

D01 - MOME Project Presentation

Abstract

The MOME cluster offers a platform for knowledge and tool exchange and for co-ordination of activities in the field of IP monitoring and measurement between current and upcoming IST projects and other European partners. Many projects include monitoring and measurement components for traffic engineering, billing and accounting, security, etc. To avoid double work/funding and to improve the strength by synergetic knowledge transfer, common activities in-between these projects are required. This is advanced by interoperability testing of monitoring and measurement components of different projects and afterwards collecting monitoring and measurement data in a common format in a measurement database. Collected data is made accessible for the community over the Internet via simple interfaces for e.g. mathematical and statistical analyses. Monitoring and measurement related contributions to standardisation bodies like IETF from the participating projects are co-ordinated by the MOME cluster. The activities are supported by the organisation of public workshops and conferences within the field of monitoring and measurement.

Keywords

MOME, Project Presentation, D01

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1 Executive Summary


MOME Monitoring and Measurement Cluster http://www.ist-mome.org		
Project Reference	IST-2003-001990	
Contract Type	CA – Co-ordination Action	
Project Duration	24 month (01/01/2004 – 31/12/2005)	
Project Volume	63 person month	
Total Budget	714.200 € (EC Contribution 529.880 €)	
Strategic Objective	Broadband for all	
Project Co-ordinator	Mr. Felix Strohmeier Salzburg Research Forschungsgesellschaft mbH Jakob Haringer Strasse 5/III A-5020 Salzburg, Austria Tel: +43 662 2288 443 Fax: +43 662 2288 222 Email: fstrohmeier@salzburgresearch.at	
Project Consortium	Salzburg Research Austria NEC Europe United Kingdom Telefónica I+D Spain Université Libre de Bruxelles..... Belgium Budapest University of Technology & Economics Hungary Warsaw University of Technology..... Poland Fraunhofer Gesellschaft, Institut FOKUS Germany TERENA Netherlands	

Table 1-1 Project Facts

1.1 Main Objectives

The overall objective of the MOME project is to co-ordinate activities in the field of IP monitoring and measurement by offering a platform for knowledge, tool and data exchange.

Project objectives:

- To evaluate the interoperability of different active and passive measurement components, tools and interfaces.
- To promote interoperability at FP6 projects.
- To select a data format for satisfying the needs of the different tools.
- To collect measurement data of different tools, convert and store it into a common format and to allow access to their measurement results via a unified interface.
- To disseminate gathered measurement data to the community via an easy-to-use web-based interface to enable statistical data analysis.
- To co-ordinate standardisation activities in the field of IP monitoring and measurement.
- To organise workshops and conferences to build a monitoring and measurement knowledge exchange platform.

The project is organised in two main phases. While the first year is dedicated to gathering information about projects and tools as well as infrastructure set-up, the second year is the main period for data collection and analysis.

1.2 Technical Approach

Although MOME is a co-ordination action, there is some technical work done in this project. This work comprises the creation and maintenance of databases for monitoring and measurement tools and measurement data including their access interfaces. The following picture depicts this approach:

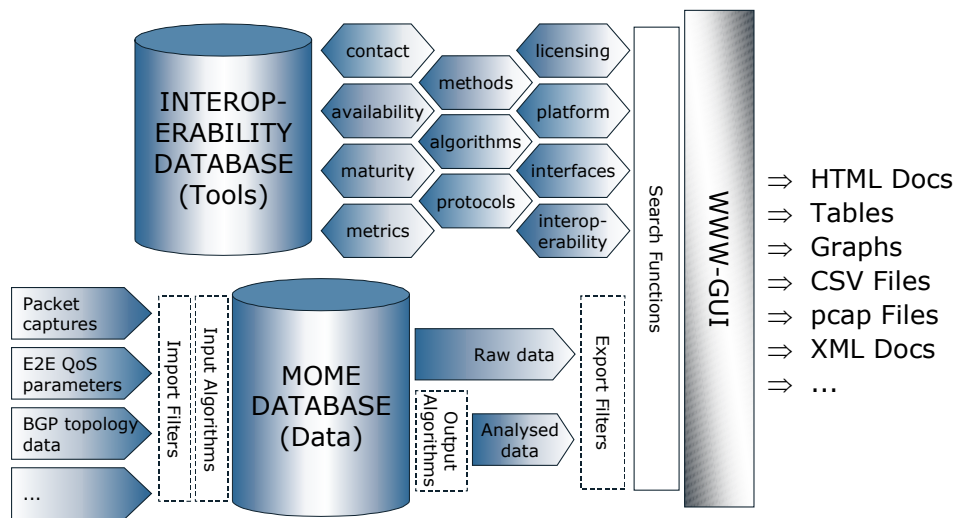


Figure 1-1 MOME Technical Approach

1.3 Key Issues

- Synchronise monitoring and measurement efforts in FP6
- Exchange measurement data
- Collect & evaluate information
- Provide database
- Promote interoperability
- Collect & distribute data
- Co-ordinate standardisation
- Create on-line searchable measurement database
- Recommend measurement tools
- Organise events
- Build tools taxonomy
- Workshops on monitoring and measurement issues
- Collect information about measurement tools
- Interoperability event
- Create on-line searchable tool database
- Conference sessions at TERENA Networking Conferences
- Perform interoperability tests

1.4 Expected Impact

Co-ordinating the measurement activities and providing assistance for projects support the development of components in different projects with interoperability to already existing tools and architectures. Future projects can base on existing technologies by adding their building blocks to fulfil the projects needs.

MOME supports current and upcoming research issues by providing real, recent measurement data in a standardised format for the public or to other projects as common base material. This measurement data can be used as input to new algorithms of statistical analyses for data reduction and result evaluation for network operation purposes like admission control, network re-provisioning, operation and maintenance, intrusion detection, etc.

MOME deals with future-oriented topics facing the most important standardisation organisations world-wide. Therefore the project contributes to the European innovation policy. The project results lead to effective contributions for standardisation and regulation of the proposed approaches.

MOME gets together specialists in the field of IP monitoring and measurement for knowledge exchange by organising workshops and conference sessions.

2 Project objectives and background

2.1 Scientific and Technological Objectives of MOME

The MOME cluster offers a platform for knowledge and tool exchange regarding IP measurements between IST projects and other European partners. MOME continues the MoMe cluster activities of FP5 (IST AQUILA, IST CADENUS, IST NGNi: benchmarking- and roadmapping reports, workshops) on the base of a long term working plan and more partners from the different MOME views.

Therefore the following scientific and technological objectives have been defined:

- To **evaluate the interoperability** of different *active* and *passive* measurement components, tools and interfaces. The results are presented in the interoperability database. This database provides a tool for the research community to select appropriate measurement applications for their purposes.
- To **promote interoperability** at upcoming FP6 projects. In addition to the Interoperability database, upcoming EU projects are informed about existing measurement solutions and help is provided in selecting tools. This can be done for instance by presenting at kick off meetings, consulting during the design phase, etc.
- To **select a data format** satisfying the needs of the different tools used within the MOME cluster. MOME provides documents to allow other IST projects to use the tools which have been selected and proven to be interoperable with the MOME database.
- To **collect measurement data** of different tools and convert it into a common format to allow access to their measurement results via a unified interface. MOME installs a measurement database for all the related projects to use by:
 1. feeding data from their experiments into it
 2. processing their data and complementary data coming from other projects which may allow a broader scope in the research conducted by the individual projects.
- To **disseminate** gathered **measurement data** to the community via a simple web-based interface to enable statistical data analysis and to **exchange** MOME-related **documents and tools** with other IST projects.
- To **co-ordinate standardisation activities** within the MOME cluster.
- To **organise workshops and conferences** to build a monitoring and measurement knowledge exchange platform for other IST projects and researchers.

In order to achieve these objectives, the core team of the MOME cluster is built by partners having strength in these different fields and perform activities also in other active and planned IST projects having monitoring and measurement components.

2.2 State of the art and its enhancements by MOME

2.2.1 Related IST projects

From FP5, the following recent MOME related IST projects have already been identified. MOME supports these projects by common activities in the field of monitoring and measurement.

- **INTERMON** (<http://www.ist-intermon.org>): The INTERMON project develops and demonstrates a scalable inter-domain QoS architecture in order to enhance the inter-domain QoS analysis in large-scale, multi-domain Internet (IPv4, IPv6) infrastructures. It integrates monitoring, topological and geographical structure mapping, modelling, simulation, optimisation and visual data mining components using common distributed QoS database with intelligent agents for

management of component's interworking and automated processing of different kind of inter-domain QoS information. The focus is to offer to Internet Service Providers (ISPs), QoS enabled end system developers and application users, an integrated inter-domain QoS analysis architecture for the purpose of operative control, planning and optimisation. MOME complements to INTERMON by evaluation of the developments in the interoperability tests and by exchanging design principles for the common measurement database.

- **SCAMPI** (<http://www.ist-scampi.org>): SCAMPI develops a scaleable monitoring platform for the Internet. It also aims to promote the use of monitoring tools for improving services and technology. The project develops a network adapter, initially at 10 Gbps speeds, tailored to the needs of monitoring tools. MOME complements to SCAMPI by evaluation of the developments in the interoperability tests.
- **6QM** (<http://www.6qm.org/>): The project 6QM is devoted to research and development of measurement technologies for Quality of Service in IPv6 networks. It creates a comprehensive system integrating the various required functions for QoS measurement, such as packet capturing, precise time-stamping, data collection, QoS metrics derivation (delay, loss, jitter etc.) and result presentation. MOME complements to 6QM by the collection and dissemination of MOME data.
- **NGN-LAB** (<http://www.ngnlab.org>): NGNLAB is a testbed to test Next Generation Network Protocols and Features such as IPv6, QoS, Security and Applications. It has two platforms interconnected with wide area GEANT network in Brussels (EuroDemo) and Basel (MULTICOMLAB). MOME makes use of NGN-LAB for interoperability testing. NGN-LAB activities are followed by Euro-Lab in FP6.

2.2.2 Standardisation Bodies

In the Internet Engineering Task Force (IETF) there are several working groups producing standards related to monitoring and measurement.

- The **IP Performance Metrics (IPPM)** working group defines objective quantitative measures of Internet performance. Defined metrics include connectivity, one-way delay, round-trip delay, delay variation, loss patterns, packet reordering, bulk transport and link bandwidth capacity.
- The **IP Flow Information eXport (IPFIX)** working group defines a protocol for exporting measured traffic flow data from a remote metering device to an application processing this data.
- The **Packet SAMpling (PSAMP)** working group defines packet sampling procedures, a protocol for exporting sampled packet information from a remote metering device to an application processing this data, and a protocol for configuring sampling devices.
- The **Remote MONitoring Management Information Base (RMONMIB)** working group develops a MIB module for the Simple Network Management Protocol (SNMP) for exporting highly detailed traffic monitoring information out of high performance monitoring devices, and for configuring the metering devices.

2.2.3 Public Measurement Databases

Different measurement databases, traffic archives and QoS information can be found in the Internet. Some of them are:

- The **Internet Traffic Archive** (<http://ita.ee.lbl.gov>), sponsored by ACM/SIGCOMM, provides analysis tools and conserved traffic traces of different network loads. Last update on this database was in April 2000. MOME enhances this approach by providing additional information and up-to-date data.
- **Network providers** (e.g. AT&T at <http://ipnetwork.bgtmo.ip.att.net>) and others (<http://www.internettrafficreport.com>) provide on their web-sites measurement data of QoS

parameters like delay, packet loss, connectivity, etc. collected in their networks as information to their customers.

- Sprints **IPMON** project (<http://ipmon.sprint.com>) provides in ca. bimonthly periods calculated trace analyses (link utilisation, packet size distribution, protocol distribution, etc.), routing information from BGP (number of ASes, prefixes, etc.) and delay information from some selected measurement points in US from their network. MOME enhances this approach on a European basis by providing also raw data for further statistical analyses.

Summarised, there are already some activities on this sector, mostly driven by US industry and research. MOME is an European counterpart in this field, getting the critical mass by co-ordinated activities of related projects.

2.2.4 Measurement Tools

A lot of different active and passive measurement tools are available and already evaluated and summarised in taxonomies e.g. at <http://www.ip-measurement.org> or <http://www.caida.org>. Many of them are available under GPL (Gnu Public License) and free to download. Goal of MOME is *not* to develop new measurement tools, but to analyse their result data format and interfaces and to evaluate the possibilities of interoperability.

2.3 Potential Impact

2.3.1 Impact of MOME in future research at the strategic objective "Broadband for All"

Measurement functions are supplementary functions that are needed in various projects for different scenarios. European projects should here rely on already existing tools and solutions already developed in other European projects. Co-ordinating the measurement activities and providing assistance for projects support the development of components in different projects with interoperability to already existing tools and architectures. Future projects can base on existing technologies by adding their building blocks to fulfil the projects needs. The interoperability of measurement tools is essential to allow the combination of measurement components and the integration in existing frameworks and architectures. Furthermore it simplifies the utilisation of analysis components and common databases. In order to allow interoperation also with other developments in the measurement area, it is important that the relevant existing and upcoming standards are understood and followed by future projects. Furthermore, measurement results should be made available to the public or at least to other projects as often as possible in order to provide common base material for future research.

Ongoing research in traffic measurement and monitoring is derived from the future technological needs. Traffic measurement techniques, methodologies and research is conducted by the features of next generation networks such as:

- QoS All-IP networking (“anywhere, anytime, anyplace communication systems”),
- globalisation and large scale networking,
- seamless network of complementary systems,
- complexity of applications (“intelligent applications” consisting of context and QoS aware components).

Since the next generation Internet services are characterised by its huge scale, diversity, and distributed administration, it is sometimes difficult to directly measure the dynamic states and performance of the network. Therefore, it is of practical importance to develop a statistical and indirect way to infer several characteristics that are expensive, or impossible in some cases, to be measured directly in a large network. Recent insights in the traffic inference and network tomography for analysis of complex networks and services have shown the need to combine measurement techniques with statistical and mathematical methods for traffic and traffic matrix estimation. The inference problems regarded as the network tomography, which often means a scheme of statistically inferring some unobservable characteristics in a network by measuring other, easily observable,

characteristics simultaneously, and especially by using correlation among those measured characteristics.

Furthermore, research on automated traffic measurement methods (traffic flow composition, etc) in real-time extended with prediction and estimation technologies are demand of high performance next generation networks and mission critical applications.

Another emerging research direction is seen in the area of real-time application oriented traffic measurement and monitoring focussed on key demands of the emerging new generation Internet like QoS and SLA monitoring of adaptive application, network security (intrusion, DoS attacks, etc) and inter-domain traffic engineering and capacity planning.

Further key focus are integrated measurement and application monitoring architectures including policies for tool integration and instrumentation like

- tools for network topology and mapping (connectivity),
- workload accounting (passive or non-intrusive),
- performance (active),
- routing (BGP routing tables)
- visualisation tools of Internet topology with spatial/temporal traffic mapping.

MOME supports these current and upcoming research issues by providing real, recent measurement data in a standardised format for the community. This measurement data can be used as input to new algorithms of statistical analyses.

To reduce the immense amount of raw data, that can be captured on high-performance networks during long-term measurements, MOME also defines what parameters should be measured and what results should be stored after pre-processing of raw data in the database, to provide valuable data for network operation purposes of e.g.

- admission control,
- network re-provisioning,
- operations and maintenance, e.g. fault discovery by analysis of measurements,
- accounting and billing,
- intrusion detection.

Summarised, MOME activities provide valuable input and a co-operation platform for other research activities targeting at the strategic objective "Broadband for All".

2.3.2 Added-value for carrying out the work at a European Level

Due to the combination of complementary expertise and Europe-wide available resources from different organisations, valuable results are reached. It should be noted that the participants already experienced other European projects and new project proposals and they all acquired specific competencies and a recognised excellence to be exploited by the other participants of the consortium. Such collaboration contributes to achieve a common relevant scientific and technological level, boosting each partner who didn't make a careful study of a specific issue to keep-up with the most recent solution; it also offers to everyone the opportunity to compare his ideas with other organisations proposals.

MOME deals with future-oriented topics facing the most important standardisation organisations world-wide. Therefore the project contributes to the European innovation policy. The project results lead to effective contributions for standardisation and regulation of the proposed approaches.

2.3.3 Relation to other research activities

The synergies between MOME and national and international research activities are summarised in the following table. This initial list will be extended during the MOME lifetime.

Programme	Activity/ Project	Interaction with MOME
FP5, IST (EU)	INTERMON	INTERMON (04/2002 – 03/2004) contributes experiences from inter-domain monitoring, modelling and visualisation research and standardisation activities (http://www.ist-intermon.org)
	NGN-LAB	ULB and NEC are involved in the NGN-LAB project (1/2001 – 12/2003) which has an important and successful QoS component, particularly as far as DiffServ is concerned, with a strong link to the IETF standardisation activities (http://www.ngnlab.org). Activities are continued in FP6 by the Euro-Lab project.
	SCAMPI	SCAMPI develops hardware and software for high-speed traffic measurement technology for the IP networks. SCAMPI contributes this technology and make it available to other MOME partners. Also SCAMPI works on standardisation of traffic measurement at the IETF and profits from a co-ordination of such activities within MOME.
	6QM	6QM develops measurement technologies for Quality of Service in IPv6 networks. Co-operation with MOME helps to define common interfaces between tools and interchangeable trace and measurement result formats.
FP6, IST (EU)	Ambient Networks	Ambient Networks develops a network layer architecture for mobile wireless networks beyond 3G. NEC, TID, BUTE and FHG are involved in this project. Ambient Networks deals with network management and charging of IP-based communication. Co-operation within MOME focuses on sharing of tools and co-ordination of standardisation at IETF and 3GPP.
	Daidalos	The work in Daidalos is closely related to Ambient Networks. In Daidalos, one focus is on measuring QoS parameters. NEC and FHG are participating in Daidalos. Co-operation focuses on sharing of tools.
	ENTHRONE	ENTHRONE develops a management framework for DVB-T using MPEG-21. NEC is participating in this project. Co-operation within MOME focuses on contributing measurement traces from DVB trials and sharing of tools.
BMBF (DE)	BIB3R	“Berlin’s Beyond-3G Testbed and Serviceware Framework for Advanced Mobile Solutions” is a local project related to monitoring and measurements at FHG.
FIT-IT (AT)	SANDY	This project deals with hard real time IP communication, where measurement and monitoring components is necessary for validation.
	EMIP	This project dealing with education of telecommunication engineers in the topic of embedded systems profits from MOME results, e.g. in the field of measurement data collection strategies.
Others	TF-NGN, GEANT, GN2	TERENA is an association of European NRENs, so is able to help with integrating national initiatives and presenting results through its various fora, in particular the TF-NGN group (http://www.terena.nl/tech/task-forces/tf-ngn). TERENA is also a partner in the forthcoming GN2 project (successor to GEANT) which includes traffic monitoring research activities. On a wider level, TERENA is able to co-ordinate with relevant activities in other continents (e.g. CAIDA) through its liaisons with Internet2, APAN and the CCIRN.

3 Project Description

The MOME Cluster offers a platform for knowledge and tool exchange between IST projects and other European partners. Many IST projects include monitoring and measurement components for traffic engineering, billing and accounting, security, etc. To avoid double work/funding and to improve the strength by synergetic knowledge transfer the following activities and results are planned:

- Interoperability testing of developed tools, components and interfaces,
- Collection and distribution of IP related monitoring and measurement data,
- Standardisation activities in the field of monitoring and measurement,
- Dissemination activities like organisation of workshop and conferences.

Figure 3-1 shows the graphical representation of the work over the project lifetime and the workpackage breakdown. In the following, the activities are described in more detail.

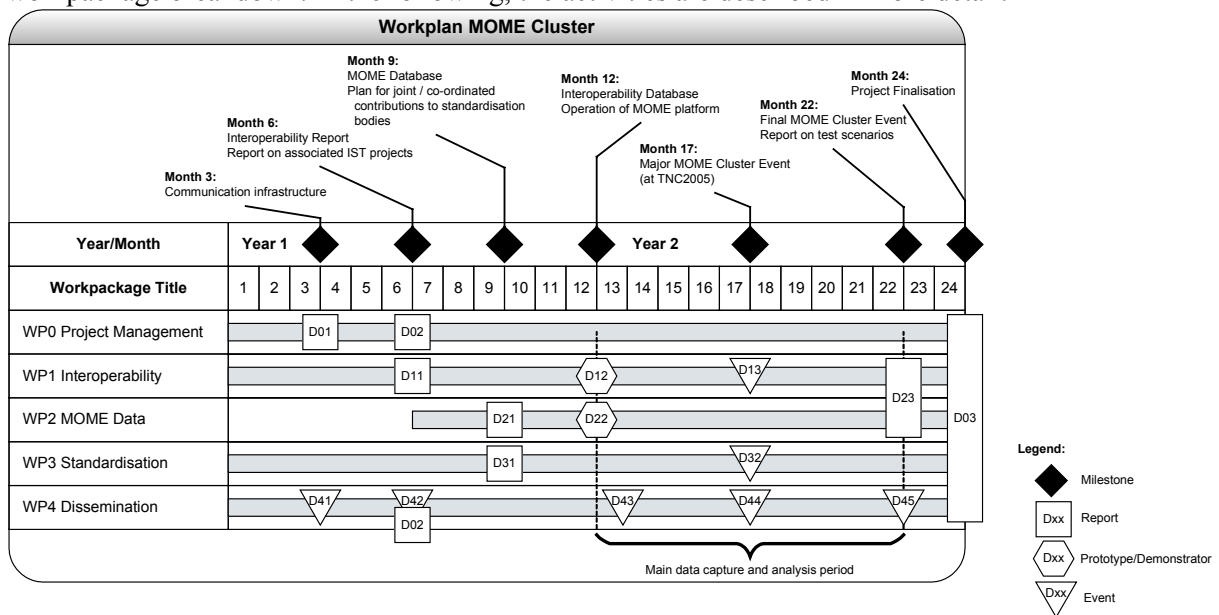


Figure 3-1 Project Workplan

3.1 Interoperability of Developed Tools, Components and Interfaces

This workpackage aims at increasing interoperability between software and hardware components, tools, and interfaces developed in different participating projects, and consequently also at increasing synergy between the projects. Interoperability allows re-using components, exchange of measured data and results, and it is a basic requirement for integrating results from different projects.

The first activity of this workpackage is an analysis of interoperability between components, tools, and interfaces used in the participating IST projects. The results are stored in the MOME interoperability database. This database is accessible via a web interface, and it allows specific search for tools, protocols and interoperability status (planned – claimed – tested, partial – full). The database is being continuously updated, when interoperability increases, when new projects join or when new tools are planned, designed, or developed. Also, the database is not restricted to tools or components developed in IST projects, but also covers well-known external (commercial and research) tools and standards.

A further activity of this workpackage is consulting of new projects during their design phases concerning inter-operability with standards and with existing or planned components of other projects. During consulting, potential interoperations should be identified and interface/protocol choices are discussed within the context of all participating projects.

Finally, interoperability testing events for monitoring and measurement is organised. They are oriented at need and progress of participating IST projects, but open also to other parties. The results of these events are used for updating the MOME interoperability database.

3.2 Understanding the Internet

For a better understanding of the processes ongoing in the Internet, measurement data is collected and made available to the community for analyses.

Data collection

The statistical analysis and understanding of the behaviour of the Internet is the base for effective network engineering. The volume of available statistical data is a fundamental parameter for the chance to derive the "Internet formulas".

Many projects/tools collect measurement data but typically each one on its own and each one in its own way. Within the MOME cluster, a database is installed as a central storage place for measured data. A uniform data format is developed that matches the individual requirements of the participating projects. The unified format allows to create a large repository of measured data that is available to researchers for several purposes. The most obvious one would be the evaluation of new models with measured data. Therefore, the MOME database is not only used for interoperability tests, but also for offering the European research society the necessary access to the raw monitored data. MOME strives for collaboration with organisations like GÉANT and RIPE for data collection of network monitoring data and routing data (e.g. the RIPE routing repository is a valuable source for routing data for the MOME database).

Data dissemination for data analysis

MOME offers database access via a easy-to-use web interface for the community. To support European and other partners with limited computing resources, a high performance computer for statistical analysis is provided. Access to state of the art statistical analysis tools is offered. Live captured data streams via the MOME database is made available in quasi real-time within defined time windows.

3.3 Standardisation

Initiation, planning and co-ordination of active contributions to the IETF is a major goal of the MOME cluster. This concerns (among others) the IETF working groups on IP Performance Metrics (IPPM), IP Flow Information eXchange (IPFIX), and Packet SAMPLing (PSAMP). The participating projects join forces when contributing to standards. Progress of MOME standards contributions is monitored and opportunities for new activities indicated and discussed within the cluster.

The IETF working groups on IP Performance Metrics (IPPM), IP Flow Information eXport (IPFIX), Packet SAMPLing (PSAMP), and Remote MONitoring Management Information Base (RMONMIB), are still actively pursuing their goals and open to further contributions and contributors. Particularly, in the IPFIX and PSAMP working groups, European authors already provide major contributions. In order to plan joint / co-ordinated MOME contributions, the following issues are analysed:

- the potential of standardising monitoring and measurement related project findings and results in IETF
- shortcomings and missing contributions within the already planned activities of the mentioned working groups
- opportunities to start new activities within the mentioned working groups or to establish new working groups

The analysis is updated continuously following the progress in standardisation. From the analysis, plans for joint / co-ordinated contributions from the participating projects are developed and recommendations for the participating IST projects are derived concerning their individual part in the joint / co-ordinated contribution. After a joint / co-ordinated has started, progress and harmonisation of contributions from individual projects is monitored.

By these actions, the already established position of European contributors in the monitoring and measurement area is strengthened and extended.

Potential work items include but are not restricted to

- modelling of flow information towards a uniform flow information model
- modelling the specification of measurement processes towards a uniform information model for configuring traffic metering devices
- protocols and/or MIB modules for configuring traffic metering devices

In addition to the IETF, also other standardisation bodies dealing with monitoring and measurement issues are considered for contributions. Particularly for the Distributed Management Task Force (DMTF) and for the 3G Partnership Project (3GPP), monitoring and measurement standardisation efforts are followed in order to identify opportunities for constructive participation.

3.4 Dissemination

A high-quality web-site is built and maintained, with links to all the public information from the MOME project. The web-site also links to relevant information of other measurement and monitoring projects and initiatives world-wide (e.g. 6QM, INTERMON and SCAMPI), and provides a calendar of important events. The site also offers authenticated web-based project management facilities for internal use.

Mailing lists are created and maintained as necessary for dissemination and internal project purposes. These are archived on the web-site.

A one- to two-day workshop is organised each year, and at the end of the project to disseminate information about MOME and associated activities, and to obtain feedback and input from the wider user community. Where possible, these are held in conjunction with other major networking events to ensure the widest possible participation. The first public workshop was on March 22-23, 2004 held together with the project INTERMON (Second International Workshop on Inter-Domain Performance and Simulation: IPS2004 in Budapest, for details see <http://www.tmit.bme.hu/ips2004/>).

Sessions focused on measurement and monitoring are held during TERENA Networking Conferences¹ to stimulate interest and promote discussion about these topics. These conferences are held annually and are the primary event for networking professionals in the research and education community.

The project liaises with European NRENs (National Research and Education Networks), universities, research institutes and commercial organisations through fora such as TF-NGN, GTP, etc. It also, where appropriate, liaises with relevant research activities in other continents (e.g. CAIDA and WAND), and with other networking associations (e.g. Internet2 and APAN). This may involve both information exchange and joint activities between key personnel.

A dissemination use plan is produced, detailing the opportunities taken by the consortium to disseminate information on measurement and monitoring activities, and partners' plans to exploit the results.

In the first year of the project, main focus is on the system design, establishing of the information infrastructure and initial data provision. The second year is mainly used for system maintenance, data collection and data analyses. In parallel the co-ordination of standardisation activities and dissemination are distributed constantly over the project lifetime.

Results achieved during the project are available after the project lifetime through

- the public deliverables,
- the contributions to standardisation bodies,
- the workshop proceedings.

The MOME platform (i.e. project web-site and databases) results stay alive after the project by one of the following options

- Another project (e.g. follow-up) continues the platform, i.e. collect and distribute data.

¹ TERENA Networking Conferences (TNCs) are prominent annual events that offer opportunities to present and discuss technical and strategic aspects of networking in the research and education community. They bring together leading figures from the research networking community in Europe and beyond, and provide a platform for learning about the latest plans and developments. They typically attract around 400 participants each year, mainly from NRENs, universities and research institutes, but also from a number of commercial organisations.

- A spin-off company continues to platform, if a business model is found.
- The data collected during the project runtime is hosted by TERENA indefinitely together with the project web-site, as they have done for all their previous IST projects (e.g. <http://www.scimitar.terena.nl>).

4 Consortium Description

The following figure illustrates the MOME Cluster Consortium and describes the position of the 8 participants within the cluster, which are building the core of the MOME co-ordination activities. Further partners from other IST projects are invited to join the MOME activities during the runtime of the project. A detailed description of each participant follows below.

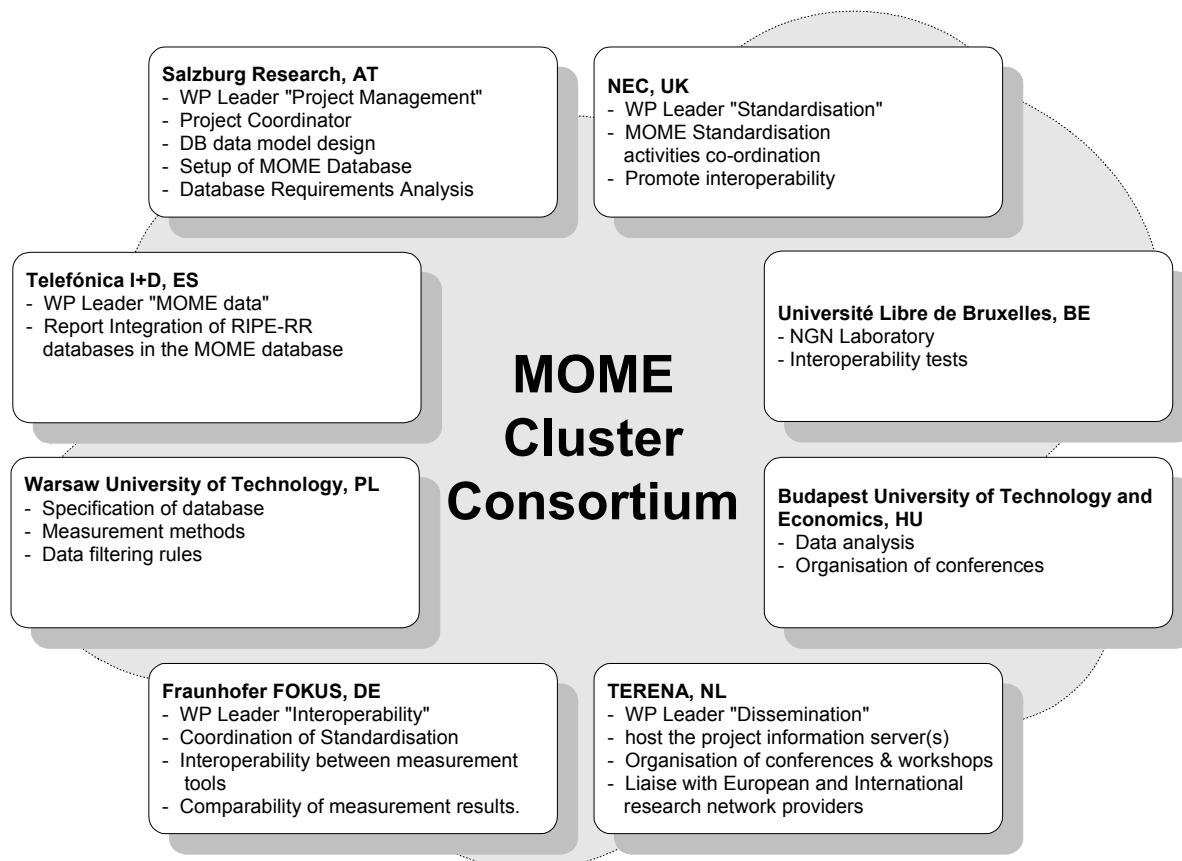


Figure 4-1 MOME Consortium

4.1 Salzburg Research, Austria (Co-ordinator)

Salzburg Research is the research institute of the province of Salzburg. Its research activities are application-driven and cover the area of information and communication technologies (ICTs). Salzburg Research defines itself as a service provider of application-oriented research services. In collaboration with our clients and partners in industry, as well as the public sector we are realising international, national, and regional research projects.

Companies of all sizes and branches are making use of Salzburg Research's know-how and organisational and strategic consultancy skills in order to realise specific research and development solutions. More information available at: <http://www.salzburgresearch.at>

Department Advanced Networking Centre (ANC)

The ANC was founded 1997 within Salzburg Research and is processing research projects together with the School of Telecommunications Engineering at the adjacent University of Applied Sciences of Salzburg. Main focus of research are several aspects of Quality of Service (QoS) within the Internet. The reference projects in the field of monitoring and measurement (main focus is on active end-to-end QoS measurement):

- ANC developed the active end-2-end QoS measurement tool CMToolset for IPv4 and IPv6, measuring QoS performance parameters like throughput, one-way delay and jitter, one-way packet loss, packet loss patterns, etc. All MOME partners have free access to the tool and are able to configure their test scenarios and to store the results into the MOME database.

- ANC was the leader of the workpackage “Distributed Measurement Architecture” in the IST project AQUILA (<http://www.ist-aquila.org>)
- ANC manages the IST project INTERMON (<http://www.ist-intermon.org>)
- ANC initiated the Monitoring and Measurement Cluster among the IST projects AQUILA, CADENUS, INTERMON, NGNI and ATRIUM.
- ANC co-operates with Telekom Austria in the area of monitoring & measurement in bilateral and national funded projects.

4.2 NEC, United Kingdom

NEC is a leading global manufacturer and service provider of telecommunication, computer and electronic devices, NEC began business in Europe in the early 1970s. Since then, NEC’s activities have steadily increased to include sales, manufacturing and R&D functions. Today, NEC has 21 affiliated companies, employing over 5000 personnel, located across Europe. NEC’s net European sales are in excess of 4000 million Euro (FY 2000-2001). NEC offers its customers high quality products, services and system solutions to facilitate greater business development opportunities in the Internet era. For further information on NEC’s products and sales & marketing activities, please visit <http://www.neceurope.com>.

The Network Laboratories in Heidelberg, Germany have been established in 1997, as NEC’s second research facility in Europe. The laboratories place special emphasis on solutions meeting the needs of NEC Network’s European customers. The Heidelberg labs focus on software-oriented research and development for the next generation Internet. New communication architectures and protocols supporting multimedia and mobility over the Internet, together with intelligent Internet services, are the core of our work. A small market research team continuously analyses market trends and market requirements to assure that R&D activities address actual market needs. The laboratories have quickly become a recognised partner in various collaborative research and development projects conducted jointly with European service providers, technology vendors and academic research groups. Less than 4 years after their inception, the labs are leading contributors to the European Union's Information Society Technology program (EU IST), as well as various national German R&D activities. NEC Network Laboratories Heidelberg staff actively contributes to scientific conferences as well as standard organisations like IEEE or IETF. At the IETF, currently seven authored or co-authored documents are progressing to become RFC.

NEC Europe Ltd., Network Laboratories’ reference projects and activities in the field of monitoring and measurement (main focus is on active end-to-end QoS measurement):

- IETF Real-Time Flow Measurement (RTFM) working group: contribution to SNMP Meter MIB standard
- ACTS IthACI: SNMP Meter MIB implementation for MPLS (multicast) traffic
- IETF IPFIX working group: co-founder and among the major contributors
- IST INTERMON task leader, contributing IPFIX protocol implementation
- IETF PSAMP working group: co-chair and co-author of documents

4.3 Telefónica I+D, Spain

Telefónica I+D, a 100% subsidiary of Telefónica. Telefónica I+D was formed in 1988 to contribute to the technological innovation of the parent company, by performing research and development activities. Over the last few years, the line of work of Telefónica I+D has evolved to conform with the objective of becoming a services creation lab. This objective is driven by the emergence of interactive multimedia services which are increasingly becoming a mayor force in the telecommunications market. Telefónica I+D employs over 831 persons. 86.6% of them hold a University degree.

Telefónica I+D is active in the following major areas:

- Services creation, related to the broadband, intelligent network, data communications, narrowband ISDN, speech technology, and public use telecommunications.
- Network and services management, using solutions based on the latest TMN standards.
- Network innovation, with the purpose of supporting Telefónica in its effort to offer the widest possible range of services.

Telefónica I+D bases its work on the use of the most advanced and competitive concepts and media. This requires thorough knowledge of the suitable technical capabilities over a range of basic technologies. The company has in depth expertise in formal methods, object oriented design and programming systems, software engineering tools, real time systems, data bases and knowledge bases, A.I. tool kits, knowledge representation and reasoning, man machine interface, and software tools for network simulation. The company has a computer centre, a micro software development tools group, and special laboratories, such as an optical transmission, Human Factors, or a video services laboratory.

Also, Telefónica I+D has developed a Innovation Plan, with the objective of anticipating solutions to the challenges that the future information society rises.

All the activities in Telefónica I+D are carried out conforming to an in house methodology, supported with tools, which has been awarded an ISO 9001 Certification in 1994.

Telefónica I+D has participated in numerous European projects: eight RACE I, eighteen RACE II, seven ESPRIT II, four ESPRIT III, and several TEN-IBS, TEN-ISDN, CTS, COST and BRITE.

Furthermore, Telefónica I+D is one of the Spanish users of the Pan-European ATM Pilot. Telefónica I+D houses one of the sites of the Spanish National Host, to which it has contributed its own ATM switching, transmission and supervision technology (RECIBA). Telefónica I+D has also been very active in EURESCOM, participating in over twenty projects.

4.4 Université Libre de Bruxelles, Belgium

ULB (“Université Libre de Bruxelles”) is one of the largest Belgian universities with about 18000 students, over 5000 staff, seven faculties including medicine and engineering, and a number of associated schools.

“Service Télématique et Communication” (STC) belongs to the Faculty of Sciences; directed by Prof. P. Van Binst, it is an R&D group with about 15 full-time staff, active in a range of projects related to advanced telematics applications, services and infrastructure.

Research, development, consultancy and training contracts are concluded with public and private institutions, including the European Commission, Belgian Ministries, and a large number of top level industrial companies.

STC has particular expertise in international standardisation, and has participation in ETSI, IETF, ITU and ISO.

STC has a well connected and supported telematics prototyping and demonstration facility, called EuroDemo, located in central Brussels, used in many European projects.

See <http://www.iihe.ac.be> for more information.

4.5 Budapest University of Technology and Economics, Hungary

The Dept. of Telecommunications and Media Informatics (DTMI) belongs to the Faculty of Electrical Engineering and Informatics at the Budapest University of Technology and Economics (BUTE). The Department assumed its present name in 1991. Its predecessor, the Department of Wirebound Communications, was established in 1949 together with the Faculty of Electrical Engineering itself. The academic staff of the Department consists of 39 people.

The Department focuses on the technology of advanced telecommunications systems, services and their integration with computer networking (including transmission, switching, signalling, protocols, routing, network management, measuring equipment, telematics, multimedia). Beside the technological aspects, regulatory, policy and management frameworks in telecommunications are also systematically dealt with.

Intensive theoretical and practical research work is carried on in the fields of telecommunication network and instruments, data networks and speech-based man-machine communications. At present a significant amount of investigations are focused on advanced telecommunication networks, i.e. on the design, organisation, economic and management aspects of telecommunication systems.

It is working permanently on a large number of development projects and consultancy activities.

The research work of the Department is closely related to its educational activity. The Department is involved in the education activity both at graduate and postgraduate level. Core courses offered:

- Telecommunications

- Infocommunication Networks
- Digital Design
- Informatics
- Data Bases

Following the basic studies students specialise in different branches (majors/minors). The Department is responsible for running the specialisation

- Telecommunications and Telematics
 - Telecommunication Management
- in the Electrical Engineering program and
- Infocommunications Services
 - IP-based Telecommunications
- in the Informatics program.

Around 20-25 new Ph.D. students join the Department each year, many of them sponsored by industry.

4.6 Warsaw University of Technology, Poland

The Warsaw University of Technology is one of the largest leading academic schools in Poland. It was officially opened in 1915. Today the University has 16 faculties and approximately 40 scientific institutes, offering research opportunities as well as engineering degree courses in numerous fields of advanced technology. The University employs over 2500 academic staff, including 376 professors and 1195 assistant professors with doctoral degrees. The University has an enrolment of more than 22,000 students.

The Broadband Network Research Group from Institute of Telecommunications Warsaw University of Technology (BNRG-IT WUT) is specialised in traffic engineering, testing and simulation of the ATM/IP networks. Since 1992 the group actively participates in EU projects like COST242, COST257, COST279, Copernicus and recently IST-AQUILA.

4.7 Fraunhofer FOKUS, Germany

The Fraunhofer-Gesellschaft e.V. is the organisation for institutes of applied research in Germany, undertaking contract research on behalf of industry, the service sector and the government. FOKUS (www.fokus.fraunhofer.de) is the Fraunhofer Institute for Open Communication Systems. FOKUS is one of the largest research labs in Europe dedicated to communication networks and multimedia services. In these areas, FOKUS is engaged in various research activities covering the aspects of multimedia signalling protocols, QoS control, network monitoring and measurement, service control, security, platforms and services, electronic commerce, mobile and broadband wireless communications and testing, interoperability and performance evaluation. FOKUS has gained considerable experience in these areas, for example in EURESCOM projects, RACE/ACTS/IST projects, DFN and BMBF projects, as well as in joint projects with industrial partners. The institute has currently a staff of 230. There are close co-operations with the Technical University Berlin and strategic partners in industry, research and government environments. FOKUS participates in the measurement-related IST projects INTERMON and 6QM. Furthermore it works on the development of passive and active measurement tools with partners from industry. FOKUS is active in standardisation in IETF and IRTF in various measurement-related groups.

4.8 Terena, Netherlands

TERENA is a not-for-profit association that represents National Research and Education Networks (NRENs) in most European countries. The current membership includes 34 full-member organisations, and 8 commercial organisations holding associate membership, with the European Commission holding observer status.

The mission of TERENA is the promotion and development of a high-quality international network infrastructure to support European research and education. Much of this work is undertaken through the TERENA Technical Programme, which is defined by the senior technical managers of the members organisations, and overseen by a smaller group of specialists known as the TERENA Technical Committee. TERENA also employs a number of staff who manage the activities on a day-to-day basis.

The TERENA Technical Programme is executed through projects and task forces working in areas of common interests. A number of seminars, workshop and other events are also organised to disseminate results throughout the NREN community. In addition, TERENA liaises and co-ordinates activities with similar organisations in North America (e.g. Internet2, CANARIE), the Asia-Pacific region (e.g. APAN) and South America. These activities allow the research and education community to jointly solve the technical and managerial issues associated with installing and operating leading-edge networks.

TERENA has extensive experience and skills in co-ordinating complex technical activities and disseminating information. Since 1996, it has also co-ordinated or been a partner in many EC-funded projects (e.g. SCIMITAR, DESIRE II & TEQUILA), and is currently the co-ordinating partner of the SCAMPI project on traffic monitoring.