Media industry meets 5G: the 5G-MEDIA project in 5G-PPP phase 2

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Abstract - The focus of research into 5G networks to date has been largely dedicated to the advances in network architectures, technologies and infrastructures throughout the projects funded in 5G-PPP Phase 1. Less effort has been put on the applications and services that will leverage and exploit such advanced 5G capabilities. 5G-MEDIA is a new R&D project funded by EC under 5G-PPP Phase 2 H2020 programme, which aims at investigating how media-related applications should be coupled and interwork with 5G networks to the benefit of both.

Index Terms – 5G networks for media applications, , Network Function Virtualization, edge-cloud, management and operation framework, Streaming as a service, 5G-MEDIA SDK and APIs, 5G-PPP

INTRODUCTION

5G networks promise to significantly reduce latency and vastly increase capacity for delivering high bandwidth data streams between high densities of people and things at low energy and with high reliability. Significant progress is being made towards the roll out of the first 5G networks in 2020, with intense research and development activities towards these objectives being undertaken around the globe and notably within the EU in the 5G-PPP [1] H2020 programme. Throughout the Phase 1 of this initiative (2015-2018) the focus of 5G research and innovation has been dedicated to the required advances in network technologies: spectrum, radio access, software-defined networking (SDN), network function virtualization (NFV) and cloud infrastructure, flexible management and control architectures and development and operations systems. However, less effort has been put on the applications and services that will make use of and exploit such advanced 5G capabilities. Media applications are amongst the most demanding services in terms of resources, requiring huge quantities of network capacity for high bandwidth audio-visual and other mobile sensory streams; in addition they demand extremely low latency for truly immersive, responsive and tactile user experiences.

I. Motivation and Objectives

The 5G-MEDIA project [2] aims at innovating media-related applications by investigating how these applications and the underlying 5G network should be coupled and interwork to the benefit of both: to ensure the applications allocate the resources they require to deliver high Quality of Experience (QoE) while at the same time the network is not overloaded with media traffic. In this respect, 5G-MEDIA [2] addresses the objectives of i) capitalizing upon and extending the outcomes of the running 5G-PPP [1] projects to offer an agile programming, verification and orchestration platform for media services, and ii) developing network functions and applications to be demonstrated in large-scale deployments of diverse requirements, targeting three well-defined use cases: Immersive media and Virtual Reality, Smart Production and User-generated Content, and Ultra High Definition over Content Delivery Network. Based on an open innovation approach, the resultant 5G-MEDIA [2] platform will be offered to third party organisations that will develop, combine, verify, deploy and validate media applications by utilizing the project's Software Development Kit (SDK) and Service Virtualization Platform. In addition, 5G-MEDIA [2] plans to introduce the concept of *Streaming-as-a-Service* that will derive in an ambitious business impact.

II. Overall 5G-MEDIA Concept and Technical approach

The 5G-MEDIA [2] will apply SDN and NFV concepts to media applications to flexibly and dynamically embed them as virtual network functions (VFNs) within the 5G networks and cloud infrastructures. In the form of virtual machines, containers or unikernels, these applications will be managed by using a serverless computing paradigm. To ensure high performance levels in terms of high bandwidth and low latency, the media application functions will be deployed close to traffic sources and sinks, and the 5G-MEDIA Management and Orchestration (MANO) function will deploy smart algorithms for configuring network paths and virtual slices to deliver the required network capacity and performance levels at the network edge. 5G-MEDIA [2] will deliver a DevOps environment for media applications which will hide the complexity of service development and deployment on the underlying 5G infrastructure, allowing developers to concentrate on the media application layer. Also, 5G-MEDIA will deliver a service virtualisation platform to orchestrate the deployment and scaling of the media applications, interacting automatically with the underlying network for the dynamic control of the network paths and forwarding graphs by applying machine learning and cognitive optimisation techniques.

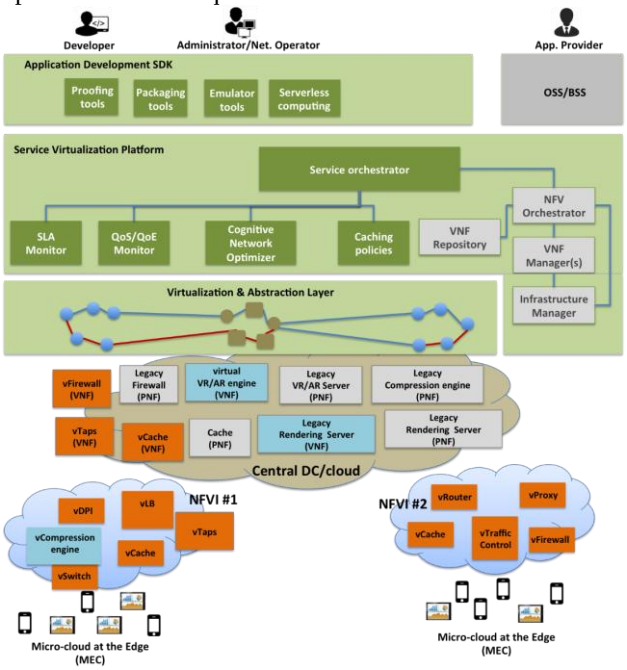

FIGURE 1. HIGH-LEVEL ARCHITECTURE OF THE 5G-MEDIA PLATFORM

The main building blocks comprising the 5G-MEDIA [2] architecture (see Figure 1) will include: (a) an Application Development SDK that accommodates all the tools for media applications development; (b) a Service Virtualization Platform that hosts the components related

to the MANO framework; (c) a VNF/NetApp Repository as well as generic components that can be used across many applications; (d) a Central Cloud environment that facilitates the deployment of legacy components and services especially those instantiated on physical/specialized hardware; (e) Network Function Virtualization Infrastructures (NFVIs) that provide cloud resources owned by different operators and managed by the Service Virtualization Platform administrator and the OSS/BSS system that allow users to gain access to 5G-MEDIA [2] platform services.

USE CASES AND SCENARIOS

5G-MEDIA [2] will undertake challenging use cases that will serve to prove the outcomes of the initiative. Such relevant scenarios, that have been already considered by the 5G-PPP in [3], are briefly introduced below.

I. Immersive applications and Virtual Reality

Tele-Immersion (TI) enables multi-party real-time interaction of users located in different parts of the globe, placing their, real-time produced, digital replicas together inside a virtual world [4]. With the ongoing Virtual Reality revolution, next generation communication applications are starting to emerge and are expected to take the networking world by storm. Quality of Service (QoS) and Quality of Experience (QoE) are top priorities in immersive media whereas availability and real-time interaction between users are considered critical challenges that need to be met as they ensure a smooth user experience. High visual quality 3D reconstructions of users are created in the form of time-varying meshes (TVM) [5] that produce a large volume of heterogeneous data, thus, creating a challenging networking scenario. Although TVM data can be compressed via static mesh compression or techniques that exploit correlations of the data over time, existing compression schemes are not yet ready to support real-time applications. The volume of data produced by real-time TI applications is increasing dramatically, imposing limitations on the transmission of data, with current network technologies. As a result, the use of 5G networking technology appears a necessity for real time TI applications not only in the gaming industry but also in other areas such as advertising or e-health. These have high requirements for (i) very high bandwidth, (ii) low latency, (iii) ultra-high reliability and (iv) broadband access in high crowd-density areas [6].

II. Remote and smart media production using user-generated content

Due to steadily rising cost, broadcasters are looking for new, low-cost and time-saving production methods, which include participatory and user-generated media archives in the production. These types of production methods are now combined under the term *Smart Production*. As sub-category of smart production techniques includes *Remote Production*. Usually, productions often need big teams and long preparation times where audio and video equipment is physically moved to outside broadcast sites where it is set-up, configured and tuned for the specific production activity. Another time-consuming part is the set-up and facilitation of a control room for sound and vision engineers, editors and the directing team. To reduce complexity and costs, more and more productions take place remotely. In a remote production, the control room is at a fixed location, usually in the facility of the broadcaster. The control of equipment at the venue itself happens remotely from this room. But establishing remote links that deliver the required performance often requires dedicated connections and it is only feasible, at acceptable cost levels, it the productions reoccur regularly from the same locations. The use of 5G-MEDIA technology helps to realize a capable alternative for more flexible and ad-hoc solutions, while the low-latency and high-quality requirements can be satisfied. Virtual encoding and compression engines have the potential to replace dedicated encoder hardware and cognitive network optimization algorithms and together with QoS-monitoring techniques can improve significantly over current Internet best-effort practices to ensure the required performance needs.

Another smart production area is the transmission of high quality content back into the studio which meets broadcast-quality performance requirements. Today interviews on the street are often recorded and then, only at a later stage, processed and edited in the studio. Often highly relevant and live contents, e.g. for breaking news, have poor or unreliable quality. 5G-MEDIA [2] has set out to improve this by ensuring that audiovisual material from remote and mobile reporters gets delivered reliably and at high quality without relying on dedicated lines and equipment.

III. Mobile Dynamic and flexible UHD content distribution over Open CDN

Internet users have access to an extremely wide and increasing variety of access devices for delivering audio-visual content, such as smart-phones, tablets and goggles. At the same time, content is growing both in volume and quality. These trends are driving a significant increase in the use of bandwidth as well as computation resources. In addition, users upload content in social networks, sharing multimedia content, which is a trend that will continue in the future. Content distribution is dependent on underlying network capabilities and requires a reliable and high quality content-aware network that is open (in terms of open standards, interfaces and protocols) to potentially everybody and pervasive in all areas of the Internet. Here, telecom operators, manufacturers, content providers have the opportunity to participate in the value

chain by implementing the necessary functions for replication, distribution and adaptation of content, without the need to be attached to legacy CDNs.

This use case will enhance the Open CDN concept by the use of a flexible network architecture with a number of new capabilities to support developers in providing apps which can make use of the 5G-MEDIA NFV approach to distribute UHD content (4K and 8K) with the minimal consumption of resources. The UHD over CDN use-case will start from a CDN approach but will be based on a dynamically adaptable configuration of virtual CDN nodes and the network segments interconnecting them and the users, with the aim of demonstrating the efficient distribution of video streams with significantly reduced consumption of network resources. The Dynamic UHD delivery use-case will prioritize a new NFV flexible network architecture, which can accommodate flexible resources and dynamicity in the allocation of computing resources and cloud-distributed functionalities.

The advantage compared to existing solutions, making content available with lower delay, jitter and consuming less network resources than current approach will allow i) to avoid the need of already established replica servers and pre-fetched allocations, thanks to the use of micro-cloud at the edge which can dynamically instantiate network application closer to the user, ii) to reduce the overhead of media delivery and reduce latency (compared to some current CDNs imposing delays of up to several seconds) by the use of a cognitive network optimizer, iii) to dynamically allow balancing and caching, by using a mixture of edge and central computational resources as required by varying supply and demand patterns.

The UHD over CDN use-case will provide a reduction of cost with a flexible and adaptable solution. Its main benefit can be summarized as: i) decentralisation of network caching, media processing and application execution, ii) advanced security, privacy and trust of the content that traverses or is cached in the network, iii) better QoS/QoE for end-users, given that the requested content, being stored within the network, is closer to them, iv) improved capabilities and reducing network resources with a flexible architecture, v) new and enhanced market opportunities for small ISPs and SMEs to join the market of audio-visual content delivery (or to expand their existing role), as it is avoiding vendor lock-in to a small number of dedicated CDN providers as in today's market.

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