 Scope

This Recommendation specifies the technical requirements and framework which allow for accounting and charging capabilities in next generation networks (NGNs). It is intended to aid in standardizing protocols and mechanisms to enable accounting and charging for NGN.

In order to support advanced accounting and charging capabilities in NGN, it is important to support policy-based accounting and charging and its associated extensions in terms of requirements, architecture, scenarios and capabilities. Other areas needing extensions are requirements in order to support advanced requirements such as dynamic rating, supporting hierarchy of customer accounts, and online and offline inter-provider settlements. This Recommendation provides such extensions to the previous ITU-T Y.2233 (2008) version.

Non technical aspects of charging in NGN (which are under the responsibility of ITU-T SG 3) and management aspects of accounting and charging in NGN (which are under the responsibility of SG 2) are out of the scope of this Recommendation.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

[ITU-T Y.2111] Recommendation ITU-T Y.2111 (2008), *Resource and admission control functions in next generation networks*.

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 settlement [b-ITU-T Q.1741.2] and [b-ITU-T Q.1741.3]: Payment of amounts resulting from the accounting process.

3.1.2 usage metering [b-ITU-T Q.825]: The abstraction of activities that monitor the utilization of resources, for the purpose of accounting and controlling the recording of usage data.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 accounting: The process of collecting and analysing NGN service and NGN resource usage metrics for the purposes of capacity and trend analysis, cost allocation, auditing, billing, etc. Accounting management requires that resource consumption be measured, rated, assigned, and communicated between appropriate business entities.

3.2.2 bidirectional flow: A bidirectional flow is a flow which is composed of packets sent in both directions between two endpoints. A bidirectional flow is composed from two unidirectional flows.

3.2.3 billing: The process after rating in which the NGN transactions of NGN event usage are compiled and bills are produced.

3.2.4 billing domain: Part of the operator network, which is outside the NGN, that receives and processes charging information from the NGN charging functions. It includes functions that can provide billing mediation and billing or other (e.g., statistical) end applications.

3.2.5 chargeable event: Activity utilizing NGN network resources and related services for:

– user-to-user communication (e.g., a single call, a data communication session or a short message); or

– user-to-network communication (e.g., service profile administration); or

– inter-network communication (e.g., transferring calls, signalling, or short messages); or

– mobility (e.g., roaming or inter-system handover); and

– any other types of service activities the network operator may want to charge for.

As a minimum, a chargeable event characterizes the resource/service usage and indicates the identity of the involved end user(s).

3.2.6 charged party: User involved in a chargeable event who has to pay parts or the whole charges of the chargeable event, or a third party paying the charges caused by one or all users involved in the chargeable event, or a network operator.

3.2.7 charging: Function within the NGN network and the associated offline charging, online charging, and billing domain components whereby information related to a chargeable event is collected, formatted, transferred and evaluated in order to make it possible to determine usage for which the charged party may be billed (offline charging) or the subscriber's account balance may be debited (online charging).

3.2.8 charging information record (CIR): Formatted collection of information about a chargeable event (e.g., time of call set-up, duration of the call, amount of data transferred, etc.) for use in billing and accounting. For each party to be charged for parts of or all charges of a chargeable event a separate CIR is required to be generated, i.e., more than one CIR may be generated for a single chargeable event, e.g., because of its long duration, because more than one charged party is to be charged, or because more than one content-type is to be charged.

NOTE – The charging information record (CIR) is also known as charging data record (CDR), as defined in [b-ITU-T Q.1741.2].

3.2.9 charging event: Set of charging information forwarded by the charging trigger function (CTF) towards the charging collection function (CCF) (offline charging) or towards the online charging function (OCF) (online charging). Each charging event matches exactly one chargeable event.

3.2.10 correlation: Capability to generate an aggregated charging information record (CIR) by combining and analysing charging events collected from the same transport/service session.

3.2.11 flow: A flow is defined as a set of IP packets passing an observation point in the network during a certain time interval. All packets belonging to a particular flow have a set of common properties. Each property is defined as the result of applying a function to the values of:

1) One or more packet header fields (e.g., destination IP address), transport header fields (e.g., destination port number), or application header fields (e.g., RTP header fields).
2) One or more characteristics of the packet itself (e.g., number of MPLS labels).
3) One or more fields derived from packet treatment (e.g., next-hop IP address, output interface).

3.2.12 metering: See usage metering.

3.2.13 near real-time: Near real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than 1 minute.

3.2.14 offline charging: Charging mechanism where charging information does not affect, in real-time, the service rendered.

3.2.15 online charging: Charging mechanism where charging information can affect, in real-time, the service rendered, and therefore a direct interaction of the charging mechanism with resource/session/service control is required.

3.2.16 policy-based charging and accounting: Charging and accounting capability based on different factors or factor group (e.g., access-specific characteristics, QoS provided by the transport for the service, specific service types, time, user subscription information, etc.).

3.2.17 rating: The process of calculating the charges for an NGN transaction.

3.2.18 real-time: Real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than 1 second.

3.2.19 session: Logical connection between parties involved in a packet-switched based communication.

NOTE – This term is used for IP connections rather than the term "call" that is normally used for a connection over conventional (circuit switched) systems. A session can be composed of one or more unidirectional and/or bidirectional flows.

3.2.20 unidirectional flow: A unidirectional flow is a flow which is composed only of packets sent from a single endpoint to another single endpoint.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

ABMF Account Balance Management Function

AOC Advice of Charge

AS Application Server

ATM Asynchronous Transfer Mode

BD Billing Domain

CAF Charging and Accounting Function

CCF Charging Collection Function

CDMA Code Division Multiple Access

CDR Charging Data Record

CGF Charging Gateway Function

CIR	Charging Information Record
CS	Circuit Switched
CTF	Charging Trigger Function
DS	Directory Service
DSL	Digital Subscriber Line
GSM	Global System for Mobile communication
FE	Functional Entity
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPCGF	Inter-Provider Charging Gateway Function
IPTV	Internet Protocol Television
LAN	Local Area Network
MPLS	Multiprotocol Label Switching
NE	Network Element
NGN	Next Generation Network
NMS	Network Management System
OCF	Online Charging Function
OS	Operating System
PD-FE	Policy Decision Functional Entity
PE-FE	Policy Enforcement Functional Entity
PS	Packet Switched
QoS	Quality of Service
RACF	Resource and Admission Control Functions
RADIUS	Remote Authentication Dial In User Service
RF	Rating Function
RMR	Resource Modification Request
SCF	Service Control Function
SMS	Service Management System
SUP-FE	Service User Profile Functional Entity
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
WLAN	Wireless LAN

5 Conventions

For unique and convenient identification of requirements, the following abbreviations and conventions are used in clauses 6 and 7:

A-B-R-0nn:

A: Type of requirements (e.g., H: high-level requirements, F: functional requirements).

B: Subsystem functional requirements (e.g., M: Metering functional requirements, C: Charging functional requirements, Pr: Protocol requirements, I: Information model related requirements, Po: Policy and rules requirements, Null: If not applicable).

R: Stands for requirement.

0nn: A requirement serial number.

6 High-level requirements for mechanisms allowing accounting and charging capabilities in NGN

– H-R-001: NGNs are required to support an architecture with open-standard interfaces to provide charging and accounting capabilities for NGN release 2 services.

– H-R-002: NGNs are required to support various charging policies (e.g., fixed-rate charging and usage-based per-session charging).

– H-R-003: NGNs are required to support accounting and charging functionality associated with the provision of both unicast- and multicast-based services. The accounting system is required to capture user information and resources used. Specifically the accounting system is required to identify which user used resources and the start and finish times associated with the use of the resources.

– H-R-004: NGNs are required to support appropriate charging arrangement models for NGN release 2 services. It is required to consider multi-service environment in NGNs including international interconnection. This may require a settlement between different types of service providers, for example, NGN network operators, content service providers, and/or application service providers. It includes transfer of accounting and charging information among them.

– H-R-005: NGNs may support flow-based accounting and charging functionality for various NGN release 2 services. Such functionality must be accurate, reliable, and scalable. Some examples of the functionality are:

  • accounting and charging for unidirectional flow resource usage;
  • accounting and charging for bidirectional flow resource usage;
  • accounting and charging for session resource usage.

– H-R-006: NGNs are required to support interfaces and protocols between network elements and accounting elements and between accounting and charging elements to collect and transport resource usage data (e.g., accounting metrics and CIRs, etc.). These interfaces and protocols are required to comply with clause 7.

– H-R-007: NGNs are required to support management functionalities for the seamless operation of the accounting and charging functional elements.

– H-R-008: NGNs are required to support policy-based charging, accounting and control for NGN services.

– H-R-009: NGNs are required to support an architecture with open-standard interfaces to provide policy-based charging and accounting capabilities and coordination with resource control, including RACF, for NGN release 2 services.

– H-R-0010: NGNs are required to support interfaces and protocols between policy control functional entities and charging and accounting functional entities.
– H-R-0011: NGNs are required to support management functionalities for the seamless operation of the policy-based accounting and charging and its associated control functional elements.
– H-R-0012: NGNs are required to support secure, reliable, and scalable operations of policy-based charging and accounting for NGN services.
– H-R-0013: NGNs are required to support high availability architecture for seamless operations in case of any hardware and software failures.

7 Functional requirements for mechanisms allowing accounting and charging capabilities in NGN

7.1 Metering functional requirements

– F-M-R-001: NGN network elements (NEs) are required to support capabilities to collect resource-usage related data in real-time.
– F-M-R-002: NGN NEs are recommended to support capabilities to collect resource-usage related data without any loss and duplication.
– F-M-R-003: NGN NEs are required to support capabilities to collect resource-usage related data based on different QoS levels.
– F-M-R-004: NGN NEs are required to support metering of resource usage with two types of units, packet count and byte count, and resource-usage duration; and may support other units.
– F-M-R-005: NGN NEs are required to support metering of resource usage with various types of granularity such as 5-tuple flow count, content-aware count, message count (e.g., e-mail messages), content count (e.g., music, movies, etc.), and may support other granularity types.
– F-M-R-006: It is recommended that metering be able to differentiate traffic flowing inside an NGN provider domain and traffic flowing between two or more NGN provider domains.
– F-M-R-007: NGNs are recommended to support per-medium metering in the context of multimedia services.
– F-M-R-008: NGNs are recommended to support interim metering, which is a snapshot of metering.
– F-M-R-009: NGN NE metering is recommended to be fault-tolerant, that is, it should be recoverable as much as possible when NE failure occurs.

  NOTE – "Fault-tolerant" does not mean 100% recoverability.
– F-M-R-010: NGNs may support a non-NE-resident metering mechanism (e.g., metering by stand-alone metering device).
– F-M-R-011: NGNs are recommended to support metering policy configuration by its users (e.g., NMS, SMS or other application entities).
– F-M-R-012: It is recommended that NGN resource-usage related data captured from NEs be held in a standard accounting metric.
– F-M-R-013: NGNs are required to support transfer of accounting metric to the charging functional entities in a secure, reliable, and efficient manner.

  NOTE – Other requirements on transfer of accounting metric to the charging functional entities are contained in clause 7.3.

– F-M-R-014: NGNs may support identification of a charging session by metered flow inspection without receiving charging start indication from an external associated functional entity such as a RADIUS server.

– F-M-R-015: NGNs are required to support either in-line or passive metering functionality. If in-line metering functionality is supported, metered traffic control may also be supported if such charging policy is applied.

– F-M-R-016: NGNs are required to support packet processing capabilities (e.g., correlation identification, call reference administration, or deep packet inspection) required to accurately identify a session.

– F-M-R-017: NGNs are required to support filtering capability to filter out a specific set of data packets based on a filtering rule (e.g., filtering based on terminal IP address or a range of IP addresses, service server IP address or a range of IP addresses, service server port numbers, and any combination of them).

– F-M-R-018: NGNs are required to support per-service metering (for example, voice service is metered per minute of use while data service is metered based on data volumes; standard data service is metered separately from premium data service).

– F-M-R-019: NGNs are required to support metering usage of payload only from service traffic.

– F-M-R-020: NGNs are required to support capabilities to identify service termination (e.g., normal termination by TCP FIN finish or abrupt termination by some network failure, etc.).

– F-M-R-021: NGNs are recommended to support activation and deactivation of QoS downgrade capabilities for certain types of traffic.

– F-M-R-022: NGNs are required to support metering the usage of customer traffic in terms of layers 3, 4, and 7.

7.2 Charging functional requirements

– F-C-R-001: NGNs are required to support off-line charging and online charging per user.

– F-C-R-002: NGNs are required to support off-line and online charging per service.

– F-C-R-003: NGN charging functional entities are required to be able to generate charging detail records for all charges incurred between the NGN customer and the NGN service provider and between NGN service providers. This includes different types of service provider relationships.

– F-C-R-004: NGNs are recommended to support both service-level and transport-level charging.

– F-C-R-005: NGNs are recommended to support both per-service charging (e.g., multimedia communications) and per-medium charging (e.g., voice, video, data).

– F-C-R-006: NGNs are recommended to support charging per flow direction. For example, incoming or outgoing flows of a particular session may be charged separately.

– F-C-R-007: NGNs are recommended to support charging for different levels of QoS (including network resource usage, e.g., bandwidth used) including when QoS is to be applied for each type of service or medium.

– F-C-R-008: NGNs are recommended to support per-service charging irrespective of the underlying technology used to deliver the service.

– F-C-R-009: NGNs are required to support per-service charging based on the underlying technology used to deliver the service.

– F-C-R-010: NGNs are recommended to support charging based on the use of extra resources.
– F-C-R-011: NGNs are recommended to support capabilities which allow for excluding charging for certain types of contents (e.g., advertisement).
– F-C-R-012: NGNs are recommended to support charging based on other criteria (e.g., location, presence, etc.).
– F-C-R-013: NGNs are required to support transfer of charging information to a billing domain with a standard-based protocol that satisfies the requirements specified in clause 7.3.
– F-C-R-014: NGNs are recommended to support AOC (advice of charge) (i.e., AOC prior to service/product consumption, AOC during service/product consumption, and AOC post service/product consumption).
– F-C-R-015: NGNs are recommended to support dynamic rating.
– F-C-R-016: NGNs are recommended to support customer account hierarchy.
– F-C-R-017: NGNs are required to support policy-based charging and its associated control on a per session basis.
– F-C-R-018: NGNs may support an adjustable charging rate during a session as a result of events related to the service.
– F-C-R-019: NGNs may support identification of charging event initiation and termination of a session without receiving information from application support functions.
– F-C-R-020: NGNs may support capabilities which allow for charging specific permitted services and blocking any other services with appropriate notice on the blocking.
– F-C-R-021: NGNs are recommended to support 3rd party charging for certain services.
– F-C-R-022: NGNs are recommended to support real-time credit refill for online charging either by user or service provider.
– F-C-R-023: NGNs are required to support real-time selection and modification of accounting policies according to customer requirements.
– F-C-R-024: A cache function is recommended to be supported. When the transfer link is broken, CIRs can be kept in the CCF. And when the link is restored, the CCF can resend CIRs to the CGF.

7.3 Accounting and charging protocol high-level requirements

– F-Pr-R-001: The NGN charging and accounting protocol is required to support a wide range of billing models (e.g., post paid, pre paid, pay per view, pay per click and sponsored campaigns).
– F-Pr-R-002: The NGN charging and accounting protocol is required to be efficient. For example, it should efficiently utilize the network bandwidth as well as introduce minimal processing and memory overheads to the network and service resources.
– F-Pr-R-003: The NGN charging and accounting protocol is required to support minimization of delays and latencies in the delivering and in the processing of the usage data.
– F-Pr-R-004: The NGN charging and accounting protocol is required to ensure that all usage records are reliably received.
– F-Pr-R-005: The NGN charging and accounting protocol is required to allow high availability of the data collection system.
– F-Pr-R-006: The NGN charging and accounting protocol is required to include or support integration of proper security mechanisms in order to avoid tampering and eavesdropping.

– F-Pr-R-007: The NGN charging and accounting protocol is required to be scalable.

– F-Pr-R-008: The NGN charging and accounting protocol is required to be easy to deploy and manage even in heterogeneous OS environments.

7.4 Accounting and charging information model high-level requirements

– F-I-R-001: NGNs are recommended to support a standardized and extensible charging and accounting information model for NGN release 1 services.

7.5 Charging policy and rule requirements

– F-Po-R-001: NGNs are required to support policy-based charging and accounting.

– F-Po-R-002: NGNs are recommended to support different charging policies for the different QoS-related transport resources within packet networks and at the network boundaries in accordance with their capabilities.

– F-Po-R-003: NGNs are recommended to support different charging polices for different access and core transport technologies (e.g., xDSL, UMTS, CDMA2000, cable, LAN, WLAN, Ethernet, MPLS, IP, ATM).

– F-Po-R-004: NGNs are recommended to support rule repository to deploy, configure and distribute policies more flexibly.

– F-Po-R-005: NGNs are recommended to support charging policy management for abnormal service termination.

– F-Po-R-006: NGNs are recommended to support QoS downgrade policy charging.

8 Architectural framework for mechanisms allowing accounting and charging capabilities in NGN

The high-level and functional requirements of policy-based accounting and charging in NGN are provided in clauses 6 and 7. In order to meet such requirements, an appropriate architecture should be established. This architecture defines functional components and their inter-relationships given by various reference points.

This clause describes a functional architecture for policy-based accounting and charging in NGN.

8.1 Overall architectural framework

The NGN charging and accounting functions are integral parts of the NGN functional architecture presented in [ITU-T Y.2012]. The accounting and charging related information is generated by functional entities within the transport stratum (e.g., access node FE, edge node FE, access border gateway FE, interconnection border gateway FE, etc.) and by functional entities within the service stratum (e.g., application support FE, serving call session control FE). These functional entities (or their proxies when FEs lack accounting and charging capabilities) transfer charging and accounting information to appropriate charging FEs in a secure and reliable manner. The information to be provided to the charging FEs is determined based on charging policies provided by the resource and admission control functions (RACF) [ITU-T Y.2111].

8.2 Functional architecture

This clause provides the functional architecture including functional entities grouped based on common capabilities, their relationships, and interfaces. The functional architecture includes functional entities that are dedicated to NGN charging and accounting, referred to as the charging and accounting functions (CAFs), and other functional entities that interact with the CAF. This functional architecture is shown in Figure 1. A description of each functional entity within the CAF follows.

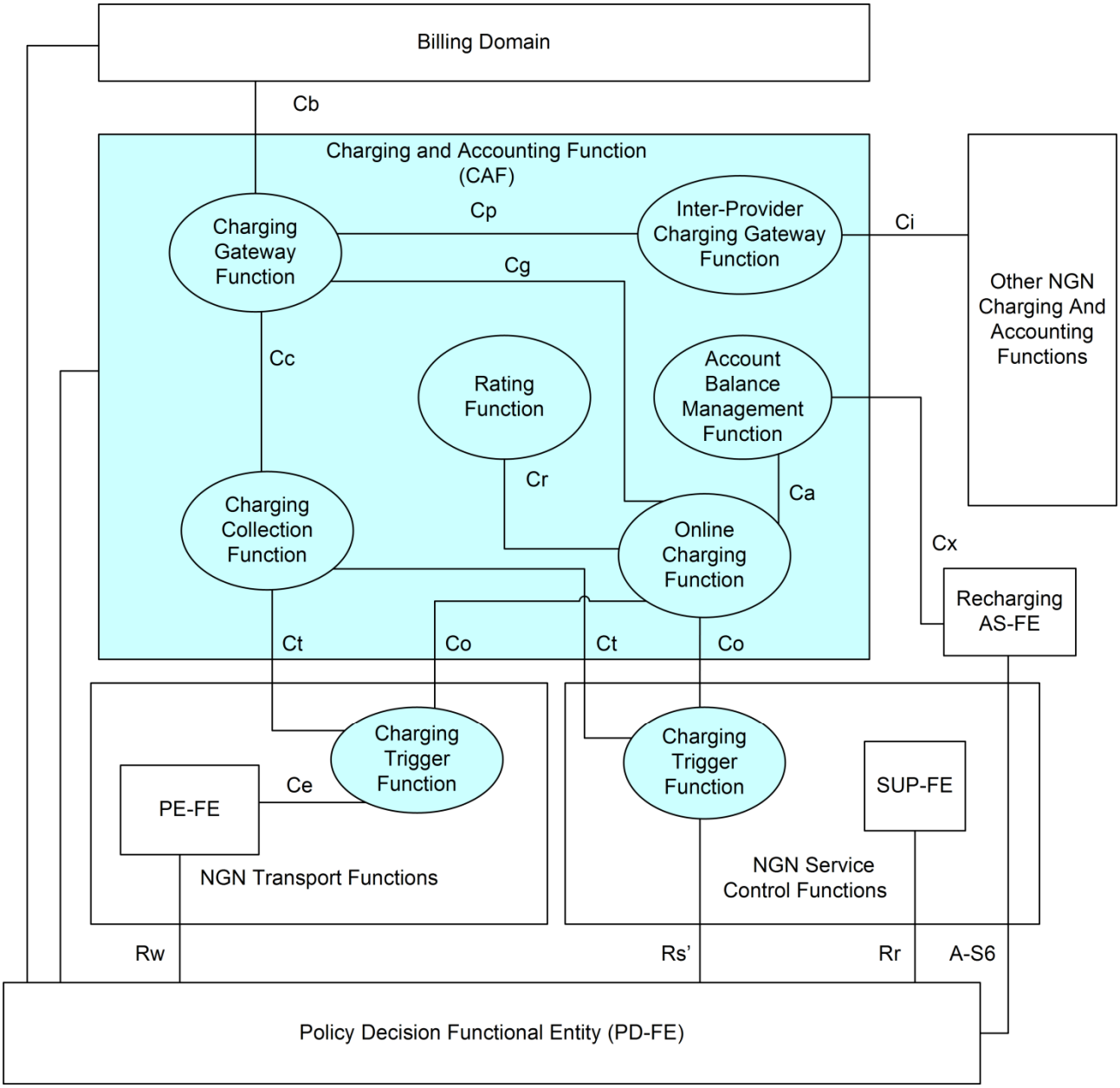

Figure 1 – Policy-based charging and accounting functional architecture

NOTE – CTFs are part of CAF, as indicated by the shading in Figure 1.

8.2.1 Charging trigger function (CTF)

As described in [ITU-T Y.2012], the CTF generates charging events based on the observation of network resource usage. In every network and service element that provides charging information, the CTF is the focal point for collecting information pertaining to chargeable events within the network element, assembling this information into matching charging events, and sending these charging events to the charging collection function. The CTF is therefore a necessary component in all network elements that provide offline-charging functionality.

The CTF also creates the charging events used for online charging. The charging events are forwarded to the online charging function (OCF) in order to obtain authorization for the chargeable event or network resource usage requested by the user. It must be possible to delay the actual resource usage until permission has been granted by the OCF. The CTF must be able to track the availability of resource usage permissions (i.e., quota supervision) during the network resource usage. It must also be able to work with other NGN functions (e.g., the PE-FE in the transport

stratum) to enforce termination of the end user's network resource usage when permission by the OCF is not granted or expires.

The CTF also supports functionality beyond event-based and session-based charging. For some NGN services which cannot be mapped into a simple event or session, more thorough analysis (e.g., application layer deep packet inspection) may be required. For example, an IPTV service which consists of normal content stream and advertisement stream can be charged in different rates depending on its content type. The CTF collects a set of packets and creates accounting data based on the charging policy and rules. Within the transport stratum, charging policies and rules are delivered by PE-FE and enforced in CTF. The CTF also sends session control requests to PE-FE. How such policy and rules are defined and provisioned into the CTF are out of scope of this Recommendation. The CTF may be resident in network elements (NEs) or a separate measurement device if an NE does not support such functionality. For content and service transaction charging, the CTF may be resident within the service stratum, thereby allowing direct measurement of usage of the application resources.

The CTF meters user traffic and creates charging information according to the charging policy. The CTF is required to be capable of processing metering by using default charging information without receiving further detailed charging information. When a customer starts a service, the CTF requests a charging policy for the subscriber to the PD-FE and buffers its packets until receiving the charging policy. If the CTF fails to get the charging policy from the PD-FE, it releases the requested customer's traffic session.

Besides the functionality described above, the CTF has the following functionalities:

- meter the data by either receiving or retrieving traffic usage data from traffic measurement functions of the access and core transport (or the usage data measurement functions of the service stratum) without loss and in real-time if online charging is used;
- meter traffic usage data via a standalone traffic measurement system from access and transport networks without loss and in real-time if online charging is used. The standalone accounting function is performed when the traffic measurement function is not embedded in the access and core transport equipment;

  NOTE – Metering should be performed based on the metering policy. It may include static or dynamic metering, scope of metering (all flows or subset), flow granularity, metered flow attributes, meter accuracy, etc. The metering policies and rules are delivered from the PD-FE to the CTF by the PE-FE. If the CTF is located in the service stratum, the metering policies and rules are controlled by the service control functions (SCFs);
- receive or retrieve user (end-point) profile data, service quality information, etc.;
- receive charging policies and rules from PD-FE via the PE-FE, or from the SCF;
- process the collected data and convert them into a packet bundle or flow record appropriately;
- perform interim buffering of usage data in the event of a metering device reboot or other network problems which prevent the reception of the data;
- send a media flow control request to the PE-FE if a condition based on the enforced charging policy is met;
- transfer the metered data (packet bundles or flow records) to the CCF via the Ct reference point.

The generated charging events are transferred to the CCF via the Ct reference point and the OCF via the Co reference point. The CTF also exchanges network resource usage authorization information via the Co reference point.

The CTF supports the metering functional requirements defined in clause 7.1, metering functional requirements.

8.2.2 Charging collection function (CCF)

As described in [ITU-T Y.2012], the CCF receives charging events from the CTF via the Ct reference point. It then uses the information contained in the charging events to construct charging information records (CIRs). The CCF also supports NGN services which cannot simply be charged by event-based or session-based charging schemes. Some examples of additional charging schemes are data volume-based, flow-based, QoS-based, content-type-based, etc. The received data from the CTF is a flow record of a particular flow of user traffic which needs to be charged. Based on the received data, the CCF performs necessary analysis functions. The analysis functions may include deep packet inspection and others to identify the chargeable events beyond simple events and sessions. The results of the CCF tasks are CIRs with well-defined content and format. The CIRs are later transferred to the billing domain through the CGF via the reference points Cc and Cb. The CCF is used for off-line charging.

Besides the functionality described above, the CCF has the following functionalities:

- receive metered data from the CTF via the Ct reference point in real-time;
- construct CIRs by performing detailed packet or flow analysis functions based on the charging scheme;
- CIRs may be constructed from single charging events, i.e., a 1:1 relation between event and CIR;
- CIRs may be constructed from a set of several charging events, i.e., an n:1 relation between event and CIR;
- each charging event is used for exactly one CIR, i.e., a 1:n relation between event and CIR (with n>1) is not possible within the CCF;
- multiple charging events that are used to create a single CIR may not necessarily be of the same type;
- there is no requirement or assumption of any synchronization between the reception of the charging event(s) and the creation of the resulting CIR. However, the CCF is required to be capable of receiving and processing charging events and generating the resulting CIR in near real-time;
- the relationship between CCF and CTF may be 1:1 (integrated CCF), 1:n or n:1 (separated CCF). This includes the possibility of NEs of different types feeding charging events into the same CCF and one NE providing the same charging event into several CCFs;
- the charging events used to build a CIR may originate from different NEs, (i.e., there is cross-NE correlation of charging events in the CCF) if and only if the charging events contain explicit information to enable correlation;

  NOTE – It is therefore possible for the CCF to create a CIR based on the correlation of charging events that are generated by the same CTF or different CTFs which may reside in different networks.
- various types of CIRs can be per data volume (e.g., data volume for a particular, whole or part of service session), per-flow (e.g., per-medium (e.g., voice, video, data), per-QoS, etc.);
- transfer CIRs to the CGF via the Cc reference point while satisfying the requirements listed in clause 7.3.

8.2.3 Online charging function (OCF)

As described in [ITU-T Y.2012], the OCF receives charging events from the CTF via the Co reference point and executes in near real-time to provide authorization for the chargeable event or network resource usage requested by the authorized user. The CTF must be able to delay the actual resource usage until permission has been granted by the OCF. The OCF provides a quota for

resource usage, which must be tracked by the CTF. Subsequent interactions may result in an additional quota being provided according to the subscriber's account balance, or they may result in no additional quota being provided, in which case the CTF must enforce termination of the end user's network resource usage.

The OCF allows more than one user to share the same subscriber's account simultaneously. The OCF responds to the charging requests from various users at the same time and provides a certain quota to each user. The quota is determined by default or by certain policies. Users can resend requests for larger quotas during the same session. The maximum available quota, however, will not exceed the subscriber's account balance.

The OCF is required to have the capability to construct CIRs for delivery to the CGF per the requirements described for the CCF in clause 8.2.2.

The OCF supports session-based, event-based, and flow-based charging functions.

8.2.4 Rating function (RF)

The RF specifically supports online charging. As described in [ITU-T Y.2012], the RF determines the value of the network resource usage (described in the charging event received by the OCF from the network) on behalf of the OCF. To this end, the OCF furnishes the necessary information to the RF and receives the rating output. The RF calculates and reserves a number of non-monetary units such as service units, data volume, flow volume, time and events. It then determines price by calculating monetary units for a given number of non-monetary units. Finally, it determines tariff information based on the subscribers contractual terms and service being requested.

For offline charging, rating is performed within the billing domain.

8.2.5 Account balance management function (ABMF)

As described in [ITU-T Y.2012], the ABMF stores the subscriber's account balance within the online charging system.

The subscriber's account balance could be represented by the remaining available traffic volume (e.g., bytes), time (e.g., minutes for calling), or content (e.g., a movie), as well as credit. ABMF checks, updates, and reserves the account balance. It may also manage counters for online charging.

As described in [ITU-T Y.2012], the ABMF stores the subscriber's account and service provider's account for 3rd party accounting within the online charging system. The service provider's account balance could be represented by the remaining available traffic volume (e.g., bytes), duration (e.g., minutes for calling), or content (e.g., a movie), as well as credit. The ABMF checks, updates, and reserves the account balance.

Security and robustness should be emphasized by encrypting key data, providing backup and failure alarm capabilities, keeping detailed logs, and so forth.

8.2.6 Charging gateway function (CGF)

The CGF receives CIRs generated by the CCF via the Cc reference point. It plays a gateway role between the NGN network and the billing domain or another NGN CGF. It uses the Cb reference point to transfer CIRs to the billing domain, and the Cp reference point to transfer CIRs to the IPCGF which will further use that information for inter-provider charging information exchanges.

The CGF entity has the following functionalities:

- receive CIRs from the CCF and OCF via reference points Cc and Cg, respectively, in near-real time;
- perform validation, consolidation, correlation, formatting, and error handling of CIRs;
- perform CIR file lifecycle management such as CDR file creation, deletion, and modification;

- perform selection of CIRs for inter-provider charging settlement per NGN provider and transfer them to the IPCGF via the Cp reference point;
- perform a standard-based transfer, that satisfies the requirements listed in clause 7.3, of charging information to the BD and IPCGF.

8.2.7 Inter-provider charging gateway function (IPCGF)

The IPCGF receives CIRs and other processed information from the CGF via the Cp reference point. It adds any additional information needed for inter-provider charging information exchanges. It uses the Ci reference point to transfer further processed CIRs to another NGN IPCGF. The Ci reference point is used to communicate CIRs for the settlement between NGN providers. It allows NGN providers to exchange CIRs in real-time over standardized interface.

The IPCGF entity has the following functionalities:

- receive CIRs from the CGF via Cp reference points;
- construct CIRs for inter-provider charging settlement. CIRs are constructed per provider basis. The CIRs can be of various types (duration-based, volume-based, event-based, etc.) depending on the settlement policy between the involved providers;
- perform standard-based transfer, that satisfies the requirements listed in clause 7.3, of charging information to the IPCGF in other NGN providers.

8.3 Reference points

8.3.1 Reference point Ct

The Ct reference point is required to support the interaction between the CTF and the CCF. The following information flows across this reference point in real-time:

- charging events for offline charging from the CTF to the CCF;
- flow-based charging events for offline charging from the CTF to the CCF;
- acknowledgements for these events from the CCF to the CTF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- real-time transactions;
- stateless mode ("event-based charging") and stateful mode ("session-based charging") of operation;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

The protocol(s) crossing this reference point may support the following capability:

- Many-to-one operation modes. Multiple CTFs may interact with a CCF. It is recommended that the CTF interacts with a single CCF to avoid potential double-billing.

The Ct reference point is an intra-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events will be specified in an interface and protocol specification and are out of scope of this Recommendation.

8.3.2 Reference point Co

The Co reference point is required to support the interaction between the CTF and the OCF. The following information flows across this reference point in real-time:

- charging events for online charging from the CTF to the OCF;
- flow-based charging events for online charging from the CTF to the OCF;

- response for these events from the OCF to the CTF. The response grants or rejects the network resource usage requested in the charging event, according to the decision taken by the OCF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- real-time transactions;
- stateless mode ("event-based charging") and stateful mode ("session-based charging") of operation;
- reliable and secure transport based on the protocol requirements given in clause 7.3;
- many-to-one operation modes. Multiple CTFs may interact with an OCF. It is recommended for the CTF to interact with a single OCF to avoid potential double-billing;

The Co reference point is an intra-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.3 Reference point Cc

The Cc reference point supports interaction between the CCF and the CGF. The following information flows across this reference point:

- CIRs are sent from the CCF to the CGF;
- acknowledgements for these CIRs are returned from the CGF to the CCF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- near real-time transactions;
- send one or more CIRs in a single request message;
- changeover to secondary destinations (alternate CGFs) in case of the primary CGF not being reachable;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

The Cc reference point is an intra-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.4 Reference point Cg

The Cg reference point supports interaction between the OCF and the CGF. The following information flows across this reference point:

- CIRs are sent from the OCF to the CGF;
- acknowledgements for these CIRs are returned from the CGF to the OCF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- near real-time transactions;
- capability to send one or more CIRs in a single request message;
- changeover to secondary destinations (alternate CGFs) in case of the primary CGF not being reachable;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

The Cg reference point is an intra-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.5 Reference point Cr

The Cr reference point supports interaction between the OCF and the RF in order to determine the value of chargeable events in terms of monetary or non-monetary units. The following information flows across this reference point:

- price request messages sent from the OCF to the RF;
- replies including price and counter information is returned from the RF to the OCF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- real-time transactions;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.6 Reference point Ca

The Ca reference point allows the interaction between the OCF and the ABMF in order to access the account of the subscriber on the OCF.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.7 Reference point Cb

The Cb reference point supports interaction between a charging gateway function and the billing domain. The information crossing this reference point is comprised of CIR files. A common, standard file transfer protocol (e.g., FTAM, FTP) is required to be used, including the transport mechanisms specified for the selected protocol.

The Cb reference point is an inter-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.8 Reference point Cp

The Cp reference point is required to support interaction between the CGF and the IPCGF. The following information flows across this reference point in real-time:

- CIRs are sent from the CGF to the IPCGF;
- acknowledgements for these CIRs are returned from the IPCGF to the CGF.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- near real-time transactions;
- stateful mode of operation;
- reliable and secure transport based on the protocol requirements given in clause 7.3;
- many-to-one operation modes. Multiple CGFs can interact with a single IPCGF.

The Cp reference point is an intra-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.9 Reference point Ci

The Ci reference point supports interaction between two IPCGFs in different NGN provider domains. The information crossing this reference point is comprised of CIR files which are additionally processed for inter-provider settlement. A common, standard file transfer protocol or

real-time protocols is required to be used, including the transport mechanisms specified for the selected protocol.

The Ci reference point is an inter-domain reference point.

The detailed information elements contained in the charging events and the relevant chargeable events are out of scope of this Recommendation.

8.3.10 Reference point Ce

The Ce reference point is required to support interaction between the CTF and the PE-FE. The following information flows across this reference point in real-time:

- charging policies and rules from the PE-FE to the CTF;
- charging control request from the CTF to the PE-FE;
- acknowledgements for these interactions between the CTF and the PE-FE.

The protocol(s) crossing this reference point is(are) required to support the following capabilities:

- real-time transactions;
- stateless mode ("event-based charging") and stateful mode ("session-based charging") of operation;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

The protocol(s) crossing this reference point may support the following capability:

- One-to-many operation modes. A PE-FE may interact with multiple CTFs. It is recommended for the CTF to interact with a single PE-FE to avoid the need to reconcile policy information received from multiple, potentially conflicting, sources.

The Ce reference point is an intra-domain reference point.

The detailed information elements contained in the relevant events will be specified in an interface and protocol specification and are out of scope of this Recommendation.

8.3.11 Reference point Cx

The Cx reference point allows the interaction between the recharging AS-FE and the ABMF in order to allow charging account balance information to be updated in real-time.

The detailed information elements contained in the recharging messages and events are out of scope of this Recommendation.

8.3.12 Reference point Rw

The Rw reference point is defined in [ITU-T Y.2111]. This reference point allows the final admission and charging decisions to be installed (either pushed or pulled) to the PE-FE from the PD-FE.

The Rw reference point is an intra-domain reference point.

8.3.13 Reference point Rs'

The Rs' reference point is required to support interaction between the PD-FE and the CTF in the service stratum. This reference point is the extension of the Rs defined in [ITU-T Y.2111]. The current Rs reference point lacks communication from PD-FE to SCF. The Rs' reference point extends such capability to support delivery of charging policies and rules. The following information flows across this reference point in real-time:

- charging policies and rules from the PD-FE (and obtained from the SUP-FE) to the CTF in the service stratum;
- acknowledgements for charging policies and rules from the CTF to the PD-FE.

This reference point is required to support the following capabilities:

- real-time transactions;
- stateless mode ("event-based charging") and stateful mode ("session-based charging") of operation;
- reliable and secure transport based on the protocol requirements given in clause 7.3.

This reference point may support the following capability:

- One-to-many operation modes. A PD-FE can interact with multiple CTFs in the service stratum. It is recommended for the CTF to interact with a single PD-FE to avoid the need to reconcile policy information received from multiple, potentially conflicting, sources.

The Rs' reference point is an intra-domain reference point.

8.3.14 Reference point Rr

The Rr reference point is required to support interaction between the PD-FE and SUP-FE in the service stratum.

The Rr reference point is an intra-domain reference point.

The detailed information elements contained in the service user profile and policy information exchanged between the SUP-FE and PD-FE are out of scope of this Recommendation.

8.4 Relationship with other NGN functional entities

The NGN CAF described in clause 8.2 depends on interactions with several other NGN functional entities that are generally described in [ITU-T Y.2012]. The following provides a summary of the other functional entities presented in Figure 1 and the relationship each has to the CAF.

8.4.1 Policy decision functional entity (PD-FE)

The PD-FE is a component of the resource and admission control functions (RACF) of the NGN, and is defined in [ITU-T Y.2111]. The PD-FE handles the QoS resource requests received from the SCF via the Rs reference point. Among other functions, the PD-FE makes the final admission decision for media flows of a given service based on network policy rules, service information, transport subscription information, and resource availability. The PD-FE controls can impact QoS parameters, bandwidth limits of flows, firewall packet inspection and filtering modes, core network ingress/egress path selections, etc.

The charging policy management function of the PD-FE interacts with the charging policy repository to retrieve charging policies and rules and transfer them to the CTF (via the PE-FE for the CTF within the transport function). How such policies and rules are created and stored are out of scope of this Recommendation. Assumption is given that such policies and rules are managed by the billing system.

8.4.2 Policy enforcement functional entity (PE-FE)

The PE-FE resides in the transport stratum, as defined in [ITU-T Y.2111]. It acts as the conduit for information from the PD-FE to the CTF. More generally, it acts as a packet-to-packet gateway at the boundary of different NGN networks and/or between the customer premises network and the NGN access network. The gate functions performed by the PE-FE are based on the PD-FE controls that are exerted at a per-flow level.

PE-FE functions that apply to charging and accounting include:

- delivering charging policies and rules received from PD-FE to CTF;
- traffic policing and shaping based on the session control request received from CTF; and

- packet-filtering-based firewall: inspecting and dropping packets based on pre-defined static security policy rules and gates installed by the PD-FE.

  There are four packet inspection modes for packet-filtering-based firewall:

  – static packet filtering: inspecting packet header information and dropping packets based on static security policy rules or the session control request received from the CTF. This is the default packet inspection mode applied for all flows;

  – dynamic packet filtering: inspecting packet header information and dropping packets based on static security policy rules, dynamic gate status, and/or the session control request received from the CTF;

  – stateful inspection: inspecting packet header information as well as TCP/UDP connection state information and dropping packets based on static security policy rules and dynamic gate status;

  – deep packet inspection: inspecting packet header information, TCP/UDP connection state information and the content of payload together, and dropping packets based on static security policy rules and dynamic gate status.

8.4.3 Other NGN charging and accounting functions

This group of functional entities represents CAF for other NGN operators. When usage measurements are shared with other NGN operators, the IPCGF ensures that CIRs are properly formatted based on the settlement policy between the involved providers.

8.4.4 Service user profile functional entity (SUP-FE)

The SUP-FE is defined in [ITU-T Y.2012]. This FE is responsible for storing user profiles, subscriber-related location data, and presence status data in the service stratum. It performs basic data management and maintenance functions.

While the SUP-FE has broader capabilities, a user profile is required to be provided in support of charging. It provides information on permitted services, subscriber mobility, location and presence information that can be relevant for charging, authentication, and authorization. Most notably, the profile information on charging provides subscriber's charging plans.

When the PD-FE requests a charging plan of the customer to SUP-FE, it gives subscriber's information to the PD-FE. The PD-FE chooses an appropriate accounting policy based on the subscriber's charging plan and delivers it to the CTF via the PE-FE.

8.4.5 Recharging AS-FE

This FE is responsible for providing connection points to a customer or 3rd party who needs to change the charging policy and to update their account in real-time. Customers can choose and change charging policy and refill their account with this function. 3rd parties can also update their account via this function. The recharging AS-FE is a specialized instance of AS-FE to support charging. A general definition of AS-FE is provided in [ITU-T Y.2012].

8.5 Billing domain

The billing domain is the part of the operator network that receives and processes charging information from the NGN charging functions. As a business support function, the billing domain is outside the NGN functional architecture. It includes functions that can provide billing mediation and billing end applications such as invoicing (including determination of adjustments, discounts, rebates and credits), payment processing, and collection management.

9 Security consideration

This Recommendation aligns with the security requirements in [ITU-T Y.2701].

Appendix I

Offline and online charging scenarios

(This appendix does not form an integral part of this Recommendation)

In these scenarios, a customer connects to an NGN network and uses a transport service or an application. For example, the customer might use a session-based service like VoIP or an event-based service such as the short message service.

The scenarios presented in this appendix are organized as follows:

I.1 Offline charging scenario based on events

I.2 Offline charging scenario based on session

I.3 Scenario for CIRs aggregation

I.4 Online charging scenario based on policy

I.1 Offline charging scenario based on event

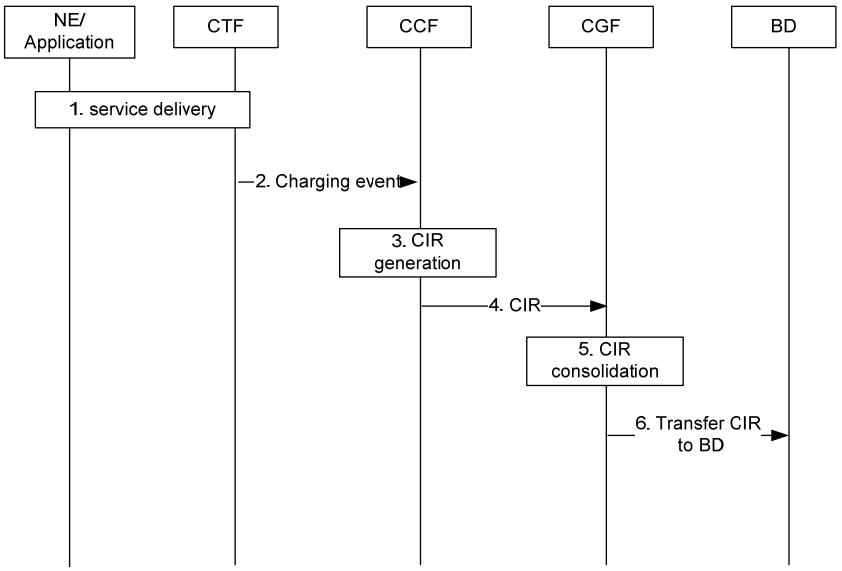

Figure I.1 – Offline charging based on events

1. The requested service is delivered by a network element (transport stratum entity) or an application (service stratum entity).
2. The CTF associated with the network element or application is triggered and then sends notification of the chargeable event to the CCF.
3. The CCF generates a CIR including charging information received from the CTF.
4. The CCF sends the CIR to the CGF.
5. The CGF shall execute the CIR's consolidation and generate a new CIR including all charging event information generated during this service delivery.
6. The CGF sends the consolidated CIR to the BD (billing domain).

I.1.1 Example of offline charging scenario based on events

The following is a specific example of a scenario involving event-based charging for a service stratum event. In this scenario, an end user queries a directory listing service to obtain a telephone number or URL based on the name of a business or resident. The information is provided by the directory services provider via a directory services application server (AS-DS) functional entity.

Upon receipt of the information, the end user might decide to immediately connect to the subject of the directory services query, or might record the information for future reference. Hence, the service event occurs independently of transport services. When a response to the query is delivered to the end user, usage accounting data is created within the NGN service stratum and processed using the offline charging procedures of the NGN charging and accounting functions (CAF).

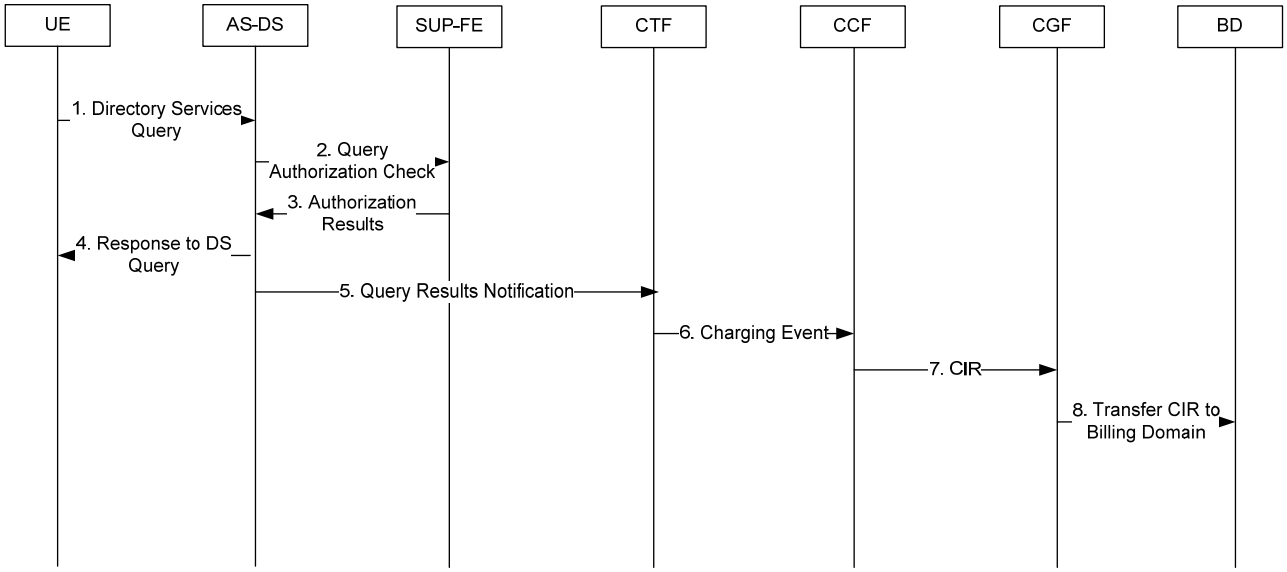

Figure I.2 – Example of event-based offline charging

1. The AS-DS receives a directory services query from the end user equipment (UE).
2. The AS-DS queries the service user profile functional entity (SUP-FE) to validate that the end user is authorized to perform a directory services query.
3. The SUP-FE will perform end-user authentication and will authorize the end user to use the application service based on profile information. The SUP-FE will inform the AS-DS of the authentication and authorization results.
4. Assuming the end user is authorized to use the service, the AS-DS will retrieve the requested directory listing information from the databases associated with this application. The AS-DS will provide a response to the end user based on the results of the directory services information retrieval procedure.
5. The AS-DS will notify the service stratum charging trigger function (CTF) of the directory services query event and results.
6. The CTF will utilize policy information provided from the PD-FE to determine whether the query is a chargeable event. For example, the policy might specify that the delivery of directory listing information is a chargeable event, but that there should be no charges for the directory service query if no directory listing is found that matches the query parameters. If the query is a chargeable event, the CTF will deliver the related charging event to the charging collection function (CCF).
7. The CCF will generate a charging information record (CIR) for the directory services chargeable event. Depending on the CIR generation policy, the CCF will create a single CIR for each directory services query chargeable event, or will aggregate chargeable events recorded during a specified time period into a single CIR. The CCF will deliver the formatted CIR to the charging gateway function (CGF).
8. The CGF consolidates CIR(s) for delivery to the billing domain. The CGF then delivers the CIR(s) to the billing domain for rating and invoicing.

I.2 Offline charging scenario based on sessions

I.2.1 Procedure for session initiation

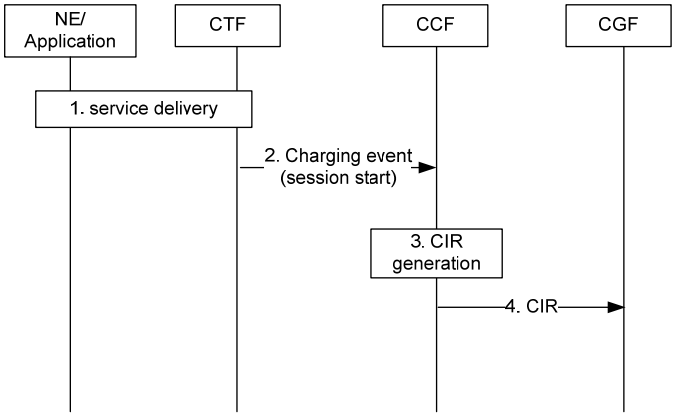

Figure I.3 – Session initiation for session-based offline charging

1. The requested service delivery is initiated (e.g., the start of a multimedia service session).
2. The CTF related to each network element or application involved in the service delivery sends notification of the chargeable event to the CCF.
3. The CCF generates a CIR including charging information received from the CTF.
4. The CCF sends the CIR to the CGF per the charging policy established. For example, the CIR might be sent when a threshold is reached (volume, timer, etc.).

I.2.2 Procedure for session modification

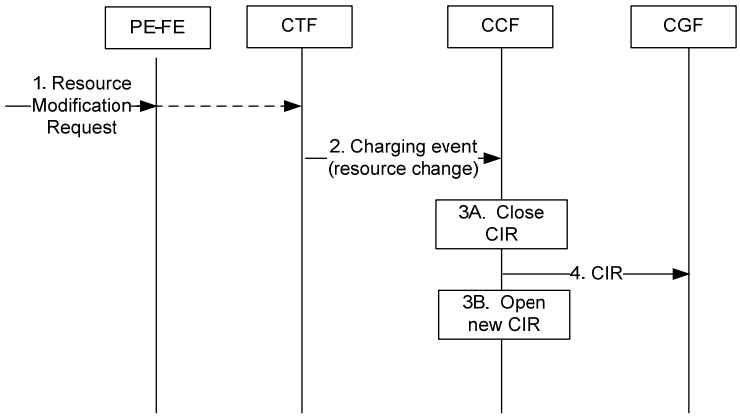

Figure I.4 – Session modification for session-based offline charging

1. The RACF instructs the PE-FE to enforce a new policy by sending an RMR (resource modification request) if some changes (bandwidth, etc.) have happened during the service delivery.
2. The CTF associated with the same network element as the PE-FE sends a charging event to the CCF indicating the resource modification has occurred
3. The CCF shall close the previous CIR and open a new CIR to collect charging information related to the new service session characteristics.
4. The CCF shall send the closed CIR including PE-FE's charging information to the CGF. The CGF shall cache this CIR for later delivery to the BD based on termination of the service session or other events as dictated by the charging policy.

I.2.3 Procedure for session release

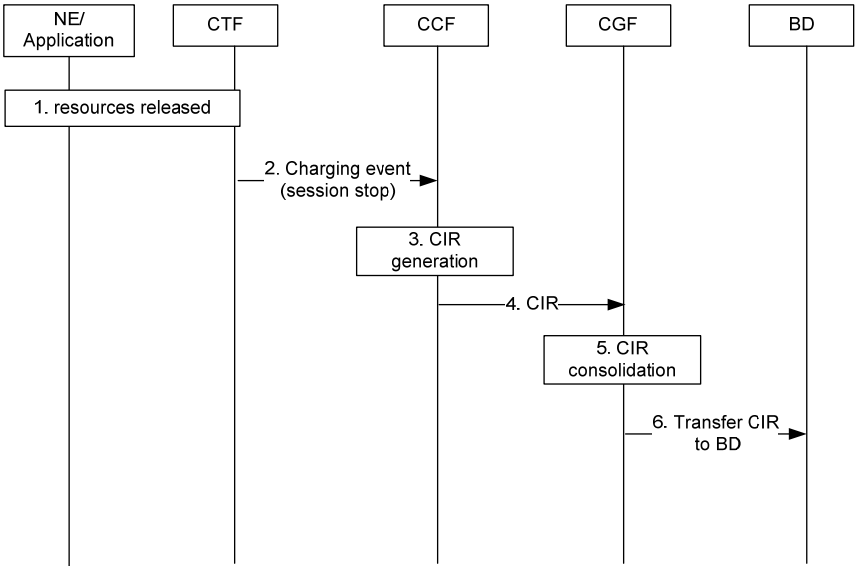

Figure I.5 – Session release for session-based offline charging

1. The requested service is released at each NE and application involved in the service. (The release of resources may be due to either end-user or PE-FE action to terminate the service delivery.)
2. The CTF related to each network element or application involved in the service delivery sends notification of the chargeable event to the CCF; the charging event shall include indication that the service session has been released and this is final charging data.
3. The CCF generates a CIR including the final charging data received from the CTF.
4. The CCF sends a CIR to the CGF for each network element and application involved in the service session.
5. The CGF shall execute the CIRs' consolidation. Based on the policy, the CCF might deliver a separate CIR for charging information received from each network element and application involved in the service session, or might correlate chargeable events to create a single CIR that aggregates the charging information received from multiple network elements and applications involved in the session (see clause I.3).
6. The CGF sends the consolidated CIR(s) to the BD (billing domain).

I.2.4 Example of offline charging based on a dynamic charging policy

The following provides an example of offline charging for a complete service session. This example includes interactions with RACF entities to acquire dynamic charging policy information.

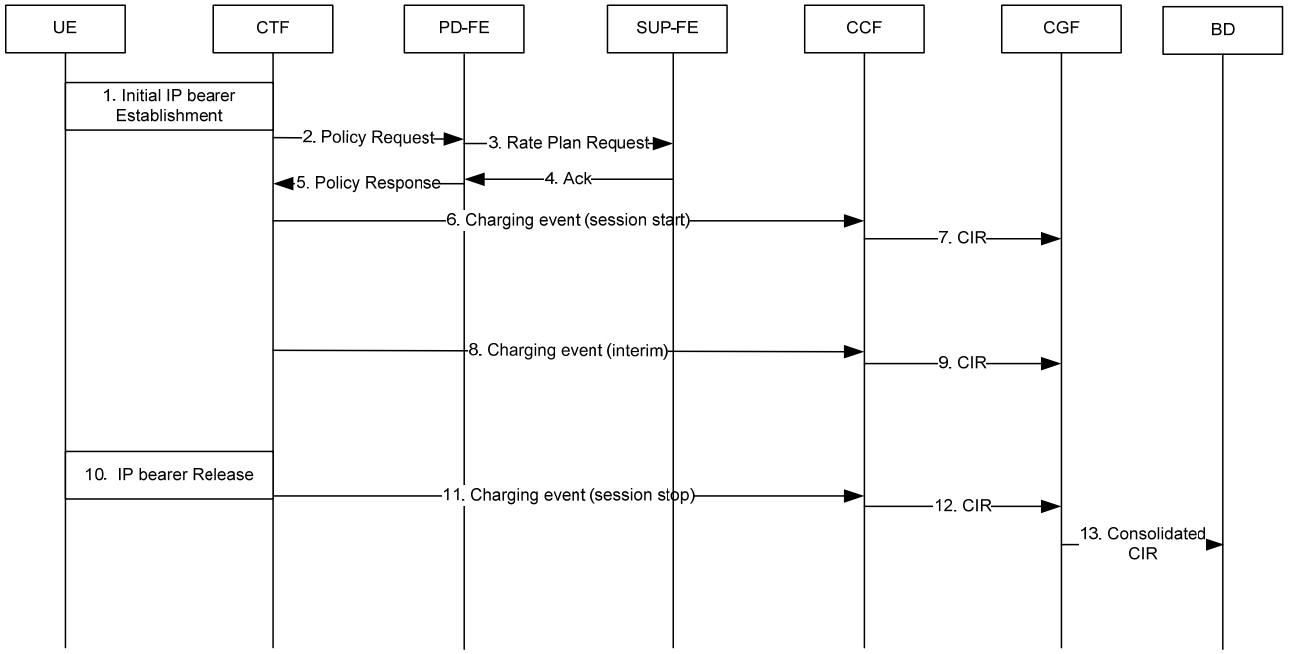

Figure I.6 – Example of offline charging based on a dynamic charging policy

1. The end user equipment (UE) first connects to the Internet via the NGN service provider. During this process, the UE is allocated a new IP address by an authentication and authorization function. The UE then initiates best-effort Internet applications such as web, FTP, and/or e-mails.
2. Such application services trigger the involved CTF to request the subscriber's policy from the PD-FE.
3. The PD-FE queries the SUP-FE for the subscriber's charging policy.
4. The SUP-FE responds with the requested information.
5. The PD-FE sends the charging policy, which is created according to the subscriber's charging policy, to the CTF via the PE-FE.
6. The CTF starts to meter the customer traffic with the enforced charging policy and sends a charging event message to the CCF to indicate the start of the service session.
7. The CCF then creates a CIR and transfers it to the CGF.
8. If warranted, the CTF creates an interim charging event according to specific criteria (limited volume, limited time, etc.) and transfers it to the CCF.
9. The CCF then creates a CIR and transfers it to CGF.
10. The UE finishes its service session and the IP connection is closed.
11. The CTF finishes metering of the customer traffic and sends a charging event message to the CCF to indicate that the service session has ended.
12. The CCF generates a CIR indicating the session has ended and sends the CIR to the CGF.
13. The CGF correlates CIRs and generates final charging information. The CGF then sends the consolidated CIR to the billing domain (BD).

I.3 Scenario for CIRs aggregation

This charging scenario illustrates the role of the CGF in aggregating charging information received from multiple functional entities involved in a session to provide a single consolidated CIR for the session. In this example, the following functional entities are involved in the session:

a) NAC-FE: Network access configuration functional entity;

b) CSC-FE: Call session control functional entity;

c) AS-FE: Application support functional entity;

d) MRC-FE: Media resource control functional entity.

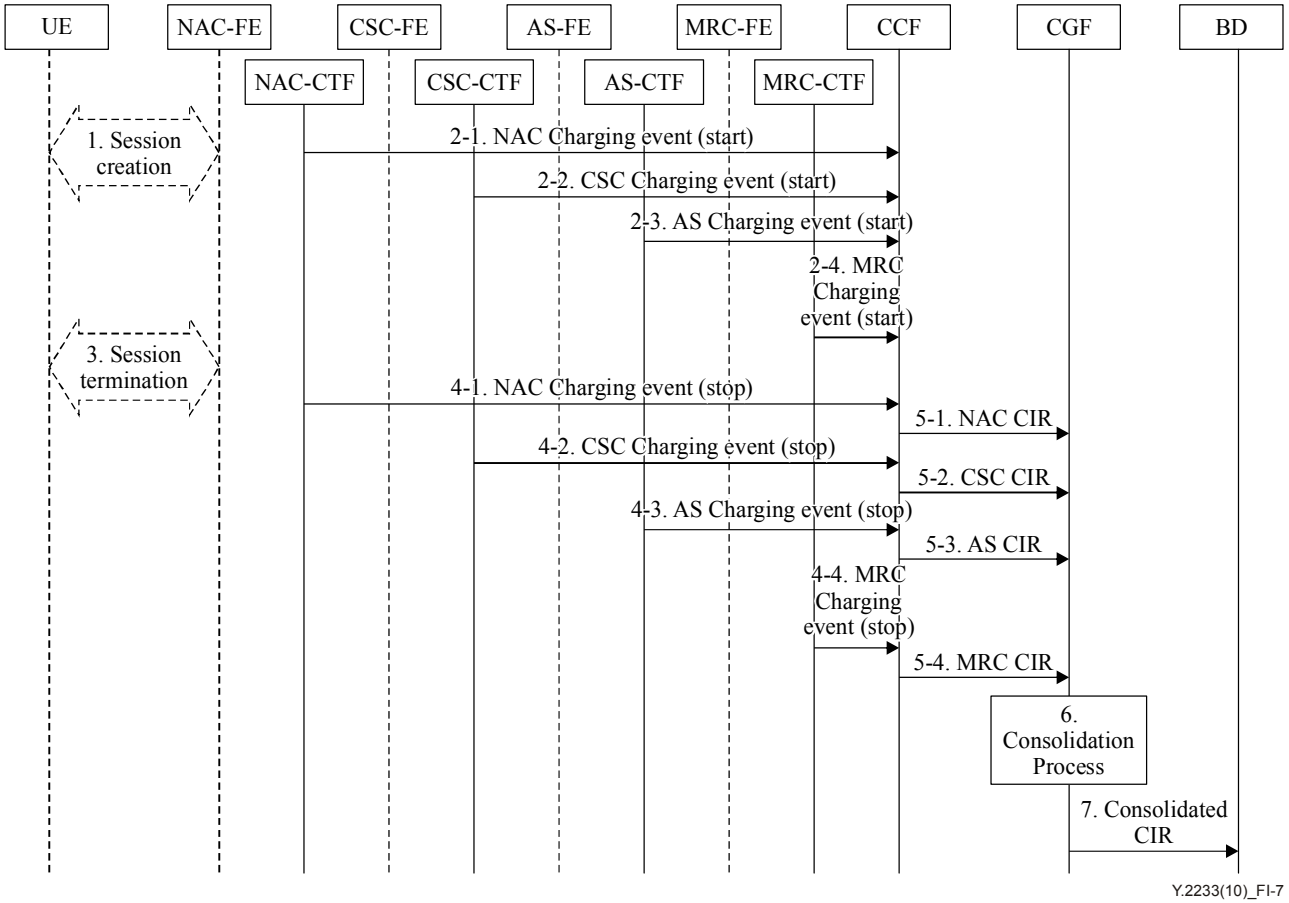

Figure I.7 – CIR aggregation

1. The end user equipment (UE) initiates a session.
2. (Steps 2-1, 2-2, 2-3 and 2-4). As each network element (NE) and application becomes involved in this session, the CTF associated with each NE and application sends to the CCF a charging event indicating the session initiation.
3. The UE terminates the session.
4. (Steps 4-1, 4-2, 4-3 and 4-4). The CTF associated with each NE and application involved in the session sends a charging event to the CCF indicating the session termination.
5. (Steps 5-1, 5-2, 5-3 and 5-4). The CCF generates a CIR based on the charging events received from each of the different NEs and applications involved in the session, and transfers each CIR to the CGF.
6. The CGF consolidates all CIRs into a new CIR that includes all charging information in the session.
7. The CGF transfers this new CIR to the billing domain (BD).

I.4 Online charging scenario based on policy

I.4.1 Procedure for session initiation

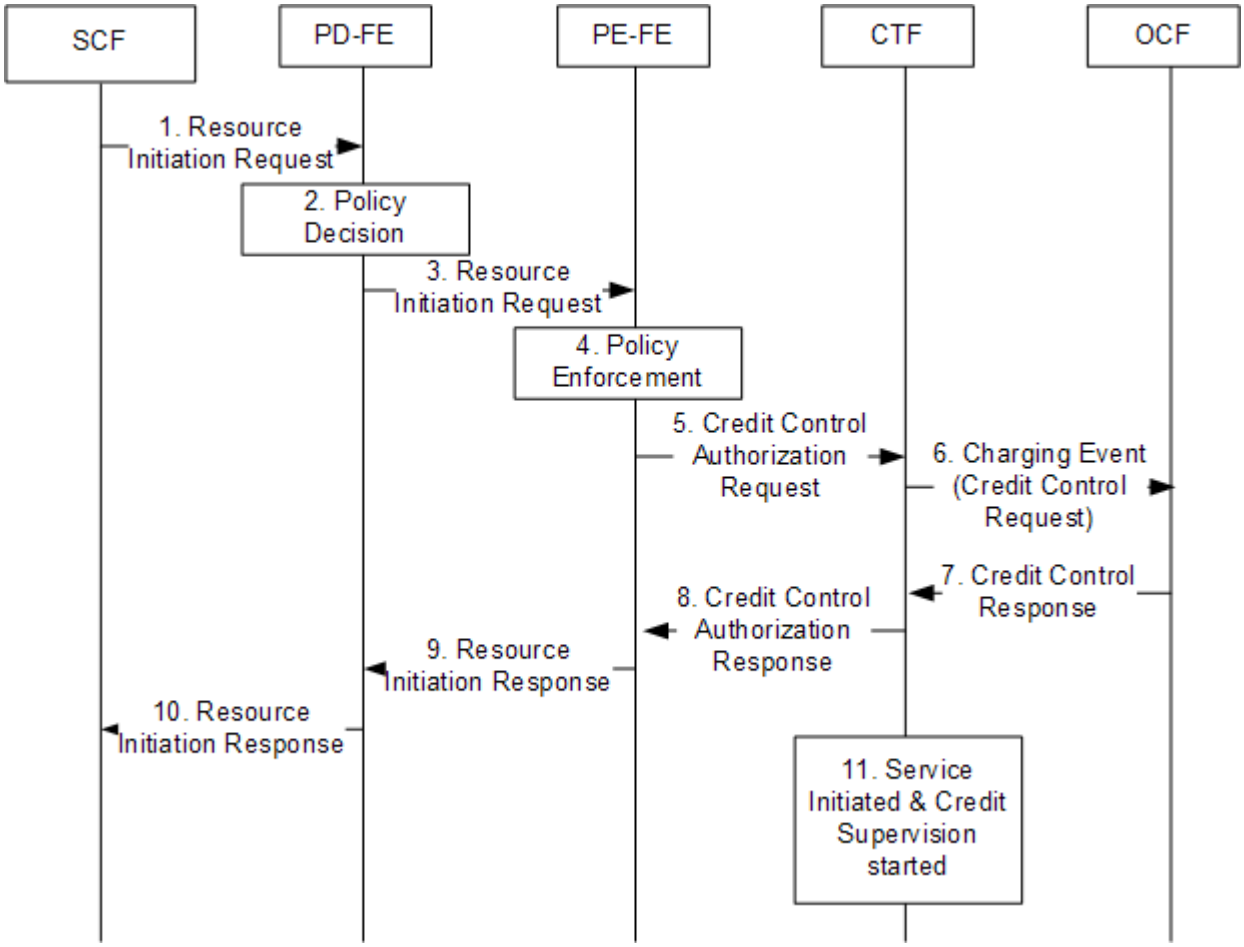

Figure I.8 – Session initiation for policy-based online charging

1. The PD-FE receives a resource initiation request from the SCF for the requested service.
2. The PD-FE makes a policy decision per the service information (service class, etc.).

3-4. The PD-FE requests the PE-FE to enforce the policy.

5-6. The PE-FE sends credit control authorization to OCF via the CTF.

7-8. The OCF checks account balance and tariff information (see clause I.4.4, steps 8-11 for further detail). The OCF then returns the credit control response back to the PE-FE via the CTF; this message includes the result of OCF's authorization. If authorization fails, the response from the OCF indicates the PE-FE should terminate this session; else the OCF reserves some units for this service.

9. The PE-FE enforces the final policy per the credit control response from the OCF: if authorization fails, PE-FE shall notify PD-FE that resource cannot be reserved. PE-FE returns the resource initiation response to PD-FE.
10. PD-FE returns the resource initiation response to SCF.
11. PE-FE and CTF start credit supervision function if the requested service starts normally.

I.4.2 Procedure for session modification

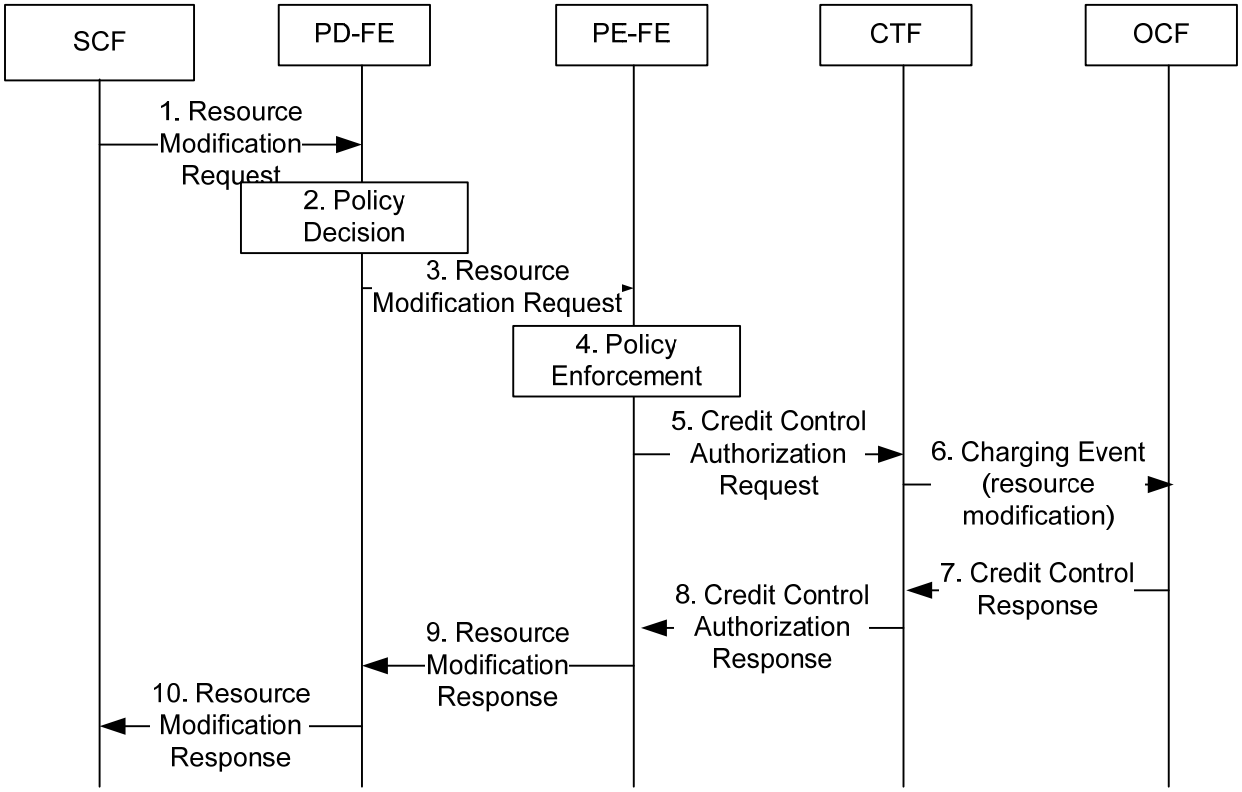

Figure I.9 – Session modification for policy-based online charging

1. The SCF notifies the PD-FE by sending a resource modification request if some changes (bandwidth, etc.) happened during service delivery.
2. The PD-FE makes a policy decision per the new service information.

3-4. The PD-FE sends the new policy for the PE-FE to enforce.

5-6. The PE-FE sends credit control authorization request to the OCF to re-authorize after receiving the resource modification request from the PD-FE. If authorization fails, the OCF indicates the PE-FE, via the CTF, which formats the changing event to include an indication of unconsumed units existing before the service is modified.

7-8. The OCF checks account balance and tariff information (see clause I.4.4, steps 8-11 for further detail). If authorization fails, the OCF notifies the PE-FE via the CTF to terminate this session; else the OCF reserves some units for this service. The OCF returns a credit control response back to the PE-FE via the CTF; this message includes the result of the OCF's authorization.

9. PE-FE enforces the final policy per the credit control response message from the OCF. If the authorization fails, the PE-FE notifies the PD-FE that resource cannot be reserved. PE-FE returns the resource modification response to PD-FE.

10. PD-FE returns the resource modification response to SCF.

I.4.3 Procedure for session release

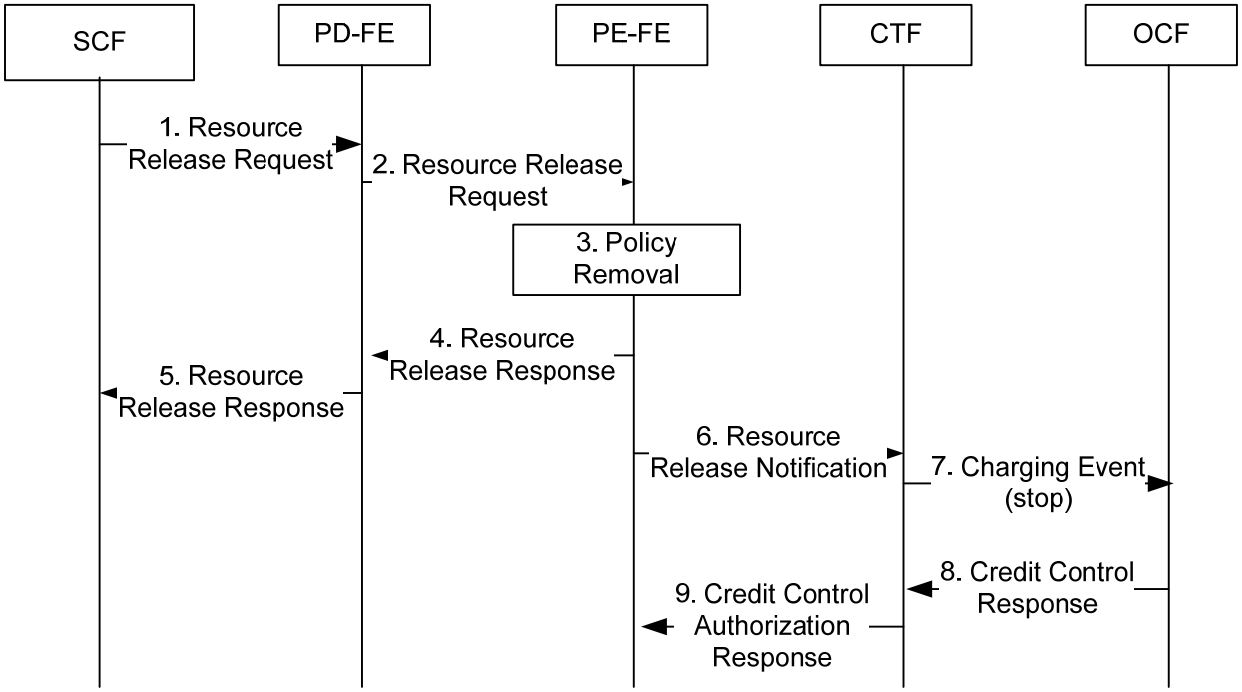

Figure I.10 – Session release for policy-based online charging

1. The SCF sends a resource release request to the PD-FE when the requested service is released.
2. The PD-FE sends a resource release request to the PE-FE.
3-4. The PE-FE shall remove the related policy and then return a resource release response to the PD-FE.
5. The PD-FE sends the resource release response to the SCF.
6-7. The PE-FE shall send a resource release notification to the OCF as a charging event delivered via the CTF; this charging event reports final consumed units.
8-9. The OCF completes the release operations related to the user account (for example, debit the customer account through interactions with the ABMF) and notifies the PE-FE of the credit control update.

I.4.4 Online charging based on a dynamic charging policy

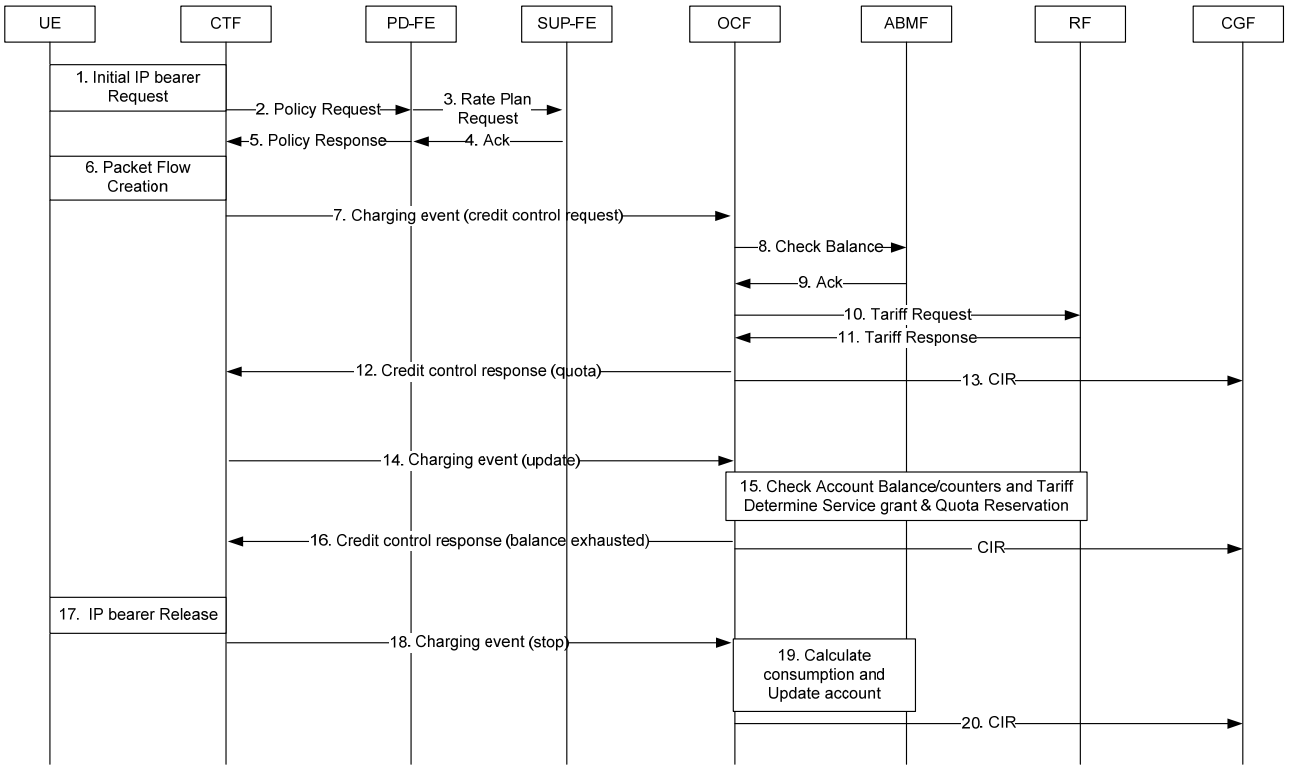

Figure I.11 – Online charging based on a dynamic charging policy

1. The UE first connects to the Internet via the NGN service provider. During this process the UE is allocated with a new IP address by an authentication and authorization function. The UE then initiates best-effort Internet applications such as web access, FTP, and/or e-mails.
2. Such application services trigger the involved CTF to request the subscriber's policy from the PD-FE.
3. The PD-FE queries the SUP-FE for the subscriber's charging policy.
4. The SUP-FE responds with the requested information, if available.
5. The PD-FE sends the charging policy, which is created according to subscriber's rate plan, to the CTF. The CTF recognizes that the subscriber's service needs to be charged online through its charging policy.
6. When the subscriber's service is initiated, the CTF starts to meter its traffic.
7. The CTF buffers the service packet at the beginning phase while sending an initial charging event (credit control request) to the OCF.
8. The OCF requests the customer's credit balance from the ABMF. If the service is supposed to be charged to a service provider's account, the OCF requests the service provider's credit balance.
9. The OCF receives a result of the credit balance from the ABMF.
10. The OCF requests tariff information applicable for this transport/service session to the RF. If the service is supposed to be charged to a service provider's account, the OCF requests the service provider's tariff information.
11. The OCF receives the tariff from the RF. Then the OCF determines the customer's quota after rating and account/counter control.
12. The OCF generates a credit control response message including customer's quota, validity-time, and tariff-time-change and sends it to the CTF.

13. The OCF sends a CIR to the CGF.
14. The CTF generates a charging event including used units to the OCF, when the customer's quota is exhausted or validity-time/tariff-time-change are triggered.
15. The OCF adjusts tariff and credit balance information following a similar procedure as in steps 8-11.
16. The OCF generates a credit control response message indicating the account balance is exhausted and sends it to the CTF, and at the same time sends a CIR to the CGF.
17. IP connection termination requested.
18. The CTF sends to the OCF a charging event that indicates the session termination and identifies the units used.
19. The OCF performs final rating for the consumed session resources and adjusts the account/counter information for the session. The OCF creates a CIR indicating the session termination.
20. The OCF sends the CIR to the CGF.

I.4.5 Scenario of refilling accounts by a customer in online charging

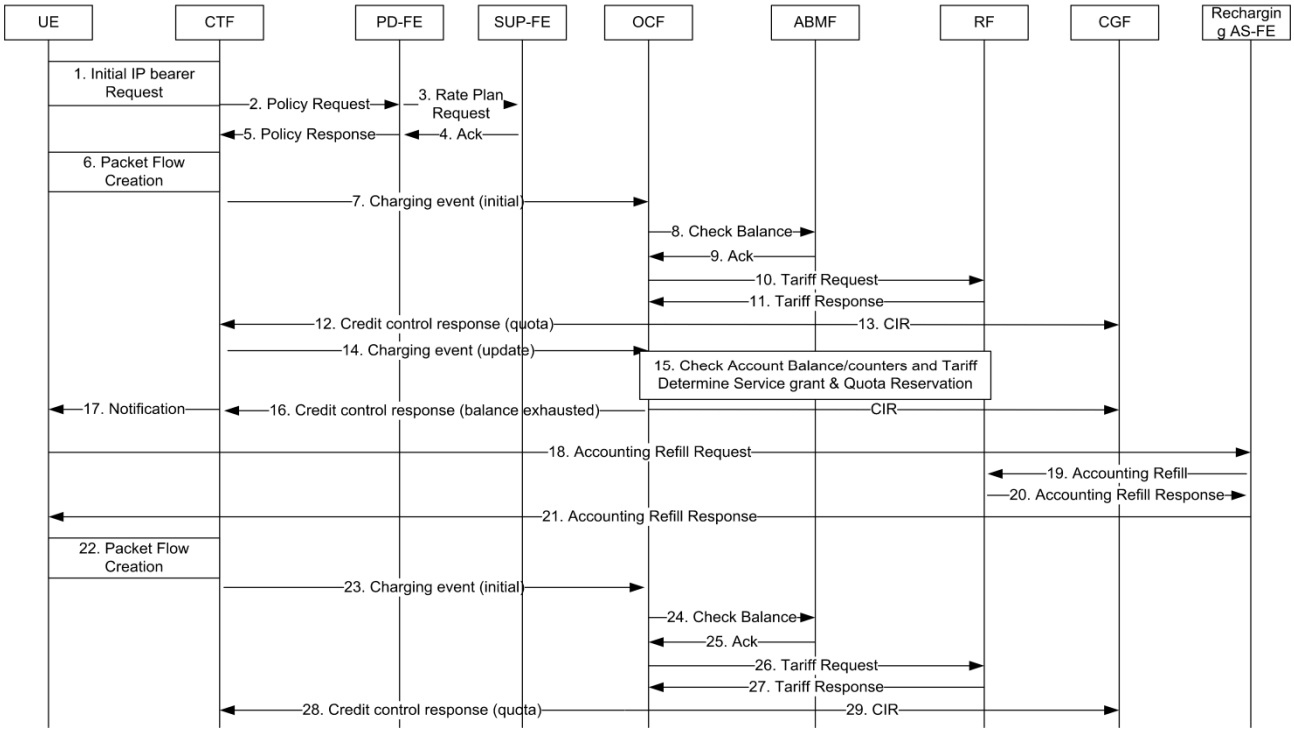

Figure I.12 – Account refilling by a customer in online charging

1. The UE first makes a connection to the Internet via the NGN service provider. During this process, the UE is allocated with a new IP address by an authentication and authorization function. The UE then initiates best-effort Internet applications such as web access, FTP, and/or e-mails.
2. Such application services trigger the involved CTF to request the subscriber's policy from the PD-FE.
3. The PD-FE queries the SUP-FE for the subscriber's rate plan.
4. The SUP-FE responds with the requested information, if available.
5. The PD-FE sends the charging policy, which is created according to subscriber's rate plan, to the CTF. The CTF recognizes that the subscriber's service needs to be charged online through its charging policy.

6. When the subscriber's service is initiated, the CTF starts to meter its traffic.
7. The CTF buffers the service packet at the beginning phase while sending an initial charging event to the OCF.
8. The OCF requests the customer's credit balance from the ABMF. If the service is supposed to be charged to a 3rd party account, the OCF requests the 3rd party's credit balance.
9. The OCF receives a result of the credit balance from ABMF.
10. The OCF requests tariff information applicable for this transport/service session from the RF. If the service is supposed to be charged to a 3rd party account, the OCF requests the 3rd party's tariff information.
11. The OCF receives the tariff and tariff-time-change result from the RF. Then the OCF determines the customer's quota after rating and account/counter control.
12. The OCF generates a credit control response message including the customer's quota, validity-time, and tariff-time-change and sends it to the CTF.
13. The OCF sends a CIR to the CGF, simultaneously with step 12.
14. The CTF generates an update charging event including used units to the OCF, when the customer's quota is exhausted or validity-time/tariff-time-change is triggered.
15. The OCF adjusts tariff and credit balance information following a similar procedure as in steps 8-11.
16. When the customer's account balance is exhausted, the OCF generates a credit control update message indicating exhaustion of account and sends it to the CTF, and at the same time sends a CIR to the CGF.
17. The CTF announces the subscriber's account status to the UE.
18. If the subscriber wants to refill its account, the UE asks the recharging AS-FE to refill account.
19. The recharging AS-FE reports to the ABMF refilling the subscriber's account.
20. The ABMF sends an acknowledgement of the account refill to the recharging AS-FE.
21. The subscriber receives a result of the request for account refill.
22. After the subscriber recognizes that its account is refilled, a new service flow starts. Before the completion of the account refill, all of the customers' traffic is blocked.
23. The CTF sends an initial charging event related to the new service flow.
24. The OCF requests the customer's credit balance to the ABMF. If the service is supposed to be charged to a 3rd party account, the OCF requests the 3rd party's credit balance.
25. The OCF receives a result of credit balance from the ABMF.
26. The OCF requests tariff information applicable for this transport/service session to the RF. If the service charged is a 3rd party account, the OCF requests the 3rd party's tariff information.
27. The OCF receives tariff and tariff-time-change result from the RF. Then the OCF determines the customer's quota after rating and account/counter control.
28. The OCF generates a credit control message including the customer's quota, validity-time, and tariff-time-change and sends it to the CTF.
29. The OCF sends a CIR to the CGF simultaneously with step 28.

I.4.6 Scenario of changing the charging policy by a customer

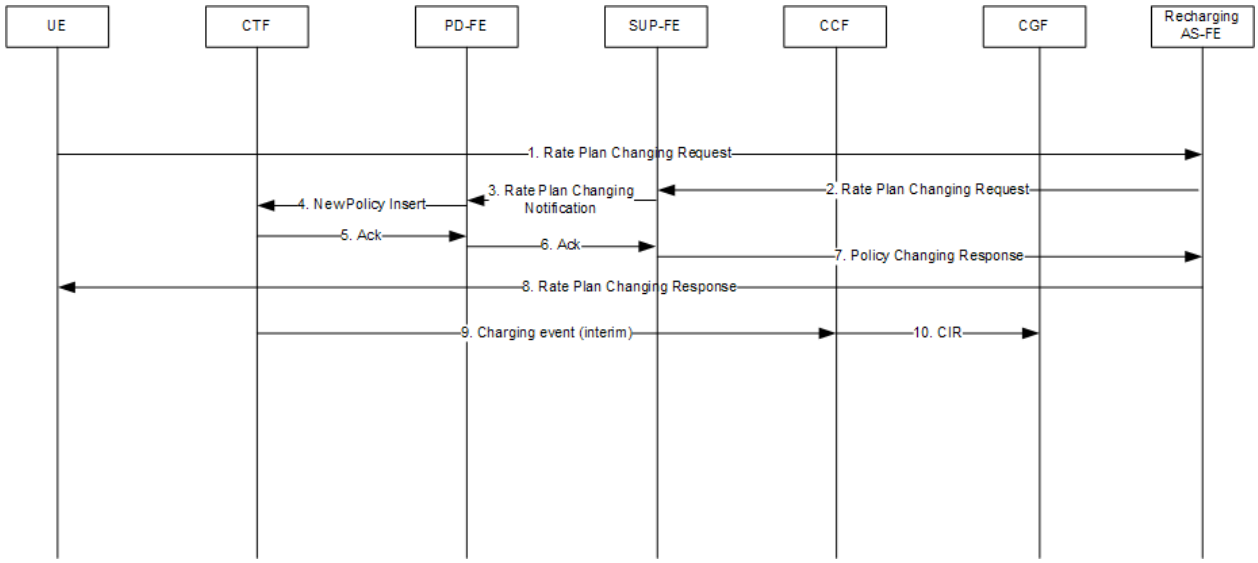

Figure I.13 – Customer-initiated policy change

1. When a customer wants to change its charging policy during a service, the customer asks the recharging AS-FE to change the charging policy.
2. The recharging AS-FE requests the SUP-FE to change the user's charging policy.
3. The SUP-FE then sends a notification of charging policy changes to the PD-FE.
4. The PD-FE inserts the new charging policy which is created with the changed rate plan and sends it to the CTF.
5. The CTF sends a result of the request to the PD-FE.
6. The PD-FE sends acknowledgement of the policy change to the SUP-FE.
7. The recharging AS-FE receives the result from the SUP-FE.
8. The subscriber receives the response from the recharging AS-FE.
9. The CTF obsoletes the previous charging information and meters the customer's traffic according to the new charging policy. The CTF sends an interim charging event indicating the change in charging policy to the CCF.
10. The CCF creates a CIR and sends it to the CGF.

I.4.7 Scenario of real-time QoS modification by charging rule

This is a scenario showing real-time updating of charging due to modifications made to QoS during a transport session when some factors (e.g., time, volume, etc.) approach a threshold. QoS is being processed automatically. For this charging policy, an online charging mechanism is used to check in real-time whether some factors related to the customer's account will limit the QoS delivered.

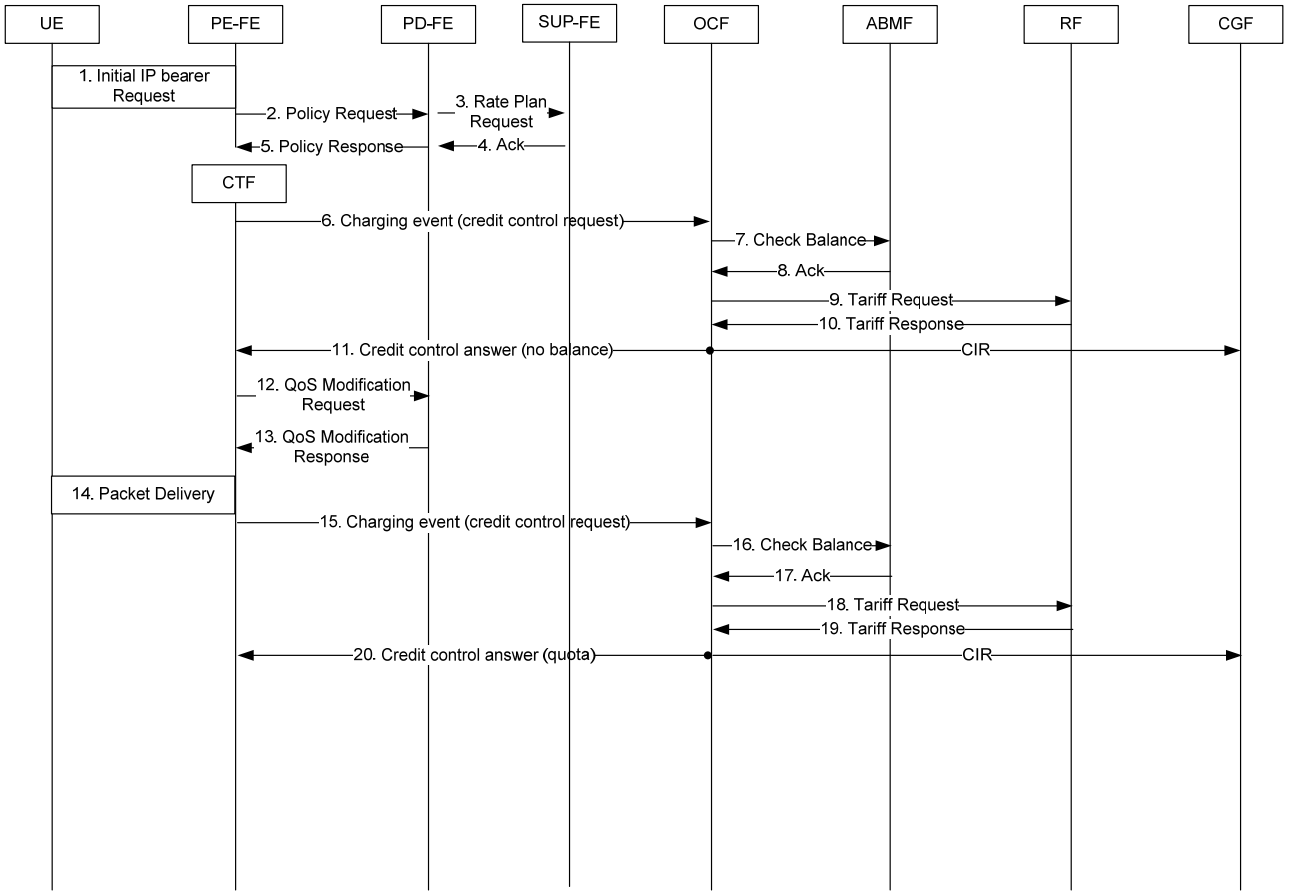

Figure I.14 – Real-time QoS modification by charging rule

1. The end user equipment (UE) first makes a connection to the Internet via the NGN service provider. During this process, the UE is allocated with a new IP address by an authentication and authorization function. The UE then initiates best-effort Internet applications such as web access, FTP, and/or e-mails, etc.
2. Such application services trigger the involved PE-FE to request subscriber's policy from the PD-FE.
3. The PD-FE queries the SUP-FE for the subscriber's charging policy.
4. The SUP-FE responds with the requested information, if available.
5. The PD-FE sends the subscriber's charging policy information to the PE-FE. The PE-FE then notifies the CTF associated with the NE serving the end user that the subscriber's service needs to be charged online through its charging policy, and instructs the CTF concerning the rules for identifying chargeable events.
6. If the user's service is permitted, the CTF sends an initial charging event message to the OCF.
7. The OCF requests the customer's credit balance from the ABMF. If the service is supposed to be charged to a 3rd party account, the OCF requests the service provider's credit balance.
8. The OCF receives a result of credit balance from the ABMF.
9. The OCF requests tariff information applicable for this transport/service session from the RF. If the service is supposed to be charged to a 3rd party account, the OCF requests the service provider's tariff information.
10. The RF provides the appropriate tariff information to the OCF.

NOTE – Steps 6-10 may be repeated as the CTF continues to monitor the session units used.

11. When the customer's account balance is exhausted, the OCF generates a credit control update message notifying the expiration of the account to the CTF, and simultaneously sends a CIR to the CGF.
12. The CTF (via the PE-FE) requests a QoS modification to the PD-FE according to the subscriber's charging policy.
13. The PD-FE modifies the subscriber's QoS with its own process and sends a result to the CTF (via the PE-FE).
14. Then new service traffic is served with new QoS policy which is predefined.
15. The CTF sends a charging event to the OCF to request quota for the new QoS.
16. The OCF requests the customer's credit balance from the ABMF. If service is supposed to be charged to a 3rd party account, the OCF requests the service provider's credit balance.
17. The OCF receives a result of credit balance from the ABMF.
18. The OCF requests tariff information applicable for this service to RF. If service is supposed to be charged to a service provider account, the OCF requests service provider's tariff information.
19. The OCF receives the tariff and tariff-time-change result from the RF. Then the OCF determines the customer's quota after rating and account/counter control.
20. The OCF generates credit control response including customer's quota, validity-time, and tariff-time-change to CTF and simultaneously sends a CIR to the CGF.

Bibliography

[b-ITU-T D.94] Recommendation ITU-T D.94 (1992), *Charging, billing and accounting principles for international aeronautical mobile service, and international aeronautical mobile-satellite service*.

[b-ITU-T Q.825] Recommendation ITU-T Q.825 (1998), *Specification of TMN applications at the Q3 interface: call detail recording*.

[b-ITU-T Q.1741.2] Recommendation ITU-T Q.1741.2 (2002), *IMT-2000 references to release 4 of GSM evolved UMTS core network with UTRAN access network*.

[b-ITU-T Q.1741.3] Recommendation ITU-T Q.1741.3 (2003), *IMT-2000 references to release 5 of GSM evolved UMTS core network*.

[b-ITU-T Y.2021] Recommendation ITU-T Y.2021 (2006), *IMS for Next Generation Networks*.

[b-ITU-T Y.2201] Recommendation ITU-T Y.2201 (2009), *Requirements and capabilities for ITU-T NGN.*

[b-ITU-T Y-Sup.1] Supplement 1 to the ITU-T Y-series (2006), *ITU-T Y.2000-series – Supplement on NGN release 1 scope.*

[b-ITU-T Y-Sup.7] Supplement 7 to the ITU-T Y-series (2008), *ITU-T Y.2000-series – Supplement on NGN release 2 scope.*

[b-ETSI ES 282 010] ETSI ES 282 010 (in force), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Charging management.*
<http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=25081>

[b-ETSI TR 180 001] ETSI TR 180 001 V.1.1.1 (2006), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Release 1 – Release definition.*
<http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=19850>

[b-ETSI TS 132 240] ETSI TS 132 240 (in force), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; Charging architecture and principles* (3GPP TS 32.240 version 7.2.0 Release 7).
<http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=26197>

[b-ETSI TS 132 260] ETSI TS 132 260 (in force), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; IP Multimedia Subsystem (IMS) charging* (3GPP TS 32.260 version 6.8.0 Release 6).
<http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=26052>

[b-ETSI TS 132 297] ETSI TS 132 297 (in force), *Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; Charging Data Record (CDR) file format and transfer* (3GPP TS 32.297 version 6.2.0 Release 6).
<http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=25384>

[b-ETSI TS 132 298] ETSI TS 132 298 (in force), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; Charging Data Record (CDR) parameter description* (3GPP TS 32.298 version 6.1.0 Release 6). <http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=27409>

[b-ETSI TS 132 299] ETSI TS 132 299 (in force), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Telecommunication management; Charging management; Diameter charging applications* (3GPP TS 32.299 version 7.7.0 Release 7). <http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=27529>

[b-ETSI TS 181 005] ETSI TS 181 005 V1.1.1 (2006), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Services and Capabilities Requirements.* <http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=21295>

[b-ETSI TS 183 058] ETSI TS 183 058 V2.1.0 (2008), *Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); SIP transfer of IP Multimedia Service Tariff Information; Protocol Specification.* <http://webapp.etsi.org/workprogram/Report_WorkItem.asp?WKI_ID=28492>

[b-3GPP TS 22.115] 3GPP TS 22.115 (in force), *Service aspects: Charging and billing.* <http://www.3gpp.org/ftp/Specs/html-info/22115.htm>

[b-3GPP TS 23.203] 3GPP TS 23.203 (in force), *Policy and charging control architecture.* <http://www.3gpp.org/ftp/Specs/html-info/23203.htm>

[b-3GPP TS 32.250] 3GPP TS 32.250 (in force), *Telecommunication management; Charging management; Circuit Switched (CS) domain charging.* <http://www.3gpp.org/ftp/Specs/html-info/32250.htm>

[b-3GPP TS 32.251] 3GPP TS 32.251 (in force), *Telecommunication management; Charging management; Packet Switched (PS) domain charging.* <http://www.3gpp.org/ftp/Specs/html-info/32251.htm>

[b-ATIS-0300075.1] ATIS-0300075.1-2006, *Usage Data Management for Packet-Based Services – Service-Neutral Protocol Specification for Billing Applications.* <http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI+ATIS+0300075.1-2006>

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2010