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Special issue on the INTERMON architecture

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Tool Interaction for Inter-domain QoS Analysis in INTERMON

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1. Mechanisms for tool interaction in INTERMON

The INTERMON architecture is aimed at integration of tools using common database for inter-domain QoS analysis.
There are different kinds of tools included in the INTERMON system, which can interact based on common user interfaces and their results stored in a common INTERMON database:

- inter-domain topology analysis
- active QoS and topology monitoring
- IPFIX traffic measurement
- Simulation toolkit
- Pattern analyser and traffic matrix explorer.

Tool interaction is aimed to provide automatically specific scenarios in the area of inter-domain QoS analysis, as for instance:

- Detection of QoS patterns in case of inter-domain routing failure
- QoS dependency on topology considering multihoming inter-domain connection
- Traffic matrix engineering considering performance (QoS metrics) of inter-domain connections.

Integrating different mechanisms, the INTERMON toolkit supports the interaction of tools for provision of concrete scenarios. These mechanisms include:

- Policies for tool invocation and data base information collection. Policies are aimed to defines order of tool execution to provide a specific scenario, access to the different physical tables of the INTERMON database (read and write permissions), and further..

- Sharing and transformation policies of data base results of different tools. Such policies specify the provision of QoS and traffic measurement data base information gained by monitoring tools as input to simulation and visual data mining tools. Transformation policies of database results define specific processing and handling mechanisms, which are in INTERMON particularly based on common document languages like XML [1].

- Parameter exchange over the user interface to provide specific inter-domain QoS analysis task. The execution of scenario requiring more tools could be based on common parameters like timing, contextual and topology specifications. For example, finding a QoS pattern for an inter-domain routing failure requires that the QoS pattern analyser receives as an input parameter, the time at which the Inter-domain topology analyser has found an error.

- User interfaces for tool interaction. There are different approaches for user interfaces of tool interaction in INTERMON derived from the requirements of user scenarios. The approaches include menu, data mining and visual data mining driven interfaces, which will be studied in this paper.

The tool interaction functions in INTERMON are realised by the user interface (GUI) of INTERMON toolkit and global controller, especially the task-processing component.
The summary of the architecture of tool interaction is shown in the following figure:

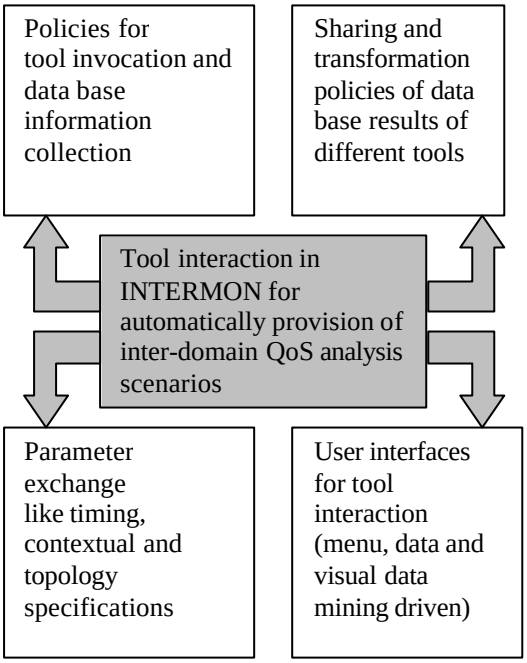

Figure 1: Architecture for Tool interaction in INTERMON

2. User Interfaces for Tool Interaction

There are different Graphical User Interfaces (GUI) for tool interaction in INTERMON (e.g. menu, data and visual data mining driven) which are derived from the needs to provide different function of interaction.
We study the different approaches and give example scenarios.

2.1 Menu driven tool interaction

Menu driven tool interaction is based on specific menus for particular tool invocation and control menus for exchange of parameter data, which is used as user input for the interworking tools.

The following picture shows the GUI of INTERMON with the menus in case of visual data mining tool invocation.

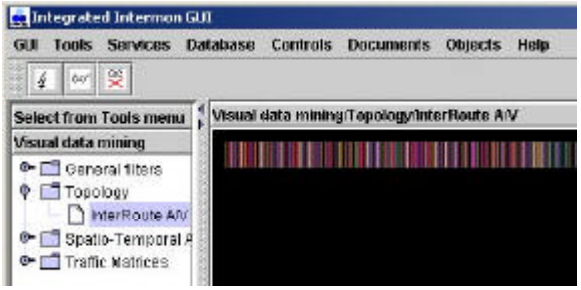

Figure 2: GUI of INTERMON Toolkit in case of visual data mining tool invocation

The next figure is aimed to show the control menus of INTERMON toolkit based on which parameters could be exchanged between the tools concerning:

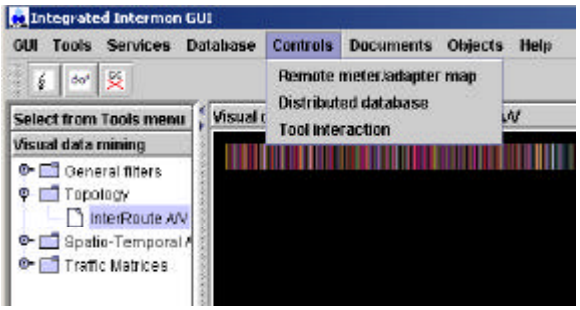

Figure 3: Control Menu of INTERMON GUI for exchange of important input parameter

This method has the disadvantage of a lack of persistence of the shared data. In effect the data is only available for the current instance of the GUI. This problem is overcome by the Data Driven Interaction approach outlined below.

2.2. Data Driven Interaction

The data driven interaction is based on sharing and transformation of data base resultant data of the tools. The information provided by the tools is stored in the data base and than tranformed to IPFIX intermediate representations to be used by particular tools.
In addition to the tools sharing data contained in the database, it is also possible for data to be shared suing the Document Repository, where results of tool requests to the Global Controller are stored. Using this approach Tool type B may request from the Repository all results generated by Tool type A in a certain timescale. Tool B can then use these results as an input parameter to to its own requests.

The data driven interaction currently is realised in the simulation toolkit, which uses data from IPFIX traffic measurement, QoS monitoring data of CM Toolset and inter-domain topologies.
The concept of the data driven interaction integrated in the INTERMON toolkit is shown in the next figure:

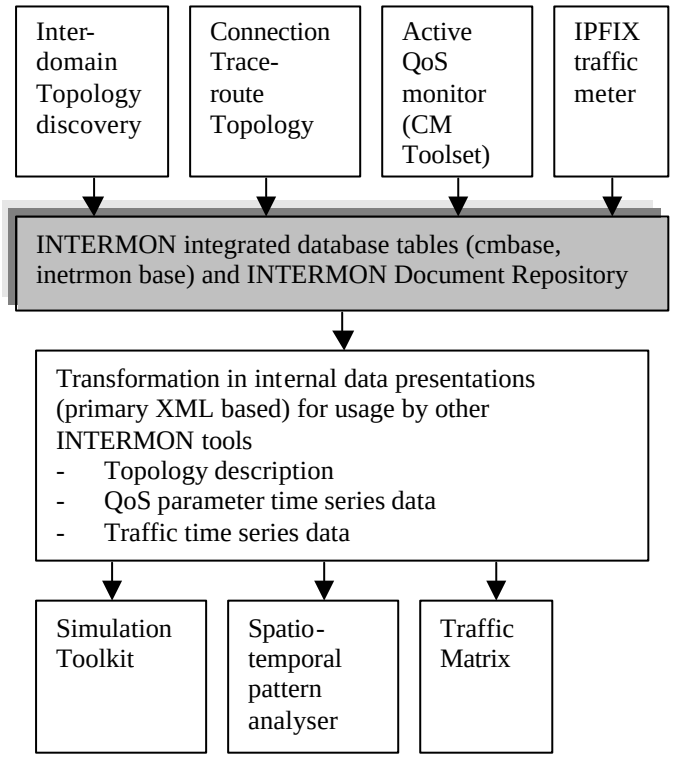

Figure 4: Data driven interaction

2.3. Visual data mining driven interaction

The visual data mining driven interaction is a new concept developed in INTERMON to emphasise on the importance of visualisation in support of inter-domain QoS analysis.

The results of different tools for inter.domain QoS nalaysis could be visualised based on 3D topology consisting of objects like:
- Autonomous systems
- Border router / exchanges / access router
- Inter-domain and intra-domain connections.

These objects are described by different characteristics:

- Time series information from database concerning traffic and measured QoS parameters. For instance, to each connection with specified time from the "cmbase" data base could be invoked and visualised measured QoS parameters of a flow including end-to-end delay, packet loss, delay jitter and throughput. Further, for each router could be assigned the traffic measurements from IPFIX meter.

- Modelling information from the data base as for instance QoS parameter patterns assigned to network connections

- Tools, which could be invoked to provide some results concerning the objects as parameter, for instance the pattern analyser could be invoked to a connection to study the connection QoS patterns or a MRCollector could be invoked to the border router as object to study the interfaces of the border router.

The visual data mining driven interaction is shown in the next figure:

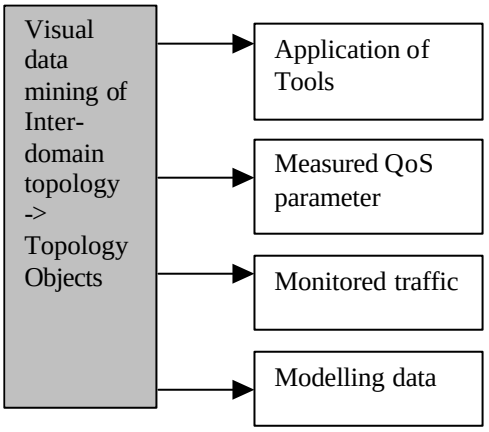

Figure 5: Visual data mining driven interaction – invocation of tools and assignement of data base information to topology objects

3. References

[1] Extensible Markup Language (XML) 1.0, W3C Recommendation:REC-xml-19980210, World Wide Web Consortium, Feb 1998,http://www.w3.org/TR/REC-xml

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Visual data mining approach for tool interaction based on inter-domain topology discovery

P.A. Aranda Gutiérrez .....

1. Goal of tool interaction based on inter-domain topology

InterRoute is a tool developed in INTERMON architecture to discover the inter-domain topology and border router quality using common data repositories [1].

InterRoute is developed with the goal to:

(1) provide an interface between public and/or private BGP-4 route and topology repositories
(2) calculate inter-domain topologies based on analysis algorithms
(3) retrieve significant inter-domain routing events
(4) compute inter-domain routing quality (e.g. stability) metric.

The following picture shows an example for inter-domain topology obtained by InterRoute.

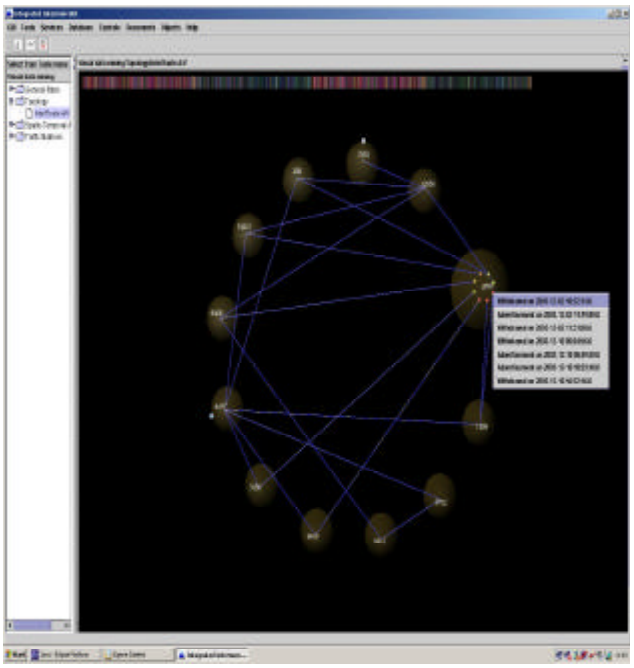

Figure 1: Inter-domain topology obtained by InterRoute

The visual data mining of InterRoute is designed to consider inter-domain topology characteristics.

The inter-domain topology views of InterRoute provide for visual data mining based on autinomous systems and border router objects.

The InterRoute distinguishes between different kinds of border router quality which are shown with different colours.

Further possible extensions planned are distinctions of the Autonomous systems by colours based on their role (backbone, transit, access, etc).

2. Visual data mining approach for tool interaction based on InterRoute

The visual data mining approach suppors the tool interaction based on visual presentations, i.e. visual driven tool interactions.

The visual driven tool interaction allows the current parameters of the tool usage to be automatically supplied to the other tools of INTERMON system which are invoked for performing of a specific scenario for inter-domain QoS analysis.

The InterRoute topology discovery is extended with the visual driven approach for tool interaction for performing of: following tasks

- Border router Quality Study for discovered inter-domain topology using invocation of MRCollector at selected border routers included in the visual presentation of the discovered topology
- .QoS Pattern Analysis of inter-domain connections y invocation of the Spatio-temporal pattern analyser to evaluate QoS parameter patterns measured for inter-domain connections included in the inter-domain topology.

In the two cases, the invoked tools (MRCollector and Spatio Temporal Pattern analyser are parameterised with the actual parameters of the inter-domain topology. .

3. Refernces

[1] P.A. Gutiérrez, InterRoute tool - Evaluation of border router stability , Newsletter Inter-domain QoS, Issue 1, July 2003

The INTERMON architecture based on global controller

Ch. Schmoll, A. Kock, I. Miloucheva .....

1. Goal of global tool and data collection control

The architecture used within INTERMON is targeted towards controlling tools for inter-domain QoS analysis. It's goal is to coordinate tool interaction with common data base access to control measurements, traffic modeling and network simulation environments.
The central component, called the Global Controller (GC) is responsible for managing data flows between the components for inter-domain QoS analysis. It's tasks are:

– Controlling Tools (monitoring, modelling, simulation and visual data mining),
– manage data base access for collection and distribution of tool relevant data,
– supplying visualisation tools with tasks and data coming from simulation results,
– authenticating users accessing the system and coordinating concurrent user requests
– interdomain-communication processes with GCs from different administrative domains (ASes)

Because the access to measured inter-domain resources (e.g. border router , Exchange Points) is restricted by Internet Service Provider (IPS), a global controller approach *per IPS* is used for coordination of tools and data base interactions.

There are two levels of coordination of tools and data bases in INTERMON:

- Private ISP layer (P-Layer), where one controller is responsible for tool control and data base interaction within one concrete ISP
- Global ISP layer (G-Layer), where interaction between global controllers works to provide exchange of tools functions (e.g. remote measurements) or data base content between different ISPs for inter-domain QoS analysis.

The tools used on P-Layer are aimed at providing analysis based on the measurement data bases of one ISP provider, for instance in case of end-to-end inter-domain QoS analysis and modelling. Example for G-Layer interaction: assuming an ISP provider is interested on obtaining spatial composition of QoS measurement data considering measurements which are collected in an INTERMON data base of another IPS provider, than based on interaction of the two respective global controllers controlling the tools and the data bases of the different ISPs, the inter-domain QoS analysis for spatial composition considering the data bases of the two ISPs is possible.

2. Functions of global controller

The global controller provides numerous functions in order to coordinate tools and data base interactions.
The architecture for interaction of tools and data bases in INTERMON using the global controller is shown in the next figure:

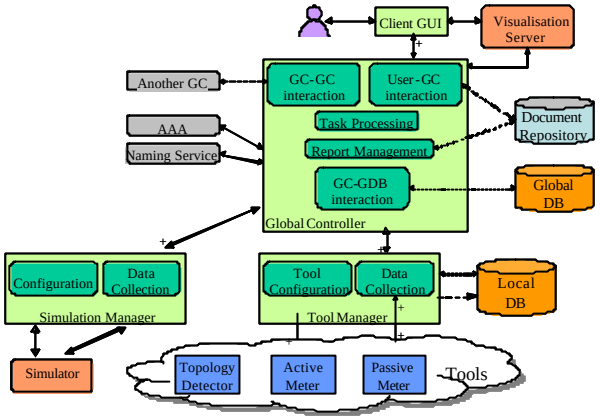

Figure 1: Coordination of tools and data bases using global controller

The interaction functions of the global controller shown in the figure have the following targets:

- Global controller/Data base Interaction - INTERMON tools exchange their results using databases repositories which can be placed locally at the place of the measured data and are aggregated globally (controlled by GC). The global storage is included centrally in the data base management system of the INTERMON toolkit belonging to an ISP.

- G-Layer Interaction (GC-GC Interaction) – A protocol is defined between the GCs installations of different ISPs in order to exchange control information data for sharing of local and global data base content belonging to different ISPs.
- Task processing – The global controller manages different tasks concerning the INTERMON tools - monitoring, simulation and visual data mining as seen in figure 1. These tasks concern registration, (de)-activation and data base access.

- Policy based considerations of INTERMON system, such as user authorisation, and authentication (AAA) and naming services (how to reach other GCs).

- Report management functions concerned with the documentation of data exchange of the tools and build human-readable result documents to document the processed tasks.

3. Outlook

The functions of INTERMON global controller concerning the P-Layer (inter-ISP) will be in the main focus for the future work the INTERMON project.
This Future work will include:

- Policy-based Task processing making use of authorisation (AAA) and naming
- Protocols for interactions of global controllers (GC-GC interaction) to provide world wide macroscopic inter-domain QoS analysis.
- user management on an per-ISP basis (P-layer)