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White paper

Telefónica's UNICA architecture strategy for network virtualisation

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A note about this white paper

This white paper was written by Analysys Mason with support from Telefónica's Global CTO organisation. Telefónica provided the information about its UNICA strategic plan, as well as guidance and access to its experts. The analysis in this report is Analysys Mason's, as is the editorial independence.

1. Executive Summary

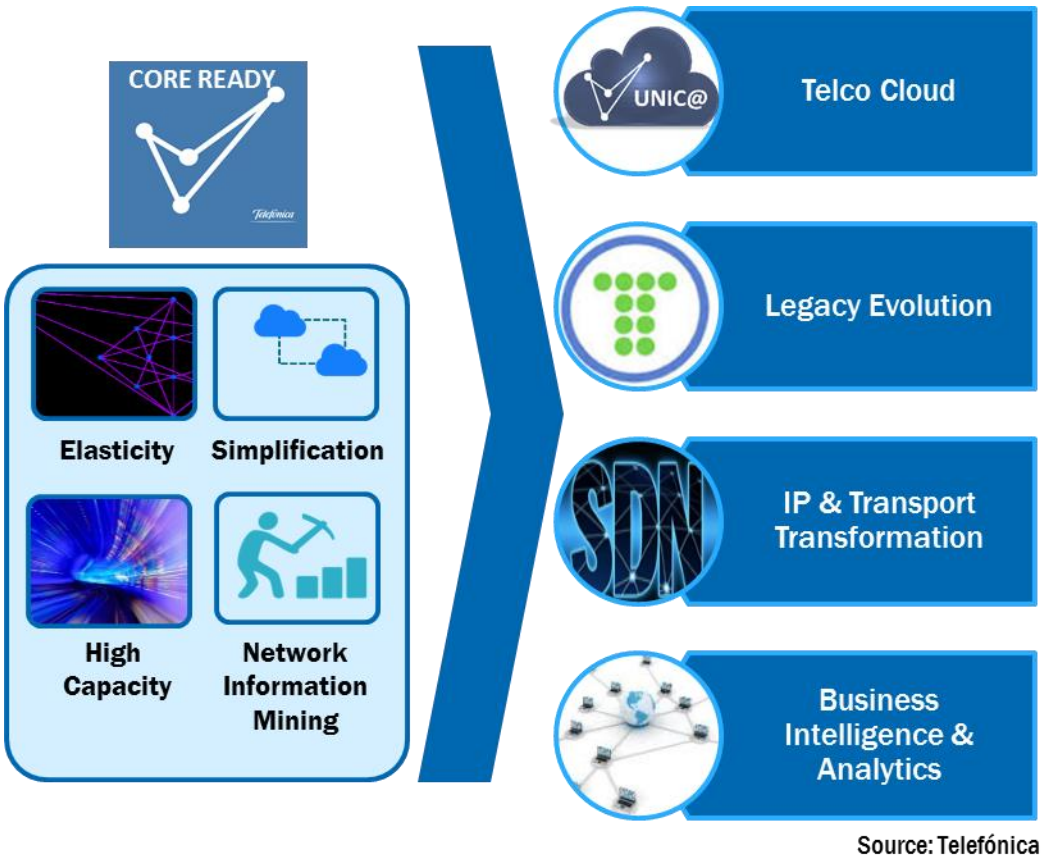
This Analysys Mason white paper, commissioned by Telefónica, explains Telefónica's network virtualisation or 'Telco Cloud' programme, including the foundational architecture that Telefónica is deploying to support future networks based on network function virtualisation / software-defined networking (NFV/SDN) technologies. It summarises the progress that the company is making in implementing NFV/SDN, from its starting point as an innovation project to the extensive programme that is today, with live deployments.

Telefónica was one of the first operators to recognise the potential of changing network architecture to incorporate cloud technologies, general-purpose hardware and a programmable network control plane. The company understood that this combination of technologies could radically transform both the cost basis and, more strategically, the capabilities and revenue-generating potential of the network. Telefónica envisages operating a future network that is fully virtualised and programmable, and which enables the company to cost-efficiently and flexibly align capacity with demand, simplify network complexity and reduce time to market for new service delivery.

As a result of its early investigations into network virtualisation, Telefónica became a founding member of the ETSI Industry Specification Group (ISG) on NFV in January 2013 and is also pursuing SDN as a critical enabler for NFV. As well as helping to define network virtualisation on an industry basis through ETSI and other initiatives, the company is also applying NFV internally.

Telco Cloud is one of four key levers associated with Telefónica's Core Ready network transformation programme. The primary objectives of the Core Ready programme (see Figure 1) are to provide Telefónica's customers worldwide with excellent connectivity in the years ahead and to support 5G requirements. The four levers of the programme, which include Telco Cloud, IP & Transport Transformation, Legacy Evolution, and Business Intelligence & Analytics, will drive the network capabilities and efficiencies that Telefónica needs to fulfil these objectives. These four pillars apply across the entire company and mandate a high level of integration between company platforms. They start to break down traditional organisational boundaries within Telefónica, encouraging collaboration, knowledge sharing and the development of solutions that encompass capabilities developed in multiple platforms.

Figure 1: Core Ready programme



As Figure 2 shows, Telefónica has an ambitious plan to virtualise its network end-to-end, across access, aggregation and backbone domains. Key to Telefónica's vision is a common, virtualised infrastructure – built using commodity cloud tools and hardware – that can support any service and application, whether an IT-like application (such as VAS, OSS and OCS) or a network-specific function (virtual network function (VNF), such as a virtualised core function, cloud RAN function and virtual CPE). From a network point of view, this infrastructure must be pervasive in order to host all the virtualised elements that compose the network and service platforms. Therefore, this infrastructure will sit in regional data centres and central offices, as this paper will explain.

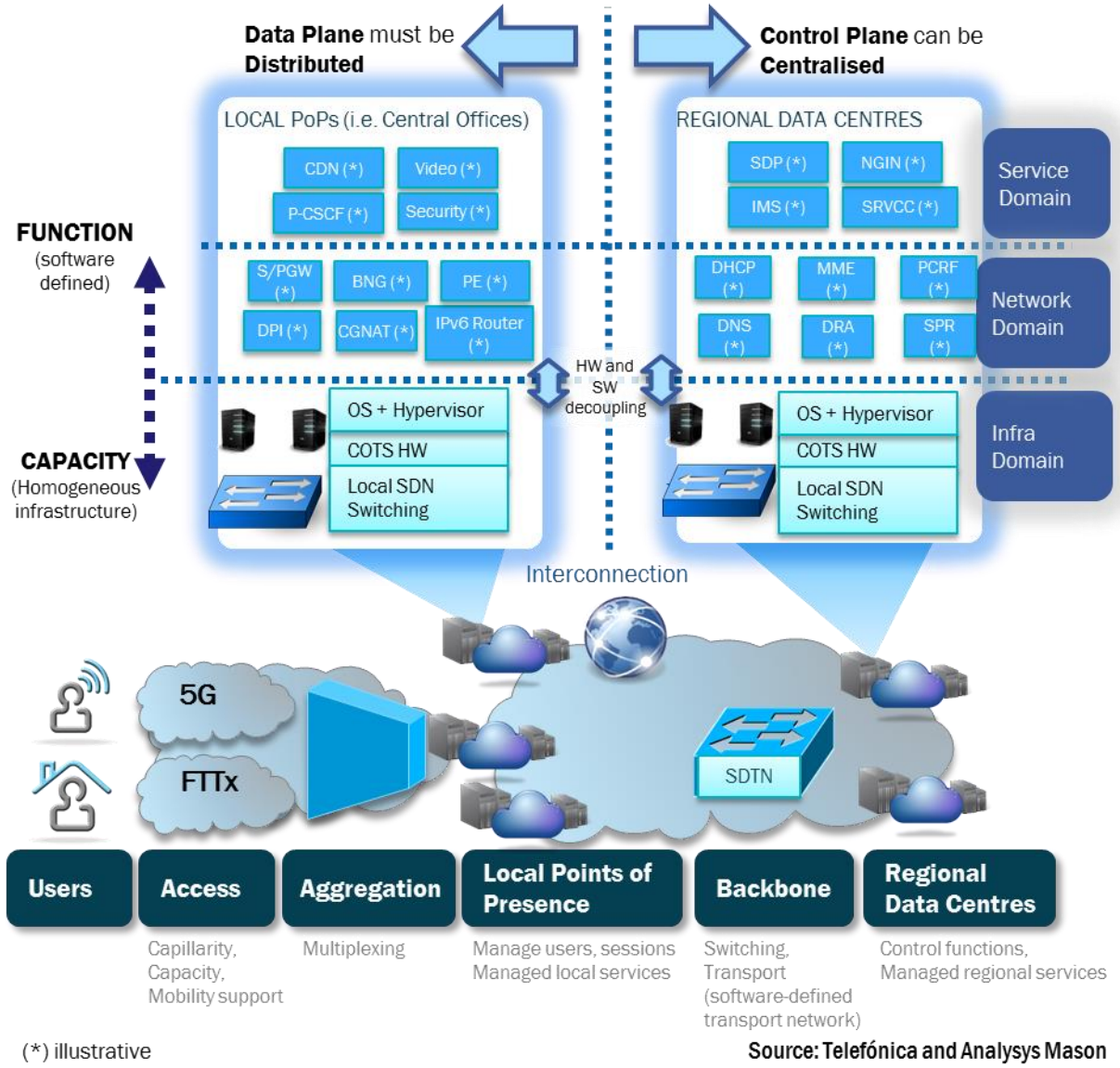
Within its UNICA programme, Telefónica has undertaken the challenging task of defining and building such an infrastructure for its entire organisation, including all its operational businesses (OBs). Telefónica chose to undertake this task because the available state-of-the-art cloud tools and general-purpose hardware have been designed for IT use and do not address the multiple, highly specific requirements of a carrier-grade networking environment. The issues that Telefónica is addressing in its UNICA Infra build and deployment include:

- the maintenance of network service-level agreements (SLAs) in a virtualised infrastructure
- the management of a geographically distributed infrastructure
- support for hybrid cloud environments so that generic applications and network workloads can be dynamically assigned to different internal, private and third-party, public clouds
- the automated, on-demand integration of new VNFs with the infrastructure

- the creation of a powerful network-wide API from which to drive the automated management of the entire UNICA environment and to abstract network management from the underlying technologies used to implement UNICA
- the co-existence of UNICA with the brownfield (traditional, physical) network.

Telefónica is pioneering solutions to these challenges in many cases.

Figure 2: Telefónica's end-to-end virtualised network vision



This paper provides a definition of UNICA and its key architectural components in section 2. Section 3 describes the way the UNICA infrastructure and components are deployed, while section 4 examines UNICA's operational requirements. Section 5 discusses the process and organisational transformation that the company needs to undergo as UNICA is rolled out across Telefónica's operating businesses, and section 6 outlines the roadmap for UNICA. Finally, in section 7 Analysys Mason assesses the challenges associated with UNICA and provides recommendations to Telefónica.

2. What is UNICA?

2.1 Definition of UNICA

Telefónica's UNICA programme is defining the company's reference architecture for network virtualisation, based on ETSI NFV concepts. ETSI NFV's architecture specification describes the components needed to run and manage VNFs and the network services in which VNFs participate.

ETSI NFV's architecture specifies:

- a common infrastructure that can host any VNF: the NFV infrastructure (NFVI),
- three layers of management and orchestration (MANO) that automate the management of the NFVI, VNFs and network services, respectively,
- interfaces and integration points between components of the ETSI NFV architecture and between NFV architecture components and external systems, such as element management systems (EMS) and OSS.

In addition to the ETSI NFV reference architecture, the UNICA programme includes:

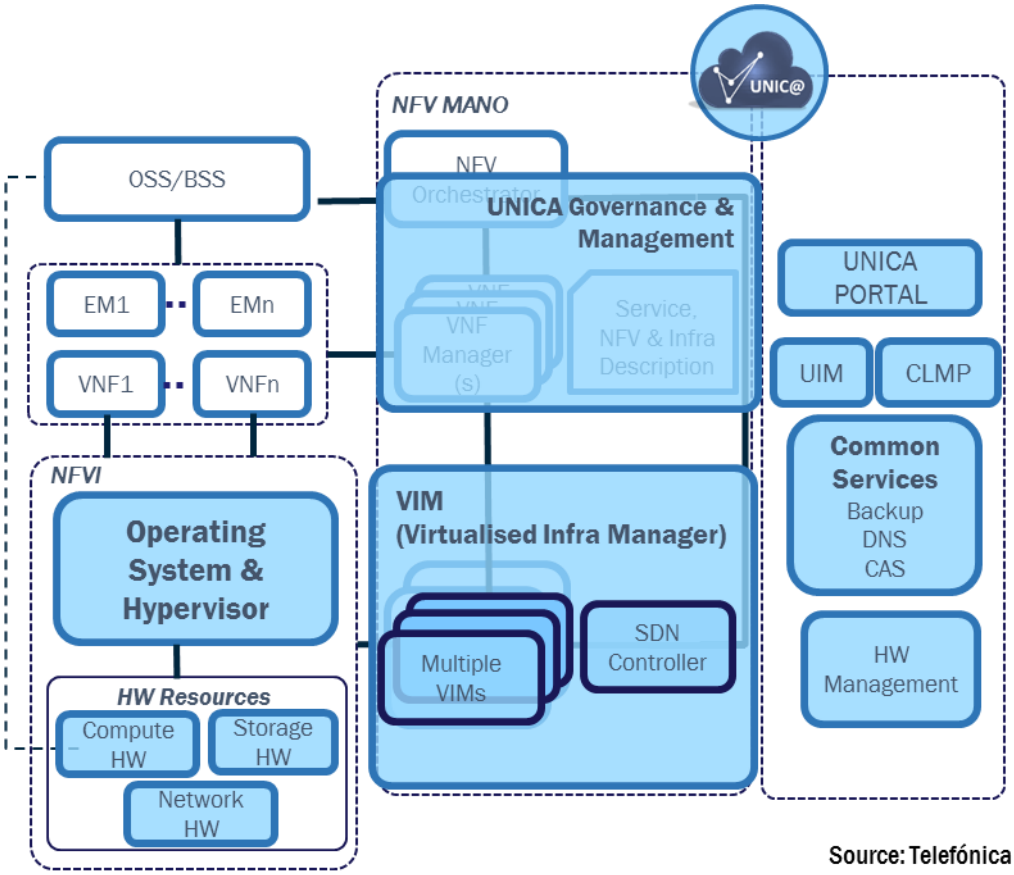
1. SDN components needed to support a Telco Cloud solution.
2. Components required to manage and supervise the entire infrastructure.

UNICA is based on open principles and uses open-source and commercial cloud technologies to ensure it is as future-proof as possible. It is designed to meet the stringent requirements of the network environment, including carrier-grade, performance and operational capabilities. UNICA is also designed for flexible deployment across multiple sites and cloud environments and to include end-to-end management extensions that support distributed deployments and other practical management requirements that are out of scope for ETSI NFV.

Figure 3 illustrates the four key components of the UNICA infrastructure architecture, which are described in more detail in the following sections. These components consist of:

- UNICA NFVI, the set of virtualisation technologies and physical resources that comprise the execution environment for VNFs
- UNICA Virtualised Infrastructure Manager (VIM), which manages the virtualisation environment and the connectivity between virtualisation elements, whether these are virtual machines or containers. Connectivity uses SDN capabilities that control both the physical and virtualised switching elements.
- UNICA Governance and Management, the set of capabilities that manage resources and match them to the needs of individual VNFs.
- UNICA Portal, UNICA Infrastructure Manager (UIM), Central Logs Management Platform (CLMP), Hardware Management and Common Services, which support user access to UNICA and additional tools to manage security and other aspects of the UNICA environment, respectively.

Figure 3: UNICA infrastructure architecture



2.2 UNICA NFVI

The UNICA NFVI consists of virtualisation technology and hardware assets: x86 compute servers, centralised storage hardware and network hardware (physical routers, switches, load balancers and firewalls) that together provide the capacity resources that VNFs can consume at runtime. UNICA intends its NFVI to be as open and flexible as possible, so it will support multiple hypervisors (KVM is supported now, support for VMware ESXi will follow shortly) and container management (Docker) in the future.

2.3 UNICA VIM

The UNICA VIM has two components: a cloud management system, which provides a single API across the different NFVI components so that they can be managed as coherent pools of cloud resources, and an SDN controller, which sets up basic, physical connectivity between physical and virtual elements. Intelligent, service-aware connectivity between VNFs is supported by UNICA Governance and Management. UNICA is standardising on the open-source, industry standard cloud management system, OpenStack, which it will source from multiple suppliers, including Ericsson, Red Hat and VMware.

2.4 UNICA Governance and Management

UNICA Governance and Management is an evolving module within UNICA. It is key to the pragmatic management of UNICA and its users, deployment options and resources. It enables UNICA to be integrated with brownfield network environments, as well as to stand alone in greenfield implementations. It encompasses two key capabilities within the ETSI NFV reference architecture: the VNF Manager (VNFM) and NFV

Orchestrator (NFVO). However, it has additional capabilities that support the distributed deployment of UNICA infrastructure and the management of multiple standards and products at VIM and NFVI level. It is also the component that mediates, through APIs, communications between UNICA infrastructure and Telefónica's existing OSS/BSS.

At present, UNICA Governance and Management focuses on managing and orchestrating NFVI resources across sites, multi-tenancy capacity, hardware types and VIMs. It maintains an inventory of physical and virtual resources and a catalogue from which UNICA users can select appropriate resources to consume. The multi-tenancy capacity supports the slicing of infrastructure since it allows multiple instances of VNFs to be deployed in parallel, guaranteeing isolation between instances. In a future release, UNICA Governance and Management will add further support for ETSI NFVO orchestration, including the ability to lifecycle manage multiple VNFs in a network service chain as a single service-level entity.

UNICA Governance and Management is also responsible for applying UNICA security measures, including authorisation, access controls and user isolation guarantees. It automates VNF lifecycle management using industry standard templates. Using VNF templates, UNICA Governance and Management automates the deployment, starting, stopping, monitoring and deletion of entire VNFs or specific VMs within a VNF. While scale-out of VNFs/VNF components is manual today, automated scale-out is on the UNICA roadmap. Telefónica's preference is to have a generic VNF lifecycle management capability that can apply to any VNF, regardless of vendor.

UNICA Governance and Management provides a basic level of NFV management and orchestration (MANO) capability now, but this will be evolved in future into the more sophisticated capabilities that Telefónica is developing with the Open Source MANO (OSM) community. Telefónica is leading this important industry initiative, joined by more than 70 service providers and vendors. The OSM community is working together on a common way of modelling VNFs (Common Information Model) so that they can easily and automatically be imported into an operator's NFV environment without the need for a lengthy, manual integration process, and independently of the technologies chosen for implementing the VIM and SDN functionalities. This will encourage the development of a VNF ecosystem that will increase the choice of VNFs available to service providers, and this means that vendors will only need to model their VNFs once to run on multiple service providers' infrastructures. The OSM community is working on the support for heterogeneous infrastructure and advanced resource allocation requirements that OSM will need to fulfil this vision.

Telefónica is an active developer of OSM, and as such, it is well-positioned to ensure a smooth migration of OSM capabilities into UNICA Governance and Management as they mature.

2.5 UNICA Portal and other Components

These modules are key to the operation and supervision of the entire UNICA infrastructure and are critical to the provision of a carrier-grade solution.

The UNICA Portal provides the user interface to UNICA capabilities, supporting two different perspectives: a UNICA infrastructure view; and a UNICA tenant view.

Ease of use is a key UNICA design principle. The portal is the same for specific users, called tenants, and administrators. Access control is based on a clear definition of roles so that different users are restricted in their access to data and ability to perform tasks according to their roles. The UNICA administrator has a full view of the UNICA domain and has an overview of all points of presence, tenants, and capacity resources. The UNICA administrator is authorised to create new tenants.

The UNICA infrastructure view enables Telefónica to provide data centre-as-a-service (DCaaS), both to internal virtual network builders and to third-party tenants (such as other service providers – see section 3.2 for more detail) that want to host VNFs and network services on Telefónica's NFVI. The UNICA infrastructure view therefore supports the management of the entire infrastructure and the creation and management of multiple tenants on top of the infrastructure.

The UNICA tenant view supports tenants of the infrastructure, who simply wish to manage their private NFVI resources and the VNFs that consume them.

The UIM (UNICA Infrastructure Manager) is the module that provides performance and fault information used to manage the UNICA infrastructure.

The CLMP (Central Logs Management Platform) is the module that correlates and presents UNICA logs information.

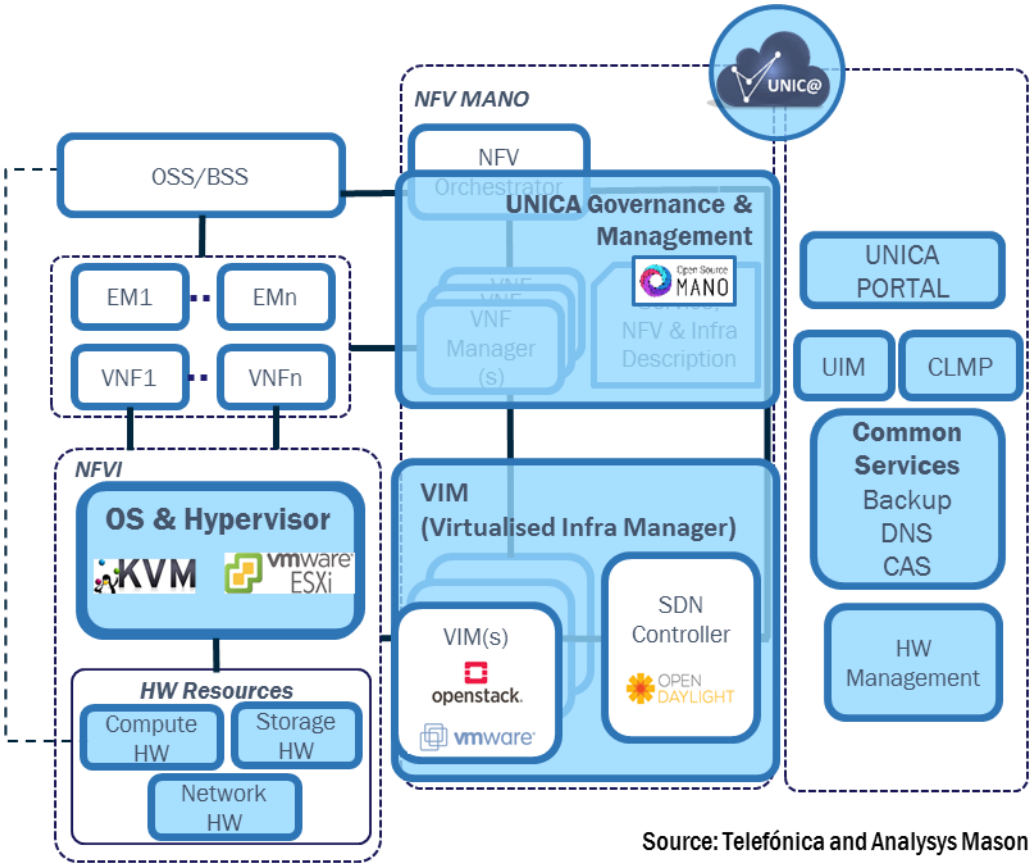
UNICA Common Services are the set of services that run on the UNICA Platform and provide common functionality to all VNFs. They are DNS, Backup, NTP and Certificate Authority Management.

Hardware Management is the module that manages all the hardware components from which the UNICA platform is built.

2.6 UNICA Infrastructure Platform

Figure 4 summarises the technology choices that Telefónica is making to realise its UNICA architecture. This paper calls an implementation of the UNICA architecture, using any or all of these technologies, the **UNICA Infrastructure Platform.** Openness is the key criterion that determines whether a specific technology implementation is included in the UNICA architecture.

Figure 4: OSM-Compliant UNICA Infrastructure



3. UNICA deployment concepts

This section discusses the concepts that govern the way a UNICA Infrastructure Platform is provided to UNICA users (tenants) as a Virtual Data Centre and how the Platform is deployed across different types of points of presence: data centres of different dimensions and central offices.

3.1 UNICA Infrastructure Platform deployment concepts

UNICA's physical infrastructure (hardware, storage, network elements, racks, power and cooling) and its management systems are deployed in **points of presence (PoPs).** Telefónica envisages that its OBs will deploy UNICA infrastructure in different types of PoPs to suit their specific needs. The company has defined two types of PoP: UNICA data centres (UNICA DCs) and UNICA central offices (UNICOs).

UNICA PoPs (DCs and COs) are grouped into **UNICA infrastructure domains**, where each domain has governance and management responsibility for the PoPs under its control. Telefónica is defining UNICA

infrastructure domains at the country level at present: Argentina, Colombia, Germany and Peru OBs are implementing UNICA domains in 2017. Domains may be more fine-grained within a country (for example, a 'Germany Mobile Core Domain') or cross-country and service-specific, such as a 'European Mobile Core Domain'. These examples merely serve to illustrate that UNICA Domains can be flexibly defined.

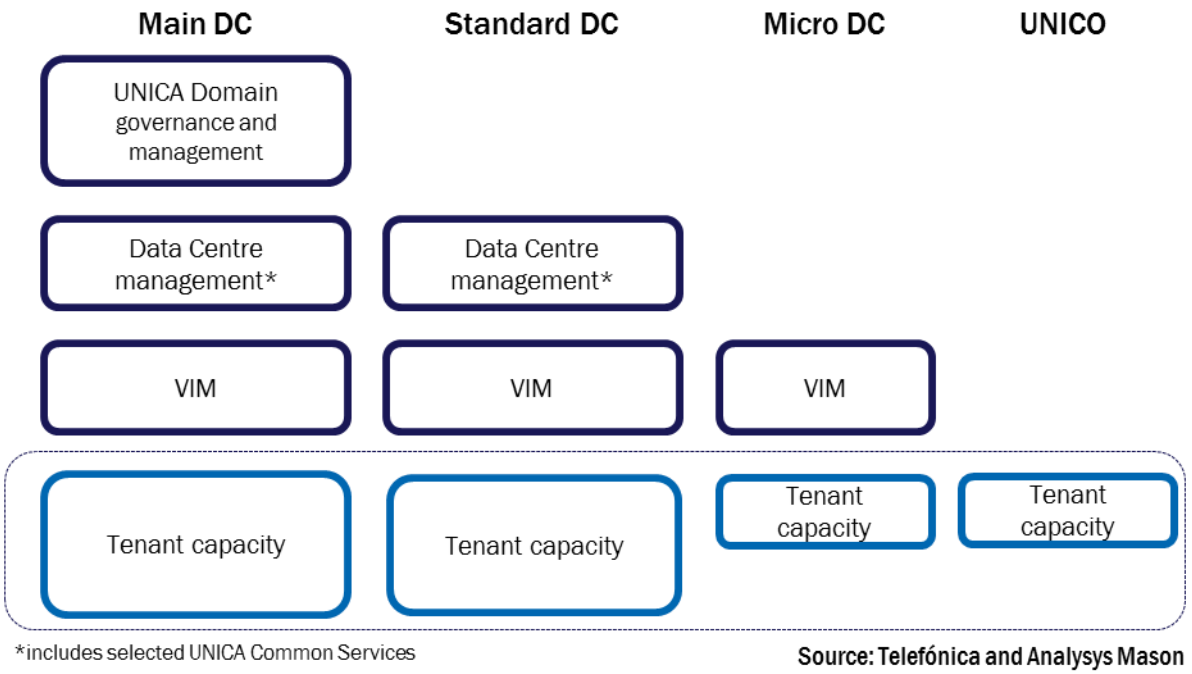
A UNICA DC is deployed where tenant demand for compute capacity is sufficiently large to justify dedicated NFV infrastructure. However, Telefónica defines three different sizes of UNICA DC, so that it can flexibly support service demand in different locations within a UNICA domain without having to over-provision or over-centralise UNICA infrastructure.

- **UNICA Main DC** is a large, centralised DC that houses the entire UNICA Infrastructure Platform and is the central point for Governance and Management for the entire UNICA Domain. Telefónica envisages that it will have a maximum of two Main DCs per UNICA Domain.
- **UNICA Standard DC** is a medium-sized data centre that can be distributed at regional level within a country, depending on service demand.
- **UNICA Micro DC** is a UNICA infrastructure implementation designed to fit in a more distributed location, which can potentially scale up to a Standard DC as demand in that location grows.

A UNICO is an evolution of Telefónica's existing central offices so that they can support distributed forwarding plane functions and run VNFs needed to serve customers at the network edge (for example, residential virtual customer premise equipment (vCPE) and virtual broadband network gateway (vBNG)). A UNICO will be based on existing physical switching and routing elements in the CO. These will be extended with x86 processing capabilities to support virtualised functions, and the CO NFV environment will be managed from UNICA DCs in the same domain. UNICOs will leverage the relationship with SDN described in section 3.3. Support for UNICOs will be added to the next release of UNICA infrastructure.

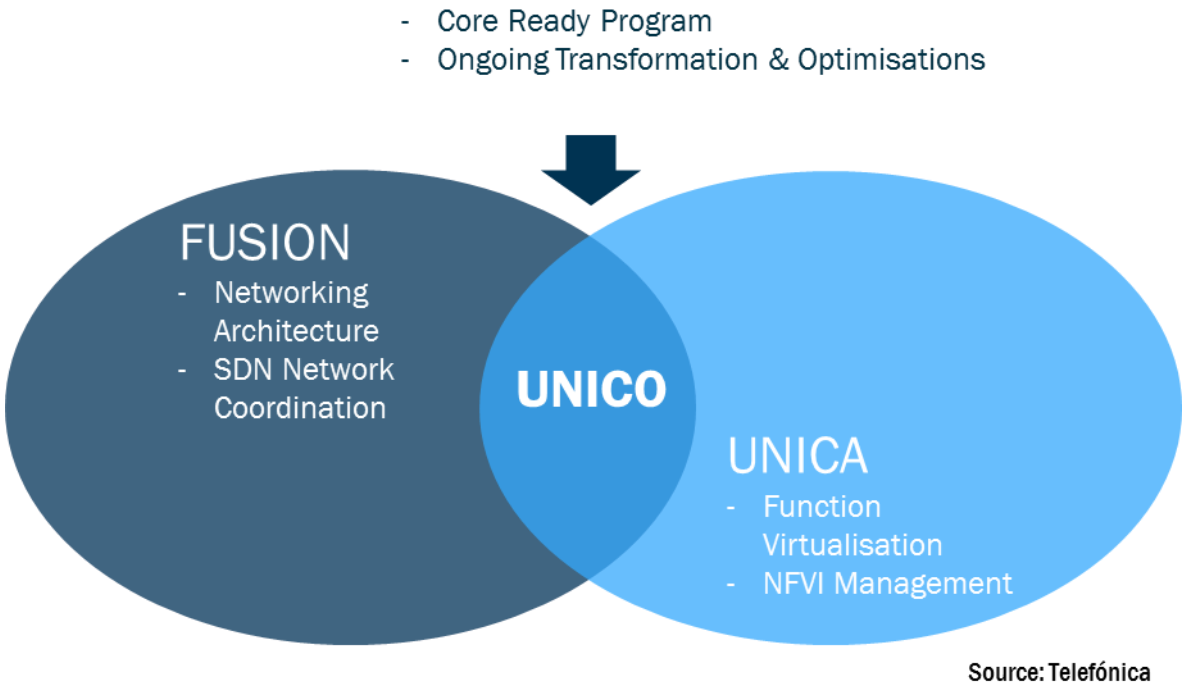
Figure 5 shows the capabilities associated with each type of PoP: the three sizes of UNICA DC and the UNICO.

Figure 5: UNICA Point of Presence types



UNICA's PoPs concept maps to Telefónica's FUSION architecture, which underpins the SDN-based IP & Transport Transformation lever of its Core Ready programme. Figure 6 illustrates the relationship between the FUSION and UNICA programmes and their critical convergence in the UNICA Central Office (UNICO), where UNICA will depend on FUSION appliances and SDN capabilities. This is an example of how UNICA can be integrated with other pillars of the company's Core Ready programme. (See section 3.3 for more on IP & Transport Transformation, FUSION and UNICA.)

Figure 6: FUSION and UNICA relationship and responsibilities



Source: Telefónica

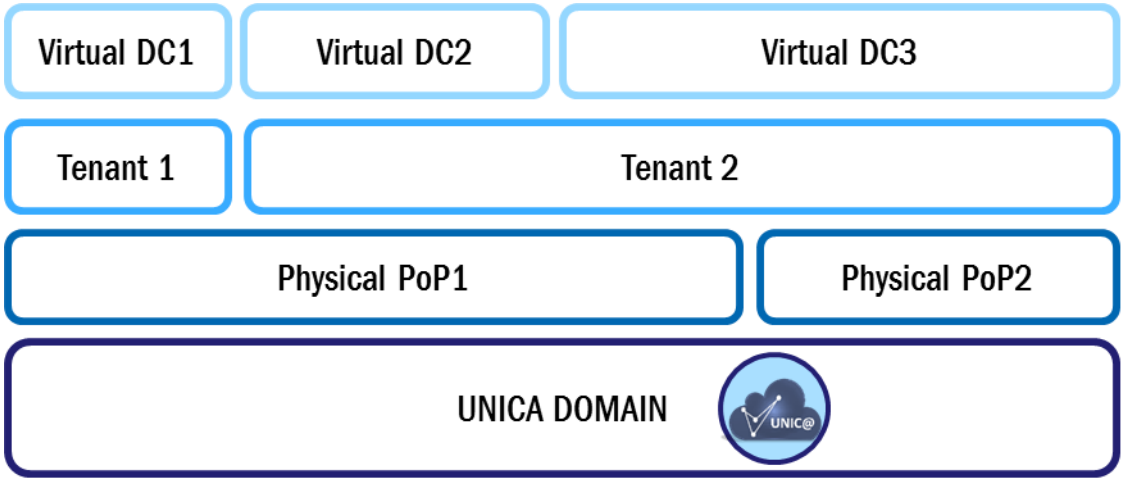
Network locations are arranged hierarchically into four levels in the FUSION architecture, where higher levels can also host lower level locations and lower level locations are increasingly distributed.

Telefónica will need to collocate NFV infrastructure with FUSION network locations as its network becomes virtualised. UNICA supports FUSION's layered topology, providing PoPs of different sizes that match the needs of different levels of the network.

3.2 Tenants and Virtual Data Centres

A **tenant** is a client of the UNICA Infrastructure Platform, to which UNICA resources from different Points of Presence are allocated. These resources can be grouped by the tenant together in a logical way to define a **Virtual Data Centre (VDC)** (see Figure 7Error! Reference source not found.**).** Although a VDC is based on shared physical infrastructure within a single data centre or central office, or even spanning multiple data centres or central offices, logically, it is a standalone entity with its own management, IP addressing and connectivity control. A tenant deploys and manages its VNFs within a VDC. A tenant may own multiple VDCs, but multiple tenants may not share a single VDC.

Figure 7: VDC logical placement view



Source: Telefónica and Analysys Mason

3.3 UNICA and SDN

Telefónica's IP & Transport Transformation lever is responsible for defining the company's SDN strategy across different network layers and technologies (network domains, such as access, core, metro and backhaul layers, and physical, IP/MPLS, optical and microwave technologies) between UNICA domains.

SDN is a key enabler of network virtualisation, because UNICA users need to set up network connectivity in the same programmable way that they create compute and storage resources to support their VNFs and network services. UNICA therefore needs to work with the SDN capabilities that are part of the FUSION architecture, and compatibility with UNICA is an important objective of IP & Transport Transformation.

SDN provides a common abstraction of network resources in each network domain, allowing them to be managed and controlled programmatically through standardised APIs. The FUSION architecture has a concept of an SDN Master Layer with end-to-end visibility across network domain-specific SDN controllers to support the programmability of the entire network.

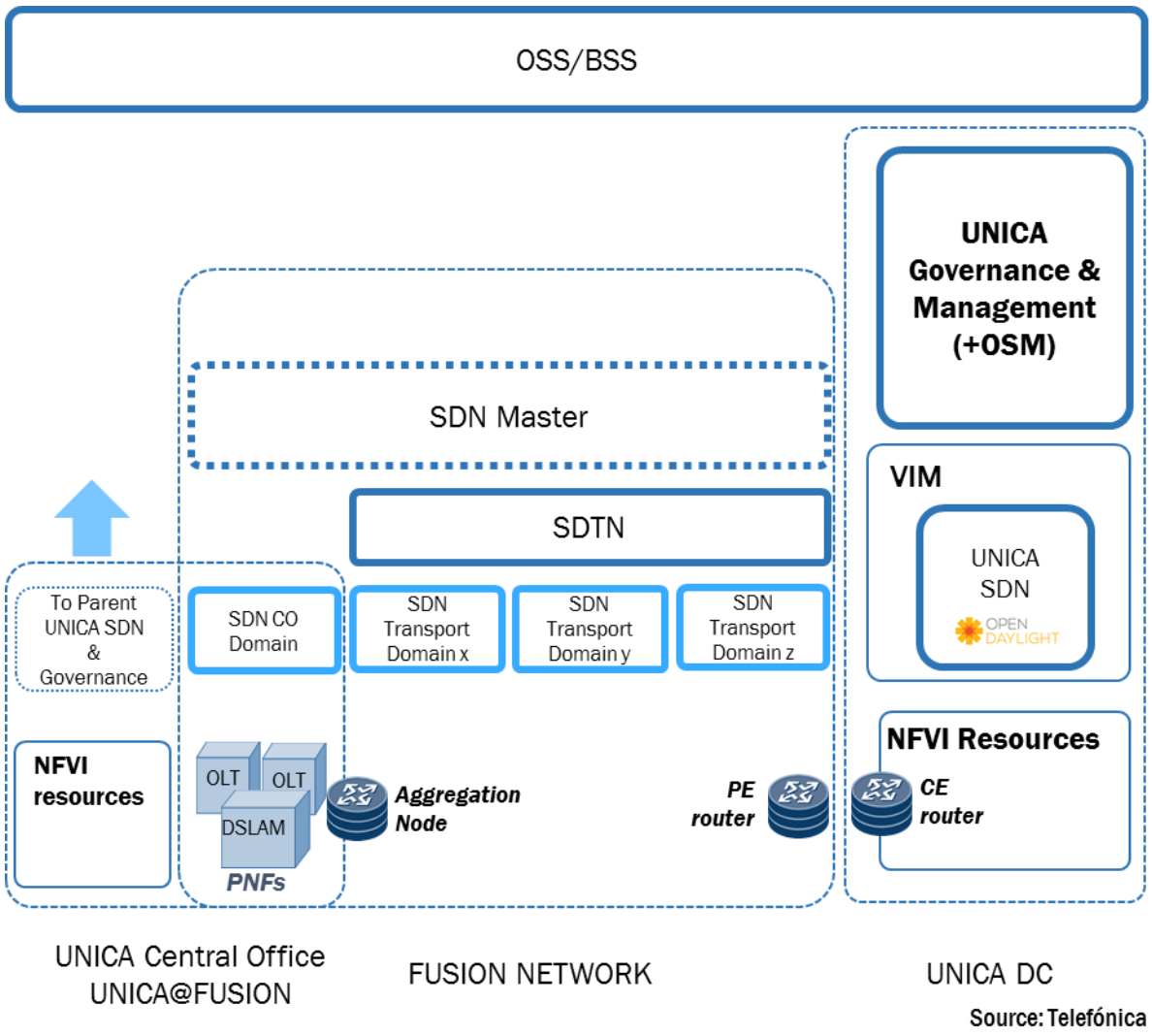
The UNICA Infrastructure Platform uses different combinations of FUSION-defined SDN controllers to:

- connect **intra data centre** components, including VNF components, VNFs and VNFs in service chains (network services)
- support **inter-data connectivity,** that is between PoPs in a UNICA domain
- connect **external networks** to a UNICA domain.

It is envisaged that SDN controllers themselves will become VNFs hosted and managed within the UNICA Infrastructure Platform.

Figure 8 illustrates the relationship between FUSION SDN and the UNICA architecture.

Figure 8: UNICA end-to-end architecture showing its integration with SDN



4. UNICA operational considerations

UNICA imposes new operational requirements on Telefónica. VNF onboarding and ongoing deployments require a fundamental shift in how technology is procured and added to Telefónica's network. UNICA also imposes new network security approaches. Finally, Telefónica's network functions and capabilities will evolve over time as dictated by business requirements and technology availability. UNICA infrastructure and management must interwork with existing business and operations support systems (B/OSS) during a long transitional period.

4.1 Overall UNICA operational requirements

Telefónica has created a set of operational and management requirements to guide UNICA's evolution. These requirements cover operational impacts, operational processes, and organisational impacts. This section focuses

on operations-related requirements and Section 5 covers the organisational impacts and related processes, focusing on governance models and skills and cultural changes mandated by UNICA.

UNICA is based on several guiding principles.

- Any new requirements must be evaluated against existing operations and maintenance processes and tools to ensure that end-to-end infrastructure and service performance is maintained at acceptable levels.
- End-to-end carrier-grade performance and security must be ensured.
- Integration efforts should be reduced where and when possible (for example, by limiting integration points, such as using a generic VNFM, rather than multiple specific VNFMs).
- New operating models will be created over time. These models will be based on the decoupling of the UNICA infrastructure and the functions that run on it for both the engineering and the deployment cycles. However, the operating models must also allow an integrated, end-to-end view of services and performance across hybrid legacy and virtual solutions.
- Wide-scale deployments must be highly automated, with configuration and performance/fault analysis based on automated responses to real-time data analysis.
- The MANO is contained within UNICA. MANO functions are not distributed to other OSS/BSS outside UNICA, and ETSI OSM will define UNICA's Governance and Management functions.

4.2 VNF deployment

VNF deployment on UNICA infrastructure is based on the principle noted in section 4.1 of limiting integration effort where and when possible. The preferred mode of deployment is to orchestrate and control the VNF using the capabilities contained within UNICA. VNF consumers must first define and create a target VDC to host the VNF, and then onboard and instantiate the VNF on that VDC through the UNICA Portal. All lifecycle management related to the UNICA infrastructure can be done via the Portal in this preferred mode. Lifecycle management of the virtual function can be carried out by the function itself, if it includes its own specific VNF manager (S-VNFM), or from the Portal using the generic VNFM (G-VNFM) functionality of UNICA Governance and Management, as noted in section 2.4, if it does not.

UNICA can accommodate several other modes of VNF deployment that support interaction with other components, such as an S-VNFM or EMS, which are external to the VNF and provide VM monitoring or supervision or VNF scaling. However, at this stage Telefónica avoids such VNF deployment modes to limit integration requirements and deployment complexity.

4.3 UNICA security

UNICA creates multiple VDCs within a single physical data centre to host heterogeneous workloads from different tenants and vendors, as depicted in Figure 7**Error! Reference source not found.**. Workloads must therefore be isolated and hardened, with security applied both to the infrastructure and VNFs. Telefónica aims to build this security into UNICA from the very start of infrastructure and application (VNF) lifecycles, taking it through into production. Security will continue to be tested once infrastructure and applications are live. Indeed, Telefónica reports that over 50% of its ongoing infrastructure and functional certification efforts are dedicated to ensuring security requirements are met.

UNICA infrastructure environment security is required at many levels, such as identity and access management; API and web application use; software management (VMs, OS, hypervisor, patches, anti-virus), and database and log management. Services running on UNICA infrastructure must also be protected through identity management and authentication, risk management, layered security control, log-enabled traceability and so on.

These embedded infrastructure and service security requirements are common globally across UNICA. However, there may be additional security requirements, such as regulatory or government legal mandates, which are specific to a country or local domain. UNICA compliance with these security requirements will be driven at the operational business or local level.

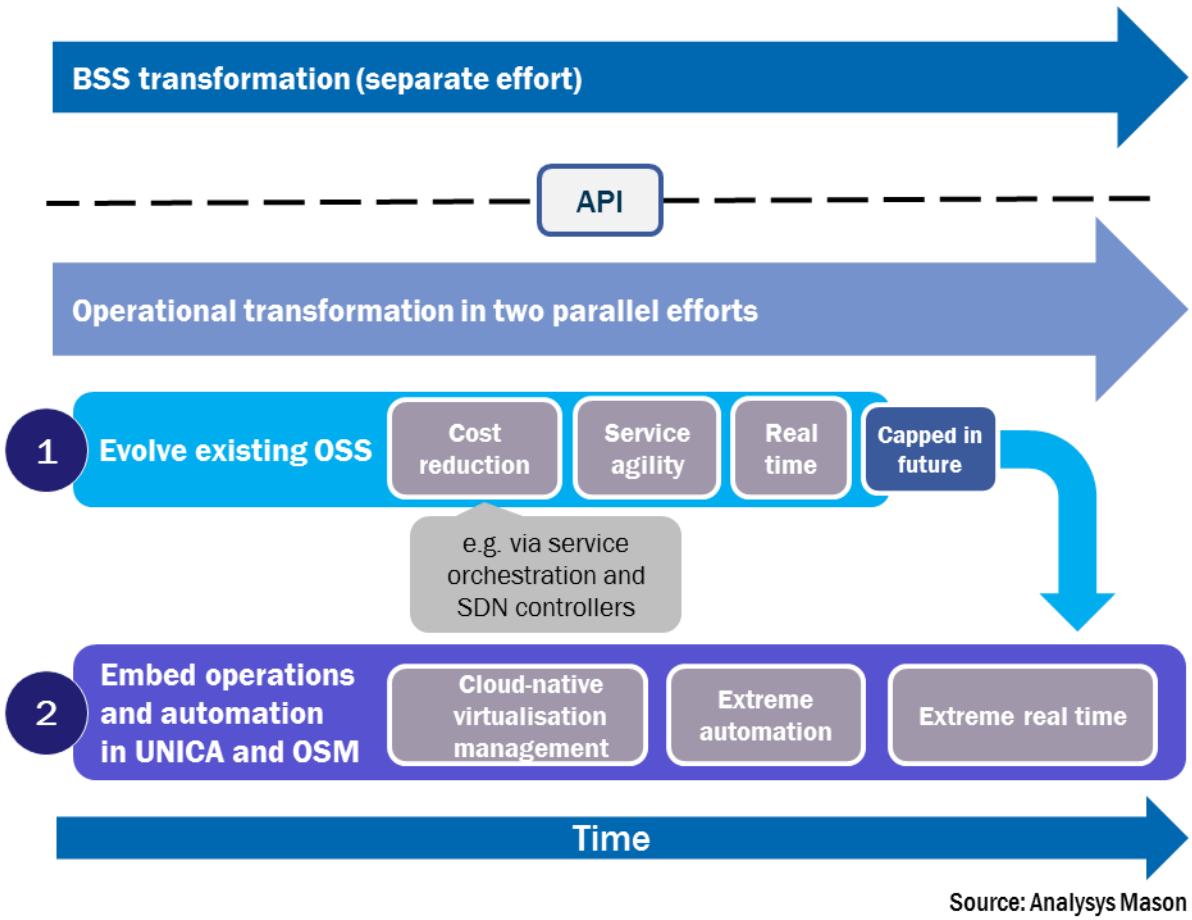
4.4 B/OSS integration

Telefónica is fundamentally not trying to build a perfect 'clean slate' architecture. Instead, it is taking a pragmatic approach to transforming its network to the target UNICA architecture over a series of steps.

Telefónica expects that there will be no changes to the existing operating model or OSS/BSS capabilities in the first step, vertical integration. (See section 6.1 for more on VNF deployment steps.) UNICA will need greater isolation from the OSS/BSS as implementation progresses to avoid integration complexity. The NFV MANO capabilities needed for UNICA G&M, as explained in Section 2.4, are contained wholly within UNICA. Integration of MANO capabilities with external OSS/BSS functionality takes place through the UNICA Infrastructure APIs.

Telefónica's OSS transformation from external, attached systems to embedded capabilities will happen over time, as shown in Figure 9. Traditional OSS will continue to be used (and improved as required) for PNF and VNF management until UNICA's embedded orchestration and management can take over. UNICA and OSM will be enhanced over many years to automate functions that are performed by OSS today. Telefónica's investment in 5G, which will increase significantly in 2020+, will provide an opportunity to virtualise most of its network. It is likely that cloud native, extreme automation and real-time embedded operational support will be essential at that point – evolving existing OSS may no longer be feasible and they may be capped.

Figure 9: OSS evolution will continue until UNICA with OSM creates a new platform for embedded virtual network management and automation



The network will be transformed over an extended timeline, so Telefónica will need to manage a hybrid physical–virtual network for a long time. Changing the way physical elements are managed will require a clear business benefit. The existing OSS will interwork with UNICA and OSM through APIs. Telefónica will make pragmatic updates to the OSS until it must pivot and transfer physical network management to UNICA/OSM. BSS integration with UNICA will be through the Governance and Management module using UNICA Infrastructure APIs.

5. UNICA organisational and process transformation

UNICA will alter network technology planning, procurement, engineering and operations processes, therefore its implementation will require the transformation of Telefónica's organisations. UNICA unifies infrastructure activities globally across Telefónica's OBs and enables common infrastructure planning and engineering for all VNFs. Infrastructure technology, engineering, operations, demand management and planning will be coordinated globally. Telefónica is establishing clear governance, growing specific resources (such as software-controlled network engineering skills) and shifting organisational culture toward software-centric networking. It

is also creating two specialised but interrelated certification teams: one for infrastructure and one for applications and network functions.

5.1 Training and skills upgrades

Telefónica recognises the need to develop UNICA-related skillsets in multiple areas. Employees must become familiar with at least some of the following, depending on their role: the UNICA architecture concept; virtualisation technologies such as hypervisors and OpenStack; cloud architecture and tools; NFV architecture and the concept of MANO; NFVI dimensioning and deployment, and the end-to-end operational processes and troubleshooting associated with both NFVI and VNFs.

Telefónica will draw on the knowledge of virtualisation that already exists across the company in the business and solution services units within its OBs. The company will formally train selected teams on the management and operational aspects of UNICA. A number of these teams will be part of the UNICA Centre of Excellence described in section 5.2, while Centre competencies (such as certification) will be extended to teams within the operational businesses.

The GCTO organisation is responsible for high level training around both the UNICA concept and the activities needed to initiate a UNICA deployment. It will train project teams on the UNICA concept, the deployment use cases for a specific VNF, dimensioning guidelines, and the required organisation and operational models. Operations personnel will receive training on UNICA installation and assurance processes, including fault and performance management, troubleshooting and lifecycle management. Planning and engineering teams will learn how to dimension the UNICA infrastructure and dependent tenant VDCs and VNFs, as well as gain detailed knowledge of UNICA engineering rules and requirements for individual VNFs.

5.2 UNICA Centre of Excellence

Telefónica expects to build its UNICA Centre of Excellence in 2018; it is in the process of defining the specifics of its structure and associated processes. The Centre will create a collaborative environment for the global experts engaged in defining and executing the first UNICA deployments. The Centre will be physically distributed and the responsibilities will be spread across the company's operational businesses. The Centre will have global labs in Spain, and local labs in every Telefonica operator.

The Centre of Excellence's key roles and responsibilities will be divided among teams responsible for areas such as the business management and governance of the UNICA Infrastructure Platform; Platform certification; innovation, VNF certification and demand management; engineering and planning; technology, security, procurement and deployments, and country domain management.

Centre of Excellence global process

Telefónica has defined a detailed business process framework, based on eTOM and ITIL best practices for service-focused businesses, and a process map that defines four key UNICA processes: Infrastructure Strategy Planning; Infrastructure Products Creation and Certification; Domain Lifecycle Management, and Global VNF Certification. The process map begins with business requirements and goes on to describe formal and detailed design, structure, documentation and communication plans. The goal is to create streamlined processes that OBs can use to effectively and efficiently align their local UNICA projects and achieve the desired business results.

Global labs

In addition to the current NFV Reference Lab, where new technologies are continuously tested for potential inclusion in the UNICA roadmap, Telefonica has a UNICA Global Lab to certify all new versions of the UNICA Infrastructure Platform. Telefónica is also creating a global VNF certification lab to test VNFs under consideration for UNICA deployment. Telefónica is seeking a partner to manage the VNF certification effort.

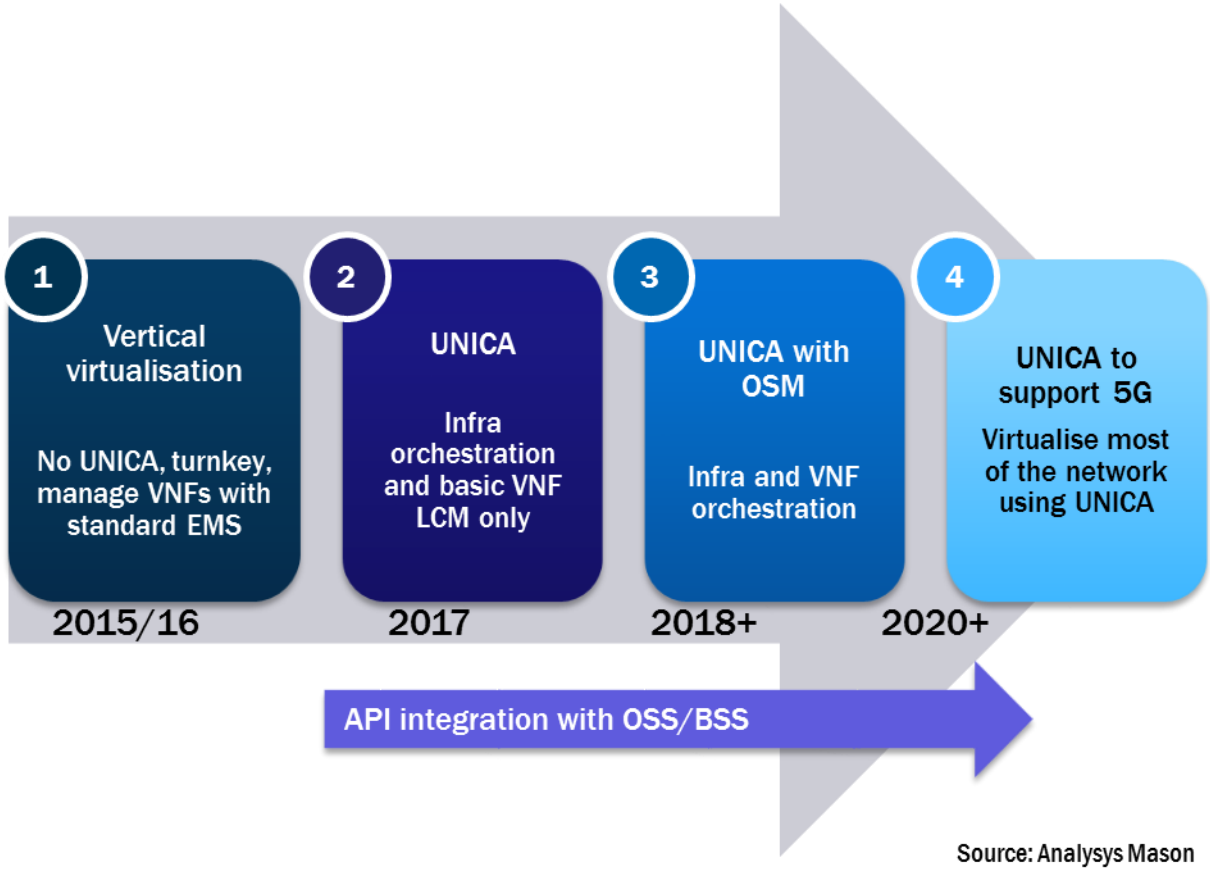
The Centre of Excellence will act as a catalyst for cloud- and virtualisation-related innovation activities. This role will help Telefonica to evolve UNICA infrastructure in line with industry solutions, relevant open source projects and standards.

6. UNICA technology and deployment roadmap

6.1 UNICA deployment roadmap

Telefónica's virtualisation deployment roadmap can be broken down into a series of steps, as depicted in Figure 10. Telefónica has a timeline for moving from step to step, but timing may shift to accommodate implementation of the best mix of mature technologies that will enable it to meet its business objectives.

Figure 10: Telefónica's four main UNICA deployment steps



Source: Analysys Mason

There are four major steps in Telefónica's virtualisation journey.

- **Vertical virtualisation.** Telefónica will deploy VNFs such as vEPC without the horizontal UNICA infrastructure platform. Instead, Telefónica contracts with a vendor for a turnkey NFV solution (Huawei for vEPC, for example)[1] that is managed using existing operational processes and existing OSS such as EMS/NMS. Such solutions do not require changes to the company's operating model or to the skills of technology and operations personnel.

  Vertical virtualisation is explicitly not the target architecture envisioned by Telefónica's UNICA strategy. However, this interim approach allows the company to cap its legacy physical approach to building network capacity, lower the deployment risk of a virtualised approach, and gain critical experience with software-controlled networks. Vendors agree to guarantee scalability and dimensioning of their solutions, interoperability with Telefónica's performance management and fault management systems, and end-to-end level 3 support of the solution. Any SDN functionality required by the vertically-virtualised solution will remain internal to that solution rather than integrated with Telefónica's SDN domains to simplify the transition to the UNICA environment when it is warranted. Further, Telefónica requires its vertical virtualisation vendors to meet minimum conditions that include a commitment that the VNFs and associated licences and hardware can be reused on the UNICA platform when Telefónica is ready to do so globally or in a specific geographic domain. Vertical virtualisation will be used by operating businesses until they implement the UNICA platform.

- **Horizontal virtualisation.** The UNICA Infrastructure Platform, as noted in section 2.1, is built on ETSI NFV architecture and cloud concepts with additional functions. Ericsson supplies the NFVI and related support for UNICA Infrastructure, which is the only infrastructure solution globally that will support VNFs.

- **Horizontal virtualisation with OSM.** Telefónica will align the UNICA roadmap with OSM to enhance the governance & management layer. OSM will bring Telefónica many benefits. These will include a common way of modelling VNFs, avoiding complex and lengthy onboarding and integration processes, and full lifecycle automation of VNFs and network services, and wider support for different VIM and SDN technologies.

- **UNICA to support 5G**. Telefónica will increase its investment in 5G in 2020+, which provides a great opportunity to use UNICA as a base for 5G network innovation.

Integration of UNICA with Telefónica's full OSS/BSS stack will be through UNICA Infrastructure APIs, as explained in section 4.4.

6.2 UNICA technology roadmap

UNICA's roadmap includes releases for the infrastructure platform and for its management, which will evolve to incorporate new networking and telecommunication business requirements. These requirements are identified through the NFV Reference Implementation Lab. The UNICA roadmap will also be co-ordinated with other Telefónica innovation initiatives, such as Customer Centric Network Innovation (CCNI). Future releases will support OSM, additional VIM technologies, provide full generic-VNFM support, and add other functional improvements.

[1] See Analysys Mason's case study on Telefónica's vEPC vertical virtualisation based on Huawei's turnkey solution: http://www.analysysmason.com/Research/Content/Case-studies/Telefónica-Huawei-vEPC-Apr2017-RMA07-RMA16-RMA18/

OSM, as an open source project, has its own technology roadmap driven by the OSM community – see section 8.1 for links to more detailed information on OSM. The UNICA roadmap will remain aligned with the OSM roadmap, ETSI NFV, and future 5G specifications.

7. Analysys Mason conclusions and recommendations

7.1 Assessment of UNICA

Telefónica has one of the industry's most ambitious and forward-looking visions for a future network based on NFV/SDN technologies. It has been working on its UNICA programme for more than 4 years, during which time it has built up a wealth of knowledge and expertise through often painful, but necessary, experience. Analysys Mason believes that Telefónica has the authority and insights to overcome the technological challenges and complexities posed by network virtualisation as a result. UNICA has a well-founded and thoughtful architecture that does not compromise on original ETSI NFV principles: independence from vendor-lock-in at every layer of the architecture; the use of commodity and, where possible, open-source, cloud technologies, and the encouragement of market innovation through UNICA's sponsorship of open-source communities. Telefónica also deeply considers and enriches the ETSI NFV architecture with practical extensions that take network characteristics and carrier-grade requirements into account. UNICA is designed for flexibility and evolution, anticipating the virtualised network needed to underpin 5G use cases.

Telefónica is playing an important role in defining the new operations for an NFV environment through its leadership in developing a key UNICA component, OSM. Telefónica has made the wise decision to create a community around OSM and the level of industry support that OSM is receiving is evidence of a strong market need for this kind of leadership. Telefónica's OSM initiative is similar in intent to AT&T's ECOMP and China Mobile/China Telecom's OPEN-O (now converged as ONAP), but OSM is taking a community-based approach to building NFV orchestration based on a community-derived common information model.

UNICA is technically strong and is being successfully introduced into Telefónica's OBs. However, the company will not reap the full benefits of UNICA until it becomes the business-as-usual architecture for all Telefónica's communications services.

7.2 UNICA Challenges

Telefónica faces two main challenges in implementing a programme as large and game-changing as UNICA.

- **Technology challenges associated with market immaturity**. Telefónica has been commendably open and transparent about the difficulty of staying true to its principles of maintaining vendor-independence within UNICA. The company is not compromising these principles, even though the fact that vendors cannot or will not yet support them is delaying UNICA roll-out. For example, the company has had notable problems with OpenStack implementations and the fact that cloud technologies do not support the specific performance and distribution requirements of network functions. Telefónica sensibly has an interim solution – vertical virtualisation – to ensure that its NFV programme is not badly derailed by technology and vendor solution immaturity. The company also has strong collaborations with multiple technology partners and influential industry organisations to ensure its requirements are reflected in their roadmaps. However, it should continue to exert pressure on UNICA vendors to live up to their

promises and collaborate with one another, and be prepared to bypass them if necessary and build new capabilities itself (as it is doing with OSM) to ensure it can realise its vision.

- **Challenges around the organisational, cultural and process transformations needed to implement UNICA.** 'Soft' transformations are much harder to effect than the development and deployment of new technology, as every company knows. Telefónica is a large organisation with multiple, diverse operating companies and a large employee population to influence and persuade. Telefónica has made good progress in identifying key sponsors for UNICA in different OBs. It has altered C-level structures to support UNICA in some opcos, built relationships between UNICA and other transformation programmes (such as FUSION), and communicated UNICA strategy and concepts both internally and externally. Telefónica can point to strong levels of co-ordination between the executives of key divisions within the company that will be affected by UNICA. However, Telefónica cannot afford to be complacent. Every gain a disruptive transformation makes is hard-won and requires significant effort and energy, as well as strong and visible C-level support. Telefónica must maintain momentum around organisational change, so that it can leverage the full potential of UNICA.

7.3 Analysys Mason's recommendations to Telefónica

We have three recommendations for Telefónica based on our review of its UNICA strategy and implementation.

1. **Telefónica is a technology innovator, but it should not simply focus on the technological foundations of UNICA. It should step up its current dialogue with business stakeholders to continue to educate and inspire them regarding UNICA's capabilities** UNICA is ambitious and forward-looking, but its initial focus has been more internal, on the network, and not as much on its external customer impact. More emphasis on UNICA's external benefits will help to maintain internal and external stakeholder interest in and support for its virtualisation initiatives.
2. **Telefónica should prioritise its operational and organisational transformations so that its operating businesses are fully technically prepared to use the UNICA infrastructure.** Telefónica's Centre of Excellence and the roll-outs of UNICA into the OBs are key to its operational and organisation transformation. The company's C-level executives have an important role to play in actively helping to keep these efforts on track, with visible support and ambitious deployment targets. The faster the Centre is implemented, the quicker the progress Telefónica can make towards establishing UNICA across the business.
3. **Telefónica needs to win greater support from the commercial side of the company for UNICA**. Exciting product, sales and marketing managers about UNICA's potential and educating them about new products and services they could deliver using the new infrastructure capabilities is critical to UNICA's success. Involving commercial stakeholders will help the business to develop ideas for new digital services and customer experience improvements, so that these are ready for implementation once UNICA is fully deployed. At present, UNICA is perceived more as a network transformation programme rather than a service innovation platform. The UNICA platform and strategy, although innovative, will not inspire the rest of the business to develop innovations to drive new service revenue without more effort to educate Telefónica's commercial organisations.

8. Appendix

8.1 Sources for further reading

For information on NFV and ETSI's ongoing role in commercialising NFV technology, see ETSI's *Network Functions Virtualisation*. Available at: http://www.etsi.org/technologies-clusters/technologies/nfv.

For specific information on ETSI NFV standards, see ETSI's filtered results for the search term 'Standards'. Available at:
http://www.etsi.org/standards-search#page=1&search=&title=1&etsiNumber=1&content=0&version=1&onApproval=1&published=1&historical=0&startDate=1988-01-15&endDate=2017-06-27&harmonized=0&keyword=&TB=789,,832,,831,,795,,796,,800,,798,,799,,797,,828&stdType=&frequency=&mandate=&collection=&sort=3.

For information on ETSI's Open Source MANO project, see *What is OSM?* Available at: https://osm.etsi.org/.

For an overview of Analysys Mason's research in next-generation and virtual networks, see *Trending topics: leveraging next-generation and virtual networks.* Available at:
http://www.analysysmason.com/Trending-Topics/Next-generation-virtual-networks/.

About the authors

Dana Cooperson (Research Director) is the research director for Analysys Mason's network-focused Software Research programmes. Her area of expertise is intelligent fixed and mobile network infrastructure. Her goal is to help customers strengthen their link in the communications value chain while evolving their business operations to benefit from, rather than be threatened by, shifts in the market. The key network infrastructure trends Dana focuses on include the integration of communications and IT assets and the drive towards software-controlled, virtual networking.

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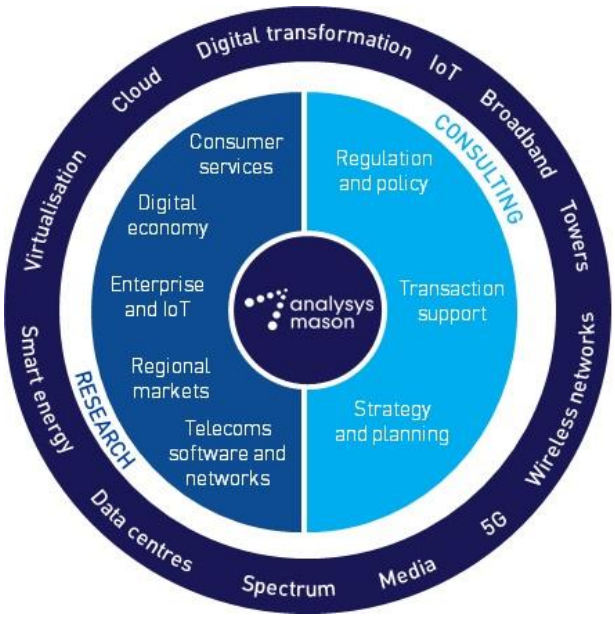

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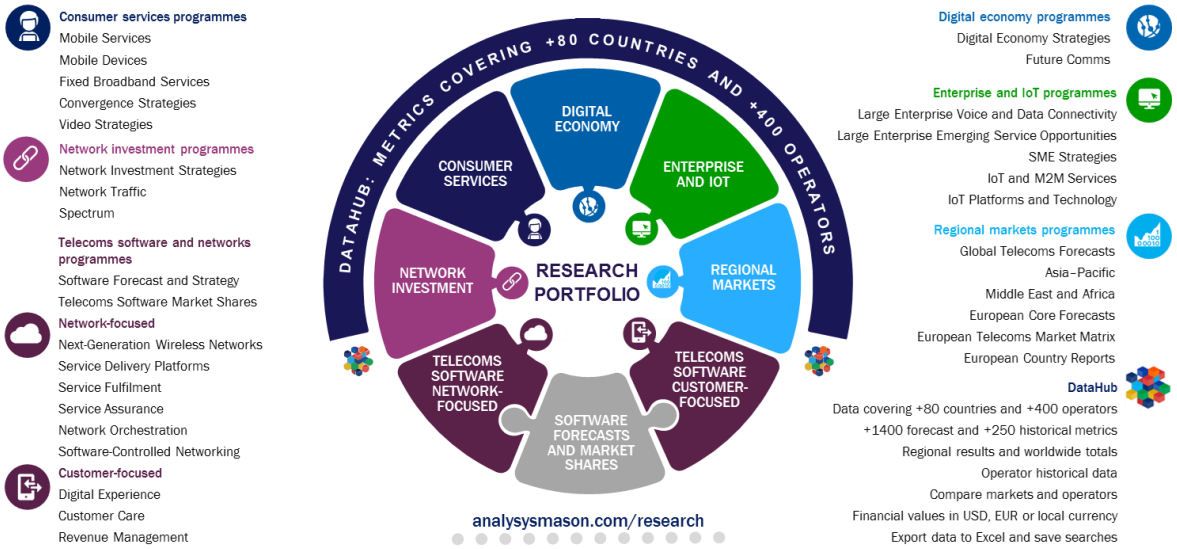

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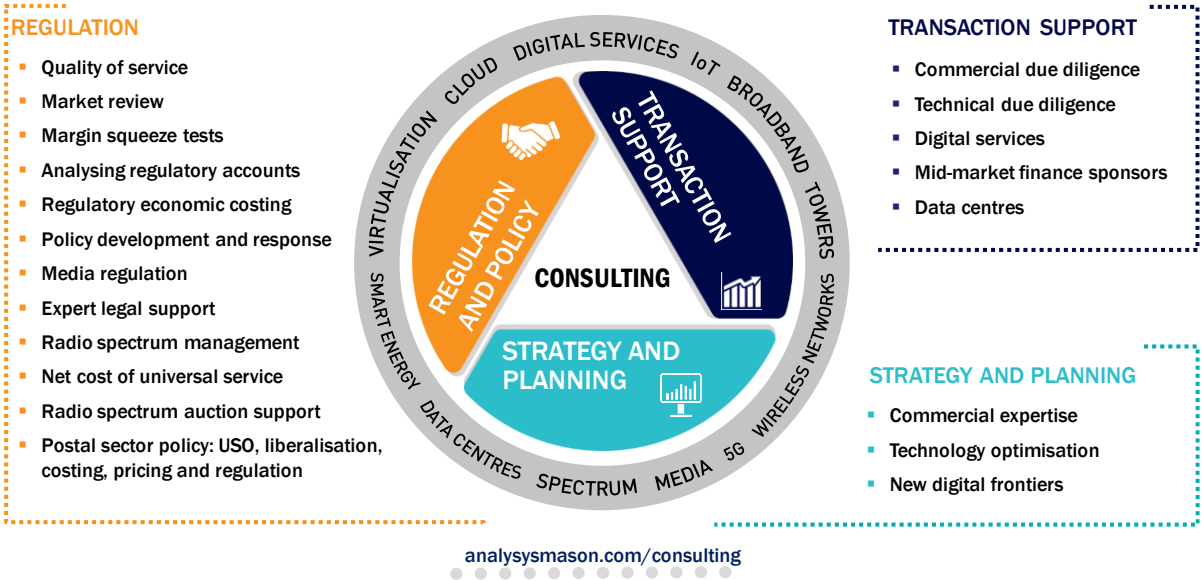

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