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White Paper: PMP OAV Architecture Analysis

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Abstract

The Performance Measurement Platform (PMP) is a distributed measurement platform consisting of small nodes with pre-installed perfSONAR software. It performs regular measurements towards selected measurement points and includes central components such as a Measurement Archive and a Dashboard. This document analyses the mapping of the PMP service architecture to the TM Forum's Open Digital Architecture to provide a standardised view of the orchestration, automation and virtualisation components and implementations within the service.



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Executive Summary

This document analyses the mapping of the Performance Measurement Platform (PMP) architecture to the TM Forum's Open Digital Architecture (ODA), with the aim of providing a standardised view of the service's orchestration, automation and virtualisation (OAV) components and implementations.

The PMP service is a platform consisting of central components and a set of small nodes that perform regular active performance measurements towards several Measurement Points (MPs) located in the core of the GÉANT network, and operated by the GÉANT network operations centre. The PMP operational team maintains an instance of the Maddash dashboard [\[PMD\]](#) for visualising performance testing between the PMP service instances in NRENs and GÉANT PoPs.

PMP incorporates different tools for different functionalities and components. Using a common reference architecture to analyse this network monitoring platform from the point of view of orchestration, automation, and virtualisation helps enable a better understanding of the system, identifying commonalities in the way these various functionalities and components are implemented, as well as a cross-comparison with other platforms, which in turn promotes future interoperability and integration.

1 Introduction

The **Performance Measurement Platform** service consists of low-cost hardware nodes with pre-installed perfSONAR software, deployed in GÉANT collaborating organisations in Europe and Africa, and central components including a central Measurement Archive (MA) and a Dashboard.

The small nodes perform regular measurements towards a few Measurement Points located in the core of the GÉANT network, which are operated by the GÉANT network operations centre. The central components that manage the platform elements gather, store and represent the performance data. These components are operated and maintained by the PMP operations team in the GÉANT project. Users of the small nodes can shape the predefined setup and configure additional measurements to suit their needs as they become more familiar with the platform.

The PMP operations team maintains an instance of the Maddash dashboard for visualising performance testing between PMP service instances in NRENs and GÉANT PoPs.

Figure 1.1 depicts the PMP service architecture and main components.

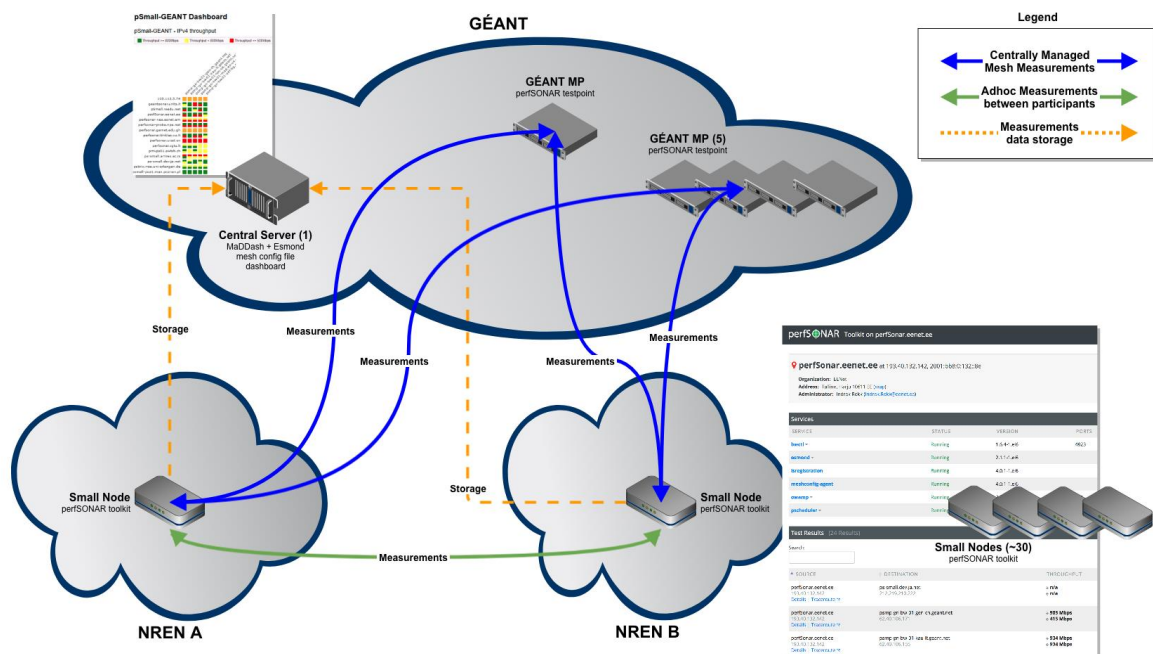


Figure 1.1: PMP service architecture

PMP service users are GÉANT collaborating organisations in Europe and Africa (NRENs or connected institutions). When users join the PMP service they typically receive a low-cost hardware node (Intel-based miniPC with 1GE interface) with a pre-installed and pre-configured perfSONAR Toolkit software. The responsibility of the hosting organisation is to assign an IPv4/v6 address and to connect the node as close as possible to the border router and keep it operational over time. Sometimes users are also asked to perform hands-on tasks locally, such as

plugging and unplugging the node from the network or changing a disk. (As the service has evolved, some hosting organisations have decided to deploy a VM-based PMP instance to replace the hardware node.)

As soon as the PMP instance is connected, the PMP service operations team configures the mesh to include the node and run scheduled perfSONAR tests between this instance and the MPs located in the core of the GÉANT network, operated by the GÉANT network operations centre. These tests include throughput, delay, packet loss and traceroute. Additional application tests are scheduled between the PMP service instance and important resources such as HTTP request time or DNS query time towards GÉANT, Google, RIPE NCC or Wikipedia websites.

1.1 Open Digital Architecture

PMP's orchestration, automation and virtualisation (OAV) architecture analysis has been conducted using the TM Forum Open Digital Architecture (ODA) [ODA] functional blocks as a reference point. The TM Forum ODA is promoted as a blueprint for new digital industry architectures, and the rationale for its selection as a reference model by the Network eAcademy team of the Network Development work package (WP6) of the GN5-1 project is given in GN4-3 Deliverable D6.6 *Transforming Services with Orchestration and Automation* [GN4-3 D6.6]. The whole set of ODA documentation sets out a common terminology, a minimum set of core design principles, and groups of decoupled functionalities. Together these define the requirements for the implementation of an agile model-driven service management architecture that incorporates orchestration and automated operations, as well as virtualised or hybrid environments.

The main concept behind ODA is that of decoupling and integration of components, which enable the selection of independent solutions for each component, while maintaining a unified overall approach that supports the full end-to-end service lifecycle (including interoperability). The high-level ODA functional architecture maps the main components by their capabilities into the ODA functional blocks (see Figure 1.2).

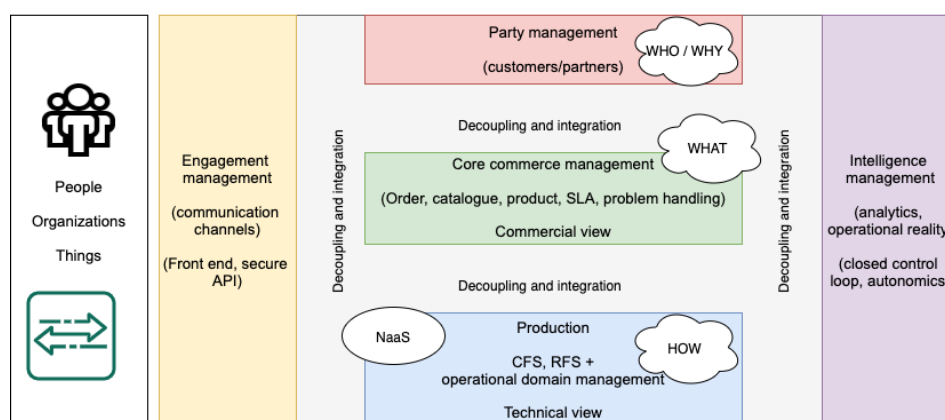


Figure 1.2: The TM Forum ODA functional architecture

To summarise:

- The **Engagement Management** functional block focuses on engagement with the end-users (people and systems) that can interact via multiple channels.
- The **Party Management** functional block handles the processes that are related to all parties that interact with the organisation and defines their roles and relationships.
- The **Intelligence Management** functional block is in charge of the implementation of data analytics processes, based on which it provides closed control loops for full automation wherever possible.

- The **Core Commerce Management** functional block focuses on the placement of products and services to the customers, and manages the product lifecycle.
- The **Production** functional block manages the delivery and lifecycle of all customer-facing and resource-facing services; these services can be based on different technologies or might be a combination of multiple operational domains, including multi-domain services provided with the cooperation of other parties.

2 Architecture Analysis

2.1 Mapping to ODA Functional Architecture

Figure 2.1 illustrates how the service management components from the Business and Operation Support System that are used to manage the PMP service are mapped to the TM Forum ODA reference architecture.

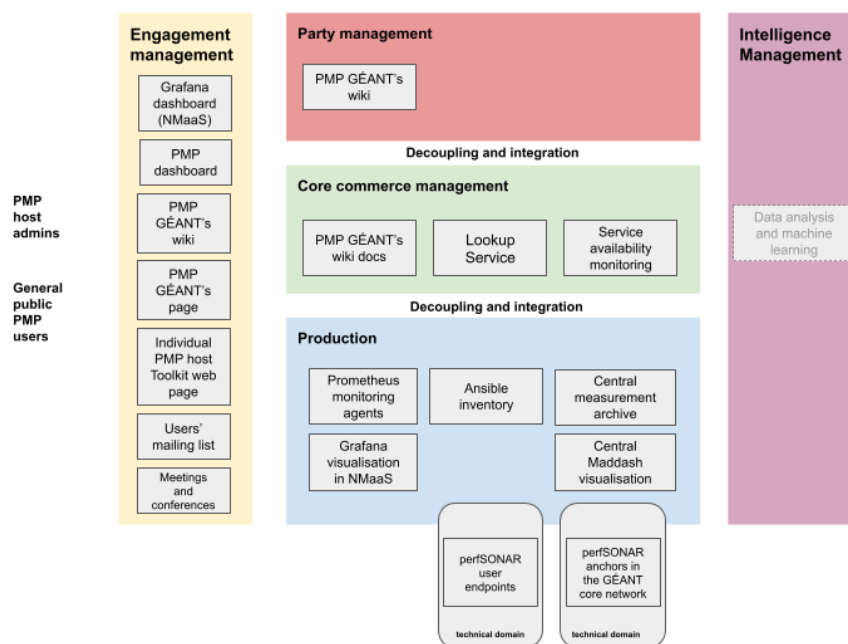


Figure 2.1: PMP components mapped to the TM Forum ODA

2.1.1 Engagement Management

Users interact with the PMP service in multiple ways. The main components of the Engagement Management functional block of the PMP service are as follows:

- The PMP web page on the GÉANT website [[PMP GÉANT](#)] – this is the public home page of the PMP service, hosted on the GÉANT's website; it presents the basic information about the service, its coverage map and main links and is used mainly as an informational site.
- GÉANT's internal wiki PMP pages [[PMP Wiki](#)] – these are a set of internal (to the project) pages available to authenticated project users. These pages contain mostly internal knowledge related to the management and operation of the service, including detailed information about all instances

distributed, the configuration of the central part of the service, and service reporting. This site's main purpose is to provide a source of information for the PMP operations team.

- PMP dashboard [[PMD](#)] – this portal provides public access to the central Maddash GUI which gives a graphical view of all historical test results within the PMP mesh.
- Grafana dashboard [[PGD](#)] – the main purpose of this portal is to visualise all operations monitoring data collected from the PMP service instances and central components. This portal is mainly used by the service operations team for day-to-day monitoring, troubleshooting and reporting, and is accessible to authenticated users only through a VPN connection.
- Individual PMP host toolkit web page – this page is available in every running perfSONAR toolkit host i.e. for each PMP node. It provides access to basic information about the PMP node instance and test results graphs via a public dashboard. In addition, each organisation hosting a PMP node has privileged access to both advanced configuration and CLI. Only authenticated users (administrators from the hosting organisation) can use the configuration options to modify the settings of the PMP node, i.e. add more local measurements or update host information.
- User mailing list – the email channel which administrators from institutions hosting the PMP instance are subscribed to and that is used for communications between the PMP service operations team and users. The mailing list can also be used by users to request service modifications or report issues.
- Meetings and conferences – the service manager as well as members of the operations team present the current status of the service at various kinds of events to collect users' feedback and engage users for more deployments.

2.1.2 Party Management

The Party Management block includes the GÉANT wiki's PMP pages [[PMP Wiki](#)] described above. This set of internal pages, which is accessible to authenticated project users, also stores contact information about users.

2.1.3 Core Commerce Management

No specific catalogue of the PMP service offering is available apart from what is already included on GÉANT's public website where the PMP service is listed under "GÉANT Network and Connectivity Services". Within the service itself, some functionalities that can help manage the PMP service and its components and lifecycle can be mapped to the Core Commerce Management block. These include:

- PMP documentation on the GÉANT wiki [[PMP Wiki](#)] – these pages contain mostly internal knowledge related to the management and operation of the service. The site's main purpose is as the source of information for the PMP operations team.
- Lookup Service [[LS](#)] – this is a graphical public perfSONAR dashboard interface built on top of the Lookup Service records. This dashboard enables searching through general statistics regarding hosts, services, communities, and measurement tests, including the PMP service instances that register to the Lookup Service. A user-friendly Grafana interface provides a deep dive into the data gathered, including but not limited to perfSONAR nodes, performed activities, trends and usage patterns.
- Measurement point service availability monitoring [[PGD](#)] (see also 2.1.1) – the main purpose of this portal is to visualise all operations monitoring data collected from the PMP service instances and central components. This Grafana-based portal is mainly used by the service operations team (after logging in via VPN) for day-to-day monitoring, troubleshooting and KPI reporting.

2.1.4 Production

The PMP components that offer functionality mapped to the Production functional block are as follows:

- Prometheus monitoring agents – Prometheus exporters are used for monitoring data acquisition and run on all the PMP monitored hosts to export local metrics such as system information, load, resource utilisation, pScheduler metrics, and so on. Prometheus aggregates time series data in real time and makes them available for central visualisation.
- Grafana visualisation in NMaaS – while Prometheus collects metrics and provides a querying language, Grafana transforms them into meaningful visualisations. The Grafana tool used for the PMP service is deployed in NMaaS and its main purpose is to visualise all operations monitoring data. A few dashboards are available to present data in several ways.
- Central measurement archive – is a deployed instance of the perfSONAR measurement archive based on the Esmond application; It stores all regular test results from the PMP mesh in a time-series database with all corresponding metadata. This archive is operated and managed by the PMP service operation team.
- Central Maddash visualisation [[PMD](#)] - the portal offers public access to the central Maddash GUI which provides a graphical view of all historical test results stored in the central measurement archive.

2.1.5 Technical Domains

The main components of the Technical Domains functional block of the PMP service are as follows:

- perfSONAR user endpoints – all PMP service instances are based on the perfSONAR Toolkit software bundle that is deployed on top of the CentOS or Debian operating system.
- perfSONAR anchors in the GÉANT core network – these are the perfSONAR hosts located and connected in the GÉANT core network (currently in Budapest, Lisbon, London, Poznań and Vienna). They are operated by GÉANT and play a vital role in the service because they are used as main targets for the scheduled regular tests for all the PMP service instances (perfSONAR user endpoints).

2.1.6 Intelligence Management

Although this aspect is not yet implemented in the PMP service, work on data analysis and machine learning has started with the aim of making use of the historical data stored in the central measurement archive to detect network performance issues and anomalies.

3 Conclusions

This document illustrates the architecture of the Performance Management Platform from the perspective of the TM Forum Open Digital Architecture and explains how each of the PMP functional elements map onto the ODA functional blocks.

PMP has a well-developed Engagement Management functional block, with a simple approach to Party Management. Being based on perfSONAR, it shares elements of the Production and Core Commerce Management blocks with this open source solution. The Intelligence management block presents opportunities for the further development of PMP, as well as the ongoing activities related to data analysis.

Mapping against a reference model helps further a better understanding of individual architectures. It also supports the potential implementation of interconnectivity or integration with other systems, including but not limited to the assessment of the applicability of individual solutions to be inherited and integrated in users' own systems, as well as differentiation analysis between systems, or partial use of components, for the purposes of future development of existing systems with PMP or of the PMP platform.

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Glossary

AAI	Authentication and Authorisation Infrastructure
API	Application Programming Interface
BI	Business Intelligence
CERT	Computer Emergency Response Team
CLI	Command Line Interface
CMS	Content Management System
CPE	Customer Premise Equipment
DB	Database
DDoS	Dynamic Denial of Service
DNS	Domain Name System
DW	Data Warehouse
GDPR	General Data Protection Regulation
IdP	Identity Provider
IP	Internet Protocol
IX	Internet Exchange
LAN	Local Area Network
LMS	Learning Management System
MDM	Mobile Device Management
ML	Machine Learning
MOOC	Massive Open Online Courses
MPLS	Multiprotocol Label Switching
NMS	Network Management System
NREN	National Research and Education Network
NOC	Network Operations Centre
OAV	Orchestration, Automation and Virtualisation
ODA	Open Digital Architecture
PoP	Point of Presence
QoS	Quality of Service
SDN	Software Defined Network
SIM	Subscriber Identity Module
SLA	Service Level Agreement
SMS	Short Message Service
SNMP	Simple Network Management Protocol
SSH	Secure Shell
R&E	Research and Education
TCS	Trusted Certificate Service
URL	Uniform Resource Locator
VLAN	Virtual LAN
VLE	Virtual Learning Environment
VRP	Virtual Routing and Forwarding
VoIP	Voice over IP
WP	Work Package