Ongoing transformations in transport networks: how making all them work

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Drivers for IP & Transport Transformation
Facing the increase of capacity and complexity

**Video**
The success deployment of video platforms explodes the network cost.
The number of unicast flows increases because of the OTT video, recordings and time-shift services.

**FTTH / 5G**
The massive fiber deployment impacts in two ways:
- Reduction of the number of required central offices.
- The traffic increment per user (x10) because of the new services.
5G KPIs require service segregation

**Network Topology**
- Current Metro based on ring topology for better use of transmission resources and influence from legacy technologies
- The metro network evolution was done separated from the CORE IP network increasing the number of hops

**IT / Systems**
- The network systems has followed the network evolution keeping a single system per network.

**Service Provisioning**
- Service provisioning complex due to multiple hops configuration
- Service provisioning systems are not unified (different systems per layer, technology...)

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CAPACITY  COMPLEXITY
Telefónica “Core Ready” Transformation Program

A new Programmable and Virtualized Network designed to:

- Re-allocate capacity in real time wherever needed, making elastic and scalable networks possible
- Provide service agility by automation
- Improve Time-to-market
- Minimize integration efforts
- Enable operation at global scale in a simplified and automated way
- Enabling E2E lifecycle management
- Sharing infrastructure in an efficient way

Network Programmability and Virtualization are key enablers for future 5G network architecture

Core Ready Program aims to enable Telefónica to support the new challenges and functionalities to be demanded by Telefónica’s customers during the coming years in the most efficient manner
Telefonica’s Transport Evolution

Ongoing transformations in Transport networks are key (and mandatory) to enable 5G

SDTN
- Architecture, Information Models, NBI & SBI interfaces, telemetry, ...

Advanced Switching & Virtualization
- Open Switching, Merchant Silicon, Virtualization at the Edge, VNFs evolution...

5G TRANSPORT
- Xhaul architectures, 5G functional split, slicing, FlexE...

ONGOING DEPLOYMENTS
UNICA: Telefonica Network Virtualization Program

Telefonica UNICA is the foundation of our NFV strategy and can be described as a Telco Cloud architecture allowing hosting and deployment of network components in an automatized fashion.

- UNICA Architecture -

Open: modular, multi-vendor, standard, evolvable

Cloud based: Elastic, Multi site, Multi Vim, Multi Tenant

Telco Grade: Secured, High availability, High performance

Efficient: Automatized deployment and network connectivity through SDN
Teletónica transformation towards 5G has already started:

- **E2E Flattened Multiservice Network**, arranged in a few hierarchical levels (typically 4, at most 5)
- **Seamless Transport** architecture and **SDN enabled** to simplify network provisioning and operation, for higher scalability and resiliency
- **Flexible**. Specific **functions** are assigned, but **not bounded, to predefined levels in the hierarchy** to increase homogeneity
- **Scalable**. **Not** required to **rearchitect** the network for new services.

![Diagram of FUSION: Telefónica IP&Transport Transformed Network](image-url)
The Path towards 5G

Challenges

- **Latency reduction** by network simplification and content proximity
- **Unified Orchestration** across the network including different technology domains and virtualization environments (UNICA)
- **Stringent requirements for Synchronism**
- **High Bandwidth** capacity up to the access
- **Service segregation for vertical customer through Network Slicing** / Strict SLAs, associated to penalties for vertical customers
- **Flexible and Fast Reconfiguration** of transport network for agile service deployment to accommodate all kind of 5G services
The future Telefónica scenario

FUNCTION (software defined, NFV)

CAPACITY (Homogeneous infrastructure)

Data Plane NFs must be Distributed

Control Plane NFs can be Centralised

LOCAL PoPs

- CDN (*)
- Video (*)
- Security (*)
- SWAN (*)
- DPI (*)
- SDN Switching
- COTS HW
- OS + Hypervisor

REGIONAL DATA CENTRES

- SDP (*)
- NGN (*)
- IMS (*)
- MVCC (*)
- DRSP (*)
- MME (*)
- PCRF (*)
- DNS (*)
- DRA (*)

ICX

5G slices

Slice 1

Slice N

(*) Illustrative, since final VNFs deployed will depend on a natural selection processes regarding traffic and digital world evolution and requirements.
UNICA architecture augments ETSI NFV architecture
UNICA will use OSM as the service orchestration layer

The goal: a new virtualized network designed to be agilely changed and operated in an automated fashion.
UNICA Central Office

- Core Ready Program
- Ongoing Transformation & Optimization Processes

FUSION
- Networking Architecture
- SDN Network Coordination

UNICA CO

UNICA
- Function Virtualization
- NFVI Management
UNICA Central Office

A phased, evolutionary approach, to account for the different needs of TEF OBs overtime, with high performance for dataplane applications.

Towards the virtualization of the IP infrastructure
Target SDTN Architecture

1. Hierarchical approach with unique SDTN Controller, offering service level abstraction

2. Per network domain SDN controller, offering network level abstraction and implementing devices configuration

3. SDTN Controller may also offer services to UNICA, in combination with the UNICA SDN Domain Controller

4. Common SDN Domain NBI and/or SBI, for multivendor SDN interoperability
Main SDTN Use Cases

- **Vendor Agnostic Configuration** ≡ speed-up vendor integration processes
- **E2E Service Orchestration** ≡ automated service instantiation end-to-end
- **NFV Coordinated Support** ≡ UNICA being able to dynamically request external connectivity services for VNFs
- **Maintenance Operations** ≡ acceleration of Time-To-Configure and Time-To-Repair
- **In-Operation Network Planning** ≡ automated reconfiguration and optimization in response to traffic changes
Advanced switching

Players from datacenter ecosystem **positioning for telco use cases** (improved L3 features and operator-like performance)

**Concepts of white-box and open switching**, defending decoupled hardware and software (e.g. TIP and OCP project)

Chipset vendors quickly evolving in the **merchant and programmable silicon** industry (driven by operators)

**Deployment Drivers**

- Reduced cost per bit
- Homogeneous commoditized hardware, decoupled from software
- Simplified operation and systems integration based on a unique software
- Avoidance of vendor lock-in
- Faster Time To Market

**New Chipsets**

**Proprietary ASICs**

**Merchant Silicon**

**Open Software**

**Open Hardware**

**New Archetypes**

**Proprietary Software + Proprietary Hardware**

**Open Software**

**Open Hardware**

**New Players**

**Players from datacenter ecosystem positioning for telco use cases** (improved L3 features and operator-like performance)
Path towards a convergent 5G Transport

Evolution of the transport infrastructure

**High Performance**
Latency Reduction & Scalable Arch.

**High Bandwidth**
FO to radio sites, 100G in Aggregation

**High Robustness**
Resilient Architecture

Tunable networks

Long-live network built

Node Cost

- Installation/commissioning costs
- HW/SW costs

Per service structure and unified orchestration

5G slices

Slice 1
Slice N

Telefonica will configure sites according to every moment’s needs, and smoothly evolve towards 5G
Types of slices and control responsibilities

Source: A Network Service Provider Perspective on Network Slicing. Luis M. Contreras and Diego R. López. IEEE Softwarization, January 2018
The Journey

- Programmability
- Virtualization
- Automation
- Slicing
**Telefonica GCTIO – IP & Transport Networks**

**FOSTERING THE INTRODUCTION OF HOMOGENEOUS ARCHITECTURES, TECHNOLOGIES AND PROCESSES IN TELEFONICA FOOTPRINT**
- Extending best practices and defining technical guidelines
- Ensuring homogeneity within Telefonica footprint
- Defining technical requirements for new global services
- Driving PoC and FOA for new technologies

**ACCELERATING IP & TRANSPORT NETWORK TRANSFORMATION**
- Bringing efficiency opportunities through E2E planning
- Establishing global catalogs
- Issuing and driving global RFx processes
- Leveraging new architectures and technologies

**ADVANCING NETWORK TECHNOLOGIES MATURITY THROUGH INNOVATION & RESEARCH**
- Defining new architectures and transport services
- Participating in internal (with Telefonica OBs) and collaborative (via EU funded programs, or with selected vendors) research
- Contributing to the community with participation in standards, communication of Telefonica’s strategy or requirements, and dissemination of results
- Transferring the research results to Telefonica OBs
Next great challenge – Multi-domain slicing

• Vertical customers can request **services** that lay **outside the footprint** of their **primary provider**
  - How to resolve this?

• **Dynamic and automated** interaction with other providers are needed but …
  - How we can **charge** and bill for that service?
  - How we can **ensure SLAs** among providers?
  - How we can **know about the capabilities** of other providers for a comprehensive e2e service provision?

• **Current wholesale and interconnection services and mechanisms** are **not enough** in the era of virtualization and programmability

• In the case of Telefónica multi-domain refers to either interconnections with other providers as well as interconnections among affiliates (**up to 17 Networks in Telefónica group!**)
Taking action
5G-Exchange (5GEx)

Objective:
From dedicated physical networks with dedicated control and dedicated services and resources for different applications...

...to a “network factory” where resources and network functions are traded and provisioned: new infrastructures and services are “manufactured by SW”

Partners include: Telenor, Deutsche Telekom, Telecom Italia, Orange, Telefónica, Ericsson, Huawei, HPE, ATOS, BISDN, RedZinc, UCL, UC3M, AUEB, BME, KTH, MNS

EU 5GPPP H2020 Grant No. 671636

http://www.5gex.eu/
5GEx High Level Architecture and Interfaces

- **Data plane**:
  - SDN nets.
  - Packet/Opto
  - Legacy nets.

- **Control plane**:
  - Network Controller
  - Domain Orch

- **Management and orchestration plane**:
  - Multi-provider Orchestrator
  - Administration A
  - Administration B
  - Administration C

- **Customer (Tenant)**:
  - Wholesale buyer interface

- **Service Management**:
  - Customer Service Request
  - Lifecycle Mgmt
  - Monitoring

- **B2B**:
  - Provider A administration
  - Provider B administration
  - Provider C administration

- **Multi-provider Orchestrator**
  - Administration A
  - Administration B
  - Administration C

- **5GEx focus**
  - ENNI

- **5GEx focus**
  - Service
  - Offerings
  - Capabilities
  - Resources

- **Time**
  - Discovery
  - Request
  - Fulfilment
  - Assurance
Taking action – 5G-TRANSFORMER
Taking action – NECOS

Slicing Models & Approaches

Business (Application & Service) plane

Control & Management plane

Infrastructure

Application Services

Network Service Orchestration

Slicing

(V) Orchestration

Service-based Slicing [3]
[Service Slice aaS]

MANO-based Slicing [2]
[NFV aaS]

VIM-dependent Slicing [1]
[Resource Slice aaS]

VIM-independent Slicing [0]
(“Bare-metal”)
[Infrastructure Slice aaS]

Network Resources

Compute Resources

Network Resources

VIM

NIM

Monitoring

Monitoring

Monitoring

http://www.h2020-necos.eu/
H2020-EUB-2017
Grant No. 777067

Telefónica
We choose it all

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Backup Slides
In order to get the **industry** focused on providing real value...

Industry should focus on providing **DIFFERENTIAL VNFs**

Current State of the Art is good enough (if properly arranged)

Network Virtualisation Infrastructure and its Management should become **COMMODITY**

**Focus is Needed to Avoid** proliferation of VERTICAL SOLUTIONS

Industry should focus on closing OpenStack gaps for carrier grade

Industry should focus on providing a common ORCHESTRATOR FRAMEWORK
Automating the deployment and operation of Network services is a challenge!
End-to-end Telco Cloud network

**DESIGN PRINCIPLES**

*Enhanced user-centric connectivity experience*

*Homogeneous infrastructure*

*Simplified and automated operations (SDN)*

*Mouldable software-defined functionality*

*Agile and open to innovation*

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**BAREMETAL**

Proprietary HW&SW per vendor

**SW & HW Decoupling**

Step 1. Network Virtualization

UNICA DC

SW = VNF

SDN Ctrl.

HW x86

Step 2. VNF Distribution & Unified Control

VNFs Distribution

Distribute Data Plane in several UNICA Central Offices (UNICA-CO)

Centralize Control Plane in UNICA DC

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Telefónica

We choose it all
Automated service deployment

- **Service level abstraction:** Service definition at the business level toward transport network customers.
- **Network level abstraction:** Network connectivity services generation, network topology compilation for route calculation and visualization.
- **Device configuration level:** Actual configuration of the network devices involved in the connectivity service.
Categorization of 5G Services

Challenges

• The virtualization of 5G Core Network and RAN makes the network functions distributed, allowing to satisfy all use cases.
• Transport network is consisting of fronthaul, midhaul, backhaul and DC interconnection.

PERFORMANCE

1000x higher mobile data volumes
10x – 100x number of connected devices
10x – 100x typical end-user data rates
5x lower latency
10x longer battery life

FLEXIBILITY

Network programmability
Agile service deployment
Affordable and sustainable
The evolution of the Transport Network is mandatory

5G requirements represent a substantial challenge for current MBH networks

<table>
<thead>
<tr>
<th>Terminal</th>
<th>RAN</th>
<th>Transport Network</th>
<th>WAN / Internet</th>
</tr>
</thead>
<tbody>
<tr>
<td>150~300Mbps</td>
<td>150~300Mbps</td>
<td>Access:50Mbps</td>
<td>10~40Gbps</td>
</tr>
<tr>
<td>4~18ms</td>
<td>10ms</td>
<td>Aggregation:200Mbps</td>
<td>100G~2Tbps</td>
</tr>
<tr>
<td>Low Capacity</td>
<td>20~50ms</td>
<td>Long Delay</td>
<td></td>
</tr>
</tbody>
</table>

Relevant 5G KPI

- **End-user Data Rates**: 10-100X
- **Mobility Volumes**: 1000X
- **Connected Devices**: 10-100X
- **Lower Latency**: 5X
- **Battery Life**: 10X

**5G uRLLC**

- **RAN Latency**: 0.5ms
- **Transport Latency**: ~0.125ms
- **Core Latency**: ~0.375ms

**5G eMBB**

- **RAN Latency**: 4ms
- **Transport Latency**: ~1.5ms
- **Core Latency**: 4.5ms

**Telefonica**
New considerations for 5G

5G mobile network services

RAN split scenarios

Interface types

5G requirements

Operator requirements

Challenges in anticipation of Vertical’s needs

But this is not all!
Target Transformed Network

From → To

• **Tree structure** → **Per-service Structure**
• **Static nature** → **Dynamic nature**
• **Separated management per segment** → **Unified orchestration**
Functionality of 5GEx interfaces

**Service Management (Ix-S)**
Used for requesting services by external customers or between MdOs of different administrative domains.

**Resource/Topology (Ix-RT)**
Used by an MdO to exchange the network topology and resource information with other MdOs.

**Resource/Control (Ix-RC)**
Used by the MdOs to reserve, provision, configure and manage resources through other MdOs.

**Catalogues (Ix-C)**
For the interaction between catalogue subsystems to build multi-domain services.

**Lifecycle Management (Ix-F)**
To communicate lifecycle mngt dependencies and workflows of NS parts or compound VNFs.

**Monitoring (Ix-Mon)**
To collect measured data and managing the probing system that facilitates network service assurance.