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GRNET OAV Architecture Analysis White Paper

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Authors: Donal Cunningham (HEAnet), Eduardo Jacob (EHU/RedIRIS), Estela Carmona Cejudo (I2CAT/RedIRIS), Iacovos Ioannou (CYNET), Ivana Golub (PSNC), Jasone Astorga (EHU/RedIRIS), Kostas Stamos (GRNET), Maria Isabel Gandia Carriedo (CSUC/RedIRIS), Roman Lapacz (PSNC), Simone Spinelli (GEANT), Sonja Filiposka (UKIM/MARnet), Susanne Naegele-Jackson (FAU/DFN), Tim Chown (JISC)

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Abstract

The document analyses the mapping of the GRNET (Greek Research and Technology Network) architecture to the TM Forum's Open Digital Architecture aiming to provide a standardised view of the components and implementations of orchestration, automation, and virtualisation for network management services.

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Acknowledgements

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Executive Summary

Analysing National Research and Education Network (NREN) architectures from an orchestration, automation and virtualisation (OAV) point of view using a common reference architecture helps align efforts between the NRENs, and find similarities in the way different functionalities and components are implemented, which in turn facilitates potential collaboration and future interoperability between organisations. In pursuit of this goal, the GN4-3 *Network Technologies and Services Development* Work Package (WP6), *Network Services Evolution & Development* Task (T2) selected the TM Forum Open Digital Architecture (ODA) as a reference blueprint architecture that can be used for such cross-comparison. The rationale for that choice is described in Deliverable D6.6 *Transforming Services with Orchestration and Automation* [DEL].

The WP6T2 team is working with NRENs to perform such mappings. In this document the team reports on an analysis of the different functional aspects of the GRNET network management system architecture, and how their components map to the ODA reference model. The mapping highlights the main characteristics and capabilities of the current GRNET network architecture, and how they fit into the main functional domains of ODA. The analysis was carried out by the GRNET network architects supported by the WP6T2 team.

1 Introduction

The Greek National Research and Education Network (GRNET) provides a network infrastructure for the Greek research and education community, and connects educational and research institutions. It also provides a variety of additional services, including cloud services, high performance computing, Firewall-on-Demand, Firewall-as-a-Service, sound-, video- and teleconference-services, and a large collection of digital services for the educational community.

GRNET's OAV architecture analysis has been conducted using the TM Forum Open Digital Architecture (ODA) [TMF_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 GN4-3 WP6T2 team is given in Deliverable D6.6 *Transforming Services with Orchestration and Automation* [DEL]. The whole set of ODA documentation provides common terminology, a minimum set of core design principles, and groups of decoupled functionalities. Together they 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 idea behind ODA is the decoupling and integration of components which enables an independent choice of solutions for each component, while at the same time maintaining a unified overall approach that supports the full end-to-end service lifecycle (including interoperability). The high-level ODA functional architecture [TMF_ODA] maps the main components by their capabilities to the ODA functional blocks as shown in Figure 1.1.

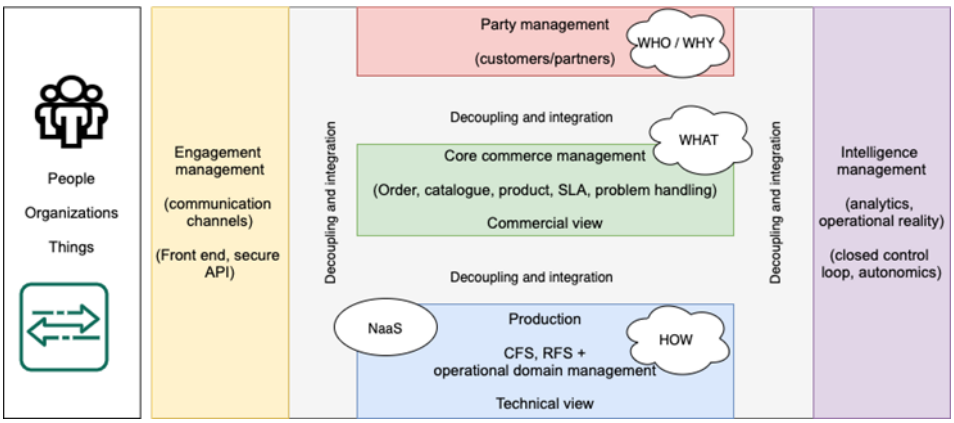

Figure 1.1: The TM Forum ODA functional architecture

In a nutshell:

- The Engagement Management functional block focuses on the 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 and, based on the analysis, 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 that 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.

In May 2019 GRNET participated in a GÉANT survey [SURVEY2019] and, as part of that, performed an analysis of existing systems and architecture components in the context of automation, virtualisation, and orchestration. Based on this analysis GRNET architectural components have been identified and matched to the TMForum Open Digital Architecture (ODA) functional blocks.

2 Architecture Analysis

2.1 High-Level OAV Approach

At the Operations Support System (OSS) layer, GRNET uses a combination of vendor-, open-source-, and in-house-built toolsets. At the Business Support System (BSS) level, it uses a combination of in-house systems with ServiceNow Information Technology Service Management (ITSM) [ITSM] and open-source alternatives (GRNET utilises open-source alternatives and ITSM, even though there is a short experience with them from GRNET).

GRNET benefits from a modular microservices-based architecture with Continuous Integration capabilities, and a best-of-breed data model that combines service provider modelling best practices at the product/service layer, and network provider modelling at the resource layer/data plane. The open source components ensure a low overall Total Cost of Ownership (TCO), and the lightweight and abstract middleware allows third party and in-house systems to be adapted and integrated into the platform. There is a very low overhead to integrating new services.

However, GRNET has a complex ecosystem that needs to be maintained and developed internally. It can be disrupted by fast-changing technologies, and has a strong dependency on in-house software expertise.

So far, GRNET has adopted a lightweight version of the TM Forum Information Framework (SID) [TMF_SID] modelling to business agreements, products, and the customer-facing services layer. It uses in-house models for resource-facing services, control, and data plane modelling, following IETF YANG modelling standards and using Openconfig. GRNET has adopted TM Forum Open APIs for the OSS/BSS integration platform (including Party management, Service catalogue management, Order management, and Resource management/activation and configuration) and has also applied a lightweight adoption of the TM Forum Business Process Framework (eTOM) [TMF_eTOM] to the OSS/BSS integration platform.

GRNET's configuration change policies require that all configuration is automated via repos, maintained in repos in the form of YAML files, and committed using a four-step commit. These policies apply to all NOC members.

GRNET data centres provide cloud services based on KVM, Ganeti and Synnefo virtualisation technology, adhering to Openstack APIs for easy UI interoperability [GRNET_DC].

2.2 Mapping to ODA Functional Architecture

The Figure 2.1 diagram presents an overview of how the components used in GRNET map to the ODA architecture. This mapping is explained in more detail below.

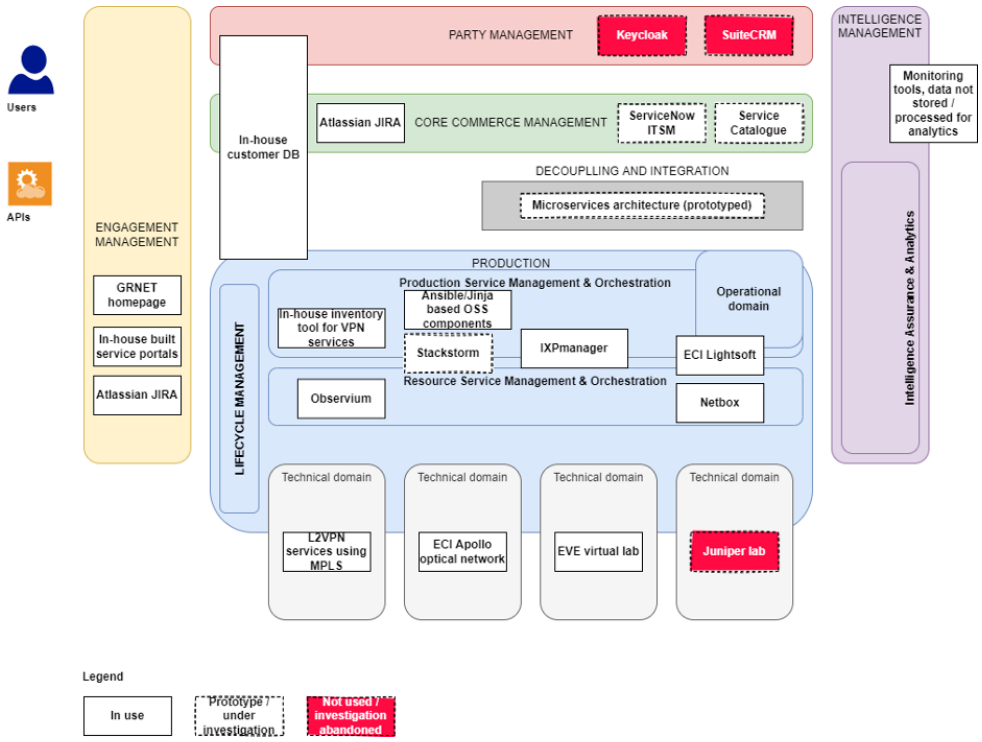

Figure 2.1: GRNET architecture mapping to the TM Forum ODA functional blocks

2.2.1 Engagement Management

This block deals with the interaction with external actors, the front-end for external users, user authentication/authorisation, and APIs to external parties.

The Engagement Management functions of ODA in GRNET can be associated with:

- GRNET's Home page which provides marketing information [GRweb]. Product information is available on the main website, and also on product-specific web pages under the same domain [Examples].
- A web page on the GRNET web portal that provides information on services that GRNET supports [GRservices].
- In-house built self-service portals for selected services.
- The usage of JIRA (to the extent that it is used as a reporting interface). The GRNET ticketing system [GRticket] can be accessed via web, phone, and email.

2.2.2 Party Management

This block deals with the management of internal and external actors, roles/rights, marketing, sales, and billing.

In GRNET, the Party Management functional domain components consist of an i**n-house customer database (DB)** for user configuration information, Service Level Agreements (SLAs) (so that it is also part of the Core Commerce block), and incident reporting tickets (so that it is also a part of the Production block) which use the Atlassian JIRA GRNET ticketing system [GRticket]. A migration to SuiteCRM was investigated but did not take place. Keycloak was also investigated but is not currently used.

2.2.3 Core Commerce Management

This block mainly deals with product inventory management, problem handling, SLA management, product testing, and agreement management.

The main components of the ODA's Core Commerce Management functional block at GRNET are:

- Ongoing work on a centralised service catalogue that lists the services GRNET offers. GRNET customers will be able to order services on the fly.
- An in-house customer database (DB) for SLAs.
- ServiceNow ITSM, with which GRNET has some experience. GRNET is currently reviewing alternatives, aiming to shift to Free Open Source Software (FOSS) [FOSS].
- Atlassian JIRA for problem management

2.2.4 Production

This block mainly deals with end-to-end service and resource lifecycle management, including multi-domain interactions, service development, infrastructure deployment, operations management, usage and performance management, workforce management, resource provisioning, service and resources catalogues, and inventories.

For the Production Management functional domain, the ODA components/modules from the GRNET digital architecture solution that can be associated are [MAM2015], [MITS2018]:

- ECI Lightsoft as the optical layer NMS.
- Observium as a resource discovery tool.
- Netbox for resource documentation and hostmaster services (hostmaster services were previously handled by an in-house built tool).
- An in-house built tool as a service inventory for VPN services (using YAML files).
- IXP Manager for IX needs.
- Ansible/Jinja-based OSS components for L2/L3 resource provisioning (Stackstorm under development) [POU2019].

GRNET's usage of Atlassian JIRA for incident management can also be listed under the production block.

Monitoring tools related to production are detailed in Section 2.2.7.

2.2.5 Technical Domains

GRNET delivers L2VPN services using MPLS technologies over its carrier network.

GRNET has deployed a reconfigurable optical network based on ECI's Apollo optical networking system. GRNET has been enabling optical trails/lightpaths over this network manually through ECI's LightSOFT NMS. GRNET has also prototyped an automated adaptor to LightSOFT, using a CORBA northbound interface from LightSOFT and exposing a TM Forum Frameworx-compliant Restful API to the upper layers of the OSS. This is currently not in use due to a lack of demand.

There are also the following testing labs (testing domain):

- EVE - The Emulated Virtual Environment Lab for whitebox testing (based on EVE-NG platform).
- Juniper Lab - used for ZTP testing, EVPN over MPLS, YANG over NetConf, for testing the orchestrated VPN provisioning solution, and, in general, as a staging environment for any new feature or protocol change that can have an impact on the network. Due to the existence of EVE and the need to transfer devices to production, this lab is no longer used.

GRNET's public cloud service [OKEANOS] is based on KVM hypervisor technology, managed by a Google Ganeti and Synnefo software infrastructure as shown in Figure 2.2. The API presented to the UI component is compatible with Openstack for better interoperability and flexibility.

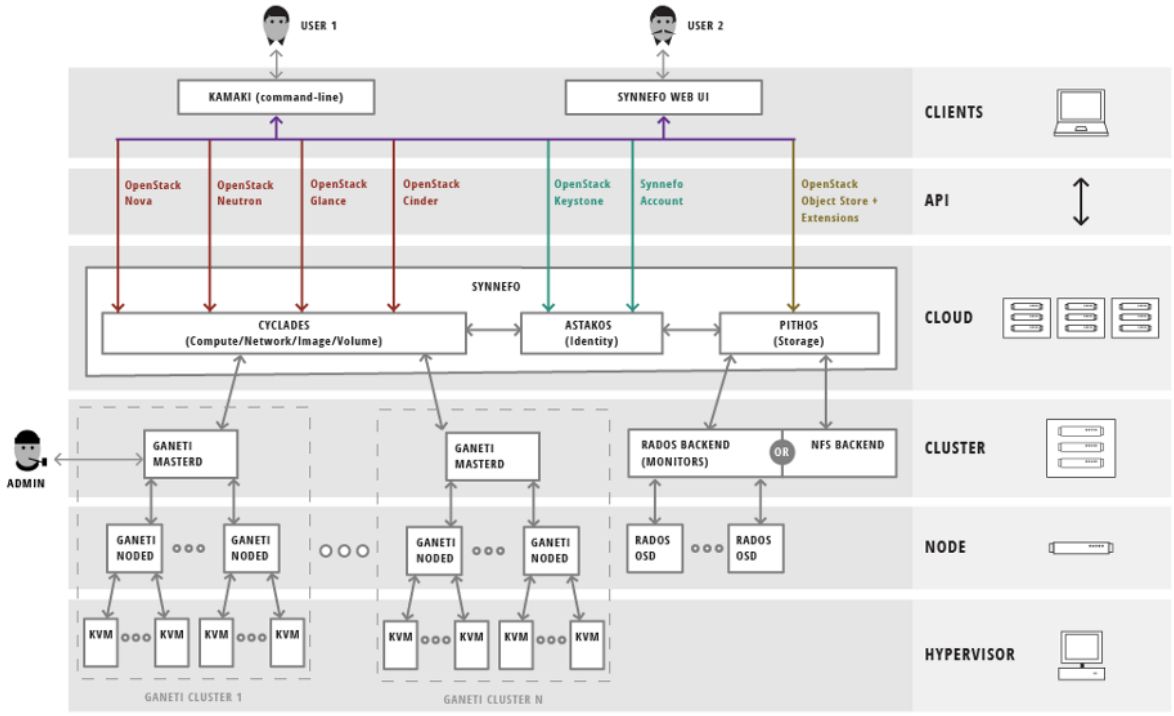

Figure 2.2: GRNET public cloud service ~okeanos architecture

2.2.6 Integration and Decoupling

This block makes the separation and communication of the core commerce block easier. It deals with the management of an API catalogue and related documentation, message routing, and API mediation.

GRNET has prototyped (not used in production) a microservices architecture for the Integration Framework, based on the Spring Boot applications as shown in Figure 2.3. Its building blocks are Adapter microservices, Translator microservices, Message Broker, Message Bus, and Storage microservice [SEV2018], [SEV2019].

In particular, GRNET uses the following solutions:

- Alfresco Activiti process engine, now migrating to Camunda BPM.
- Apache ActiveMQ as message broker.
- A message bus is implemented using Apache Kafka.
- For the API handling of requests regardless which kind of transport is used, a microservice was implemented in-house using Apache Camel, as a Spring Boot application.
- Storage microservice, implemented in-house as a Spring Boot application.
- In-house built wrappers for all third-party systems integrations.

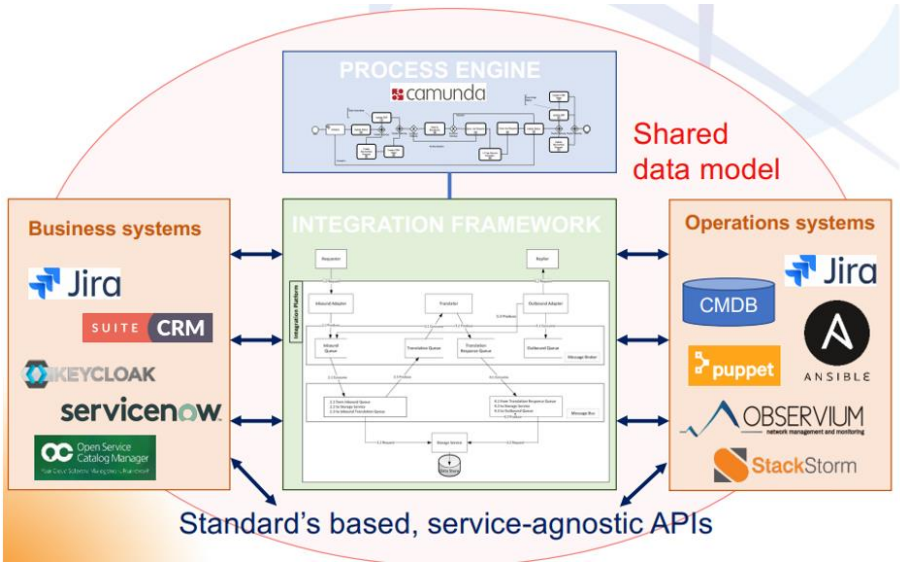

Figure 2.3: Microservices offered to Business Systems by GRNET.

2.2.7 Intelligence Management

This block mainly deals with data analytics and data aggregation, for marketing and sales forecasting, and for network performance evaluation.

GRNET uses several monitoring tools as a part of the Production block as shown in Figure 2.4. The GRNET Network Monitoring Tools can be accessed from a portal web site. The Network Monitoring Tools Portal [GRNET_NETMON] includes links to:

- Looking Glass (IPv4 and IPv6 ping, trace, BGP)
- MRTG Network Graphs
- QoS MRTG
- Rancid CVS repository
- Database visualisation

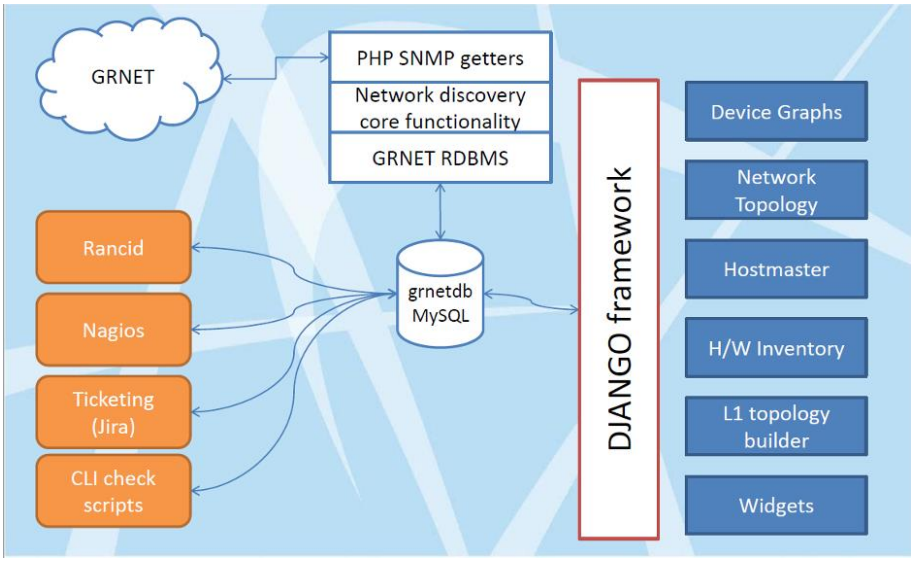

Figure 2.4: GRNET NOC network monitoring & visualisation tools

3 Conclusions

Although the GRNET architecture has been independently developed with a number of distributed components and subsystems, it can generally be aligned with the ODA core principles and design concepts. More specifically, the following systems/systems can be aligned and mapped using the ODA architecture:

- The GRNET website
- The in-house customer database (DB), ServiceNow ITSM
- ECI Lightsoft, Observium, Netbox, an in-house built tool used for service inventory, IXP Manager, Ansible/Jinja
- Atlassian JIRA and the monitoring tools, as explained in Section 2.2.7
- The GRNET public cloud service architecture
- The microservices offered to business systems by GRNET
- The GRNET NOC network monitoring and visualisation tools

The ODA reference architecture is iterative and versatile, to a great extent modular, and the process of implementing an orchestrator will be easier for GRNET with ODA alignment, as will its decoupling and integration approach in the context of multi-domain orchestration.

The architecture at GRNET follows the principles of API-based functional building blocks that provide the ability to incorporate many internal systems' components, but also to integrate them with other external systems (if needed) in a multi-domain manner. Overall, the ODA principles (using Open APIs and TM Forum Frameworx standards) can assist the move towards a digital transition at a flexible pace, while remaining compatible with other NRENs who are also aligned to the ODA reference architecture.

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[TMF_ODA]	https://www.tmforum.org/oda/
[TMF_SID]	https://www.tmforum.org/information-framework-sid/

Glossary

API	Application Programming Interface
BGP	Border Gateway Protocol
BPM	Business Process Modelling
BSS	Business Support System
CVS	Concurrent Versions System
DB	Database
EVE	Emulated Virtual Environment
EVPN	Ethernet Virtual Private Network (VPN)
FOSS	Free Open Source Software
IETF	Internet Engineering Task Force
IP	Internet Protocol
ITSM	Information Technology Service Management
IX	Internet Exchange
IXP	Internet eXchange Point
KVM	Kernel-based Virtual Machine
L	Layer
MPLS	Multiprotocol Label Switching
MRTG	Multi Router Traffic Grapher
NMS	Network Management System
NREN	National Research and Education Network
NOC	Network Operations Centre
OAV	Orchestration, Automation and Virtualisation
ODA	Open Digital Architecture
OSS	Operations support system
QoS	Quality of Service
SLA	Service Level Agreement
TCO	Total Cost of Ownership
TMF	TeleManagement (TM) Forum
eTOM	TM Forum Business Process Framework
UI	User Interface
VPN	Virtual Private Network
WP	Work Package
YAML	YAML Ain't Markup Language
YANG	Yet Another Next Generation
ZTP	Zero-Touch Provisioning