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Deliverable D8.5 (DS4.1.2): Model for perfSONAR Integration with Wider Management Systems

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Abstract

A model for integrating perfSONAR with wider management systems is presented which shows how the multi-domain monitoring service could be integrated with a network management system or set of network monitoring tools, with other services, tools and applications, or for use by an end-user.

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Executive Summary

This document presents a model for perfSONAR integration with wider management systems.

At present, perfSONAR is available in two “flavours”: perfSONAR-PS – suited to End-to-End monitoring, and perfSONAR MDM – suited to performance evaluation along multi-domain crossings. This document focusses on perfSONAR MDM (Multi-Domain Monitoring), which today is implemented in 55 installations and 30 networks and is mostly installed as a stand-alone tool working independently of the network monitoring tools used to examine and manage the network.

A recent analysis by SA4 T1 and SA4 T3 of the use of perfSONAR MDM, presented in a Workshop at the 2013 GÉANT3plus Symposium [pS_future] [pS_survey], identified three different contexts in which the tool could be used. This document presents a model for the integration of perfSONAR in the following scenarios:

- Used with a network management system (NMS) in a single network, an NREN or a multi-domain network.
- Used for monitoring the performance of another service/tool /application or its individual components.
- Used for performance measurements by an end user, or from one user towards a measurement point in the perfSONAR measurement points network.

The model presented in this document could be of assistance in current and future implementations of perfSONAR.

1 Introduction

perfSONAR is a service that enables NREN Network Operation Centres (NOCs) and Performance Enhancement Response Teams (PERTs) to collaborate in providing seamless network performance, working together to identify, prevent or solve performance issues for network users.

The development of perfSONAR began during the GÉANT2 project and has continued through the GN3 and GN3plus projects. Although initially developed as a joint collaboration with ESNet and Internet2, the work of the two teams later led to the evolution of perfSONAR in two different directions ("flavours"): perfSONAR-PS (developed by ESNet and Internet2) and perfSONAR MDM (developed within GÉANT projects). From the user and data collection perspectives the perfSONAR-PS solution follows more decentralised model, with local user control panels and a data store associated with each Measurement Point, whereas the perfSONAR MDM solution relies on central management model, with User Interface for MPs and data retrieval and a centralised data store for each type of measurement.

perfSONAR MDM [pS_home] [pS_docs] has been installed in several networks for many years. Based on the survey conducted in September 2013 among perfSONAR users, the tool is mostly used for on-demand achievable bandwidth measurements and on-demand one-way delay measurements. It is also used to access historical measurement data, such as historical one-way delay measurement data, jitter, achievable bandwidth, traceroute, historical one-way packet loss, input/output errors and interface utilisation.

In several cases, perfSONAR was used as a stand-alone tool, separate from the network monitoring system (NMS) of the network. perfSONAR was used by the network operations team for overall network performance monitoring, for troubleshooting specific network connectivity performance issues or for verification of agreed network connectivity speeds. Network operations teams usually have a range of tools, with best practices indicating that they should be closely integrated in the network monitoring system. As a way of achieving an improved uptake of perfSONAR, this approach is clearly worth exploring.

Recently, there was a drive to promote the use of perfSONAR in research communities such as LHCONE, EGI, or XiFi [D8-2_DS4-1-1]. For such an implementation, perfSONAR would be required to test network performance from the perspective of a member of the project that uses the network as the underlying (i.e. transport) layer for their activities. Such an approach does not necessarily require the same method and the same "flavour" of perfSONAR as in the case of using perfSONAR to monitor the core network.

Proposed models for all three aspects of perfSONAR usage – integration with a network management system; performance monitoring of other services/tools/applications; and monitoring the network from an end-user perspective – are presented in Section 2. Conclusions are presented in Section 3.

2 Integrating perfSONAR with Wider Management Systems

perfSONAR is an infrastructure for network performance monitoring, making it easier to solve end-to-end performance problems on paths crossing several networks. It contains a set of services delivering performance measurements in a federated environment. These services act as an intermediate layer, between the performance measurement tools and the diagnostic or visualisation applications. This layer is aimed at making and exchanging performance measurements in between, using well-defined protocols.

perfSONAR is based on a services-oriented architecture software design. This means that the set of elementary functions has been isolated into different components called 'services', which can be provided by different entities to accomplish the functionality of a large scale performance monitoring solution.

In the original vision of perfSONAR as a protocol, a valid approach to integrating it in a Network Management System (NMS) would have happened by encouraging the developers of this system to implement perfSONAR interfaces in order to use it as a data source. In practice however, such an approach proved to be unsuccessful and there was a need to make the connection between perfSONAR and NMSs within the service infrastructure, rather than as an external interface. For this approach, a new integration model was required.

The proposed model covers three distinct environments of perfSONAR use. It is:

- Used with a network management system in a single network, an NREN or a multi-domain network.
- Used for monitoring the performance of another Service/Tool/Application or its individual components.
- Used for performance measurements by an end user, or from one user towards a measurement point in the perfSONAR measurement points network.

The models presented in this document could help current and future perfSONAR implementers to make perfSONAR a useful contribution to network management. In all these instances, perfSONAR should be stable, easy to install, easy-to-use and well supported.

2.1 perfSONAR Integration with a Network Management System

In the case where perfSONAR is installed as a support monitoring tool, either by an NREN or in a multi-domain network, integrating the perfSONAR components into an existing NMS or Set of Network Monitoring Tools (SoNMT) could be beneficial for the network operations team.

The benefit can be in the form of a reduced number of components that need to be maintained and developed (since individual components can be reused) and there is a unified user interface.

Although network monitoring is well defined in standardisation documents, through different monitoring categories [ITU-T_Rec_M.3400] and the business processes that it should cover [TMF_GB921], network monitoring systems or toolsets differ from network to network. A survey was conducted, about the current organisation of NREN NOCs and the tools that are used for their everyday work by the TERENA Task Force Network Operations Centre (NOC) in 2012 [Survey_analysis]. The survey results have shown that there is no universal network monitoring solution that can fit any network; equally, there is no universal solution for the integration of perfSONAR with a NMS or SoNMT.

Currently the perfSONAR suite allows for various deployment scenarios ranging from a strictly private deployment scenario for an organisation with private pS UI, pS MPs and MAs, to an open solution, where public pS MPs are shared and managed by a single instance of pS UI, possibly even without a dedicated MA.

Regardless of the perfSONAR deployment scenario, potential perfSONAR integration with the rest of the Network Management System (or SoNMT) is shown in Figure 2.1.

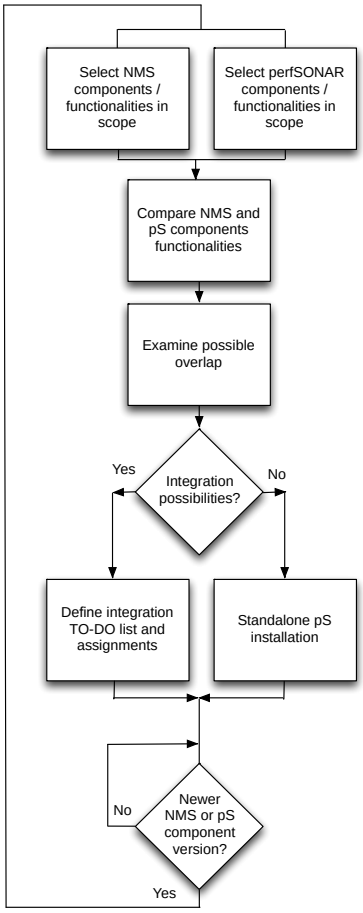

Figure 2.1: Model for integrating perfSONAR for NMS or perfSONAR component versions.

The first step is to define the network monitoring tools within the NMS and compare them to perfSONAR components' functionalities. Integration possibilities should be examined for any overlapping areas and an integration to-do list and assignments should be defined, together with the time frame. If there are no overlapping areas, or integration is not possible, then perfSONAR may be installed as a stand-alone tool.

There is no universal solution for perfSONAR—NMS (SoNMT) integration, but still four different possibilities for integration are identified:

- Integration with the perfSONAR User Interface.
- Integration based on perfSONAR protocol for message exchange between components.
- Using perfSONAR as a common source of status information for the NMS (SoNMT).
- A comprehensive Network Status Application.

These four scenarios are discussed below in Sections 2.2 to 2.5.

2.2 Integration with the perfSONAR User Interface

The following approaches to integration engage the User Interface (UI), specifically, the perfSONAR UI:

- Providing direct access to specific measurements from specific time slots and/or specific sets of interfaces (such as providing unique URLs for opening a specific metric for a specific time slot). Such an approach has already been successfully implemented for on-demand measurements in perfSONAR.
- Providing a means for specialised/customised views like metrics related to a specific network segment, path or other points of view, as required.
- Integration with the NMS or the Set of Network Management Tools (SoNMT). An example of this would be the integration with the circuit-monitoring tool, CMon [CMon].
- Automated generation of alerts, emails or action tickets in a ticket reporting system, although such a solution lacks versatility and no specific plans are considered in this direction.

Any combination of the above points is expected to be of benefit to perfSONAR partners and users, and could be extended when requirements from a specific NMS are assessed.

2.3 Integration based on perfSONAR Protocol Message Exchange between Components

perfSONAR, has been designed with inter-process communication in mind, which should ease interoperability between different implementations (so-called “flavours”) of perfSONAR. This approach also helps in interfacing perfSONAR components with any network-capable system, ranging from command line scripts (as used by experienced perfSONAR users) to more complex and application-specific solutions, which may require network status monitoring based on active or passive measurement. Currently, all communication between the components of pS-MDM is based on the strictly-formatted XML messages known as the perfSONAR protocol. Any service or user sending a correctly formatted message to the respective service will receive an XML response with the results of the requested measurement, if there is one, or an indication that it was unsuccessful. A NMS using such a message exchange would be able to gain information about the clients’ MPs, the Lookup service and the currently supported Measurement Archives of pS-MDM – RRD-MA (for interface statistics), SQL-MA (for achievable bandwidth measurements) and HADES-MA (for latency measurements) – from all perfSONAR services, except the perfSONAR UI.

An immediate solution here would be to prepare a set of example queries in order to support users and partners in their first attempts to make use the full power and flexibility of the perfSONAR suite. These queries could then become the basis for the more complex network status evaluation application outlined in section 2.5.

2.4 Using perfSONAR as a Common Source of Status Information for the NMS or SoNMT

One of the best ways to integrate with the majority of NMSs is to implement a facility in perfSONAR components that would allow them to act as recognised measurement data resource. The widespread deployment of the SNMP standard makes it the most suitable choice for integration with perfSONAR. Such an implementation would then act at a lower level than even perfSONAR protocol messages. From the perspective of the perfSONAR suite making active measurements, there are two different approaches to acquiring network status information, these are: using SNMP traps, and acting as an SNMP resource.

2.4.1 Using SNMP traps

perfSONAR can be developed to use SNMP traps to generate alerts about events in the network. Unlike the network monitoring systems that use SNMP traps to keep informed about events based on passive information about the network (and which can, on their own, be unreliable), perfSONAR can combine the SNMP traps' alerting mechanism with the active measurements that it currently provides to create additional sources of information about the network. This requires that the perfSONAR team develops and implements features for all client measurement tools with a specific configuration for each of them, which allows different thresholds for each requested SNMP trap to be defined. Thus each processed measurement would be assessed and corresponding alerts generated to the wider management systems. Implementation details and security implications would be left to the user who sees potential in such integration.

2.4.2 Acting as an SNMP resource

perfSONAR MA components that store and expose the collected measurements could also act as an SNMP resource for wider management systems. This would, in contrast to the previous solution, employ the SNMP polling mechanism to provide the current status of executed measurements and their results. An NMS would then be able to query perfSONAR for the latest measurement data and use that data to plot a history chart or draw trends. This only works with MA components where time-series data is available, since SNMP polling agents cannot wait for a new measurement to be taken when it queries an MP in real time.

In this second approach, the perfSONAR team would first need to define a new SNMP Management Information Base (MIB) so that unique Object Identifiers (OID) can be used to unambiguously query the MA about the stored measurements. This MIB would need to be versatile and extensible enough so that any type and number of measurements stored in the MA can be made available to the SNMP client.

2.5 perfSONAR as a Comprehensive Network Status Application

A comprehensive network status evaluation application would require a stand-alone application that evaluates the network status based on a more complex set of network metrics, over time. This would be based on regular evaluations of the network status, including stored measurements within perfSONAR Measurement Archives. The formula for evaluating the network status would not be limited to the results from current active or passive measurements on clients, but could be broadened to include the results from historical measurements stored in the respective MAs, comparing them to results from different MPs as well.

Typical application examples are:

- Evaluating the status of a specified point in the network, based on a time-series of metrics for an MP.
- Evaluating the status of a specified path or a network segment based on a combination of time-series and different types of metrics from interconnected MPs.

Such an application would require more research and design consideration before it could be implemented and is not in the scope of GN3plus SA4 T1.

2.6 perfSONAR for Performance Monitoring of other Services/Tools/Applications

Important single- or multi-domain services, applications and/or tools should be monitored to check that they are performing the functions they were designed for. Monitoring should cover fault-finding as well as performance indicators, security, configuration and accounting. Since perfSONAR supports active monitoring, it should be possible to extend it to monitor the IP network performance of selected services, tools and applications, of individual components or of the links within such systems.

As before, the same model can be applied for this case but with one small difference. In the first case it is known that perfSONAR can be installed as a stand-alone tool; in the second case, it is not known (without a thorough analysis) if perfSONAR can be used at all, including, in the case where integration is not possible, if it can be used as a standalone tool. Therefore, the model presented in Figure 2.2 is slightly expanded to require a test of perfSONAR's applicability as a standalone tool. Again, functionalities of services, tools and applications should be defined, analysed against perfSONAR functionalities and overlapping areas examined for potential integration and optimisation.

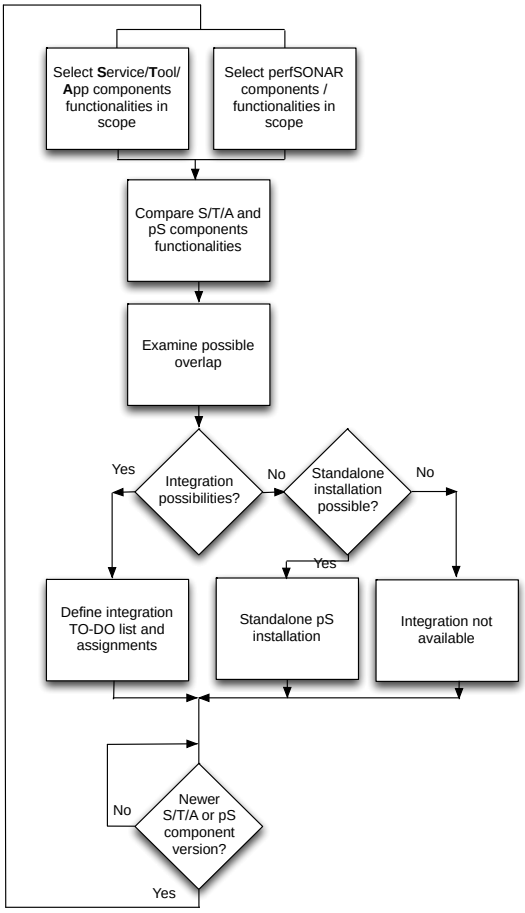

Figure 2.2: Model for Integrating perfSONAR for performance monitoring of other Services, Tools and Applications

Once the initial analysis is performed, a decision is made for the feasibility of integration. The analysis is repeated if there are any changes to perfSONAR functionalities, design changes, or any of the services/tools/applications under consideration are changed.

As with the first case, possible integration areas are:

- With the perfSONAR User Interface.
- With the use of perfSONAR protocol for message exchange between components.
- With a common use (or integration) of MPs or the MA.
- With the use of SNMP traps to monitor and produce alerts about performance changes from, or between individual components.

Note that a further round of analysis is needed for each case of integrating perfSONAR with a service, tool, or application.

2.7 perfSONAR for End-Users

Tailoring perfSONAR to suit the needs of end-users is different from the other two scenarios where overlaps between perfSONAR and other systems are examined as a basis for their integration. In this case, end users (rather than NOC specialists) would use perfSONAR as part of their everyday routine as the tool for testing the performance of their network connectivity.

A typical scenario for such an implementation is with end users as participants of a multi-domain, world-wide project, who for their everyday activities use the network as an underlying platform for their work and business processes. As such, the network is not their main focus (or does not have to be their main focus), but is a transport medium for their work and the results of their work.

The assumption is that such end-users will use their personal devices to access the network, and are interested in high-quality connectivity towards another project participant, possibly in another country, or in an important service running over the network. Each interested user should have a perfSONAR client that can be started from their personal networking device. This client should be able to test the performance towards either another user with a similar perfSONAR client, or towards an existing perfSONAR MP. Users should be able to initiate measurements from their end, and be able to view the measurement results on a graphical user interface.

This implementation could be carried out using the preconfigured virtual appliance, simplifying the deployment of a perfSONAR MP. Note that this model is not one of integration with the NMS or SoNMT, but it could be considered a form of integration with the wider management systems.

3 Conclusions

The Deliverable presents three possible scenarios for the implementation of perfSONAR into wider management systems:

- Used with a network management system in a single network, an NREN or a multi-domain network.
- Used for monitoring the performance of another Service/Tool/Application or its individual components.
- Used for performance measurements by an end user.

The first and second scenarios assume an integration with other software components, either with the NMS used for the monitoring and management of a single- or a multi-domain wide area network. The third scenario presents how perfSONAR can be incorporated into an end-users' everyday routine when examining the performance of the network.

In order to consider the integration of perfSONAR with wider management systems, the functionalities of individual components within these systems should be determined and then compared with individual components of perfSONAR. Since they can differ from one network to another, it is not possible to provide a universal solution. Instead, the integration approach must proceed on a case-by-case basis. However, given the current perfSONAR architecture, possible areas of integration can be via the perfSONAR UI, via the perfSONAR protocol for message exchange or via using perfSONAR as a common source of status information for SNMP-based systems.

The second possible integration of perfSONAR is to monitor the performance for software tools, applications and services. Primary services that come to mind are those developed or used within GÉANT projects or within the GÉANT community. In order to be able to define how perfSONAR is able to interoperate with those services and how it can be integrated, a thorough analysis needs to be performed. This document provides a model of the approach that can be taken to perform such an analysis. As with the first case, a possible integration can be seen in MP/MA structures, in the data representation, the use of SNMP traps and the use of perfSONAR protocol for message exchange. An individual analysis is needed to determine the best way to integrate for any particular case.

The use of perfSONAR by end-users should enable easier performance measurement from a desktop towards any measurement point in the network. This is a way of integrating perfSONAR into other user communities that have a single or a small number of measurement points, and that rely on an underlying network operated by other teams or organisations, as is the case with the European Grid Infrastructure (EGI) and similar projects.

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Glossary

EGI	European Grid Infrastructure
EGI.eu	The EGI website (www.egi.eu)
ESnet	Energy Sciences Network
Internet2	A consortium led by over 200 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies
LHCONE	LHC Open Network Environment
LHC	Large Hadron Collider (at CERN)
MDM	Multi-Domain Monitoring
MIB	Management Information Base
MP	Measurement point
MA	Central Measurement Archive
NMS	Network Management System
NOC	Network Operation Centre
NREN	National Research and Education Network
OID	Object IDentifiers
perfSONAR	Performance focused Service Oriented Network monitoring ARchitecture, an international collaboration for network monitoring
perfSONAR-PS	An open source development effort to create a collection of easy-to-use and easy-to-install perfSONAR network performance monitoring services and tools
perfSONAR UI	perfSONAR user interface
PERT	Performance Enhancement and Response Team
RRD	Round Robin Database tool
SoNMT	Set of Network Monitoring Tools
SNMP	Simple Network Monitoring Protocol
URL	Uniform Resource Locator, a string of text used by Web browsers to locate documents and other resources
XIFI	XIFI is a project of the European Public-Private-Partnership on Future Internet (FI) supported by the Seventh Framework Programme
XML	Extensible Markup Language