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Interim report on training, standardization and technology transfer

The EMANICS Consortium

Caisse des Dépôts et Consignations, CDC, France
Institut National de Recherche en Informatique et Automatique, INRIA, France
University of Twente, UT, The Netherlands
Imperial College, IC, UK
International University Bremen, IUB, Germany
KTH Royal Institute of Technology, KTH, Sweden
Oslo University College, HIO, Norway
Universitat Politècnica de Catalunya, UPC, Spain
University of Federal Armed Forces Munich, CETIM/UniBwM, Germany
Poznan Supercomputing and Networking Center, PSNC, Poland
University of Zürich, UniZH, Switzerland
Ludwig-Maximilian University Munich, LMU, Germany
University of Surrey, UniS, UK
University of Pitesti, UPI, Romania

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For more information on this document or the EMANICS project, please contact:

Dr. Olivier Festor
Technopole de Nancy-Brabois — Campus scientifique
615, rue de Jardin Botanique — B.P. 101
F—54600 Villers Les Nancy Cedex
France

Phone: +33 383 59 30 66
Fax: +33 383 41 30 79
E-mail: <olivier.festor@loria.fr>

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E-mail: a.pras@utwente.nl
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Executive Summary

This document is an interim report of the activity undertaken in work-package 5 for training, standardization and technology transfer in the area of device, network and service management. The objectives of this work-package are:

- the support of tutorial set-up and training initiatives to the outside world,
- the contribution to standardization organizations,
- the organization of Technology Transfer days, and
- the interaction and liaison with other projects.

In the first phase of EMANICS two tutorials were presented at the IFIP/IEEE NOMS'2006 conference in Vancouver; in the area of Network and Service Management this is the most important conference of the year. The first tutorial was presented by Mark Burgess (HIO) and titled: *"Theory and Practice of Configuration Management in Decentralized Systems"*. The second tutorial was presented by George Pavlou (UniS) and titled: *"Traffic Engineering and QoS Management for IP-based NGNs"*. In addition, Radu State presented in May 2006 two tutorials at the University of Pitesti: one on *"VoIP management"* and one on *"Internet Worms"*. In September 2006 Aiko Pras (UT) presented a tutorial on *"Internet Management"* at the University of Nancy.

With respect to book publications, many EMANICS members are currently contributing the *"Handbook of Network and Systems Administration"*. This book will be published by Elsevier, the editors are Mark Burgess (EMANICS) and Jan Bergstra; the advisory editors are Rob Kolstad and Morris Sloman (EMANICS).

In the first reporting period EMANICS partners have contributed to the following four IETF WGs: *"Integrated Security Model for SNMP"* (ISMS), *"Network Configuration"* (NetConf), *"Next Steps in Signaling"* (NSIS) and the *"Transport Area Working Group"* (TSVWG). The ISMS WG is co-chaired by an EMANICS partner (Jürgen Schönwälder, IUB); all 2006 IETF meetings, including the ISMS Interim Meeting, were attended by EMANICS members. Eight Internet-Drafts were co-authored; these drafts fall into the following four categories: *"SNMP over IEEE 802 networks"*, *"SNMP over (secure) transports"*, *"SNMP traffic measurement"* and *"DiffServ resource management"*.

EMANICS partners have also been very active within the *"Network Management Research Group"* (NMRG) of the *"Internet Research Task Force"* (IRTF). This group is chaired by an EMANICS partner (Jürgen Schönwälder, IUB); this year's meetings are organized by various EMANICS partners (Mark Burgess - HIO, Rolf Stadler - KTH, Aiko Pras - UT, Jürgen Schönwälder - IUB, and Gabi Dreo Rodosek - CETIM).

Three Technology Transfer (theta) activities have been organized thus far; in Oslo, Nancy and Utrecht. The idea behind these activities is that (multiple) EMANICS partners interact with industry and exchange ideas and experiences.

EMANICS partners have interacted with various related projects, including the MOME IST coordination action, the Euro-NGI NoE, CNRS WIDE, the EUNICE Forum and the Grand Colloque STIC.

The general conclusion is that WP5 is running according plans. A problem, however, is that most WP5 activities must be performed by senior staff members; some partners with an Additional Costs (AC) model have expressed problems justifying expenses and therefore only parts of their activities have been integrated in WP5.

1 Introduction

The title of work-package 5 is “training, standardization and technology transfer” for de-vice, network and service management. The objectives of this work-package are:

- The support of tutorial set-up and training initiatives to the outside world.
- The contribution to standardization organizations,
- The organization of Technology Transfer days.
- Interaction with industry and liaison with other projects.

To reach these objectives, three tasks have been defined:

- T5.1: Tutorials and publications
- T5.2: Standardization
- T5.3: Interaction with industry and other research projects

This document is the interim report produced after the first nine months and shows the activities undertaken in this initial period. Section 2 discusses the tutorials and publications that have been created, Section 3 discusses standardization and Section 4 discusses the interaction with industry and other research projects. Section 5 provides the conclusions.

All tutorial slides, meeting minutes and internet-drafts can be downloaded from the EMANICS website; to keep the size of this deliverable reasonable, these have not been attached as annex.

2 Tutorials and Publications

On April 3, 2006, a tutorial was presented by Mark Burgess (University of Oslo) at the IFIP/IEEE NOMS'2006 conference in Vancouver. For the area of Network and Service Management this was the most important conference of the year. The title of the tutorial was: "Theory and Practice of Configuration Management in Decentralized Systems". On April 7, 2006, another tutorial was presented by George Pavlou (University of Surrey) at the same conference. The title of the tutorial was: "Traffic Engineering and QoS Management for IP-based NGNs". In addition, Radu State presented in May 2006 two tutorials at the University of Pitesti: one on "*VoIP management*" and one on "*Internet Worms*". In September 2006 Aiko Pras (UT) presented a tutorial on "*Internet Management*" at the University of Nancy.

With respect to book publications, many EMANICS (and other) researchers are currently busy with writing chapters for the Handbook of Network and Systems Administration. This book will be published by Elsevier, editors are Jan Bergstra and Mark Burgess (EMANICS), the advisory editors are Rob Kolstad and Morris Sloman (EMANICS).

Note that the production of normal research papers will be reported in other WPs.

2.1 Theory and Practice of Configuration Management in de-centralized Systems

The title of the first tutorial is "*Theory and Practice of Configuration Management in de-centralized Systems*". The tutorial was prepared and presented by Prof. Mark Burgess, University College Oslo, Norway. This subsection provides the text as advertised on the NOMS website. The slides are available from the EMANICS website (WP5).

2.1.1 Abstract

What is configuration management? Often at NOMS we think only of network management — i.e. the management of network devices like routers and switches. Host management, on the other hand, has been studied more in the Unix community. Increasingly we are seeing these two worlds converge, as network devices run embedded GNU/Linux or Free BSD operating systems. So what are the differences? One difference is the file abstraction — host operating systems have files and databases that contain configuration data. What are the technologies for managing these? Should they be centralized?

Autonomy is a central concept in modern computing technology. Increasingly computers are being managed by their owners rather than by centralized authorities. In the early 1990's the author developed the automation system *cfengine* for configuring and maintaining Unix-like operating systems, based on an arbitrary model of either centralized or decentralized control. It was based on the idea of voluntary cooperation — a topic which is now centre stage in autonomic and pervasive computing. *cfengine* was conceived to be able to run on any device, no matter how large or small. Moreover, it started a field of research into configuration management at the USENIX configuration management workshops and was the proof-of-principle for several key results. Today *cfengine* is used on an estimated million computers around the world, both in large and small companies.

Cfengine is a tool for setting up and maintaining a configuration across a network of hosts. It embodies a very high level declarative language, much higher-level than scripting languages, together with an autonomous, smart agent and machine-learning monitors. The idea behind *cfengine* is to create a single "policy" or configuration specification that

describes the setup of as many or as few hosts in a network, without sacrificing their autonomy. *Cfengine* runs on each host and makes sure that it is in a policy-conformant state; if necessary, any deviations from policy rules are fixed automatically. Unlike tools such as *rdist*, *cfengine* does not require hosts to open themselves to any central authority, nor to subscribe to a fixed image of files. It is a modern tool, supporting state-of-the-art encryption and IPv6 transport, that can handle distribution and customization of system resources in huge networks (tens of thousands of hosts).

2.1.2 Outline

The tutorial focuses on the general principles of configuration management and uses *cfengine* as an example which integrates the state of the art research. The list of topics follows the following plan:

- What is configuration management?
- What is a policy?
- States and data models
- Patterns and anomalies - configuration or behavior issues
- The Chomsky hierarchy of languages
- The basic principles of configuration management and *cfengine*
- Autonomy or centralization?
- Syntax and Semantics - is XML important?
- The components of *cfengine* and how they are used
- What does a host policy look like?
- Promise theory as a modelling tool
- The basic *cfengine* operations and semantics
- Convergence
- *Editfiles* - an example sub-language
- The overlapping-set model for classes
- Operator ordering: When does it matter?
- What kind of network models can we use?
- Trust and security model
- Peer model utilities
- Host monitoring and integrating feedback
- *cfenvd* and cyclic time
- Interfacing to *tcpdump*
- Understanding *cfenvgraph* output
- Future developments and discussion

The tutorial ends with a discussion of where *cfengine* is going, and how it can be extended to encompass configuration management, integrating switches and routers with host configuration in data centres.

2.2 Traffic Engineering and QoS Management for IP-based NGNs

The title of the second NOMS tutorial is “*Traffic Engineering and QoS Management for IP-based NGNs*”. The tutorial was prepared and presented by Prof. George Pavlou, Centre for

Communication Systems Research, University of Surrey, England. This subsection provides the text as advertised on the NOMS website. The slides are available from the EMANICS website (WP5).

2.2.1 Abstract

Next Generation IP-based Networks will offer Quality of Service (QoS) guarantees by deploying technologies such as Differentiated Services (DiffServ) and Multi-Protocol Label Switching (MPLS) for traffic engineering and network-wide resource management. Despite the progress already made, a number of issues still exist regarding edge-to-edge intra-domain and inter-domain QoS provisioning and management. This tutorial will start by providing background on technologies such as DiffServ, MPLS and their potential combination for QoS support. It will subsequently introduce trends in Service Level Agreements (SLAs) and Service Level Specifications (SLSs) for the subscription to QoS-based services. It will then move to examine architectures and frameworks for the management and control of QoS-enabled networks, including the following aspects: approaches and algorithms for off-line traffic engineering and provisioning through explicit MPLS paths or through hop-by-hop IP routing; approaches for dynamic resource management to deal with traffic fluctuations outside the predicted envelope; a service management framework supporting a “resource provisioning cycle”; the derivation of expected traffic demand from subscribed SLSs and approaches for SLS invocation admission control; a monitoring architecture for scalable information collection supporting traffic engineering and service management; and realization issues given the current state-of-the-art of management protocols and monitoring support. The tutorial will also include coverage of emerging work towards inter-domain QoS provisioning, including aspects such as: an inter-domain business model; customer and peer provider SLSs; an architecture for the management and control of inter-domain services; inter-domain off-line traffic engineering; and QoS extensions to BGP for dynamic traffic engineering. Relevant industrial activities such as *IPsphere* will be also covered. In all these areas, recent research work will be presented, with pointers to bibliography and a specially tailored Web page with additional resources.

2.3 Practical Voice over IP

A tutorial “*Practical Voice over IP*” has been presented in May 2006 by Radu State (INRIA) at the University of Pitesti. The purpose of this tutorial was to provide a hands-on approach for VoIP deployment based on open source technology. The tutorial started with an overview on PSTN technologies, and went next into VoIP/PSTN integration, signalling and practical VoIP.

The topics included:

- PSTN networks
- Erlang modelling
- VoIP architecture
- Signalling protocols: SIP/H.323
- VoIP security
- Open source based VoIP with Asterisk

2.4 *Internet Worms*

A tutorial on “*Internet Worms*” has been presented in May 2006 by Radu State (INRIA) at the University of Pitesti. The following topics were addressed:

- Real world examples of worm infections
- Attacks and propagation techniques used by worms
- Mathematical modelling of worm epidemics
- Mitigation and defensive approaches

2.5 *Internet management*

A tutorial on “*Internet Management*” has been presented in September 2006 by Aiko Pras (UT) at the University of Nancy. The tutorial discusses architectures, protocols and techniques to manage Internet systems. The architectures that are discussed range from the simplistic manager-agent model, to more advanced distributed management models. The discussion on protocols includes the Simple Network Management Protocol (SNMP), the Network Configuration (NetConf) protocol and new approaches based on Web Services technologies. The tutorial gives an overview of the most important MIBs (MIB-2, IF-MIB, IP-MIB, RMON and the Host resources MIB), as well as the syntax to define these MIBs (SMI). All three SNMP versions are discussed. The tutorial concludes with a lab session.

3 Standardization

In the first nine months of 2006 several EMANICS partners contributed to the IETF standardization process and joined IRTF “Network Management Research Group” (NMRG) meetings. This chapter provides an overview of these activities; Section 3.1 discusses the EMANICS contributions to the IETF standardization process and Section 3.2 gives an overview of EMANICS contributions to the IRTF-NMRG.

3.1 IETF

This section discusses the EMANICS contributions to the IETF standardization process. Section 3.1.1 gives an overview of the IETF Working Groups to which contributions have been made; parts of the text within that section is copied from the IETF WG pages. Section 3.1.2 mentions the IETF meetings that have been attended and Section 3.1.3 lists the internet-drafts to which contributions have been made.

3.1.1 Working Groups

EMANICS partners have contributed to the following IETF WG:

- Integrated Security Model for SNMP (ISMS)
- Network Configuration (NetConf)
- Next Steps in Signaling (NSIS)
- Transport Area Working Group (TSVWG)

In addition, Jürgen Schönwälder (IUB) is member of the IETF MIB Doctors and joined in 2006 the IETF Security Directorate, for which he reviewed a number of documents (*draft-ietf-idmr-dvmrp-v3-as.txt*, *draft-ooms-v6ops-bgp-tunnel-06.txt* and *draft-huston-ipv6-iana-specials-01.txt*).

ISMS

The *Integrated Security Model for SNMP* (ISMS) WG is co-chaired by Jürgen Schönwälder, who works at IUB and is member of the EMANICS NoE.

The goal of the ISMS working group is to develop a new security model for SNMP that integrates with widely deployed user and key management systems, as a supplement to the USM security model. For this integration the working group will define a standard method for mapping from AAA-provisioned authorization parameter(s) to corresponding SNMP parameters.

In order to leverage the authentication information already accessible at managed devices, the new security model will use the SSH protocol for message protection, and RADIUS for AAA-provisioned user authentication and authorization. However, the integration of a transport mapping security model into the SNMPv3 architecture should be defined such that it is open to support potential alternative transport mappings to protocols such as BEEP and TLS. The ISMS WG covers the following work items [8]:

- Specify an architectural extension that describes how transport mapping security models (TMSMs) fit into the SNMPv3 architecture.
- Specify an architectural extension that describes how to perform a mapping from AAA-provisioned user-authentication and authorization parameter(s) to *securityName* and other corresponding SNMP parameters.

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- Specify a mapping from RADIUS-provisioned authentication and authorization parameter(s) to *securityName* and other corresponding SNMP parameters.
 - Specify a mapping from locally-provisioned authentication and authorization parameter(s) to *securityName* and other corresponding SNMP parameters.
 - Define how to use SSH between the two SNMP engines
 - Specify the SSH security model for SNMP.

NETCONF

The goal of the Netconf working group is to produce a protocol suitable for network configuration, with the following characteristics [10]:

- Provides retrieval mechanisms which can differentiate between configuration data and non-configuration data.
- Is extensible enough that vendors will provide access to all configuration data on the device using a single protocol.
- Has a programmatic interface.
- Uses a textual data representation, that can be easily manipulated using non-specialized text manipulation tools.
- Supports integration with existing user authentication methods.
- Supports integration with existing configuration database systems.
- Supports network wide configuration transactions (with features such as locking and rollback capability).
- Is as transport-independent as possible.

The Netconf protocol uses XML for data encoding purposes, because XML is a widely deployed standard which is supported by a large number of applications. XML also supports hierarchical data structures. The Netconf protocol should be independent of the data definition language and data models used to describe configuration and state data. It should be possible to transport the Netconf protocol using several different protocols. The group will select at least one suitable transport mechanism, and define a mapping for the selected protocol(s).

NSIS

The *Next Steps in Signaling Working Group* is responsible for standardizing an IP signaling protocol with QoS signaling as the first use case. The working group concentrates on a two-layer signaling paradigm. The intention is to re-use, where appropriate, the protocol mechanisms of RSVP, while at the same time simplifying it and applying a more general signaling model [11].

The NSIS WG develops a transport layer signaling protocol for the transport of upper layer signaling. In order to support a toolbox or building block approach, a two-layer model will be used to separate the transport of the signaling from the application signaling. This allows for a more general signaling protocol to be developed to support signaling for different services or resources, such as NAT & firewall traversal and QoS resources. The initial NSIS application will be an optimized RSVP QoS signaling protocol. The second application will be a middle box traversal protocol. An informational document detailing how Differentiated Services can be signaled with the QoS Signaling protocol will be made.

Security is a very important concern for NSIS. The working group will study and analyze the threats and security requirements for signaling. Compatibility with authentication and authorization mechanisms such as those of Diameter, COPS for RSVP and RSVP Session Authorization will be addressed.

TSVWG

The Transport Area receives occasional proposals for the development and publication of RFCs dealing with transport topics that are not in scope of an existing working group or do not justify the formation of a new working group. TSVWG serves as the forum for developing such work items in the IETF [12]. The working group meets if there are active proposals that require discussion. The currently active TSVWG work items mostly fall under the following topics:

- Maintenance of the Stream Control Transmission Protocol (SCTP), which involves bug fixes to the SCTP specifications and their progression along the standards track.
- Maintenance of the Resource Reservation Protocol (RSVP), which involves bug fixes to the RSVP specifications and their progression along the standards track. This work item may also include a small number of extensions to RSVP or advisory documents to address specific application scenarios.
- Maintenance of IP Differentiated Services (DiffServ) mechanisms, which involves mostly advisory documents on the use of DiffServ in specific application scenarios.
- Selected other work items, which are mostly in TSVWG for historic reasons. These include an extended statistics MIB for TCP and the quick-start mechanism for TCP and IP.

3.1.2 IETF Meetings

In 2006 the following IETF meetings took place:

- ISMS Interim Meeting; February 13-14, 2006, Boston, USA,
- 65th IETF, March 19-24, 2006; Dallas, USA,
- 66th IETF, July 9-14, 2006; Montreal, Canada,
- 67th IETF, November 5-10, 2006; San Diego, USA.

The ISMS Interim Meeting at MIT in Boston was attended and co-chaired by Jürgen Schönwälder from the IUB. The goal of that meeting was to figure out how to send SNMP notification over SSH. The meeting was a success in the sense that it managed to establish a common ground for SNMP experts, SSH experts, and RADIUS experts. The report of this event is available on the EMANICS website.

The 65th IETF meeting in Dallas was attended by Georgios Karagiannis (UT), who participated in the NSIS and TSVWG working groups to investigate (amongst others) interoperation issues between NSIS signaling and the protocols used for policy control and resource configuration, such as SNMP, COPS-PR, NETCONF, ForCES and GSMP. Although not physically present, Jürgen Schönwälder co-chaired the 65th IETF ISMS working group meeting from his office at IUB. The audio stream from Dallas had at least the quality of international conference calls and jabber allowed him to actually participate in the discussion, thanks to the jabber scribes.

The 66th IETF meeting in Montreal was attended by four researchers from three EMANICS organizations (IUB, INRIA and UT). Jürgen Schönwälder (IUB) again co-chaired the ISMS working group and produced the WG minutes, based on the notes made by Olivier Festor

(INRIA). After the 66th IETF meeting Jürgen Schönwälder organized an ISMS follow-up conference call on July 27th, and produced minutes of that call.

At the 66th Montreal meeting Olivier Festor, Radu State and Jürgen Schönwälder also contributed to the IETF NETCONF WG and joined the interim meeting. IUB served as a note taker during that meeting, and contributed ideas on how to handle notification streams which allows simple implementations and more complex implementations in terms of interleaving notification streams and commands streams. Georgios Karagiannis (UT) again joined the NSIS and TSVWG working groups

To attend the 67th San Diego meeting, EMANICS has granted funding to Georgios Karagiannis (UT) to participate in the NSIS and TSVWG working groups and join the Pre-Congestion Notification (PCN) BOF.

An overview of EMANICS participation to IETF meetings is provided in Table 1.

	Name	Organization	EMANICS funding	Role
ISMS interim	Jürgen Schönwälder	IUB	Yes	ISMS co-chair Editor of Internet-drafts
65th IETF	Georgios Karagiannis	UT	No	Editor of Internet-drafts
66th IETF	Jürgen Schönwälder	IUB	Yes	ISMS co-chair Editor of Internet-drafts
66th IETF	Olivier Festor	INRIA	No	
66th IETF	Radu State	INRIA	Yes	
66th IETF	Georgios Karagiannis	UT	Yes	Editor of Internet-drafts
67th IETF	Georgios Karagiannis	UT	Yes	Editor of Internet-drafts

Table 1: EMANICS participation to IETF meetings

3.1.3 Publications

In the first nine months of the EMANICS NoE eight Internet-Drafts were co-authored by EMANICS partners. These drafts fall into the following categories:

- SNMP over IEEE 802 networks
- SNMP over (secure) transports
- SNMP traffic measurement
- DiffServ resource management

A short description of these drafts can be found in the next subsections; the complete text can be downloaded from the EMANICS website.

SNMP OVER IEEE 802 NETWORKS

In the first nine month of 2006 three versions of the internet-draft “*Simple Network Management Protocol (SNMP) over IEEE 802 Networks*” were produced by EMANICS partners (EMANICS members are indicated in bold):

- **J. Schönwälder**, T. Jeffree: Simple Network Management Protocol (SNMP) over IEEE 802 Networks, draft-schoenw-snm-ether-00.txt, May 2006

- **J. Schönwälder**, T. Jeffree: Simple Network Management Protocol (SNMP) over IEEE 802 Networks, draft-schoenw-snmp-ether-01.txt, July 2006
- **J. Schönwälder**, T. Jeffree: Simple Network Management Protocol (SNMP) over IEEE 802 Networks, draft-schoenw-snmp-ether-02.txt, September 2006

This internet-draft specifies how SNMP messages can be transmitted directly over IEEE 802 networks. A detailed overview of the documents that describe the Internet-Standard management framework is provided in section 7 of RFC 3410; this internet-draft supplements the standard SNMP transport mappings defined in RFC 3417. This transport mapping was written in order to help the IEEE 802.1aj working group. The IESG has approved this internet-draft in October 2006.

SNMP OVER (SECURE) TRANSPORTS

Two versions of the internet-draft "*Transport Subsystem for the Simple Network Management Protocol (SNMP)*" were produced by EMANICS partners in the first nine months of 2006:

- D. Harrington, **J. Schönwälder**: Transport Mapping Security Model (TMSM) - Architectural Extension for the Simple Network Management Protocol (SNMP), draft-ietf-isms-tmsm-03.txt, May 2006
- D. Harrington, **J. Schönwälder**: Transport Subsystem for the Simple Network Management Protocol (SNMP), draft-ietf-isms-tmsm-04.txt, October 2006

This document describes a Transport Subsystem, extending the Simple Network Management Protocol (SNMP) architecture defined in RFC 3411. It describes a subsystem to contain transport models, comparable to other subsystems in the RFC3411 architecture. As work is being done to expand the transport to include secure transport such as SSH and TLS, using a subsystem will enable consistent design and modularity of such transport models. This document identifies and discusses some key aspects that need to be considered for any transport model for SNMP. It also defines a portion of the Management Information Base (MIB) for managing models in the Transport Subsystem.

SNMP TRAFFIC MEASUREMENT

In the first nine month of 2006 two versions of the internet-draft "*SNMP Traffic Measurement*" were produced by EMANICS partners

- **J. Schönwälder**: SNMP Traffic Measurement, draft-schoenw-nrmg-snmp-measure-01.txt, March 2006
- **J. Schönwälder**: SNMP Traffic Measurement, draft-irtf-nrmg-snmp-measure-00.txt, May 2006

The Simple Network Management Protocol (SNMP) is widely deployed to monitor, control and configure network elements. Even though the SNMP technology is well documented, it remains relatively unclear how SNMP is used in practice and what typical SNMP usage patterns are. This internet-draft proposes to carry out large scale SNMP traffic measurements in order to develop a better understanding how SNMP is used in real world production networks. It describes the motivation, the measurement approach, and the tools and data formats needed to carry out such a study.

DIFFSERV RESOURCE MANAGEMENT

The following Internet-draft has been produced in 2006:

- **G. Karagiannis**, L. Westberg, A. Bader, Hannes Tschofenig: Resource Unavailability (RU) Per Domain Behavior, draft-karagiannis-ru-pdb-02.txt, June 2006

The draft specifies a Per Domain Behavior (PDB) that provides the ability to Diffserv nodes located outside Diffserv domain(s), e.g., receiver or other Diffserv enabled router to detect when the resources provided by the Diffserv domain(s) are not available. This PDB is used when the negotiated Service Level Specification (SLS) is associated to throughput (or bandwidth) and when the SLS agreed throughput bound is not statically but loosely defined in order to allow a more efficient utilization of the Diffserv domain(s) and a simpler network management operation. This PDB can be applied in association with either a single Diffserv domain or multiple neighboring Diffserv domains. This specification is denoted as Resource Unavailability (RU) PDB and it follows the guidelines given in RFC 3086.

3.2 IRTF

In the first nine months of 2006 EMANICS members organized two Internet Research Task Force (IRTF) Network Management Research Group (NMRG) [13] meetings and prepared a third meeting. The IRTF-NMRG is chaired by Jürgen Schönwälder (IUB). Table 2 gives an overview of the EMANICS participation to these IRTF-NMRG meetings.

Meeting	Name	Organization	EMANICS funding	Role
Stockholm	Olivier Festor	INRIA	Yes	
Stockholm	Rolf Stadler	KTH	Yes	Organizer
Stockholm	Aiko Pras	UT	Yes	
Stockholm	Kyrre Begnum	HIO	No	
Stockholm	Mark Burgess	HIO	No	Organizer
Stockholm	Siri Fagernes	HIO	No	
Stockholm	Guillaume Doyen	INRIA	No	
Stockholm	Laurent Andrey	INRIA	No	
Stockholm	Radu State	INRIA	No	
Stockholm	Jürgen Schönwälder	IUB	No	NMRG chair
Stockholm	Alberto Gonzalez Prieto	KTH	No	
Stockholm	Fetahi Wuhib	KTH	No	
Montreal	Jürgen Schönwälder	IUB	Yes (for IETF meeting)	NMRG chair
Montreal	Radu State	INRIA	Yes (for IETF meeting)	
Montreal	Olivier Festor	INRIA	No	Minute taker
Utrecht	Olivier Festor	INRIA	Yes	
Utrecht	Aiko Pras	UT	Yes	Organizer

Table 2: EMANICS participation to IRTF-NMRG meetings

Meeting	Name	Organization	EMANICS funding	Role
Utrecht	Rolf Stadler	KTH	Yes	
Utrecht	Burkhard Stiller	UNIZH	Yes	
Utrecht	Mark Burgess	HIO	No	
Utrecht	Jürgen Schönwälder	IUB	No	NMRG chair / organizer

Table 2: EMANICS participation to IRTF-NMRG meetings

3.2.1 19th NMRG meeting - Stockholm

The 19th NMRG meeting focused on *Promise Theory* and *New Approaches to Distributed Management*. The meeting took place on January 13 and 14 2006, and was attended by 21 people, of which 12 came from EMANICS institutes.

The part on *Promise Theory* was organized by Mark Burgess (HIO). At DSOM 2005 he presented a paper in which he introduced a model where nodes in a network cooperate based on promises they make to other nodes. Nodes are considered to be highly autonomous in their decisions but they might promise a certain behavior to others and take benefits of the promises made by other nodes. This model leads to a different view at policies.

The part on *New Approaches to Distributed Management* was organized by Rolf Stadler (KTH). The need for network management in large-scale and dynamic network environments calls for solutions beyond traditional management paradigms. Approaches based on network programming, management overlays, p2p computing, as well as distributed aggregation and control schemes, have been recently proposed to engineer management systems that scale beyond 1000s of nodes and are robust regarding topology changes and failures. The second day of the workshop explored this issue further, investigated whether there are any management-specific building blocks missing, and how massively distributed approaches relate to conventional ones developed in the past. The workshop included presentations and demonstrations by the management research group at KTH.

3.2.2 20th NMRG meeting - Montreal

The 20th NMRG meeting was held on July 10th in conjunction with the 66th IETF meeting. The focus of the meeting was on the network management traffic measurement activities of the NMRG. The meeting was attended by about 40 people, most of them from outside EMANICS. The meeting was chaired by Jürgen Schönwälder (IUB); the minutes were made by Olivier Festor (INRIA). Two presentation (slides only) were provided by Jürgen Schönwälder.

3.2.3 21th NMRG meeting - Utrecht

The 21th NMRG meeting will be held in cooperation with EMANICS on Thursday October 19th and Friday October 20th in Utrecht (Netherlands). The organizers of this meeting are Aiko Pras (UT), Jürgen Schönwälder (IUB), and Gabi Dreo Rodosek (CETIM).

The goal of the meeting is to discuss the *Future Direction of Network and Service Management Research*. In the last decade this area has undergone several changes. While some research topics have matured over the years into their own little areas (e.g.

policy-based management or fault management), there are other areas that are more driven by advances in technologies. This includes technologies that need new management approaches but also technologies that can be utilized for more effective management. The purpose of this jointly organized workshop is to bring together researchers, operators, vendors and technology developers to identify promising future directions of network and service management research. The outcome produced by the workshop should be a description of research directions that is felt worthwhile to explore in a time frame of the next 5 years.

4 Interaction with industry & other research projects

4.1 *Theta days*

In the first phase of EMANICS three theta days have been organized.

4.1.1 Oslo

On April 20, 2006, a first theta day was organized by HIO in Oslo. This day was a big success. In the morning there was a Distinguished panel debate on "The technical and legal challenges of global network services"; panelists were Inger Marie Sunde (UIO), Christian With (Datatilsynet/Data Inspectorate), Helge Skrivervik (Team Mellvik) and Geir Isene (Freecode AS). In the afternoon there were three tutorials on "Automated Configuration with Cfengine", "Basic Networking Concepts" and "Virtual Linux Management with MLN".

4.1.2 Nancy

On October 6, 2006 a half day theta day on network monitoring was organized at the headquarters and NOC of the CIRIL, the operator of the research network in the north-east of France. From EMANICS there were partners from UT (Aiko Pras, Tiago Fioreze) and INRIA (Isabelle Chrisment, Laurent Andrey, Radu State). Several people from CIRIL attended, including Carol Proc and Francois Schwaab.

The objective of this theta day was to establish a first contact and to provide a mutual bilateral exchange of ideas and problems between the CIRIL team and the EMANICS consortium. The meeting started with two presentations. The first presentation offered an overview of the network infrastructure managed by CIRIL. CIRIL is a regional ISP and service provider for all academic institutions, ranging from research lab, universities and regular schools in the Lorraine region. This overview covered the architecture, topology, technologies, and future evolutions of the CIRIL network. A second presentation was concerned with intra-network flow monitoring and the *netMAT* package. The CIRIL team identified the need and problems that they had to address in order to leverage the Netflow supporting monitoring platform towards a fine grained and accurate tool, capable to monitor flows that are sourced and addressed to entities within the CIRIL network. This topic is of particular interest in to the EMANICS consortium, where self-management for optical networks is mainstream research at UT. Additional discussions covered SNMP and difficulties/problems related to the integration of vendor specific management platforms.

4.1.3 Utrecht

A joint EMANICS / IRTF-NMRG Workshop on "Future Direction of Network and Service Management Research" will be organized on 19-20 October 2006. Organizers are UT, IUB and CETIM. The workshop will be hosted by SURFnet, and attended by world-wide leading researchers from industry, operators and academia. From industry there will be participants from HP, Cisco, Ericsson, Huawei, NEC, Technion, Avaya and Lucent. Operators will come from Orange France Telecom, Switch, Tiscali and Korea Telecom. From outside EMANICS researchers will come from Pohang University of Science and Technology and University of Murcia; from within EMANICS researchers will come from University College Oslo, LORIA - INRIA, University of Twente, International University Bremen, KTH and the University of Zurich.

A description of this workshop can be found on the EMANICS website, the NMRG site and in the "Knowledge plan and Dissemination Environment section".

4.2 Cross-project interaction

4.2.1 MOME

On February 27, 2006, Aiko Pras (UT) attended in Salzburg the MOME [14] Workshop. MOME was an IST coordination action that offered a platform for knowledge and tool exchange, and for coordinating activities in the field of IP monitoring and measurement between IST projects and other European partners. The platform provided information on the interoperability of monitoring and measurement tools, as well as measurement data in a common format. The MOME project concluded on 31 March 2006, although the MOME database is still maintained. Within EMANICS, the MOME results are used in WP6 for the creation of a database of network management software.

4.2.2 EURO-NGI

On April 6, 2006, Jürgen Schönwälder (IUB) attended in Valencia, Spain, a conference organized by the related Euro-NGI NoE [15]. He gave an invited talk, called " Perspectives on Network Management".

Both Euro-NGI and EMANICS are very positive about future collaboration; it was therefore agreed to organize two joint events, one associated with the EMANICS AIMS conference in 2007 and a second associated with the EuroFGI conference that will also be organized in 2007.

4.2.3 CNRS WIDE

On September 18-19, 2006 Olivier Festor (INRIA) attended the CNRS WIDE meeting, which was held in Paris.

4.2.4 EUNICE

On September 18-20, 2006, Aiko Pras (UT) attended the EUNICE [16] 2006 Summerschool, which was organized in Stuttgart, Germany. This Summerschool is generally attended by many researchers from EMANICS, EURO-NGI and E-Photon. At the Steering Committee meeting of this Summerschool it was decided to investigate the possibility to organize the EUNICE Summerschool next year in Twente (the Netherlands) as a joint EMANICS - EURO-NGI activity.

4.2.5 Grand Colloque STIC

On November 16-17, Olivier Festor (INRIA) gave a presentation on "The Management Plane in Autonomnic Networks" at the french TIC (Technologies de l'Information et de la Communication) colloquim to which close to 1000 participants fom academia and industry did participate. The presentation is available on the EMANICS web portal.

5 Conclusions

WP5 is structured within three tasks:

- T5.1: Tutorials and publications
- T5.2: Standardization
- T5.3: Interaction with industry and other research projects

In the first period, five tutorials have been created and presented; in April two at the NOMS 2006 conference in Vancouver, in May two at the University of Pitesti and in September one at the University of Nancy. All tutorials can be downloaded via the EMANICS website.

Many EMANICS researchers are currently contributing to the Handbook of Network and Systems Administration, which will be published by Elsevier. The editors of this handbook are Jan Bergstra and Mark Burgess (EMANICS), the advisory editors are Rob Kolstad and Morris Sloman (EMANICS).

Within Internet management standardization, EMANICS partners hold strong positions within IETF WGs and the IRTF-NMRG. The chairs of the IETF-ISMS and the IRTF-NMRG are EMANICS members. EMANICS partners have contributed to several IETF WGs, in particular the Integrated Security Model for SNMP (ISMS), Network Configuration (NetConf), Next Steps in Signaling (NSIS) and the Transport Area Working Group (TSVWG). EMANICS members have organized three highly successful IRTF-NMRG meetings, are members of the IETF MIB Doctors and the IETF Security Directorate. In the first period eight Internet-Drafts were (co-)authored by Emanics partners.

In the first phase of EMANICS three theta days have been organized (Oslo, Nancy and Utrecht), and interaction took place with the EURO-NGI NoE, the EUNICE Forum, the MOME IST coordination action, CNRS WIDE and the Grand Colloque STIC. For 2007 several collaborative events are planned with EURO-NGI and EUNICE.

The general conclusion is that WP5 is running well. The creation of tutorials and the organization of theta days goes a bit slower than originally expected, but this is compensated by the contribution to IETF and IRTF activities, which is a bit higher than expected.

A problem, however, is that most WP5 activities must be performed by senior staff members; some partners with an Additional Costs (AC) model have expressed problems claiming expenses and therefore only parts of their activities have been integrated in WP5. In addition, some partners are more active than others (although this may be compensated in other WPs).

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7 Abbreviations

AAA	Authentication, Authorization, and Accounting
AC	Additional Costs
BGP	Border Gateway Protocol
CETIM	University of Federal Armed Forces Munich
COPS	Common Open Policy Service
DiffServ	Differentiated Services
DSOM	Distributed Systems, Operations and Management
HIO	Oslo University College
IETF	Internet Engineering Task Force
INRIA	Institut National de Recherche en Informatique et Automatique
IRTF	Internet Research Task Force
ISMS	Integrated Security Model for SNMP
IUB	International University Bremen
KTH	Royal Institute of Technology
LMU	Ludwig-Maximilian University Munich
MIB	Management Information Base
MPLS	Multi-Protocol Label Switching
NetConf	Network Configuration
NGN	Next Generation Network
NMRG	Network Management Research Group
NOMS	Network Operations and management Symposium
NSIS	Next Steps in Signaling
PDB	Per Domain Behavior
PSNC	Poznan Supercomputing and Networking Center
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RMON	Remote Monitoring
RSVP	Resource Reservation Protocol
SCTP	Stream Control Transmission Protocol
SLA	Service Level Agreements
SLS	Service Level Specifications
SMI	Structure of Management Information
SNMP	Simple Network Management Protocol
SSH	Secure SHell
TIC	Technologies de l'Information et de la Communication
TLS	Transport Layer Security
TMSM	Transport Mapping Security Model
TSVWG	Transport Area Working Group
UniS	University of Surrey
UniZH	University of Zürich
upc	Universitat Politecnica de Catalunya
UPI	University of Pitesti
UT	University of Twente
VoIP	Voice over IP
WG	Working Group