Multi-disciplinary Inter-domain Monitoring:
The benefits of the INTERMON project for Service Providers

Pedro Andrés Aranda Gutiérrez
Telefónica I+D
C/Emilio Vargas,6 – 28043 Madrid - Spain
email: paag@tid.es

Abstract

The INTERMON project [1] produced an integrated toolkit for interdomain QoS measurement, monitoring and simulation, which covers a wide spectrum of approaches to interdomain network management, ranging from day-to-day operations to long term network planning activities. It is a first step towards a Next Generation Network Management Framework with Resource Optimisation capabilities. This paper shortly presents the requirements of this framework and the INTERMON toolkit; then it focuses on the two complementary network topology detection tools and their application scenarios and presents the direction of future research complementary to the Next Generation Network Management Framework emerged from the INTERMON project.

Introduction

The new challenge of broadband networks is performance-based strategic planning based understanding and considering performance from the user and application perspectives. Service providers have repeatedly expressed the need for an integrated measurement and modelling framework aimed at long term monitoring and analysis of Quality of Service requirements at application level. It should consider the different factors impacting on the performance of the broadband infrastructure:

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

Such a next generation platform should provide a “feedback loop”, in order to optimise its resource planning and management decisions. Figure 1 shows the main components of a such a Next Generation Network Management Framework.

In addition to the change in paradigm, the challenge of interdomain scenarios is the fact that each domain in under independent management. Even in the case of collaboration between ISP's, many crucial aspects of network policy are kept as well hoarded secrets, since they are the source of differentiation between providers and, thus, part of their branding.

Topological data, and explicitly data from the Border Gateway Protocol BGP-4 [2], often fall under this category and are considered confidential by Service Providers. They are rarely shared, and only partial views, obtained from Internet Exchange Points by projects like Oregon Route Views[3] and the RIPE-NCC Routing Information Service [4] are publicly available. Other topological data can be obtained by means of network tomography, but these data rely on traceroute traffic, which is very often blocked by Service Providers due to security concerns.

The INTERMON project : overview

The INTERMON project produced during its activities between 2002 and 2004 an integrated toolkit for interdomain QoS measurement, monitoring and simulation, which covers a wide spectrum of approaches to interdomain network management, ranging from day-to-day operations to long term network planning activities. Cooperation between

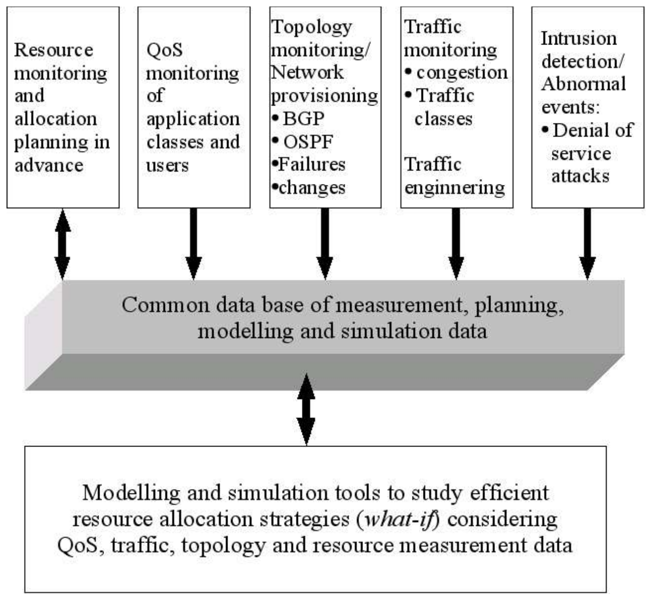

Figure 1 : A Next Generation Network Management Framework

Service Providers is promoted, but not mandatory. The liberty of each Service Provider to control which data are exported from his INTERMON system to other Service Providers is total.

Figure 2 shows an overview of the different components integrated in the system, their relationship and the nature of the task implemented by each component. INTERMON integrates three kinds of components, namely measurement tools , analysers and simulators around a central, distributed database, to which the components contribute data and from which they retrieve data to perform their tasks. While measurement components only contribute data to the database, analysers and simulators both contribute and retrieve data from the common database. A comparison of Figure 1 and Figure 2 shows that INTERMON already implements some of the components of the proposed Next Generation Network Management Framework.

This paper concentrates on two acquisition tools for topological data and compares the implications and applications of each of them.

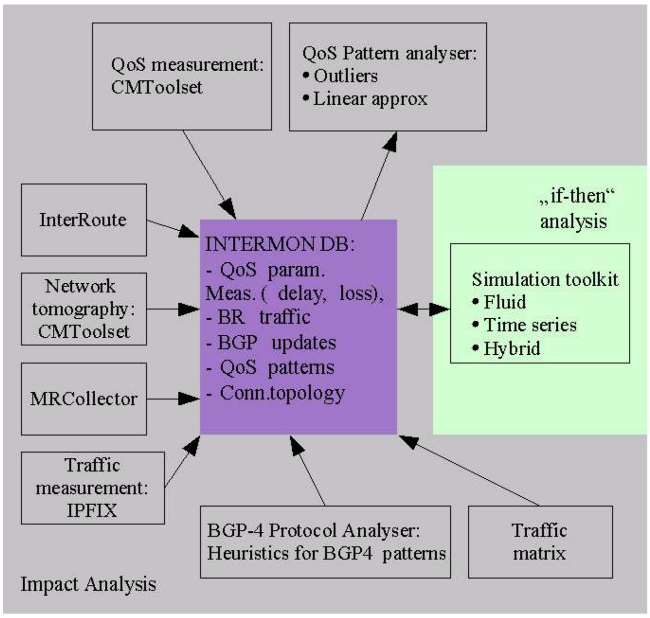

Figure 2: The INTERMON architecture

The components we analyse in this paper are the network tomography component of the CMToolset[5] and InterRoute[6]. Their approach to obtaining interdomain topologies and the aggregation level of their results are completely different and thus tailored towards the analysis of different problems.

Routing analysis

SLA, or generally speaking, QoS provision in inter-domain environments is highly dependent on topology changes. The INTERMON toolkit can be used to study the topology behaviour of a specific end-to end scenario for a specified period and obtain QoS patterns which characterise the particular topologies in order to use these patterns for forecasting and planning considering concrete topologies.

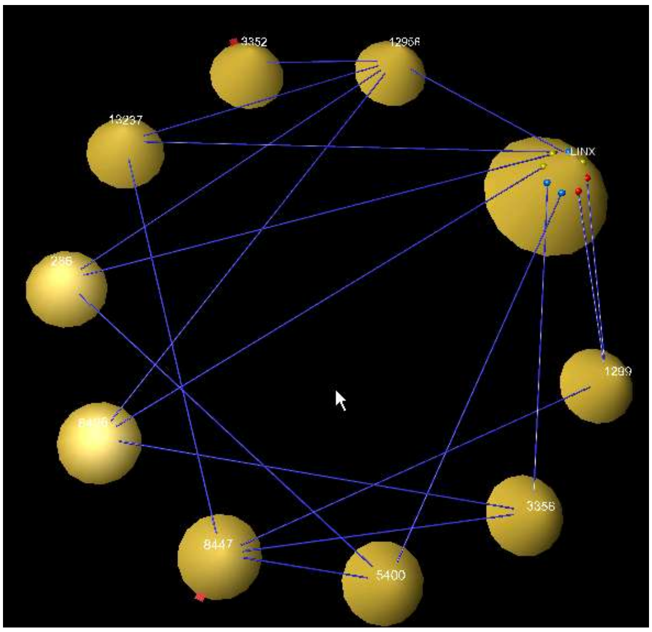

Figure 3: Inter-domain topology at BGP-4 level

The differences between the QoS patterns obtained for different topologies are of special interest when assessing inter-domain network infrastructures for capacity planning. Topology discovery in this scenario is based on interaction of two technologies:

- **InterRoute** builds the inter-domain topology view at Autonomous System level of the end-to-end connection based on the BGP-4 routing information extracted from public routing information repositories (i.e. RIPE-NCC). The limited scope of the publicly available BGP-4 information contained in the public route repositories can be overcome if the provider using the INTERMON toolkit sets up a RIPENCC-like private route repository in his Autonomous System.

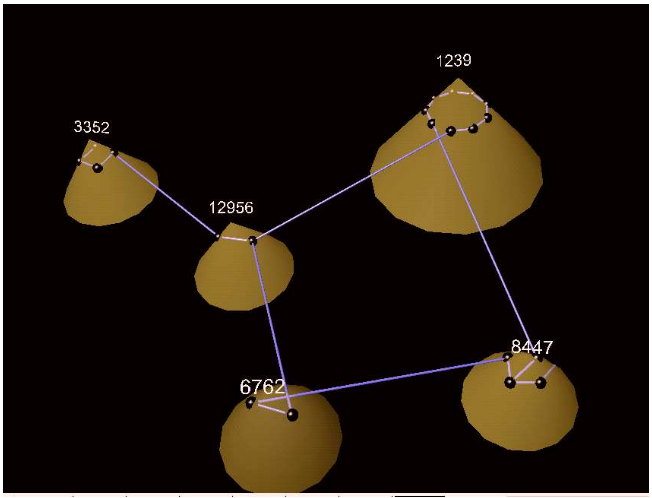

Figure 4: Interdomain topology obtained with tomography

- **Active topology discovery** is implemented with the traceroute facility of the CMToolset. It discovers the route changes of the connection by actively probing the network. Results are stored in a data base for later dependency study. Used when fine-grained analysis of the alternative topologies is required, this tool obtains the hop-by-hop topology with intermediate routers and evaluates the round trip times to them.
  Active topology probing impacts on network performance and poses a certain risk on the network infrastructure. Misuse of active probing technologies for Denial of Service Attacks in the past has prompted many service providers to filter probing packets out of their networks.

Comparison: InterRoute vs. tomography

Figures 3 and 4 show the alternative routes of an end-to-end scenario between two Internet Service Providers using both tools.

In the first case, BGP-4 information obtained at the London Internet Exchange LINX is used. The tool shows all border routers deployed in the London Exchange, which are able to send packets to either endpoints in the scenario.

All feasible paths, i.e. the active and all stand-by paths, which appear on the routing routing tables are shown. Border routers at the LINX appear with different colours, depending on the stability of the router during the observation period. The stability is derived from the BGP-4 activity related to the endpoints of the end-to-end system on these routers. The nature of the BGP-4 updates determines whether there has been any discontinuity in the end to end path. The timestamps on the BGP-4 updates determine the precise moment, where routing related disruptions happened, making the relating of BGP-4 updates to QoS incidents quite straight forward.

The active network tomography reconstructs the paths from the traceroute-alike probes generated by the CMToolset. The probes constitute samples of the network state at specific points in time. The paths shown were actually taken by the network probe traffic during the measurement period. Assuming no specific traffic engineering techniques are applied, it is safe to assume that these paths will most probably be followed by the network traffic around the times where the probes were launched. No information about other potential traffic paths can be derived from this information.

Both approaches are complementary. Network tomography allows InterRoute to select the BGP-4 routing data repository best suited for a specific end to end scenario. It also singles out the end to end paths used by the traffic from all possible paths computed by InterRoute. Behavioural information for most or all intermediate routers can only be obtained by means of network tomography and precise time information for specific routing events can only be computed by InterRoute.

Repositories and their applications

Any QoS incident analysis tool relies on the existence of network state information for the network segment in a time slot around the precise instant of the incident. Both tools presented in this paper rely upon different types of data repositories: InterRoute works with publicly available BGP-4 routing data repositories, while the tomography component build a private repository of measurements on the INTERMON database, which is, as a matter of fact, a multidisciplinary repository of measurements accessible to all INTERMON tools.

One of the main lessons of the INTERMON project was that huge network measurement data repositories are needed to investigate sophisticated network phenomena. Collecting these data for each new research is extremely inefficient. Since many projects produce and rely on network measurements, the logical consequence is to try to connect all these projects and allow their measurements to be shared. This is the aim of the MOME cluster[8]. MOME is logically connecting a significant number of projects which are measuring the Internet and using these measurement data. The synergistic effect of MOME should reduce the number of redundant measurements done on the Internet and, thus, reduce the stress produced by measurement traffic on the Internet.

Finally, the myriad of routing data available should also help in the development of enhancements for the new IPv6 Internet. Enhancements to BGP4+ to better cope with current best practises like multihoming will benefit from real network data. Simulations implementing these enhancements can show their ability to cope with real network situations and assess the benefits of their deployment during the design stage.

Conclusions

This paper has presented a high level view of the INTERMON toolkit and two network topology detection tools integrated in it.

INTERMON provided new insight on performance issues in several scenarios. "Causal" QoS behaviour studies have established the impact of BGP-4 protocol patterns on the end-to-end QoS. It also showed the importance of measurement data repositories and the benefits network operators can draw from it.

But network measurement should not be a goal by itself. In the case of INTERMON, network measurement is the supporting activity for network management and network planning activities of Internet Service Providers. Two lines of research have been identified in the 5th and 6th Framework Programmes of the European Commission, one concentrating on measuring the Internet and the other on studying the data recorded in measurement campaigns. As a consequence, the MOME cluster was started to provide a coordination between European Research Projects in the field of Network Measurement.

The experience of INTERMON can be used to implement a next generation integrated performance monitoring and analysis architecture providing Stable Quality of Service (QoS) provision and optimal resource allocation for applications in broadband networks.

In the future, the data stored in routing repositories should also provide routing protocol designers with real life input for testing and simulating much needed enhancements for the routing protocols in the core infrastructure of the new IPv6 Internet.

Acknowledgements

INTERMON was an IST FP-5 project and MOME is an FP-6 coordination action co-funded by the European Commission. The work on InterRoute was greatly eased by the existence of the RIPE-NCC RIS repositories.

References

1. INTERMON IST-2001-34123 http://www.ist-intermon.org
2. Y. Rekhter, T. Li: RFC 1771: A Border Gateway Protocol (BGP-4), March 1995
3. David Meyer: "University of Oregon Route Views Project", Advanced Network Technology Center/University of Oregon http://antc.uoregon.edu/route-views/
4. RIPE-NCC RIS, Routing Information Service Project, http://www.ripe.net/projects/ris/
5. CM Toolset: Internet measurement with the Communication Measurement Toolset, http://cmtoolset.salzburgresearch.at/
6. P.A. Aranda Gutiérrez, I. Miloucheva: “Integrating Inter-domain Routing Analysis in Novel Management Strategies for Large Scale IP Networks”, NEW2AN'2004, St. Petersburg, Russia
7. I. Miloucheva, P.A. Aranda Gutiérrez, A. Nassri, D. Hetzer, M. Beoni: "INTERMON architecture for complex QoS analysis in inter-domain environment based on discovery of topology and traffic impact”, IPS'2004, Budapest, Hungary
8. MOME IST-2004-01990 http://www.ist-mome.org