

5G and Media & Entertainment

Whitepaper

19 January 2016

Five key messages from this whitepaper

1. User habits and expectations with regards to media consumption are profoundly changing. While linear TV on a stationary display (TV set), possibly supported by local caching for non-real time viewing, will continue to be a very important element, the overall Media and Entertainment (M&E) user experience is broadening and deepening rapidly. This refers to types of services (linear media, on-demand content, user-generated content, games etc.), environments in which consumption takes place (on the move, in the home, etc.) and user devices (TV sets, smartphones, tablets, wearables, watches, virtual reality devices)
2. M&E services have to cope with increasing demand regarding data rates, number of concurrent users and/or more stringent QoS requirements. High quality and high-resolution audio-visual services are the most important drivers for increased downlink data rates, whereas user generated content, including sharing of social media, is the driver for increased uplink data rates
3. 5G will integrate seamlessly different network technologies - including unicast, multicast and broadcast – and capabilities (e.g. caching) which may be needed to provide M&E services for all M&E use cases
4. Scalability of 5G networks will be of critical importance for sustainable business models for network operators as well as for applications, device and service providers and hence for continued device and service innovation
5. 5G shall also foster the M&E innovation ecosystem by opening simple APIs / toolkits / environments to adapt the network capabilities to content application needs in real time

Contributors

The following companies and organisations have contributed to this whitepaper (in alphabetical order):

BBC	Alan Boyle, Andrew Murphy, Chris Nokes
Deutsche Telekom	Rachid El Hattachi
EBU	Darko Ratkaj
ESA	Maria Guta
Eurescom	Uwe Herzog
Ericsson	Hugo Tullberg, Joerg Huschke, Thorsten Lohmar
IDATE	Vincent Bonneau
Incites	Ioannis Neokosmidis
Intel	Michael Färber
IRT	Ralf Neudel
Nokia	Karl Josef Friederichs, Helmut Schink
Orange	Jean-Sébastien Bedo, Pierre-Yves Danet
Samsung	Belkacem Mouhouche
SES	Alexander Geurtz, Christine Leurquin, Ray Sperber
SWR	Roland Beutler
TeamCast	Gerard Faria
Telecom Italia	Raffaele de Pepe, Andrea di Giglio
Telenor	Terje Tjelta
Telespazio	Fabio Annibali
Thales Alenia Space	Christophe Nussli
TNO	Lucia D'Acunto
TU Braunschweig	Daniel Rother

Editors

Alexander Geurtz, SES

Uwe Herzog, Eurescom

Contents

Five key messages from this whitepaper.....	1
Contributors.....	2
1. Introduction	4
2. Requirements.....	5
3. Use cases.....	5
4. Socio-economic drivers of Media & Entertainment	6
5. Critical requirements	9
6. 5G as a catalyst for Media & Entertainment	11

1. Introduction

Media & Entertainment (M&E) have been revolutionised over the last years. Among most of the readers of this white paper, who could have predicted the digital transformations which are today reality? Who could have foreseen the ways kids and other early adopters consume media and entertainment content, produce content, share content and experiences, play games, etc. This has come as a complement to lean-back linear TV. Who could have imagined teens creating, commenting and sharing pictures, video and other content when they want, and where they want, and with whom they want? Who could have bet that thousands of people would broadcast their sport challenges on the web? Even if most likely clear signs of changes were coming up, the size of the new M&E wave has been much bigger than expected by anyone of us.

The biggest change driving all others in M&E is associated with the fact that the individuals themselves do not only passively consume, but interact, share, chat, talk, tweet, while walking, running, driving, commuting by subway or train etc., during their media and entertainment enjoyment. Under this influence, the M&E industries converge in all fields:

- Devices are expected to support M&E with high quality and maximum flexibility
- Video content and interactive user-experience converge into integrated platforms with a digital web-like experience
- M&E content follows the end-user wherever he/she is or is going
- Professional productions are complemented by self-productions by the end-users on social networks, other community platforms, as well as by aggregators and service providers producing original content
- User Generated Content (UGC) is becoming more and more used in both personal and professional environments and most of this content is stored and shared in the cloud

M&E convergence is enabled by several key technological developments including progressively larger and cheaper storage, increasing processing power, and better connectivity.

M&E services are consuming more and more network capacities due to higher usage and also to larger amount of data. In order to optimise the use of the network capacities, it is necessary that the on-demand resource parameters (latency, bandwidth, security, connectivity...) are allocated and configurable as required by the service.

While these massive changes energise the M&E industry and its economic impact, they pose extreme technical challenges to the underlying distribution infrastructure. 5G should be able to answer these challenges, and turn them into opportunities for all stakeholders.

5G comes as the union of point-to-point and point-to-multipoint (including broadcast) capabilities and networks that are currently considered rather vertically integrated like cellular, wireless, fixed, satellite, air platforms, and digital terrestrial television (DTT). This will deliver a seamless, integrated and optimised solution to M&E, with the aim of maximizing end-user M&E experience. 5G will enhance the capabilities experienced in networks today.

2. Requirements

5G shall provide an answer to all challenges faced, in terms of:

- **Volume:** Both on the downlink and the uplink. This is enabled by i) rapid advances in video compression and transmission solutions; and ii) low-cost storage and caching. Video quality is evolving to the highest audio-visual standards like Full HD or 4k UHD, with growing on-demand consumption complementing linear TV and audio broadcasting in the user experience. This growing video consumption is fuelling the demand for high downlink capabilities and efficient caching. Growth of UGC requires increases in uplink capabilities. Caching and network storage must also support uploading/upstream transmission of such content. Cloud TV, expecting to ensure coding/decoding function in the cloud should also require high capacity
- **Any Device:** Content delivery solutions for fixed and mobile devices such as tablets, connected TVs and any connected devices, that also enable usage of multiple devices, companion devices which complement the main screen to bring additional information
- **Anytime:** Ability to deliver live TV but also Video on Demand (VoD) and games at the busy hour without signs of congestion, excessive latency and delays, at sustainable cost and without the need for excessive spectrum and other network resources
- **Anywhere:** Ability to deliver and consume M&E services anywhere, independently from the user's location or movement including the best network connectivity
- **Quality of Service:** Ability to provide, for mobile, nomadic as well as stationary usages, the required Quality of Service for M&E enjoyment, e.g. low error rates for video and audio and low latency for gaming. Also, ability, within an integrated network, to seamlessly and optimally switch between sources (e.g. unicast/multicast, adaptive streaming, etc.), using appropriate business and network interfaces (including APIs) to allow dynamic resources allocation per network slice. Finally, ability to allow service personalization (e.g. dynamic/personal advertisements and user context awareness)
- **Security:** For end-users as well as for protecting content-owners and associated content rights, including the ability to provide efficient access control of cached video content

3. Use cases

5G shall enable at least six main families of M&E use cases in the 2020s with an overall user experience that well exceeds that of 4G and other legacy networks:

- **Ultra High Fidelity Media:** Rapid progress in display and capture technologies is enabling a new, highly immersive viewing experience with ultra-crisp, wide-view pictures with deep contrast and unparalleled multi-channel sound. Both linear (e.g. live programming, streaming) and non-linear (e.g. on-demand) content will be used for providing this Ultra High Fidelity Media experience. In order to guarantee a high quality of experience for Ultra High Fidelity Media, the future 5G network should be able to support efficient network management high speed transport capabilities and strategies, e.g. by means of local and network caching of content. Large, home-centric, displays (e.g. UHD TV screens) and portable devices (e.g. smartphones, tablets, Virtual Reality devices) will allow the full quality experience

- **On-site Live Event Experience:** Large scale event sites, such as cinemas, stadiums and hall parks are more and more being connected in order to give better experience to their customers (replay, choose a specific camera, language, augmented reality to bring additional information, etc)
- **User Generated Content & Machine Generated Content:** People and objects are and will capture more and more content in order to share it with others in the cloud. That means that the future 5G network should be able to support on demand high upload bandwidth and streaming from various devices / objects (camera, health and wellness measurements, building sensors...) in order to bring a good user experience in such a situation
- **Immersive and Integrated Media:** Media will become immersive and highly interactive to provide ambient media consumption at home but also on the move, with content capable of following the users and adapt to his ambient for viewing (e.g. In the car, at home etc.) New 5G capabilities will enable immersive video experience, to retransmit holographic type video beyond telepresence (2D) closer to a virtual presence experience in 3D. In the business environment for instance people are more and more working in a collaborative way even in the same company in order to be more efficient and to accelerate the innovation to the market - immersive video conferencing will simulate the face to face experience that present videoconferencing systems do not allow
- **Cooperative Media Production:** This covers the many facets of media production. Content will be captured and shared immediately, utilising 5G enabled cameras and microphone, from anywhere to anywhere with additional metadata automatically pre-attached e.g. spatial location date. The content will be worked upon by different users in multiple locations simultaneously and the content should be able to be automatically repurposed for different requirements i.e. second screens, interactive games. The immediacy of access to content, as it is created, should drastically reduce media production timescales
- **Collaborative Gaming:** Gaming will expand into a full immersive multi-sensorial environment which will result in a more realistic experience, improved ability for users to collaborate within the game and no limitation on the number of simultaneous users. Similar to other media areas, gaming is likely to move from a primarily “home based” experience towards an “anywhere” experience with user collaboration being both simultaneously in the physical world and the augmented reality domain, based on the users actual location. Game development may also become more cooperative with users directly interacting with the developers in real time

4. Socio-economic drivers of Media & Entertainment

Growing capabilities of user devices: The advances in user devices, coupled with innovative services drive user expectations, in particular in terms of choice, quality, availability, and affordability. There is a wide and growing choice of devices which can receive media services for viewing and listening, from stationary TV sets and home radio receivers to personal computers, tablets & smartphones, game consoles, media boxes or even whole wall UHDTV displays. A rapidly growing number of smartphones' and tablets' displays enable high quality video, and analysts predict that the use of video on such devices will grow substantially. Many devices are equipped with high quality video cameras and consumers use the devices for taking and sharing pictures as well as sharing videos. Many consumers use special cameras like helmet-mounted cameras to record and share their experience with others. 5G systems need to provide more uplink capacity for sharing information. In order to reach the audience on any device at any time and in any place,

broadcasters and other content providers use multiple delivery means, including both broadcast and broadband platforms.

Linear vs. on-demand consumption: While on-demand video traffic has grown significantly, linear/live still makes up the vast majority of overall daily viewing. Broadcasters and other media service providers provide a range of content and services, including linear radio and TV as well as time-shifted, on-demand, hybrid, and data services. There is a clear trend towards a more on-demand consumption of TV content. Linear Channels are still important, in particular for live events. Media consumption on mobile devices is increasing, inside homes and also outside. On-demand viewing is currently mostly concentrated on certain popular programmes with the addition of a long tail.

Peaks in media consumption: There can be significant peaks of simultaneous viewing, e.g. during large live events, be it sporting events such as the Olympic Games or popular entertainment shows. There is the potential for more video on mobile devices to be watched live around such events if barriers to consumption such as cost and capacity bottlenecks are lowered or removed. Peaks in consumption are amplified through consumer use of social media during such large events.

Convergence and hybridisation: A key feature of future scenarios – that is already visible now – will be convergence, particularly in the domain of distribution. Convergence will involve Internet, phone, TV, mobile and content (in music, video, gaming, etc.). Convergence will rely on very high-speed networks and will be inextricably linked to seamless access to content: the idea of ATAWAD (anytime, anywhere, on any device – including ‘heavy’ content, transmedia).

Similar to this is the hybridisation of two or more technologies or media, such as Internet TV, portable video, or mobile messaging, which expands the possibilities to modify and extend media in new ways. Also pure media convergence will continue in many fields; for example, book publishing will be more and more interlinked with audio-visual, gaming, etc. Developments in wiring and materials carrying digital information and in the cost and availability of bandwidth will be essential.

Cloud technologies: Tablets and smartphones are inherently wireless/cellular devices, and as such require high capacity wireless/cellular connectivity. Their processing and storage power are limited due to constraints as e.g. size, weight and cost. Continuous ‘ubiquitous’ access to the Cloud can lower these limitations.

Internet of Things: A world of interconnected devices, the age of the Internet of Things, will generate a spectrum of use cases and new applications. Everything from TV and telephony to home lightning can be interconnected.

Innovative services: New services will emerge in the future. Video 360°, e.g., will give a new immersive dimension to content consumption, enabling users to navigate in real or virtual content in a more realistic manner. This will need more powerful networks, able to support larger amount of data with the appropriate quality of service. 5G should also offer more flexibility to allow the development of innovative services. The challenge is to achieve this with 10-100x change in the scale and at sustainable economics.

IP and Object-based audio/video: The use of IP technologies in TV and radio production is likely to be transformative over the coming decades, offering the ability of a more object-based approach to programme making and delivery. This could allow, for instance, different parts of a programme to be captured and delivered using different bearers as appropriate. These could then be brought together and rendered on a device in the form most suitable for a particular user and their environment at any given time.

Technology becoming transparent to users: End-users have demanding expectations regarding media and entertainment which are getting more stringent every day. However, end-users do not want to care about which networks and technologies are used to bring

them their content or data-experience. They just want to have what they need, when they want, or any device, at any time, without limitation or constraints. Although perceived as irrelevant by the end-users, the networks behind the Media & Entertainment experiences of the end-users will have to deliver, and to provide a frictionless user-experience always matching the user’s social behaviour.

Media and entertainment is a large market: As shown in Figure 1, the digital content market represents globally about 155 billion EUR already, with a dematerialization rate of around 45% applied to the content industry (including books, video, games, music, but not live TV). Europe represents between 25 and 30% of this market. Such market size has also a significant impact on employment in Europe. According to Ernst & Young (cf. Figure 2 **Error! Reference source not found.**), more than 7 million Europeans are directly or indirectly employed in creative and cultural activities — 3.3% of the EU’s active population. Television and Film industries cumulate 1.25 million employments. 5G will have to answer to these market dynamics and to its societal and economic impacts.

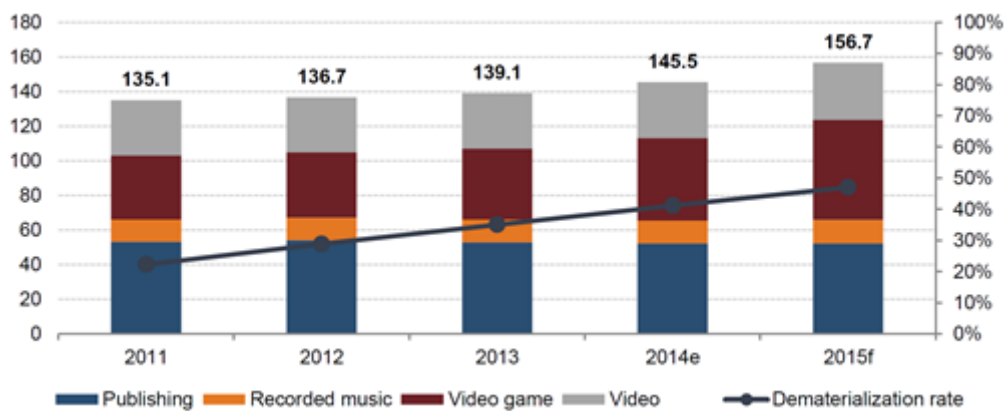


Figure 1: Global market of online content (in billion EUR) (source: IDATE)

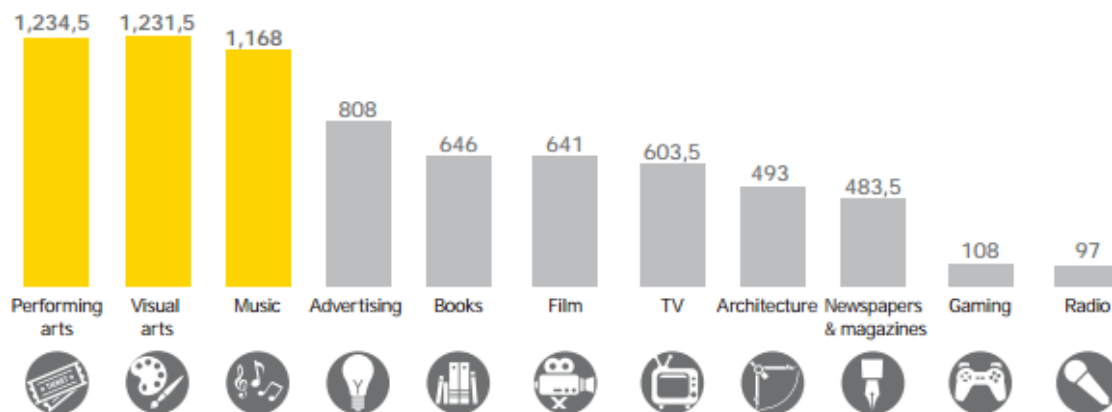


Figure 2 Employment in cultural and creative industries in Europe in 2012 (in thousands) (Source: Measuring cultural and creative markets in the EU, Ernst & Young December 2014)

5. Critical requirements

In order to achieve the Media & Entertainment experience that consumers and businesses are starting to expect “anywhere, anytime”, a number of critical requirements need to be met in terms of improved capabilities. As shown in Figure 3 below, these requirements are a function of the use case.

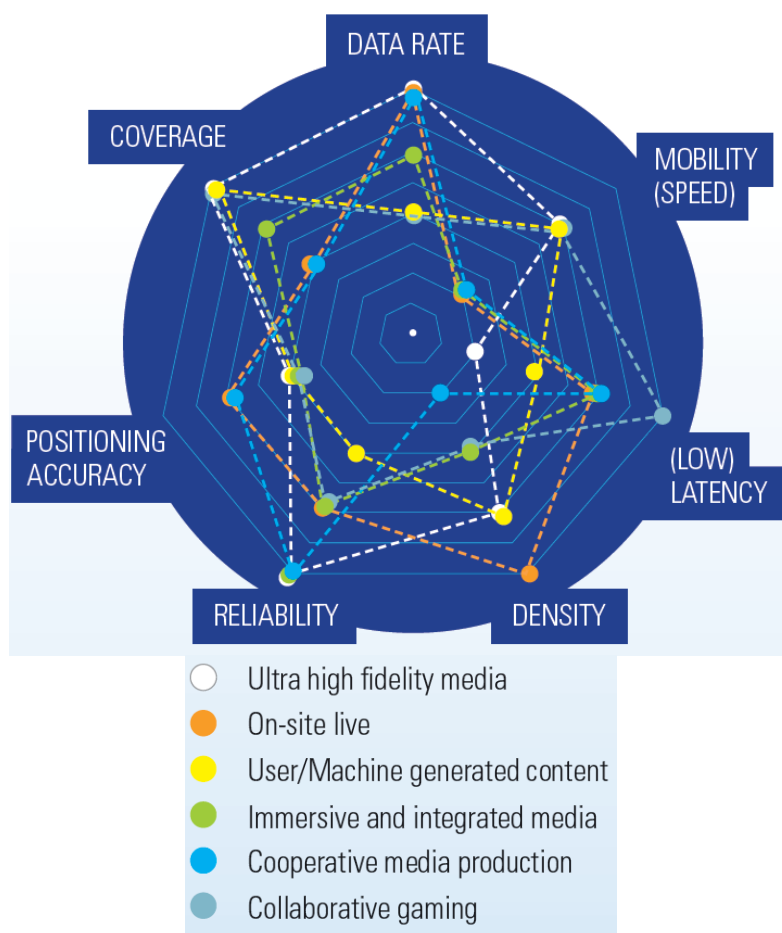


Figure 3 Capability spider diagram for Media & Entertainment

We can give the following definitions for the eight axes of this spider diagram:

- **Data Rate:** Required bit rate for the application to function correctly. It corresponds to the data rate received by the user device
- **Mobility (speed):** Maximum relative speed under which the specified reliability should be achieved
- **E2E Latency:** Maximum tolerable elapsed time from the instant a data packet is generated at the source application to the instant it is received by the destination application. If direct mode is used, this is essentially the maximum tolerable air interface latency. If infrastructure mode is used, this includes the time needed for uplink, any necessary routing in the infrastructure, and downlink
- **Density (number of devices):** Maximum number of devices per unit area that are 5G capable, although they might not all be generating traffic simultaneously for the specified application

- **Reliability:** Maximum tolerable packet loss rate at the application layer within the maximum tolerable end-to-end latency for that application
- **Position Accuracy (Location):** Maximum positioning error tolerated by the application
- **Coverage:** Area within which or population for which the application should function correctly, i.e. the specified requirements (latency, reliability and data rate) are achieved

The quantification is based on the following ranking: (0) No requirement, (1) Low level of requirement or no specific constraint, (2) Medium level of requirement, which could be satisfied with existing legacy systems (3) High level of requirement, which may be at the limit or not satisfied with the existing legacy systems and (4) Very high level of requirement, corresponding to the 5G Infrastructure PPP targets and Key Performance Indicators (KPIs).

We can note that several Media & Entertainment use cases require a very high data rate with Ultra High Fidelity Media and On-site Live Event Experience being the most important drivers for downlink throughput and Cooperative Media Production being the most important driver for uplink throughput. Maximum values for these use cases are in the order of Gb/s if we consider cloud applications and 4K (and beyond) video formats. In addition, On-site Live Event Experience requires a very high density with several thousands of devices connected simultaneously in a single stadium or concert hall. It makes this use case the most demanding with a data volume density of up to at least 0.75 Tbps for a standard stadium in the 2020s, as estimated by NGMN¹. This very challenging target, which is not reachable with 4G and its evolutions, will require a seamless integration of various innovative technologies including broadcast and millimetre waves.

Furthermore, Ultra High Fidelity Media, User / Machine Generated Content and Collaborative Gaming have strong requirements on geographic and/or population coverage. Indeed, these everyday life services need to be available in all conditions and offer user experience continuity regardless of if the user is in his house basement, in a city centre, or in a village or in a high speed train or an airplane. Achieving this target would be a significant improvement compared to today's situation where the digital divide is a reality, preventing certain parts of the population, for instance in isolated villages, to benefit from 4k or HD video streaming.

The following additional capabilities are also assessed as key from the Media & Entertainment perspective:

- **Service Deployment Time:** Duration required for setting up end-to-end logical network slices characterized by respective network level guarantees (such as bandwidth guarantees, End-to-End (E2E) latency, reliability...). 5G Infrastructure PPP targets 90 minutes for service deployment time. This will bring the required flexibility to scale up down demanding media and entertainment services on certain areas (e.g. live HD retransmission of an event)
- **Security:** System characteristic ensuring globally the protection of resources and encompassing several dimensions such as authentication, data confidentiality, data integrity, access control, non-repudiation, privacy, etc.
- **Identity:** Characteristic to identify sources of content and recognize entities in the system. It is particularly needed for Media & Entertainment in order to ensure that only appropriate subscribers have access to a protected content

From this overview of critical requirements for Media & Entertainment use cases, we can recall that it is key that 5G enhance significantly available data rates as well as service

¹ https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf

continuity in all situations whether in buildings, in cities and villages, in very dense areas like stadiums and in transport environments. It will allow for services with higher quality available everywhere, any time and on any device. In addition, 5G should bring higher flexibility to set up service level agreements in near real time and higher security such that content is delivered only to authorized end users, despite the trend to use various devices and access networks.

6. 5G as a catalyst for Media & Entertainment

The growing demand for video presents challenges to cellular networks in unicast mode and it will not be efficient or economic to distribute live video and audio across thousands of network cells and perhaps several mobile network operators (MNO) in parallel in case a large number of users simultaneously demand the service.

Content distribution requires much more than IP connectivity between a media repository and a consumer. Consumers need a sufficient Quality of Experience which can be provided by a controlled throughput and latency. It can be achieved through various technologies such as QoS enforcement (Information Centric Networking, DiffServ, QCls, access control etc.), distributed storage of media close to consumers (also known as Content Delivery Networks) or broadcast and multicast.

Overall, thanks to the ever more competitive telecommunication 5G services market, new business models will emerge, promoting closer collaboration between network service providers, and between network service providers and their suppliers. This collaboration shall ensure improved network and end-to-end service quality, which enhances customer experience. Collaborative services imply the association of fixed and wireless as well as terrestrial and satellite network service providers to deliver services with common multi-service control layer and assured quality in contrast to competitive services that imply a form of competition between the involved network service providers.

As a conclusion, 5G is a catalyst for Media and Entertainment as it will be capable of supporting all user cases which community and individuals demand. And it will be scalable to adapt and match any future user cases which may even not be foreseeable today.