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Deliverable DS2.3.1: Monitoring Service Portfolio

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Abstract

This document outlines a strategy for monitoring services in the GN3 multi-domain environment, details key inputs into this strategy and provides a high level description of services that are proposed, in development, in production or retired.

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Executive Summary

In GN2, two unrelated activities, JRA1 (Performance Measurement and Management) and SA3 (Introduction of Multi-Domain Services), developed and deployed various monitoring tools and functionalities. This deliverable outlines a strategy for monitoring services in the GN3 multi-domain environment, so that these tools, parallel international developments and user requirements can be combined to provide a flexible service portfolio for monitoring GÉANT services. It documents key inputs into this strategy and provides a brief description of multi-domain services that are proposed, in development, in production or retired.

The document comprises the following sections:

- Introduction (page 2).

  An introduction to monitoring activities in the GÉANT service area. Key terminology is introduced and defined to provide a common base for understanding the basic technology and product or service names used in the portfolio. The section also introduces supporting service management concepts and explains how these contribute to the interpretation of the service portfolio.

- Approach (page 8).

  This section outlines what information was considered to identify services for potential inclusion in the portfolio. It details experiences and lessons learned from GN2, highlights the preferences of National Research and Education Networks (NRENs) for particular monitoring data and operational models, and outlines the approaches to performance monitoring at other, similar organisations for potential cooperation and inspiration. For each case, a brief analysis is provided, and observed risks are highlighted.

- Conclusions (page 13).

  An overview of the monitoring services recommended for entry into the portfolio. Greater technical detail for each proposed service is provided in appendices.

1 Introduction

This deliverable outlines a strategy for multi-domain monitoring services in GN3, documents key inputs into this strategy and gives a high level description of services that are proposed, in development, in production or retired. Details of costing, detailed operational models and technical details are not provided in the deliverable, but instead handled in individual business cases as part of the service management process.

1.1 Background

This monitoring service portfolio uses initiatives and products that were started and developed during the GN2 project. Over 40 perfSONAR (Performance Focused Service Oriented Network Monitoring Architecture) monitoring architecture components were designed and implemented during the project in JRA1 (Performance Measurement and Management). A subset of these was deployed in 5 NRENs and GÉANT as a pilot monitoring service. In parallel, passive monitoring tools were developed within the same research activity, and a passive monitoring pilot was deployed by SA3 (Introduction of Multi-Domain Services) in year 4 of the GN2 project. The purpose of these pilots was to test the tools in a large-scale real network environment, gain experience in using the tools, gather user feedback and draw conclusions about the tools' usability and usefulness. The results and experience from this work informs the choices and direction of a monitoring service portfolio in GN3.

The introduction of a service management framework to the services developed during the GN3 project requires the maintenance of an overall GN3 service portfolio. This includes this document which describes the portfolio's network monitoring services. The service portfolio will track all services currently offered and in operation, and all service developments in their current lifecycle phases of the development process. Initially, a service proposal will be made in the form of a business case and service description. Once a service proposal is accepted, the service will be listed in the service portfolio as a service in development, and pilot deployments may take place. When the service is accepted as operational, the service will be added to the service catalogue, which contains all operational and supported multi-domain monitoring services that NRENs can offer in the GN3 service area.

1.2 Concepts Used in Building the Portfolio

1.2.1 ITIL

The Information Technology Infrastructure Library (ITIL [ITIL]) is the comprehensive documentation of best practices for IT service management. This framework aims to provide services to customers that are fit for purpose, stable and trusted. ITIL service management takes the form of a service lifecycle.

The service management processes in the GN3 project are influenced by and adapted from ITIL and this document commonly uses (ITIL) framework elements and terminology. Details of the portfolio's use of ITIL are described in the *Service Portfolio Management* section below.

1.2.2 Service Portfolio Management

The GN3 service management framework relies heavily on the horizontal interaction between all relevant activities to ensure that all information available from customers and partners is successfully used in managing the service lifecycle. This interaction is facilitated by the GN3 Service Coordinator.

The service lifecycle adapts and shapes the ITIL service management mechanism according to the GN3 needs.

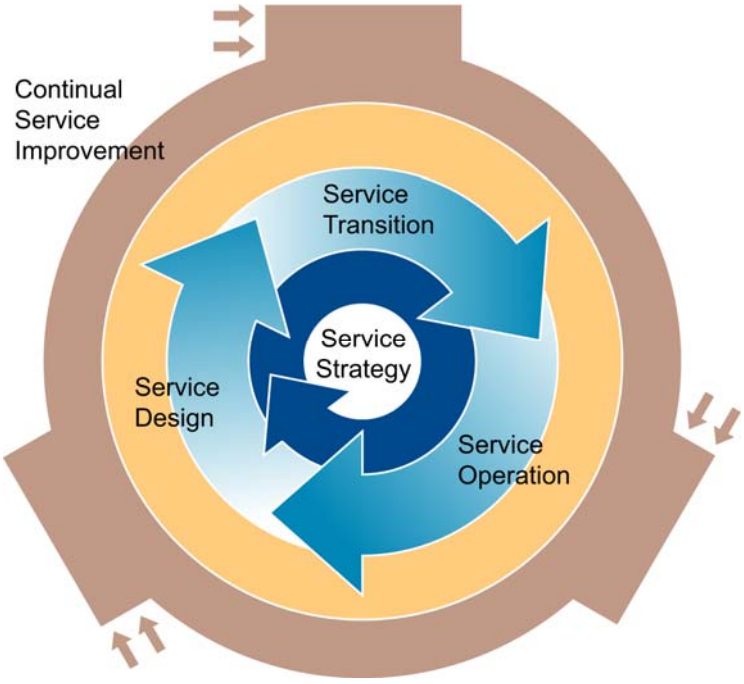

Figure 1.1: ITIL Service lifecycle.

Service Strategy

During the Service Strategy phase of Service Management Framework the following tasks are performed:

- Definition of stakeholder requirements.

  In conjunction with the GN3 NA4 (Liaison and Support) Task 2 (Internal Cooperation) and Task 3 (Liaison with Projects and Initiatives) and the Project Office, the service activity defines and documents the user and stakeholder requirements which constitute the backbone of a Business Case established in support of the service proposal.

- Definition of the service.

  A high level definition of the service is created and the service objectives and management goals to support the Business Case are specified. The service definition is created with potential involvement from the JRAs, who may have triggered the new service, and the Service and Technical Coordinator.

- Development of the Business Case.

  Based on the user requirements and the high level definition of the service, a business case is built to support the development of the service. The business case undergoes an editorial board review in the Project Management Team (PMT) and approval is requested through the GN3 Exec.

Once the Business Case is accepted and future funding approved for the development of the service, the service lifecycle is moved into the Service Design phase. Depending on the complexity of the service, some or all parts of the next phase of service design work may need to be completed before a business case is presented.

Service Design

During the Service Design phase the following tasks are performed:

- Design and development of a detailed service solution.
- Design of measurement methods and metrics.
- Further identification and management of risks.

Once all steps are completed, the Service Design is put up for approval by the PMT and GN3 Exec to ensure further funding for the development. In case of a positive decision, the work is moved into the Service Transition phase.

Service Transition

In the Service Transition phase the following tasks are performed:

- Building the service solution.
- Testing the service solution.
- Release and deployment management for service components.
- Change management for service and service components.

Once all steps are successfully and measurably completed, the service moves into the Service Operations phase.

Service Operations

In the Service Operation phase the following tasks are performed:

- Setup of service desk and service portal.
- Setup of service reporting.
- Announcement of service to NRENs. Information on participation and status is provided via a central point for all multi-domain services.

Continual Service Improvements

When a service improvements step is identified, the Continual Service Improvement phase takes place:

- Adjustment of the business case, user requirement and service description in line with the improvements envisaged.
- Assessment of the risk involved and identification of a product replacement if the service is planned to be retired.

Service improvement steps can be positive, e.g. identifying the possibility of extra functionality or extra cost saving, or negative, e.g. failing to reach key performance indicators, quality issues in service delivery. They can be identified during the regular service reviews, or based on management feedback from the Management reports, from service operator feedback via SA2 T2 (Multi-Domain Service Coordination & Operations), from customer feedback via GN3 NA4 Task 2 and Task 3, or from technological and operational advances. The Service and Technical Coordinators are expected to have critical input in identifying opportunities and problems.

Depending on the nature of improvement and the effect on the overall service portfolio, approval may be required at the GN3 Exec and NREN Policy Committee (PC) level.

1.3 Assumptions

The maintenance of this monitoring service portfolio is a key part of the Service Management Framework. The service portfolio will track all monitoring services currently offered in the GÉANT service area and in operations, and all service developments in their current lifecycle phases of the development process. It is assumed that the results of a service operation will be validated by the Service Management Framework process and appropriate decisions (business case approval, service retirement) will be taken by GN3 project supervisory bodies. The operational delivery of any service mentioned in this document is dependent on successful business cases being approved in this process.

The portfolio is not a static document. It is planned that the monitoring service portfolio is reviewed on a yearly basis. When a service improvement step is identified (based on management feedback, from user feedback or from technological and operational advances), the service management process will call for adjustment to the business case, user requirement and service description in line with the improvements envisaged. It will also be

possible to look for a product replacement if the service is planned to be retired. These updates and changes will be reflected in an updated portfolio document.

The monitoring portfolio should provide a multi-domain monitoring service in support of the Performance Enhancement and Response Team (PERT) activities piloted in GN2, and support SA2 T2 (Services Coordination and Operations) in defining and carrying out operational processes.

The monitoring service portfolio must follow the strategic view outlined in the project's Description of Work (DoW), as well as the specific milestones and interactions. GN3 initiatives focus on meeting the operational expectations of the users of multi-domain services in a cost-effective manner. The sustainability of these services relies equally on the use of cutting-edge technologies, harmonisation of services definitions, and provision of high quality, operational support. A monitoring service that spans multiple domains and is offered to a potentially large number of end users should be provided seamlessly across the different management domains. End users expect an efficient and user-friendly operation of the service portfolio from the GÉANT service area. However, the scalability and sustainability of the services is dependent on delivering them in a cost-effective manner with operational concerns and capabilities being a key part of the service design.

It is assumed that the monitoring services delivered in GN3 will be built upon tools, software and concepts developed in GN2, specifically initiatives on perfSONAR and passive monitoring.

The perfSONAR concept, as developed in GN2 as a term, has multiple facets, carrying their own assumptions [perfSONAR]:

- A consortium of organisations who seek to build network performance middleware that is interoperable across multiple networks and useful for intra- and inter-network analysis. This enables a global view of the network, at which point it becomes possible to effectively troubleshoot performance problems and access the available data placed in various administrative domains. It is assumed that compatible service delivery will also be a function of this consortium.

- A protocol that supports development of a measurement framework for accurate Internet traffic measurement and monitoring. This framework is based on loosely coupled distributed services that provide a common interface for applications to interact with different monitoring tools and users to obtain and manipulate measurement data. The perfSONAR framework has a modular architecture, allowing components to be added, left out or replaced relatively easily. The communication between a client and a service or between services uses the well-established mechanism of XML messages implemented according to the Open Grid Forum's Network Measurement Working Group schema specification. It is assumed that the multi-domain aspect of the services delivered will depend on the perfSONAR protocol.

- A large number of interoperable software packages (implementations of various services) that implement an interoperable performance middleware framework. Those sets of code are developed by different partners. The GÉANT-developed packages are available under the heading perfSONAR MDM (Multi-Domain Monitoring). It is assumed that development of new software packages will be kept to a minimum and driven by service needs. Development efforts will therefore be focussed on improving the performance, reliability and manageability of existing tools.

The Monitoring Services Portfolio will combine the capabilities of the protocol and software packages, and the requirements and benefits of international collaboration into specific perfSONAR-based services offered by the GÉANT service area to support end-to-end network monitoring across geographically distributed domains (GÉANT, NRENs) and for different user groups (NOC/PERT, projects, end users).

In passive monitoring, test packets are not sent across the network. Instead the characteristics of real network traffic are observed and analysed. Many important network performance characteristics are inherent properties of real traffic, and can therefore only be obtained from passive monitoring.

In principle, passive monitoring is a more powerful approach than using test packets, but it is also more computing-intensive, as large volumes of data need to be analysed in real time. It therefore requires relatively expensive packet capture hardware (monitoring cards). As no test packets are sent, it does not affect the traffic it is monitoring, can give a continuous picture of the network utilisation and allows analysis of real network use.

2 Approach to Populating the Monitoring Service Portfolio

To determine which services should be introduced into the monitoring service portfolio, the following inputs were considered in addition to the project's DoW:

- Analysis of the GN2 installations from an operations perspective.
- Survey of NREN Chief Technical Officers (CTOs).
- Performance monitoring approaches in other communities.

These three areas were not evaluated to identify actual user requirements and technical functionality, but to determine what services and operational models could be deployed in order to meet documented user requirements [perfUse] in a scaleable, achievable, cost-effective manner.

As part of continuous service improvement, results are delivered by the JRA2 activity (Multi-Domain Network Service Research), which carries out more advanced research into delivery of multi-domain services. These results will be evaluated and incorporated where this delivers an improvement to service. Future surveys may also target projects such as Baltic Grid II, SEE Grid, e-VLBI and FEDERICA.

2.1 Analysis of GN2 Installations

During the previous GN2 project a Multi-Domain Monitoring pilot was deployed, which involved 5 partners and the GÉANT backbone. The pilot was the first stage in releasing an operational perfSONAR MDM service. It was used to evaluate the perfSONAR MDM service and its support. Supporting remote sites in installing products, working as a single point of contact for perfSONAR MDM related issues, tracking problems, interacting with third parties, and installing and maintaining managed perfSONAR deployments provided valuable experience for service operation.

A perfSONAR MDM managed service was also successfully deployed for the Large Hadron Collider Optical Private Network (LHCOPN) to monitor the private optical network between CERN and the eleven Tier1 sites across the world. The Application Service Desk deployed, supports and manages the monitoring infrastructure for LHCOPN.

In year 4 of the GN2 project, SA3 developed and deployed a passive monitoring infrastructure across four GEANT2-NREN boundary links in a pilot phase (namely ACAD, CESNET, PIONIER and SWITCH). Four monitoring applications are currently running on this infrastructure. They are accessible from a central web page, alongside active monitoring applications. A report on of the experience with development, deployment and using this infrastructure was published as Milestone MS.3.7.5 [MS.3.7.5].

2.1.1 Analysis

For the perfSONAR MDM pilot at NREN sites, all available perfSONAR components were deployed, but some of them attracted more use, such as RRD MA or BWCTL MP. Generally, the level of utilisation by Network Operations Centre (NOC) and PERT was low. This is attributed mainly to the small deployment scale and problems with data availability and accuracy.

The pilot showed that although usability was a priority for perfSONAR software product design, the pilot showed that further improvements in the automation and standardisation of installation and configuration are needed (in line with systems administration best practices) to meet the needs of operators and administrators

Easy web service manageability and better integration with existing NOC workflows is a must have for larger scale service deployments in the heterogeneous environments of different network domains. This should be provided in form of configuration assistance (e.g. generating a metadata file from existing monitoring databases and tools like MRTG or Cacti) and the provision of alarms.

The pilot experience showed that end users who were not familiar with the perfSONAR web services were not easily able to understand the functionalities and administration of the products. This lead to an increased workload for the Service Desk and support. Good, well-structured user documentation is therefore needed, as well as a simple, automatic provision of initial configuration which leads the user through the process smoothly and in a time-effective manner.

A perfSONAR MDM managed service was also deployed for LHCOPN to monitor the private optical network between CERN and the eleven Tier1 sites across the world. The Application Service Desk deployed, supports, manages the monitoring infrastructure for LHCOPN. However, the final deployment took a lot of time, mainly due to complicated logistics, hardware purchase and GPS installation problems where dedicated server monitoring solutions were used.

Hardware failure exacerbated by the lack of a support contract, faulty firmware and some software stability issues were challenges faced during the passive pilot. The high cost per card made widespread deployments expensive. The small deployment scale was also identified as an issue for the passive pilot, as information becomes more useful, the wider the coverage is. Therefore, the lower cost cards need to be investigated for future developments.

2.1.2 Risks

The Service Desk's operational experience from the perfSONAR MDM pilot indicated that software problems (initial configuration) and hardware problems (time consuming purchase and GPS installation issues) can significantly slow down the service deployment both for managed and unmanaged monitoring services. Difficulties in product installations and configuration or special hardware requirements can negatively impact the acceptance of perfSONAR MDM services deployed at NRENs. Overhead is caused by the requirements for extensive advanced knowledge of local issues such as GPS antenna installation possibilities or larger than expected rackspace availability

If a managed service is offered, the purchase of infrastructure and the deployment in remote locations can prolong the installation process and require constant coordination by the Service Desk. It also requires sufficient Service Desk staffing to provide the required service deployment coordination and extensive user support. This means that less development resource is available to improve tool quality, maintainability and performance, and that the service cannot benefit from local knowledge.

Experience gained from the passive monitoring pilot shows that the purchase of monitoring stations (servers), monitoring cards and other dedicated hardware should include support from the manufacturer or supplier. This should include replacement of faulty hardware within a specified period of time, and support for software provided with monitoring cards (driver upgrades, etc.). Support should be provided on site (that is the manufacturer or supplier should arrange for shipping of hardware replacement in both directions).

Feedback from APM (Access Port Manager) members indicated that although consistent service provision is important, it is also worthwhile to make components available on a non-service basis for NRENs to evaluate and give feedback on, with no particular quality expectations. Focussing exclusively on packaged, fully implemented services risks neglects this aspect of community interaction and development.

2.2 Survey of NREN CTOs

To get further directions for the perfSONAR multi-domain service design and software development, a survey was conducted by SA2 T3 in 2009. A questionnaire was sent to all CTOs in the GÉANT community. Of the 38 questionnaires 25 were returned.

The survey consisted of questions related to the perfSONAR software suite components, covering areas where demand, service applicability or the direction future developments needed clarification. Questions also aimed to identify what type of role NRENs might play in the delivery of multi-domain monitoring and what benefits they might gain from such a service.

2.2.1 Analysis

The availability of metrics is a critical factor in the provision of a monitoring service. An important point in the survey has been the investigation of metrics that may be monitored from an NREN perspective. It shows that nearly all NRENs already do monitoring via SNMP (utilisation, interface errors and output drops), presenting to

existing per-domain NOC visualisation tools, and are only partially interested in using perfSONAR for this function. It also means that this kind of performance data is already widely available in domains and could be provided to a multi-domain monitoring service under appropriate conditions. Active measurements metrics are only measured by a part of the NRENs. More than a third of the NRENs expressed an interest in a solution via perfSONAR for these metrics. Several NRENs indicated that they would like to receive dedicated hardware boxes for this purpose from the project. The response to a question about using flow-based tools indicates willingness to share NetFlow data between operators, given an appropriate policy. The results also indicate interest in activities related to passive monitoring.

In addition to investigating what metrics should be provided, questions also evaluated to what extent NRENs would be users as well as providers of multi-domain monitoring. There is significant interest in getting a flexible alarming solution based on available measurements. Several NRENs are interested in a solution for the monitoring of End-to-End (E2E) links, and approximately half of the NRENs are interested in tool support for achievable bandwidth measurements. Customisable, intuitive visualisation based on a weathermap is also of interest.

An examination of database and operations systems preferences has shown a shortlist of two well known systems which should be supported for NREN deployment.

2.2.2 Risks

A third of the NRENs indicated that they would like to get perfSONAR as a service that is completely paid for and managed by the project. The remaining NRENs expressed a preference to manage their own monitoring installations. This poses difficulties in how full multi-domain coverage can be achieved in a fair way. It imposes a significant cost burden directly on the project for approaches requiring dedicated hardware such as active or passive dedicated measurement equipment. It also increases the central support element for equipment management, configuration and maintenance. By focussing on meeting the requirements of NRENs who prefer to manage their own monitoring instances, resources can be devoted to improving the stability and manageability of software. This work will then benefit a later extension to cover the remaining one third of sites with a potential managed service by reducing operational overhead to manage and maintain the software.

2.3 Network Performance Monitoring in other Communities

One of the contexts of perfSONAR is a consortium of organisations who build network performance middleware that is interoperable across multiple networks and useful for intra- and inter-network analysis. Apart from the GN3 community, Internet2 and ESNET from the USA, Canarie from Canada and RNP from Brazil have active perfSONAR development interests.

Internet2 developed perfSONAR-PS (pS-PS) which is a set of independent software services that implement the perfSONAR protocols and targeted audience for full implementation of these services in Network Operation Centres at universities and regional networks. pS-PS services are designed to be compatible with all other perfSONAR software that implements the perfSONAR protocols, and feature several products deployed currently in ESnet/Internet2 backbones and all USAtlas Tier2 Sites.

The Brazilian National Research and Education Network, RNP, actively develops a Command Line Measurement Point as well as CACTISonar and Internet Computer network Eye (ICE) analysis and visualisation tools intended to facilitate the use of perfSONAR infrastructure. Using a friendly user interface familiar to network operators, they enable administrators to manage all tests that are scheduled to run among a group of network sites. The monitoring infrastructure is currently deployed in the EELA-2 project (composed of a set of Latin American academic networks) resource centres.

2.3.1 Analysis

All organisations involved in perfSONAR development recognise the need to display the data in a relevant and user-friendly way. New software releases of perfSONAR-PS are also focussed on usability and stability, with features that include improved visualisation, alarming and improved documentation [FEAT]. Interoperability with international monitoring deployments provides has added value to European users, e.g. to support the LHC community needs consistently. Collaboration on particular developments as started in GN2, and incorporation of external perfSONAR products could bring some efficiency benefits to all parties.

2.3.2 Risks

Collaboration on software development in GN2 highlighted the importance of having a suitable Intellectual Property Rights (IPR) policy to govern the choice of software license among collaborators. With an increased focus on maintainability and stability of software, tighter guidelines for change management and coding best practice should be adopted for collaborative work on production or near-production components. It is also important that the visibility of the GÉANT community in contributing to these developments is maintained appropriately. The incorporation of non-GÉANT developed perfSONAR products into perfSONAR MDM services is dependent on the agreement of suitable support parameters that meet the requirements and risk tolerance of the relevant service, and on suitable IPR.

3 Conclusions

Based on the experiences from GN2, NREN feedback, project strategic goals and international standing, three services will be specified in detail, business cases developed and appropriate service management steps carried out. Although some of these services might already be regarded as in production since GN2 (e.g. a perfSONAR MDM for a private networks instance deployed to the LHCOPN), they will be realigned and re-evaluated according to the GN3 service management methodology.

- perfSONAR MDM for private networks.

  A tailored, customised delivery of monitoring capabilities for private networks within the GÉANT service area. Private network customers and users care about the perfSONAR protocol, community and implementations only in as much as they impact the cost and standard of the delivered solution.

- perfSONAR MDM Basic.

  A core set of perfSONAR components with federated delivery by and for NRENs and their users. The perfSONAR MDM Basic service is focussed providing a performance monitoring and diagnostics infrastructure for NOCs and performance engineers in the GEANT Service Area that is interoperable with similar infrastructures delivered by global partners. Ultimately the same infrastructure will ensure a reliable and comprehensive monitoring picture for NREN end users and researchers.

- Passive monitoring.

  A set of passive monitoring capabilities integrated with the perfSONAR framework, located in NRENs and providing a service to NRENs and their users.

A high-level service description for each service is included in the appendices. Suitable branding will be determined in cooperation with NA2.

It is recognised that the individual perfSONAR software components developed in GN3 and GN2 can provide value and recognition for the GÉANT community outside the context of managed and/or supported services. It is proposed that all components (where existing IPR permit this) be suitably licensed and made available for open exploitation, with the origin and stakeholder credits clearly identified. This will allow NRENs and the user community to freely extend their own basic deployments, provide an opportunity to track and identify popular components for later incorporation (without compromising the quality expectations of the basic or managed service variants), and ensure a visible profile for GÉANT multi-domain monitoring developments.

Appendix A perfSONAR MDM Service for Private Networks - Service Description

A.1 Functionality

The perfSONAR MDM service for private networks provides users with access to network measurement data from multiple network domains. Users can collect monitoring data from all domains where the service is deployed in order to visualise network characteristics and troubleshoot related issues. This customised version of perfSONAR products is going to be used for the monitoring connections of the private network established with the use of multiple technological and administrative domains like GÉANT and NRENs infrastructures. It monitors the IP and circuits operations of the network using active and passive measurement techniques. It provides up-to-date information about the network health and assists operational teams, users and the GÉANT End-to-End Coordination Unit in diagnosing network-related issues. This perfSONAR service will be operated by a perfSONAR Service Desk, which is run by the GN3 project, which operates the network monitoring infrastructure on behalf of the client and provides first level support. Training is provided to the representative users of the service to familiarise them with the operation and usage of the analysis tools, and to enable them to understand the measurements data.

A.2 Target Users

The perfSONAR MDM service for private networks is designed for the specific monitoring of the IP and circuit operation of a multi-domain network which establishes private communication (private network) between a set of sites, using a shared network infrastructure (GÉANT, NRENs). The monitoring infrastructure will be placed at the administrative boundaries in order to monitor the interconnections between network nodes and establish demarcation points that help distinguish network issues from those at the end sites. Active and passive measurement techniques will be used to monitor the network connectivity between network sites. This includes:

- TCP achievable bandwidth.
- One-way delay and delay variation.
- ICMP RTT.
- Traceroute information.
- Interface utilisation.
- Input and output errors.

- Path status.

Users of this service will be able to collect monitoring data from all domains where the service is deployed, visualise network characteristics and troubleshot issues.

Users of private networks may include international research groups, projects or activities that are provided with their own connectivity services with large capacities. The perfSONAR MDM service for private networks may also be used by the GÉANT End-to-End Coordination Unit which supervises multi-domain circuits.

A.3 Technical Specification

The paragraphs below provide a summary of the network metrics that are monitored by the perfSONAR MDM service for private networks.

- Achievable bandwidth measurements.

  Active TCP achievable bandwidth measurements between two network sites. The bandwidth on the network is measured in regular intervals, using the TCP protocol. Both scheduled and on-demand measurements can be carried out. The measurements are archived and visualised for troubleshooting and trend analysis.

  These measurements are supported by BWCTL MP, SQL MA products and HADES servers. Direct access to graphs is supported via the weathermap.

- IP interface statistics.

  IP interface SNMP statistics for IP connectivity between two network sites. The current and historical IP link statistics include link capacity, link utilisation, input and output errors. The interface statistics are collected and archived, and could then be visualised for troubleshooting and trend analysis.

  The interface statistics are supported by RRD MA. Visualisation is supported by the weathermap and perfsonarUI.

- Delay and jitter measurements.

  Active delay and jitter measurements between two network sites. One way delay and jitter on the network are measured in regular intervals, archived, and visualised for troubleshooting and trend analysis.

  Delay and jitter measurements are supported by HADES servers. Visualisation is supported by the weathermap.

- Packet loss and reordering measurements.

  Active packet loss and reordering measurements between two network sites. Packet loss and reordering on the network are measured in regular intervals, archived, and visualised for troubleshooting and trend analysis.

  Packet loss and reordering measurements are supported by HADES servers. Visualisation is supported by the weathermap.

- Traceroute information.

  Active routing path measurements are conducted between two network sites using traceroute. Hop count and the routing path on the network are measured in regular intervals, archived and visualised for troubleshooting and trend analysis.

  Traceroute information is supported by HADES servers. Visualisation is supported by the weathermap.

On a pre-production basis, the following is also offered:

- Lightpath circuit status.

  The real-time status of circuits connecting all domain sites. This includes the current and historical status, indicating whether lightpath is up or down. The circuit status is collected from optical network devices in private network domains and archived. It could then be visualised for troubleshooting and trend analysis.

  The lightpath circuits status is supported by E2EMon MP and SQL MA products. Visualisation is supported by the weathermap and the E2E Monitoring System.

Table A.1 summarises the products included in the perfSONAR MDM service.

Product name	Code version	Supported system	Documentation status
SQL MA	2.1.1	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
SSH/Telnet MP	1.3.4.1	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
Authentication Service	1.1	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
BWCTL MP	0.51	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
Lookup Service	1.3.1	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
HADES MA	Managed	Managed	Managed
RRD MA	3.1.1	Debian 4.0, RHEL 4.x, 5.x	Installation and configuration guide
HADES	Managed	Managed	Managed
E2EMon (pre-production only)			
E2EMon MP (pre-production only)			Installation and configuration guide
Customised weathermap			
perfsonarUI	0.15		
Customised portal			

Table A.1: Products of the perfSONAR MDM service for private networks.

A.4 Operational Specification

A.4.1 Support

The perfSONAR MDM service for private networks will be operated by the Service Desk run by the GN3 project. The Service Desk acts as a single point of contact that can be reached via telephone and email. It provides support to the users with the help of Operational Level Agreements with providers of hardware, operating system and various development teams responsible for monitoring tools and perfSONAR products.

The Service Desk uses a Trouble Ticket System to acknowledge reported incidents (usually by users). To help the Service Desk detect incidents before they are reported, special tools are used to monitor the health of deployments and raise alerts problems with deployments are detected. This proactive incident detection assists the Service Desk in the speedy acknowledgement and resolution of certain incidents. The Service Desk also maintains an information repository that correlates and stores information related to the perfSONAR MDM service.

The Service Desk will offer the following support for the monitoring service:

- First level of support, 7.5h x 5d x 52w per year. The operating hours are 9:00 am to 17:30 pm GMT.
- Installation and management of the measurement tools, data archives and visualisation tools.
- Management of the hardware and operating systems to ensure the reliability of the measurement tools and the data.
- Ensuring the integrity of the monitoring infrastructure, availability of the measured data, data quality and data archiving.

A.4.2 Operational Model

This perfSONAR MDM service for private networks provides a complete solution that includes support for the monitoring software, the operating system and the required hardware that are needed to provide reliable and precise monitoring of the network. This is a fully managed solution, where the monitoring service is implemented, configured and maintained by the GN3 Service Desk. The tailored elements of the service must be offered on a cost-recovery basis, should they exceed a basic threshold.

Appendix B perfSONAR MDM Basic – Service Description

B.1 Functionality

The perfSONAR MDM Basic service is focussed on providing a performance monitoring and diagnostics infrastructure for NOCs, PERTs and performance engineers in the GÉANT service area that will enable users at the edge of the network to identify performance capabilities and leverage the people and tools necessary to improve their end-to-end experience. This version of a perfSONAR-based service is established with the use of resources provided by multiple technological and administrative domains. Initially, these are GÉANT and NRENs, but this may be extended to participating campus networks. This service will be interoperable on a global level with similar services offered by international partners. The perfSONAR MDM Basic service will focus on using and combining readily available performance information to provide an end-to-end picture, delivering functionality useful to existing NREN workflows (e.g. alarms). The priorities will be to deliver a lightweight and stable set of tools for domains to deploy and manage easily. A live CD-based installation will be provided.

B.2 Target Users

Target users of this service are primarily members of PERTs and NREN NOCs who support end users of IP connectivity services provided over the GEANT service area who need to view performance data or perform tests (e.g. for event planning, research or operational needs). However, the ultimate beneficiary of the service is the end user. By providing the multi-domain monitoring and diagnostics infrastructure as a service to network performance teams and NOCs, performance issues for end users can collaboratively be identified, prevented and solved.

B.3 Technical Specification

The minimum technical specification is under development based on:

- 1:1 interviews with NRENs who expressed a preference to run their own monitoring systems.
- Requirements of the PERT community.

- Requirements identified in collaboration with global partners.

The following functionality is anticipated but subject to validation against NREN workflows:

- Throughput.
  - Continuous (10 packets/sec each sec) OWD.
  - Periodic (2-4 per day) max. NIC throughput, frequent + short duration and occasional long duration tests permitted.
  - UDP up to 1G.
- Utilisation, errors, discards, drops.
- Visualisation integrated into NREN NOC/PERT workflows, reusing existing tools where possible.

Coverage should aim to cover all intra-domain paths, inter-domain links and occasional multi-domain paths. Interfaces at participating domain boundaries should be instrumented with perfSONAR. The infrastructure must be discoverable via the perfSONAR Lookup Service, reachable, and functionality enabled by policy

B.4 Operational Specification

B.4.1 Support

The Service Desk will offer the following support for the monitoring service software:

- First level support, 7.5h x 5d x 52w per year. The operating hours are 9:00 am to 17:30 pm GMT. Support is offered primarily to domains who are participating in service delivery.

B.4.2 Operational Model

The perfSONAR MDM Basic monitoring service will be collaboratively delivered by participating domains. These domains will be responsible for provisioning data to the service and ongoing maintenance of the locally installed perfSONAR suite of tools. They will be supported by the Service Desk in the first instance, with escalation to developers as 2nd line. Bug reports will be accepted directly.

Appendix C Passive Monitoring Service – Service Description

C.1 Functionality

The passive monitoring service provides a perfSONAR-compatible passive monitoring infrastructure based on the use of specialised packet capture and processing hardware in order to make network characteristics available that are inherent to real network traffic and cannot be obtained using other methods. Examples of such characteristics include load dynamics in short timescales, protocols and application used in the network, trends in their usage and traffic anomalies.

C.2 Target Users

The passive monitoring service targets the following user groups (in approximate order of priority):

- PERT
- Networking researchers.
- NOC.
- Network planners.
- General public.

PERT engineers will use performance characteristics related to network behaviour and real user traffic for advanced performance problem resolution (e.g. presence of various protocols, packet loss in real traffic, load dynamics, anomalies and trends). Because GÉANT is a research network, it is a unique opportunity to acquire a depth of information not possible in commercial networks. Therefore, networking researchers will use detailed information from passive monitoring about the behaviour of a large high-speed network to study protocol and application design for the future Internet. Performance characteristics and particularly their changes and anomalies can be useful for the GÉANT and NREN NOCs. Network planners will use development trends in network usage, such as traffic volumes, dynamics, protocol and application composition for planning of future network extensions and traffic engineering. The general public will be able to access selected statistical information, particularly when provided in a common user interface with active monitoring results, such as throughput and delay.

C.3 Technical Specification

The paragraphs below provide a summary of the performance metrics that are monitored by the passive monitoring service.

- Traffic classification for protocols and applications.

  Current and historical link load is measured at short intervals (1s) and network traffic is classified into known protocols and applications in several layers of OSI (Open Systems Interconnection) hierarchy. This also includes the classification of protocols that use dynamically allocated ports, such as passive FTP (File Transfer Protocol), HTTP (Hypertext Transfer Protocol, which can use other ports than 80 and 443), Skype telephony or file-sharing protocols, such as BitTorrent, Gnutella or DC++.

  Traffic classification is supported by ABW (Available Bandwidth) and DiMAPI (Distributed Monitoring Application Programming Interface) products. Dedicated monitoring hardware. visualisation is supported by ABW.

- Packet loss.

  Statistics of packet loss experienced by real user traffic from flows passing through the network. Statistics of matched flows passing between two monitoring points are also provided.

  Packet loss is supported by Packetloss2, DiMAPI and dedicated monitoring hardware. Visualisation is supported by Packetloss2.

- Geographical characteristics.

  Information about the geographical distribution of sources and destinations of network traffic. Information such as throughput achieved by users communicating between particular countries is computed.

  Geographical information is supported by the Geoflow product.

- Availability of passive monitoring service infrastructure.

  Access to passive monitoring stations (checked from the central station). The current status of a specified set of running processes is also provided. Events are reported and logged, and processes are automatically restarted.

  Availability of passive monitoring service infrastructure is supported by the Perfmon product. Visualisation is supported by Perfmon.

- Status of hardware components of passive monitoring service.

  The current and historical status of hardware components of passive monitoring stations. Statistics about CPU usage are provided separately for each CPU core and each type of usage (system, user, nice, iowait, irq, softirq), CPU load (a length of job queue waiting for CPU allocation), shared memory usage and passive monitoring card packet drops.

  The hardware components status is supported by the Servmon product. Visualisation is supported by Servmon.

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Glossary

ABW	Available Bandwidth
APM	Access Port Manager
BWCTL	Bandwidth Controller
CPU	Central Processing Unit
CTO	Chief Technical Officer
DiMAPI	Distributed Monitoring Application Programming Interface
DoW	Description of Work
E2E	End-to-End
FTP	File Transfer Protocol
GMT	Greenwich Mean Time
GPS	Global Positioning System
HADES	Hades Active Delay Evaluation System
HTTP	Hypertext Transfer Protocol
ICE	Internet Computer network Eye
ICMP	Internet Control Message Protocol
IP	Internet Protocol
IPR	Intellectual Property Rights
ITIL	Information Technology Infrastructure Library
JRA	Joint Research Activity
LHCOPN	Large Hadron Collider Optical Private Network
MA	Measurement Archive
MDM	Multi-Domain Monitoring
MP	Measurement Point
NA	Network Activity
NOC	Network Operations Centre
NREN	National Research and Education Network
OSI	Open Systems Interconnection
PC	Policy Committee
perfSONAR	Performance Focused Service Oriented Network Monitoring Architecture
PERT	Performance Enhancement and Response Team
PMT	Project Management Team
pS-PS	perfSONAR-PS
RRD	Round Robin Database
RTT	Round Trip Time
SA	Service Activity
SNMP	Simple Network Management Protocol

SQL	Structured Query Language
SSH	Secure Shell
T	Task
TCP	Transmission Control Protocol
XML	Extensible Markup Language