INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2005-2008

STUDY GROUP 13

TD 370 (WP 3/13)

English only

Original: English

Question(s): 2/13 Geneva, 16-27 April 2007

TEMPORARY DOCUMENT

Source: Editor

Title: Draft Recommendation Y.ngn-account: Requirements and framework allowing accounting and charging capabilities in NGN (Seoul, Korea, March 5-9 2007)

TSB Note: the complete document is available in soft copy only.

The text below constitutes the revised version of Y.ngn-account agreed as output of the Q.2/13 Rapporteur Group meeting in Seoul, Republic of Korea, 05 ~ 09 March 2007 based on NGN/GSI-Doc 168 (3/13) of January 2007 Rapporteur meeting.

The revised version includes agreed changes based on input documents NGN-GSI/WD-11~15, 22, 24, 26, 27, 29, 31 ~ 33, and 37-LATE submitted to the meeting, results of meeting discussions, March 6th conference call, and drafting activity.

This Recommendation is one of the Q.2/13 high priority working items to be consented in near future. The following topics are the main areas for enhancement to this document (priorities in decreasing order):

- Clarifications on the definitions of terminology used in this draft recommendation
- Additional service and functional requirements and harmonization with SG3, SG4 and relevant SDOs such as 3GPP, TISPAN, ATIS TMOC, and others
- Functional Architecture Enhancement focusing on NGN services and capabilities
- Accounting and charging scenarios
- Overall Architectural Framework Enhancement
- Security considerations
- Level of detail in Appendix I including ETSI TISPAN practices

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Abstract

The objective of this document is to provide technical requirements and framework allowing accounting, charging and billing capabilities within NGN Release 1. It is intended to aid in standardizing protocols and mechanisms to support accounting and charging for NGN.

~~*[**Editor's Note**: This document addresses requirements and framework for accounting, charging, and billing for NGN Release 1, but it is also intended to be extensible for future releases.]*~~

Requirements and Framework Allowing Accounting and Charging Capabilities in NGN

Table of Contents

1. Scope 6

2. References 6

3. Definitions 7

4. Abbreviations 11

5. Conventions 12

6. High-level Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 12

7. Functional Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 13
   - 7.1. General Functional Requirements 14
   - 7.2. Metering Functional Requirements 14
   - 7.3. Charging Functional Requirements 15
   - 7.4. Charging and Accounting Protocol Requirements 16
   - 7.5. Charging and Accounting Information Model Requirements 16
   - 7.6. Charging Model Related Requirements 16

8. Architectural Framework for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 17
   - 8.1. Overall Architectural Framework 17
   - 8.2. Functional Architecture 18
   - 8.2.1. Charging Trigger Function (CTF) 19
   - 8.2.2. Charging Collection Function (CCF) 20
   - 8.2.3. Online Charging Function (OCF) 20
   - 8.2.4. Rating Function (RF) 21
   - 8.2.5. Account Management Function (AMF) 21
   - 8.2.6. Usage Metering Function (UMF) 21
   - 8.2.7. Meter Collection Function (MCF) 22
   - 8.2.8. Charging Gateway Function (CGF) 23

9. Accounting and Charging Scenarios 23
   - 9.1.1. Charging Scenarios for NGN Multimedia Services 24
   - 9.1.2. Charging Scenarios for PSTN/ISDN Emulation and Simulation Services 24
   - 9.1.3. Charging Scenarios for Internet Access 24
   - 9.1.4. Charging Scenarios for other NGN Release 1 Services 24

10. Security Consideration 24

Appendix I: Study on Existing Accounting and Charging Practices 25

I.1. Accounting and Charging Practice in PSTN 25

I.1.1. Main Requirements and Principles 26

I.1.2. High-level Architecture 26

I.2. Accounting and Charging Practice in 3GPP 27

I.2.1. Main Requirements and Principles 28

I.2.2. High-level Architecture 30

I.3. Accounting and Charging Practice in ATIS TMOC 31

I.3.1. Main Requirements and Principles 31

I.3.2. High-level Architecture 35

I.4. Accounting and Charging Practice in the Internet 36

I.4.1. Main Requirements and Principles 36

I.4.2. High-level Architecture 37

I.5. Comparison 37

Bibliography 38

~~1. Scope ..... 4~~

~~2. References ..... 4~~

~~2.1. Normative References ..... 4~~

~~2.2. Informative References ..... 4~~

~~3. Definitions ..... 5~~

~~4. Abbreviations ..... 6~~

~~5. Service Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 ..... 7~~

~~6. Functional Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 ..... 8~~

~~6.1. General Functional Requirements ..... 8~~

~~6.2. Metering Functional Requirements ..... 8~~

~~6.3. Charging Functional Requirements ..... 9~~

~~6.4. Charging and Accounting Protocol Requirements ..... 9~~

~~6.5. Charging Model Related Requirements ..... 10~~

~~7. Architectural Framework for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1 ..... 10~~

~~7.1. Overall Architectural Framework ..... 10~~

~~7.2. Functional Architecture ..... 11~~

~~7.2.1. Charging Trigger Function (CTF) ..... 12~~
~~7.2.2. Charging Collection Function (CCF) ..... 12~~
~~7.2.3. Online Charging Function (OCF) ..... 12~~
~~7.2.4. Rating Function (RF) ..... 12~~
~~7.2.5. Account Management Function (AMF) ..... 13~~
~~7.2.6. Usage Metering Function (UMF) ..... 13~~
~~7.2.7. Meter Collection Function (MCF) ..... 13~~
~~7.2.8. Charging Gateway Function (CGF) ..... 14~~

~~8. Accounting and Charging Scenarios ..... 14~~
~~8.1.1. Charging Scenarios for NGN Multimedia Services ..... 15~~
~~8.1.2. Charging Scenarios for PSTN/ISDN Emulation and Simulation Services ..... 15~~
~~8.1.3. Charging Scenarios for Internet Access ..... 15~~
~~8.1.4. Charging Scenarios for other NGN Release 1 Services ..... 15~~

~~9. Security Consideration ..... 15~~

~~Appendix I: Study on Existing Accounting and Charging Practices ..... 16~~
~~I.1. Accounting and Charging Practice in PSTN ..... 16~~
~~I.1.1. Main Requirements and Principles ..... 17~~
~~I.1.2. High-level Architecture ..... 17~~
~~I.2. Accounting and Charging Practice in 3GPP ..... 18~~
~~I.2.1. Main Requirements and Principles ..... 19~~
~~I.2.2. High-level Architecture ..... 21~~
~~I.3. Accounting and Charging Practice in ATIS TMOC ..... 22~~
~~I.3.1. Main Requirements and Principles ..... 22~~
~~I.3.2. High-level Architecture ..... 26~~
~~I.4. Accounting and Charging Practice in the Internet ..... 27~~
~~I.4.1. Main Requirements and Principles ..... 27~~
~~I.4.2. High-level Architecture ..... 28~~
~~I.5. Comparison ..... 28~~

1. Scope

~~The objective of this document is to provide~~This Recommendation provides technical requirements and framework which will allow for~~ing~~ 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, which are under the responsibility of ITU-T SG3 and ~~are out of the scope of this document. And~~ management aspects of accounting and charging in NGN, which are under the responsibility of SG4 ~~and~~ are out of the scope of this Recommendation~~document~~.

2. References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Document. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Document 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.

Note: In this Recommendation all normative references are included in clause 2 and indicated in format "[xxx]", e.g. "[Y.2001]", and all non-normative references are included in Bibliography and indicated in format "(xxx)", e.g. "(Y.2171)".

[Y.2012] ITU-T Recommendation Y.2012 (2006), Functional requirements and architecture of the NGN

[Y.2201] ITU-T Recommendation Y.2201 (2006), NGN Release 1 Requirements

[Suppl. To Y.2000] ITU-T Y.2000 series Supplement 1 (2006), NGN release 1 scope

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

~~*[**Editor's Note**: references to be updated (other ITU-T Rec. etc.)*~~

~~*Need to differentiate Normative and Informative]*~~

~~2.1.Normative References~~

~~[1] FGNGN-OD-00244r2 FGNGN Output Document "Draft FGNGN-FRA Version 7"~~

~~[2] FGNGN-OD-00253 FGNGN Output Document "NGN Release 1 Scope Document"~~

~~[3] FGNGN-OD-00252 FGNGN Output Document "NGN Release 1 Requirements"~~

~~**2.2.Informative References**~~

~~[1] ETSI TISPAN_NGN TR 00001 Release 1 Definition~~

~~[2] FGNGN-OD-00254 FGNGN Output Document "Guidelines for NGN security Release 1"~~

~~[3] 3GPP TS 32.240 V6.3.0 "Telecommunication management; Charging management; Charging principles".~~

~~[4] 3GPP TS 32.250 V6.1.0 "Telecommunication management; Charging management; Charging data description for the Circuit Switched (CS) domain".~~

~~[5] 3GPP TS 32.251 V6.1.0 "Telecommunication management; Charging management; Charging data description for the Packet Switched (PS) domain".~~

~~[6] 3GPP TS 32.260 V6.0.0 "Telecommunication management; Charging management; Charging data description for the IP Multimedia Subsystem (IMS)"~~

~~[7] FGNGN-OD-00082 FGNGN Output Document "NGN security requirements for Release 1"~~

~~[8] TMOC-AIP-2005-024R10 "Usage Data Management for Packet-Based Services - Service-Neutral Architecture and Protocol Requirements"~~

3. Definitions

[Editor's note: All definitions copied from other sources should contain the related reference]

This ~~r~~Recommendation defines the following terms:

3.1 A~~a~~ccounting: Process of apportioning charges among NGN operators

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
X.462 (96), 3.1	Accounting: The action of collecting information on the operations performed within a system and the effects thereof.
Q.825 (98), 3.1.1	Accounting: Set of functions required for Usage Metering, Charging and Billing
ITU-T Recommendation M.60 (93), 2000	Accounting Management: Accounting management: set of functions which enable the use of [A.K. add "next generation"] network services to be measured and the costs for such use to be determined and rendered
TMOC-AIP-2007-042R2~~, XXX~~	The process of collecting and analyzing 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
ITU-T D.000 (02), A.22	The procedure whereby accounting revenue is shared between terminal Administrations, and, as appropriate,

	between the Administrations of transit countries

3.2 Bi-directional Flow: A Bi-directional flow is a Flow which is composed of packets sent in both directions between two endpoints. A Bi-directional flow is composed from two Uni-directional flows.

3.3~~2~~ B~~b~~illing: function whereby CDRs generated by the charging function(s) are transformed into bills requiring payment.

[Editor's Note:- Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
Q.1741.2 (02), 3.11; Q.1741.3 (03), 3.13	A function whereby CDRs generated by the charging function are transformed into bills requiring payment
Q.825 (98), 3.1.6; Q.1703 (04), 3.2	Administrative function to prepare bills to service customers, to prompt payments, to obtain revenues and to take care of customer reclaims
TMOC-AIP-2007-042R2~~, XXX~~	the process after rating in which the NGN transactions of NGN event usage are compiled and bills are produced

3.3 Billing Domain: part of the operator network, which is outside the NGN core network~~,~~ that receives and processes ~~CDR files~~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

3.4 C~~c~~hargeable 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 characterises the resource / service usage and indicates the identity of the involved end user(s).

3.5 C~~c~~harged 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.

3.6 C~~c~~harging: 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).

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
Q.1741.1 (02), 3.7; Q.1741.2 (02), 3.15; Q.1741.3 (03), 3.18	A function whereby information related to a chargeable event is formatted and transferred in order to make it possible to determine usage for which the charged party may be billed.
Q.825 (98), 3.1.8	The set of functions needed to determine the price assigned to the NGN service utilization

3.7 Charging Information~~Data~~ Record (CI~~D~~R) [based on 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 CI~~D~~R shall be generated, i.e. more than one CI~~D~~R 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

3.8 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.

3.9~~8~~ 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)

Required for checking with 3GPP definition

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
TBD	An abstraction of a sequence of interactions, resulting in conveyance of information from a producer object to a consumer object. NOTE - A flow may be used to abstract over, for example, the exact structure of a sequence of interactions, or over a continuous interaction including the special case of an analogue information flow.

3.10 Inter-provider~~carrier~~ Settlement: payment of amounts resulting from the accounting process.

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition

Q.1741.2 (02), 3.111; Q.1741.3 (03), 3.115	Payment of amounts resulting from the accounting process.
X.462 (96), 3.9	The reconciliation of accounts between MHS service providers. The settlement policy used is subject to a bilateral agreement.

3.X.X Metering : see Usage Metering

3.11~~9~~ ~~n~~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.

3.12~~0~~ O~~o~~ffline charging: charging mechanism where charging information does not affect, in real-time, the service rendered.

3.13~~1~~ O~~o~~nline 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.

3.14~~34~~ **Rating**: The process of calculating the charges for NGN transaction.

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
ITU-T Q.1742.1 (02), 7.6; Q.1742.2 (03), 7.6; Q.1742.3 (04), 7.6	Entity that takes the unrated call detail information and applies the applicable charge and tax related information. The charge and tax information is added using the standard format.

3.15~~2~~ R~~r~~eal-time: real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than 1 second.

[Editor's Note: Alternative definition is proposed. Final decision will be made in the April 2007 meeting]

Reference	Definition
Q.9 (88), 6103	Pertaining to the processing of data by a computer in connection with another process outside the computer according to time requirements imposed by the outside process
TMOC-AIP-2007-042R2~~, XXX~~	operational deadlines from event to system response. In the context of the subject matter of this document, real-time is related to the operational deadline for generating, processing, and transporting accounting, charging and billing information to a desired conclusion. The exact value of this operational deadline may vary depending on the particular implementation.

	For example it can be set to ‘less than 1 second’

3.16 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 uni-directional and/or bi-directional flows.

~~**3.13 settlement:** payment of amounts resulting from the accounting process.~~as above

3.17 Uni-directional Flow: A Uni-directional flow is a Flow which is composed only of packets sent from a single endpoint to another single endpoint.

Usage Metering [Q.825]: The abstraction of activities that monitor the utilization of resources, for the purpose of accounting and controlling the recording of usage data.

4. Abbreviations

This Document uses the following abbreviations:

~~*[Editor’s Note: TBA]*~~

3GPP	Third Generation Partnership Project
AFE	Accounting Functional Entity
AOC	Advice of Charge
ATIS	Alliance for Telecommunications Industry Solutions
BD	Billing Domain
BFE	Billing Functional Entity
BSS	Business Support System
CAF	Charging and Accounting Functions
CCF	Charging Collection Function
CDR	Charging Data 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
IPDR	Internet Protocol Detail Record
ISP	Internet Service Provider
LCS	Location Services
MCF	Meter Collection Function

MMS	Multimedia Messaging Service
NE	Network Element
NGN	Next Generation Networks
NMS	Network Management System
OCF	Online Charging Function
OS	Operating System
PS	Packet Switched
PLMN	Public Land Mobile Network
QoS	Quality of Service
RF	Rating Function
SMS	Service Management System
TMOC	Telecom Management and Operations Committee
TS	Technical Specification
UMF	Usage Metering Function
UMTS	Universal Mobile Telecommunications System
UTC	Coordinated Universal Time
WLAN	Wireless LAN

5. Conventions

[~~**Editor's Note:**~~ For unique and convenient identification of requirements, ~~we use~~ the following abbreviations and convention are used in clauses 6 and 7~~and abbreviations in section 5 and 6~~:

A-B-R-00n:

A: Type of requirements (e.g., ~~S~~H: high-level ~~service~~ requirements, F: functional requirements, P: protocol requirements, I: information model related requirements, M: charging Model related requirements etc.)

B: Subsystem functional requirements (e.g., A: accounting functional requirements, C: char~~in~~ging functional requirements, G: General functional requirements, Null: if not applicable)

R: stands for requirement

00n: a requirement serial number]

~~5.~~6. High-level~~Service~~ Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1

This ~~section describes~~clause provides high-level~~service~~ requirements ~~for~~ specific to the accounting and charging capabilities ~~for~~to be provided in NGN Release1.

- H~~S~~-R-001: NGNs are required to support an architecture with open-standard interfaces to provide charging and accounting capabilities for NGN Release 1 services ~~should be available~~

- ~~Open architecture should be available for accounting and charging. It should be able to handle various NGN services~~
- ~~S~~H-R-002: NGNs are required to support ~~V~~various charging policies~~ should be supported~~ (e.g. fixed rate charging and usage based per-session charging)
- H~~S~~-R-003: NGNs are required to support ~~Appropriate~~ accounting and charging functionality associated with the provision of both unicast and~~ is necessary even when the~~ multicast ~~functionality is used~~based services. The accounting system ~~should be able~~is required to capture user information and resources used. Specifically the accounting system is required~~must be capable of~~to identify~~ing~~ which user used resources and the start and finish times associated with the use of the resources~~ The network operator should be able to grasp user activities (which user received which information and when he started and finished receiving)~~
- H~~S~~-R-004: NGNs are required to support appropriate ~~C~~charging arrangement models ~~should be appropriate~~ for NGN Release 1 services. ~~This model should be as simple as possible but it must be fair as well.~~ It ~~should~~ is required to~~shall~~ 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.~~among wireline, wireless and broadcasting service providers~~
- H~~S~~-R-005: NGNs are required to support ~~A~~flow-based~~ppropriate~~ accounting and charging functionality ~~to support~~for various NGN Release 1 services~~ should be available~~. ~~This includes both active and passive, and intrusive and non-intrusive measurement functionality.~~ Such functionality must be accurate, reliable, and scalable. Some examples of the~~uch~~ functionality are~~includes but not limited to~~:
  - Accounting and charging for uni-directional flow resource usage
  - Accounting and charging for bi-directional flow resource usage
  - Accounting and charging for session resource usage
  - ~~Per user-session record usage statistics~~
  - ~~Per macro-flow usage statistics~~
  - ~~Per micro-flow usage statistics~~
  - ~~Inter-provider flow usage statistics~~

~~o S-R-006: Charging Data Information Model for NGN should be developed~~

- H~~S~~-R-006~~7~~: NGNs are required to support ~~Efficient, reliable, secure~~ interfaces and protocols between network elements and accounting elements and between accounting and charging elements ~~in NGN should be available~~ to collect and transport resource usage data. (e.g., accounting metrics and CI~~D~~Rs, etc.) These interfaces and protocols are required to ~~-~~comply with clause 7 of this Recommendation
- H~~S~~-R-007~~8~~: NGNs are required to support m~~M~~anagement functionalities~~y~~ for the seamless operation of the accounting and charging functional elements.~~ should be available~~

~~6.~~7. Functional Requirements for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1

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

~~6.1.General Functional Requirements~~

~~To be completed.~~

~~6.2.~~7.1. Metering Functional Requirements

- F-M-R-001: NGN ~~N~~network elements (NEs) ~~in NGN~~are required to support capabilities ~~should be able~~ to collect resource usage related data in real-time

- F-M-R-002: NGN NEs ~~in NGN~~ should ~~be able~~support capabilities to collect resource usage related data without any loss

- F-M-R-003: NGN NEs ~~in NGN should~~are required to ~~be able~~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 ~~related data collection shall support~~ with two ~~various~~ types of units~~criteria~~, ~~such as~~ packet count and ~~,~~ byte count, resource usage duration and may support other units

  F-M-R-XXX NGN NEs ~~shall~~are required to support metering of resource usage with various types of granularity such as 5-tuple flow count, ~~application-aware flow count,~~ content-aware count, message count (e.g., e-mail messages), content count (e.g., music, movie, etc.), and ~~others~~ may support other granularity types.

- F-M-R-005: metering should be able to differentiate traffic flowing inside an ~~administrative domain~~NGN provider domain and traffic flowing between two or more ~~administrative domains~~ NGN provider domain

- F-M-R-006: NGNs should support per-medium metering ~~should be supported~~ in the context of ~~(~~multimedia services~~)~~ [Editor's Note: need to clarify whether this requirement is mandatory (be required to) or recommended (should) or optional (may)]

- F-M-R-007: NGNs should~~all~~ support interim metering, which is a snapshot of metering~~, should be supported~~

- F-M-R-008: NGN NE metering should 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-009: ~~when~~ NGNs may support non-NE-resident metering ~~is not supported, other metering~~ mechanism (e.g., metering by stand-alone ~~probe-based~~ metering device) ~~should be provided according to the provider needs~~

- F-M-R-010: NGNs should~~all~~ support metering policy configuration ~~should be configurable~~ by its users (e.g., NMS, SMS or other application entities)

- F-M-R-011: NGN resource usage related data captured from NEs should be held in a standard accounting metric~~common information model~~

- F-M-R-012: NGNs are required to support transfer of accounting metric to the charging functional entities in secure, reliable, and efficient manner. Note: other requirements on transfer of accounting metric to the charging functional entities exist in the sub-clause 7.3 ~~accounting metric transfer to the charging functional entity~~ ~~should be secure, reliable, and efficient~~

~~6.3.~~7.2. Charging Functional Requirements

- F-C-R-001: NGNs are required to support both on-line and off-line charging ~~should be supported~~

- F-C-R-002: NGN charging functional entities are required to ~~should~~ be able to generate charging detail records for all charges incurred between ~~a~~ NGN customer and NGN~~a~~ service provider and between NGN service providers. This includes difference types of service provider relationships.~~, e.g. fixed to fixed, mobile to mobile, mobile to fixed, fixed to broadcast, mobile to broadcast, and other 3rd party providers~~

~~F-C-R-003: charging should be applied in fair manner between charging parties~~

- F-C-R-003~~4~~: NGNs are required to support both service level and transport level charging ~~should be supported~~

- F-C-R-004~~5~~: NGNs are required to support both per-service charging (e.g. multimedia communications~~all~~) and per-medium charging (e.g. voice, video, data) ~~should be supported~~

- F-C-R-005~~6~~: NGNs are required to support charging per ~~sub-~~flow direction ~~may be supported~~. For example, incoming or outgoing ~~sub-~~flows of a particular session may be charged separately

- F-C-R-006~~7~~: NGNs are required 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 ~~should be supported~~or medium

~~F-C-R-008: charging for different levels of QoS (including network resource usage, e.g. bandwidth used) applied for each medium should be supported~~

- F-C-R-007~~9~~: NGNs are required to support per-service charging irrespective of the underlying technology to deliver the service ~~should be supported~~.

- F-C-R-008~~10~~: NGNs are required to support per-service charging based on the underlying technology to deliver the service ~~should also be supported~~

- F-C-R-0~~1~~09~~1~~: NGNs are required to support charging based on the use of extra resources ~~should be supported~~

- F-C-R-010~~2~~: NGNs are required to support capabilities which allow for excluding charging for certain types of contents (e.g. advertisement) ~~may be excluded~~

- F-C-R-011~~3~~: NGNs should~~shall~~ support charging based on other criteria (e.g., location, presence, etc.) ~~should be supported~~

- F-C-R-012~~4~~: NGNs are required to support charging record should be able to be delivered either on-line or off-line with an appropriate signaling mechanism and initiation of usage record transfer should be possible from either a service initiator or a responder ***Editor's note****: splitting of charging indication to be considered.*

- F-C-R-013~~5~~: NGNs are required to support secure, reliable, and efficient transfer of c~~C~~harging ~~Data Records (CDRs)~~information ~~should be delivered~~ to Billing Domain ~~reliably, securely, and with~~with a standard-based protocol that satisfies the requirements specified in the clause 7.~~4~~3

- F-C-R-014~~6~~: NGNs are required to ~~shall~~ support AOC (Advice Of Charge) ~~should be supported~~ Editor's note: this requirement will be kept as "is required to" if no contributions against it are received.

~~6.4.~~7.3. Accounting and Charging ~~and Accounting~~ Protocol high level r~~R~~equirements

- F-P-R-001: NGN Charging and Accounting Protocol is required to support a wide range of billing models.
- 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 r~~R~~equirements

- F-I-R-001: NGNs should support ~~Common(~~standardized~~)~~ and extensible Charging and Accounting Information Model for NGN Release 1 services ~~should be developed(supported) [Editor's Note: further details will be developed]~~

~~6.5.~~7.5. Charging Model Related Requirements

*[**Editor's note:** ~~The following text has to be rewritten as requirements.~~ Further contributions in this regard are invited.]*

Current charging technical models may not be sufficient to the scope of NGN. In this section, possible gaps are identified and enhanced policies and models are provided if necessary. Required QoS capabilities for NGN services might be one of the needs for enhanced policies and models. This work has to be carefully conducted in cooperation with the related study groups in ITU such as ITU-T SG3 and external standard bodies. (e.g., 3GPP)

~~Enhanced models should be as simple as possible but they must be fair as well. They should consider multi-service environments in NGN including international interconnections. This may~~

~~require settlements between different types of providers, for example, among wireline, wireless and broadcasting service providers.~~

~~*[Editor Note: the following considerations are needed]*~~

~~*The charging model of NGN should be described by consideration of information value chains among content providers, service providers and network providers. Also, various value-added functions including information processing and storing capabilities should be taken into account.*~~

~~7.~~8. Architectural Framework for Mechanisms Allowing Accounting and Charging Capabilities within NGN Release 1

[Editor's Note: This is a high-level architectural framework, the detailed functional architecture will be contained in separate documents.]

~~7.1.~~8.1. Overall Architectural Framework

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

In order to fulfill 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.

~~*[Editor's Note: a figure should be provided here to describe the interaction between accountin and, charging functions and other functions. (e.g., management functions, service & call control functions, transport functions, and customer functions)]*~~

[Editor's Note: ~~NGN functional architecture diagram used in figure 1 is still in the progress in FRA [v7] document and, thus, this diagram needs continuous alignment as it progesses~~Charging and Accounting functions or functional entities in NGN functional architecture need further investigation. Further contributions to identify them are invited.]

Figure 1 shows the current NGN functional architecture [Y.2012]. The shaded boxes with colors represent functional modules in NGN which generate accounting and charging related information either directly or indirectly.

Figure 1. Positioning of Accounting and Charging Functions in the NGN Functional Architecture for Release 1

~~7.2.~~8.2. Functional Architecture

~~*[Editor's Note: further functionality needs to be added and details on the reference points are to be added. Further contributions on this topic are invited.]*~~

This section provides functional architecture including functional entities grouped based on common capabilities, their relationships, and interfaces. ~~And~~ Ddescription of~~n~~ each functional entity~~ies~~ follows.

Figure 2. Functional Architecture of Charging and Accounting in NGN

[Editor's note] Clauses 8.2.1 to 8.2.5 contain agreed upon baseline text against which contributions may be submitted. However, it should be noted that this text has not been fully reviewed.

[Editor's note] In alignment with clauses 8.2.1 to 8.2.5, figure 2 will be updated.

~~7.2.1.~~8.2.1. Charging Trigger Function (CTF)

As described in [Y.2012] t~~T~~he 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 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.

The detailed functionality that the CTF should provide is the capabilities of supporting metering functional requirements defined in the section 6.2 Metering Functional Requirements.

~~[Editor's Note: This section defines detailed functionality of the CTF which is not described in the section 7.5.1 of Y.2012. Additional text is further to be provided.]~~

~~7.2.2.~~8.2.2. Charging Collection Function (CCF)

As described in [Y.2012] t~~T~~he 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~~Data~~ Records (CI~~D~~Rs). The results of the CCF tasks are CI~~D~~Rs with well-defined content and format. The CI~~D~~Rs 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.

- 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 synchronisation between the reception of the charging event(s) and the creation of the resulting CIR. However, the CCF shall 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) or 1:n (separated CCF). This includes the possibility of NEs of different types feeding charging events into the same CCF.
- 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.

~~[Editor's Note: This section defines detailed functionality of the CCF which is not described in the section 7.5.2 of Y.2012. Additional text is further to be provided.]~~

~~7.2.3.~~8.2.3. Online Charging Function (OCF)

As described in [Y.2012] t~~T~~he OCF receives charging events from the CTF via Co reference point and executes in near real time to provide authorization for the chargeable event or network resource usage requested by the 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.

~~[Editor's Note: This section defines detailed functionality of the OCF which is not described in the section 7.5.3 of Y.2012. Additional text is further to be provided.]~~

~~7.2.4.~~8.2.4. Rating Function (RF)

As described in [Y.2012] t~~T~~he 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).

~~[Editor's Note: This section defines detailed functionality of the RF which is not described in the section 7.5.4 of Y.2012. Additional text is further to be provided.]~~

~~7.2.5.~~8.2.5. Account Management Function (AMF)

As described in [Y.2012] t~~T~~he 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 money.

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

~~[Editor's Note: This section defines detailed functionality of the AMF which is not described in the section 7.5.5 of Y.2012. Additional text is further to be provided.]~~

~~7.2.6.~~8.2.6. Usage Metering Function (UMF)

The UMF collects network resource usage data and generate charging events. Its main purpose is to support 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 UMF can collect a set of packets and make it a packet bundle or generate a flow record based on the policy configured by the MCF via Cu reference point while satisfying the requirement listed in section 7.3~~4~~. The packet bundle or flow records can be transferred to the MCF

for detailed analysis via the same reference point. The UMF may be resident in network elements (NEs) or a separate measurement device if an NE doesn't support such functionality.

The UMF 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 on-line 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 on-line charging is used. Standalone 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 in appropriate occasions such that a metering device reboots or other network problems which prevents the reception of the data
- Transfer the metered data (packet bundles or flow records) to the MCF via Cu reference point

~~7.2.7.~~8.2.7. Meter Collection Function (MCF)

The MCF collects metered data provided by the UMF via Cu reference point. It then uses this information to construct CDRs. The CDRs are later transferred to the CGF via Cg reference point for further processing. The MCF is provided for 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 UMF is a packet bundle or a flow record of a particular flow of user traffic which needs to be charged. Based on the received data, the MCF performs necessary analysis functions and generates appropriate CDRs and transfers them to the CGF via the reference point Cm. The analysis function includes deep packet inspection and others to identify the chargeable events beyond simple events and sessions.

The MCF has the following functionalities:

- Receive metered data from the UMF via Cm reference point in real-time
- Construct CDRs by performing detailed packet or flow analysis functions based on charging scheme
- Various types of CDRs 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, and etc.

- Perform standard-based, reliable, and secure transfer (file oriented transfer or non file oriented transfer, in real time or near real time) of charging information~~CDR file transfer~~ to the CGF

~~7.2.8.~~8.2.8. Charging Gateway Function (CGF)

The CGF receives CDRs generated by the MCF and CCF via Cc and Cm reference points. It plays a gateway between NGN network and the Billing Domain or another NGN CGF. It uses Cb reference point to transfer CDRs to Billing Domain and Ci to convey CDRs to another NGN CGF. The Ci reference point is used to communicate CDRs for the settlement of accounting rate between NGN providers.

The CGF entity has the following functionalities:

- Receive CDRs from the MCF, CCF, and OCF via reference points, Cm, Cc, and Cg respectively in near-real time
- Perform validation, consolidation, formatting, and error handling of CDRs
- Perform CDR file lifecycle management such as CDR file creation, deletion, and modification
- Construct CDRs for inter provider charging settlement. The CDRs can be various types (duration-based, volume-based, event-based, etc.) depending on the settlement policy between the involved providers
- Perform standard-based, ~~reliable, and secure CDR file~~ transfer, that satisfies the requirement listed in section 7.3~~4~~, of charging information to the BD or the other NGN CAF

~~8.~~9. Accounting and Charging Scenarios

~~*[**Editor's Note**: This section will use the high level protocol elements described in section 11. Subsections need to be aligned with the updated FGNGN service classification [4]]*~~

This section describes various accounting and charging scenarios based on NGN service classification [4].

(Editor Note: The following text needs review)

The following are cost models to be considered for charging scenarios:

- *cost model of information services including supplementary and value-added functions*
- *cost model of information and application creation*
- *cost model of communication and networking*
- *cost model for information processing and storage service*

The charging scenarios have to support the regulatory environment. Also, they should be aware of technology evolution for security and content protection.

~~8.1.1.~~9.1.1. Charging Scenarios for NGN Multimedia Services

~~8.1.2.~~9.1.2. Charging Scenarios for PSTN/ISDN Emulation and Simulation Services

~~8.1.3.~~9.1.3. Charging Scenarios for Internet Access

~~8.1.4.~~9.1.4. Charging Scenarios for other NGN Release 1 Services

~~9.~~10. Security Consideration

*[**Editor's Note**: This section should align with the general work on NGN security (Y.2701)~~[11][TBD]~~]*

This section describes any security issues regarding accounting and charging for NGN.

Appendix I: Study on Existing Accounting and Charging Practices

[Editor's Note: The contents of comparison will be confirmed by SG4.]

In this section, the outcome of the study and analysis of 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 pro and cons of each approach are carefully examined. The objective is to apply the results to NGN environment to derive the most appropriate solution.

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

[Editor's Note: the whole new content of Section I.1 and text modification to Section I.4 have not been examined in detail due to lack of Kobe meeting time. They have a provisional value and need to be confirmed at next meeting. Comments on the text are invited.]

Editor's note: one clause related to ETSI TISPAN practices has to be considered

I.1. Accounting and Charging Practice in PSTN

Accounting and charging in PSTN has a long history compared to any other cases described in this section. 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 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

I.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 itemised 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 (eg Value Added Service Provider) charging;
- to provide details required for Customer Care purposes

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

- It shall support on-line and off-line charging to support pre-pay, post-pay, advice of charge, 3rd party charging, etc.
- It shall be possible to charge separately for each type of medium used (eg voice, data) in a session and for each service used (eg 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 pre-pay top-up.
- It shall be possible for charging to be applied based on location, presence etc

I.1.2. High-level Architecture

Accounting and Charging processes in PSTN are following 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 1 below illustrates a possible architecture of accounting and charging for PSTN. It also shows the relationship with TMN architecture.

I.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 the present document 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 the following figure.

Figure 5.1 : Charging specifications structure

I.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 itemised 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 (eg 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 summarised as follows:

- It shall be possible to charge separately for each type of medium used (eg voice, video, data) in a session and for each service used (eg 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 pre-pay 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 duration of a voice call, for the amount of data transmitted (eg 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 pre-pay, 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.

I.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 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 standardisation is provided in Figure 5.2.

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 5.2: Logical ubiquitous charging architecture and information flows

I.3. Accounting and Charging Practice in ATIS TMOC

The objective of the accounting and charging specifications work in ATIS TMOC 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.

I.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 recordging, 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.

I.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 section 5.3. 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 behavior 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 mechanism.
- 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

I.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 support integration of proper security mechanism that are 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 nonexclusive license 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. Optionable – certain parts of the protocol should be optionable 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. Support 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 meta data should be sent once (prior to the data records)
- Additional meta-data 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 meta-data representation of message sets and record/message structures should be easily defined externally
- Efficiency of reliability, availability and de-duplication

I.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 5.3 shows the key interfaces and elements found within the TMOC-AIP RDC&P reference model, represented in an abstract form.

Figure 5.3: TMOC-AIP RDC&P Reference Model

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 record 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

I.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 the 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 settlement. Peering is used among ISPs with approximately equal capacity in terms of size of the network and traffic volume exchanged. No financial settlement is involved in this case. Transit settlement is usually applied among 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 has grown, the Internet interconnection and settlement structure has also evolved. 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.).

I.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 positive and negative effects. 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 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 prince incentives [1]. Over-provisioning which has been taken by most ISPs to solve such problems hardly justify the investment. Thus, some providers tried to introduce other pricing policies but the resistance from the customers have 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 can't 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.

I.4.2. High-level Architecture

As described in the above sections, any standardized mechanisms for accounting and charging in the Internet don't 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 the figure 2.

There exist a hierarchical relationship between customer, regional ISPs, and transit ISPs. Charging policy between customers and regional ISPs is mostly flat-rate based. Regional ISPs has transit purchase relationship with its transit ISPs. Private peering is used between transit ISPs.

Figure 2. Typical Accounting and Charging Policies for the Internet

I.5. Comparison

[Editor's note] This clause contains modifications which have not been fully reviewed.

	PSTN	3GPP	ATIS TMOC	Internet
Service Scope	Telephony	GSM, UMTS	All IP- based Network ~~s~~Services, both present and future~~IP based~~	Internet Applications

			~~Networks~~	
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~~Usage~~	Flat-rate
Inter-provider Settlement	TBD	Conform to D.94	ATIS-0300075.1-2006~~TBD~~	Peering & Transit settlement
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~~CDR~~	N/A
Charging Data Transfer Protocol	Off-line,	FTP, etc.	ATIS-0300075.1-2006, either FTP or Streaming Protocol~~IPDR File Transfer Protocol~~	N/A
QoS Compliancy	High	High	Per service, as rich as the Service Definition desires~~Medium~~	Low
Implementation Complexity	Low	High	Low—off-the-shelf source code libraries available~~High~~	Low

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

Note: In this Recommendation all references to normative references are indicated in format "[xxx]", e.g. "[Y.2001]", and all references to non-normative references indicated in format "(xxx)", e.g. "(Y.2171)".

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