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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

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Recommendation ITU-T Y.2233

Requirements and framework allowing accounting and charging capabilities in NGN

Summary

Recommendation ITU-T Y.2233 provides technical requirements and framework which will allow for accounting and charging capabilities within NGN release 1. It is intended to aid in standardizing protocols and mechanisms to enable accounting and charging for NGN.

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

Source

Recommendation ITU-T Y.2233 was approved on 25 January 2008 by ITU-T Study Group 13 (2005-2008) under the WTSA Resolution 1 procedure.

FOREWORD

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Requirements and framework allowing accounting and charging capabilities in NGN

1 Scope

This Recommendation provides technical requirements and framework which will allow for accounting and charging capabilities within NGN release 1. It is intended to aid in standardizing protocols and mechanisms to enable accounting and charging for NGN.

Non-technical aspects of charging in NGN and management aspects of accounting and charging in NGN 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 (2006), *Functional requirements and architecture of the NGN release 1*.

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 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, and 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 core network that receives and processes charging information from the NGN core network charging functions. It includes functions that can provide billing mediation and billing or other (e.g., statistical) end applications. It is only applicable to offline charging.

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 OCS/BD 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 [based on b-ITU-T Q.1741.2]: 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.

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

3.2.10 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 field (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).

3.2.11 inter-provider settlement: Payment of amounts resulting from the accounting process.

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

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

3.2.18 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.

3.2.19 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:

AFE Accounting Functional Entity

AMF Account management function

AOC Advice of Charge

BD Billing Domain

BFE Billing Functional Entity

BSS Business Support System

CAF Charging and Accounting Function

CC Credit Control

CCF Charging Collection Function

CDR Charging Data Record

CIR Charging Information Record

CFE Charging Functional Entity

CGF Charging Gateway Function

CS Circuit Switched

CTF Charging Triggering Function

GPRS General Packet Radio Service

GSM Global System for Mobile communication

FE Functional Entity

IMS IP Multimedia Subsystem

IP Internet Protocol

IPCGF Inter-Provider Charging Gateway Function

IPDR Internet Protocol Detail Record

ISP Internet Service Provider

LCS LoCation Services

MMS Multimedia Messaging Service

NE Network Element

NGN Next Generation Network

NMS Network Management System

OCF Online Charging Function

OCS Online Charging System

OS Operating System

PS Packet Switched

PLMN Public Land Mobile Network

QoS Quality of Service

RF Rating Function

SMS Service Management System

UMTS Universal Mobile Telecommunications System

UTC Coordinated Universal Time

WLAN Wireless LAN

5 Conventions

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

A-B-R-00n:

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, P: protocol functional requirements, I: charging information model functional requirements, Null: if not applicable)

R: stands for requirement

00n: a requirement serial number.

6 High-level requirements

This clause provides high-level requirements specific to the accounting and charging capabilities to be provided in NGN release 1.

– H-R-001: NGNs are required to support an architecture with open-standard interfaces to provide charging and accounting capabilities for NGN release 1 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 1 services. It is required to consider multi-service environment in NGN 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 1 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.

7 Functional requirements

This clause describes functional requirements specific to the accounting and charging capabilities.

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 should 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, 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, movie, etc.), and may support other granularity types.
– F-M-R-006: metering should 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 should support per-medium metering in the context of multimedia services.
– F-M-R-008: NGNs should support interim metering, which is a snapshot of metering.
– F-M-R-009: NGN NE metering should be fault-tolerant, that is, it should be recoverable as much as possible when NE failure occurs.

  NOTE 1 – "fault-tolerant" does not mean 100% recoverability.
– F-M-R-010: NGNs may support non-NE-resident metering mechanism (e.g., metering by stand-alone metering device).
– F-M-R-011: NGNs should support metering policy configuration by its users (e.g., NMS, SMS or other application entities).
– F-M-R-012: NGN resource usage related data captured from NEs should 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 2 – Other requirements on transfer of accounting metric to the charging functional entities exist in clause 7.3.

7.2 Charging functional requirements

– F-C-R-001: NGNs are required to support offline charging and may support online charging.

– F-C-R-002: NGN charging functional entities are required to be able to generate charging detail records for all charges incurred between NGN customer and NGN service provider and between NGN service providers. This includes different types of service provider relationships.

– F-C-R-003: NGNs should support both service level and transport level charging.

– F-C-R-004: NGNs should support both per-service charging (e.g., multimedia communications) and per-medium charging (e.g., voice, video, data).

– F-C-R-005: NGNs should support charging per flow direction. For example, incoming or outgoing flows of a particular session may be charged separately.

– F-C-R-006: NGNs should 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-007: NGNs should support per-service charging irrespective of the underlying technology to deliver the service.

– F-C-R-008: NGNs are required to support per-service charging based on the underlying technology to deliver the service.

– F-C-R-009: NGNs should support charging based on the use of extra resources.

– F-C-R-010: NGNs should support capabilities which allow for excluding charging for certain types of contents (e.g., advertisement).

– F-C-R-011: NGNs should support charging based on other criteria (e.g., location, presence, etc.).

– F-C-R-012: NGNs are required to support transfer of charging information to billing domain with a standard-based protocol that satisfies the requirements specified in clause 7.3.

– F-C-R-013: NGNs should 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-014: NGNs should support dynamic rating.

– F-C-R-015: NGNs should support customer account hierarchy.

7.3 Accounting and charging protocol high-level functional requirements

– F-P-R-001: NGN charging and accounting protocol is required to support a wide range of billing models (e.g., postpaid, prepaid, pay-per-view, pay per click and sponsored campaigns).

– F-P-R-002: 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-P-R-003: 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-P-R-004: NGN charging and accounting protocol is required to ensure that all usage records are reliably received.

– F-P-R-005: NGN charging and accounting protocol is required to allow high availability of the data collection system.

– F-P-R-006: NGN charging and accounting protocol is required to include or support integration of proper security mechanisms in order to avoid tampering and eavesdropping.

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

– F-P-R-008: 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 functional requirements

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

8 Architectural framework

8.1 Overall architectural framework

The high-level and functional requirements of accounting and charging for NGN are provided in clauses 6 and 7. In order to meet such requirements, an appropriate architecture should be established. This architecture includes overall and subsystem functional architectures. These architectures will define functional components and their inter-relationships given by various reference points.

This clause describes an overall functional architectural for accounting and charging for NGN. This architecture will provide a relationship with other NGN components in the highest level point of view. It intends to cover accounting and charging for NGN release 1 scope.

In order to fulfil the requirements for accounting and charging in NGN, accounting information should be collected from the charging associated NGN functional entities or other proxies when FEs lack accounting capabilities and transferred securely and reliably to appropriate charging FEs.

Figure 1 shows the current NGN functional architecture [ITU-T Y.2012]. The shaded boxes represent functional modules in NGN which generate accounting and charging related information.

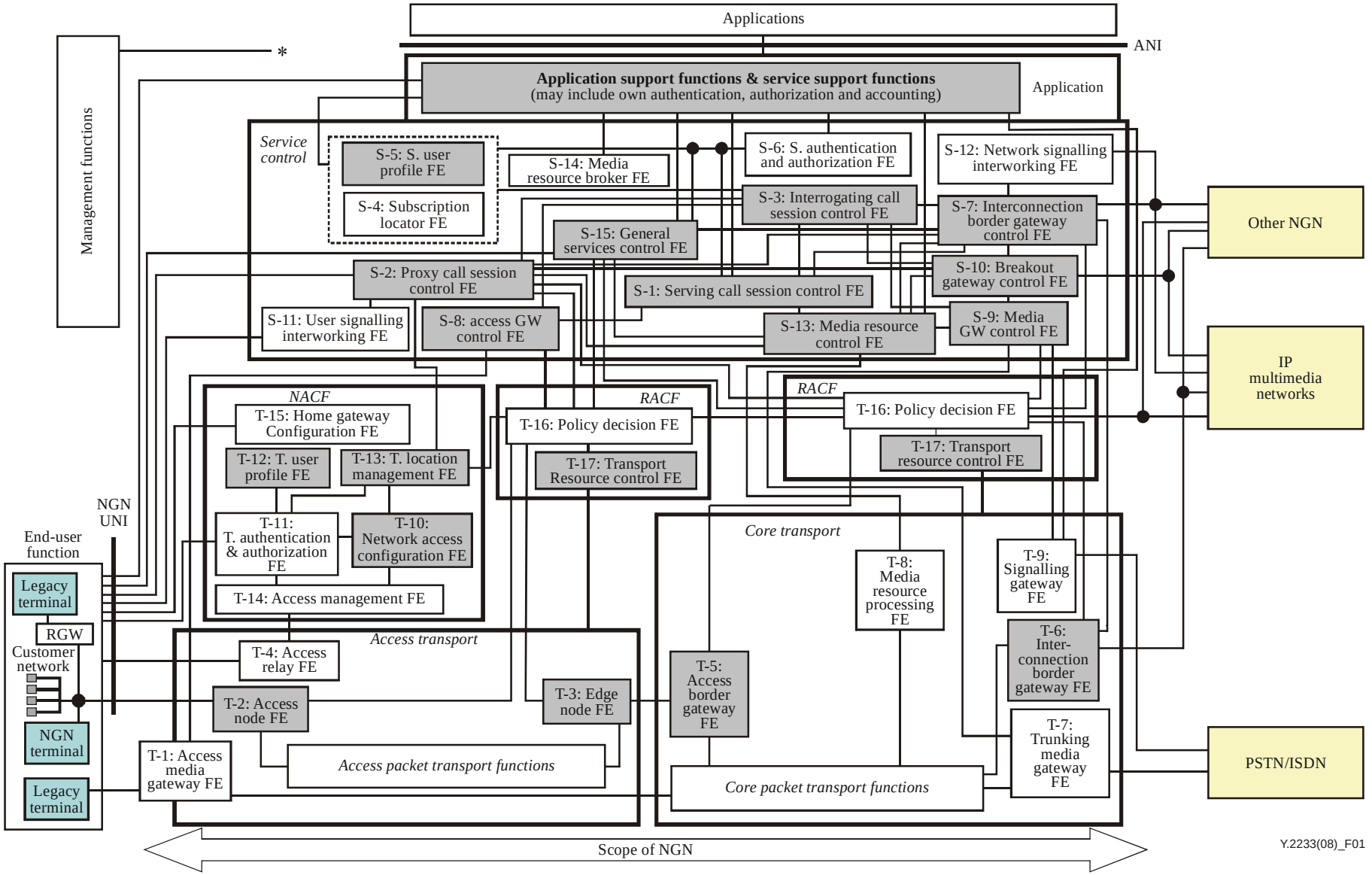

Figure 1 – Positioning of accounting and charging functions in the NGN functional architecture for release 1

8.2 Functional architecture

This clause provides the functional architecture including functional entities grouped based on common capabilities, their relationships, and interfaces. A description of each functional entity follows.

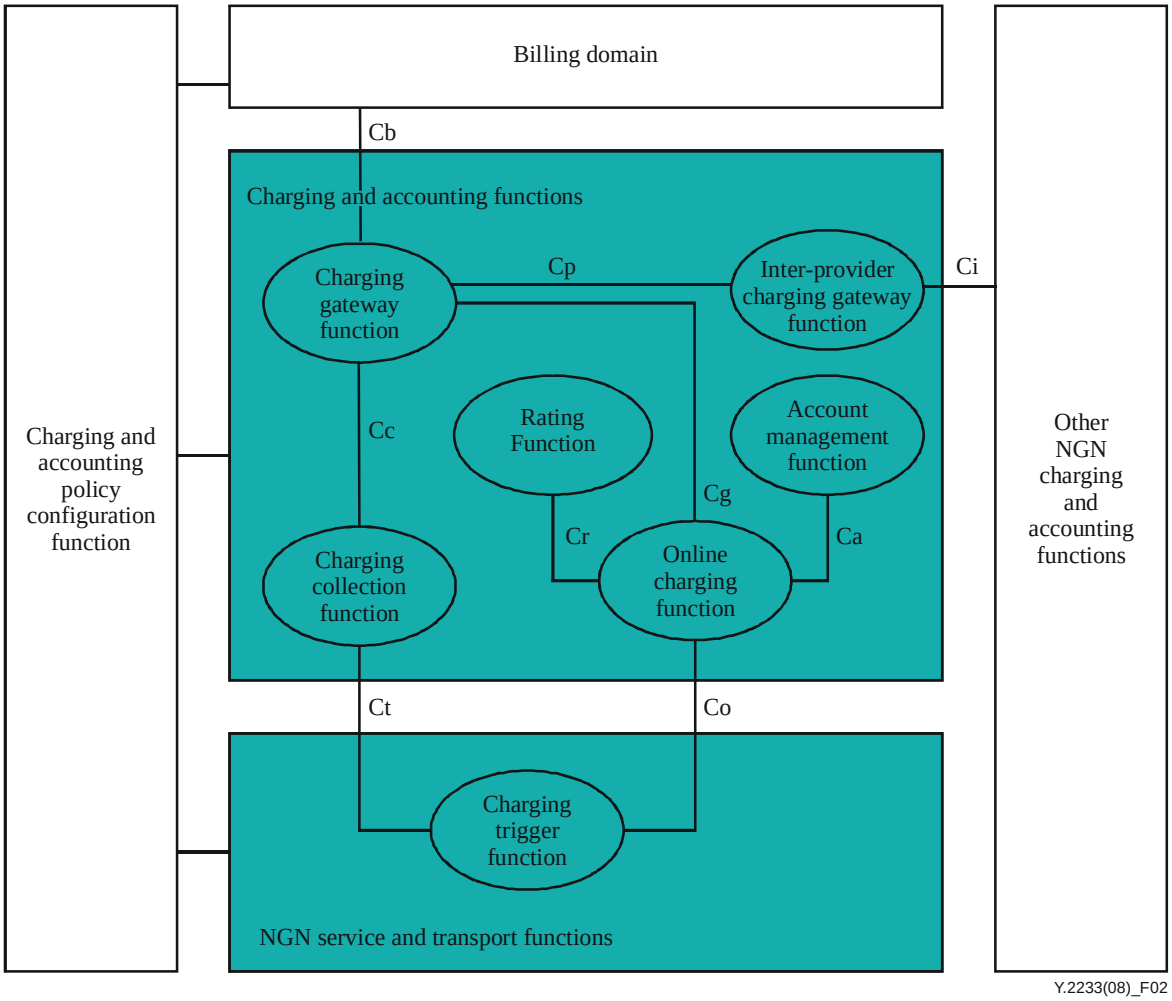

Figure 2 – Functional architecture of charging and accounting in NGN release 1

8.2.1 Charging triggering 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 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. 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.

Besides 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 without loss and in real-time if online charging is used.

– Meter traffic usage data via a stand-alone traffic measurement system from access and transport networks without loss and in real-time if online charging is used. Stand-alone accounting function is performed when traffic measurement function is not embedded in the access and core transport equipment.

– 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.

– Receive or retrieve user (end-point) profile data, service quality information, etc.

– Process the collected data and convert them into a packet bundle or flow record appropriately.

– Perform interim metering on appropriate occasions such that a metering device reboots or other network problems which prevent the reception of the data.

– Transfer the metered data (packet bundles or flow records) to the CCF via Ct reference point.

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

CTF should support metering functional requirements defined in clause 7.1.

8.2.2 Charging collection function (CCF)

As described in [ITU-T Y.2012], the CCF receives charging events from the CTF via the reference point Ct. 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 function 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 offline charging.

– Receive metered data from the CTF via Ct reference point in real-time.

– Construct CIRs by performing detailed packet or flow analysis functions based on 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., a 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.
– 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.
– All charging events used to build a CIR must originate from the same NE, i.e., there is no cross-NE or cross-NE-type correlation of charging events in the CCF.
– 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) or per-QoS).
– Transfer CIRs to the CGF via the Cc reference point while satisfying the requirement 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 supports session-based, event-based, and flow-based charging functions.

8.2.4 Rating function (RF)

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 also works with the offline charging module, and it determines the value of the network resource usage (described in the charging event received by the CCF from the network). For this, it calculates and reserves a number of non-monetary units such as service units, data volume, flow volume, time and events. It then determines the 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 the service being requested.

8.2.5 Account management function (AMF)

As described in [ITU-T Y.2012], the AMF 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. AMF checks, updates, and reserves the account balance. It may also manage counters for online charging.

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 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 IPCGF via the reference point Cp.

– Perform standard-based transfer, which satisfies the requirement 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 Ci reference point to transfer further processed CIRs to another NGN IPCGF. The Ci reference point is used to communicate CIRs for the settlement of accounting rate between NGN providers. It allows NGN providers exchange CIRs in real-time over standardized interface.

The IPCGF entity has the following functionalities:

– Receive CIRs from the CGF via the 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, which 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 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 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 in clause 7.3.

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

– One-to-many and many-to-one operation modes

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 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 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 in clause 7.3

– One-to-many and many-to-one operation modes

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 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 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 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 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 message is sent from the OCF to the RF

– Reply including price and counter information is returned from the RF to the OCF

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

– Real-time transactions

– Reliable and secure transport based on the protocol requirements 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 AMF 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 required to support the following capabilities:

– Near real-time transactions

– Stateful mode of operation

– Reliable and secure transport based on the protocol requirements 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.

9 Security consideration

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

Appendix I

Offline and online charging scenarios

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

This appendix describes two general accounting and charging scenarios which cover NGN release 1 services.

In these scenarios, a customer connects to an NGN network and uses an IP bearer service and a session-based service like VoIP.

I.1 Scenario for offline charging

The following scenario describes a general accounting and charging scenario for offline charging (see Figure I.1):

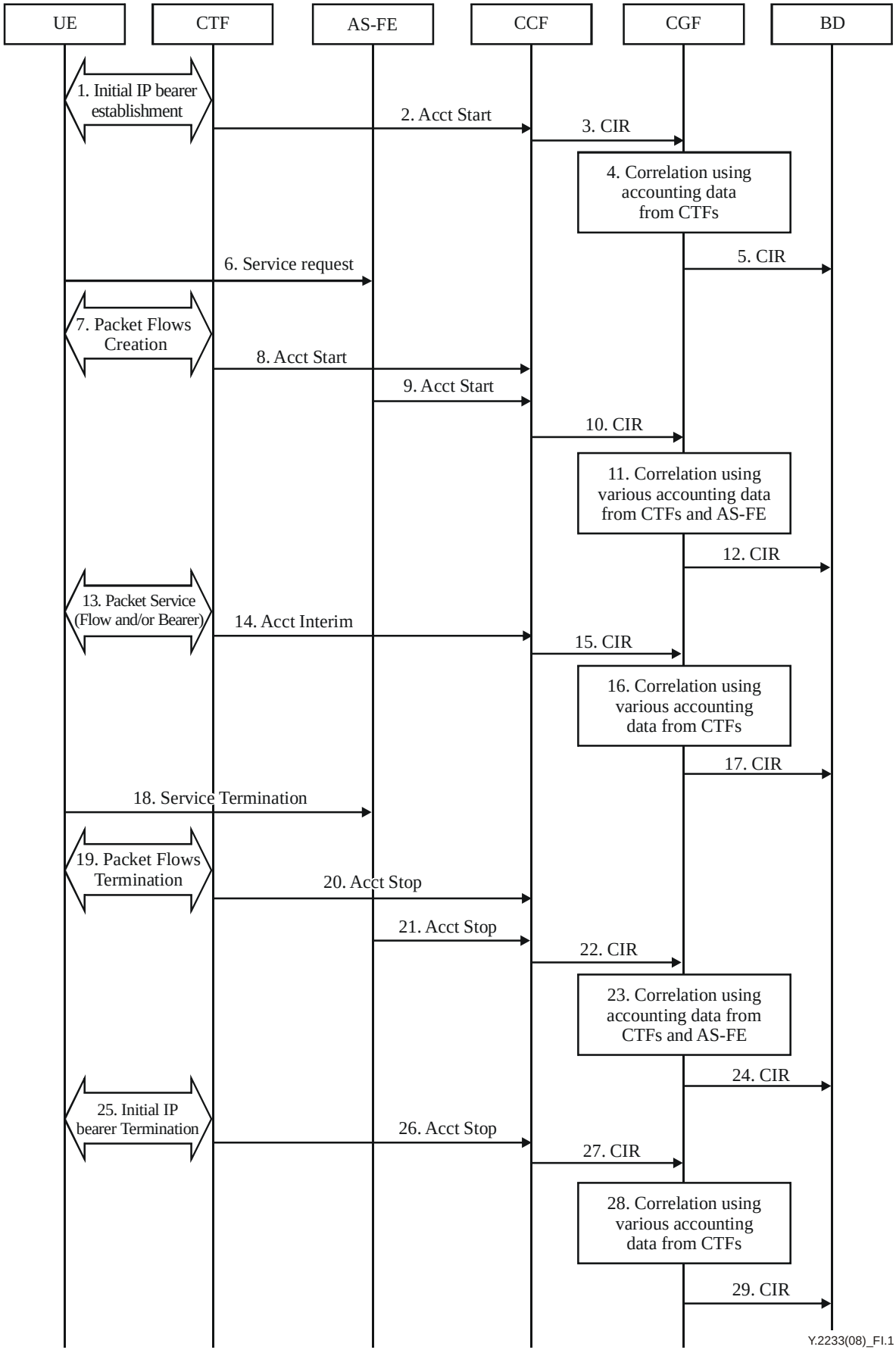

Figure I.1 – Offline charging scenario for NGN release 1 services

1 UE first makes a connection to the Internet via its NGN service provider. During this process, UE is allocated with a new IP address by an authentication and authorization function. UE then either initiates best-effort Internet applications like web, FTP, and/or e-mails, etc.

2 Such application services trigger the involved CTF to generate Account Start message to the CCF.

3 CCF then creates a CIR and transfers it to CGF.

4 CGF correlates CIRs received from CTFs and creates a correlated CIR.

5 CGF transfers it to BD.

6 UE requests a session-based service on the same user equipment to AS-FE (e.g., VoIP service via SIP Invite).

7 The corresponding service packet flow is now created.

8 CTF sends Accounting Start to CCF for the newly created service packet flow.

9 AS-FE sends Accounting Start message to CCF based on the service usage.

10 CCF then creates a CIR and transfers it to CGF.

11 CGF correlates CIRs received from various CTFs and AS-FE. And it creates a correlated CIR.

12 CGF transfers it to BD.

13 Either session-based services or services requiring charging policy treatment are further used.

14 The relevant CTF generates Account Interim messages to CCF.

15 CCF then creates a CIR and transfers it to CGF.

16 CGF correlates CIRs received from various CTFs. And it creates a correlated CIR.

17 CGF transfers it to BD.

18 After UE finishes its service, it sends a service termination request to AS-FE.

19 The packet flows between UE and CTF stops.

20 CTF sends Account Stop message to CCF.

21 AS-FE also sends Account Stop message to CCF.

22 CCF creates a CIR and transfers it to CGF.

23 CGF correlates CIRs received from CCFs and AS-FE. The information used for the correlation is traffic usage (e.g., traffic volume) from CTF, service charging information (e.g., service duration) from AS-FE, and flow detail information (e.g., layer 7 flow specific information).

24 It transfers a correlated CIR to BD.

25 IP bearer connection termination requested.

26 It triggers CTF to send Account Stop message to CCF.

27 CCF creates a CIR and transfers it to CGF.

28 CGF correlates CIRs received from CCFs.

29 It transfers a correlated CIR to BD.

I.2 Scenario for online charging

The following scenario is a general accounting and charging scenario for online charging (see Figure I.2):

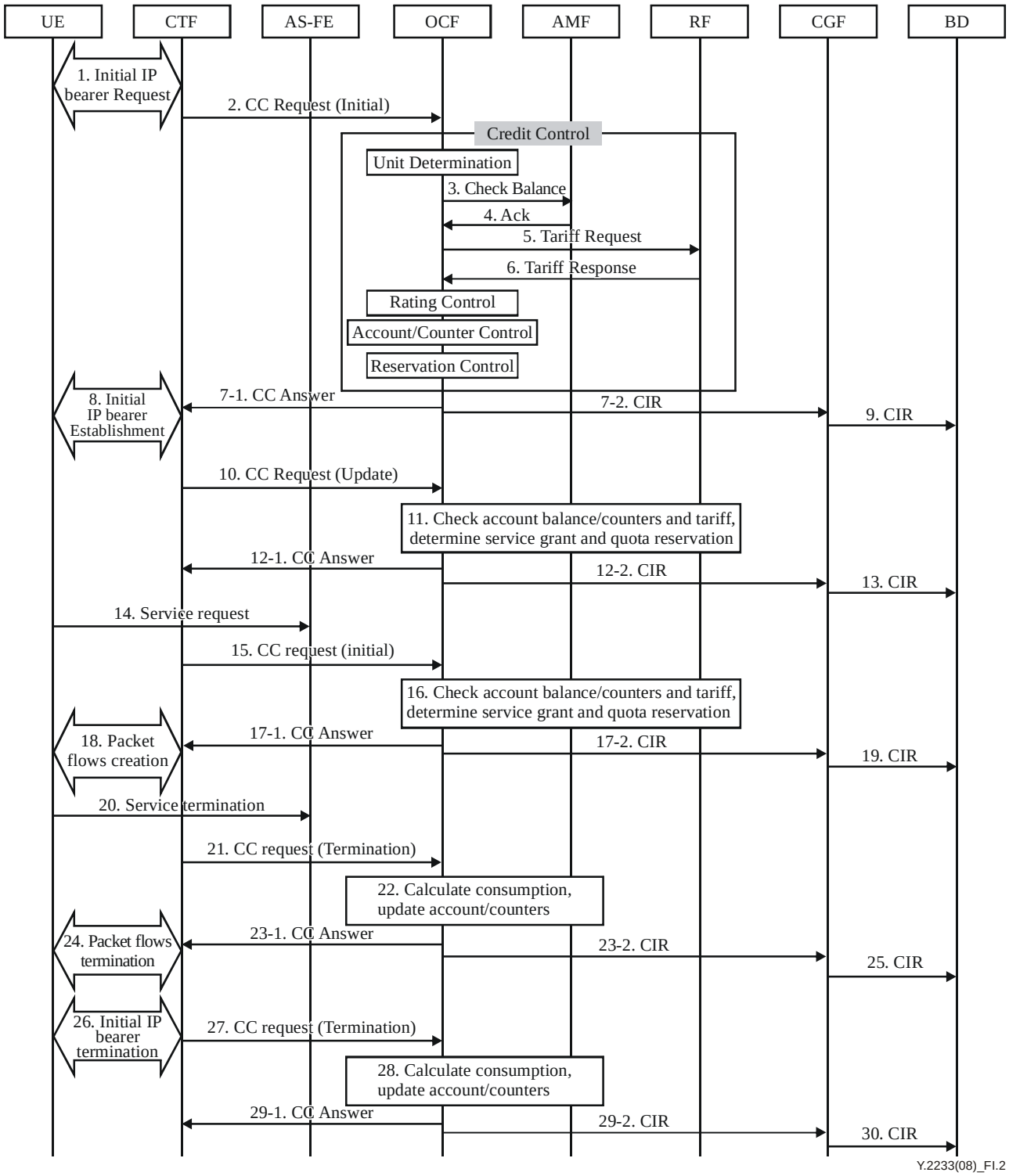

Figure I.2 – Online charging scenario for NGN release 1 services

1 UE first makes a connection to the Internet via its NGN service provider. During this process, the UE is allocated with a new IP address by an authentication and authorization function. After CTF, including NE, generates AA (authorization and authentication) request message to the authentication and authorization function, it receives AA answer message with online provisioning information.

2 CTF generates CC (credit control) Request initial message to OCF, triggered by AA Answer message.

3-4 After charging unit determination, OCF requests customer's credit balance to AMF and receives a result via Ca interface.

5-6 OCF requests tariff information applicable for this bearer/session to RF and receives tariff and tariff-time-change result via Cr interface. Then OCF determines customer's quota after rating and account/counter control. The shaded box shows an example case for credit-control process to determine service grant and reservation. The details for the functionalities, such as unit-determination, rating-control, accounting/counter-control, reservation are out of scope of this Recommendation.

7 OCF generates CC answer initial message including customer's quota, validity-time, and tariff-time-change to CTF, and sends CIR to CGF simultaneously.

8 The initial IP bearer connection is fully established between UE and CTF.

9 CGF transfers CIRs to BD.

10 CTF generates CC request update message including used unit to OCF, when customer's quota is exhausted or validity-time/tariff-time-change are triggered.

11 OCF adjusts tariff and credit balance information with the similar procedure as the case of (3)-(6) process.

12 OCF generates CC answer update message including quota, validity-time, and tariff-time-change to CTF, and sends CIR to CGF simultaneously.

13 CGF transfers CIRs to BD.

14 UE requests a session-based service on the same user equipment to AS-FE (e.g., VoIP service via SIP Invite).

15 CTF generates CC request initial message to OCF.

16 OCF checks tariff and account balance information for this session via Cr and Ca interface, then determines service grant and quota reservation.

17 OCF generates CC answer initial message including quota, validity-time, and tariff-time-change to CTF, and sends CIR to CGF simultaneously.

18 Packet flows are created between UE and CTF.

19 CGF transfers CIRs to BD.

20 After UE finishes its service, it sends a service termination request (e.g., SIP BYE) to AS-FE.

21 CTF sends CC Request termination message including used unit to OCF for the packet flow.

22 OCF performs final rating for the consumed session resources (e.g., duration or packet) and adjusts the account/counter.

23 OCF generates CC answer termination message, and sends CIR to CGF at the same time.

24 The packet flows between UE and CTF stop.

25 CGF transfers CIRs to BD.

26 IP bearer connection termination requested.

27 CTF sends CC Request termination message including used unit to OCF.

28 OCF performs final rating for the consumed session resources and adjusts the account/counter.

29 OCF generates CC answer termination message, and sends CIR to CGF at the same time for IP bearer services.

30 CGF transfers CIRs to BD.

Appendix II

Study on existing accounting and charging practices

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

In this appendix, the outcome of the study and analysis of the current accounting and charging practices used in PSTN/ISDN services, mobile communication services, cable and broadcasting services, and the Internet service is provided. Commonalities and differences and pros and cons of each approach are carefully examined. The objective is to apply the results to the NGN environment to derive the most appropriate solution.

This appendix consists of five clauses: accounting and charging practices for PSTN, 3GPP, TMOC, and the Internet and a comparison clause. In each clause, the main requirements and principals and architecture for each approach are described. Lastly, the comparison of the main characteristics of each is presented in a table.

II.1 Accounting and charging practice in PSTN

Accounting and charging in PSTN has a long history compared to any other cases described in this clause. Its practice, thus, has been stabilized in the market with such abundant experiences. PSTN service includes pure voice telephony, leased line, telex, facsimile, leased line services, and other data services over PSTN networks. Accounting and charging policies and technical functionality have been well defined in the various D-series Recommendations shown in the table below.

Private leased telecommunication facilities	D.1-D.9
Tariff principles applying to data communication services over dedicated public data networks	D.10-D.39
Charging and accounting in the international public telegram service	D.40-D.44
Charging and accounting in the international telemessage service	D.45-D.49
Charging and accounting in the international telex service	D.60-D.69
Charging and accounting in the international facsimile service	D.70-D.75
Charging and accounting in the international videotext service	D.76-D.79
Charging and accounting in the international phototelegraph service	D.80-D.89
Charging and accounting in the mobile services	D.90-D.99
Charging and accounting in the international telephone service	D.100-D.159
Drawing up and exchange of international telephone and telex accounts	D.160-D.179
International sound- and television-programme transmissions	D.180-D.184
Charging and accounting for international satellite services	D.185-D.189
Transmission of monthly international accounting information	D.190-D.191
Service and privilege telecommunications	D.192-D.195
Settlement of international telecommunication balances of accounts	D.196-D.209
Charging and accounting principles for international telecommunication services provided over the ISDN	D.210-D.279

Charging and accounting principles for universal personal telecommunication	D.280-D.284
Charging and accounting principles for intelligent network supported services	D.285-D.299

II.1.1 Main requirements and principles

Since there are many PSTN services, their requirements of accounting and charging vary. Instead of describing the entire requirements which are too bulky, we provide basic and main requirements as follows:

- to provide a call detail record for all charges incurred and requiring settlement between the different commercial roles;
- to enable Administrations using computer-based billing and accounting systems to transfer information to each other in encoded form, without the need for decoding into conventional printed form and subsequent encoding into machine-readable form;
- to allow fraud control by the home environment and the serving network;
- to allow cost control by the charged party;
- to provide at the beginning of a chargeable event an indication to the charged party (if involved in the chargeable event) of the charges to be levied for this event;
- to allow itemized billing for all services charged to each subscription, including voice and data calls, and services offered by home environments;
- to enable the home environment to provide a prepay service and to enable the serving network to support that prepay service for the home environment's subscribers;
- to allow interconnect (inter-operator) charging;
- to allow network operator to 3rd party supplier (e.g., value-added service provider) charging;
- to provide details required for customer care purposes.

The high-level principles that will guide the charging requirements are summarized as follows:

- It shall support online and offline charging to support prepay, post-pay, advice of charge, 3rd party charging; etc.
- It shall be possible to charge separately for each type of medium used (e.g., voice, data) in a session and for each service used (e.g., voice call, dial-up service, or facsimile, etc.);
- It shall be possible to suppress charging for certain types of connection, e.g., when a customer receives tones or network announcements or during sessions such as automated prepay top-up;
- It shall be possible for charging to be applied based on location, presence, etc.

II.1.2 High-level architecture

Accounting and charging processes in PSTN follow the traditional management process, that is, usage accounting and charging. The processes started from proprietary methods and have evolved into the standard-based management one, e.g., TMN-based accounting and charging management. Figure II.1 below illustrates a possible architecture of accounting and charging for PSTN. It also shows the relationship with TMN architecture.

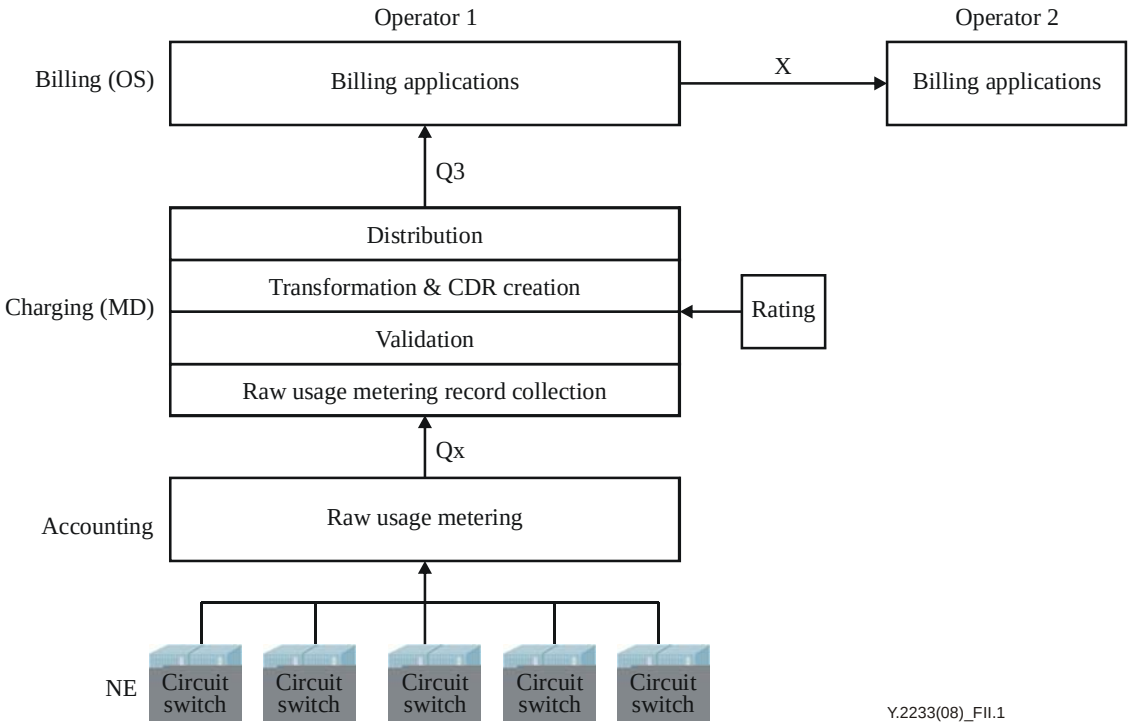

Figure II.1 – Accounting and charging architecture for PSTN

II.2 Accounting and charging practice in 3GPP

3GPP has been defining a series of technical specifications (TSs) that specify the GSM/UMTS core network charging architecture and principles and others:

– the content of the CDRs per domain/subsystem/service (offline charging);

– the content of real-time charging events per domain/subsystem/service (online charging);

– the functionality of online and offline charging for those domains/subsystems/services;

– the interfaces that are used in the charging framework to transfer the charging information (i.e., CDRs or charging events).

A set of domain/subsystem/service specific TSs covers the bearer (CS, PS, WLAN domains), subsystem (IMS) and service (MMS, LCS, etc.) levels, respectively, in the 32.25x, 32.26x and 32.27x TS number range. These TSs describe the mapping of the common architecture specified in this Recommendation onto the specific domain/subsystem/service and the scenarios and information for online and offline charging that are specific to the domain/subsystem/service. They are commonly referred to as the "middle tier (charging) TSs".

A set of TSs in the 32.29x range covers common aspects such as CDR parameter and syntax descriptions, online and offline charging applications, and the charging interactions within the network (CDR transfer) as well as between the network and the billing domain (CDR file transfer).

The complete document structure for these TSs is outlined in Figure II.2.

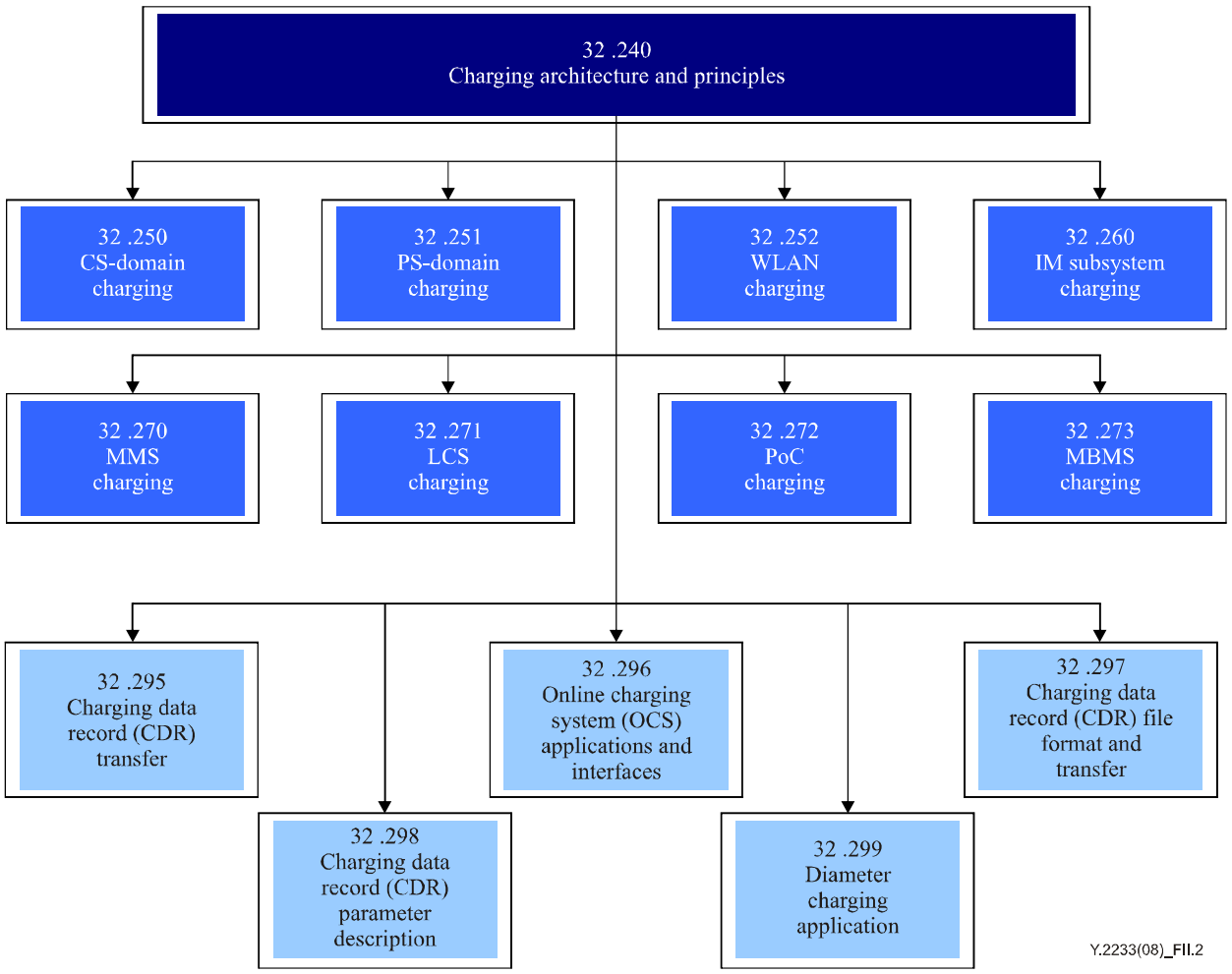

Figure II.2 – Charging specifications structure

II.2.1 Main requirements and principles

The main new requirements for 3GPP system charging and accounting are:

– to provide a call detail record for all charges incurred and requiring settlement between the different commercial roles;

– to allow fraud control by the home environment and the serving network;

– to allow cost control by the charged party;

– to provide at the beginning of a chargeable event an indication to the charged party (if involved in the chargeable event) of the charges to be levied for this event;

– to allow itemized billing for all services charged to each subscription, including voice and data calls, and services offered by home environments;

– to enable the home environment to provide a prepay service and to enable the serving network to support that prepay service for the home environment's subscribers;

– to allow interconnect (inter-operator) charging including mobile operator to mobile operator, and mobile operator to fixed operator (circuit switched & IP), and mobile operator to IP network provider; and mobile operator to I-WLAN operator;

– to allow network operator to 3rd party supplier (e.g., value-added service provider) charging;

– to provide details required for customer care purposes;

– to support the shared network architecture so that end users can be appropriately charged for their usage of the shared network, and network sharing partners can be allocated their share of the costs of the shared network resources.

The high-level principles that will guide the charging requirements are summarized as follows:

– It shall be possible to charge separately for each type of medium used (e.g., voice, video, data) in a session and for each service used (e.g., voice call, streaming video, file download);

– It shall be possible to charge for different levels of QoS applied for and/or allocated during a session for each type of medium or service used;

– It shall be possible to charge each "leg" of a session separately. This includes the incoming and outgoing legs and any forwarded/redirected legs.

NOTE – The legs mentioned here are logical legs, i.e., not necessarily identical to actual signal and traffic flow. Even though tromboning may be avoided by optimal routing, the operator should still be able to charge for the 'virtual legs' of the call;

– The user can be charged according to the service used irrespective of the technology used to deliver it (that is, the charge is not derived from whether 2G or 3G is used);

– The user can be charged according to the technology used to deliver a service (that is, different charges can be applied on 2G and 3G);

– It shall be possible to charge a user according to the network resources used. For example, if a large bandwidth is required to use high quality video, the user could be charged accordingly. This is related to charging by QoS;

– It shall be possible to charge users flexibly for the use of extra resources (in at least the same network) for all legs of the call. For example, if a video component is added to a voice call, the use of extra radio resource at both ends of the call could be paid for by each user in the call or totally by the initiating user;

– It shall be possible to suppress charging for certain types of connection, e.g., when a customer receives tones or network announcements or during sessions such as automated prepay top-up;

– It shall be possible for the home network to charge its customers while roaming in the same ways as when they are at home. For example, if duration based charging is used for charging for streaming music in the home network, then it shall be possible to apply the same principle when the user is roaming;

– It shall be possible for operators to have the option to apply charging mechanisms that are used in GSM/GPRS. For example, for the duration of a voice call, for the amount of data transmitted (e.g., for streaming, file download, browsing) and for an event (one-off charge);

– It shall be possible for a network operator to charge its users for activities while roaming so that the home network will get the capability to raise service charges depending on the roamed-to network, e.g., because of inter-operator charges for the use of service capabilities within the visited network which will in general depend on the serving network. The ability to supply all the necessary information for all the charging options will depend on the capability of the visited network. For service capabilities which are provided by the home network, however, it is required that the call data records created allow to identify the serving network of the served subscriber;

– It shall be possible for charging to be applied based on location, presence, push services, etc.;

– It shall be possible to charge using prepay, post-pay, advice of charge, 3rd party charging techniques;

– It shall be possible for the home network to apply different tariffs to national calls and short messages established/sent by their subscribers while roaming in their home PLMN depending on whether or not the called subscriber's home PLMN equals the calling subscriber's Home PLMN, rather than on the called subscriber's MSISDN;

– For circuit switched interconnection only, a capability is required to collect information regarding user rate and user protocol at the interconnection point so that, e.g., the identification of CS video telephony at the interconnection point for inter-network accounting purposes becomes possible.

II.2.2 High-level architecture

In order to fulfil the above requirements and principles, appropriate charging information needs to be generated and collected by the network elements of the PLMN and forwarded to the appropriate charging and billing systems. Several logical charging functions are needed in the network in order to provide the functionality described above for online and offline charging, respectively.

The architectural differences between the domains (e.g., PS), services (e.g., MMS) and subsystems (e.g., the IMS) affect the way in which the charging functions are embedded within the different domains, services and subsystems. However, the functional requirements for charging are always the same across all domains, services and subsystems. An overview of a common approach for the definition of the logical charging functions, which provides a ubiquitous logical charging architecture for all GSM and UMTS network domains, subsystems and services that are relevant for charging standardization is provided in Figure II.3. For better understanding of the mapping between the ITU-T functional architecture and the 3GPP functional charging architecture, Table 11-1 specified in clause 11 of [ITU-T Y.2021] provides information on the correspondence between 3GPP IMS functional entities and NGN functional entities. Figure 1 identifies functional entities related with charging and accounting.

It should be noted that this common charging architecture provides only a common logical view and the actual domain/service/subsystem specific charging architecture depends on the domain/service/subsystem in question. The physical mapping of the common logical architecture onto each domain, subsystem or service is described in the respective middle tier charging technical specifications.

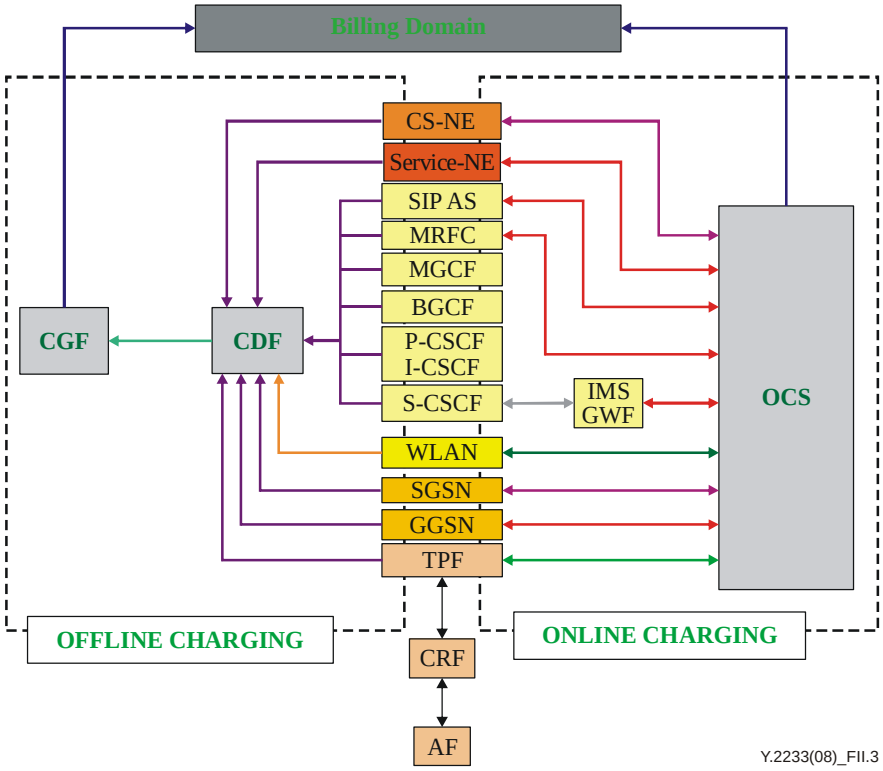

Figure II.3 – Logical ubiquitous charging architecture and information flows

II.3 Accounting and charging practice in ATIS TMOC

The objective of the accounting and charging specifications work in ATIS TMOC [b-ATIS 0300075.1] is to facilitate the integration of IP-based network elements into billing, reporting and assurance systems. In particular, one key goal is to define a service-independent usage record format and exchange protocol to facilitate the flow of usage information from IP network elements managers to support systems.

II.3.1 Main requirements and principles

TMOC defines requirements in two main categories: functional and application requirements. Functional requirements are defined in terms of information model, data encoding, data recording, data transfer, reporting mode, and security. Application requirements are defined in terms of characteristics of requirements imposed by applications, high availability, transparency, flexibility, and efficiency.

II.3.1.1 Functional requirements

A Information model

- The information specification shall indicate, for all usage attributes, if the information is required, optional or conditional.
- The information specification shall indicate usage attributes data type.
- Where appropriate, a type of value/unit shall be specified to denote the unit of measure of an associated attribute value.
- The information specification shall be expressed in an open standards based language.

B Data encoding

- Data encoded from the information model shall preserve the semantics and typing specified.

- Encoding shall be decodable via the information model.
- Encoding shall employ rules amenable to computational efficiency.
- Encoding shall employ rules amenable to transmission efficiency.

C Data recording

See the recording/metering sub-section in clause II.3.2. In addition:

- Time synchronization – It must be possible to synchronize timestamps generated by a recording process with coordinated universal time (UTC).
- In case of an overload, for example lack of memory or processing power, the recording process may change its behaviour in order to cope with the lack of resources.
- The maintenance of usage records may include creating new usage records, updating existing ones, computing usage statistics, deriving further usage properties, detecting usage expiration, and deleting usage records.

D Data transfer

- Data transfer shall employ open standards based protocol.
- Data transfer shall account for each usage data.
- Data transfer shall allow detection of missing usage data.
- Data transfer shall allow for retransmission of usage data.
- Retransmitted usage data shall either be marked so as to differentiate the retransmission from the original transmission or be known to not have been retransmitted by virtue of some implicit protocol mechanisms.
- The end-points NEs/SEs and collector(s) can be located at different independent administrative domains. The data transfer protocol should work well across multiple administrative domains.

E Reporting modes

- Push mode – A delivery method where the NE/SE provider transmits usage data to collector(s) on a fixed, predictable schedule, or in response to an event. It is mandatory that the transfer protocol will support this mode of reporting.
- Pull mode – A delivery method where a collector polls the NE/SE periodically, or in response to an event, in order to gather usage records, usually through a request/reply mechanism. The transfer protocol will optionally support this mode of reporting.

F Security

II.3.1.2 Application requirements

A) Characteristics of requirements imposed by applications

In specifying the requirements of the accounting protocol, applications may impose specific constraints on those requirements, depending on aspects unique to an application. The following are characteristics which would be profiled in various combinations, depending on the requirements of an individual application:

– *Reliability*

a) Requires proper operation over any appropriate network environment such as across disruptive WAN links.

b) Ensures that the flow export system is reliable in that:

- It minimizes the likelihood of flow data being lost (for example, due to resource constraints in the exporter or in the collector).

- It accurately reports a loss if it occurs.
- It allows preventing delivery of service as long as reporting usage information is not guaranteed to an arbitrarily high level of reliability, determined by the operator of the service.

c) There shall be a mechanism for the collector to indicate acceptance of responsibility for the safety of the usage data.

d) Is mandatory in order to:

- Support critical accounting, billing and charging applications.
- Comply with various legal and regulatory requirements.

e) The protocol will have sufficient mechanisms for all records to be reliably received by the collector, and for duplicate information to be identified and removed.

– *Uniqueness*

Cost-effective de-duplication mechanism is needed in order to eliminate redundant duplication of data records. It should be possible to cost-effectively eliminate duplicates. Cost-effective de-duplication is only achieved if the de-duplication could be achieved by evaluation of a small subset of the redundantly transmitted data – in the order of magnitude of the number of redundantly transmitted records.

– *Completeness*

a) Auditing support – The protocol should enable auditing.

b) Includes or supports integration of proper security mechanism that is needed in order to avoid tampering and eavesdropping.

B) High availability

Carrier grade availability demands at least 99.999% of system up time. The protocol should enable and support this high availability. High Availability can be achieved by:

a) A proper protocol that includes data delivery with intrinsic fault-tolerance.

b) Implementation of cost-effective "collection system" architecture that includes hot-standby nodes with flexible configurable fail-over and recovery modes. Hot-back-up should allow a secondary collector to receive event according to a configurable defined criteria.

c) A proper mechanism is needed in order to maintain persistent connections and to minimize delays in processing of the usage data. For example, tunable keep-alive messages can be used to support slow transport.

C) Transparency

a) Encoding-independent information model. External way to describe data.

b) Transport independent.

c) Patent-free specification – In order to make it very open and reusable, the accounting protocol should be freely implementable, royalty and patent free. No restrictions from patents in some form or another (including filing of any patents concerning the protocol) may be applicable. Alternatively the holder of such patent(s) should be willing to make available a non-exclusive licence under such patent(s), on fair, reasonable, and non-discriminatory terms and conditions.

D) Flexibility

a) Extensible – It should be easy to introduce new services and new attributes.

b) Optional – Certain parts of the protocol should be optional in order to:
   - Allow simple (low cost with minimal demand of resources) implementations that preserve the protocol core and still suit relatively simple scenarios.
   - Support backward compatibility of previous protocol versions.

c) Scalable **–** The protocol should be able to continue to function well when its context (e.g., the collection system) is changed in size or volume. Typically, the rescaling is to a larger size or volume. Moreover, the protocol should be able not only to function well in the rescaled situation, but to actually take full advantage of it. For example, in terms of performance, larger amount of data, higher data rates and larger number of exporters and/or sessions that could be handled.

d) Supports a wide range of billing models.

e) Supports arbitrary concurrent export of different types (structures) of data records. Ability to relay multiple types of data concurrently.

f) Supports real-time streaming – The protocol should allow for both encoding and decoding entities to process the documents in a stream-oriented fashion (event-based – stream of events continuously sent from device, not file based). That is, a decoding entity does not need to read to the end of the document before beginning to extract information. Similarly, an encoding entity does not need to have all the information in memory before beginning to write the document. This streaming property can be critical when exchanging large sets of accounting information.
   - Immediate transmission of usage information with minimal latency and no need to close batches periodically should be supported.

g) Manageable – The protocol should allow large heterogeneous deployment of multi-vendor, multi-version, and multi-template to be managed and rolled up easily. For example this can be achieved through version, capability and template negotiation, e.g., upgrades on either side are automatically supported.

h) Back-end "friendly" – The protocol should support a variety of OSS/BSS, including billing, fraud, performance management, fault management, etc.

i) Backward compatible and forward compatible – Each and every version of the protocol should be interoperable with previous and forward versions of the protocol.

E) Efficiency

a) The protocol should allow efficient implementation in network elements, networks, as well as in collection systems, for example efficient memory footprint (that may be achieved by utilizing small buffers).

b) The protocol should utilize the network link efficiently, for example:
   - Avoid unnecessary copies and conversions in network/service element, e.g., only one copy should be sent (to the active collector).
   - Only the data required by the collector should be exported.
   - The core metadata should be sent once (prior to the data records).
   - Additional metadata information should be only referenced.
   - Compact data representation (e.g., non-AVP) should be used.

c) The protocol should allow efficient parsing and processing of data records:
   - Low complexity.
   - Extensible metadata representation of message sets and record/message structures should be easily defined externally.
   - Efficiency of reliability, availability and de-duplication.

II.3.2 High-level architecture

The TMOC-AIP RDC&P specification defines a set of interfaces for exchanging usage records between TMOC-AIP RDC&P-enabled devices or systems. Figure II.4 shows the key interfaces and elements found within the TMOC-AIP RDC&P reference model, represented in an abstract form.

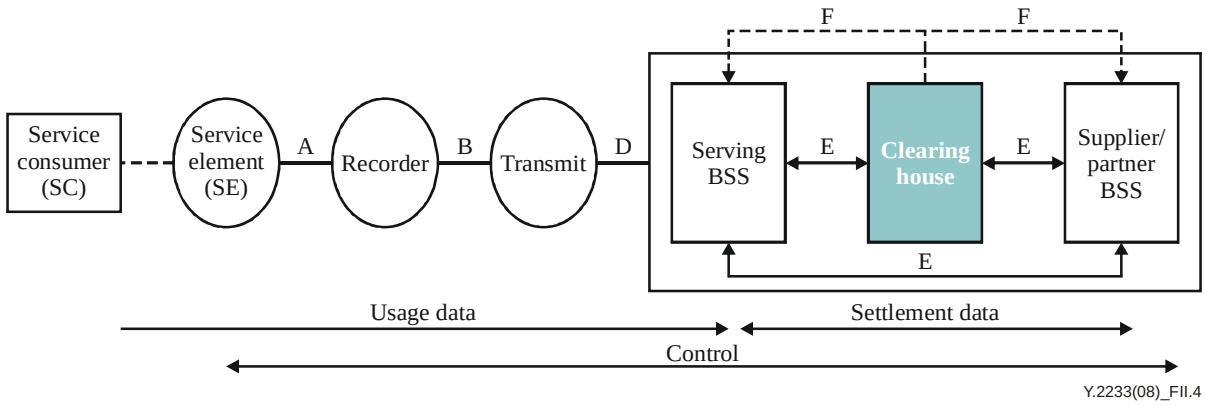

Figure II.4 – TMOC-AIP RDC&P reference model

The main architecture capabilities are:

– Recording/Metering – A recorder may generate usage information in a process called recording or metering. The usage information can be passed via the B interface (see below) to either the persistent storage or the transmitter.

– Storing – The TMOC-AIP RDC&P architecture provides persistence to the usage records that are recorded by a recorder. A persistent storage can receive usage records from one or more recorders. Usage records may be packaged and stored in a non-volatile medium. Selected packages of usage records can be retrieved from the repository of packaged usage records and transmitted (or retransmitted) to one or more transmitters.

– Exporting – A Transmitter is responsible for delivering usage records to BSSs. The usage records may be retrieved from a persistent storage. Alternatively, usage records may be received from the recorder. Usage records of the same service type are organized into groups and transmitted (or retransmitted) to one or more BSSs, using one of a set of transfer protocols.

– Aggregating – Usage records are accumulated at the BSS and mapped to a set of aggregated records that the BSS manages internally.

– Normalizing – Redundancy is eliminated, e.g., duplications of usage records are deleted.

– Correlating **–** Data received at multiple BSS collectors is correlated.

II.4 Accounting and charging practice in the Internet

In the Internet, accounting and charging can be considered from two aspects: within an Internet service provider (ISP) and between Internet service providers. In the former case, flat-rate charging is adopted by most ISPs and per-customer accounting is seldom used. Some ISPs use a variation of flat-rate charging with the combination of usage metering over a certain percentile (e.g., over 95%). In the latter case, the most common practices are peering and transit financial arrangements or agreements. Peering is used among ISPs with an approximately equal capacity in terms of size of the network and traffic volume exchanged. No financial exchange between providers is involved in this case. Transit arrangements are usually between ISPs with different capacity, for example, ISP with long distance coverage and local access ISP. In this case, the small ISP typically utilizes the upstream ISP's facility by paying transit fee. As the size and complexity of the Internet grows, the

Internet interconnection structure range of hybrid peering/transit financial arrangements continues to evolve. Recently, international Internet exchange has been popular to reduce the cost involved in the Internet interconnection between various ISPs and other service providers (e.g., content providers, etc.).

II.4.1 Main requirements and principles

The current Internet was built based on the end-to-end principle and its usage is open to everyone without discriminating the service quality among them. This has led to positive and negative effects. The positive side is that flat rate has naturally been adopted as pricing policy of network services. However, due to this, it has become difficult to limit the usage of scarce bandwidth of the Internet. This resource overuse triggers congestion and congestion externalities. Congestion externalities are the costs in the form of waiting times and unrealized data transmissions that a single user may impose on other users without having to pay for the inconveniences caused. This constellation results in the so-called tragedy of the commons, where a common resource is overused due to wrong price incentives. Over-provisioning which has been taken by most ISPs to solve such problems hardly justifies the investment. Thus, some providers tried to introduce other pricing policies but resistance from customers has prevented from realizing it.

Thus, due to the history of Internet and its evolution, the main requirements and principles of accounting and charging are relatively simple. Flat-rate charging is the dominant policy and no usage accounting is necessary. However, other movements to add flexibility in the policy have been introduced. In the Internet, the customer is charged for their transport usage not for the contents. Content charging based on its usage is now getting attention as a new requirement. Content charging can be either provider-based or server-based. The former denotes the case where a provider is responsible for the bill and the latter is for the case where an organization who owns the content issues the bill. In both cases, flat-rate charging cannot meet the requirements. Usage-based charging policy needs to be introduced. This issue is still under discussion both technically and politically. It requires major changes in the traditional accounting and charging for the Internet.

II.4.2 High-level architecture

As described in the above clauses, any standardized mechanisms for accounting and charging in the Internet do not exist like PSTN or other cases. There are some industry standards for CDR data model and its delivery protocol for IP networks, though. Thus, instead of describing the architecture of accounting and charging, the current Internet interconnection architecture and typical charging policies are illustrated in Figure II.5.

There exists a hierarchical relationship between customer, local, regional and tier-1 transit ISPs. Charging policy between customers and regional ISPs is mostly flat-rate based. Transit, peering, and hybrid charging policies are used between the ISPs.

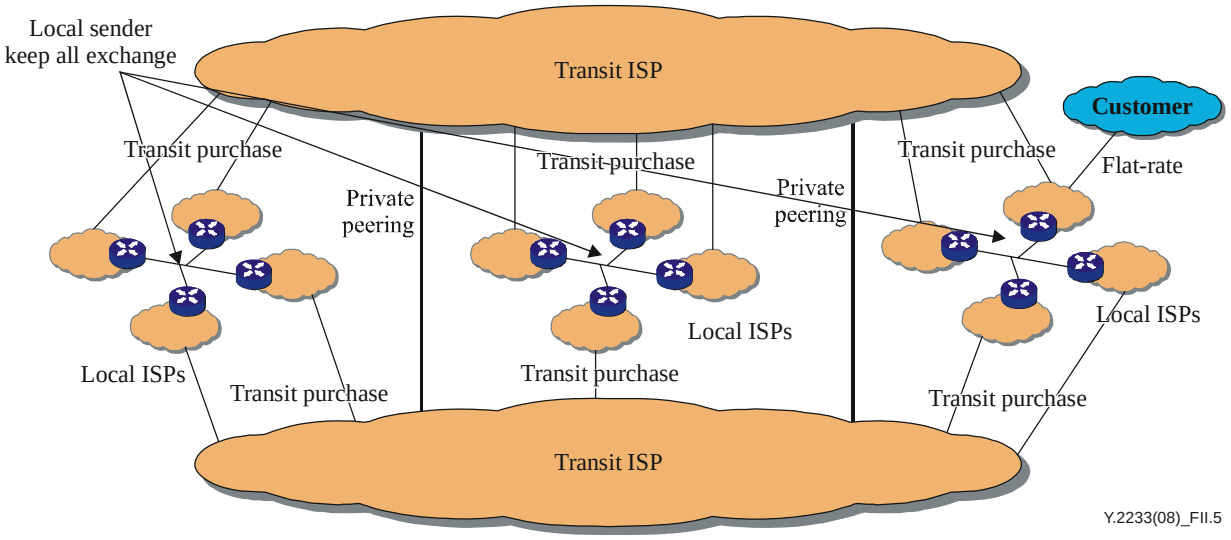

Figure II.5 – Typical accounting and charging policies for the Internet

II.5 Charging and accounting practice in ETSI TISPAN

This clause provides an overview of the ETSI TISPAN work about charging and accounting, categorized according to:

– TISPAN Release 1,

– TISPAN Release 2.

II.5.1 Charging in TISPAN Release 1

Requirements

In [b-ETSI TS 181 005], on page 18, paragraph 4.12 "Charging and Accounting", it is said: "Charging and accounting in NGN will be based on the collection of information from appropriate entities in the form of charging data records (CDRs). The requirements for charging and accounting shall be as contained in TS 122 115". In [b-3GPP TS 22 115], for example, the general charging requirements are defined in chapter 4 and the CDR requirements are defined in chapter 5.

Charging architecture

[b-ETSI ES 282 010] specifies charging applicable to NGN, but not to a PSTN/ISDN emulation other than for an IMS contained within that subsystem. For TISPAN NGN Release 1, this Recommendation is applicable to offline charging derived from the IMS and application servers only. The Stage 1 requirements for charging are derived from [b-ETSI TS 181 005].

This Recommendation endorses some 3GPP documents – with modifications – which are:

– [b-ETSI TS 132 240];

– [b-ETSI TS 132 260];

– [b-ETSI TS 132 297];

– [b-ETSI TS 132 298];

– [b-ETSI TS 132 299].

II.5.2 Charging in TISPAN Release 2

Requirements

In TISPAN R1, only offline charging was implemented. In R2, also online charging shall be supported.

As a new feature, the real-time transfer of tariff information in interworking scenarios shall be supported in TISPAN, in order to support value-added services that are billed by the caller's operator, e.g., premium rate services (0900) or hotlines. Such services often appear as 3rd party services where the tariff information resides in the called network and the caller's operator does not have this information. This tariff information must be submitted by the external provider in real-time, so that the caller's operator is capable:

– of using the imported tariff information in online charging
– of including the imported tariff information into a CDR for charging and billing purposes
– of providing AOC (advice of charge) information to the caller

The following interworking scenarios must support this feature:

– Interworking between two TISPAN NGNs
– Interworking between a TISPAN NGN and PSTN/ISDN
– Interworking between a TISPAN NGN and a PES

For the interconnection scenarios, the following new charging requirements are applicable:

– All the charging and accounting information shall be collected as closest as possible to the interconnection point.
– A session or a service instance shall be uniquely identified within a network domain to allow a correct accounting and charging.
– The identities of the originating network and of the destination network shall be unique and transported at signalling layer.

Charging architecture

[b-ETSI ES 282 010] V2.0.2 describes charging-related functionalities for TISPAN NGN Release 2. The scope of TISPAN R2 comprises the following functionalities:

– Offline charging
– Online charging
– Real-time transfer of charging information through signalling protocols in order to support AOC in interworking scenarios
– Charging of new services, e.g., IPTV, FMC, or interconnection scenarios (e.g., new IBCF-CDR)
– RACS support of charging

The general charging requirements for TISPAN endorse the already above-mentioned 3GPP documents, aligned to Release 7. All the modifications are decided and shared with 3GPP by means of LS.

Charging protocol

[b-ETSI TS 183 058] defines the optional procedures and informational elements needed on the protocol to transport NNI charging information.

II.6 Comparison

	PSTN	3GPP	ATIS TMOC	Internet
Service scope	Telephony	GSM, UMTS	All IP-based network services, both present and future	Internet applications
Charging model supported	Usage-based (duration & location)	Usage, Duration, Bandwidth, QoS, etc.	Any metric of service consumption, either from the service consumer experience or from the service element telemetry	Flat-rate (local ISPs)
Inter-provider settlement	TBD	Conform to [ITU-T D.94]	[b-ATIS-0300075.1]	Peering, transit and hybrid arrangements
Accounting granularity	Per call	Per data flow	Per flow	Per aggregate
Charging data information model	CDR	CDR	XML-based service definition schemas, binary-encoded for operational efficiency	N/A
Charging data transfer protocol	Off-line	FTP, etc.	[b-ATIS-0300075.1], either FTP or streaming protocol	N/A
QoS compliancy	High	High	Per service, as rich as the service definition desires	Range of QoS dependent upon contract
Implementation complexity	Low	High	Low – off-the-shelf source code libraries available	Low

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