5G-MEDIA

Programmable edge-to-cloud virtualization fabric for the 5G Media industry

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Agenda

• Technical challenges & Vision
• Use Cases
• 5G-MEDIA Architecture
  • Service Development Kit (SDK)
  • Application Development Lifecycle
  • 5G-MEDIA Catalogue
  • Cognitive Network Optimisation
  • NFV MANO Resource Orchestration
  • Faas VIM: standards-compatible integration
• Current Status & Next steps
Technical challenges & Vision

• **Motivations:** Fast-growing Media & Entertainment vertical industry
  • 5G for high performance network services
  • High volumes
  • Any Device, Anytime, Anywhere
  • QoS
  • Telcos, manufacturers and media content providers are looking for solutions to design and deploy media functions for replication, distribution and adaptation of media contents

• **Our focus:** Consolidate/build an orchestration and DevOps platform for network media services and applications running on 5G networks
Technical challenges & Vision

SDK and DevOps environment for Media Application

- Hide the complexity of ...
- ... service development
- ... deployment on the underlying 5G network
- ... distributed cloud infrastructure

Service Virtualisation Platform

- Orchestrate deployment and scaling of media applications, interacting with the underlying network for dynamic control of resource
- Applying machine learning and cognitive optimisation
Use Case 1
*Tele-Immersive Media*

Use Case 2
*Smart + Remote Media Production*

Use Case 3
*UHD over Content Delivery Network*
Use Cases

Use Case 1
Tele-Immersive Media

Use Case 2
Smart + Remote Media Production

Use Case 3
UHD over Content Delivery Network

5G Media
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Use Cases

Use Case 1
Tele-Immersive Media

Use Case 2
Smart + Remote Media Production

Use Case 3
UHD over Content Delivery Network

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Service Development KIT (SDK)
Service Development Kit

[Image of Service Development Kit interface]
Application Development Lifecycle

Service Monitoring

- Application Descriptor Package
- Validator
- Private Catalogue
- Packaging (Unikernel, Docker, iSO)
- Editor

Emulator

- CNO
- VIM-EMU (Openstack)
- K8S-VIM (Openwhisk)
- Profiler

Source Code

Application/Development/Lifecycle
5G-MEDIA Catalogue

SERVICES DEVELOPMENT KIT
- Private NSD/VNF Catalogue
- Editor
- Validator
- Service Monitoring
- Emulation toolkit
- Profiling

SERVICE VIRTUALIZATION PLATFORM
- 5G-MEDIA CATALOGUE (PUBLIC)
  - Standard NBI handler
  - Policy Engine
  - DBs (policy, SDN apps, MEC apps...)
  - Notification Dispatch
  - SDN plugin
  - MANO plugins

MEDIA SERVICE MAPE
- Cognitive Network Optimisation Engine
  - Analysis
  - Planning
  - Data Adaptation/Translation
  - Execution
  - QoS/QoE Monitoring Service

NFV MANO SERVICE ORCHESTRATION
- Public NS/VNF Catalogue
- Network Service Orchestrator
- NS/VNF Repository
- VNF Manager

NFV MANO RESOURCE ORCHESTRATION
- VIM Plugin
- WIM Plugin
- FaaS VIM Plugin
- SDN Plugin

5G-MEDIA AAA

MEDIA FUNCTION DEVELOPER
MEDIA APPLICATION DEVELOPER
MEDIA SERVICE DEVELOPER (MEDIA) SERVICE PROVIDER
SVP OPERATOR

OSS/BSS

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Catalogue key features

• **Unified and extendable format for descriptors**
  - NSDs [ETSI GS SOL 001]
  - VNF packages [ETSI GS SOL 001, ETSI GS SOL 004]
  - PNFDs [ETSI GS SOL 001] – ongoing
  - MEC apps [ETSI GS MEC 010-2] – ongoing

• **Package descriptors**
  - Common base + domain specific extensions for app config/monit, NFVI options, etc.

• **MANO domain-specific translation** from common to specific descriptors
  - Support of OSM R3 and OSM R4/R5 catalogue APIs & IM

• **Extended Interfaces to MANO** (NFVO, VIM)
  - Base LCM behaviors → basic NFV interfaces and descriptors
  - Additional behaviors (e.g. load images, configure hw acceleration, other tuning on NFVI, etc.) → additional interfaces and descriptors

• **Discovery, advertising, publishing, validation of descriptors** across catalogues from different providers
  - Policy-based management for level of descriptors’ visibility

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Media Service MAPE

SERVICE DEVELOPMENT KIT
- Private NSD/VNF Catalogue
- Editor
- Validator
- Service Monitoring
- Emulation toolkit
- Profiling

SERVICE VIRTUALIZATION PLATFORM
- Standard NBI handler (OS-MaNFV ref point)
- DBs (policy, SDN apps, MEC apps...)
- Notification Dispatch
- SDN plugin
- MANO plugins
- Policy Engine
- 5G-MEDIA AAA

MEDIA SERVICE MAPE
- Cognitive Network Optimisation Engine
  - Analysis
  - Planning
  - Data Adaptation/Translation
  - Execution
  - QoS/QoE Monitoring Service

NFV MANO SERVICE ORCHESTRATION
- Public NS/VNF Catalogue
- Network Service Orchestrator
- NS/VNF Repository
- VNF Management (VNF Mgmt)

NFV MANO RESOURCE ORCHESTRATION
- VIM Plugin
- WIM Plugin
- FaaS VIM Plugin
- SDN Plugin

Open Source MANO

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Cognitive Network Optimisation

Compression level (low, medium, high, or premium quality) and/or Switching between CPU/GPU

CNO (RL Agent)

Output
(e.g. compression level, switching between CPU/GPU)

Neural Network

States

Reward

QoE score, cost of computational resource, etc.
available capacity loss, latency bit rates, buffer size, CPU/GPU usage, etc.

Computational resources
CPU/GPU usage of VNF, Available CPU/GPU on host

Network related measurements
(e.g. available capacity, latency, loss.)

QoE Score
QoE metrics bit rate, smoothness, stalling, subtitle lag

Video related measurements
download time of past K chunks, throughput of past K chunks, bitrate of the downloaded last chunk, current playback buffer level

vCompression and/or Speech-To-Text

Network Link

QoE Probe

RTVE (Broadcast site)
NFV
MANO
Resource Orchestration
FaaS VIM: standards-compatible integration
FaaS VIM: standards-compatible integration

- Design goals achieved
  - ETSI MANO compatible
  - Minimal changes to ETSI MANO flows
  - Pluggable FaaS framework
  - PaaS and IaaS neutral
  - Virtualisation technology neutral

- Reference implementation based on
  - Apache OpenWhisk
  - Kubernetes (K8s)
  - Open Stack

- Basic flow
  - OSM initiates
  - FaaS VIM invokes VNF as an OpenWhisk action
  - OpenWhisk offloads to K8s
  - K8s provides networking and placement
Use Case 1
Tele-Immersive Media

Goal: Ensure Quality of Experience for real-time multi-party applications, enabling HQ 3D virtual reconstructions of users

Required 5G-powered features:
- Enable VNF transcoding
  - Accommodate high computational power
  - Support GPUs container integration
- Transcoding in the edge
  - Minimize latency and core traffic
- Instantiate transcoders on demand upon session initiation
- Accommodate other event-based media processing functions (e.g. replay clips)

Main Expected Benefits: Improved QoE for players/spectators and support of real time Tele-Immersive applications
UC1: Test Scenario - NCSRD Topology

Map the scenario to 5G-MEDIA testbed

General Scenario from WP2

OSM VIM

Faas Plugin

REST

OpenWhisk

Master K8s

K8s

C1

C2

K8s

C3

C4

IaaS (Open Stack)

2 PCs w/ GPU & K8s workers

Game Server

Player 1

Player 2

CERTH

NCSRD

vTranscoders

Map the scenario to 5G-MEDIA testbed

General Scenario from WP2

OSM VIM

Faas Plugin

REST

OpenWhisk

Master K8s

K8s

C1

C2

K8s

C3

C4

IaaS (Open Stack)

2 PCs w/ GPU & K8s workers

Game Server

Player 1

Player 2

CERTH

NCSRD

vTranscoders
Use Case 2

Mobile Contribution, Remote and Smart Production in Broadcasting

Goal: Provide broadcasters with ad-hoc, scalable, flexible and time-saving production mechanisms leveraging professional and user-generated remote media content

Required 5G-powered features:
- Efficient development and deployment of virtualized media functions (Software-based media functions/applications)
- VNF instantiation on demand (using Function-as-a-Service approach)
- Efficient resource allocation and usage
- Dynamic network and transmission optimisation according to the demands of the transfer (use of MAPE and CNO)
- Cognitive Network Optimiser (CNO) performs statistical analysis and pushes decisions to the service orchestrator
- Location-based service provisioning/allocation (at the edges)
- Guarantee Quality of Service (prioritise video traffic)

Main Expected Benefits: Reduction in costs, personnel, time and complexity for remote production, enabling exploitation of user-generated media content.
UC2: Test Scenario – Telefónica Topology

Map the scenario to 5G-MEDIA testbed

General Scenario from WP2

Telefónica Topology with UC2 Workflow

Venue

Telefónica testbed

Broadcast

To further processing or distribution

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UC2: Test Scenario – Telefónica Topology

Map the scenario to 5G-MEDIA testbed

General Scenario from WP2

Telefónica Topology with UC2 Workflow
UC2: VNF Implementation

vCompression Engine
- Compression/Decompression of audio visual content for WAN/internet transfer
- Based on OpenSource tool FFmpeg and GStreamer

Media-Process Engine
- Video signal switching
- Based on OpenSource tool Voctocore, FFmpeg and GStreamer

Speech-to-Text Engine
- Conversion of audio signals into text
- Based on the Google Speech API (for now)
- Speech-to-Text Demonstrator (‘helper VNF’) for browser replay and subtitle overlay
Use Case 3

**UHD over Content Delivery Network**

**Goal:** Deliver new capabilities to media service providers by distributing UHD content (4K and 8K) with an optimal consumption of resources

**Required 5G-powered features:**
- End-to-end QoS/QoE control
- Caching policies to balance bandwidth vs. caching
- Management of the service chaining
- Traffic Classification at the edge
- Media transcoding and caching at the edge

**Main Expected Benefits:** Better experience for end users and new market opportunities in content delivery
UC3: Test Scenario – ENG Topology

Map the scenario to 5G-MEDIA testbed

General Scenario from WP2

vOriginalUDS + vlibraries
vCache (Mid)
vTranscoder (Mid)
vCache (Edge)
vTranscoder (Edge)
vCache (Edge)
vTranscoder (Edge)

5G-MEDIA SVP
MAPE

5G APPS CATALOGUE
Open Source MANO

openstack

ENG CENTRAL CLOUD

vCDN

Origin Server

PNF

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Current Status & Next steps

• Deliverables on specification and initial implementation in 5G-MEDIA website
  • http://www.5gmedia.eu/outcomes/deliverables/

• Initial demos for each use case presented in September 2018
  • Each use case deployed VNFs in a single NFVI (NCRD, ENG, Telefónica)
  • Demonstrate initial release of platform components

• Extensions/Upgrades expected until June 2019
  • Refine platform components
  • Focus on tighter platform integration
  • Experiment with multi-PoP scenarios

• Main dissemination activities planned: EuCNC 2019
Acronyms and Definitions

• AAA................ Authentication, Authorization, Accounting
• ADMIN........... Administrator
• API............... Application programming interface
• APP............... Application
• AR............... Augmented Reality
• BSS............... Business Support System
• CDN.............. Content Delivery Network
• CLI............... Command Line Interface
• CNO.................. Cognitive Network Optimizer
• CPU............... Central Processing Unit
• DB............... Database
• DevOps........ Software development (Dev) and information technology operations (Ops)
• E2E.............. End-to-End
• ENG................ Engineering – Ingegneria Informatica SPA
• ETSI........... European Telecommunications Standards Institute
• ETSI GS......... ETSI Group Specification
• ETSI GS SOL..... ETSI GS Solution Specification
• ETSI GS MEC..... ETSI GS Mobile Edge Computing
• FaaS............. Function As A Service
• GPU............. Graphics Processing Unit
• GW............... Gateway
• HGU............. Home Gateway Unit
• IaaS............ Infrastructure as a Service
• IM............... Information Model
• LCM............. LifeCycle Management
• MANO........... Management and Orchestration
• MAPE........... Monitor Analyse Plan Execute
• MEC............. Micro Edge Cloud
• NBI................ North-Bound Interface
• NCSRD........ National Center for Scientific Research
• NFV.............. Network Function Virtualisation
• NFVI............. Network Function Virtualization Infrastructure
• NFVO............. Network Function Virtualization Orchestrator
• NS............... Network Service
• NSD............. Network Service Descriptor
• OSM............. Open Source Management and Orchestration
• Os-Ma-NFVO..... Operation System-Managemant-Network Function Virtualization Orchestrator
• OSS............. Operation Support System
• OW............. OpenWhisk
• PNF............. Physical Network Function
• PoP............. Point of Presence
• RTVE........... Corporacion de Radio y Television Espanola SA
• QoE............. Quality of Experience
• QoS............. Quality of Service
• SDK............. Service Development Kit
• SDN............. Software-Defined Networking
• SVP............. Service Virtualization Platform
• VIM............. Virtual Infrastructure Manager
• VNF............. Virtual Network Function
• VNFD........ Virtual Network Function Descriptor
• VNM............ Virtual Network Function Manager
• VR............. Virtual Reality
• WIM............. WAN Infrastructure Manager
• XGSPON........ 10-Gigabit-capable symmetric passive optical network
Thanks to all partners!