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Dynamic information concerning research, standardisation and practical issues of inter-domain QoS

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*In this issue:*

INTERMON Discussion for Future Research & Development in Europe

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### **“Inter-domain Networking” Research Forum**

Inter-domain Networking Research Forum is an open international communication and informational platform, aimed at collecting and systematising knowledge, technologies and tools concerning macroscopic and inter-domain phenomena in the Internet as well as promoting standardisation and deriving future visions for the Internet based on the current state-of-the-art.

The forum supports the information interchange for the emerging field of inter-domain and macroscopic Internet studies and tries to encourage and promote inter-disciplinary and multi-disciplinary researches and standardisation.

The motivation for the Inter-domain Internet research forum is that the inter-disciplinary and multi-disciplinary work is the only credible way forward in configuration and understanding of behaviour of a rapidly changing inter-domain environment as the Internet. Outstanding problems are rapidly evolving networking technologies, open issues in routing protocols, Broadband-for-all services, and the migration to IPv6.

Initiated by the INTERMON project and inspired by the challenges for advanced measurement, simulation and visual data mining to discover macroscopic inter-domain structures in the Internet, the Inter-domain Networking Research Forum's aim is to exchange inter-disciplinary tools, research and

experiences in the area of the inter-domain and macroscopic studies.

The Inter-domain Networking Research Forum as Cluster could have the following goals:

1. Collection and exchange of research papers, performance data, tools and experience in the following areas:

- BGP-4 and Inter-domain routing algorithms and policies analysis
- Inter-domain and macroscopic topology and structure analysis
- Inter-domain traffic and performance analysis
- Inter-domain connectivity analysis – border routing devices, Autonomous systems interconnection
- Inter-domain QoS and SLA monitoring and performance study for applications including Voice over IP (VoIP)
- Inter-domain modelling and simulation
- Inter-domain routing data repositories and mining of routing data
- Inter-domain routing and performance study in the framework of Ipv6 and Mobile Communication

2. Development of roadmaps for further research of inter-domain routing issues in the area of Broadband for all services focussed on:

- BGP-4 protocol and Inter-domain routing algorithms and policies
- Inter-domain and macroscopic topology and structure analysis
- Inter-domain traffic and performance analysis
- Inter-domain QoS and SLA specification, monitoring and performance study for applications including VoIP
- Inter-domain routing data repositories and mining of routing data
- Inter-domain routing and performance study in the framework of IPv6 and Mobile Communication.

3. Support of international standardisation activities considering inter-domain routing, topology and performance analysis. There is a need for international co-ordination and standardisation in the exchange of BGP-4 routing data in order to maximise the results obtained from common BGP-4 repositories in abnormal event evaluation (i.e. failure, DoS attack, etc.) in inter-domain environments.
4. Development of interfaces to public tools aimed to study inter-domain routing, topology, performance, traffic issues
5. Co-ordination between European projects and their support in inter-domain routing , topology, performance and traffic analysis
6. Provision of common user interfaces to inter-domain topology, traffic, routing and performance (QoS parameter) data bases
7. Co-operation with RIPE NCC (Research IP Europeans) - <http://www.ripe.net/> - and GEANT for real world data to promote the analysis of inter-domain routing , traffic and performance data, including measurement based modelling, pattern analysis and simulation for inter-domain environment
8. Organisation of the Inter-domain Performance and Simulation workshop (IPS), initiated by INTERMON
9. International programs for international co-operation on inter-domain research with leading international organisations and institutes such as CAIDA (Cooperative Association for Internet Data Analysis <http://www.caida.org>).

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### **Performance management for broadband networks for efficient resource utilisation and enhanced QoS provision**

For enhanced Quality of Service provisioning and optimal resource usage in emerging broadband infrastructures, there is a need of integrated measurement and modelling technologies aimed at long term monitoring and analysis of application Quality of Service requirements considering different factors impacting the performance in the broadband infrastructure:

- Network provisioning

- Resource usage and planning,
- Topology and routing behaviour
- Traffic engineering
- Abnormal events.

For building of an integrated performance monitoring and analysis architecture aimed to support the stable Quality of Service (QoS) provision and optimal resource allocation for applications in broadband networks, the experience of the European IST Project INTERMON (see [1]) is discussed and evaluated. INTERMON is based on interaction of different kinds of tools - topology discovery, traffic monitoring, QoS parameter measurement, modelling, simulation and visual data mining – with access to a common data base. Using tool and data base integration, INTERMON architecture supports the study of the QoS parameter behaviour dependent on the inter-domain topology changes, border router traffic and BGP-4 protocol patterns.

There is an important problem in the broadband networking infrastructures currently not faced in INTERMON, which is the provision of monitoring data for resource utilisation to provide a “feedback” for optimal resource planning and management decisions. The new challenge of broadband networks is performance-based strategic planning based understanding and considering performance from the user and application perspectives.

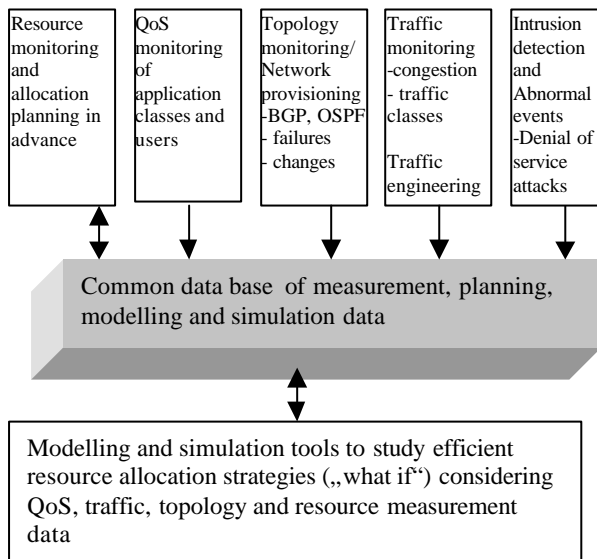
INTERMON has been used to improve our understanding of performance issues in several scenarios. "Causal" QoS behaviour studies have established the impact of BGP-4 protocol patterns on the end-to-end QoS .

The goal now is to evolve the INTERMON system toward an integrated performance management architecture, concentrating on efficient resource allocation and utilisation which would build on extensive "feedback" from integrated monitoring data bases. A critical foundation of the performance management architecture for broadband networks is to understand:

- how the user and application quality of service is impacted by different factors: resources, topology, traffic, network provisioning, abnormal events

- how efficient resources are used and resource planning could be done based on “feedback” from monitoring data.

An approach to component integration for powerful performance management of broadband networking infrastructures focussed on optimal resource and QoS is given in the following figure:



**Figure 1: Integrated performance management architecture for optimisation of resource usage and QoS provision in broadband network infrastructures**

The proposed architecture should be able to answer the challenges for broadband network infrastructures:

- network management across multiple service providers,
- network management performance across multiple technologies
- Scalability requirements: the size of the networks being managed, variety of application profiles and the number of users..

Based on tools, monitoring data bases and automated tool interaction, different factors for QoS provisioning in broadband networks are addressed, such as:

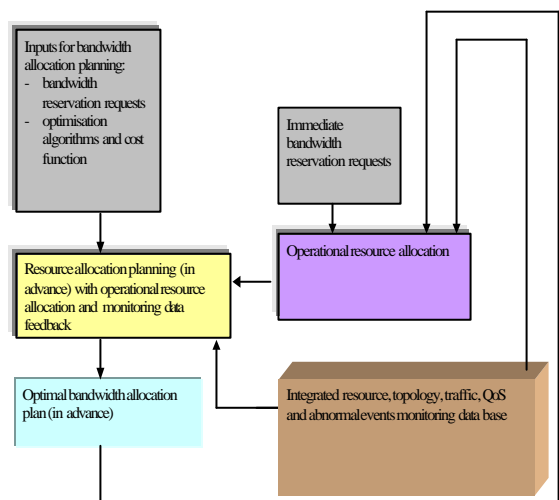
- Resource Provisioning and Allocation

- Network availability and fault management to provide alters on outage
- Traffic Engineering
- Topology impact
- Intrusion detection such as Denial of Service Attacks.

The main steps of a scenario based on such tool interaction are:

- monitoring and analysis of factors for QoS behaviour(traffic, topology, resources)
- detection of causes for abnormal QoS behaviour (topology changes, network provisioning, Denial of service attacks)
- planning of resources and traffic engineering based on topology, traffic and QoS monitoring data considering user and application profiles with feedback from monitoring of abnormal QoS behaviour.

An example scenario of tool interactions in broadband networking infrastructure using common data bases for resource allocation planning at ISP access points is shown in figure 2:



**Figure 2: Scenario for optimal resource allocation using QoS feedback**

In order to validate if the planned resources are optimal for the application and user profiles resource allocation planning (in advance) at ISP access points needs feedback from QoS, resource and traffic monitoring measurements, such as:

- volume and class of application traffic
- number of users.

Common monitoring information processed by different tools is used as the input for in advance resource planning. This process can be adapted to ensure optimal QoS provision.

“What if” analysis on different kind of resource allocation strategies depending on applications and users can be performed with a simulation loop enhancing the present in the INTERMON architecture with different kind of resource allocation strategies, applications and users.

.Detection of “causes” for performance problems should be used to take appropriate planning decisions: different resource allocation planning strategies are need to respond to:

- congestion in the network
- inter-domain routing changes
- link failures.

QoS degradation due to congestion has to be monitored closely and network upgrades should be planned in advance.

