Embedding 5G solutions enabling new business scenarios in Media and Entertainment Industry

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Abstract—5G is promising a drastic change when it comes to providing services to vertical sectors. At technology level, different initiatives are working on finding new or more efficient solutions for solving aspects related to 5G. Those technologies are expected to deeply change the market for all the involved stakeholders. This paper aims to give a view of the 5G-MEDIA project on how the market could change by means of the introduction of technologies for empowering the 5G value, looking at it from the perspective of the vertical domain, specifically for media organizations. The paper presents three business scenarios, as a potential future roadmap for the adoption of the technologies resulting from the project.

Keywords—5G, 5G stakeholders, 5G technologies, business scenarios, SMEs, Media industry.

I. INTRODUCTION

5G is likely to lead to a great change when it comes to providing services to vertical sectors. At technology level, different H2020 research projects involved in the 5G Infrastructure Public Private Partnership (5G PPP) [1] as well as initiatives from ETSI [2] and MEF [3] work on technologies and solutions related to 5G, such as Software Defined Networking (SDN), slicing deployment, Network Functions Virtualisation (NFV), Virtual Network Functions (VNFs) orchestration and management, cloud-native event driven serverless model, network automation, and others. This will ensure the availability of services tailored to each vertical sector, enabling them in turn to provide new or more efficient services to their customers. The deployment of those technologies and the introduction of 5G in many vertical sectors could prove very disruptive not only for the stakeholders currently involved in the telecoms sector, but also for the players of the vertical sectors. Their business models might need to be reshaped to consider a completely new paradigm, which is also likely to modify the relationships between existing players, and to open up opportunities for new market entrants. This might prove to be a chance for SMEs, who are by nature more flexible and may be less reluctant to change than larger incumbent players, leading to large growth and global leadership. This should benefit those SMEs who will be the first ones to take this path i.e. using 5G technology to develop new and innovative solutions and applications in the vertical markets they already know well, or to take advantage of their expertise in 5G to develop disruptive solutions to reach new markets.

One of the relevant vertical industry is represented by the Media and Entertainment (M&E) sector, which has been going through a revolution in recent years. The consumption of media by users has markedly changed, as the habits and expectations of using services in the M&E sector. In the last period the user experience of M&E has been considerably expanding. This has been happening for services such as on-demand content, user generated content and interactive games, the consumption of which takes place on the move or at home, on different user devices such as smartphones, tablets, TV sets, wearable, watches, etc. M&E services must currently be ready to respond to a growing demand in terms of data transfer rates, quality of service and number of users connected. Media applications represent amongst the most demanding services, requiring high amounts of network capacity as well as extremely low latency for synchronous audio-visual streaming in production quality.

The response to the needs of the M&E market is undoubtedly given by 5G networks and the resulting service innovation. The enormous growth in data related to the development of Internet of Things, accessing content from fixed to mobile locations, and the demand for high performance to encourage the development of particularly sophisticated digital services, have already placed 5G at the core of the M&E market.

The 5G-MEDIA Horizon-2020 5G-PPP Phase 2 project aims at delivering an integrated programmable service platform for the design, development, and operations of media applications in 5G networks, by providing mechanisms to flexibly adapt service operations to dynamic conditions and react upon events. It leverages new options for more flexible, ad-hoc and cost-effective production workflows, by replacing dedicated lines and hardware equipment with software virtualized network functions (VNFs) facilitating semi-automated smart production in remote locations. The 5G-MEDIA project aims at innovating media-related applications by investigating how these applications and the underlying 5G network should be coupled and interwork for the benefit of both.

This paper, after giving a brief overview of the 5G-MEDIA results in section II, presents the three main business scenarios identified as potential future roadmap for the adoption of project technologies results in the market, with the scope of presenting how the new technologies can modify the engaged stakeholders and the business relationships (section III).

II. 5G-MEDIA PROJECT RESULTS OVERVIEW

A. 5G-MEDIA Architecture and use cases

The 5G-MEDIA approach delivers an integrated programmable service platform for the development, design and operation of media applications in 5G networks. The high-level architecture of the 5G-MEDIA service platform is shown in *Figure 1*. It includes three main parts:
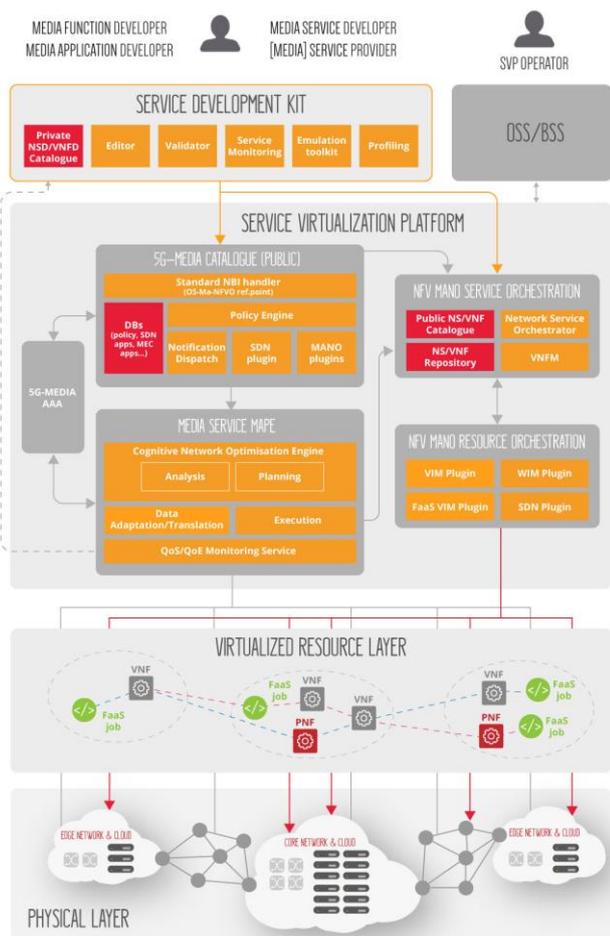
Figure 1: 5G-MEDIA High Level Architecture

- An Application/Service Development Kit (SDK) that supports the development of new media applications through emulation, testing and validation tools and leverages the Function as a Service (FaaS) programming model.

- A Service Virtualization Platform (SVP) using Open Source MANO (OSM) as NFV-MANO framework. Within the 5G-MEDIA project, two new Virtualized Infrastructure Manager (VIMs) are provided, in addition to those supported by OSM, i.e. the

Function as a Service (FaaS) VIM, which enables the use of the so-called FaaS concept and the OpenNebula VIM. Moreover, new components were developed to facilitate the orchestration and portability of media services, i.e., the 5G-MEDIA Catalogue designed to be NFV MANO platform-agnostic, the AAA mechanisms allowing Authentication, Authorization and Accounting of users and the Media Service MAPE providing the intelligence behind the MANO to dynamically manage infrastructure resources for the deployed media services according to observed changes in user demand patterns, availability and performance of network and computational resources.

- Different Network Function Virtualization Infrastructures (NFVIs) comprising the "Physical Layer", i.e., cloud computing resources provided by different operators that host generic and media-specific VNFs depicted at the "Virtualized Resource Layer".

Starting from that architecture, 5G-Media aims at offering new use cases with a very high demand on data rate, offered in a heterogeneous environment and to a wide range of devices. The project results aim at enabling to broaden the user experience, and at offering high quality and high resolution media services to the end users.

Specifically, the 5G-MEDIA results have been validated and demonstrated in three selected use cases:

- Use Case 1 aims at ensuring Quality of Experience for real-time multi-party tele-immersive applications, enabling real-time HQ 3D virtual reconstructions of users.

- Use Case 2 [4] aims to provide broadcasters with ad-hoc, scalable, flexible and time-saving production mechanisms facilitating (semi-) automated smart production in remote locations

- Finally, Use Case 3 [5] aims at delivering new capabilities to media service providers by distributing UHD content (4K and 8K) in a flexible manner through virtual CDN.

B. 5G-MEDIA innovation aspects

The 5G-MEDIA platform pioneers the application of Function-as-a-Service (FaaS) for VNF management, complementing traditional VM based VNFs with FaaS based media specific functions, aiming at dramatically reducing development cycles and slashing operational costs to 5G-MEDIA users. The combination of the FaaS approach with the VNF packaging and the possibility of inserting FaaS VNFs in a typical VNF forwarding graph is one of the main innovation aspects of the proposed 5G-MEDIA approach. Another specific innovation of the 5G-MEDIA project is the NFV MANO platform-agnostic catalogue, which uses a novel generalized and extendible format for representing Network Services (NSs) and VNFs to enable the use of Virtual Functions in federated MANO systems (e.g. complement a domain's catalogue of NSs and VNFs with items made available by other federated domains). In addition, the 5G-MEDIA platform integrates the Media Service MAPE component that relies on machine learning techniques and optimization policies management to adapt the

deployment of media services seamlessly to continuously meet expected Quality of Experience (QoE) requirements.

III. 5G-MEDIA BUSINESS SCENARIOS AS A ROADMAP FOR THE ADOPTION OF THE RESULTS OF THE PROJECT: THE MEDIA PERSPECTIVE

A. *Environment and stakeholders*

Media service providers and broadcasters are companies that offer services to end-users or other companies. For example, a media company may offer tele-immersive games to players around the world, or to a company that needs to process and distribute video files. Those stakeholders usually need to put additional effort in order to create live video, broadcast programs, high quality Over-The–Top (OTT) contents in a market more and more competitive at global level especially, with newcomers in the markets providing new, better or more efficient services to the end customers. Media companies usually manage internally the activities related to the production and provision of their customer services using their internal hardware infrastructure and negotiating specific contracts with network providers for the connectivity as well as with ICT providers and vendors for the hardware, software, consulting and support supply. Today, dedicated connections are established between the event location or venue and the broadcaster's site, to guarantee the high performance and quality of the transmitted media that are required. Companies currently face challenges to manage the process for providing their services/products to their final customers. The equipment that they use is very expensive and the vendor lock-in is high, especially due to strong hardware dependency. There are also constraints in terms of connection and limited Quality of Experience *(QoE)* due to a lack of bandwidth and high latency.

In the description of the business scenarios in the next paragraph, the project used a specific terminology for identifying the involved stakeholders, that is briefly described in this part. The main stakeholder categories are:

- *Media Organization* - includes all the organizations/companies involved in mass media, television, radio, publishing, video games and Internet distribution as well as media service providers (in particular SMEs) which provide audio-visual media services or rather media related services and applications inside the media market.
- *ICT organization* - includes all the suppliers of hardware and software, ICT support, ICT consultancy as well as system integration that provide their services and products to mainly to the infrastructure providers and to media organizations.
- *Infrastructure owner/provider* - includes a large set of stakeholders that work for providing infrastructure as a service. They go from data center providers to private/public cloud providers including edge computing point providers.
- *Network Operator* – this category includes all the stakeholders who provide connectivity services to the other stakeholder involved in the system.
- *Services Virtualization Platform (SVP) operator* – includes actors that provide or will be able to offer

virtualization services , on the top of the existing available infrastructures, to provide virtualization services as independent operator.

B. *Value Network Methodology*

The complexity of the 5G market and of the vertical markets (e.g.. M&E), requires for its analysis a methodology able to take in account all stakeholders and their relationships.

The notion of "value network" was described in 1986 by Thorelli [6] to be composed of "nodes or positions (occupied by firms, households, strategic business units inside a diversified types of organizations) and links manifested by interaction between the positions". Allee in 1999 [7] defined a value network as: "complex dynamic value exchanges between one or more enterprises, its customers, suppliers, strategic partners and the community". She also stressed that the value flows in general are not simply one directional, but are interwoven, interdependent and multidirectional and highlighted the existence of non-monetary exchanges of knowledge and benefits within a value network.

For the representation of the business scenarios, it has been used a simplified graphical representation based on the value network theory. The main stakeholders who work together with media companies to deploy media services/products to final customers in a 5G environment as well as their main relationships in terms of operational and revenue flows are identified and introduced. We aim at showing that the M&E organizations current status and the main relationships among those involved stakeholders can change by means of adopting new technologies like the one proposed by 5G-MEDIA. Consequently, new actors could emerge on the market, giving also new business opportunities to the stakeholders already involved.

C. *5G-MEDIA Business Scenarios*

1) *5G-MEDIA technologies solutions adopted and managed by media company*

This business scenario contemplates the possibility, that the main 5G-MEDIA project outcomes will be adopted and managed by media companies supported by ICT organizations where needed and deployed in their own or third -party infrastructures. The main envisaged relationships will be between the media company, ICT organizations, infrastructure owners/providers and with network operators, in a direct or indirect way. ICT organizations will provide the main 5G-MEDIA outcomes such as a software creating specific relationships with the media company, when there is a need for support and consultancy on this software or on other needed services.

Media companies will be able to integrate 5G-MEDIA solutions inside their infrastructure or in third party infrastructures. This will help them reduce their internal costs and improve their flexibility, optimizing the use of the infrastructure resources. In this case, media companies would make an investment in 5G solutions instead of investing in dedicated hardware, optimizing the productivity of the available resources.
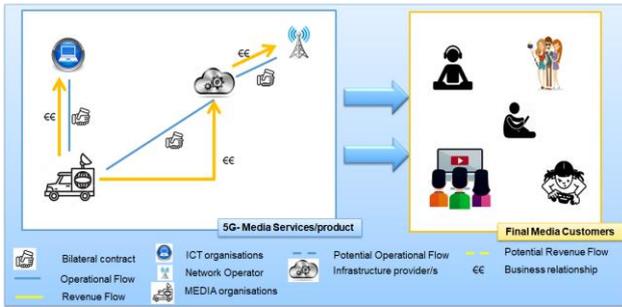
Figure 2: 5G-MEDIA outcomes adopted directly by media company business scenario

Specific agreements should be defined between media companies and infrastructure providers to negotiate both network and resources capabilities, and between media companies and ICT providers for managing 5G-MEDIA services in the selected infrastructure. Most parts of the network connectivity should be still provided by network operators, but the adoption of 5G-MEDIA will enable the implementation of new, more efficient internal processes for producing and providing end customer services as well as for performing their business. On the one hand, media companies will then improve their offering, covering more events or being able to assure a faster delivery [4], for instance for covering an event or live news, and on the other hand, they will be able to reduce their internal costs by means of a focused resources management.

2) 5G-MEDIA technologies solutions adopted and used by infrastructure owner/providers for offering services to media

5G-MEDIA outcomes may be adopted by organizations such as infrastructure owner/providers. The 5G-MEDIA solutions and specifically the part of the related SVP could be adopted by the infrastructure owners/providers to optimize the usage of their resources according to customer requirements in terms of media. On top of that, this will enable them to offer to Media companies (and potentially also to other domains) specifically tailored services for the instantiation of the end-customer virtualized services. In this scenario, the Infrastructure owners/providers would need to have a specific relationships/contracts in place with the ICT providers or vendors about the required software, support, and hardware, as well as with the network operators for the infrastructure connectivity.

The infrastructure providers can decide to provide media companies with their resources, as a service. According the media company's needs, it is possible to envisage at least two types of contracts between infrastructure providers and media companies as well as with other vertical domains: a) for industrial supply; and b) for event supply.
The first case covers continuous service supply by part of the infrastructure providers for offering media services (e.g.: video on demand, online games, etc.).
The second case is about supplying service for specific period in time for example for an event (e.g.: live, concert, football match etc.).
In both cases, we are talking about offering the instantiation and supplying of network optimization services as a service. Consequently, a "pay for use" or "pay as you go" payment method should then be considered attractive for vertical

companies in particular in the case of "event supply". In this case, media companies would hire a media virtualized service for a certain time period in order to cover an event, without the need to invest in hardware or dedicated connections.
For the industrial supply, which requires long time service provisioning, it could be more convenient to adopt a more traditional pricing policy, such as contracting a monthly or annual fee according to the consumption.
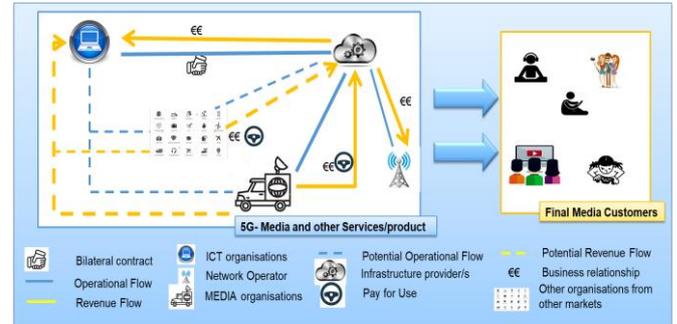
Figure 3: 5G-MEDIA outcomes adopted into Infrastructure providers business scenario

This business scenario, with respect to the previous one, will lead to a completely different process for media companies to produce and provide their services, through a workflow based on the functions virtualization and the dynamic efficient resource allocation. Some of the main envisaged advantages for media (or other vertical) companies, enabled by that scenario, are: i) the possibility to reduce or delate the vendor lock-in, ii) making vertical company cost structure more flexible but being at the same time, speedily able to produce, iii) test and launch in the market high quality end customer services. The 5G solutions seen in a global way and not just as connectivity improvement, will consequently give to M&E industry a new opportunity for choosing new processes for developing and providing products/services. From the point of view of the infrastructure providers, adopting such solutions as the one offered by 5G-MEDIA is an opportunity for exploiting their resources in a more efficient and optimized way, with the possibility to offer new services to media as well as to other vertical sectors, on the basis of the available infrastructure.

3) 5G-MEDIA technologies solutions adopted by independent operators for offering services to media

One of the main limitations of the previous scenarios is given by the geographical boundaries of the physical location of the infrastructure resources, as well as of the availability of the resources of a given infrastructure owner. As considered by [8], to assure a good quality of services for the final user in terms of metrics such as latency and throughput, it is important that some parts of the needed infrastructures are close to users (edge points). Those requirements are often difficult to be met from only one infrastructure owner/provider. In addition, it is relevant to consider the impact of the Internet of Things (IoT), that can be considered as distributed points with computational capabilities. Those IoT infrastructures are usually owned by

organizations belonging to a vertical sector. Moreover, the expected cost for increasing network capacity and deploying 5G are too high for assuring profitability for network providers [9].

Consequently, it is very important for the business and economic impact of 5G, to analyze how it is possible to overcome those limitations. "Federation", both at communication and computational level, represents a possible approach for managing the needed resources sharing and for providing final customer services. The exploitation of 5G features requires a converged view on the usage of communication and computational resources as well as a separated view between resource ownership and management. The results of 5G-MEDIA, specifically the SVP and the specific VNFs developed for the Media domain, aim to give business opportunities to stakeholders who without owning infrastructures, want to operate as an independent on the top operator, offering specific services for the dynamic orchestration of Media Industry services, leveraging on third-parties infrastructures/resources. As illustrated in *figure5*, the Service Virtualization Platform (SVP) Operator will be able to work as a bridge between the different stakeholders involved in the process (ICT providers, Infrastructure owner) for offering media final services. In this scenario, the SVP operator defines the needed relationships (as well as the SLA) with one or more infrastructures owner/providers, as well as with one or more network operators. If needed, the SVP operator will request consultancy and software solutions to ICT organizations (for instance about VNFs, and their relationships may be more easily managed by SW licenses).
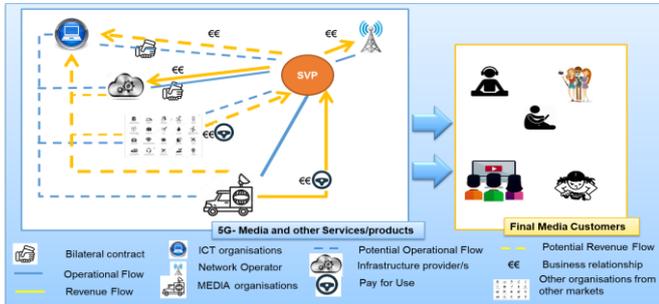
Figure 4: 5G-MEDIA outcomes adopted by independent SVP operators business scenario

This scenario offers to media organizations new options for more flexible, ad-hoc and cost-effective production workflows, by replacing dedicated connections and hardware equipment with software functions deployed in an operator, facilitating smart production and contribution in remote locations as well as distribution to a higher number of users and attending more events simultaneously.

IV. CONCLUSION

This paper, starting from the main technological results of the 5G-MEDIA project, has provided a view on how those technologies could impact the 5G ecosystem and more specifically the M&E market. Three main business scenarios have been presented. As demonstrated, the adoption of such future solutions will allow broadcasters or media companies to cover more events, reduce production costs and time deployment, distribute UHD content over vCDN, enhancing the viewer's QoE and reaching more population. It also has provided an idea on how the business relationships can change on the market with the adoption of solutions like the ones proposed by 5G-MEDIA project.

ACKNOWLEDGMENT

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