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# Deliverable DJ1.0.1: Plan for Transition of Multi-Domain Monitoring Service (JRA1) into Production



## Deliverable DJ1.0.1

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## Abstract

This Deliverable describes the Multi-Domain Monitoring service being developed under GN2 JRA1. It considers the steps necessary to migrate this activity to an operational service and sets out initial ideas about the transition process necessary to implement such a service. The organisational structures to provide user and supplier support are described as well as the intermediate steps that are possible in the implementation of a fully operational service.

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## 0 Executive Summary

Over the last two years and a half, JRA1 has been developing and prototyping perfSONAR (Performance oriented Service Oriented Network monitoring Architecture) web-services with the principal objective of integrating existing measurement tools and measurement databases within those web-services. Those perfSONAR web-services aims at offering the capability of allowing individual users, or user groups, to understand the performance of the multi-domain network infrastructure which they use. Visualisation tools, making use of functionalities provided by web-services have also been developed, and allow users to see graphical representation of network performance.

Several groups of users of those monitoring information and capabilities have been identified, the three most important being:

- The NOC (Network Operation Centres) and PERT (Performance Enhancement Response Team) to verify the health of end-to-end network service and to troubleshoot incidents
- Projects wishing to get access to monitoring information for the end-to-end services they used and potentially have them displayed by visualisation tools

It is thus necessary, for those users, to ubiquitously get access to monitoring information and to perform monitoring actions along the networks that the end-to-end services crosses. A Multi-Domain Monitoring (MDM) service allows user groups to do just so. It enables a user to gain access to a set of network performance data or to perform network monitoring actions in different network domains. The performance data and the monitoring actions are accessed in a uniform way in each domain and have the same meaning in each network domain. The Multi-Domain Monitoring (MDM) service is relying on the XML NM-WG schema used by the perfSONAR web-service to provide ubiquitous access to the information and functionalities. In addition to the XML schema, the MDM services relies on perfSONAR visualisation tools to offer tailored view of the information to specific user groups. An MDM service is initially thought to be provided within Europe and agreement will have to be negotiated with other continents to extend the service across the world for our users. The MDM service will be provided to the users with an SLA and indications of its geographical spread.

To help the users and the MDM “deployers” of the MDM service, a support infrastructure will be set-up. It consists of three support levels: Support Level1 the service desk, in charge of the incidents and the communication with the users and “deployers”. The Support Level2 consists of the system administrators in charge of the servers where the perfSONAR web-services and visualisation tools are installed. The Support

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Level3 consists of the developers in charge of supporting the code developed. All perfSONAR web-services and visualisation tools will follow a strict release process and test phase before being used in operation.

The transition to service will be done in four phases. The first one, pre-roll out, consists at setting up the support infrastructure. It will be followed by a pilot trial phase where the perfSONAR web-services will be deployed within five RENs (Research and Educational Network) and GÉANT2. The objectives for the pilot trial are to offer a MDM service to PERT and NOCs, to understand the issues that are faced in moving from a development into an operational environment in respect with deployment and support. No AA (Authentication Authorisation) will be available during the pilot. After the pilot trial, a prototype phase will involve 11 RENs and GÉANT2. It aims at verifying that the SLA offered can be respected and that a “turn key solution” service can be offered to networks who don’t have the resources to deploy and manage locally the MDM service. The manpower needs for the transition to operation are still under investigations.

# 1 Introduction

The main goal of JRA1 is to deploy a measurement framework (perfSONAR) for accurate network traffic measurement and monitoring. To support end-to-end network monitoring across distributed domains (GÉANT2, NRENs) and for different user groups (NOC/PERT, projects, end users), JRA1 provides a framework that is based on distributed perfSONAR web-services. These provide a common interface for applications to interact with different monitoring tools and allow users to obtain and manipulate measurement data. This allows a user of the framework to obtain a “global” view of the network performance. This enables a user to effectively troubleshoot network performance problems by accessing the available data collected from the various geographically distributed domains.

The perfSONAR framework has a modular architecture, allowing services to be added, removed, or replaced relatively easily. This is possible because perfSONAR is designed as a co-ordinated collection of web-services and visualisation tools. The framework is realized by a set of base services, which are:

- Measurement Point web-service (MP): invoked measurement tools
- Measurement Archive web-service (MA): databases of measurement data
- Lookup web-Service (LS): “Yellow Pages” to find perfSONAR services
- Authentication Authorisation web-Service (AA): defines roles for users

These web-services can be accessed via user visualisation tools, which are:

- perfsonarUI: visualisation of performance data
- CNM: “Consumer Network Management” visualisation of topology and utilization data

PerfSONAR is flexible enough to exploit different specialized measurement tools and manipulate archived data (possibly with the use of additional services). The communication between a client (e.g. a visualisation tool) and a web-service or between web-services uses the well-established mechanism of SOAP XML messages implemented using the Global Grid Forum’s (GGF) Network Measurement Working Group (NM-WG) schema

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specification. For more information about the perfSONAR, its services and the terminology, please refer to annexe B.

JRA1 has developed a number of tools for capturing network performance data, analyzing this data and making it available, in an accessible way to users, via perfSONAR web-services. It is envisaged that a variety of users with differing skill sets and requirements will wish to exploit perfSONAR web-services. The issues raised by the transition from the development activity to an operational service are developed in the following sections. This includes:

- a definition of the multi-domain monitoring (MDM) service (section3) that will be delivered to the users together with associated service level agreements.
- the model for supporting the Multi-Domain Monitoring service described with respect to the user's service access (section 4). The various networks in a multi-domain environment which provide elements of the service (the suppliers of the service), need to be sure that the service being offered by them is part of and conformant to an overall standardised approach to support.
- the description of the internal support for suppliers of measurement data provided in section 5 .
- the release management process, which has been presented in a previous deliverable [DJ1.3.2], is highlighted in section 5.4.
- the risks, associated with the transition are highlighted in section 7
- an estimate of the resources needed for service operation are provided in section 8 together with an example of the costs and manpower required to deploy a MDM service provided in Appendix A.
- a more detailed description of the internal structure of the perfSONAR framework is available in appendix B.

## 2 User Categorisation

It is important to differentiate the sets of potential users so that the tools and services developed can be tailored to meet the specific needs of groups of users. To date, three distinct groups have been identified. A brief description of the groups and their likely requirements for a MDM service is set out below.

- **NOC/PERT users:** Staff members of Network Operation Centres (NOC) or Performance Enhancement Response Teams (PERT) are interested in detailed performance information, available in a timely manner and as little aggregated as possible. This is necessary to identify the root causes of performance problems and can also help to track security-related incidents. The NOC/PERT users would also like to be able to execute “on-demand” tests and may wish to develop their own visualisation tools for special purposes, as well as using the perfSONAR visualisation tools.
- **Project members:** Members of a co-operative project, exploiting network resources would like to view network performance data with respect to their project. For larger projects like EGEE which are developing their own approach to visualisation, the perfSONAR measurements serve as basic input which is enriched with project-specific information and displayed with such visualisation tools. For other projects, it is also possible that perfSONAR visualisation tools to be adapted to project needs.
- **Individual end users:** The set of individual end users is heterogeneous. Its needs will therefore be refined as the project progresses. Some end users who experience a problem with a network connection would like to know whether the problem is local or caused by the backbone networks. For this case the perfSONAR visualisation tools should deliver appropriate performance information in an easy to understand manner. Other end users, more interested in network research issues, may wish to get data from real network infrastructures to assist in their own research.

## 3 Service Definition

This section describes the Multi-Domain Monitoring (MDM) service that GÉANT2 will be offering to users.

As described in Section 2 above various types of users will exploit an MDM service. In the following sections, user is used as a generic term for a user of any Multi-Domain Monitoring service.

The suppliers of an MDM service are the set of networks that take part in the offering a Multi-domain Monitoring service to users. The suppliers are the interconnected networks that together offer connectivity to users and that have installed the measurement devices, RRDs with monitoring data, which can be accessed via perfSONAR web-services developed by JRA1. This includes NRENs, Regional networks, universities, etc.

### 3.1 Multi-Domain Monitoring Service

The Multi-Domain Monitoring (MDM) service enables a user to gain access to a set of network performance data or to perform network monitoring actions in different network domains. The performance data and the monitoring actions are accessed in a uniform way in each domain and have the same meaning in each network domain.

A list of potential performance data and monitoring actions is provided below <sup>1</sup>

- Performance data: network link status and utilisation, delay and throughput data between two networks. Additional useful metrics are: network backbone and access links interface packet drops, utilisation and status, circuit errored Seconds, equipment status, delay or throughput data within the networks.
- Monitoring actions: perform on-demand TCP throughput and delay test between two machines; retrieve “show commands” on multiple routers.

<sup>1</sup> This exact list of performance data and monitoring actions per user type will be specified over Y3 per type of users as they have different needs.

The request for performance data or monitoring actions is further specified with the help of metadata which are associated to them in a request. The metadata describe the type of measurement data, the entity or entities being measured and the particular parameters of the measurement. The metadata which can be specified in a request are for example:

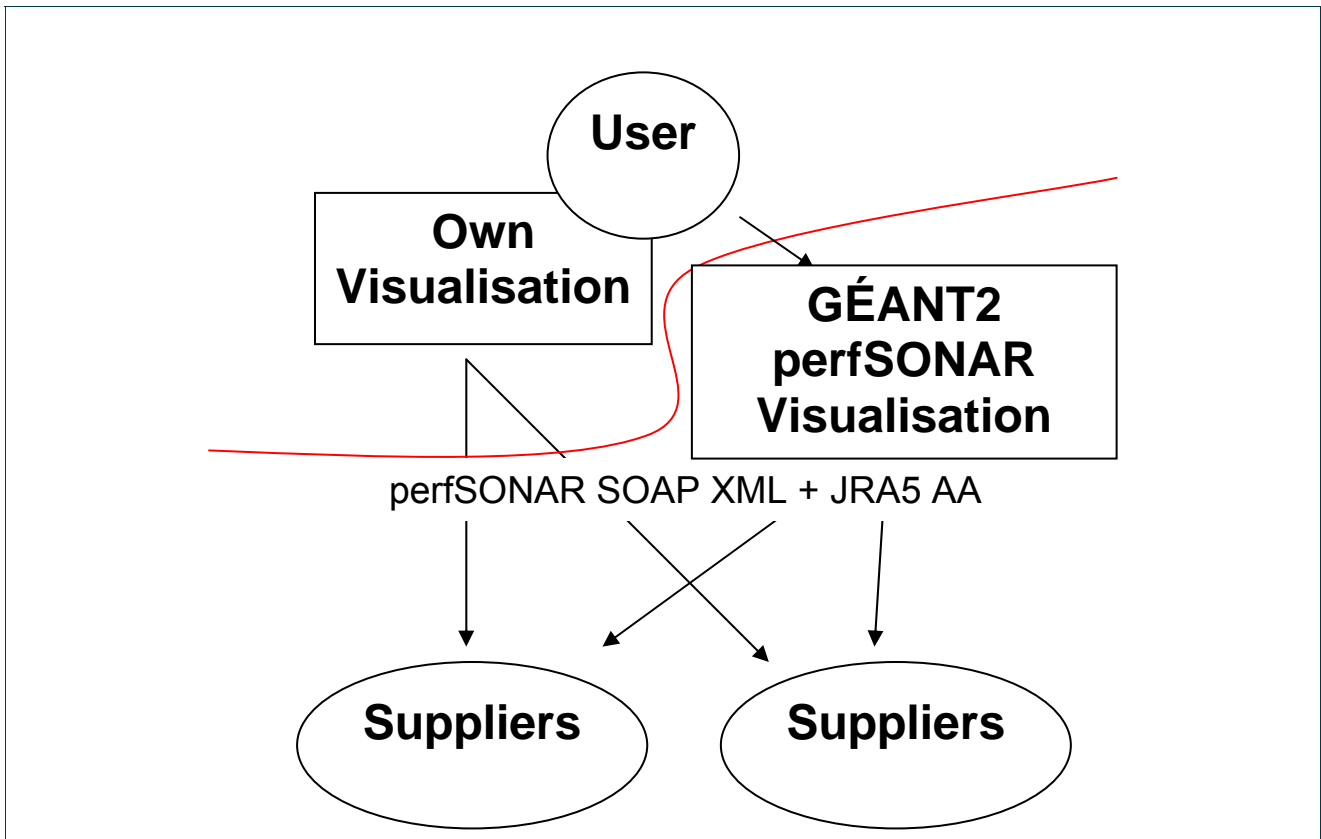
- The time intervals from which one wishes to retrieve the information,
- When starting an on-demand tests, IP header fields such as the Type of Service, packet size or the IP version can be specified, specific command line parameters. This allows the user to, for example, specify the type of service he/she wished to monitor.

The metadata parameters entered allows the user to refine his/her request based on his/her needs. The parameters allowed are dependent on the monitoring tool capabilities deployed by the suppliers.

## 3.2 Access to the service

The Multi-Domain Monitoring service allows a user to access the performance data or to trigger monitoring actions in two ways:

- Through a perfSONAR web service interface making use of xml messages defined by the GGF Network Monitoring Working Group (NM-WG).
- Through a perfSONAR monitoring visualisation tool provided by the GÉANT2 project.



**Figure 3.1:** An MDM service provides two way to a user to access the data – the perfSONAR interface or a perfSONAR visualisation provided by the GN2 project.

In **Figure 3.1**, the red line represents the Multi-Domain Monitoring service border between a user and the supplier. A user can either build his own visualisation tool and access the data provided by the supplier through the perfSONAR web service interface or make use of perfSONAR visualisation tools (provided by the GÉANT2 project) to access those data. The perfSONAR web-interface makes use of xml messages defined by the Global Grid Forum (GGF) Network Monitoring Working Group (NM-WG).

In the first case, the users can build tools to elaborate complex performance data, e.g. by concatenating performance data retrieved along an end-to-end (e2e) path in order to determine the performance. The information is retrieved through perfSONAR web service interface by accessing the suppliers' perfSONAR web-services along the e2e path (for example to get the link capacity and the link utilisation along an end-to-end path. The end-user can also summarise the information retrieved to provide a dash board which shows at a glance the behaviour of the network. They could also build a network weathermap. For troubleshooting and identifying the cause of a problem, the advanced users such as the NOC could create complex test suites triggering on-demand tests at regular intervals.

In the second case, a user can access monitoring data or can perform monitoring actions through perfSONAR monitoring visualisation tools provided by the GÉANT2 project (a “GÉANT2 perfSONAR visualisation”)<sup>2</sup>. These tools use the same perfSONAR web service interface as the users’ tools. Examples of tools developed by GÉANT2 are perfsonarUI or CNM. The user needs to login to those GÉANT2 perfSONAR visualisation tools. The GÉANT2 perfSONAR visualisation tool will authenticate the user through the JRA5 AA Infrastructure and will then contact an authorisation service to know what the user can access as information or functionality.

Because the MDM service can make use of limited resources on a measurement machine or on the network and to protect the network integrity, access to an MDM service is subject to authentication and authorisation. The user will have to login to the GÉANT2 perfSONAR visualisation tools or when creating a user tool, this tool should authenticate itself or its user to an authentication service and get authorised.

The MDM service also offers the user application the capability (metrics, monitoring actions, etc) of discovering what functionalities can be made available to the user and where they are located.

Multiple types of user are expected to make use of MDM service and, depending on the network services they use (e.g. IP Best Effort, E2E L2 circuits, etc), or depending on the role they play within the network community, (E.G. NOCs or PERT), they will need to access overlapping or disjoint set of data types and/or types of measurement. For example, not all IP network users and the layer2 point-to-point circuits’ users will access the same type of information as the realm they are getting their service from is different. The IP user will wish to access layer3 link capacity and utilisation or TCP throughput test results whilst the layer2 point-to-point circuit users will want to know about the status of the constitutive layer2 circuits. A PERT member will share some interests with IP users, but in addition will also need to be able to start on-demand tests of hundreds of Mbps to troubleshoot a problem. Because of the intrusiveness of such tests, the on-demand capability cannot be made available to all the IP users as the network has limited resources.

### 3.3 Services Level Agreement

In order to users receive a consistent and predictable service a Service Level Agreement will be defined. This will be between the user and the service suppliers who are cooperating to offer a Multi-Domain Monitoring service. SLAs are the mechanisms for agreeing, configuring, delivering, guaranteeing, and evaluating the obtained Multi-Domain Monitoring service.

The quality of the Multi-Domain Monitoring service will be evaluated based on the adherence to the promised Service Level Agreements (SLA).

Since the MDM services targets different profile of users and involves multiple parties several versions of SLAs will need to be defined, Section 3.3.1 highlights the template of the SLA used with the different users.

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<sup>2</sup> This doesn’t mean that the visualisation tool covers only the GÉANT2 network, this means that the visualisation tool has been provided by the GÉANT2 project. The tool provides information about the GÉANT2 community (NREN, regional networks, etc).

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It is envisaged that the MDM service will be rolled out over a period of time, initially with differencing levels of coverage in different participating networks. Not all suppliers will be able to offer full geographic coverage or a complete set of measurement capabilities on day-one. It is therefore proposed to have a graduated scale representing the capability of suppliers to provide service according to a set of operational parameters and evaluate the conformance of suppliers to these parameters. The definition of the sets of operational parameters and conformance requirements is work in progress. It is envisaged that three classes of service will be defined, (pilot, prototype and operational)

To offer an SLA to the user, it is necessary to know the level of involvement of the suppliers in offering the MDM service so that the user knows what he/she can expect. It is foreseen that, as it may take time to deploy the services, and to cover a large geographical footprint including accesses to end-institution, the supplier will be categorised as MDM service compliant (all the service and large geographical deployment covering most of network and the end-institutions accesses), as MDM service supportive (smaller set of services with a limited geographical deployment, fewer end-institutions accesses are covered) or as not supporting the MDM service. To the user, those level of compliance need to be translated in terms of what can be achieved overall in relation to the connectivity which he wishes to monitor and not be seen as a set of individual network capabilities. A weathermap exposing the “compliance” category per country and per network will be shown. The compliance level will be defined during the first half of 2007.

SLAs need to be established and agreed between suppliers so that the SLA provided to any user group is consistent across all the domains.

### 3.3.1 SLA between the Supplier and the Users

The SLA between the MDM service suppliers, who have installed perfSONAR web-services to offer an MDM service and the user of that service, contains a Service Level Specification.

The administrative information covers the following points,

- The duration in time
- The service availability guarantee
- The formula on how to calculate the service availability
- The description of how the SLA is being monitored
- The response time to adjust an SLA
- The fault handling procedure
- Quality and performance of support and Service Desk
- The description of the service and a description on how a user can access the service.

The Service Level Specification specifies the geographic availability of the service, the performance data, the monitoring actions, and the metadata accessible by the users.

### 3.3.2 Geographic Availability of Services

Users will mostly be interested in end-to-end monitoring information. Ideally this means that the framework is available in all the networks involved in the end-to-end paths to be monitored. In the context of the GN2 project, the Multi-Domain Monitoring Service thus needs to be offered at least across the set of European R&D networks. This can involve, depending on the footprint of the network service that the user wishes to see monitored:

- The end-site institution as close as the network end-user as is possible.
- The access between the end-site institutions and the national network infrastructure.
- The national infrastructure, covering the national, regional and metropolitan networks (backbone and accesses).
- The access between the national network infrastructure and the pan-European network infrastructure.
- The pan-European network infrastructure.

The level of national compliance to the MDM service must be defined in relation to the percentage of the backbone covered and the percentage of end-site institutions where an MDM service has been made available.

The geographical coverage that a Multi-Domain Monitoring service offers to a user will depend, amongst other things, on the footprint of the network services that user wishes to monitor (e.g. point to point Gigabit Ethernet services and IP best effort service have different footprints).

Services used by network users can also involve multiple continents. Thus, MDM service users will be interested in accessing monitoring data or performing monitoring actions over multiple areas or continents. There are two ways for an international group spanning across multiple continents to access network monitoring information in between their sites.

1. In the first case, they can request access to MDM service to the GÉANT2 community and to other R&D communities independently from one another, in which case they would be using several set of credentials to access the MDM service and would most likely need to build their own visualisation tools to see the data from the involved communities in a single visualisation tool.
2. In the second case, it will be necessary to establish bi-lateral or multi-lateral agreements with service providers in those other communities in order to offer a consistent service to the user. These agreements need to cover the whole path up to the network users. The networks involved are mostly R&D networks which interconnect with European R&D networks (nation wide network as ESnet, SINET, Abilene, or continent wide networks as Alice or TEIN). The agreement negotiated with these networks should cover the data supply and the mutual capability of performing actions using the perfSONAR SOAP – XML web-interface. It is preferable to have the agreement between continents so that a European NREN would not have to establish an agreement with all the NRENs, regional networks and

end-institutions from other continents. The process to establish those agreements will be defined over the next year but should follow the same framework as the SLA established between the European MDM service suppliers.

## 4 User Support

Users making use of Multi-Domain Monitoring service will be offered support from the GÉANT2 community. As highlighted by **Figure 3.1**, users have two way of accessing monitoring data or performing actions

- Through a perfSONAR visualisation provided by GÉANT2
- By developing their own tools which will access the perfSONAR web-interface that make use of xml messages defined by the Global Grid Forum (GGF) Network Monitoring Working Group (NM-WG).

The support structure that will be set-up is highlighted in section 4.1 and the specific information that will be provided for each user group is described in respectively section 4.2.

Support will be offered for the GÉANT perfSONAR visualisation tools or the perfSONAR web-services once they have been released (see section 5.4 for more information about release management).

### 4.1 Three Support Levels for Users

- Level1: Service Desk. the first line of support that users will contact when they are encountering problems with the MDM service. The Level1 Service Desk duties can be summarised as to identify the issue raised by the user, to advise or solve it if possible, if not, to relay the issue to the proper person or group. The Service Desk assumes ownership of an incident through its entire lifetime.
- Level2: the administrators, they are responsible for the suppliers' local machines and the perfSONAR web services or GÉANT perfSONAR visualisation tools provided by the GÉANT2 project. Their main duty is to ensure that the Multi-Domain Monitoring service is available, in particular the perfSONAR web-services or the GÉANT perfSONAR visualisation tool.
- Level3: the perfSONAR web-services and GÉANT perfSONAR visualisation tools developers. Their role as level3 support is to fix the software bugs reported by the Level1 Service Desk or by the level2 administrators.

The RENs have the responsibility of having data existing and made available to the perfSONAR web-services. The REN Level2 has the responsibility to ensure that those data are accessible.

The support level 1 will have two roles: user support and supplier support. They have been separated in this document to highlight the user support and provider support offered. The roles are performed by the same people. The same approach is adopted for level2 administrators and level3 developers.

### Level1 Service Desk Duties

The Level 1 Service Desk duties are, when receiving a request from a user,

- to log the user request , questions and incidents in a trouble ticket system.
- to send an acknowledgement to the user who originated the request.
- to identify the issues raised by the user. Issues can be related to installation, configuration and utilisation of the GÉANT2 perfSONAR visualisation tools or to the utilisation of perfSONAR web-service and the perfSONAR SOAP XML interface.
- to investigate the reachability of the constitutive elements of the MDM service, for instance the perfSONAR web-services and other tools (visualisation or measurement tools) used to offer such service.
- Where appropriate to, redirect the issue to the appropriate person or group in the other levels. For instance the Level2 support of the supplier from which the issue seems to be coming from (e.g. when in case a web-service is unavailable or not operating properly). Or the L3 support, when the problem is related to a software bug. This is done by filling a bug report in a bug tracking system.
- to update the documentation based on the outcome of the investigation: MDM documentation, perfSONAR web-service documentation, underlying tools documentation, MDM service user guides, GÉANT2 perfSONAR visualisation tools FAQ).
- to maintain a Request for Enhancement list based on the users comments, and send them to GÉANT2 JRA1.
- to monitor the overall availability of the MDM service.
- to assume ownership of an incident through its entire lifetime .

SA3 WI-15 In Service Support is an activity which has been set-up to support the MDM service. During GN2 Year3, SA3 WI-15 will define, set-up and operate the user and supplier support. SA3 WI-15 will initially be staffed by people who are involved in the development of the perfSONAR web-services and of the GÉANT2 perfSONAR visualisation tools. From the experience gained in the pilot, they will review the support process and produce training material for GN2 Year 4, where the level1 support Service Desk will be staffed by engineers who will operate the Service Desk during a prototype phase. The Level1 Service Desk is expected to

operate during working hours from Monday to Friday, 8:30 – 17:00 Central European Time. They will send an acknowledgement to a user request within 4 working hours.

As the number of users and suppliers are expected to increase over time and to spread over multiple countries (and thus languages), it is foreseen that the “centralised” service desk structure of a small group of people provided by SA3 WI-15 In Service Support may not be suitable to support the user and potentially the suppliers. Depending on the deployment footprint of the service, the number of users and the number of request received, a scalability problem needs to be solved. As supporting software is a fairly new exercise it is envisaged that, as experience is accumulated in the next year clearer picture will emerge of the detail of the user support structure. This work should be covered during Year3.

### Level2 Administrators Duties

The Level2 administrators’ main goals are to ensure that the infrastructure on which the MDM service is based, i.e. perfSONAR web-services and the GÉANT perfSONAR visualisation tools, is up and running and reachable by the users. Their duties are, when receiving a request from the Level1 Service Desk or from a user<sup>3</sup>include , ,

- to log the requests
- to send an acknowledgement the person who originated the request to the level2.
- to identify the issues raised by the user. This implies to verify that the MDM service and its constitutive perfSONAR web services and/or GÉANT perfSONAR visualisation tool(s) are up and running (hardware, OS, perfSONAR web-services, GÉANT perfSONAR visualisation) and reachable (firewall).
- after investigation, to redirect the issue to the appropriate person or group (level3 support, local NOC, local developer<sup>4</sup>, level1 Service Desk).
- to update perfSONAR web services and/or GÉANT perfSONAR visualisation tool(s) after a new release required by a bug.
- to maintain the MDM constitutive perfSONAR web-services and/or GÉANT perfSONAR visualisation tool(s) (HW, OS, perfSONAR web-services, GÉANT perfSONAR visualisation).
- to monitor the availability of the MDM service within the local network or the availability of the GEANT perfSONAR visualisation tool(s) they are in charge of.
- to ensure that the information provided by the MDM service is up-to-date.

The main objective of the level2 support is to provide a MDM service accessible at any time: 24 hours a day, seven days a week. The level2 support will be provided by a dedicated team within each MDM service supplier

<sup>3</sup> As this section is dedicated to user support, it is assumed that the constitutive perfSONAR web-services of a MDM service and/or the visualisation tool(s) have already been installed.

<sup>4</sup> The local developer is the developer from the supplier which has provided the code to stitch the perfSONAR web-service with the local supplier monitoring infrastructure.

for the access to perfSONAR web-services and by SA3 WI-15 In Service Support for the GÉANT perfSONAR visualisation tools.

If a user has identified that the problem is service unavailability and has identified the supplier responsible for this service, the user should be able to contact the level2 support directly. But in principle, it is preferred to go through the Level1 support.

### Level3 Developers Duties

The main goal of the level3 developers is to fix the bugs reported by the level1 Service Desk or by the level2 administrators<sup>5</sup>. Their duties are, when receiving a request from the level1 Service Desk or level2 support, ,

- to log the requests using a bug tracking system which has to be kept up-to-date.
- to send an acknowledgement the person who originated the request to the level3.
- to investigate and identify the issue related to the perfSONAR web-services or GÉANT perfSONAR visualisation and their dependencies and to provide a patch and released the perfSONAR web-service or the GÉANT perfSONAR visualisation tool.
- to update the documentation based on the outcome of the investigation: MDM documentation, perfSONAR web-service documentation, underlying tools documentation, MDM service user guides, GÉANT perfSONAR visualisation tools FAQ).

The level3 developers' support is staffed by people who are involved in the development of the perfSONAR web-services and of the GÉANT perfSONAR visualisation tools. When working on solving a bug or answering a support request, the developers, acting as level3 support. This allow to the dedication of time from the developer for the support. The level3 support is available during working hours: from Monday to Friday, 8:30 – 17:00 central European time.

In addition to the three level of support, user workshop will be organised. Those workshops will teach the users how to make use of the GÉANT perfSONAR visualisation tools or of the perfSONAR web-service SOAP-XML interface.

## 4.2 User information

Dedicated web-pages will be made available for each separately identifiable group of users. A separately identifiable group of users is a group having the same monitoring needs (e.g. L2 circuits monitoring or IP troubleshooting for NOCs). Web-pages will also be set-up for each GÉANT perfSONAR visualisation tools and for each web-service.

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<sup>5</sup> The development of new features is not covered in this section as it is not related to the support, but is rather related to providing new functionalities to the perfSONAR web-services.

## User Information

For each consistent set of users identified a web-page will be set-up. This web-page should be a reference page that the users can access when they will be looking for information related to the MDM service they use.

The web-page will contain:

1. The MDM service definition.
2. The MDM monthly SLA report.
3. The list of GÉANT2 perfSONAR visualisation tools and/or perfSONAR web-services they can access, a brief description of what they do and a pointer to their dedicated pages. The content of those pages are described in the following sections.
4. Level1 and Level2 support contact information
5. The MDM service deployment footprint.

In addition to that web-page, a web-page will be set-up to explain to a user

- what a Multi-Domain Monitoring service is
- what are its benefits
- how it can be accessed
- what is the level of support that can expect
- what is the deployment footprint for the MDM services
- if he is a new user which would like to get access to an MDM service, who can be contacted to have access to a MDM service in Europe.

### 4.2.1 GÉANT perfSONAR Visualisation Tool Information for Users

For each GÉANT perfSONAR visualisation tool, a webpage containing all the information needed to install, configure and use it will be provided. This page will contain:

1. A pointer to
  - a) Either the downloadable GÉANT perfSONAR visualisation tool (when the application can be installed on a user machine).

- i) Whenever possible, javawebstart will be used so that the application update happens automatically. When it is not possible to use this technology, or when a new release becomes available, the user will be notified through an announcement mailing list.
  - b) Or the URL where the GÉANT perfSONAR visualisation tool is hosted.
2. A GÉANT perfSONAR visualisation tool user guide.
3. A GÉANT perfSONAR visualisation tool installation guide.
4. A Pointer to appropriate FAQ's .
5. Level1 and Level2 support contact information
6. A request for enhancement form.

The software made available to the users will be tested, released, documented and compatible with a perfSONAR web-services that make up the MDM service. perfSONAR Web-Services Information for Users

For each perfSONAR web-service, a web-page describing it will be set-up. It will contain

1. The description of the perfSONAR XML NM-WG messages (syntax) and the sequence of message to follow to communicate with the MDM service.
2. A Pointer to the appropriate FAQ's .
3. Example of perfSONAR XML compliant messages to communicate with the perfSONAR web service.
4. Level1 and Level2 support contact information..
5. A feedback or request for enhancement form.

## 5 Supplier Support

To offer to user a Multi-Domain Monitoring service, suppliers will have to deploy perfSONAR web-services and/or GÉANT perfSONAR visualisation tools and operate them. They will be helped in this effort by SA3 WI-15 In Service Support, which, in addition of supporting users, will also support suppliers in offering an MDM service. The suppliers will be supported for the installation, the configuration, the operation and the use of the perfSONAR web-services and of the GÉANT perfSONAR visualisation tools. The support model is highlighted in section 5.2.

Support will be offered for the GÉANT perfSONAR visualisation tools and for the perfSONAR web-services once they have been released by SA3 WI-15 (see section 5.4 for more information about release management).

The responsibilities and what is expected from a Multi-Domain Monitoring service supplier is described in section 5.1. , The release management process is described in section 5.4.

### 5.1 Supplier Responsibilities

The supplier who wants to offer a Multi-Domain Monitoring Service has the responsibility to deploy, operate and support the perfSONAR web-services and the GÉANT perfSONAR visualisation tools which are part of the MDM service. This implies:

- agreeing with other suppliers to offer an MDM service to set of users and to define the scope of the MDM service for any particular user
- deploying the perfSONAR web-services and GÉANT perfSONAR visualisation tools required by the MDM service to comply with one of the deployment level defined and buy the necessary equipment.
- feed the perfSONAR web-services with the MDM required measurement data and functionalities
  - this can imply some development work to feed the data to the perfSONAR web-service or to modify a perfSONAR web-service to make use of an existing measurement database or of an existing measurement tool.

- measuring the availability of the MDM service on a 24/7 basis and to provide the information to the level1 Service Desk.
- setting -up a level2 support team to support the users (as described in section 4.1) and other suppliers and in section (as described in section 5.2)
- keeping up to date the information provided to users (e.g. circuits upgrades, topology changes etc)
- ensuring the availability of the MDM service (opening ports, deploying AA) and opening user access.
- monitoring the MDM service availability on a 24/7 basis.
- upgrading the service to a newer release when necessary.
- reporting any problem to the MDM support level1 Service Desk in due form and due time.
- contacting the MDM support level1 Service Desk to request enhancements

Examples of a potential the list of services that is expected to be deployed for NOC members and for projects using layer2 end-to-end connectivity are provided in **Error! Reference source not found.** As an indication, it describes what a supplier would be expected to provide as data for a MDM service tailored for the NOCs and what it is implied in terms of hardware and costs as well as the manpower needed to install and maintain the web-services. Suppliers can thus have a better view of what is implied by offering a Multi-Domain Monitoring service. The exercise is done for the NOC as their needs for monitoring information and functionalities can be seen as a super set of the other type user needs.

## 5.2 Support and Maintenance of Software

To support the Multi-Domain Monitoring Service suppliers, three levels of supports, are foreseen:

- Level1: the Service Desk, the first line of support that the suppliers will contact when they are encountering problems with the MDM service. The Level1 Service Desk duties can be summarised as identifying the issue raised by the suppliers, giving advice or solving problems if possible, if not, then relaying the issue to the proper support level. The Service Desk assumes ownership of an incident through its entire lifetime.
- Level2: the administrators, they are responsible for the suppliers' local machines and the perfSONAR web services or perfSONAR visualisation tools provided by the GÉANT2 project. Their main duty is to ensure that the Multi-Domain Monitoring service is available, and in particular the perfSONAR web-services or the GÉANT perfSONAR visualisation tool they are responsible of.

- Level3: the perfSONAR web-services and GÉANT perfSONAR visualisation tools developers. Their role as level3 support is to fix the software bugs reported by the Level1 Service Desk or by the level2 administrators.

As part of the support, workshops explaining how to install configure and how to use the perfSONAR web-services and the GÉANT perfSONAR visualisation tools will be organised for suppliers.

As mentioned in the User Support section, the user and supplier support duties described in the User Support and Support and Maintenance Software sections are duties performed by the same level1, level2 and level3 support groups. The information provided in the User Support sections for the staffing of the three levels of support and its availability are applicable to both the roles performed by the support teams.

### Level1 Service Desk Duties

The Level 1 Service Desk duties are, when receiving a request from a supplier very similar to the ones to be performed when receiving a request from a user, with slight differences (highlighted in *italic*). They are amongst other,

- to log *supplier* requests, questions and incidents in a trouble ticket system.
- to send an acknowledgement to a *provider* who originated the request.
- to identify the issues raised by a supplier. issues can be related to installation, configuration and utilisation of the GÉANT perfSONAR visualisation tools *and of* perfSONAR web-service *and their interactions (covering the utilisation perfSONAR SOAP XML interface)*.
- to investigate the reachability of the constitutive elements from the MDM service, for instance the perfSONAR web-services and other tools (visualisation or measurement tools) used to offer such service.
- after investigation, to redirect the issue to the appropriate person or group. For instance the Level2 support of the supplier from which the issue seems to be coming from (e.g. when in case a web-service is unavailable to not operating properly). Or the L3 support, when the problem is related to a software bug. This is done by filling a bug report in a bug tracking system.
- to update the documentation based on the outcome of the investigation: MDM documentation, perfSONAR web-service documentation, underlying tools documentation, MDM service user guides, GÉANT perfSONAR visualisation tools FAQ).
- to maintain a Request for Enhancement list based on the users comments, and send them to GÉANT2 JRA1.
- to monitor the availability of the MDM service.
- to assume ownership of an incident through its entire lifetime.

## Level2 Administrators Duties

The Level2 administrators' main goals are to ensure that the MDM constitutive perfSONAR web-services or GÉANT perfSONAR visualisation tools are up and running, reachable and working. Their task description is very much the same as for supporting the user (expect that it targets the suppliers).

The main objective of the level2 is to provide a MDM 24/7 available service. The level2 support will be provided by dedicated team within each MDM service supplier for what concerns the access to perfSONAR web-services and by SA3 WI-15 In Service Support for what concerns the GÉANT perfSONAR visualisation tools. The support is provided during working hours.

## Level3 Developers Duties

The main goal of the level3 developers is to fix the bugs reported by the level1 Service Desk or by the level2 administrators<sup>6</sup>. Their duties are the same as the one described for the user support except that they covers supplier problems. In addition, the level3 can also provide advices to the suppliers on how to adapt a perfSONAR web-service to make use of local tools or data stored in a local archive.

The role is undertaken by SA3-WI15 In Service Support, to which the same developers than the ones who have developed the perfSONAR web-services and GÉANT perfSONAR visualisation tools are dedicating resources. The level3 support is available during working hours.

## 5.3 Suppliers information

Dedicated web-pages will be made available for the suppliers for each GÉANT perfSONAR visualisation tools and for each web-service.

### 5.3.1 GÉANT perfSONAR Visualisation Tool Information for Suppliers

For each GÉANT perfSONAR visualisation tools, a webpage containing all the information needed to install, configure and use it will be provided. This page will contain:

1. A pointer to the downloadable the GÉANT perfSONAR visualisation tool (when the application can be installed on the user machine).
2. A Pointer to a bug tracking system.
3. A Pointer to the FAQ.

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<sup>6</sup> The development of new features is not covered in this section as it is not related to the support, but is rather related to providing new functionalities to the perfSONAR web-services.

4. A GÉANT perfSONAR visualisation tool installation and configuration guide.
5. Level1 and Level2 support contact information.
6. A request for enhancement form.

The software made available to the supplier will be tested, released, documented and compatible with a perfSONAR web-services constitutive of the MDM service. (These points will be described in the release management section).

### 5.3.2 perfSONAR Web-Services Information for Suppliers

For each perfSONAR web-service, a web-page describing it will be set-up. It will contain

1. A pointer to download the perfSONAR web-service.
2. A perfSONAR web service specification, including the interface definition and dependencies and request/reply examples.
3. A Pointer to a bug tracking system.
4. A Pointer to the FAQ.
5. A perfSONAR web-service installation and configuration guide.
6. Level1 and Level2 support contact information..
7. A feedback or request for enhancement form.

## 5.4 Release Management

The release management process and testing have been developed in DJ1.3.1 – Implementation Report – Phase I. It corresponds to the points 1, 2, 3, 9, 10, 12 and 13 of the list below. The list below is an extension of this work and provides a check list so that it can be ensured that all the tests and proper documentation are provided before a web-service or visualisation tool is released. This process may be refined based on the experience gained over time.

The release management ensures that software (perfSONAR web-services or GÉANT perfSONAR visualisation tools) provided to the suppliers is working as expected (the interface have been functionally tested), that the installation process works properly and that the proper documentation has been delivered.

Starting from a software developed by JRA1, the release management process follows:

1. Define the new services/functionalities to be added into a new release.
2. Unit test<sup>7</sup> the software.
3. Put the software in the stable branch of the SVN (a software versioning system)<sup>8</sup> The tool should comply with a list of functionalities defined in advance.
4. Provide a user guide (JRA1)
5. Provide an installation guide (JRA1)
6. User test (beta) and installation, JRA1 testers and external tester whenever possible (Testing functionalities, installation process and user guide). (JRA1)
7. Bug fixing for problem reported (JRA1). Iteration with point 6.
8. Edit the guides defined in 4 and 5 based on feedback provided in 6. (SA3 WI-15)
9. Put the software in stable branch to be named. The software becomes a Release Candidate (RC#).
10. Functional test (SA3 WI-15) the software or test different scenarios.
11. Stress test whenever possible. Otherwise mentioned when not possible to test. (SA3 WI-15)
12. Bug fixes (JRA1), Iterate with point 10 and 11 (JRA1).
13. Release the code from stable into release. (SA3 WI-15).
14. Announce the release (SA3 WI-15).
15. Start supporting the released software.

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<sup>7</sup> Unit testing are also called white box testing, by opposition to black box testing where you test only the external of the service. With unit testing, you test the internals. When delivering a perfSONAR service relying on an existing measurement tool, that measurement tool should also be functionally tested.

<sup>8</sup> Note that the timing is slightly different form the perfSONAR document.

## 6 Service Rollout

The service roll out will happen in four phases.

Pre roll-out phase: this phase consists of defining the MDM service and its SLA, defining the procedures to be followed (deployment, support, monitoring, release management, tests, documentation, test workshop) and set-up the different tools. This phase will be done during Year3.

The Pilot phase: an MDM service is offered to a user (NOC or E2ECU most likely) from a small restricted set of suppliers (15% of the NRENS) and for a restricted set of capabilities. The networks taking part to the MDM pilot should ideally host a PERT as the PERT is one of the two groups of users targeted by the MDM. The trial phase should start in April until August 2007. No AA Authentication and Authorisation Service would be available at this time and support would be provided only during working hours. The objectives for the pilot trial are to understand the issues that are faced in moving from a development into an operational environment in respect with deployment and support and to test (dry runs) the different procedures defined during the per roll-out phase and modify them according to the experience gained. Training material to train level1 Service Desk support personal will be developed (Q3-Q4 Year3).

**Figure 6.1** shows the perfSONAR web-services that will be deployed by the NRENS and the metrics that will be provided. The data will be used by personarUI and CNM visualisation tools.

Project:	GN2
Deliverable Number:	DJ1.0.1
Date of Issue:	12/02/07
EC Contract No.:	511082
Document Code:	GN2-06-105v8

Service	Metric/Functionality	
RRD MA or SQL MA	L3 link utilisation	Historical
	L3 link capacity	Historical
L2 status MP (*)	L2 circuit status	Latest
SQL MA (*)	L2 circuit status	Historical
Hades MA (3 tool deployment per REN)	OWD, IPDV, OWPL	Historical
	traceroute	Historical
Telnet/SSH MP	Delay RTT	On-demand
	show command	On-demand
	Traceroute	On-demand
BWCTL MP (3 instances per REN)	Achievable throughput (TCP)	On-demand
	UDP throughput	On-demand
Lookup Service	Service discovery	

**Figure 6.1:** Pilot Metrics and perfSONAR web-services.

(\*) The L2 status MA or the SQL MA for the L2 status information need to be deployed only if the network is offering L2 circuit services to a group served by the GN2 project (the NREN has the choice of the web-services it wishes to deploy).

The Pilot Phase is followed by a Prototype phase and taking into consideration the outcome of the Pilot. The aim of the Prototype is

1. to have a larger set of networks (40% of the NRENs) offering a MDM service to the European REN NOCs, PERTs and to a limited number of projects (limited to 3), as well as offering a larger national footprint
2. to verify that the SLA offered can be respected and
3. to offer a turn key solution service to networks who don't have the resources to deploy and manage locally the MDM service.

These include issues of training, reporting and service level management that will be tested during the prototype. The Service Desk (support level1) will be provided by a dedicated team of supporters. The AA service will be available.

The tool developers will hand over the level1 support Service Desk to a dedicated support team which will operate during working hours. AA will be available. A larger set of capabilities will be provided (see **Figure 6.2**, the new capabilities are highlighted in orange). This will happen during GN2 Year4.

Service	Prototype/Functionality	
RRD MA or SQL MA	L3 link utilisation	Historical
	L3 link capacity	Historical
	L3 Interface Output drops	Historical
	L3 Interface Input drops	Historical
L2 status MP	L2 circuit status	Latest
SQL MA	L2 circuit status	Historical
Hades MA	OWD, IPDV, OWPL	Historical
	Achievable throughput (TCP)	Historical
	UDP throughput	Historical
Telnet/SSH MP	traceroute	Historical
	Delay RTT	On-demand
	show command	On-demand
BWCTL MP	Traceroute	On-demand
	Achievable throughput (TCP)	On-demand
Hades MP	UDP throughput	On-demand
	OWD, IPDV, OWPL	On-demand
Lookup Service	Service discovery	
Topology Service	Topology information	
Auth or GiDP	Authentication Service	
Autz	Authorisation Service	

**Figure 6.2:** Prototype Metrics and perfSONAR Web-services.

The Fully Operational Service, a larger deployment is expected in this phase (more countries and offering monitoring points closer to the end-users). The level1 support Service Desk may be distributed amongst several organisations. The service will be available 24/7.

The four phases representing the initial ideas on roll out. It is recognised that more detailed planning and documentation will need to be developed as part of the transition to service process

## 6.1 Pre Rollout Checklist

This section lists tasks which must be completed before rollout of an MDM service . This covers the setting up of the support infrastructure.

- Define the release management process.
  - o Set-up a CVS to store the code.
  - o Set-up a bug tracking system.
  - o Define code testing strategy.
- Define the MDM service and its constitutive web-services.
  - o Define the SLA and how to monitor it, implement it and set-up a monthly reporting system.

- Define which country will take part to which phases.
  - Define the procedure for a new user group to access a MDM service.
- Define the software support policy for the trial and the prototype.
  - Define the support procedures (level1-2-3) and clarify responsibilities with NOCs and PERT and implement them.
  - Define the documentation procedure.
  - Set-up users Information pages, Supplier information pages.
  - Provide installation, configuration and user guides.
  - Set-up a perfSONAR web-services monitoring instance.
  - Set-up a login system.
  - Set-up a system for the Request for Enhancements.
- Create the installation workshop material.

## 6.2 Timetable and Process of Transition

Below are the initial ideas that highlight the main steps that will form part of the transition to service process, a more detailed workplan will be defined as the support team is being set-up.

- Definition of the Multi-Domain Monitoring service targeting the NOCs and user groups - end of October 2006.
  - the performance data
  - the monitoring actions
  - the metadata
  - the data exchange policy.
  - the SLA
- Define Documentation Team role – end of October 2006
- RFE set-up – end of October 2006
- Monthly Reporting set-up – end of November 2006
- Define the three level of support - end of November 2006
- Set-up the release management process – end of November 2006
- perfSONAR web-services and GÉANT perfSONAR visualisation tool documentation – end of January 2007
- Develop functional test code for perfSONAR web-services and the GÉANT perfSONAR visualisation – end January 2007.
- Set-up the support team – end of January 2007
  - Login system
  - Teams

- Email addresses
- User and provider web-pages – end of February 2007
- Have the MDM service definition validated by the PERT, the APMs (NOCs) the EXEC and NREN PC - end of March 2007
- Identify which NRENs to take part to the trial –end of March 2007
- **Trial** – supplier deployment – starting early April 2007
- **Trial** – supplier deployment achieved and offer service to NOC and to a project – end of May 2007
- Define Generic end-user access – May 2007
- Support documentation and training material – end of July 2007
- **Prototype** – Set-up Level1 dedicated Service Desk – by end of October 2007
- AA integrated within perfSONAR web-services and GÉANT perfSONAR visualisation tools – end November 2007
- **Prototype** - supplier deployment – starting early November 2007
- **Prototype** - supplier deployment achieved – end of May March 2008
- **Operational** – set-up distributed Level1 support Service Desk – August 2007
- **Operational** - supplier deployment – starting early September 2008
- **Operational** - supplier deployment achieved – end of December 2008

## 7 Possible Risks

This section lists the initial idea about risks that may be encountered in the transition to service process. A risk analysis will be performed to develop further the list and to plan the actions to be covered to reduce the risks.

Risk analysis implies analysing the probability of occurrence of an event that would have a negative effect on the adoption of the MDM service by RENs and judging the impact of the event on the roll out of the MDM service. All risks must be documented and a response plan for the most important ones must be developed. All other risks are reviewed as the roll out progresses and the risk management plan is periodically reviewed, in order take note of new risks and re-assesses probability and impact of existing risks.

Probability represents the likelihood that the negative event will occur.

Impact is judged according to the implications on Schedule (S), Cost (C) and Performance (P). Some events will affect one or more of these parameters, the most typical incidence is on Cost (C) and Schedule (S). The current risk management plan for the MDM roll out has not specified in quantitative terms which risks should be dealt with, i.e. the quantitative impact on cost, schedule and performance.

The responses to risk are classified as:

- Avoid: the risk is eliminated;
- Transfer: ensure that consequences of risk are transferred to 3<sup>rd</sup> party, such as a contractor;
- Mitigate: reduce probability of occurrence or impact on cost, schedule or performance ;
- Accept: simply take note of the risk.

The risk analysis has two focuses: the pilot and the longer term. The risks and effects describes mostly the long term and the response to the risks are expressed for the pilot and prototype.

- perfSONAR web-services and visualisation tools may not be released when the Multi-Domain Monitoring Service for the deployment phase of the pilot trial. Several causes can be identified: late delivery of the some components (functionality missing), lack of documentation, functional testing not performed on time (this risk is being considered independently of the timely release of perfSONAR web-services).
  - Effect: it is not possible to start the MDM pilot trial without a minimum set of services to offer a minimum set of information, otherwise the utilisation of the MDM during the pilot would be close to nil as the users wouldn't have a critical mass of data/functionalities to make the MDM worth using. A critical mass of deployment must also be reached as the interest of a service such as the MDM is, as for a phone system, proportional to the square of its footprint

deployment. RENs need to be ensured that the web-services and tools they are deploying are reliable.

- Impact: High as without a minimum set of perfSONAR web-services and visualisation tools, the pilot trial cannot start (and thus we cannot evaluate the support infrastructure set-up).
- Impact Area: Schedule (S) of the Pilot and Performance (P) of the MDM service.
- Response to risk: AVOID/MITIGATE: A sub-set of set of perfSONAR web-services and visualisation tools have been selected as the minimum set of services needed to launch the Pilot (LS, RRD MA, SQL MA, SSH/Telnet MP, BWCTL MP, Hades MA, CNM and personarUI) based on their advancement and the added value they will bring to the users. The resources have mostly been concentrated towards the release of those services over the introduction of new features. This should allow having enough resources for the development, the documentation and the release to be done on time. The “mitigate” response comes from the functional test (see next point).
- Lack of resources to perform independent testing the software.
  - Effect: the software might be provided with bugs if not tested and the current level of resource and the setting up of automated tools for functional tests will delay the release of software needed for the pilot.
  - Impact: High as the inter-action between services might not work and bugs may deter user from using the MDM service. This would provide a bad advertisement for perfSONAR and the MDM service and may hamper further new deployments. The pilot trial might be delayed.
  - Probability: High as we are lacking of dedicated independent testing resources.
  - Impact Area: Schedule (S) and Performance (P) of the MDM service.
  - Response to risk: MITIGATE for the Pilot Prototype: The functional test team is in charge of testing three web-services. The web-services developers have been asked to test one another service to ensure independent tests over providing new functionalities. The burden of testing on the developers is quite high. For the long term, we would ideally need an independent test team not involved in the development.
- AA not available on time for the trial
  - Effect: not possible to differentiate between of users and thus offer them different view based on the group they are part of.
  - Impact: High as AA is the key service to have the MDM service widely deployed within the RENs and due to local legislation.

- Probability: High, AA not planned before July 2007.
- Impact Area: Performance (P) of the MDM service as it cannot be offered widely, Scheduling (S).
- Response to risk: MITIGATE: Prioritise the development of AA over development of new functionalities or services (resource protection service, transformation service, push interface, scheduler components). The pilot trial will be offered to a well defined group of users: the PERT and GÉANT2 consortium NOCs for which no restriction on the data and functionalities offered during the trial are needed. The perfSONAR web-services and visualisation tools instance deployed during the pilot will be announced only to them on a password protected page that only the PERT and NOC can access. This relies on the password and URL not being redistributed in the open for the duration of the pilot trial.
- Suppliers don't see enough benefit to Multi-Domain Monitoring service.
  - Effect: they don't deploy the perfSONAR web-services.
  - Impact: High as their network is not covered and end-institutions can't be reached.
  - Probability: Medium as seen from the interest rose during various meeting.
  - Impact Area: Performance (P) of the MDM service as a critical mass of deployment must be reached as the interest of a service such as the MDM is, as for a phone system, proportional to the square of its footprint deployment.
  - Response to risk: MITIGATE: (i) Refine the use cases by presenting/demonstrating/running hands-on of the perfSONAR web-services and visualisation tools so that we get feedback from users and enhance the visualisation tools so that they bring the functionalities expected based on the feedback received (tackle in particular the RENs NOC requirement. (ii) Involve international project (EGEE, eXpress, LHC) which could benefit from perfSONAR so that when interested they can ask for RENs to deploy it. (iii) Communicate properly about the advantages of perfSONAR/MDM to the RENs bosses. (iv) Work on easing the deployment of perfSONAR web-services TRANSFER: to the EXEC committee/NREN PC
- perfSONAR service installation discouraging
  - Effect: several effects possible, all abandon the installation, don't upgrade to newer versions, don't extend the geographical footprint, and don't deploy additional web-services.
  - Impact: High as it is preventing to reach a wide MDM service deployment footprint and middle term survivability of the MDM service as its interest is proportional to the square of its footprint deployment.

- Probability: High, a lot of end-institution in the US have abandoned the installation of the service and many network in Europe stop to try deploying the tools after a day of trials.
- Impact Area: Performance (P)
- Response to risk: MITIGATE for the Pilot Prototype: (i) Divert resource from development to enhance the installation process for the next release and draw conclusion from the pilot about its suitability. (ii) All the service to comply to a similar installation process. (iii) Promote the service support (how to contact them). (iii) Enable the capability of having multiple web-services instance on a single machine (this prevents installation problem and reduce the number of equipment needed, but might hamper the performances of the web-services). For the long term, the installation process will need to be enhanced and possibly an alternative solution will have to be found in the case solution brought for the Pilot and Prototype aren't sufficient.
- perfSONAR service configuration discouraging
  - Effect: several effects possible: abandon the installation, don't upgrade to newer versions, don't extend the geographical footprint, and don't deploy additional web-services.
  - Impact: Medium - the task is in the hands of the RENs installing it and requires little intervention from the developers.
  - Probability: Medium as effort have been spent to overcome this issues and as it is mostly about building configuration population scripts. The configuration task is mostly in the hands of the RENs and they only need to follow examples provided.
  - Impact Area: Performances (P)
  - Response to risk: ACCEPT: scripts for automatic configuration have been provided and can be modified but it is not possible to build universal scripts. The configurations of web-services have been simplified.
- Data stitching into a perfSONAR service discouraging or resource intensive.
  - Effect: several effects possible, all preventing to provide a wide service footprint and middle term survivability of the MDM service: abandon the deployment, don't upgrade to newer versions, don't extend the geographical footprint, and don't deploy additional web-services.
  - Impact: High as it is preventing to reach a wide MDM service deployment footprint and middle term survivability of the MDM service as its interest is proportional to the square of its footprint deployment.
  - Probability: Medium, This is mostly impact the L2 status information, less the L3 information.

- Impact Area: Performance (P)
- Response to risk: L2 MITIGATE: proper documentation need to be provided to allow the NRENs to stitch the data and this is already the case for the L2 status. Deployment meeting are organised for the L2 status..L3: ACCEPT.
- PerfSONAR Web-service and visualisation performance not sufficient.
  - Effect: the user stops using it as considered tool slow and fall back to their previous habit of only looking at the national statistics.
  - Impact: High as it result of the MDM service not being used.
  - Probability: High
  - Impact Area: Performances (P) of the MDM service
  - Response to risk: ACCEPT for the pilot and prototype: due to the limited amount of resources and as the utilisation of the MDM service and of perfSONAR web-services and visualisation tools still is in a concept proofing phase, we won't be able to put additional resources on that topic before the end of Y3. The priorities are on AA, test and on installation. For the longer term, once that the AA and the multi-LS will have been integrated within the release, the problem will have to be investigated thoroughly and solution will have to be provided (up to re-writing the services in a another programming language).
- GÉANT perfSONAR visualisation tools (and the framework behind it) not sufficiently user friendly. It is not possible to know what web-services are alive.
  - Effect: the user stops using it and fall back to their previous habit.
  - Impact: Medium. The MDM is not used.
  - Probability: High as the display are not intuitive and as several people are experiencing problem when first using them.
  - Impact Area: Performance (P)
  - Response to risk: MITIGATE: (i) user training are organised, (ii) web-tutorials on how to use the tools should be set-up, (iii) during year4, proper effort should be spend on having the tools more user friendly.
- Networks don't deploy the perfSONAR web-services or don't want to open access to the required data.
  - Effect: the MDM service is not deployed enough to be useable.

- Impact: Medium to High depending on the extend to which a REN don't provide the expected data.
- Probability: Medium.
- Impact Area: Performance (P) of the MDM service.
- Response to risk: MITIGATE: The introduction of AA and a clear categorisation of the user should help the RENs to control who can access the data.

## 8 Resources

### 8.1 In the Transition Process

The whole process as described in section 6.2 will need to be further refined, defined and documented, in particular the prototype phase. Thus the resources needed for a transition to service process will be more precisely specified as part of the process itself to be refined accordingly. The resources expected for the pre-trial and the trial are :

- Definition of the Multi-Domain Monitoring service targeting the NOCs and user groups, the SLA definition and review by the perfSONAR community, the APM/NOCs and the NREN PC – 5 person month.
- Define Documentation Team role, perfSONAR web-services documentation, GÉANT perfSONAR Visualisation tool documentation and user and supplier web site – 7 person months,
  - o It has to be noted that the initial documentation is provided by the JRA1 developers – equivalent to 6 person months.
- Update the documentation for 6 months – 2 person months.
- Set-up the release management process – 2.75 person months.
- Maintain the release management tools – 2 person months.
- Provide releases for 6 months – 1 person month.
- Develop functional test code for perfSONAR web-services and the GÉANT perfSONAR visualisation test procedures – 15 person months.
- Update the test suite and procedures for 6 months – 2 person months.
- Set-up of the monthly reporting – 3.25 person months.
- Maintain and update the service monitoring – 1 person month.
- Define the three levels of support and procedures, set up the support team – 3.75 person months.
- Run the level 1 support for a six months – 3 person months.
- Run the level 3 support for a year – 6 person months.
- Create support documentation and level1 Service Desk training material – 4 person months.
- Set-up a dedicated level1 Service Desk for the prototype phase – 2 person months.
- Organise user and supplier training – 6 person months.

Total resources for the pre-trial and for the trial: 65.75 person months. A total of 42 person month are available SA3 WI15 Y3 (23.75 person month missing). The planning of the transition to service manpower are still being refined.

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## 8.2 Estimated to Operate the Service

The whole process of supporting the services will need to be further refined defined and documented. The figures provided here are indicative of our current expectations.

Operating the Multi-Domain Monitoring service:

- Update the documentation – 4 person months
- Maintain the release management tools – 2 person months.
- Update the test suite and procedures – 4 person months.
- Run the level 1 support – 12 person months (two people full time).
- Run the level 3 support – 6 person months.
- Organise user and supplier trainings – 6 person months.
- Provide releases – 2 person months.
- Maintain and update the service monitoring – 2 person months.
- Maintain and support the release management tools – 2 person months.

Total for operating the multi-domain monitoring service: 40 person months.

## 9 Conclusions

This document presents the definition of the perfSONAR based Multi-Domain Monitoring service, the description of the service support that will be offered to the users and to the MDM suppliers as well as the process for the release of software. We currently envisage that the process of transition to service will last for 24 months, going through three phases. During the two first phases (pre-roll out and trial) the support infrastructure and processes will be refined, documented, set-up and tested. Over all the phases, the deployment footprint of the Multi-Domain Monitoring service will increase: more countries and more end-institution within a country will be covered. A risk analysis for the transition to service will also be prepared.

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- [owping]** <http://e2epi.internet2.edu/owamp/owping.man.html>
- [perfSONAR ]** <http://www.perfsonar.net>
- [RNP]** Brazilian National Research and Education Network. Home page: <http://www.rnp.br>
- [SEEREN2]** South-Eastern European Research & Education Network project, <http://www.seeren.org>
- [SVN]** [http://www.perfsonar.net/jra1-wiki/index.php/Anonymous\\_Revision](http://www.perfsonar.net/jra1-wiki/index.php/Anonymous_Revision)

## Acronyms

<b>[AA]</b>	[Authentication and authorization]
<b>[ABW]</b>	[Available BandWidth]
<b>[API]</b>	[Application program interface, a set of routines, protocols, and tools for building software applications.]
<b>[BWCTL]</b>	[Bandwidth Test Controller, a tool for establishing bandwidth; currently a wrapper around lperf.]
<b>[CNM]</b>	[Customer Network Management, a graphical user interface]
<b>[CVS]</b>	[Concurrent Versions System]
<b>[DB]</b>	[DataBAse]
<b>[DiMAPI]</b>	[Distributed MAPI]
<b>[FAQs]</b>	[Frequently Asked Questions]
<b>[GUI]</b>	[Graphical user interface]
<b>[HTTP]</b>	[Hypertext Transfer Protocol]
<b>[HTTPS]</b>	[HTTP with additional encryption/authentication]
<b>[HW]</b>	[Hardware]
<b>[ID]</b>	[Identification]
<b>[IPPM]</b>	[Internet Protocol Performance Metrics]
<b>[JRA3]</b>	[Joint Research Activities 3: Security Services]
<b>[JRA4]</b>	[Joint Research Activities 4: Development of Network Services]
<b>[JRA5]</b>	[Joint Research Activities 5: Roaming and Authorisation Services]
<b>[LS]</b>	[Lookup Service; see Section 4.4 and 4.4 for more information.]
<b>[MA]</b>	[Measurement Archive; see Section 4.3 for more information.]
<b>[MAPI]</b>	[Monitoring Application Interface]
<b>[MIB]</b>	[Management Information Base]
<b>[MP]</b>	[Measurement Point; see section 4.2 for more information]
<b>[MRTG]</b>	[Multi-Router Traffic Grapher]
<b>[MDM]</b>	Multi-Domain Monitoring
<b>[NEMO]</b>	[Network Monitor]
<b>[NMWG]</b>	[Network Measurement Working Group; part of the Global Grid Forum effort. The group has focused on developing schemas for network measurement requests and responses.]
<b>[NIC]</b>	[Network Interface Card]
<b>[NOC]</b>	[Network Operations Center]
<b>[NREN]</b>	[National Research and Education Network]
<b>[OID]</b>	[Object Identifier]
<b>[OS]</b>	[Operating System]
<b>[OSI]</b>	[Open Source Initiative]

<b>[OWAMP]</b>	[One Way Active Measurement protocol (OWAMP)]
<b>[OWD]</b>	[One-way delay]
<b>[OWDV]</b>	[One-way delay variation]
<b>[P2P]</b>	[Peer-to-peer]
<b>[PERT]</b>	[Performance Enhancement Response Team]
<b>[Q/A]</b>	[Quality assurance]
<b>[RC]</b>	[Release Candidate]
<b>[RRD]</b>	[Round robin database]
<b>[SEEREN2]</b>	[South-eastern European Research & Education Network, second generation]
<b>[SNMP]</b>	[Simple Network Management Protocol]
<b>[SOAP]</b>	[Simple Object Access Protocol]
<b>[TCMP]</b>	[Tracefile Capture Measurement Point]
<b>[UI]</b>	[User interface]
<b>[URL]</b>	[Uniform Resource Locator]
<b>[XML]</b>	[eXtensible Markup Language]

## Appendix A MDM Service – Hardware, cost and manpower indications

This section provides initial indications about the hardware, manpower effort and the cost of deploying a Multi-Domain Monitoring Service. It makes assumptions about what the Multi-Domain Monitoring Service, could be. All the figures provided in this annex are for information only and offer a potential direction to better highlight the resources of an MDM service.

In the table below, the “perfSONAR web-services” contains the type of perfSONAR web-services and the metrics and functionality that the service can offer to one or several groups of users (listed in the “MDM Service targeting” column). Some web-services are needed when offering an MDM service to any type of users (all). It has to be noted that access restrictions can be applied. The “Where?” column indicate how many web services - have to be installed and where. The “HW” column indicate the type of hardware<sup>9</sup> needed to host the web-service as well as additional equipment required and the “Cost” column give an indicative price for the hardware.

The “Installation/Configuration” column indicates the time to install and to configure the service in days per web-service. The time spent on installation and configuration will vary from one type of web-service to another one. The “Data/functionality Stitching” column indicates the amount of day needed to modify the perfSONAR few classes of the perfSONAR web-services to take into account the table of a local DB or to integrate an existing measurement tool within a perfSONAR web-services. It is not possible at this stage to provide an estimate for the manpower required for the AA component as it is under development by JRA5.

The figures will be refined during Year3.

<sup>9</sup> The Hardware platform are provided as indication. No stress tests on different platform have been conducted yet.

MDM Service targeting	perfSONAR web-Service	Where?	HW (*)	Cost	Installation/Configuration (in working days)	Data/functionality Stitching (in working days)
NOC, end-user, project	Measurement Archive Web Service (link utilisation, drops, errors)	One per network (or two for higher availability - optional)	Regular Server	4,000.00 €	2	10
NOCNOC, end-user, project	SSH/Telnet Measurement Point (Looking glass functionality)	One per network (or two for higher availability - optional)	Regular PC	1,250.00 €	2	2
NOCNOC, end-user, project	SNMP Measurement Point	One per network (or two for higher availability - optional)	Regular PC	1,250.00 €	2	2
NOC	TCP throughput and delay measurements	One per PoP	Hades/BWC TL PC (*) + GPS antenna + Interface on router or on switch + GPS installation	N PoP * (1,250.00€ + 1,000€ + one 1Gbps interfaces on the equipment (**)) + 1000€ (***)	3 per PC	0
E2E L2 Project, NOC	L2 status Web Service	One per network (or two for higher availability - optional)	Regular Server	4,000.00 €	1	20
All	cNIS	One per network (or two for higher availability - optional)	Regular Server	4,000.00 €	1	10
All	Lookup Web Service	One per network (or two for higher availability - optional)	Regular Server	4,000.00 €	1	0
All	Authorization Service	One per network (or two for higher availability - optional)	Regular PC	2,500.00 €	unknown	unknown
All	Authentication Service (JRA5)	One per network (or two for higher availability - optional)	Regular PC?	1,250.00 €	unkown	unkown

The total for the “all user” web-services needed by all network (common Network Information Service, Lookup , Authorization service and the Authentication Service):

- Cost: 3 \* 4,000€ + 2,250 €
- Installation 2 person days +?
- Stitching: 10 person days +?

For a higher availability, a resilient service is needed (the service are replicated):

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- Cost:  $6 * 4000€ + 2 * 2,250 €$
- Installation 4 person days +?
- Stitching: 10 person days +?

To provide the data to a NOC, in addition to the “all user” web-service, a Measurement Archive, a SSH/Telnet MP, an SNMP MP, one TCP throughput and delay MP per PoP (or at least per PoP of importance for the users)

- Cost:  $3 * 4,000 € + 3 * 2,250 € + N * (1,250€ + \text{router/switch interface} + 1000€ + 1000€)$ , N being the number of location that will be equipped (ranging from 1 to the number of PoP).
- Installation: 5 person days +  $N * 3$
- Stitching: 14 person days

For higher availability, the Measurement Archive, a SSH/Telnet MP, an SNMP MP should be replicated. This would give:

- Cost:  $6 * 4,000€ + 6 * 2,250 € + N * (1,250€ + \text{router/switch interface} + 1000€ + 1000€)$ , N being the number of location that will be equipped (ranging from 1 to the number of PoP).
- Installation: 8 person days +  $N * 3$
- Stitching: 14 person days

To provide L2 data, you need a web-service providing L2 status data in addition to the “all user” (which could be doubled for higher resilience).

- Cost:  $1 * 4,000€$
- Installation 1 person days
- Stitching: 20 person days

Additional manpower to monitor and report on the MDM service availability (estimated to 5 days initially), maintain the web-service and provide a level2 support for the web-services deployed (estimated to 10-20 days a year) within the network is also expected.

(\*) Hades/BWCTL PC configuration (or equivalent) :

- one Pentium4 mainboard
- with two 10/100/1000MBit onboard network cards
- one Intel® Pentium4 3,0 GHz CPU
- 512MB DDR-RAM main memory, PC400, ECC (2 x 256MB)
- one 80GB hard disk drive,
- Three year support

Regular Server

- Dual CPU card

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- 4 x 1Gb memory
- with two 10/100/1000MBit onboard network cards
- 2 x 73GB SAS disk, DVD
- Three year support.

(\*\*) The interface expected at fist are 1Gbps, but with the evolution of the technologies and of the user requirements, some will be upgraded to 10Gbps. Going for a 10Gbps solution would imply using more powerful PCs with bus capable of dealing with 10Gbps in a single flow.

(\*\*\*) During the installation on GÉANT, the cost varied from 60€ for the cable to 1,200€ when the work had to be carried out by a company mandated by the carrier hotel tenant). In some country, local legislation may impose a yearly tax on the antenna outside a building.

## Appendix B Description of JRA1 and perfSONAR

The main objective of JRA1 is to define and develop a monitoring and measurement capability to allow individual users, or user groups, to understand the performance of the multi-domain network infrastructure which they use. In the first two years of the GN2 project, JRA1 has focussed its efforts on the design, development and prototyping of “perfSONAR” (Performance oriented Service Oriented Network monitoring Architecture) web-services, with the principal objective of integrating existing measurement tools and measurement databases within those web-services. Visualisation tools, to allow users to see graphical representation of network performance, making use of functionalities provided by web-services have also been developed. The developments have followed a three layered architecture known as the “General Framework Design” which was defined at the beginning of the project. The first layer consists of the measurement tools and databases in place within the networks. The information and functionality provided by those measurement tools and databases are typically not available outside the administrative domain of the network and there is, today, considerable variation in the ability of individual users to access them. The second layer sits on top of the measurement tools and databases. It consists of perfSONAR web-services which provide a ubiquitous access to the measurement tools and databases. Finally the third layer consists of visualisation tools and alert tools making use of the perfSONAR web-services layer. The work has gone beyond the development of the tools and services, and has also included their prototype deployment within different networks.

The work is done in collaboration with ESnet (USA) and Internet2 (USA). More recently, RNP (Brazil) has also joined the development.

In order to carry out performance measurements, twelve measurement boxes, capable of measuring “one-way delay” and TCP throughput, have been installed in different European locations to form a mesh of measurements between selected locations. The data so measured are retrievable through a tailored perfSONAR Measurement Archive web-service. Fourteen Measurement Archives web-services forming a Round Robin Database (RRD) providing link utilisation and link capacity have been installed in 13 networks across Europe, North and South America. A Round Robin Database is one of the most commonly used databases by Research and Education network operators to store performance information such as link utilisation.. It aggregates the data over time, so that the database doesn’t increase in size over time. Two perfSONAR Lookup web-services have also been installed to indicate to users which perfSONAR web-services are available, what their capabilities are (in term of measurement functionality or data) and the locations where they can be found.

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The perfSONAR web-services and the visualisation tools developed will serve as a base to provide a Multi-Domain Monitoring (MDM) service to users. It is the intention to offer this measurement framework as a “supported” service for users. This deliverable considers the issues raised in making the transition from the current development activity to a supported service.

## B.1 What is perfSONAR?

perfSONAR has **three** contexts:

- perfSONAR is first a “consortium” of [organizations](#) who seek to build network performance middleware that is **interoperable across multiple networks** and useful for intra- and inter-network analysis. One of the main goals is to make it easier to solve end-to-end performance problems on paths crossing several networks
- perfSONAR is a **protocol**. It assumes a set of roles (the various [service types](#)), defines the protocol standard (syntax and semantics) by which they communicate, and allows anyone to write a service playing one of those roles. The protocol is based on SOAP XML messages and following the Open Grid Forum ([OGF](#)) Network Measurement Working Group ([NM-WG](#)).
- perfSONAR is, finally, an example **set of code** (implementation of services) that attempts to implement an interoperable performance middleware framework. Those sets of code are developed by different partners. Some pieces of code are “more important” than others because their goal is to ensure interoperability between domains (e.g. the Lookup Service and the Authentication Service). Different subsets of code are important to each partner, with a great deal of overlap. The services developed acts as an intermediate layer, between the performance measurement tools and the diagnostic or visualization applications.

## B.2 Services Overview

As mentioned above, the main goal of JRA1 is to deploy a measurement framework (perfSONAR) for accurate Internet traffic measurement and monitoring. To support end-to-end network monitoring across geographically distributed domains (GÉANT2, NRENs) and for different user groups (NOC/PERT, projects, end users), JRA1 provides a framework that is based on distributed perfSONAR web-services.. These provide a common interface for applications to interact with different monitoring tools and allow users to obtain and manipulate measurement data. This allows a user of the framework to obtain a “global” view of the network performance. This enables a user to effectively troubleshoot network performance problems by accessing the available data collected from the various geographically distributed domains.

The perfSONAR framework has a modular architecture, allowing services to be added, removed, or replaced relatively easily. This is possible because perfSONAR is designed as a co-ordinated collection of web-services and visualisation tools. The framework is realized by a set of base services, which are:

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- Measurement Point web-service (MP): invoked measurement tools
- Measurement Archive web-service (MA): databases of measurement data
- Lookup web-Service (LS): “Yellow Pages” to find perfSONAR services
- Authentication Authorisation web-Service (AA): defines roles for users

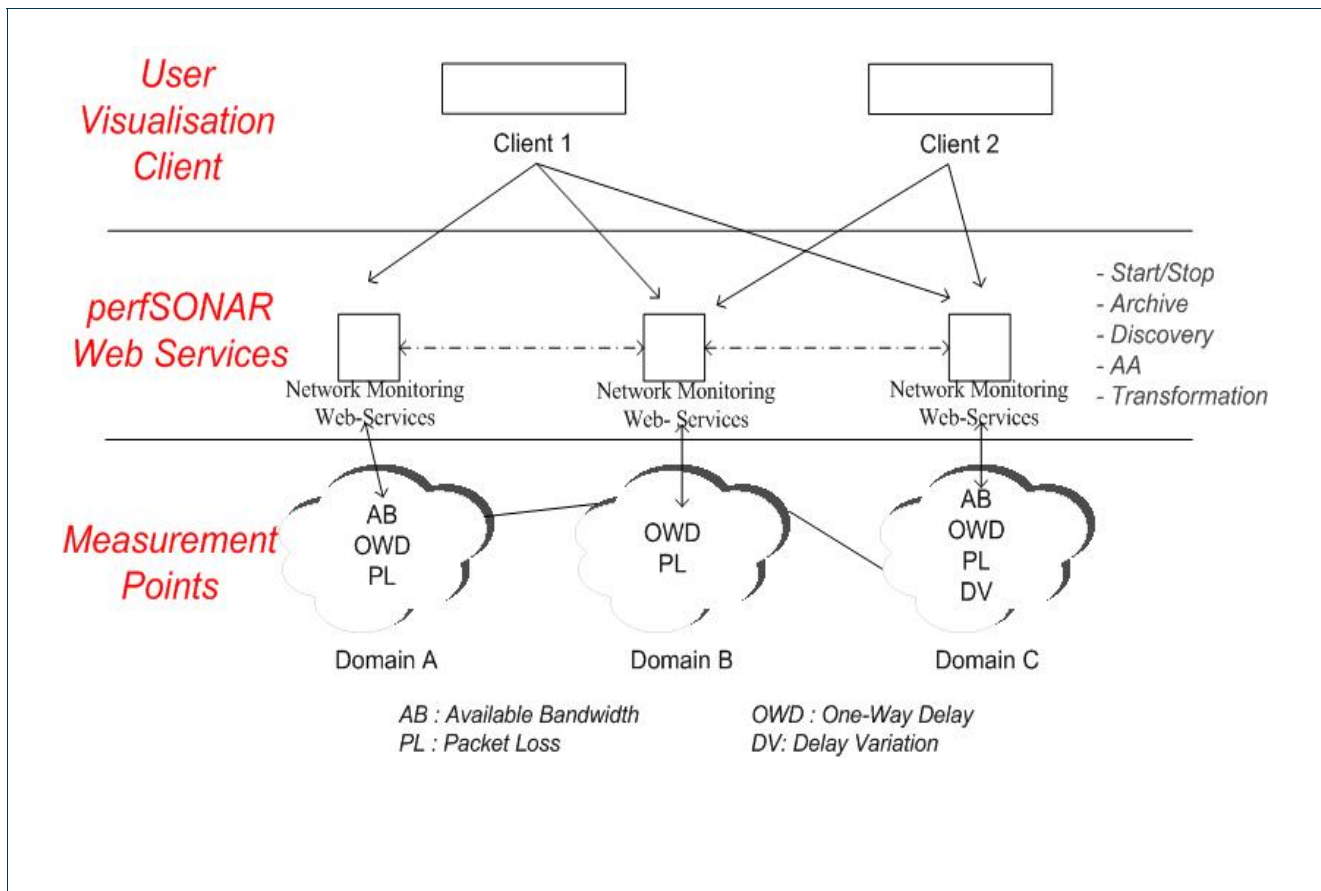
These web-services can be accessed via user visualisation tools, which are:

- personarUI: visualisation of performance data
- CNM: “Consumer Network Management” visualisation of topology and utilization data

PerfSONAR is flexible enough to exploit different specialized measurement tools and manipulate archived data (possibly with the use of additional services). The communication between a client (e.g. a visualisation tool) and a web-service or between web-services uses the well-established mechanism of SOAP XML messages implemented using the Global Grid Forum’s (GGF) Network Measurement Working Group (NM-WG) schema specification.

### B.3 Structure of perfSONAR

The PerfSONAR framework implements a front end for various measurement tools and archives for measurement data. This creates a level of abstraction, enabling perfSONAR clients to access these various data in a standardized format, independent from their original data format, or tool specific interface for using a measurement tool. The perfSONAR web-services will be described separately in the following sections and an overview of the perfSONAR is highlighted with the following picture.



**Figure B.1:** perfSONAR model overview

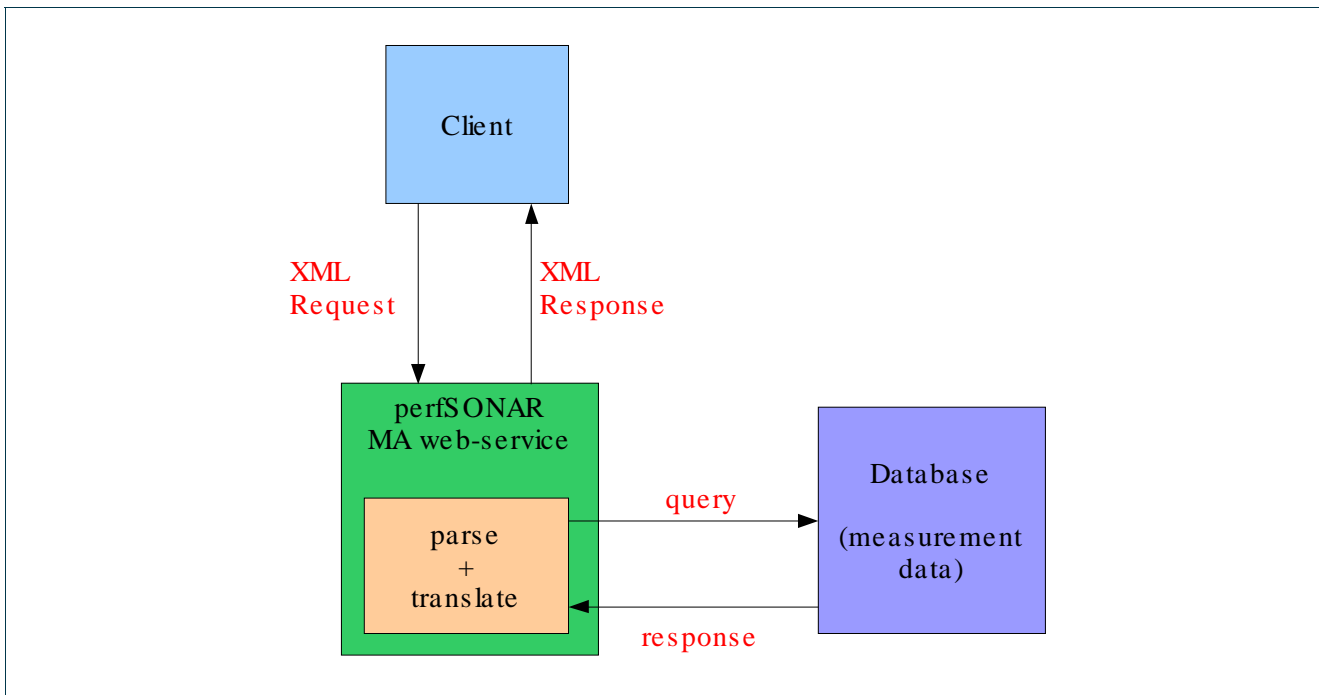
In **Figure B.1:** perfSONAR model overview, the different networks (Domain A, Domain B and Domain C) have deployed tools and databases providing different types of data and functionalities (AB – Available Bandwidth, PL – Packet Loss, OWD – One Way Delay and DV – Delay Variation). The tools or databases used vary from network to network. This is a major reason why multi-domain monitoring is not straightforward. Above those monitoring tools and database sits the perfSONAR web-services. These web-services provide an abstraction layer from the type of measurement tools and database deployed by a network for the user visualisation tools. The third layer corresponds to the visualisation tools. The visualisation tools can access in an ubiquitous way the monitoring information and functionalities from multiple domains thanks to the perfSONAR web-services.

### B.3.1 Base web-services

The following perfSONAR web services are described below

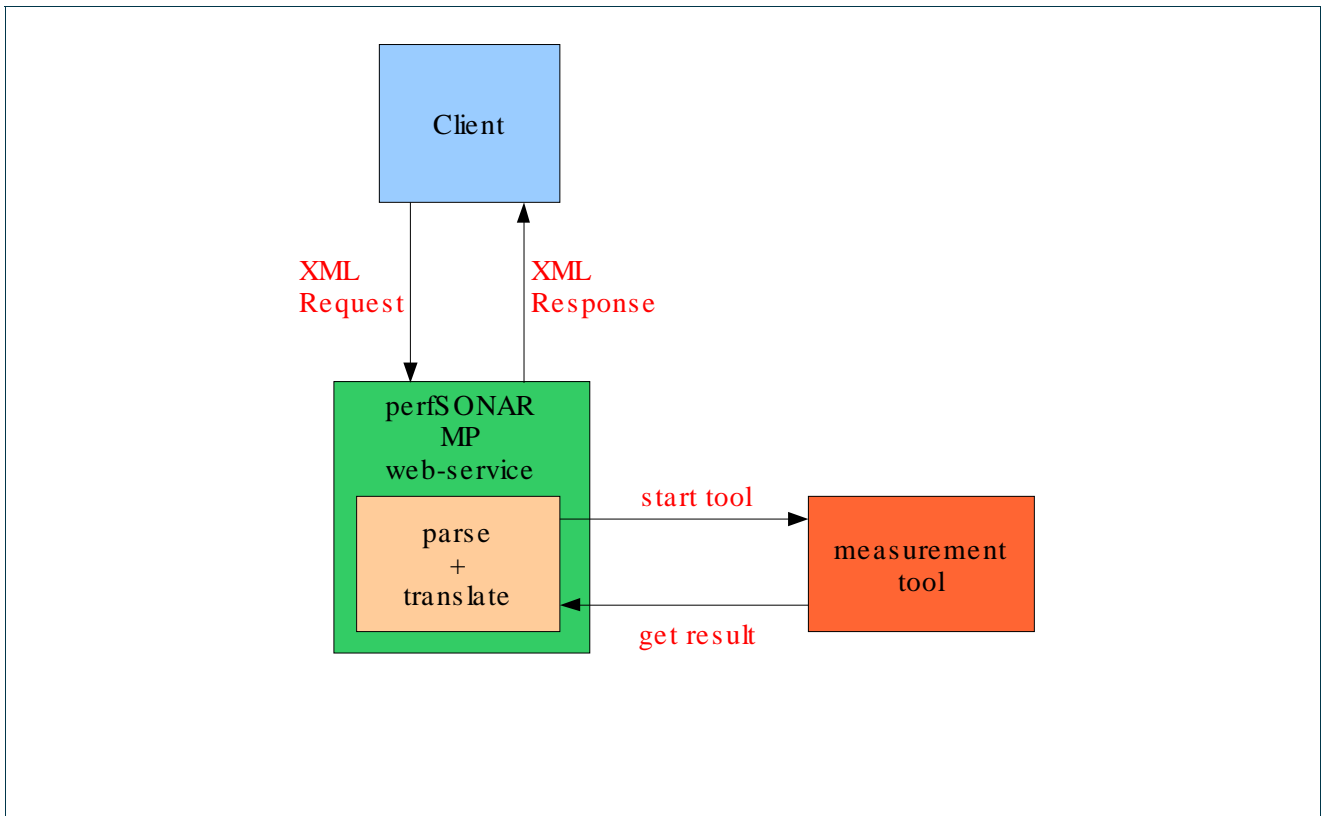
- Measurement Archive web-service: A Measurement Archive is a web-service providing access to measurement data stored in a database (e.g. SQL or RRD). The data can be accessed via XML requests, which specify the data set in a standardized way by using metadata definitions. These metadata include the end points of the measurement, the start and end time of the measurement and various parameters,

such as the IP version, the type of service being used, packet size, etc, which define the data to be collected as the object of the measurement. The request is parsed and translated into a database language request and the database is queried. If the requested data is stored in the database, the PerfSONAR service gets back the data from the database and provides the data to the user in a defined XML data format corresponding to the sent XML request; otherwise it returns an error message.



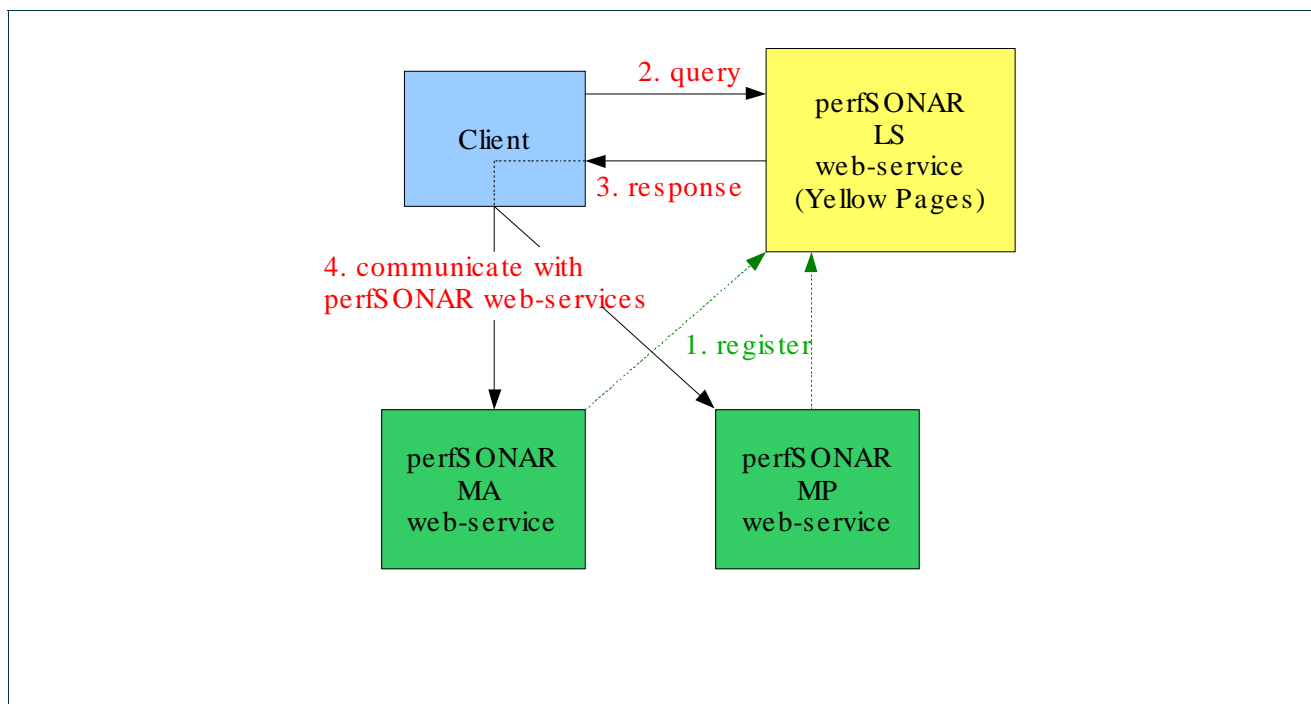
**Figure B.2:** Request/response schema of perfSONAR MA web-service

- Measurement Point web-service: A Measurement Point (MP) is a web-service providing access to the functionality of a measurement tool, allowing the user to run on-demand tests. If the perfSONAR Measurement Point web-service receives a request for a measurement, it parses the request and translates it into a measurement tool command and invokes the measurement tool. It then returns the results in a defined XML data format. MP web-services do not store or transform existing data, but have the capability to push them into an existing Measurement Archive web-service.



**Figure B.3:** Response schema of perfSONAR MP web-service.

- Lookup web Service (LS): To find available MA and MP web-services, which could be geographically distributed across the whole world, it is essential to have a “known point of information service” (a kind of “Yellow pages” for perfSONAR web-services). The web-services register in the Lookup webService (LS) (see Figure B.4 step 1). The LS register the perfSONAR web-services which have send registration information. A user queries (see Figure B.4, step 2 and 3) the LS to discover the existence and the location of MAs and MP web-services and their functionalities. Once the web-service location is known, the client can communicate with the web-service (step 4).



**Figure B.4:** Client asking LS web-service for MA and MP web-services location and capabilities

### B.3.2 Measurement tools and archives

PerfSONAR serves as an interface to various measurement tools and data archives. It is possible to integrate any existing measurement tool or archive by providing a data format description in the Network Measurement Working Group (NM-WG) for this new tool or archive. As part of JRA1 existing measurement frameworks were integrated (e.g. the Hades < one-way-delay, one-way-delay-variation and packet loss measurement framework or a Measurement Point implementation for TCMP). In principle, every measurement tool or archive can be interfaced to the perfSONAR framework by implementing the access interface. Thus, PerfSONAR is not limited to the services provided by JRA1 itself but can be used by other developers to offer their own tools with a perfSONAR interface as well.

### B.3.3 Visualisation tools for accessing the data

For the users of such a monitoring framework, the data is made accessible by several visualisation tools. The JRA1 developers provide two tools, the “Customer Network Management” (CNM) a web client and the perfsonarUI, both visualising data from currently deployed Measurement Archives. As the interface to perfSONAR services is standardized, it is possible to develop customized monitoring applications, easily accessing perfSONAR services with a single interface.