Monitoring and Measurement Cluster – 001990

D31 - MOME Standardisation Plan and Recommendations

Abstract

This document gives an overview of standardisation activities concerning IP monitoring and measurement in various standardisation bodies. For each body, known contributions from IST projects are described and opportunities for participation are listed. The opportunities are summarized in a standardisation plan and recommendations for activities related to monitoring and measurement in the IST programme.

Keywords

MOME, standardisation, Internet Protocol, measurement, monitoring, traffic flow, IETF, 3GPP, ITU

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Table of Contents

List of Figures

List of Tables

List of Acronyms

3GPP	The 3rd Generation Partnership Project
CLI	Command Line Interface
CRANE	Common Reliable Accounting for Network Elements
DMTF	Distributed Management Task Force, Inc.
GB-RG	Grid-Benchmark Research Group
GMA	Grid Monitoring Architecture
GGF	Global Grid Forum
IESG	Internet Engineering Steering Group
IETF	Internet Engineering Task Force
IMRG	Internet Measurement Research Group
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPDR	IP Detailed Record
IPFIX	Internet Protocol Flow Information eXport
IPPM	Internet Protocol Performance Metric
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IRTF	Internet Research Task Force
IST	Information Society Technologies
ITU	International Telecommunication Union
MIB	Management Information Base
MPLS	Multiprotocol Label Switching
NMA-RG	Network Measurements for Applications Research Group
NM-WG	Network Measurement Working Group
NMRG	Network Measurement Research Group
PSAMP	Packet SAMPling
QoS	Quality of Service
PR-SCTP	Partially Reliable Stream Control Transmission Protocol
RFC	Request For Comments
RTFM	Realtime Traffic Flow Measurement
RTT	Round Trip Time
SG	Study Group
SIP	Session Initiation Protocol
SLA/SLS	Service Level Agreement / Service Level Specification
SNMP	Simple Network Management Protocol
WG	Working Group

Executive Summary

This document gives an overview of standardisation activities concerning IP monitoring and measurement in several standardisation bodies. For each body, known contributions from IST projects are described and opportunities for participation are listed in Section 2. Section 3 summarises the opportunities in a standardisation plan and gives recommendations for active participation out of the IST programme in the standardisation of monitoring and measurement.

Two main recommendations are given. The first one is continuing the strong and successful active participation in standardizing traffic metering technology within the Internet Engineering Task Force (IETF). This recommendation is particularly directed to projects and project partners that have already built up expertise in IETF standardisation. The second recommendation is becoming active in the Internet Measurement Research Group (IMRG) of the Internet Research Task Force (IRTF). This group is very open and looking for interesting work items. This recommendation is particularly directed towards new projects exploring new area in traffic measurement or in its application.

A minor recommendation concerns activities in the 3rd Generation Partnership Project where IP traffic measurement is under standardisation for accounting and charging purposes, but work on this issue has already progressed far in 3GPP and the opportunity to participate is only given if actions start immediately.

1 Introduction

Usually, monitoring and measurement of Internet traffic involves not just a single application, but a combination of different tools that process measured information on different levels. In order to exchange information between these tools, agreed common information models, data models, file formats, and protocols are required.

The exchange of information can serve different purposes as listed in Table 1.

Purpose of Interaction	Type of Interaction
configuration and control of traffic measurement processes	control
monitoring traffic measurement processes	control
query request for transmission of specified measured data	control
the transmission of measured data itself	data

Table 1: Interaction Between Components of Traffic Measurement Applications

The illustration of the general Internet traffic measurement process in Figure 1 shows that measured traffic data primarily contains packet records with raw per-packet information or flow records with aggregated per-flow information.

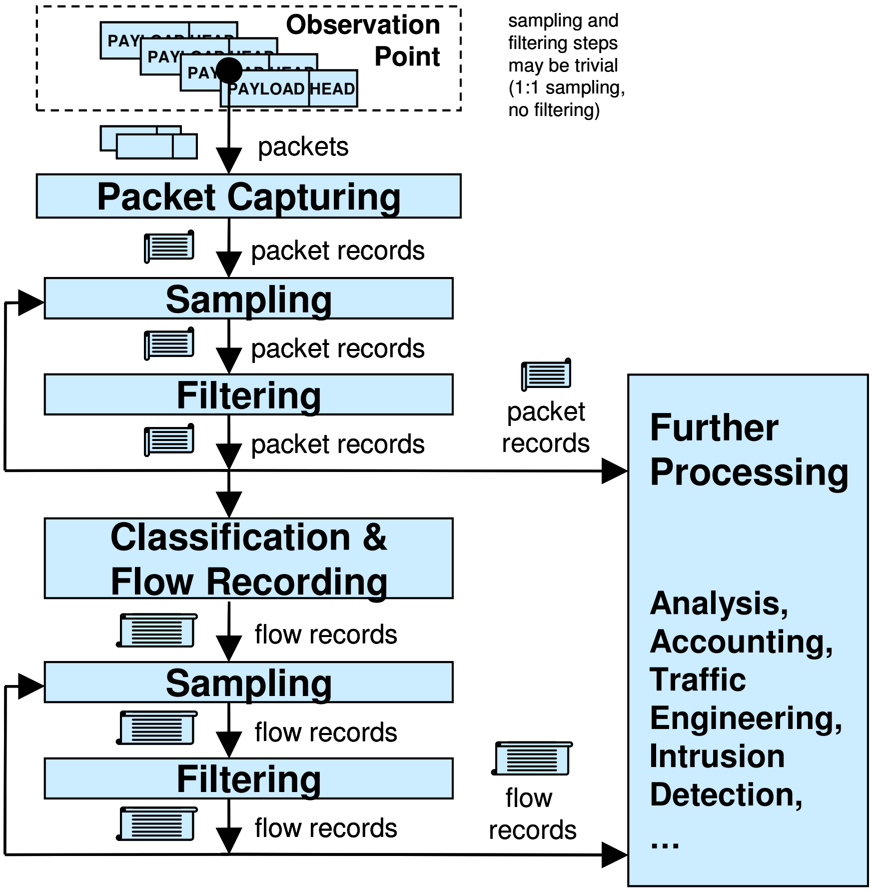

Figure 1: Generic Traffic Measurement Process

After observing and capturing individual IP packets at an observation point, (parts of) captured packets are further processed as packet records. Optional processing steps are *sampling* and filtering. The output of packet level processing are packet records. Tools for packet capturing and for further processing interact by using common formats for packet records. Records can be exchanged using Application Programming Interfaces (APIs), packet record exchange protocols, packet record files (e.g. tcpdump files) or packet record entries in a database. Analogous considerations apply to *traffic flow* records that are created by packet record classification and flow recording.

To achieve interoperability between different tools or components of Internet monitoring and measurement applications, standardisation of the interactions listed in Table 1 is required. The most obvious standardisation body for Internet traffic measurement is the Internet Engineering Task Force (IETF) that develops most of the Internet-specific standards. But also other generals telecommunication standardisation bodies, such as the International Telecommunication Union (ITU), and standardisation bodies dedicated to specific technologies or application areas, such as the 3rd Generation Partnership Project (3GPP) or the Global Grid Forum (GGF).

This document gives an overview of standardisation activities concerning IP monitoring and measurement in several standardisation bodies. For each body, known contributions from IST projects are described and opportunities for participation are listed in Section 2. Section 3 summarises the opportunities in a standardisation plan and gives recommendations for active participation out of the IST programme in the standardisation of monitoring and measurement.

2 Monitoring and Measurement Standardisation Overview

This section gives and overview of standardisation bodies that are involved in standardising IP traffic monitoring and measurement standards.

2.1 Standardisation Bodies

The following list of standardisation bodies is discussed. Most bodies are industry fora not producing legal standards, but often standards that are de-facto standards. Only the ITU is a legal standardisation body.

Acronym	Name	URL	Status
IETF	Internet Engineering Task Force	www.ietf.org	industry
IRTF	Internet Research Task Force	www.irtf.org	industry
ITU	International Telecommunication Union	www.itu.int	legal
3GPP	3rd Generation Partnership Project	www.3gpp.org	industry
IPDR	IPDR.org	www.ipdr.org	industry
GGF	Global Grid Forum	www.ggf.org	industry

Table 2: Standardisation Bodies for IP Traffic Measurement

2.2 IETF

The Internet Engineering Task Force defines standards for the Internet, particularly protocols and information models are standardised. IETF work is structured into areas and working groups. Traffic measurement standards are developed by the IP Performance Metrics (IPPM) and Real-Time Flow Measurement (RTFM) WGs in the Transport Area and by the Packet SAMPling (PSAMP), IP Flow Information eXport (IPFIX), and Remote MONitoring Management Information Base (RMONMIB) WGs in the Operations and Maintenance Area. In addition to traffic measurement specific WGs, also other WGs defined standards providing traffic measurement features, particularly, definitions of Management Information Base (MIB) modules for the Simple Network Management Protocol (SNMP).

2.2.1 SNMP MIB Modules

The Simple Network Management Protocol (SNMP, [16]) serves for communication between a management application (SNMP manager) and SNMP agents at managed nodes, such as hosts, routers, and other devices. The agent offers access to managed objects containing information about the managed node, such as its type, configuration, state and current performance values.

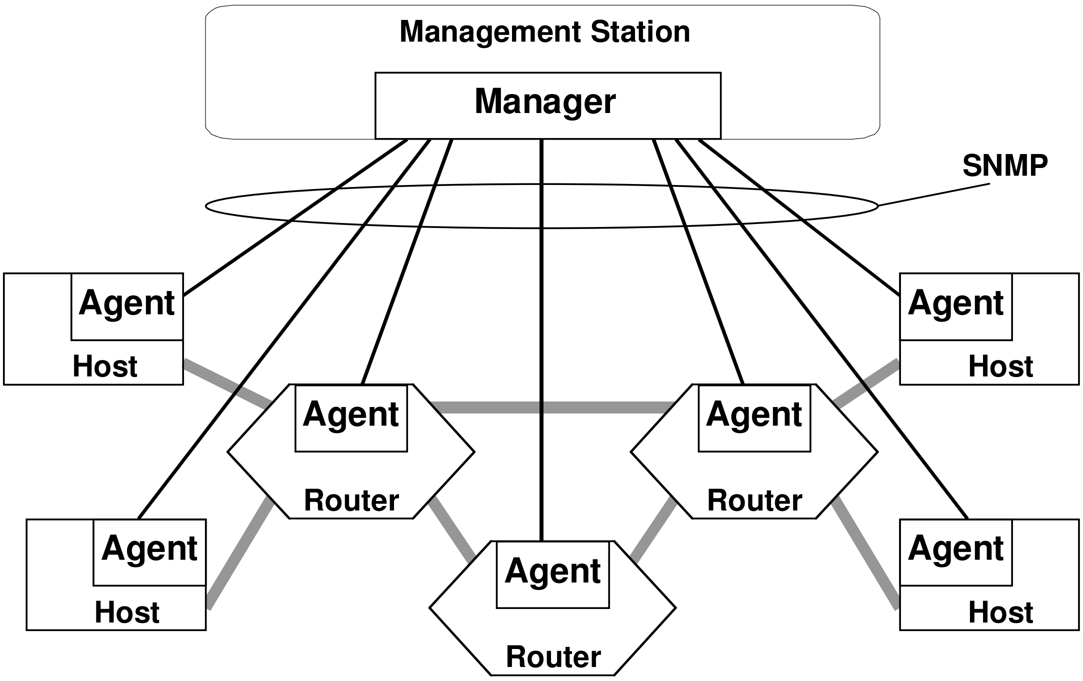

Figure 2: SNMP Application Scenario

Managed objects are structured in a Management Information Base (MIB). Individual MIB modules define portions of the MIB, for example, the Interface MIB module defines objects representing state and configuration of all IP interfaces of a device. Via SNMP the manager can send read requests and write requests for particular managed objects to the agent. This way, the manager can retrieve, for example, the configuration and status of an IP interface by reading the corresponding managed objects. By writing objects, a manager can, for example, manipulate the state of an interface.

In 1991 the IETF standardised a basic MIB module called MIB-II [1]. This module contained all objects that were useful as default for a device with IP interfaces. The MIB-II module contained

- incoming and outgoing counters for bytes and packets per IP interface,
- incoming and outgoing counters for bytes and datagrams per UDP socket,
- incoming and outgoing counters for bytes and segments per TCP socket.

Today, most of the definitions in the MIB-II module have been updated and these definitions are split over several documents. For example, the managed objects concerning IP interfaces are defined in the IF-MIB module [5], the objects concerning UDP and TCP are defined in the UDP-MIB module [4] and the TCP-MIB module [2].

With the counters in these MIB modules, basic traffic measurement can be performed at communication endpoints that are usually located at the hosts. At routers only the coarse granular byte and packet counters per interface were available, per connection information on UDP or TCP data streams were only available if the router was a communication endpoint. For measuring individual traffic flows passing a router further means are required. These are standardised by dedicated working groups, such as the RMONMIB, RTFM, IPFIX and PSAMP WGs.

Open issues and Opportunities for Contributions

The definition of default managed objects for devices with IP interfaces is very stable. If needed some of the specific documents are updated, but usually the updates do not concern traffic measurement-related issues.

2.2.2 RMONMIB – Remote MONitoring MIB module

The Remote MONitoring MIB module WG is the longest running of the WGs concerned with traffic measurement. The RMONMIB WG develops a very complex, flexible and powerful MIB module for detailed analysis of network traffic. The MIB module covers configuration of a measurement process as well as retrieving measured data. The RMONMIB is suited for detailed and specific network analysis tasks on different network layers.

RMONMIB probe implementations have high performance and typically have hardware support. They are too complex and expensive for massive deployment, for example in every router. RMONMIB implementations can operate offline when a management station will not be in constant contact with its remote monitoring devices. This is sometimes by design in an attempt to lower communications costs (especially when communicating over a WAN or dialup link), or by accident as network failures affect the communications between the management station and the probe.

For this reason, the RMONMIB allows a probe to be configured to perform diagnostics and to collect statistics continuously, even when communication with the management station may not be possible or efficient. The probe may then attempt to notify the management station when an exceptional condition occurs. Thus, even in circumstances where communication between management station and probe is not continuous, fault, performance, and configuration information may be continuously accumulated and communicated to the management station conveniently and efficiently. Given the resources available on the monitor, it is potentially helpful for it continuously to run diagnostics and to log network performance. The monitor is always available at the onset of any failure. It can notify the management station of the failure and can store historical statistical information about the failure. This historical information can be played back by the management station in an attempt to perform further diagnosis into the cause of the problem.

The monitor can be configured to recognize conditions, most notably error conditions, and continuously check for them. When one of these conditions occurs, the event may be logged, and management stations can be notified in a number of ways.

Because a remote monitoring device represents a network resource dedicated exclusively to network management functions, and because it is located directly on the monitored portion of the network, the remote network monitoring device has the opportunity to add significant value to the data it collects. For instance, by highlighting those hosts on the network that generate the most traffic or errors, the probe can give the management station precisely the information it needs to solve a class of problems.

An organization may have multiple management systems for different units of the organization, for different functions (e.g. engineering and operations), and in an attempt to provide disaster recovery. Because environments with multiple management stations are common, the RMONMIB can deal with more than one management station, potentially using its resources concurrently.

The basic RMONMIB specification [14] is accompanied by several functional or technology-specific extensions, such as the Token Ring RMON MIB [2]. It provides objects specific to managing Token Ring networks. The RMON-2 MIB [5] extends RMON by providing RMON analysis up to the application layer. The SMON MIB [6]extends RMON by providing RMON analysis for switched networks. An overview of all extensions is given in [25].

The WG planned to shutdown several times already and always another small issue came up that was worth continuing the work. The most recent issue is real-time application quality of service monitoring. This work is already progressed quite far and only few more small contributions are expected.

Contributions from IST Projects

The only known contribution was an Internet draft and a presentation with contributions from the ACTS IthACI project.

Open issues and Opportunities for Contributions

In general, this WG is always open for further extensions. But experiences showed that very few proposals have been accepted and that most of them came from the same core team that is participating in this group for many years already. Therefore, in a realistic view, the chances to join this WG with new contributions are rather small.

2.2.3 RTFM – Real-Time Flow Measurement

The Real-Time Flow Measurement (RTFM) WG was established in 1995. It developed an architecture for traffic measurement [12] containing a Manager that controls the measurement process, a Meter that measures traffic flows and a Reader that receives traffic flow measurement results from a Meter, see Figure 3.

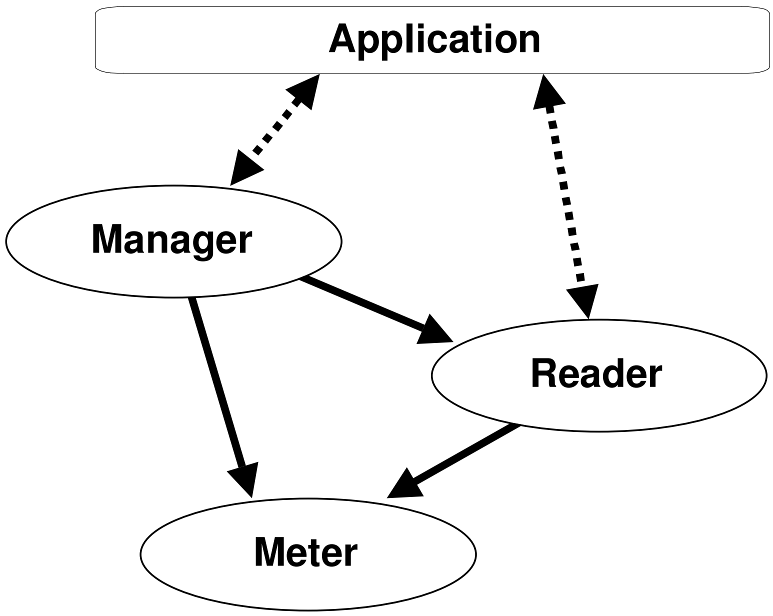

Figure 3: The RTFM Architecture

The manager communicates with an application that requires traffic measurement results. The application tells the Manager which kind of measurement is required. The Manager configures one or more meters according to the application's requirements and instructs a reader to regularly collect measurement information from the Meter. The Reader makes these results available to the application.

The main standard developed by the RTFM WG is the Meter MIB. This is an SNMP MIB module that specifies communication between Manager and Meter as well as between Reader and Meter via SNMP. The Meter MIB, particularly the interface between Manager and Meter is very powerful concerning functionality, but at the same time it is highly complex and difficult to use. The rules for traffic measurement, that are transmitted from Manager to Meter are coded as machine code for a packet-processing engine defined in [12]. There are only two implementations of the Meter MIB known, one by IBM used for internal purposes and one called NeTraMet by Nevil Brownlee, the chair of the RTFM WG. Since the source of NeTraMet is open and can be used free of charges, this powerful tool has been used by many universities in various research projects.

Contributions from IST Projects

Contribution to the RTFM working group were made by the ACTS IthACI project. In this project IP over ATM technologies were studied as a contribution to the development of Multiprotocol Label Switching (MPLS). Results of IP over MPLS traffic measurement in IthACI served as input for RFC 2724 [13].

Open issues and Opportunities for Contributions

This working group is closed.

2.2.4 IPFIX – IP Flow Information eXport

The IP Flow Information eXport (IPFIX) WG standardises a protocol for exporting information on observed packets. An initiative of the IST MobiVAS project contributed to establishing this WG. In December 2000 a first BoF session was organized at an IETF meeting based on experiences with the RTFM architecture. The BoF was titled RTFM2, because the intention was to improve RTFM in order to increase its usability and acceptance. A request for establishing a new WG was rejected by the Internet Engineering Steering Group (IESG), because the IESG members did not like the idea to improve a failed approach. Instead, they recommended to develop a new standard independent of RTFM. In summer 2001 another BoF session was held titled IP Flow eXport (IPFX), which basically suggested standardising a protocol similar to the proprietary Cisco NetFlow protocol. This attempt was successful and in autumn 2001 a new WG called IP Flow Information eXport (IPFIX) was established..

The WG defined requirements for IPFIX [29] that were based on five kinds of applications requiring traffic flow measurements: IP-based charging, traffic analysis, traffic engineering, QoS monitoring and intrusion/attack detection. The group developed an IPFIX architecture shown in Figure 4.

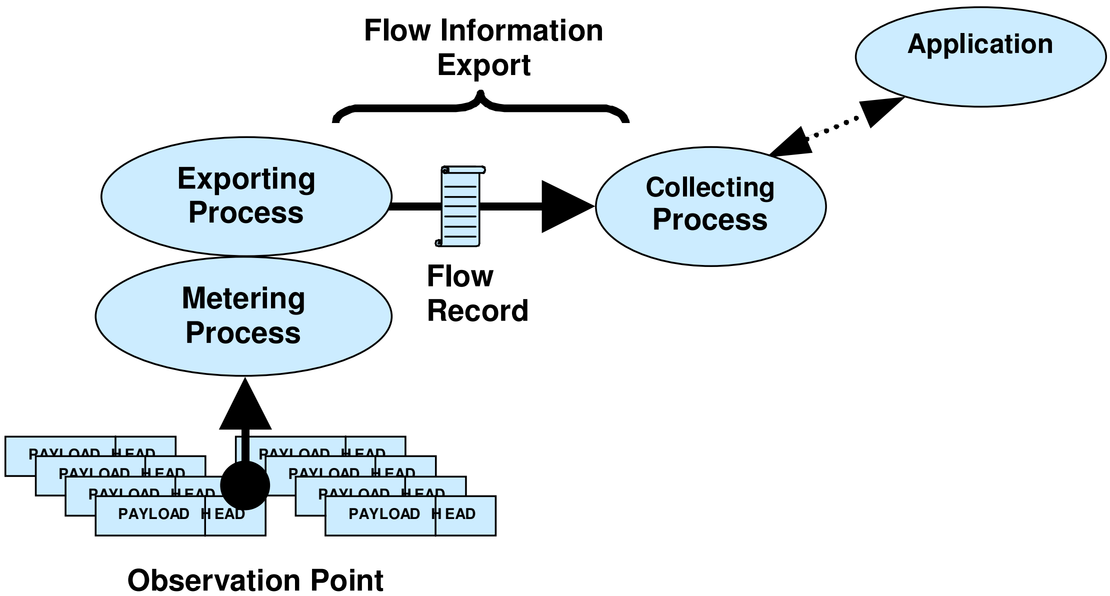

Figure 4: The IPFIX Architecture

At an observation point IP packets are observed and their headers (including transport headers and potentially also some application layer headers) are captured and forwarded to a metering process. The metering process samples and filters packet headers and maps the remaining headers to IP flows. Properties of flows are stored in flow records. An exporting process exports flow records over an IP network using the IPFIX protocol to a collecting process. There flow records are received and available for processing by an application. There can be multiple instances of all components of the architecture. The IPFIX architecture can be applied to various kinds of measurement devices and scenarios. Figure 5 gives an overview of potential IPFIX devices.

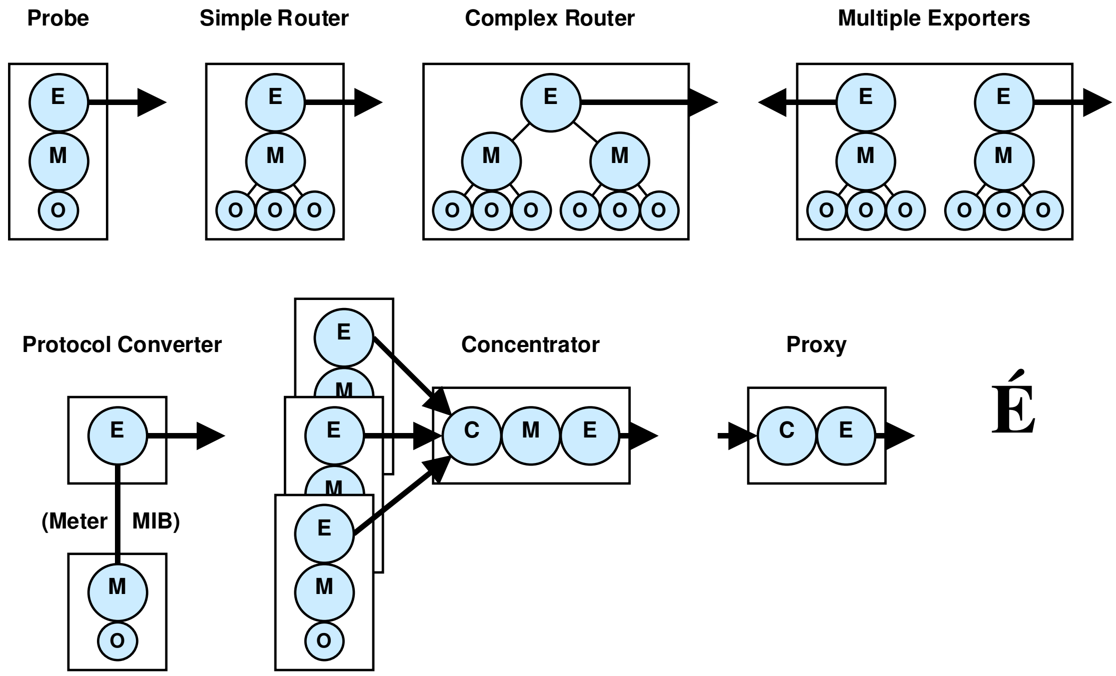

Figure 5: IPFIX Devices

The examples in Figure 5 are composed of one or more of the following elements: observation point (O), metering process (M), exporting process (E), and collecting process (C). The observation points shown in the figure are always the most fine-granular ones supported by the respective device.

A typical probe contains a single observation point, a single metering process, and a single exporting process. A basic router extends this structure by multiple observation points. Here, the observation point of a particular flow may be one of the displayed most fine-granular observation points, but also it may be a set of them.

A more complex router may host more than one metering process, for example one per line card. Alternatively, a complex router may host different exporting processes for flow records generated by different metering processes. A protocol converter makes use of a metering process that can be accessed only by protocol(s) other than the IPFIX protocol, for example SNMP and the Meter MIB module [5]. Then the exporting process receives flow record from a remote metering process and exports these records using the IPFIX protocol.

A concentrator receives flow records via the IPFIX protocol, merges them into more aggregated flow records, and exports them again using the IPFIX protocol. Finally, a very simple IPFIX-related device is a proxy. It just receives flow records using the IPFIX protocol and sends them further using the same protocol. A proxy can be useful for traversing firewalls or other gateways.

Different to many previous non-standard protocols for exporting flow records, the IPFIX protocol uses dynamic flow record structures. So-called flow record templates are sent initially from an exporting to a collecting process. They define the structure of flow records by specifying the set of elements contained in a record. The exporter may change the flow record structure over time if it announces the change by an according flow record template. Also more than one template can be in use at a time. Each flow record contains a template identifier indicating the template that describes the record's structure. Figure 6 shows the format of a typical IPFIX packet.

Packet Header	Flow Record Template	Flow Record	Flow Record	. . .	Flow Record Template	Flow Record

Figure 6: IPFIX Packet Format

After a packet header indicating protocol version, packet length and some information about the exporting process, a template flow record describes the format of the following flow records. After some flow records, another flow record template specifies a new format for further flow records.

As basic transport protocol for IPFIX, UDP, TCP and PR-SCTP (Partially Reliable Stream Control Transmission Protocol, [16][29]) were discussed. The working group decided having the use of PR-SCTP mandatory for all compliant implementations and TCP and UDP as optional protocols. PR-SCTP was preferred because different to UDP it is congestion-aware and reduces bandwidth in case of a congestion. Compared to TCP, PR-SCTP was preferred because of its much simpler state machine on the sender side. This saves resources on lightweight probes and router line cards.

After defining requirements, the IPFIX working group worked on an architecture document, a protocol specification and a specification of an information model. All three documents are in a rather mature state and their completion is expected soon – with end of editing in spring 2005 and publication in autumn 2005. Furthermore, the WG works on a document containing applicability statements. Explicitly not covered yet is the subject of IPFIX device configuration. Any discussion on this issue was excluded by the WG charter.

Contributions from IST Projects

The IST MobiVAS project contributed to establishing this WG. Three initial Internet drafts were written and two Bird-of-Feather sessions were organized at IETF meetings. After the WG was established, substantial contributions were made by the IST InterMon project including contributions as author or editor to five working group documents in 29 versions and 2 individual Internet drafts. The InterMon project was – together with Cisco – the technical driver of this WG. After termination of the InterMon project, some of the contributors from InterMon continued their contributions to IPFIX standardisation as part of their activities in the IST EuroLabs Specific Support Action.

The IST SCAMPI project gave input to the IPFIX working group by an Internet draft on IPFIX implementation experiences and resulting recommendations.

Open issues and Opportunities for Contributions

All work items of the WG charter are covered by a sufficient number of contributors. A re-chartering of the IPFIX WG might happen in spring 2005. Potential issues for a new charter include

- Configuration and Monitoring of IPFIX Devices
  The obvious issue at the IETF would be developing an IPFIX MIB module. This could be derived from the PSAMP MIB (see below).
- Implementation Guidelines
  Some implementation issues, for example the implementation on network address translators has already been discussed in the WG.
- Integration of Flow sampling
  So far, only packet sampling was considered by the WG documents, although also flow sampling has already been discussed by the WG.

2.2.5 PSAMP – Packet SAMPling

The Packet SAMPling (PSAMP) WG standardises a protocol for exporting information on observed packets. This WG was founded after two BoF sessions in March and July 2002, when the IPFIX WG was already working. While flow records containing information on sets of observed packets with common properties are in the focus of the IPFIX WG, PSAMP focuses on more basic reports of single

IP packets. Most of the function blocks, however, that are used by the PSAMP architecture are also contained in the IPFIX architecture as shown by Figure 7.

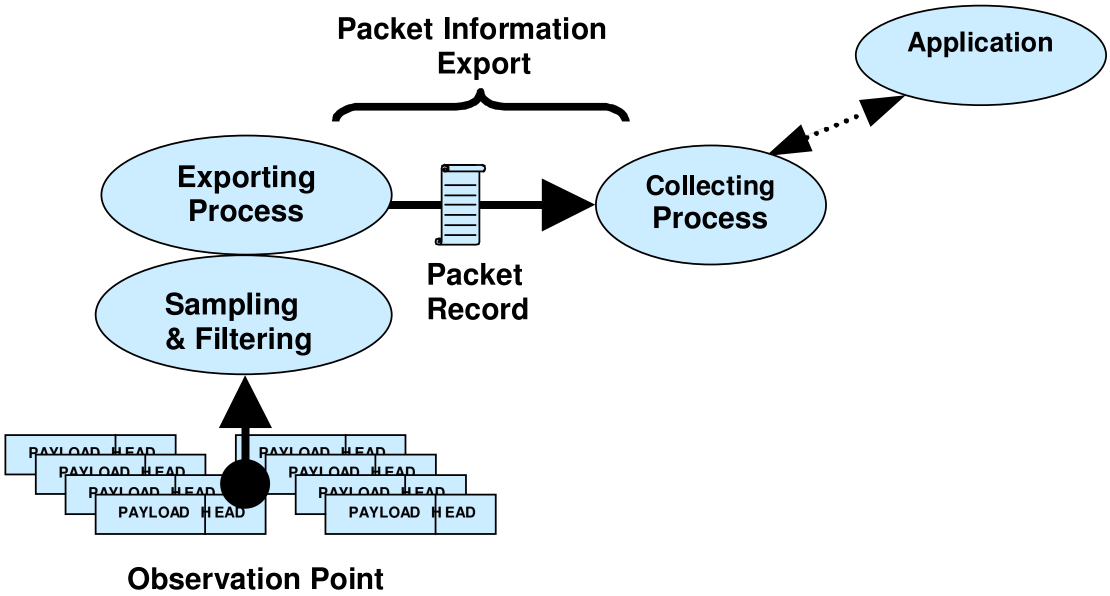

Figure 7: The PSAMP Architecture

The most significant difference between both architectures is the aggregation of packets into flow records, which is only contained in the IPFIX architecture.

The PSAMP WG decided to re-use the IPFIX protocol for packet information export. At the time of this decision, the IPFIX protocol met all requirements for this purpose except the export of captured parts of packets with variable length. On request of the PSAMP WG, the IPFIX WG added such a feature to the IPFIX protocol. With this extension, the IPFIX protocol can be used also for packet information export by just extending the IPFIX information model.

The PSAMP WG is working on five documents describing:

- the PSAMP framework and architecture,
- packet sampling and filtering methods,
- the use of the IPFIX protocol for PSAMP,
- the PSAMP information model (as extension of the IPFIX information model),
- a MIB module for reading and writing the PSAMP device configuration.

All documents are progressing well, but several issues are on hold, because they depend on output of the IPFIX WG. Only a few items have been discussed by the WG that are not yet covered by these documents. One is the better support of IPv6 packets by sampling methods, another one is a document on PSAMP applicability.

Contributions from IST Projects

Similar to the IPFIX WG, substantial contributions to the PSAMP WG were made by the IST InterMon project including contributions as authors or editor to four out of five working group documents in 14 versions and 2 individual Internet drafts. The InterMon project was – together with Cisco – chairing the WG and – together with AT&T and Cisco – the technical driver of this WG. After termination of the InterMon project, some of the contributors from InterMon continued their contributions to IPFIX standardisation as part of their activities in the IST EuroLabs Specific Support Action.

Open issues and Opportunities for Contributions

All work items of the working group charter are covered by a sufficient number of contributors. A re-chartering of the PSAMP WG might happen in summer 2005 but it is expected that the WG will rather be closed than continues at this point in time. Still, potential issues for a new charter include better support for IPv6 packets (if this issue is not solved until then) and a document on PSAMP applicability.

2.2.6 IPPM – IP Performance Metrics

The IP Performance Metrics (IPPM) WG standardises a set of metrics to evaluate the quality, performance and reliability of Internet data delivery services. The metrics defined by the WG provide a quantitative measure of performance and characterize different features and service classes. Together with the metric definition, a measurement procedure is also provided. Up to now the following metrics have been defined:

- Connectivity. RFC 2678, "IPPM Metrics for measuring connectivity" [5], defines several metrics determining whether pairs of hosts (IP addresses) can reach each other. The document proposes analytical metrics to define one-way and two-way connectivity at one point in time and over an interval of time. Methodologies to evaluate those metrics are then contributed too.
- One-way delay. RFC 2679, "A one-way delay metric for IPPM" [8], defines analytical metrics called singleton, sample, and statistics to measure one single observation of one-way delay, a sequence of singleton delays measured at times taken from a Poisson process and define and discuss statistics of this sample
- One-way loss. RFC 2680, "A one-way packet loss metric for IPPM"[9] is the companion document of RFC 2679, and has pretty much the same structure. It also uses singletons, samples and statistics to define a metric for one-way packet loss across Internet paths.
- Round-trip delay is defined in RFC 2681 ("A round-trip delay metric for IPPM") [10]. The document uses the same schema as for the previous two RFCs.
- Delay variation is described in "IP packet delay variation for IPPM" (RFC 3393)" [22]. This document refers to a metric based on the difference in the one-way delays of selected packets. Both the case of pairs of hosts with synchronized clocks and without synchronized clocks are addressed in the document.
- Loss patterns. The RFC 3357, "One-way loss pattern sample metrics" [19], proposes two derived metrics, based on the base metrics defined in the other IPPM RFCs, called "loss distance" and "loss period". The former captures the frequency and length (burstiness) of loss once it starts, while the latter captures the spacing between the loss periods. Their definition has been motivated by the fact that for certain applications the loss pattern or loss distribution strongly influences the perception of performance.
- Bulk transport capacity has been defined in "A Framework for Defining Empirical Bulk Transfer Capacity Metrics" (RFC 3148) [16]. Bulk Transport Capacity (BTC) measures the ability of a network to transfer certain amounts of data with a single congestion-aware transport connection (e.g. TCP).
- Packet reordering is still at a draft stage [33]. The existing draft defines metrics to evaluate if a network has maintained packet order on a packet-by-packet basis. As in other IPPM documents, it starts by defining a reordered singleton using it as a basis for the definition of sample metrics for several dimensions.
- Link bandwidth capacity is in its initial stage. The editor of the draft has been appointed in August 2004 during the 60th IETF meeting.

Another aspect currently covered within the Working Group is the definition of a reporting Management Information Base (MIB) for managing network measurements based upon the IPPM metrics [34]. The MIB definition specifies how the measurement results should be managed and reported and how/when alarms should be pushed.

Re-chartering of the group is expected to happen in Spring 2005.

Contributions from IST Projects

The IST 6QM project is contributing several drafts to this WG. The drafts all address mainly the design of a reporting MIB. While the group is discussing the eventuality to define another IPPM MIB, this document, currently in its sixth version and fully implemented could make it to informational RFC.

Open issues and Opportunities for Contributions

There is currently a discussion going on on the appropriateness of the proposed reporting MIB. There seems to be no consensus with the actual MIB, defined too complex, while there is interest in defining a lightweight MIB. It is still an open point whether the design of a simpler MIB should be part of the charter.
Another opportunity to contribute would be in the area of multi-to-multi measurements or traceroutes. The chairs encourage submitting individual drafts and the WG seems to agree on these as valid topics. No contributions have been submitted up to now.

2.3 IRTF

The Internet Research Task Force (IRTF) is a pre-standardisation organisation closely related to the IETF. It aims at promoting research in areas important to the evolution of the Internet that are not yet explored sufficiently for standardisation. The work is done in small, long-term working groups focused on specific topics related to internet protocols, architecture, applications and technology. Among the IRTF research groups related to monitoring and measurement are

- the Internet Measurement Research Group (IMRG) focusing on Internet measurements and
- the Network Management Research Group (NMRG).

2.3.1 IMRG

The Internet Measurement Research Group (IMRG) provides an open forum for discussion of Internet measurement research issues. The scope includes all kinds of network measurement (active techniques, passive monitoring, end-point probing, in-network methods, network layer, transport layer, application layer, etc.) and both designing new measurement techniques and analyzing measurements of the network are of interest for the Working Group (WG). Besides this, IMRG is also trying to increase interactions between operators, developers of measurement tools and techniques, and researchers who analyze and model Internet dynamics.

Recent work done in the IMRG is related to the evaluation, and discussion on the motivation for a protocol for Internet measurement. The protocol proposed, the IP Measurement Protocol (IPMP) [25], has not been approved by the review team within IMRG, but the need for some sort of measurement protocol seems still to be a point of interest for the group. While a discussion on the suitability of IPMP is still going on, its rejection from the group makes the topic a good target for future contributions.

Also, the problem of deploying SLAs that cross ISP boundaries has been raised. Inter-domain measurement and monitoring is another area to contribute to. In 2003, during the 57th IETF meeting, a BoF called ISPMON was proposed. Its aim was to address inter-domain measurements. While the BoF at the time didn’t succeed to become an IETF WG, we feel that the interest for the topic is there (an ISP, SPRINT, was proposing the BoF) and it might be an interesting area to contribute to in the future.

Beyond these two issues, the IMRG is not a very active research group and support for this group by the research community is limited.

2.3.2 NMRG

The Network Management Research Group (NMRG) investigates new technologies for Internet management. Different to the IMRG, the NMRG did not start as an open group but as an exclusive group of top researchers in the area with membership by invitation only. The membership rules have been loosened since then, but still the NMRG is an important group for the discussion of upcoming trends and recent results and experiences in network management.

Several IETF working groups in the operations and management area have been discussed first in the NMRG before BoF sessions for them were held and the groups were established.

Monitoring and measurement are only side issues at the NMRG, but often upcoming issues are discussed at the NMRG before the IMRG takes care of the issue.

Contributions from IST Projects

So far, there have been very few concrete contributions from IST projects to the IMRG. The IST NGN-Labs project contributed several presentations at NMRG meetings but did not participate in further NMRG activities.

Open issues and Opportunities for Contributions

Certainly, the NMRG is very open for interesting new contributions. But since monitoring and measurement is not the core subject of the NMRG, contributions should be preferred that are related to network management, for example measurement of network management processes or management of monitoring and measurement processes. Other issues should rather be contributed to the IMRG.

2.4 ITU

The International Telecommunication Union (ITU) is a legal standardisation body that decides on standards by votes from participating countries. It develops standards in its telecommunication section (ITU-T) with focus rather on connection-oriented telecommunication. But with the Internet protocol entering the backbone of telephony networks and with Internet connectivity becoming an issue of basic connectivity supply to the world's population, the ITU-T more an more covers Internet standardisation.

The ITU developed a lot of standards on monitoring and measurement of traffic in non-IP networks, such as SDH, ATM, etc. These standards are not covered by this document.

2.4.1 SG 3 – Study Group 3

The ITU-T Study Group 3 (SG 3) is responsible for studies relating to tariff and accounting principles for international telecommunication services and study of related telecommunication economic and policy issues. To this end, Study Group 3 shall in particular foster collaboration among its members with a view to the establishment of rates at levels as low as possible consistent with an efficient service and taking into account the necessity for maintaining independent financial administration of telecommunication on a sound basis.

Relevant to IP monitoring and measurement are the tariff principles for International Internet Connectivity (IIC). This covers the way in which Internet traffic at exchange points between different Internet connectivity providers is measured and accounted. A first very basic document for this purpose was agreed on in 2000 [17]. However, this recommendation consisting in its core of just 5 lines of text was considered to rudimentary. Particularly small operators and small or developing countries felt that the needed more regulation in this area in order to have a more fair market.

Therefore, SG 3 currently works on a revision of [17] that covers more details. Besides political and economical constraints, the issue is also related to technical constrains in the area of IP traffic measurements.

Open issues and Opportunities for Contributions

SG 3 is plans to complete the revision of D.50 in Autumn 2004. Anyway, participation from EU projects is difficult, because only legal participants, such as national representatives are considered at ITU. Still technical recommendations and text contributions by any source with the appropriate expertise are welcome.

2.5 3GPP

The 3rd Generation Partnership Project (3GPP) is an industry forum for standardizing technology for 3rd generation mobile phone systems with the tendency to extend the terminals far beyond the phone capabilities known from 2nd generation mobile phone systems, such a GSM phones. 3GPP follows a clear trend towards applying IP in more and more components. The core network is already defined as an IP-based network, the access network, that so far is based on ATM transport, is expected to use IP transport in future releases of 3GPP standards. For 3GPP terminals, the support of IP is obligatory already.

3GPP is dealing with traffic measurement on three levels and on three stages. For all specification stage one is the definition of requirements. For IP monitoring and measurement, this is done in the Service Architecture Working Group 1 (SA1). On stage two, architectures are defined in SA2. On stage three, functions and protocols for monitoring and measurement are defined in SA5.

The first level of usage-based IP packet accounting is the radio access network. Here, IP packets are encapsulated into frames, and there is no instance capable of reading IP information. Therefore, only packet count and byte count information is available for accounting. Standardisation of monitoring and measurement at this level is already completed.

The second level is at the gateway between the access network and the IP-based core network. Here all IP packets are fully visible and still can easily be mapped to the sending terminal or receiving terminal, respectively. At the 3GPP, traffic accounting and charging at this level is called IP flow-based bearer-level charging. For this issue, 3GPP standardisation has already reached stage 3. SA5 is starting to define functions and protocols.

The third level is monitoring and measurement based on application-level signalling. 3GPP has defined the IP Multimedia Subsystem (IMS) to which IP applications signal their communication requests using the Session Initiation Protocol (SIP). At this level IP data streams are accounted based on the information extracted from SIP signalling. No real packets are measured, but signalling messages indicating (by their encoder type) which kind of packets are sent from where to where. IMS accounting and charging is at the same stage as IP flow-based bearer-level charging. SA5 just started defining functions and protocols.

For online charging, charging rules, traffic accounting and credit control are involved and need to interact with each other via reference points. For offline charging, charging rules, traffic accounting, charging collection functions and charging gateway functions are involved.

2.5.1 SA5 – Service Architecture Working Group 5

IP flow-based bearer-level charging [27] and IMS charging are current issues of 3GPP SA5 [20]. Work on IP flow-based bearer-level charging started in early 2004 and work on IMS charging in summer 2004.

The main goal of IP flow-based bearer-level charging is increasing charging capability and charging flexibility compared to packet accounting on the radio access level. The work is targeted at variable charging schemes applicable to existing and new IP services. Flexibility of charging should include volume-based charging, time-based charging, offline-charging (post-paid), credit-based online charging (pre-paid), charging per service, and individual charging schemes for value-added services.

SA2 has developed a charging architecture for online and offline charging. For offline charging, shown in Figure 8, the main components are an Application function (AF) that generates flow-based charging rules and transmits them via the Rx reference point to a rule function that configures the traffic measurement functions on traffic plane. From here, IP traffic flow records are transmitted via the Gz reference point to a charging collection function that accumulates user's charging records or to a charging gateway function that forwards flow records to other external charging functions, for example to a value-added service provider.

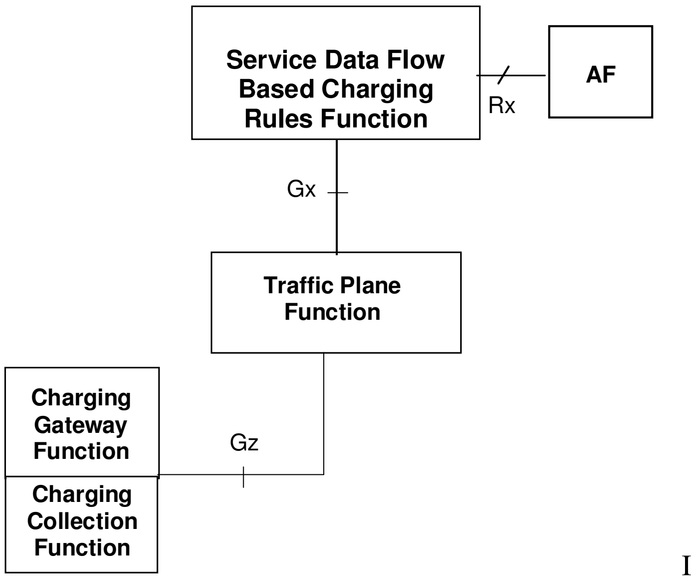

Figure 8: 3GPP IP Flow-Based Online Charging Architecture

Initially, SA5 discussed using IPIFX as protocol for reference point Gz, but finally the DIAMETER protocol was selected. For online charging, reference point Gz is replaced by Gy and the traffic measurement functions on the traffic plane do interact with online credit control functions (Figure 9).

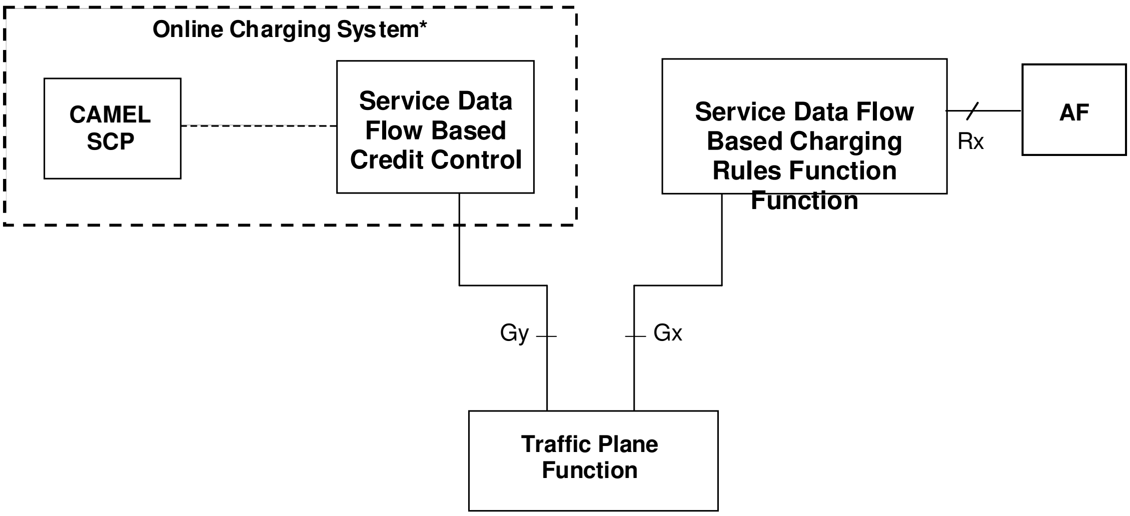

Figure 9: 3GPP IP Flow-Based Online Charging Architecture

For credit control now the traffic plane functions must provide more than just traffic measurement functionality, because in the case that credit is exhausted, also functionality for blocking traffic needs to be included.

Contributions from IST Projects

There are no known contributions from IST projects.

Open issues and Opportunities for Contributions

At the time of this writing, there is still a chance for joining SA5 and contributing to charging issues. However, this time window will close soon, probably already in 2004.

2.6 IPDR.org

IPDR.org is an industry forum developing technology for IP traffic-based accounting and charging. The main goal of the members of this forum is defining a common information model for IP detailed records containing accounting information on the usage of IP services. IPDR.org developed the IP Detailed Record (IPDR) specification [29] that defines an information model for IP accounting records. The model uses XML as specification languages and re-uses standardized XML data types.
Recently, IPDR.org adopted the Common Reliable Accounting for Network Elements (CRANE) [23] as transport protocol for IPDR records.

The IPDR work is completed and acceptance of their standard is limited to a small group of IP accounting systems and applications

Contributions from IST Projects

There are no known contributions from IST projects.

Open issues and Opportunities for Contributions

Since the work in IPDR.org on traffic measurement appears to be completed, there are no opportunities for future contributions.

2.7 GGF

The GGF is structured in 9 areas. Each area consists of multiple working groups and research groups. Measurement related topics are discussed in the area Information Systems and Performance (ISP). The group developed a Grid Monitoring Architecture (GMA, [19]) for fault detection, performance analysis and tuning, performance prediction and task scheduling in grid networks.

2.7.1 NM-WG – Network Measurements Working Group

The area consists of further working groups that work on measurement related topics. The Network Measurements Working Group (NM-WG) defines which metrics are of relevance to supervise and support the operation for applications and middleware in grid environments. It develops methods to describe theses metrics in a standardized way. The working group cooperates closely with the IETF IPPM working group and with the Internet2 End-to-end initiative. The group has issued a document on "A Hierarchy of Network Performance Characteristics for Grid Applications and Services" which describes metrics useful for grid applications. Terminology and metrics are strongly related to those defined in the IETF IPPM working group. Furthermore the group works on an XML schema for the description and representation of the measurement results. The working group maintains a tools classification web page with a list of measurement tools that can be used to measure the relevant metrics for grid environment.

2.7.2 GB-RG – Grid Benchmark Research Group

In addition to this there are two research groups in the area. The Grid Benchmark Research Group (GB-RG) will define metrics to rate the functionality, performance and efficiency of grid architectures. With this different architectures and implementations can be compared. Furthermore the metrics are used to inform users about the capabilities of a system (which can be used as a basis for adapting applications to the grid capabilities). The group also plans to provide reference implementations.

2.7.3 NMA-RG – Network Measurements for Applications Research Group

The Network Measurements for Applications Research Group (NMA-RG) investigates what network performance parameters are most relevant for the grid middleware. The information on the relation between network performance and middleware can be used as basis for developing a network-aware middleware.

Contributions from IST Projects

The GGF attempts to use metrics and methods standardized within the IETF (mainly IPPM group). If a project has not specifically Grid-oriented measurement tools or data, it is much better for this group to submit their ideas directly to the IETF or IRTF instead to the GGF. Nevertheless, it may be of value to make the GGF aware of new metrics and methods submitted as drafts to the IETF/IRTF. Furthermore if metrics or methods are specifically developed with grid applications in mind or are of special value for grid environment it would be advantageous to discuss requirements and methods with the GGF groups (especially the NM-WG).

Open issues and Opportunities for Contributions

The GGF is highly oriented towards the IETF measurement activities. Therefore measurement standardization should be rather done in IETF/IRTF and then adopted by GGF. So instead of using this forum to standardize measurement methods and metrics and instead of advising IST projects to contribute to the GGF one could rather see the GGF as a user of the MOME results.

The NM-WG group maintains a list of measurement tools for measuring network parameters that are needed in grid scenarios. So it seems that a tool database would be of value for the GGF. The MOME project should contact the NM-WG when the MOME tool database is available. The GGF could in general profit from MOME results, so that MOME might take a chance to present results to some GGF groups.

Maybe special support with regard to grid applications could be added to the MOME databases in order to support grid people who seek for tools or data with certain attributes.

3 Opportunities for Contributions

This section summarizes the open standardisation issues, opportunities and contributions from IST projects reported in the previous section. Based on this overview, it gives a recommendation for future involvement of IST projects in monitoring and measurement standardisation.

3.1 Contributions from IST projects

Standardisation of traffic measurement at the IETF is already significantly influenced by IST projects, particularly by the already completed InterMon project, but also by ACTS MobiVAS, IST SCAMPI, IST 6QM, IST NGN-Lab and IST EuroLabs. It is highly recommended to maintain this high level of contribution in order to consolidate the a clear recognition of contributions from Europe.

3.2 Standardisation Opportunities

There are several minor standardisation opportunities in different bodies, but there is only one that is permanently open: the Internet Measurement Research Group (IMRG) of the IRTF. All other research opportunities have certain windows of time where participants can easily join the standardisation process and can influence it.

The time window of IP traffic measurement in 3GPP will very soon be closed, definitely at the end of 2004.

At the IETF two new time windows are expected in spring 2005. The IPPM WG and the IPFIX WG will be re-chartered at that time and new work items can be added to the WG charters. In IPPM, chances of acceptance are high for work on defining a traceroute metric and defining a multi-to-multi measurement metric. At IPFIX re-chartering may open an opportunity for contributing to the standardisation of a network management interface to IPFIX devices by defining an IPFIX MIB module and to specifying implementation recommendations for IPFIX devices.

3.3 Recommendations

Based on past experiences and the identified opportunities for participation in standardisation activities, two main recommendations are given.

The strong and successful active participation in standardizing traffic metering technology within the IETF should be continued. A lot of expertise has been accumulated by European IST project and they have become a driving force in standardising traffic monitoring and measurement in the IETF. Particularly, the projects and project partners that already built up expertise in IETF standardisation should continue their activities and encourage other projects to join them for building up a strong European participation that brings European aspects and European points of view into the standardisation process, for example the higher need for privacy of data.

The Internet Measurement Research Group (IMRG) is a very good platform for new ideas, technologies or application of them in the area of IP traffic measurement. This platform can easily be used by IST projects with new ideas, because it is very open and looking for more participation. Particularly for new projects and for projects investigating basic issues in long term research activities, it is recommended to join the IMRG as active members.

A minor recommendation concerns activities in the 3rd Generation Partnership Project where IP traffic measurement is under standardisation for accounting and charging purposes, but work on this issue has already progressed far in 3GPP and the opportunity to participate is only give if actions start immediately

3.4 Standardisation Plan

According to the recommendations in the previous section, there are two actions to be performed by the MOME WP3:

- Establishing a team for continuing the successful contribution to the IETF IPFIX and IPPM standardisation.
- Identifying research areas in participating IST projects that are suited as work items for the IMRG and encouraging the corresponding projects to bring their contributions to the IMRG.

Both actions are explained in more detail below.

3.4.1 IPFIX Standardisation Team

A team should be established that continues the successful contributions to standardisation work in the IETF IPFIX and IPPM WGs. Suitable candidates can be project partners in the 6QM, Lobster, EuroLabs and other project participating in the MOME cluster. This team should include partners experienced in IETF standardisation as well as “interested newcomers” in order to spread gained knowledge and experience among the projects.

The team should be established by the end of 2004 in order to be prepared for the potential re-chartering of both WGs. For the IETF meeting in March 2005 the team should prepare four Internet drafts before the deadline for this meeting and in order to be presented at this meeting:

- a draft submitted to the IPPM WG proposing a metric for traceroute measurements,
- a draft submitted to the IPPM WG proposing a metric for multi-to-multi measurements,
- a draft submitted to the IPFIX WG proposing an MIB module for monitoring and optionally also for configuring IPFIX devices,
- a draft submitted to the IPFIX WG proposing implementation guidelines for IPIFX implementations

All four drafts have a reasonable chance to be accepted as work item of the respective WG. Still, there might be competing drafts and the WG may reject these work items, but currently, no such competing drafts or initiative to write them are known and the WG chairs show interest in adding these work items to their charter.

The MOME WP3 will take care of shaping this team. The detailed actions include:

- Contacting related IST projects and suited partners within these projects,
- Organizing a phone conference with interested parties in order to explain the plan,
- Organizing a kick-off meeting with committed partners,
- Monitoring progress of the Internet drafts to be written,
- Coordinating discussions with IPFIX and IPPM WG chairs and the corresponding IETF area directors

Results and experiences with this process will be reported and discussed at the MOME standardisation event in summer 2005.

3.4.2 Identifying potential contributions to the IRTF IMRG

MOME WP3 will identify research areas of IST projects participating in the MOME cluster which are suited for a new activity in the Internet Measurement Research Group (IMRG) of the IRTF. For each identified area, the potential of a contribution to the IMRG will be evaluated and the corresponding projects, and partners within these projects will be encouraged to start respective initiatives in the IMRG, and they will be consulted while doing so.

A list of areas together with the names of the corresponding projects and candidate partners to perform the initiative in the IMRG will be prepared for the MOME audit in February 2005. Initiatives are expected to start in spring 2005.

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