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## Internet Protocol (IP) based networks;
## Parameters and mechanisms for charging

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# Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Services and Protocols for Advanced Networks (SPAN).

# Introduction

ETSI has already established an ETSI Technical Report on **Parameters and Mechanism for Charging in ATM based Networks**, see ETR 123 [1], produced by former ETSI STC NA5. With the emergence of IP and the trend to use IP not only for the "best effort" service as it is done today, the question on how to charge such diverse services emerges.

With the background of the work done for ETR 123 [1] the follow up body of ETSI STC NA5, the ETSI WG SPAN8 (formerly NA8) has to prepare a comparable document for IP based services.

# 1 Scope

The present document gives guidance in selecting charging parameters and the appropriate charging mechanisms in the IP (Internet Protocol) based networks of the future.

In the today's Internet there is no detailed collection of charges implemented. Users are charged by the Internet Service Provider (ISP) either:

- a flat rate;
- a time dependent rate; or
- a volume class dependent rate.

In addition the telecommunication service to access the ISP is charged by the Telecommunication Network Operator.

Such charging schemes will persist but with the emergence of the Internet - especially with the evolution towards commercial operation - the need arises to collect charging information for diverse services. These charges may be composed of various parameters and components according to the service split among several operators. The present document concentrates on such cases only where parameters are collected.

Therefore, the present document describes a first set of parameters relevant for charging and the mechanisms needed for collection of charging information in IP based networks. The general principles for charging are listed which apply to IP based networks. These parameters are applicable to all types of IP based services. Nevertheless an appropriate set of parameters can be selected for each type.

Collection of charging information will be done both by network operators and service providers for the usage of resources. The present document describes parameters and mechanisms from a technical point of view. Therefore, the term "operator" is used throughout the present document where it is applicable to service providers, to network operators, or to both service providers and network operators.

Accounting, tariffing and billing of IP based services are outside the scope of the present document. Nevertheless these issues are also of great interest for IP based networks and services. Accounting (or settlement) is currently discussed in ITU-T Study Group 3 and for the Internet Telephony Service in ETSI Project TIPHON.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETR 123: "Broadband Integrated Services Digital Network (B-ISDN); Parameters and mechanisms provided by the network relevant for charging in B-ISDN".

[2] TR 101 619: "Network Aspects (NA): Considerations on network mechanisms for charging and revenue accounting".

[3] IETF RFC 1889: "RTP: A Transport Protocol for Real-Time Applications"; H.Schulzrinne, S.Casner, R.Frederick, V.Jacobson; January 1996.

[4] IETF RFC 2205: "Resource ReSerVation Protocol (RSVP) - Version 1 Functional Specification", L. Zhang, R. Braden, S. Berson, S. Herzog, and S. Jamin; September 1997.

[5] IETF RFC 2208: "Resource ReSerVation Protocol (RSVP) Version 1 Applicability Statement Some Guidelines on Deployment"; A. Mankin, F. Baker, B. Braden, S. Bradner, M. O`Dell, A. Romanow, A. Weinrib, L. Zhang; September 1997.

[6] IETF RFC 2475 "An Architecture for Differentiated Services"; S.Blake, D.Black, M.Carlson, E.Davies, Z.Wang, W.Weis; October 1998.

[7] ITU-T Recommendation E.164: "The international public telecommunication numbering plan".

[8] IETF RFC 1700: "Assigned Numbers"; J. Reynolds, J. Postel.

[9] IETF RFC 2063: "Traffic Flow Measurement: Architecture"; N. Brownlee, C. Mills, G. Ruth; January 1997.

[10] IETF RFC 2064: "Traffic Flow Measurement: Meter MIB"; N. Brownlee, University of Auckland, New Zealand, January 1997.

[11] IETF RFC 2123: "Traffic Flow Measurement: Experiences with NeTraMet"; N. Brownlee; March 1997.

[12] IETF RFC 2213: "Integrated Services Management Information Base using SMIv2"; F. Baker, J. Krawczyk, A. Sastry; September 1997.

[13] IETF RFC 2214: "Integrated Services Management Information Base Guaranteed Service Extensions using SMIv2"; F. Baker, J. Krawczyk, A. Sastry; September 1997.

[14] IETF RFC 2215: "General Characterization Parameters for Integrated Service Network Elements"; S. Shenker, J. Wroclawski; September 1997.

[15] IETF RFC 2382: "A Framework for Integrated Services and RSVP over ATM"; E. Crawley L. Berger, S. Berson, F. Baker, M. Borden, J. Krawczy; August 1998.

[16] IETF RFC 2212: "Specification of Guaranteed Quality of Service"; S. Shenker, C. Partridge, R. Guerin; September 1997.

[17] M. Canosa, M. De Marco, A. Maiocchi: "Traffic Accounting Mechanisms for Internet Integrated Services", In Proceedings of SPIE VV'98, Vol. 3529 Internet Routing and Quality of Service, Boston, Massachusetts, 1.-6. November , 1998.

[18] A. Maiocchi: "NeTraMet & NeMaC for IIS Accounting: User’s Guide", CEFRIEL, Politecnico di Milan, May 1998.

# 3 Definitions and abbreviations

## 3.1 Definitions

Many definitions relevant for the present document are already contained in ETSI TR 101 619 [2]. The most important ones are repeated here.

For the purposes of the present document, the following definitions apply:

**Accounting**: revenue sharing amongst operators.

NOTE 1: Also known as "settlement" and "revenue accounting".

**Billing**: process of transferring the stored charging information for a user into a bill. [TR 101 619 [2]]

**Charging**: the determination of the charge units to be assigned to the service utilization (i.e. the usage of chargeable related elements). [TR 101 619 [2]]

**Content provider**: entity which offers information to the user.

**Flow**: unidirectional communication relation from one user to another user dedicated to and established for the transfer of data belonging to one service and one interaction, started by a trigger and terminated by the end of the data transfer or an interruption (e.g. transfer of a file via ftp).

NOTE 2: The flow start time is the time when the first packet is sent. The flow ends if no more packets are sent for a pre-defined time interval (maximum allowed flow idle time). (See also IntServ Flow.)

**IntServ Flow**: unidirectional flow of IP packets for which in an IntServ (RSVP) reservation is valid.

NOTE 3: Since RSVP allows senders to share a reservation (resource) a flow can have multiple source addresses (one flow per session). For unicast sessions or if a distinct reservation is made, the flow has only one sender. An IntServ flow is defined by its source address(es), optional source port, destination address and destination port [15].

**Metering**: The measurement of "components" which can be used for charging such as the duration of the call. In the present document named also "collection of charging information".

**Network charging capabilities**: a set of procedures performed by the network elements in order to determine all the parameters of one communication session, which are required for assessing the effort provided by the network, and to determine the values of these parameters.

**Network layer service**: the provision of resources by the network for the transmission of data.

NOTE 4: To provide services above the best effort delivery the mechanisms of the Integrated Services or the Differentiated Services Model can be used.

**Network Operator**: entity which is operating a public telecommunication network. If local networks are operated the network operator can provide access for subscribers and users. [TR 101 619 [2]]

**Pricing**: the correlation between "money" and "goods" or "service".

NOTE 5: The term is not generally used in telecommunications, the usual term being "tariffing".

**Service provider**: entity that can provide a service to a user having established a call by a network operator. The network operator may be the service provider. [TR 101 619 [2]]

**Phase**: period within a session in which the traffic characteristics do not change.

NOTE 6: A new phase is entered if the reservation parameters are renegotiated.

NOTE 7: If a session can consist of multiple flows, the traffic characterization can be different for each flow. A phase specifies a period of a session or a period of a flow. Since charging parameters (like price per time unit or length of a measurement interval) can depend on the time of day, the entering of a new time period (e.g. business hours) might be also considered as the entering of a new phase.

**Revenue accounting:** technical process of accounting the collected revenue for joint service provision to a group of users and distributing it to the interworking and/or co-operating service/network providers. [TR 101 619 [2]]

**RSVP session**: session (data flow) defined by destination address (unicast or multicast), optionally destination port number and the protocol ID of the transport-layer protocol [4].

NOTE 8: For multicast communication a destination port is not mandatory. For unicast communication a destination port number should be specified in order to distinguish several unicast sessions to the same hosts.

**Service**: That which is traded by a provider.

**Service subscriber**: entity, i.e. a user-identity, which subscribes to a service offered by the service provider.

**Session**: communication relation between one user and another or other users, characterized by a clearly defined starting point and a clear defined termination point (e.g. login and logout - see also RSVP session definition).

NOTE 9: An internet session could be seen as when a connection is opened between an email reader and a POP3 email server or when a user dials up an ISP in order to browse the WWW. More complicated sessions are for example multiparty interactive video conference over a broadband internet. The key point regarding a session, from the perspective of charging, is that it provides an opportunity for use coupled with start and end points in order to create a billable event.

**Tariff**: charged price per usage element or per group of usage elements. [TR 101 619 [2]]

**Tariffing**: determination of the prices to be applied for services and service elements. [TR 101 619 [2]]

**User**: entity which actually uses a service.

## 3.2 Abbreviations

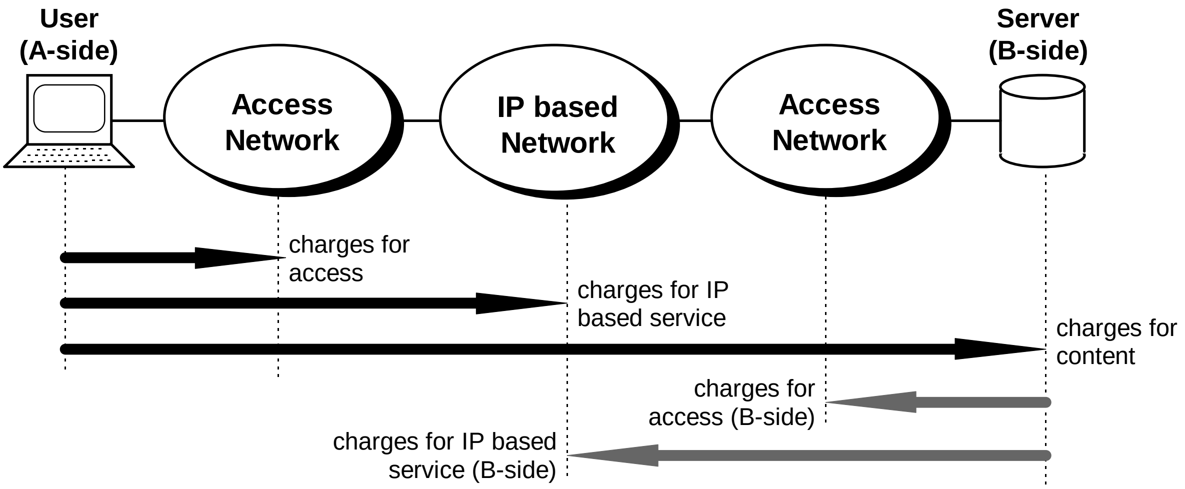
For the purposes of the present document, the following abbreviations apply:

| | |
|---|---|
| ATM | Asynchronous Transfer Mode |
| B-ISDN | Broadband Integrated Services Digital Network |
| CL | Connectionless |
| DIFFSERV | Differentiated services |
| DS | Differentiated Services (field) |
| ID | Identification |
| IntServ | Integrated services |
| IP | Internet Protocol |
| ISP | Internet Service Provider |
| MAN | Metropolitan Area Network |
| MIB | Management Information Base |
| MPLS | Multi Protocol Label Switching |
| N-ISDN | Narrowband Integrated Services Digital Network |
| OS | Operations System |
| PHB | Per Hop Behaviours |
| POP3 | Post Office Protocol, Version 3 |
| QOS | Quality of Service |
| R | Router |
| RSVP | Resource Reservation Protocol |
| RTFM | Real Time Flow Measurement |
| RTP | Real-Time Transport Protocol |
| SLA | Service Level Agreement |
| SNMP | Simple Network Management Protocol |
| SRL | Simple Ruleset Language |
| SW | Switching System |
| TOS | Type of Service (field) |
| TR | Technical Report |
| WWW | World Wide Web |
| XC | Cross Connect |

# 4 Reference Configuration

## 4.1 Network aspect

Figure 1 shows the reference configuration of the network the further considerations are based on as well as the flow of charges. It consists of an Access Network to the IP based network and the IP based network itself.




**NOTES**:
One operator might operate more than one of the networks shown.
The shown networks might consist of a concatenation of several networks of the same type.
The server is shown to represent the usual usage of the Internet. It might also be a second user.
The B-side can also be a gateway in case of "Internet Telephony".

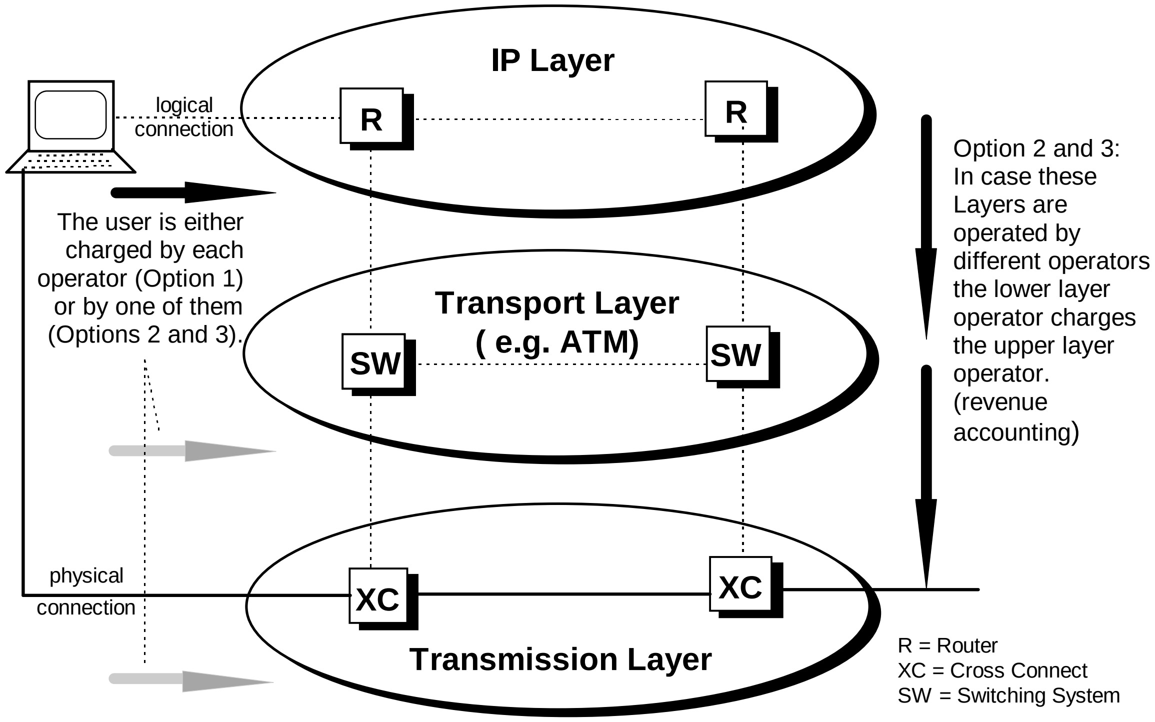
**Figure 1: Reference configuration and charges**

The user is charged for several components of his communication (which are usually provided by several operators) such as:

- charges for the **content** (to be paid to the content providers);
- charges for the **access** to the network (to be paid to the access network operator);
- charges for the IP based **service** (to be paid to the operator of the IP based network).

There might be other components and other operators/providers. The present document concentrates only on the third component: the IP based network (the third bullet).

Usually each of the above mentioned networks is composed of several networks operating on different layers. This principle is shown in Figure 2.




NOTE: The shown layers may consist of a concatenation of several networks operating at this layer.

**Figure 2: Principle of charging between layers**

The commercial interrelationship between the providers presets a number of alternatives, e.g.:

1) Every provider charges the end-user individually. This requires that the providers one by one can identify the end-user or in other words: the user is customer of several providers.

2) One provider charges the end user on behalf of all providers. This requires revenue accounting later. The user is still customer of several providers but only one of them (usually the one operating the highest layer in consideration) charges him.

3) One provider buys the service from the other providers. This makes the end-user charging simple. The user is only a customer of one of the providers.

Options 2 and 3 need "charging between layers" which means revenue accounting between individual providers. In option 2 this can be done off line, which means not necessarily during the session.

## 4.2 Charging reference model

The relationship between all actions related to charging is shown in Figure 3. Three main areas can be distinguished:

- the area with strategic and market relevance - this relates to tariffing;
- the area with administrative relevance - this relates to charging, accounting and billing;
- the area with technical relevance - this relates to the collection of parameters for charging.

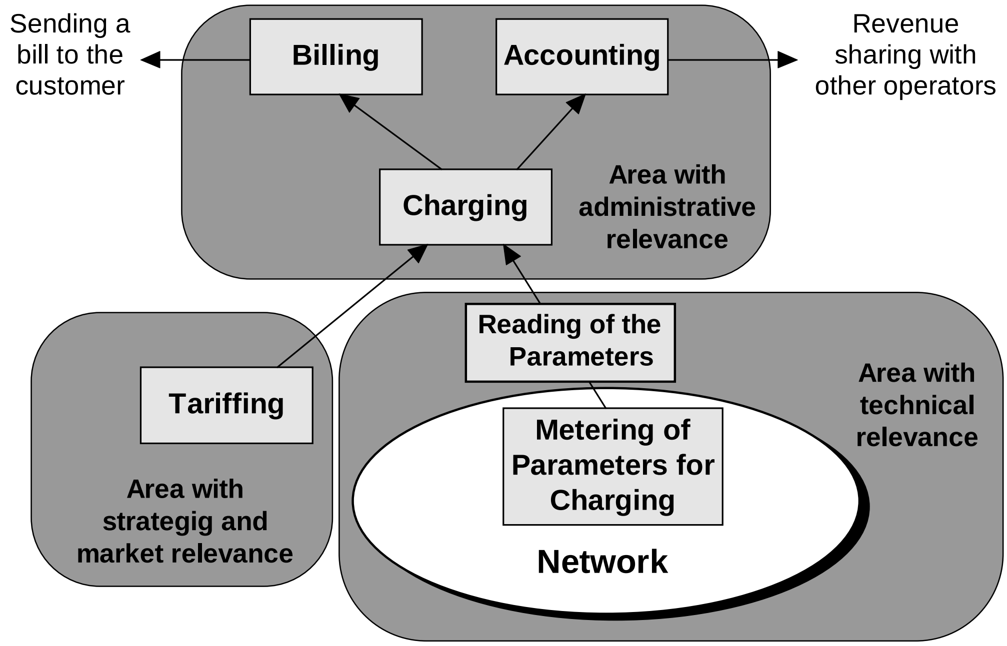
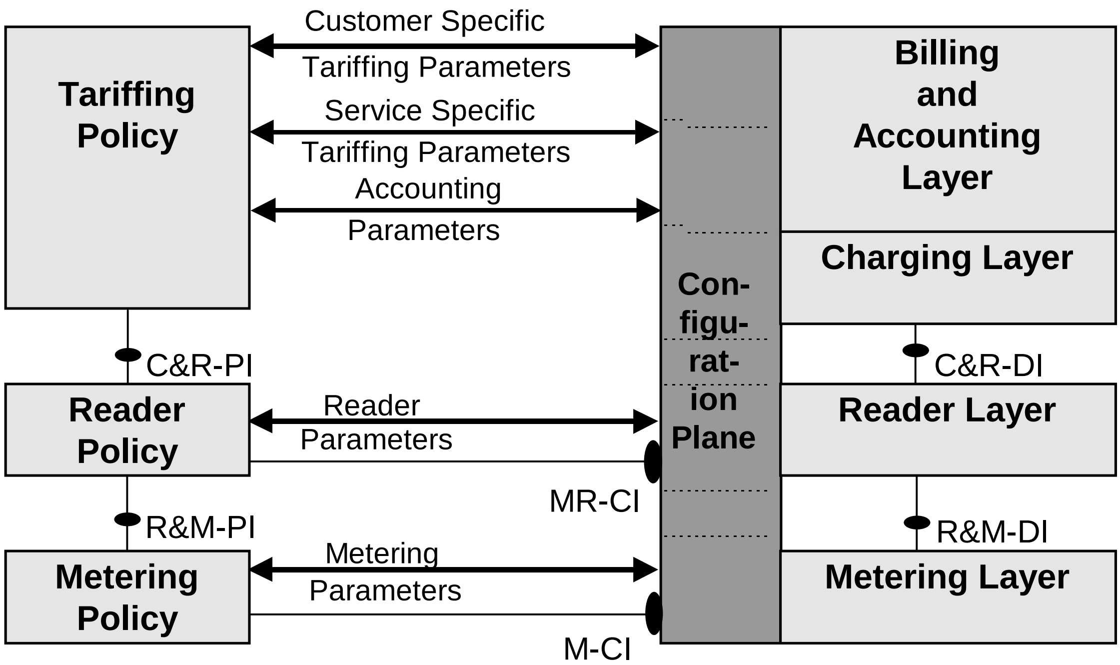



**Figure 3: Relationship between the different tasks in the charging/accounting/billing process**

A corresponding reference model for classifying functional entities required for charging in IP based networks, and for describing their interaction is shown in Figure 4. The left part of the figure represents the policy part i.e. the commercial intelligence in which the parameters currently are decided based on the market situation (i.e. tariffing policies, reader policies and metering policies). The parameters are added as temporary data to the layers in the right part of the figure through the configuration plane. The right part of the figure represents the four different functional layers of the charging machinery that encompass processing of data relevant for charging.




| | | | |
|---|---|---|---|
| C&R -DI | Reader / Accounting Data Interface | R&M-DI | Metering / Reader Data Interface |
| R-CI | Reader Configuration Interface | M-CI | Metering Configuration Interface |
| C&R-PI | Reader / Accounting Policy Interface | R&M-PI | Metering / Reader Policy Interface |

**Figure 4: Charging and accounting reference model with policy interfaces, configuration interfaces and data interfaces**

The ***metering layer*** specifies functional entities for metering of resource usage or recording and counting of charge related events. Metering permits distinction between reservation of network resources, and actual usage of network resources. This distinction is useful as resources that are reserved but not used by a user may be offered to a different user, but usually under different conditions (lower price). Charging schemes may reflect this difference, e.g. by charging separately for reservation, and for actual usage.

The ***reader layer*** encompasses functional entities that access data provided by metering entities via the Metering and Reader Data Interface (R&M-DI) and forward it for further processing to the charging layer. For supporting multicast charging, this layer can select appropriate meters. Transfer of metering data to the reader can be initiated explicitly (the reader initiates transfer of metering data) or implicitly (after a triggering event such as detection of a new flow, the meter initiates transfer of metering data to the reader).

Entities of the ***charging layer*** process usage data that has been collected by meter readers, try to consolidate it based on service parameters and create *accounting data sets, or* accounting records, which are passed via the Reader and Charging Data Interface (C&R-DI) to the charging layer for the assignment of prices. For support of multicast charging, the multicast topology including splitting points can be reconstructed by entities of this layer, supporting algorithms such as cost sharing between receivers. In a multi-provider environment, entities of this layer can distribute collected usage data to other domains. A simple evaluation of current costs can be used to display an estimation of accumulated costs for the service user, or for control purposes by the customer organization or by the provider. For charging of multicast services, algorithms for *cost allocation* can assign costs to specific endpoints, such as sender(s) and receivers of a multicast group.

Entities of the ***billing and accounting layer*** translate costs calculated by the charging layer into monetary units and generate bills for the customers and clearing information to other operators involved in the communication. Algorithms of the billing and accounting layer may combine technical considerations with economic considerations, such as volume of resources used by the customers, and marketing methods (e.g. offering discounts).

Annex C shows a reference implementation using RSVP.

The rest of the document only considers the parameters which can be used in the metering layer.

## 4.3 Service Aspect

The Internet Protocol is connectionless in its nature and currently supports only a service type which does not guarantee any Quality of Service. This is called "best effort" service. With the emerging of applications which need a kind of guarantee (so called Real Time Services) new mechanisms are necessary. The answers of the Internet Community were the Real Time Protocol (RTP) [3] and the Resource Reservation Protocol (RSVP) [4] associated with mechanisms to manage the resources in network elements.

In the evolution from today's Internet to an IP based multiservice network three principle services are discussed:

- best effort service;
- controlled load service;
- guaranteed service.

The last two need both a protocol on the IP level like RSVP together with appropriate mechanisms for resource management as well as the support of a lower layer (layer 2) which guarantees this service. One example of such a layer 2 protocol is ATM.

Due to concerns about the scalability of RSVP [5], a new approach called Differentiated Services (DIFFSERV) [6] has been proposed. It is assumed that this new approach needs precise and flow specific resource reservation. Currently two so called "per hop behaviours" (PHB) are defined:

- Assured PHB; and
- Expedited PHB.

Further work is been done on the quality issue in IP-based networks.

Another aspect of the connectionless nature is that it is not possible to speak of a connection - nevertheless there is some kind of "begin" and "end" of the communication. The term used for this period is "session". Within this session periods of different bandwidth can be distinguished which can e.g. be handled by different settings in the underlying connection. These periods are called "phases". This concept is shown in Figure 5.

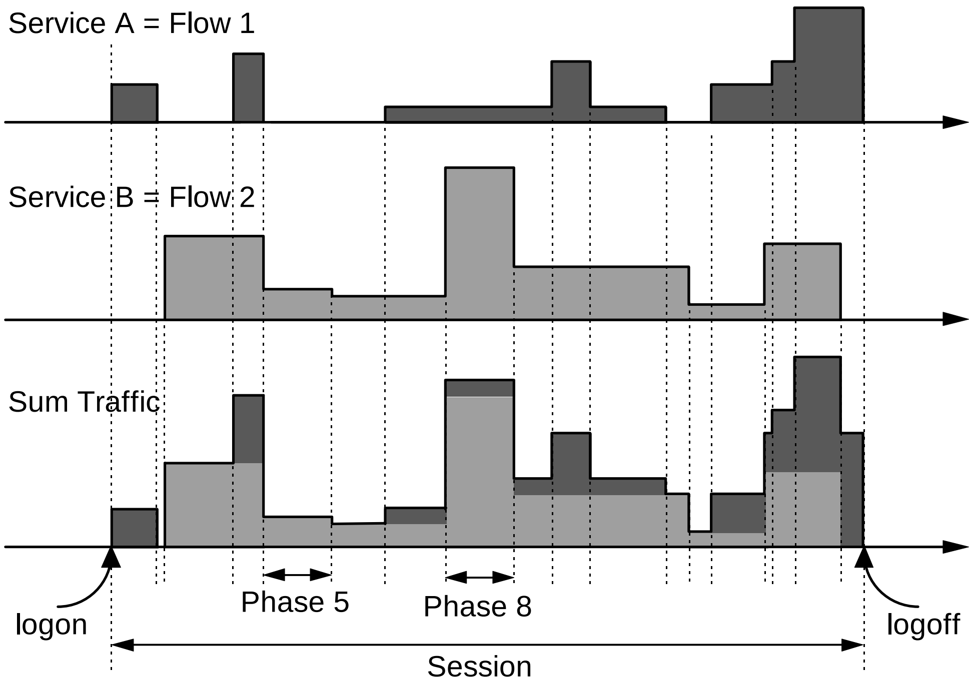



**Figure 5: Terminology with respect to the Service Aspect**

A session can consist of one or more flows. An example is an Internet-session where different services (e.g. WWW, e-mail, ...) are used in parallel and the content is loaded in an interleaved manner.

A phase is a time interval of a session or flow in which the reservation parameters are fixed. If the reservation parameters are changed a new phase is entered.

# 5 Charging principles applied to IP based networks

In order to better understand which network capabilities are necessary, the following principles for charging are assumed:

- There will be not only one charging principle in IP based networks but a variety depending on the needs and policies of the network operator.
- A "basket" of charging parameters will be provided from which the network operator will make a selection.
- The Internet Protocol layer may use charging information received from the underlying layer (e.g. ATM, see figure 2).
- Charges to the user will base on a combination of e.g. charges for connection set up, periodical charges and usage based charges.
- It should be possible for the user to predict charges. This issue needs separate studies. It is outside the scope of the present document. Prediction of the charges could be achieved by applying a simple understandable charging scheme or by giving the user feedback on the current price. The required accuracy of the prediction depends on user preferences and the usage scenarios. For some cases it may be sufficient for the user to have an estimation and/or to set a maximum charge that must not be exceeded.

# 6 Parameters relevant for charging in IP based networks

## 6.1 List of parameters

Collection of IP charging information can be based on parameters and service related events recorded by the IP network in real time. Weighting factors may influence the conversion of parameters into charges to the service subscriber. Which parameters are used and how they are weighted is a matter of tariffing and outside of the scope of the present document.

The Collection of charging information of the IP based network may be divided into two fundamental components:

- the access component (not related to the Access Network but rather to the components which are fixed during the session - see parameters B1); and
- the utilization component (see parameters B2).

However, it is important to realize that in a connectionless network like the Internet, in practice some of the parameters which might be used for charging cannot be measured precisely because no clear Flows (and also phases) exist which are bounded by a clearly defined starting and termination point while maintaining a defined grade of service. The Internet will not be easily billable until starting and termination points exist with associated grade of service definitions. Making precise charging is a matter of acceptance of the tools for monitoring, recording and charging.

Figure 6 and table 1 contain the parameters for components which might be relevant for collection of charging information in an IP based network.

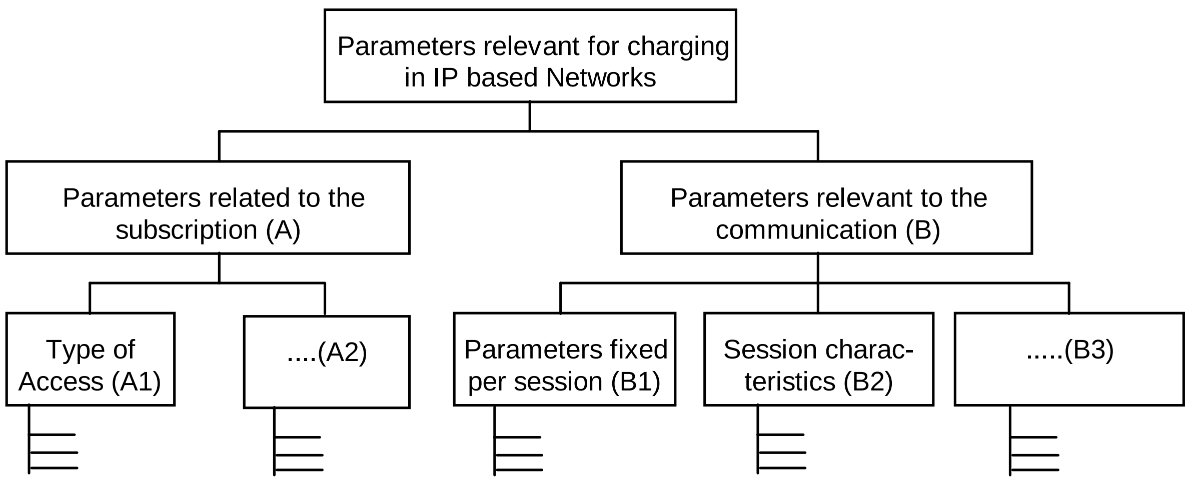



**Figure 6: Parameter categories in tree representation**

A) parameters related to the subscription (access component).

These parameters allow operators to be compensated for the facilities required for a service subscriber to access a service or services (e.g. those facilities specifically provided to that service subscriber). They are independent of the utilization:

**Table 1: Parameters related to the subscription**

| | Parameter | | |
|---|---|---|---|
| A 1) | Type of access | | |
| | A1.1) | Physical characteristics | |
| | | *A 1.1.1)* | *Geographical distance to the first access node of the provider network* |
| | | *A 1.1.2)* | *Physical connection (e.g. fibre length and type, access equipment),* |
| | A1.2) | Pre-defined limits | |
| | | *A 1.2.1)* | *Maximum available bandwidth* |
| | | *A 1.2.2)* | *Maximum number of connections/flows* |

B) parameters related to the communication / access to service (session component).

Utilization charges should be in accordance with the service requested by the service subscriber. These charges should in principle be determined on the basis of the network resources and any additional functions required to provide the service to the service subscriber. These should be possible by considering a set out of the parameters shown in table 2.

The utilization component reflects reserved resources and resources actually used.

It should be noted that the values of the parameters should be collected for each direction of an IP based communication relation separately.

**Table 2: Parameters related to the communication**

| | Parameter | | | Comment | | G | I | D |
|---|---|---|---|---|---|---|---|---|
| B1) | **fixed per session.** | | | This component reflects e.g. the utilization of the control resources: | | | | |
| | B1.1) | Type of services; | | | | X | | |
| | B1.2) | session start time (time of day - day of week - day of the year) | | | | X | | |
| | B1.3) | User ID | | if the user logs on with different IDs | | X | | |
| B2) | **session/flow characteristics.** | | | This component reflects the utilization of the network resources. It takes into account the concept of flows and phases as described above. Most of these parameters are relevant for individual flows within a session. | | | | |
| | B2.1) | communication partner; | | S,F | | X | | |
| | B2.2) | duration; | | S,F | | X | | |
| | B2.3) | time of day - day of week - day of the year; | | S,F | | X | | |
| | B2.4) | priority ("weight"); | | F | | X | X | |
| | B2.5) | provided QoS | | F | | X | X | X |
| | | *B2.5.1)* | *loss* | | | | | |
| | | *B2.5.2)* | *delay* | | | | | |
| | B2.6) | traffic contract parameters; | | F | | | X | |
| | | *B2.6.1)* | *minimum transmission unit* | | | | | |
| | | *B2.6.2)* | *maximum transmission unit* | | | | | |
| | | *B2.6.3)* | *backlog* | | | | | |
| | | *B2.6.4)* | *delay* | | | | | |
| | | *B2.6.5)* | *slack term* | | | | | |
| | B2.7) | violation of traffic contract parameters; | | F | | | X | |
| | | *B2.7.1)* | *discard flag* | | | | | |
| | B2.8) | reserved resources; | | S,F | | | X | |
| | | *B2.8.1)* | *maximum rate* | | | | | |
| | | *B2.8.2)* | *burst size* | | | | | |
| | B2.9) | volume actually used; | | S,F | | X | X | |
| | | *B2.9.1)* | *volume sent in bytes* | | | | | |
| | | *B2.9.2)* | *volume received in bytes* | | | | | |
| | | *B2.9.3)* | *volume sent in packets* | | | | | |
| | | *B2.9.4)* | *volume received in packets* | | | | | |
| | B2.10) | multipoint aspects | | S | | X | | |
| | | *B2.10.1)* | *number of receivers* | | | | | |
| | | *B2.10.2)* | *number of senders* | | | | | |
| | | *B2.10.3)* | *individual reservation parameters for each receiver* | | | | | |
| | | *B2.10.3)* | *individual provided QoS parameters for individual segments of multicast tree, or for each receiver* | | | | | |
| NOTE: | F = applicable for Flows, S = applicable for Sessions, G = general, I = applicable when IntServ is used, D = applicable when DIFFSERV is used. | | | | | | | |

The above list covers all aspects relevant for collection of charging information in IP based networks at this point in time. Nevertheless, it might be possible that the parameters listed above will not be sufficient in the future and that evolving new services will lead to additional parameters that need to be measured inside the network.

On the other hand due to increasing complexity a restriction to a subset of the parameters should be aimed at.

## 6.2 Description of the parameters

This subclause describes the parameters listed in subclause 6.1 in detail and gives some examples of possible measurements.

**A1) Type of access**

This parameter is related to the capacity provided by the network operator, the maintenance, the redundancy, etc. (e.g. number of links installed, bit rate of the links), independent of the actual use.

**B1.1) Type of service**

There might be different charges for different services. Especially keeping in mind that for a best effort service no reservation, but for a guaranteed service a blocking of resources and a lot of processing is needed it seems appropriate to represent this in the charges (e.g. best effort, controlled load, guaranteed delay, ...).

**B1.2) Session start time**

The time of day - day of week - day of year when the session has started is a fixed characteristic of the session.

**B1.3) User ID**

The user ID is fixed for the duration of a session. (This may be a permanently assigned ID like an E.164 [7] number or temporarily assigned ID which is only relevant for one session. Details are outside the scope of the present document.)

**B2.1) Communication partner**

This is important because communication with different communication partners might be charged differently. This reflects on the one hand e.g. communication with one of the operators but also later on to realize special discounts.

A communication partner (which can be a process on a server machine) can be represented by a user identifier, an IP address and a port number.

**B2.2) Duration**

The length of the session.

**B2.3) Time of day - day of week - day of year**

Especially important for discount tariffing.

**B2.4) Priority** (another word used is "weight")

Describes the priority of the flow. This can be used for differentiated services and similar reservation mechanisms. Possible values are: premium, assured, etc.

The priority can be determined e.g. by monitoring the relevant codepoint (TOS field or DS field) of the IP packets.

**B2.5) Provided Quality of Service (QoS)**

The provided Quality of Service reflects the actual received quality. This can differ from the reserved quality. It includes loss and delay parameters for the observed flow.

**B2.6) Traffic contract parameters**

The **maximum transmission unit** (B2.6.1) is the maximum packet size for this flow that will conform to the traffic specification. The **minimum transmission unit** (B2.6.2) is the minimum datagram size for this flow. The policing algorithm treats smaller messages as though they were this size.

This is used to allow reasonable estimation of the per-packet resources needed to process the packets of a flow [12] and [14]. If RSVP is used as flow set-up protocol, both values can be obtained directly from the RSVP flow specification.

Some additional parameters are relevant for guaranteed service [16] and [13].

The **backlog** (B2.6.3) parameter describes the data backlog that can result from the deviation of real implementations from a bit-by-bit queuing service. The backlog is caused by the fact that the data within the packets may leave the queue in a packet service later than they would in a bit-by-bit service. For packetized weighted fair queuing the backlog is smaller or equal to the maximum packet size of the network.

The **delay** (B2.6.4) describes the maximum packet transfer delay through the service element (e.g. router).

The **slack term** (B2.6.5) represents the amount by which the end-to-end delay bound will be below the required end-to-end delay assuming each router along the path reserves the bandwidth that was specified for the guaranteed service. Is the actual provided delay smaller than the required delay (slack term > 0), the network can increase the delay if it is necessary for example to accept new flows. The parameters for guaranteed services can be read directly from the RSVP flow specification.

(see also B2.8)

**B2.7) Violation of traffic contract parameters**

The **discard flag** (B2.7.1) indicates whether packets which do not conform to the reserved parameters are discarded or downgraded to best effort service. Such packets might be charged differently compared to conforming packets.

**B2.8) Reserved resources**

The **rate** (B2.8.1) and **burstsize** (B2.8.2) describe the maximum rate and burstsize, which have been reserved for the flow. In case of RSVP the values can be calculated from the parameters given in the flow specification (Tspec and Rspec structures). For controlled load service the rate is set to the token bucket rate r (given in the Tspec). For guaranteed service the parameter is set to the service rate R (given in the Rspec). Note that there is no resource reserved for the best effort service.

Reserved resources (and traffic contract parameters) for integrated services can be measured by capturing RSVP messages and extracting the flowspec parameters. A method for capturing reserved resources which extends an RTFM meter is presented in [17].

**B2.9) Volume actually used**

The **volume sent in bytes** (B2.9.1) or the **volume received in Bytes** (B2.9.2) respectively, is a counter that counts the total data volume (in bytes) which has been transferred (sent/received) so far. The distribution of the data volume over the (bigger) time interval can be estimated, if necessary.

The **volume sent in packets** (B.2.9.3) or the **volume received packets** (B2.9.4) respectively, is a counter that counts the total number of packets which has been transferred (sent/received) so far.

Volume actually used can be measured by classifying the packets according to flow attributes and counting the number of bytes or packets that match the attributes. A measurement architecture based on a packet matching engine is specified by the IETF Real Time Flow Measurement (RTFM) working group [9], [11] and [10].

**B2.10)multipoint aspects**

For multicast communication further parameters are required to handle the aspects of cost sharing between receivers and heterogeneous QoS within a multicast group. In order to split savings that were achieved through the usage of a shared link in a fair way between the group members (if the members are paying), information about the multicast tree is needed.

The parameters in detail:

The **number of receivers** (B2.10.1) is relevant if costs are shared between receivers. The charging for a particular receiver has to depend on the number of receivers that are members of the group.

The **number of senders** (B2.10.2) is needed if several senders send to a multicast group, where cost sharing can then be done between senders.

The **individual reservation parameters for each receiver** (B2.10.3) is relevant if members of a multicast group reserve different QoS parameters (which is possible e.g. with RSVP) in order to allow fair charging.

QoS provided for individual segments of the multicast tree (B2.10.4), or for each receiver: Due to the usage of different physical links, local congestion and other effects, the actual provided QoS can differ for the members of the group. Parameters specifying individual QoS include loss and delay (see B2.5).

# 7 Charging mechanisms required in IP based networks

The following functions and capabilities are part of the charging entity in the network element:

- functions for the measuring of the parameters or for monitoring of the charge related events;
- an activity generating charging records from the measured and monitored data and reports for the management system;
- a storage function, necessary for storage of charging records over a limited period of time;
- the capability to detect whether there is still sufficient storage capacity for new records;
- a timer function to be able to send reports to the management system at regular intervals;
- a data communications facility for communication with the management system for e.g. conveying data records by request and alarms;
- availability control and performance monitoring; recording and communication of relevant events. (This has not necessarily to be done in real-time).

Only the first point will be dealt with in this clause. The other points are more or less related to accounting functions and have no direct impact on the network.

Clause 6 list a variety of parameters relevant for the collection of charging information for an IP based network. The parameters can be divided into three categories:

- parameters which are relevant for service providers without impacting the network. This category covers all parameters related to the subscription (point A) in Clause 9);
- parameters which impact the network and are well known from today's networks. This category covers the parameters related to the utilization of such resources which are fix per session (point B1) and the parameterscommunication partner, duration, time of day - day of week - day of the year, reserved resources - points B1), B2.2), B2.3) and B2.8);
- parameters which impact the network and are related to the IP technique.

Only the third category is specific to the IP technique. All the measurements are made at the IP layer; not at higher layers of the user plane. Measurements should take place at the border routers of the provider network.

# Annex A (informative): Example of a charging record

This table is based on the work of ACTS project SUSIE. The SUSIE project is concerned with charging mechanism for Premium IP Services. The table is used as an example for such a charging record. Other possibilities exist.

**Table A.1: Example of a charging record**

| Parameter | | Type | Range/unit |
|---|---|---|---|
| **Measurement point identification** | | | |
| | IP Address Length | Short | 32 ...128 [bit] |
| | IP Address | String [4..16] | |
| **Record Description** | | | |
| | Type of Record | Short | |
| **Flow Description** | | | |
| | Flow Type | Short | IPv4, IPv6, etc. |
| | Flow Owner | Short | QoS Setup Protocol, Flow, management or others |
| | Flow Start Time | | |
| | Destination Address | String [4..16] | |
| | Destination Netmask | String [4..16] | |
| | Source Address | String [4..16] | |
| | Source Netmask | String [4..16] | |
| | Destination Address Length | Short | [bit] |
| | Source Address Length | Short | [bit] |
| | Protocol | Short | (UDP=17,TCP=6) |
| | Destination Port | String [2..4] | |
| | Source Port | String [2..4] | |
| | Flow ID (for IPv6 flows) | Long | 0..16777215 |
| **Reserved Resources** | | | |
| | Service | Short | BE=1, Guaranteed Delay=2, Controlled Load=5 |
| | Rate | Long | [bits/s] |
| | Burstsize | Long | [bytes] |
| | Weight | Long | premium, assured, etc. |
| | Min Transmission Unit | Long | [bytes] |
| | Max Transmission Unit | Long | [bytes] |
| | Discard *(defines what happens to policed traffic - discarded or treated as best effort)* | Short | 1=discard, 0=back to BE, -1= not present |
| | Backlog | Integer | [Bytes] |
| | Delay | Integer | [µs] |
| | Slack Term | Integer | [ms] |
| **Used Resources** | | | |
| | Measurement start time | | |
| | Measurement stop time | | |
| | Distance Notation | Short | IP hops, switches, etc. |
| | Distance (to the destination) | Long | |
| | Volume sent | Long | [bytes] |
| | # of IP packets sent | Long | |
| | Burstiness Notation | Short | Simple style, token bucket style, etc. |
| | Burstiness | Long | |
| | Data extension flag | Boolean | True => more data exists |
| | Data extension start | | Starting point of additional data |

Only the volume sent is considered because for the backward direction a separate charging record has to be used.

# Annex B (informative): Example of a charging record using MPLS

**MPLS service detail record**

This section defines a service detail record for MPLS. The record can service as a basis for billing for broadband Internet services which use QoS, delivered by MPLS and is a method of providing QoS to IP based services. MPLS is currently being standardized by the IETF. The primary goal of the MPLS working group is to standardize "a base technology that integrates the label swapping forwarding paradigm with network layer routing."

The service detail record is drawn on the work of the ACTS project CANCAN which developed a connection detail record (CDR) for ATM and the SUSIE project which developed a Premium IP Network Accounting Record for the internet. From these CDRs a variant is proposed based on an internet draft MIB for MPLS.

**MPLS Service Detail Record Reference**

The reference source is:

- CANCAN Deliverable D3. July 1996. (ATM-Connection Detail Record).
- SUSIE SUISE Deliverable D3 November 1998 (Premium IP Network Accounting Record).
- MPLS Traffic Engineering MIB, 16 Feb 1999, IETF, MPLS Traffic Engineering Management Information Base Using SMIv2, draft-ietf-mpls-te-mib-00.txt Arun Viswanathan , Cheenu Srinivasan, Lucent Technologies.
- A Framework for Multiprotocol Label Switching, November 21, 199 <draft-ietf-mpls-framework-02.txt> R. Callon et al.

**MPLS-Service Detail Record**

A suggested service detail record format for MPLS is given below, using ASN.1 notation. It should be noted that this is a draft document and needs further refinement based on a final RFC for MPLS and discussion within the SUSIE project.

**Table B.1: Example of a charging record for MPLS**

| Parameter name | TYPE | Size (bytes) | FORMAT | UNITS | RANGE | Notes |
|---|---|---|---|---|---|---|
| ***Connection Information:*** | | | | | | |
| VersionNumber | OCTET STRING | 3 | ? | | | MPLS-SDR Version identification |
| AttributeMask | BIT STRING | 8 | Bit Mask | | | Indicates which SDR fields are present |
| ConnectionReference | BOOLEAN | 1 | | | 0 .. 1 | |
| ConnectionReferenceUni | OCTET STRING | 8 | ???????? | | | |
| CLPI | ENUMERATED | 1 | | | allowed(0), restricted(1), not_available(2) | |
| ConnectionNUMBER | OCTET STRING | 20 | MplsTeIANA AddrFamily | | | RFC 1700 [8] - Assigned Number |
| ConnectionNUMBER | OCTET STRING | 20 | MplsTeIANA AddrFamily | | | RFC 1700 [8] - Assigned Number |
| ConnectionCreationTime | GeneralizedTime | 14 | yyyymmddhhmmss | | | Local time |
| ConnectionCreationTimeOffSet | INTEGER | 2 | | [minutes] | -24*60 … 24*60 | Offset to UTC |
| ConnectionEndTime | GeneralizedTime | 14 | yyyymmddhhmmss | | | Local time |
| ConnectionlEndTimeOffSet | INTEGER | 2 | | [minutes] | -24*60 … 24*60 | Offset to UTC |
| EntryCreationTime | GeneralizedTime | 14 | yyyymmddhhmmss | | | Local time |
| EntryCreationTimeOffSet | INTEGER | 2 | | [minutes] | -24*60 … 24*60 | Offset to UTC |
| ConnectionClearCause | INTEGER | 1 | | | 0 … 255 | |
| ConnectionConfiguration | INTEGER | 2 | | | 0 … 65535 | |
| mplsTunnelName | OCTET STRING | 26 | | | | |
| mplsTunnelDescr | OCTET STRING | 26 | | | | |
| mplsTunnelDirection | INTEGER | 4 | | | | |
| mplsTunnelIndex | INTEGER | 2 | | | | |
| mplsTunnelLocalCookie | OCTET STRING | 6 | | | | Obtained by concatenating the head-end LSR's IP address with the tunnel index |
| mplsTunnelRemoteCookie | OCTET STRING | 6 | | | | |
| mplsTunnelSetupPrio | INTEGER | 4 | | | | |
| mplsTunnelHoldingPrio | INTEGER | 4 | | | | |
| Reserved1 | OCTET STRING | 4 | | | | |
| Reserved2 | OCTET STRING | 4 | | | | |
| Reserved3 | OCTET STRING | 4 | | | | |
| ***Contract Information:*** | | | | | | |
| MplsTunnelInMaxRate | INTEGER | 4 | | bits/sec | 0… 2147483647 | |
| MplsTunnelInMeanRate | INTEGER | 4 | | bits/sec | 0… 2147483647 | |
| MplsTunnelInMaxBurstSize | INTEGER | 4 | | bits | 0… 2147483647 | |
| MplsTunnelOutMaxRate | INTEGER | 4 | | bits/sec | 0… 2147483647 | |
| MplsTunnelOutMeanRate | INTEGER | 4 | | bits/sec | 0… 2147483647 | |
| MplsTunnelOutMaxBurstSize | INTEGER | 4 | | bits | 0… 2147483647 | |
| Reserved4 | OCTET STRING | 4 | | | | |
| Reserved5 | OCTET STRING | 4 | | | | |
| ***Usage Information:*** | | | | | | |
| MplsTunnelOutCellCount | INTEGER | 8 | | [cells] | 0 ... 1.8446744 * 10^19 | |

| Parameter name | TYPE | Size (bytes) | FORMAT | UNITS | RANGE | Notes |
|---|---|---|---|---|---|---|
| MplsTunnelInCellCount | INTEGER | 8 | | [cells] | 0 ... 1.8446744 * 10^19 | |
| DisruptionDuration | INTEGER | 4 | | [seconds] | 0 ... 2147483647 | |
| PeakCellRate | INTEGER | 4 | | [cells/sec] | 0 ... 2147483647 | |
| MeanCellRate | INTEGER | 4 | | [cells/sec] | 0 ... 2147483647 | |
| RowStatus | ENUMERATED | 1 | | | Update(0), Delta(1), Complete(2), … | |
| Reserved6 | OCTET STRING | 4 | | | | |
| Reserved7 | OCTET STRING | 4 | | | | |
| Reserved8 | OCTET STRING | 4 | | | | |
| ***Extra services:*** | | | | | | |
| ServiceTag | OCTET STRING | 40 | | | Service Definition Information | |
| Reserved9 | OCTET STRING | 4 | | | | |
| Reserved10 | OCTET STRING | 4 | | | | |

# Annex C (informative): Reference Implementation

Components of meter layer and reader layer are described by the Real Time Flow Measurement Architecture (RTFM) [9]. For metering, the tool NetTraMet (Network Traffic Meter, [11]) can be used. NeTraMet describes how SNMP can be used for the configuration of a meter and for the transfer of metering data between meter and reader, employing a special meter MIB. The NetTraMet meter is a stand-alone SNMP agent which stores measured data in a meter MIB defined in [10]. An extension of NetTraMet allows for monitoring of RSVP states (see [18]). Further extensions are planned (see HaBR98, Bibliography). NeTraMetThe uses rules for pattern matching of IP flows. Pattern matching rules are given in special rulesets [9]. A Simple Ruleset Language (SRL) has been developed to simplify the creation of rulesets (see Brow98a, Bibliography).

# Bibliography

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.


- "Ideas on an IP Broadband Accounting MIB based on ATM", Daan van Egmond (Cap Gemini Netherlands B.V.) on behalf of ACTS Project CANCAN, [ETSI NA8 02/98 TD24].
- "Charging for Premium IP Services in the European Information Infrastructures & Services Piolt", Donal Morris (Teltec) on behalf of ACTS Project SUSIE, [ETS NA8 06/98 TD13].
- "An approach to pricing of connectionless network services"; Martin Karsten, Ralf Steinmetz; Proceedings of MMNS'97, Chapman Hall, [ETSI NA8 06/98 WD1].
- "An embedded charging approach for RSVP"; Martin Carsten, Jens Schmitt; Lars Wolf, Ralf Steinmetz; International Workshop on Quality of Service '98, Napa, California USA, May 18-20 1998, [ETSI NA8 06/98 WD2].
- TS 101 321: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Inter-domain pricing, authorization and usage exchange".
- Brow98a: N. Brownlee. SRL: A Language for Describing Traffic Flows and Specifying Actions for Flow Groups. Work in progress in IETF.
- HaBR98: S.W. Handelmann, N. Brownlee, G. Ruth, S.Stibler: New Attributes for Traffic Flow Measurement. Work in progress in IETF.

# History

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