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CYNET OAV Architecture Analysis – Update

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Abstract

This document is an update of a previous published analyses of the mapping of the CYNET 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 within Research and Education organisations connected to the NRENs.

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Executive Summary

This document analyses CYNET's network architecture components by comparing its current status to TM Forum's Open Digital Architecture (ODA) and to the previous mapping document [OAV-CYNET-v1]. It aims to provide a standardised view of its components and implementations of orchestration, automation and virtualisation (OAV). This is the second version of the document, as some components have evolved since the first document was published [OAV-CYNET-v1], and this updated version emphasises the progress and modifications made to these components over the past four years. Modifications were driven by the need to improve functionality, ensure greater scalability, and advance in automation.

The previous analysis, together with the OAV Maturity Model [OAV-MM] have been pivotal in fostering the evolution of the architecture in CYNET, and this updated version continues to support the development of its potential to align with future OAV multi-domain processes and workflows across Europe. This updated analysis concludes that the CYNET architecture, although independently developed and still at an early but more evolved stage of its automation journey compared to the previous one, can be aligned with the ODA core principles and design concepts. Overall, the ODA information governance (with Open APIs and TM Forum Frameworx standards [FRAME]) can help CYNET move towards a digital transition at its own pace while remaining compatible with others who also work aligned to the ODA reference architecture.

1 Introduction

CYNET is Cyprus' National Research and Education Network (NREN). It provides a network infrastructure for the Cypriot Research and Education Community and connects educational and research institutions. CYNET-II, the national backbone of CYNET, is connected to the European backbone GÉANT, which is part of the worldwide community of research and education networks.

This document updates the previous analysis of the components of CYNET's network management system architecture, focusing on the Orchestration, Automation and Virtualisation (OAV) aspects of its implementation. The NREN community can use this analysis to compare their own components and approaches with those of CYNET, and may find similarities that inspire them to work together on their journey towards OAV.

This mapping is part of a set of mappings of different NREN management architectures against ODA, thus providing a common reference point, and the means for a cross-NREN comparative analysis of components and approaches.

The TM Forum ODA is used as a blueprint for new digital industry architectures. 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 was given in GN4-3 Deliverable D6.6 Transforming Services with Orchestration and Automation [D6.6]. 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 independent choice of 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 function blocks (see Figure 1.1 below).

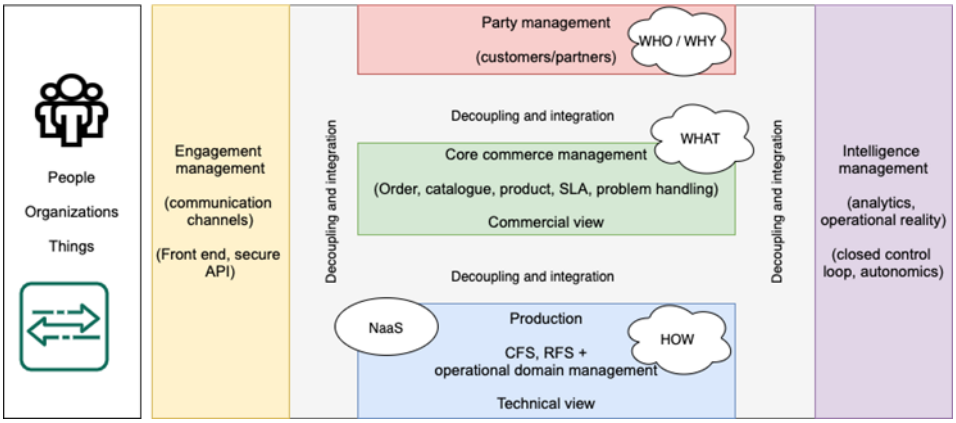

Figure 1.1: The TM Forum ODA functional architecture

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.

2 Architecture Analysis

This section provides a high-level approach to the OAV Architecture analysis, followed by the mapping of individual operational systems' to the blueprint architecture of TM Forum ODA.

2.1 High-Level OAV Approach

CYNET, as the National Research and Education Network of Cyprus, serves a small community of research and educational institutions, connecting them to the larger European backbone, GÉANT. Historically, CYNET's workflows have been largely manual due to the manageable size of its network and the relatively small number of institutions it supports, totalling only 15 members [MEMBERS]. However, with the evolving landscape of digital infrastructures and the increasing need for efficiency, CYNET is in the early stages of transitioning toward (OAV) [OAV-CYNET-v1]. This shift aims to ensure that CYNET remains aligned with future multi-domain OAV processes and workflows across Europe, benefiting from automation and virtualisation to improve service delivery and scalability. One example where CYNET could benefit from using OAV would be to offer Campus Network Management as a Service [CNaaS] to its connected institutions.

To achieve this transformation, analysing the architecture to map it to a common blueprint and self-assessing its status through an OAV Maturity Model [OAV-MM] are seen as good tools to guide CYNET through the necessary improvements to align with the new architecture visualised in its plans. For this reason, CYNET has fulfilled the OAV Maturity Model survey [OAVS] twice, in order to be able to compare the initial status (stage) for each one of the sub-dimensions with the desired one and trace a plan for the gradual transformation of processes. Initially, the organisation will focus on standardising and automating its most basic workflows, such as ticketing and resource management, which currently rely on manual processes like Excel-based systems [EXCEL]. By implementing small-scale automation, CYNET can reduce errors and increase operational efficiency. Integrating orchestration tools and cloud services will gradually replace manual configurations, laying the groundwork for more complex automation, and the usage of Network Monitoring as a Service (nmaas) [NMAAS], that CYNET plans to integrate within its network. As CYNET matures, the focus will shift to integrating these automated processes across multiple domains, ensuring seamless coordination between services. This will allow the organisation to offer more sophisticated self-service capabilities to its users, empowering institutions to manage their own network configurations. Full monitoring and performance analysis automation through tools like perfSONAR [perfSONAR] and SNMP-based tools will eventually lead to a more dynamic and responsive infrastructure capable of adjusting to network demands in real time.

At its peak maturity, CYNET will have achieved a fully automated and virtualised architecture, where the entire service lifecycle, from provisioning to monitoring, is managed autonomously. This optimisation level will improve efficiency and ensure that CYNET can scale and adapt to future demands, aligning itself with European-wide OAV initiatives. The maturity model thus provides a clear roadmap for CYNET to evolve from its current state into a highly automated, agile network infrastructure that is fully compatible with the broader research and education community.

2.1.1 Workflow Analysis

The current Operation Support System (OSS) in CYNET has evolved to integrate both commercial and open-source modules, significantly enhancing its capacity to manage the growing demands of its network. CYNET now uses a combination of VMWare [VMWare] virtualisation for virtual hosting alongside Azure cloud [AZURE] services for resource provisioning and cloud management and uses tools that, even not being nmaas themselves, are currently offered inside nmaas and will be easier to integrate with it in the future. Workflow monitoring and ticketing continue to be managed through the Help Desk System integrated with Request Tracker for Incident Response (RTIR) [RTIR]. Office 365 email notifications are employed for employee task management, and Excel worksheets are still used for resource inventory tracking and workforce management.

However, as part of its transition toward OAV, CYNET has begun integrating more automated tools to streamline these processes [OAV-CYNET-v1]. The workflow for handling customer service requests has also improved. Customers interested in services, such as CYNET's offerings, can now interact with the 'Services Connect' web portal, where they can browse the product catalogue and submit requests directly through the front-end service portal, reducing manual handling [CONNECT]. Submitted requests are automatically logged into the help desk ticket system, where a ticket is generated and assigned based on predefined workflows. The manager still oversees the assignment of complex tickets to technicians, but automation has been introduced to handle routine tasks, such as updating customer roles and permissions. Instead of requiring manual intervention in systems like Azure or OpenLDAP, certain permissions changes and resource activations are now handled through automated scripts, reducing the need for technician oversight in straightforward cases. These scripts work in conjunction with service/resource configuration tools that streamline resource provisioning and activation.

Once the technician completes the service setup and integrates monitoring tools and protocols such as perfSONAR, SNMP-based tools, or Zabbix [ZABBIX], the system automates customer notifications and updates the service data. Previously manually updated Excel worksheets for tracking, are automatically synchronised with the help desk system, reducing human error and improving overall workflow efficiency. This integration of orchestration and automation tools marks a significant step forward in CYNET's journey towards full OAV implementation, where service processes are streamlined, and operational efficiency is improved.

2.1.2 Goals and Requirements

Although its workflows are currently not fully supported by automation or orchestration, CYNET plans to use orchestration with automated components in the future. Setting up a central configuration management database for automating network provisioning is a benefit of establishing automation and orchestration. This will ensure the integrity of the configuration and accurate monitoring by having a single source of truth for configuration data rather than using multiple version control repositories of configuration files on network devices. An advantage of using a multi-domain management orchestrator is granting self-service operations to customers (e.g. Cyprus universities) requesting network additions or changes.

As mentioned above, CYNET is also planning to provide Campus Network Management as a Service (CNaaS) inspired in the work done about CNaaS in the GN4-3 project [CNaaS-GN4-3]. Such a service will have self-service management features and integration through an orchestrator to enable universities to manage their campus networks using nmaas components and VirtualNOC [VNOC]. Therefore, having a solid basis on automation and virtualisation techniques, as well as a multi-domain management orchestrator, will be a necessity for providing the service and letting customers manage their own networks.

For the above reasons, CYNET will, in the future, hand over control to the customer via a self-service portal. CYNET sees this self-service approach as a benefit of OAV implementation in addition to the enhanced management of the complete service lifecycle (i.e. strategy decision, design, build, operate, improve), which targets the operations of provisioning, change-add-remove, termination, and the capability to offer composable services. The main requirements for the realisation of orchestration and automation, as seen by the CYNET development team, include:

- One place to hold all the network configurations (central repository).
- Automation through orchestration. Any automating component can use this central repository of all network configurations to set up a series of network elements automatically.
- Flexible and dynamic network design in a security-conscious manner. Therefore, it will be able to detect and restrict unauthorised access. However, if any unauthorised change occurs on a network element, provisioning will enable the automation component to roll back the changes at a specific time based on the central repository of all network configurations.
- Use of standardised interfaces based on REST Application Programming Interfaces (APIs).
- Definition of workflows that will be part of predefined processes for service provisioning, using standardised steps that are essential to deploy each specific service type.

The final aim is to move towards working with different technology domains. Uniformly managing all devices (for networking and services) belonging to a technical domain will enable the creation of standardised workflows on the orchestration layer.

2.2 Mapping to ODA Functional Architecture

CYNET is following a flexible reference architecture in its digital transformation process to ensure that its OAV platforms will be compatible with other NRENs and to allow CYNET to proceed with OAV at its own pace.

Figure 2.1 below represents CYNET's Network Management System (NMS) architecture components in the context of the TM Forum ODA functional representation. The grey boxes in the diagram represent CYNET's NMS architecture components, and their placement within the ODA functional blocks is defined based on their main functionalities.

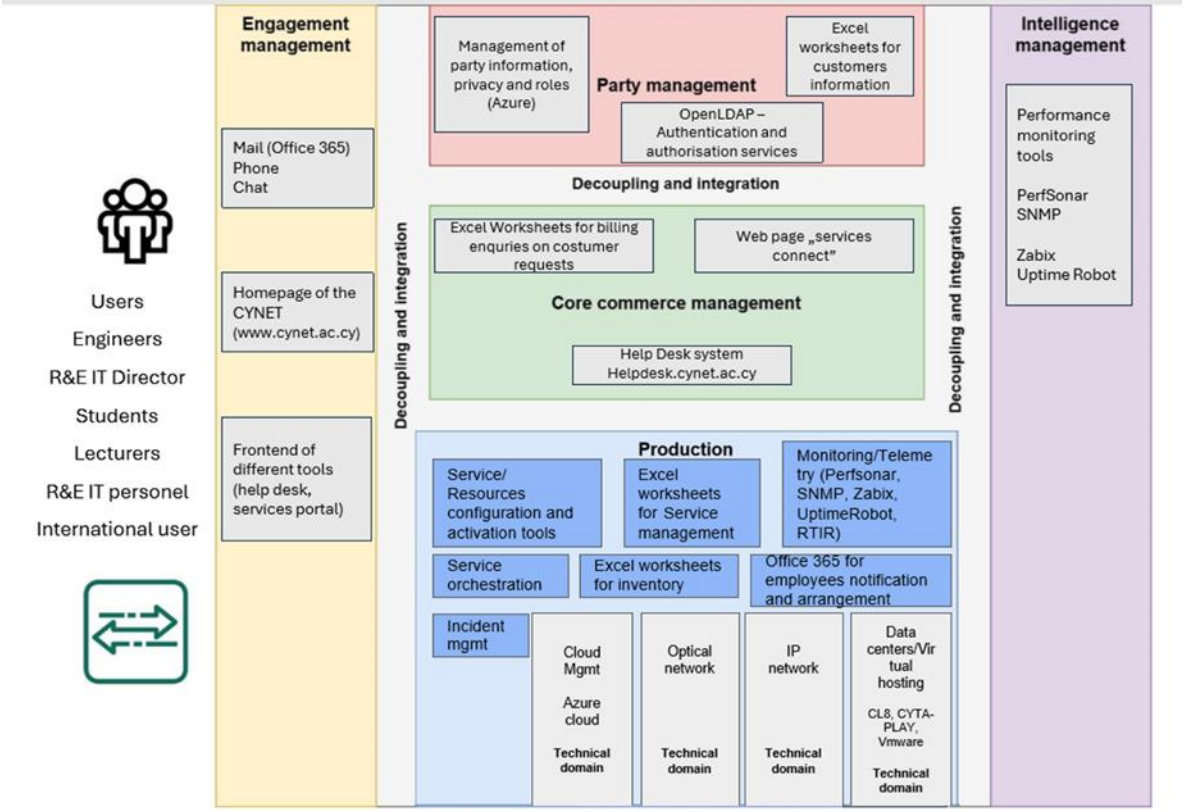

Figure 2.1: CYNET's NMS components mapped to the TM Forum ODA

Compared to the previous OAV Architecture mapping, the architecture is now more structured, with fewer manual tools and more integration, and with a clearer separation of the different technical domains, which helps evolving the services step by step.

Compared to the ODA core concepts and design principles, the CYNET architecture adopted and is still using similar ideas and approaches, like using an RTIR-based service management process that is not only responsible for the implementation and lifecycle of the service but also for the monitoring of the service and the tracking of SLAs. In this case, the RTIR ticket system would be part of the core commerce management functional block.

The following sections describe all functional blocks of the ODA architecture and how CYNET's current architecture can be mapped to this reference model, as it was in the past. This, combined with the results of the OAV Maturity Model report will again allow for the self-assessment and identification of common interfaces for OAV processing in the multi-domain environment for GÉANT NRENs and CYNET's other partners and customers.

2.2.1 Engagement Management

The **Engagement Management** functions in CYNET, as mapped within the ODA framework [ODA], focus on the interaction and communication channels available to users for accessing services and support. This domain handles customer and user engagement through a combination of traditional communication methods and modern digital tools. The goal is to ensure efficient and seamless communication between CYNET and its users, which includes engineers, students, lecturers, IT personnel, and international users. The following components are part of CYNET's Engagement Management domain, and play a critical role in enabling these interactions:

1. **The Home page of CYNET** [CYNET]**:** The homepage serves as the central point for providing users with detailed information about CYNET's services, policies, processes, and network-related updates It also offers marketing content and service catalogues, allowing users to explore CYNET's offerings in a self-service manner.
2. **Customer Support and Management Procedures:** CYNET offers customer support by guiding users through the process of accessing services. For customer management, users are directed to download relevant PDF files for billing or service inquiries [PROCEDURES]. Once completed, the forms are submitted via email, ensuring that the appropriate procedures are followed for activating or modifying services.
3. **Mail:** Traditional mailing channels are available for users requiring physical communication or documentation exchange, ensuring accessibility for all customers [CONNECT]. Office 365 is the primary communication channel for engaging with customers and providing essential service information, notifications, and updates to existing and potential customers. Email also promotes new or existing services to targeted user groups and stakeholders.
4. **Phone:** Phone support is provided as an additional channel for real-time customer engagement, allowing users to contact CYNET directly for immediate inquiries or troubleshooting.
5. **Custom (in-house) Chat Tool:** Chat functionality is included to provide users with a faster, more convenient way to interact with CYNET support teams. It offers real-time assistance and can handle routine inquiries, improving response times.
6. **Front End of Different Tools:** CYNET provides a user-friendly front-end for its help desk, services portal, and other tools, allowing users to submit service requests, track issues, and access support. These front-end platforms are integrated into CYNET's service infrastructure, streamlining user interactions with the network.

2.2.2 Party Management

The **Party Management** functions in CYNET, as mapped within the ODA framework, focus on managing the information and relationships of both existing and new customers. This domain handles customer data, manages roles and permissions, and ensures that the correct access rights are assigned within CYNET's services. These functions ensure that customer information is accurately stored, managed securely, and organised, using manual and automated tools for managing customer accounts. The following components are key to the Party Management domain in CYNET:

1. **Microsoft Cloud and OpenLDAP Active Directory services for the Management of Customer Accounts (Delete/Update/Insert):** CYNET uses them to manage customer accounts. This includes creating, updating, or deleting customer accounts as needed. Managing customer roles and permissions is critical, ensuring that the correct access is provided based on a customer's needs and status.
2. **Excel Worksheets for storing customer information:** Excel worksheets are utilised for manually storing and managing customer data, including information on new and existing customers. This system also functions as a backup solution for maintaining customer details and tracking any changes in customer status or service subscriptions.
3. **Azure:** Azure services manage customer accounts in the cloud, providing a scalable and secure platform for handling customer identity, roles, and permissions. This cloud-based infrastructure allows for efficient role management and seamless integration with CYNET's broader service offerings.
4. **OpenLDAP:** OpenLDAP is employed for directory services, managing the customer database, and providing authentication and authorisation services. It allows centralised management of customer roles and permissions, ensuring access rights are securely maintained across CYNET's services.

2.2.3 Core Commerce Management

The **Core Commerce Management** functions in CYNET, aligned with the ODA framework, are responsible for managing customer orders, tracking service requests, and managing the product catalogue. This domain focuses on managing customer interactions, ticketing systems, and providing both CYNET and GÉANT services. The goal is to ensure that customer requests are efficiently processed, tracked, and resolved through a structured system that integrates manual and automated tools. The following components are key to the Core Commerce Management domain in CYNET:

1. **Excel Worksheets for Storing Customer Request Records (Order Forms):** Customer requests, including order information, are captured using Microsoft Excel template worksheets, which are subsequently used for billing inquiries. These worksheets are a manual process for handling customer orders and tracking the details needed for further processing.
2. **Managing Tickets and Problems:** Tickets and customer-reported problems are initially tracked using Excel worksheets. The data collected from these worksheets includes key details such as the SLA (Service Level Agreement) and ticket information. When the service is completed, these Excel sheets are stored on a file server for archival and reference purposes.
3. **Product Catalogue (Services Connect):** The 'Services Connect' component, hosted on the CYNET website, provides the product catalogue for users [CONNECT]. It lists all available services, allowing customers to browse and select services relevant to their needs. The product catalogue is a central hub for managing the services CYNET offers and helps streamline customer engagement by providing easy access to service offerings.
    a. **GÉANT Services:** In addition to its own services, CYNET also offers and gives information on several GÉANT services through the 'Services Connect' component. These services include widely used solutions like certificates, eduroam, perfSONAR, nmaas, PMP, network connections towards GEANT and the Internet and eduVPN. These services extend CYNET's product offerings, aligning with global standards and tools offered by GÉANT, which supports the Research and Education (R&E) network community.
    b. **Non-GÉANT Services (EUMEDGRID Project):** CYNET also provides services related to the EUMEDGRID project, such as EUmedGrid support and EumedConnect2, offering infrastructure and resources for research collaboration across Europe and the Mediterranean. These non-GÉANT services are also presented within the product catalogue.
4. **Ticketing System:** Tickets are created manually based on customer inputs and tracked throughout the service's lifecycle. The ticketing system is crucial for maintaining the flow of communication and resolution between CYNET's support teams and its customers.

2.2.4 Production

The **Production Management** functions in CYNET, aligned with the ODA framework, focus on the orchestration, automation, and management of service delivery, including service provisioning, incident handling, workforce management, and infrastructure monitoring. CYNET utilises manual tools, such as Excel worksheets, automated systems like the Request Tracker for Incident Response (RTIR), and VMware and CL8 data centre resources for virtualised infrastructure. The following components and processes are mapped to this functional block:

1. **Service Provisioning Process:** Service provisioning starts with a request from new or existing customers. Customers use a template Excel file downloaded from the CYNET website and submit it via email. In future, CYNET plans to offer a web application that allows users to input the required information. The administrative personnel responsible for customer SLAs and service implementation create a ticket in RTIR, which initiates a workflow to be handled by CYNET technicians.

2. **Service Management:** Service management, including installation monitoring and troubleshooting, is handled through Excel worksheets that track tickets, incidents, and workflows across CYNET departments. These worksheets and the RTIR system ensure proper documentation and incident resolution. Office 365 is used for storage and file services. It provides secure, cloud-based storage solutions, allowing efficient document management, collaboration, and sharing across the organisation. The OneDrive and SharePoint platforms within Office 365 store important files, such as service records, configuration data, and customer-related documents.
3. **Ticket Assignment and Resolution:** Managers assign and track tickets using RTIR. Once a technician resolves the issue, the ticket is updated and closed in the system. The technician informs the customer via email and requests the manager to update Excel worksheets with relevant service information, which is then saved on a file server for future reference.
4. **Service and Resource Inventory Updates:** During the resolution of service requests or incidents, if any changes are made to customer infrastructure, such as new software or hardware installations, the service/resource inventory is updated. These updates are stored in Excel worksheets, ensuring accurate tracking of customer infrastructure.
5. **Monitoring Tools (perfSONAR, SNMP, Zabbix):** Monitoring tools like perfSONAR, SNMP-based tools, and Zabbix track the performance of CYNET's network and server infrastructure in real-time. These tools track real-time metrics related to network bandwidth, latency, CPU, memory, and storage usage, helping CYNET ensure optimal performance. This domain is critical in proactively identifying and resolving potential issues before they affect service quality.
6. **Employee Notification and Request Submission:** CYNET uses Microsoft Office 365 for employee notification and request submission. This cloud-based email service enables seamless communication between the support teams and customers, facilitating request handling and workflow management.

2.2.5 Technical Domains

CYNET's infrastructure is organised into multiple technical domains, each handling specific functions related to network management, virtualisation, storage, and service delivery. These domains ensure the smooth operation, scalability, and efficient management of CYNET's services. The following are the key technical domains in CYNET:

1. **Virtual Hosting Domain (VMware):** This domain hosts CYNET's internal services and customer-facing applications using VMware virtualisation technology. The virtual infrastructure, supported by data centres such as CL8 and CYTA-PLATY, allows CYNET to manage resources flexibly and ensure the high availability of virtual machines and applications. VMware provides a reliable platform for provisioning virtualised environments, ensuring scalable service delivery and efficient use of hardware resources.
2. **Cloud Management Domain (Azure):** Azure Cloud Management handles the provisioning and control of cloud-based services, including virtual machines, data storage, and cloud-based applications. This domain integrates CYNET's infrastructure with the cloud, enabling seamless scaling and redundant service delivery. It supports both internal services and customer solutions, ensuring that CYNET can manage workloads in a flexible, resilient cloud environment
3. **IP Network Domain:** The IP Network Domain manages all network infrastructure related to IP-based communication. This includes using Juniper routers and switches to ensure high-performance data routing and IP traffic management across CYNET's network. The domain provides critical connectivity between CYNET's internal systems, external customers, and the broader R&E networks it supports.
4. **Optical Domain:** The Optical Domain involves managing CYNET's high-speed fibre-optic network. This infrastructure supports large-scale data transfers across the network with minimal latency and high bandwidth, forming the backbone of CYNET's data transmission capabilities. It provides long-distance, high-capacity connectivity vital for research and educational institutions, ensuring that CYNET can maintain performance across all services.

2.2.6 Intelligence Management

The **Intelligence Management** functions in CYNET, aligned with the ODA framework, focus on gathering, managing, and analysing operational data for network performance, capacity planning, and troubleshooting. The goal is to leverage data-driven insights to improve service quality, optimise resource utilisation, and ensure the smooth operation of the network infrastructure. These functions ensure that CYNET's services remain reliable and efficient. The following components are mapped to this functional block:

1. **Data Gathering and Telemetry (SNMP based tools like Zabbix, and perfSONAR):** perfSONAR is utilised for network performance monitoring and telemetry, collecting detailed data about network behaviour, latency, throughput, and other vital metrics. Additionally, SNMP monitoring through tools like Zabbix ensures comprehensive tracking of the health and performance of CYNET's servers and network devices. These tools provide the foundational data to troubleshoot issues, perform capacity planning, and ensure that CYNET's infrastructure operates efficiently.
2. **Data Visualisation and Graphing (Zabbix):** Zabbix offers detailed data visualisation and network graphing capabilities, enabling CYNET technicians to track real-time metrics and detect trends in network performance easily. This visualisation helps identifying potential issues before they affect services, contributing to better resource planning and faster incident resolution.
3. **Manual Feedback and Control Loop:** Currently, the feedback loop or closed control loop in CYNET is implemented manually. Based on the data gathered from perfSONAR, SNMP logs, and Zabbix, CYNET technicians analyse and adjust the infrastructure as needed. While this provides flexibility, it leaves room for further automation in the future to improve the efficiency of the control loop.
4. **Capacity Planning and Troubleshooting:** CYNET technicians analyse the data gathered by perfSONAR, SNMP logs, and Zabbix to plan capacity upgrades, optimise resource allocation, and troubleshoot network issues. By continuously monitoring network health, CYNET can proactively address potential bottlenecks and improve overall service performance.
5. **Integration with Production Management:** Monitoring tools such as perfSONAR and SNMP logs are also associated with the Production Management domain because they provide real-time data on the operational status of CYNET's infrastructure. This real-time monitoring is essential for tracking runtime metrics and ensuring the smooth operation of production services.

2.2.7 Decoupling and Integration

The **Decoupling and Integration** functions in CYNET, aligned with the ODA framework, focus on managing the flow of information between different components of the network and service infrastructure. Currently, these processes are largely manual, outlining how data and operational tasks are transferred between systems and teams. These manual procedures describe how information moves from one system, such as the ticketing system (RTIR), to others, like Excel workbooks and monitoring tools. The current system involves manual processes for managing information flow, such as transferring customer requests, service updates, and monitoring data across different platforms. For instance, when a ticket is closed in RTIR, the service details and updates are manually entered into Excel sheets to ensure proper record-keeping and service tracking. CYNET sees significant potential for automating these manual processes in the future. Automation could streamline the transfer of information, improving accuracy and reducing human errors. Potential areas for automation include scripts for updating permissions, automated data synchronisation between the help desk system and service tracking sheets, and integrated workflows between cloud management tools like Azure and Office 365 and internal systems. As CYNET transitions toward orchestration, automation, and virtualisation, automating decoupling and integration processes will become key to improving efficiency and service delivery. This shift will reduce the need for manual intervention, enabling smoother and more seamless integration across CYNET's network and service infrastructure.

3 Conclusions

The CYNET architecture, while independently developed from the start and still in the early stages of its automation journey, is well-positioned to align with the ODA core principles and design concepts. The modular nature of the ODA reference architecture makes it highly adaptable to CYNET's current infrastructure, and its iterative design provides the flexibility needed to scale automation efforts over time. As CYNET implements orchestration, aligning with ODA's decoupling and integration approach will significantly streamline the process, especially in multi-domain orchestration, and will help offering new self-provided services in the future, like Campus Network Management as a Service (CNaaS).

CYNET's current architecture already strongly aligns with ODA's information governance principles. By utilising API-based functional building blocks, CYNET can more easily integrate its internal systems, such as the help desk, performance monitoring, and cloud management tools, with external systems where necessary. Using industry de-facto standard tools like Azure, Office 365, VMware, and perfSONAR creates a solid foundation for integration across multiple domains, ensuring compatibility with external services and other networks that follow the ODA framework.

Insights from the previous architecture analysis, combined with the adoption of Open APIs and TM Forum Frameworx standards, will support CYNET's ongoing digital transformation, enabling gradual evolution while ensuring future compatibility with other networks and service providers adhering to ODA standards. This flexible yet structured approach ensures that CYNET can continue to improve its automation, orchestration and integration capabilities over time while remaining aligned with international best practices and evolving industry standards.

In conclusion, CYNET's architecture, with its existing infrastructure and future automation plans, is well-suited for alignment with ODA principles. Key strengths include its modularity, the adoption of standardised APIs and tools, and the potential for seamless integration and automation across domains. As CYNET progresses, the ODA framework will provide a roadmap for further optimisation and digital transformation, ensuring long-term scalability and operational efficiency.

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Glossary

API	Application Programming Interface
CNaaS	Campus Network Management as a Service
CYNET	Cyprus National Research and Education Network
NMS	Network Management System
nmaas	Network Monitoring as a Service
NREN	National Research and Education Network
OAV	Orchestration, Automation and Virtualisation
ODA	Open Digital Architecture
OSS	Operation Support System
R&E	Research and Education
RITR	Request Tracker for Incident Response
WP6	Work Package 6: Network Development