5G Workshop with Verticals

Brussels, 18 June 2015

Organised by European Commission and 5G Infrastructure Association

Workshop Report

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About the workshop

Whilst earlier network generations have been designed as general purpose connectivity platforms with limited differentiation capabilities across use cases, the situation is changing for the definition of 5G networks. Faced with an ever larger portfolio of applications to serve and with a corresponding skyrocketing number of requirements to satisfy, it is now commonly recognised that future networks will have to consider requirements by vertical sectors from the onset. This is not only the case for future very high bandwidth usage, but also for a new range of targeted applications such as mission-critical applications. 5G mission-critical networks are hybrid networks that connect machines and humans directly and via mobile networks to provide future services through highly reliable, low-latency and broadband services.

Against this background, the workshop aimed at fostering the interactions between the more traditional ICT sector and the potential users, to further trigger the wide-scale adoption of 5G systems in vertical industries. The goal was to initiate a process whereby closer structured links can be established between the various communities towards a common understanding of the set of requirements of the various sectors and how these translate into design, architecture, technology and performance requirements, such that 5G adoptions may become a reality across the largest possible user communities. The intention was also to fuel 5G design debates with the most advanced set of requirements that 4G and its planned evolution may not be in a position to fully satisfy. These aspects will also be important to correctly steer the 5G PPP developments, including at downstream deployment level, in domains like standardization and regulation.

The workshop was a fruitful start of the crucial discussion with the vertical sectors in the development of 5G, and it will be followed up by further activities described in this report.

Vertical sectors addressed in the workshop sessions

1) Health
2) Automotive
3) Factory
4) Energy
5) Media & Entertainment

Health

Purpose of the session

The session aimed to create a shared understanding between experts from the healthcare domain and experts from the ICT/5G community on the challenges and needs in the health sector and how they translate into requirements for 5G. Furthermore, the session was regarded as a first step in the 5G – health dialogue, with the goal of initiating concrete actions for including vertical sector requirements from healthcare in the development of 5G.

Trends and needs in the health sector

The discussion on vertical sector challenges and needs in healthcare was stimulated by presentations from Cindy Fedell, Informatics Director at Bradford Teaching Hospital; Stefano Micocci, Cup 2000; Anastasius Gavras from Eurescom, Coordinator of FI-STAR; Alex Hryniewicz, Head of Multiplatform at Maverick Television; Philippe Cavallo, Scuola Superiore Sant'Anna; and Denis Abraham, Mines Telecom. From these presentations and ensuing discussions, a number of common themes emerged.

Decentralisation

There is a trend in the health sector towards decentralization, moving care close to the point of need. Due to cost and quality reasons, it is considered more effective to provide the care for example at the patient's home or on the move. ICTs are a crucial enable for decentralization. An example provided was a planned virtual ward for monitoring of patients at home by a clinician in Bradford.

Virtualisation

Processes that used to happen only in the analogue world are moving to the digital world. Virtualisation is required for scenarios like remote surgery and all types of tele-monitoring. The transfer of processes from the physical world to the virtual world will have a number of technological, social, and regulatory implications related to data management (see below) and liability. In the latter case, current regulation may not sufficiently cover new service provisioning models, where it may not be clear in case of failure, whose legal responsibility it is, e.g. the doctor's or the network operators'.

Mobility

It is estimated that mobile health services could save billions of euro of healthcare costs in the EU. At the same time mobile health monitoring services could improve the safety and comfort of patients through monitoring of vital functions. There are also advances in mobile diagnostics through multi-functional mobile health devices, which are particularly relevant for healthcare provisioning in remote areas without medical infrastructure. Mobility is also crucial for emergency scenarios, when patient information is needed already at the point of care and on the way to the hospital.

Data management

With the flood of digital information coming from remote monitoring sensors, electronic health records (EHR), a number of challenges emerge. One challenge is to filter out the right information relevant to patients and doctors. Another challenge is to manage and integrate all the information from different sources, like, e.g., sensors, patient files at hospitals and patient files kept by general practitioners.

Due to the sensitive nature of the information, data security and privacy are of key importance and will increase in importance with growing amount of data and the ubiquity of access to health data. An important challenge in this context is to give the patients control over their own data.

New business models

The combined effect of decentralization, virtualization and mobility is leading to the emergence of new business models within and outside of the heavily regulated 'official' healthcare system. These business models will be based on the replacement of highly qualified and scarce medical personnel by machines and less qualified personnel, e.g. in remote health monitoring scenarios.

Challenges and technical requirements for 5G

Based on the trends and sectoral needs in the health sector, a number of challenges and technical requirements for 5G were identified, which are captured in the table below.

Challenges	Needs	Requirements to 5G infrastrucure
Monitoring and capturing (image, etc)	Configurability and data acquisition (user) Tele-monitoring (care taker), automated diagnostic, low battery consumption	Filtering, Semantic representation of data, speed (>300km/h), throughput, deployment/overage, mobility
Analyzing	Data request and settings (care taker), reasoning systems, access to experts	Traceability, data access and usability
Acting	Vehicles (robot, ambulance, helicopter)-infrastructure communication; Remote controls of robots (surgery, other care services); Exoskeleton and mechanical tools for re-habilitation	Low latency, Speed, Mobility, Reliability, QoS, QoE, coverage, speed (>300km/h), deployment/overage
Storage (data)	Data management , maintenance, accessibility (in any context, anytime, anywhere), privacy, security, indoor/outdoor behavior, size, data control and visibility (user)	Capacity, speed, security, reliability and availability (99.999%), and QoS, trustworthy, deployment/overage
Rendering (audio, video, etc.)	QoE (images), easy interactions, human-machine interface	Speed, latency, reliability
Liability and regulations	Standards, legislation, non-repudiation, privacy, spectrum management	Standards and interoperability
Business model and usage scenarios	Stakeholders, interfaces, ecosystem, social networks, machine-human networks, spectrum	Architecture, network and resources slicing, virtualization, scalability, network control-ability

One aspect in the discussion was how the challenges and needs of the health sector could be addressed in the transition period until the rollout of 5G. There was some agreement that many requirements can already be covered by enhanced LTE (4G). However, in order for this to happen e-health requirements need to be integrated in 4G as well as 5G.

Another specific requirement from the health sector stressed in the discussion was to have a better uplink. There was agreement that relationship between uplink and downlink has to change, as proactive consumers and patients will want to upload their (health) data. It was noted that this is currently not included in the 5G KPIs. Uplink will change.

Next steps

The session concluded with suggestions for next steps to be taken in the coming weeks and months. The following action items were proposed by the convenor and the 5G Association caretaker:

- Review of inputs to ICT work programme 2016-17 to include vertical sector requirements
- Joint discussion/work on project proposals to Call 2 of the 5G-PPP
- Demos at the Mobile World Congress 2016
- Tests and large scale trials of 5G reflecting requirements of vertical sectors
- White paper on 5G use cases, scenarios and requirements for the health sector
- Inclusion of vertical sector representatives as observers at the 5G Infrastructure Association

It was agreed to use the distribution list of the session participants to continue the discussion on the next steps.

Automotive

Introduction

The session addressed the following three main mid- and long-term challenges for society, which are related to the mission of the automotive industry sector within the entire ITS (Intelligent Transportation Systems) ecosystem:

- **Public** – to ensure efficient and safe transport of people and goods in wide areas, in particular for growing population and businesses in high density areas with increasing traffic problems as well as in low populated and distant areas ensuring economically affordable transportation
- **Ecological** – to ensure the most efficient use of energy for transportation services, contributing to reasonable usage of natural resources and directly contribution to decrease of CO2 emission and reduction of other negative environmental impacts, caused by transport and logistics services
- **Economical and business related** – to ensure further development of transport and logistic as well as enable development of new related services and products, contributing to sustainable economic growth and creation of new jobs

To come with the identified challenges, the automotive industry is currently working on research and development of a number of applications for and around vehicles. Among them, the following application areas have been identified and discussed at the workshop as the main drivers for 5G networks derived from particular areas of interests from the automotive industry:

- **Digital infrastructure in vehicles** – ensuring availability (transmission, storage, and update) of significant amount of information in vehicles for entertainment and working purposes (connected car with all services as at home or in office), improving driver experience in interaction with the vehicles and its components, as well as to support applications and services mentioned below.
- **Smart navigation** – going beyond nowadays navigation systems by involving, sharing, and considering/processing a significant amount of available relevant information provided by central traffic and environmental operation centres but also by individual drivers and/or a future generation of devices in future generation of all types of vehicles. The smart navigation will also integrate all related requirements coming from wide deployment of **electro vehicles** expected to happen during the next decade.
- **Virtual drivers' assistance** – virtual reality features in vehicles, such as interactive wind screen driver display
- **Cooperative driving** – presenting the drivers traffic and other situations on and around the transport routes of interest, which are not visible for them, and processing the available information to help drivers or automated functions in vehicles to make decisions by considering available information from central traffic observation points and shared information from other vehicles and their cooperative driving systems.
- **Automated vehicle / autonomous driving** – probably the biggest challenge for automotive industry today aiming at introduction of the following levels of automation
    - Cruise control, basic parking assistance, distance control – todays features
    - Enhanced parking assistance (e.g. smart phone enabled) and automatic driving in traffic congestions

- Automatic driving on highways and other appropriate/selected roads and situations
- Fully autonomous parking
- Robot taxi – fully autonomous driving – a long term challenge

Requirements on 5G network infrastructure from automotive industry

Network structure and management

In order to ensure network efficiency from both technical and commercial points of views, the automotive and ITS sectors are looking for unique shared collaborative network infrastructure. The network management should ensure an easy establishment of virtual networks with all needed capabilities within the overall 5G infrastructure, which can be widely deployed. The virtual networks can be than used by specific operators offering ITS related services, which can be the nowadays network operators (and operators of future 5G networks) but also so-called ITS service providers.

Need for dedicated ITS network – physically separated from the global network – might be needed only for critical safety related services only. However, the autonomous vehicle functions will not require such networks which might be necessary for other transportation systems (e.g. railways).

Network capabilities

Network coverage – availability of wireless services – is crucial for wide deployment of ITS services along the roads and a good coverage must be ensured in low density areas as well. Data has to be available practically everywhere, not necessarily stored but therefore efficiently and fast transferred from central and local pointe to destinations, in particular vehicles on move.

It is expected that number of base stations to be deployed along the roads will be very high, if data and control are routed via base stations. A better economic solution is provided by network assisted V2X. The base stations will have to support cellular assisted vehicles positioning, going beyond GPS capabilities in precision.

IoT and cloud based services, involving extremely large number of devices, is of very high importance for the ITS services.

Connectivity requirements

5G will need to support hybrid communications and support various types of connectivity and involved communications technologies. The main reason is the fact that it will be difficult to change technologies which are already in use in automotive sector and ITS at large and, therefore there is a need for technology integration under 5G umbrella.

For example, it is expected for Europe and US that by the year 2020 the automotive industry will install WLAN based technologies in the next generation of vehicles, which will then last for upcoming decade and longer, whereas 5G are not expected to be adopted by the automotive industry before 2022/2023, probably even not before 2025. WLAN cannot provide the QoS requirements needed for low latency and broadband ITS services needed for future ITS services like Autonomous Driving support. In China a different approach could be discussed, i.e. not adopting WLAN.

High-speed, low latency and high reliability communication

Reliable and low latency high-speed communication will be needed for almost all applications mentioned above. In particular, capable high-speed links in up-link transmission direction – vehicle to vehicle, vehicle to infrastructure – will be needed for the cooperative driving as well as for the autonomous driving.

For the first case, the capable uplinks are needed to enable share of so-called drivers' views, ensuring transmission of this information or rather already processed relevant data to other drivers either directly or via the infrastructure's nodes. In this way, the drivers are informed about relevant situation in the near environment and intention of other drivers in area of interest, so they can react accordingly manually or with support of smart devices integrated in the vehicles, including virtual drivers' assistance. Therefore, the related requirements are very strong in terms of transmission rates and latency.

On the other hand, the autonomous driving services and applications will need to be fully independent, particularly in critical situations where there is no possibility to gather and process information from sources outside of the affected vehicle (no time, network/transmission failure, etc.). However, experience in the autonomous driving can be significantly improved by applying features of the cooperative driving and even by involving a kind of a centralised operation when possible.

Safety support

To support safety as a very important requirement of the automotive industry, the following requirements on the 5G have been identified:

- Fast recovery processes after lost network coverage or connection and definition of efficient related protocols and algorithms
- Enough and free of interferences spectrum for all mentioned applications and services
- Appropriate security standards to support safety offering different levels of security, from simple to complex, depending on its concrete purpose

Business and operational issues:

- 5G including services and applications enabled by 5G, should take over as much functions in the future vehicle, to ensure costs saving of of in this case not needed equipment in vehicles , e.g. specific sensors
- Roaming among operators and technologies has to be seamless in real terms. Also, service subscription principles/thinking should be further developed and simplified, e.g. could we do it without SIM cards
- Cooperation and exchange of requirements with other vertical, (non ICT), sectors is seen as needed to ensure efficient definition of 5G requirements covering all needs. The synergies in services and applications development related to multiple sectors as well as collaboration in equipment (e.g. sensor) development and production are welcomed as well.

Main conclusions

- High requirements on QoS capabilities, high transmission rates and low latency for transmitted data are set for 5G network infrastructure by automotive and ITS sectors
- The automotive industries require support for hybrid networking features in 5G, allowing the integration of old communication technologies, which are already in use, in the next decade
- Usage of one radio technology and unique 5G network infrastructure will be beneficial for all use cases
- Low latency and security are needed to be ensured for all services, whereas safety will be based on autonomous functions of sensors and other devices placed in vehicles
- There is a need for joint design and testing in upcoming Phase 2 of the 5G PPP programme with significant involvement of the automotive industry
- 5G is seen as enabler for new automotive services, such as cooperative and autonomous driving
- A trade-off between sophisticated sensors in vehicles and low QoS communications as well as between less sophisticated sensors and high QoS communications will need to be made to save production costs and ensure economically efficient solutions
- Challenge remains for both automotive and ICT sectors on how to manage human and robot (autonomous) driving concurrently
- A need for precise cellular network based positioning has been identified

What was not discussed at the workshop and needs to be addressed soon:

- Business models between operators and vehicle makers
- Sharing economy among all involved actors and across entire value network
- Nomadic nodes as service to operators
- Communications via mm waves

Factory

Purpose of the session

The session aimed to create a shared understanding between experts from the manufacturing domain and experts from the ICT/5G community on how the challenges and needs of the Factory of the Future translate into requirements for 5G. Furthermore, the session was regarded as a first step in the 5G – manufacturing dialogue, with the goal of initiating concrete actions for including vertical sector requirements from manufacturing in the development of 5G.

Trends and needs of the factory of the future

Presentations by Silvia Castellvi from ATOS, Guillermo Gil from Tecnalia, and Tom Van der Horst from TNO provided an overview and prepared the ground for a discussion on trends and needs of the factory of the future as part of the fourth industrial revolution, which is branded as Industry 4.0. The Industry 4.0 market is expected to grow by 204% by 2025, offering huge opportunities for Europe. Key sectors are currently automotive and avionics.

Industry 4.0 includes a change from mass production to customized production, from make-to-stock to make-to-order. What is important in an Industry 4.0 scenario is the communication between the plants and the monitoring of machines, robots, and material flows. It is no longer just about production, but also about product-related services.

The factory of the future will organise itself and implement the vision of 'design anywhere, produce anywhere', which will lead to new business models (see below).

In the factory of the future, mobility is a key element, as employees moving around need to know about the status of processes.

Industry 4.0 depends on the following communication requirements to be met:

- user experience should be independent of the network
- all elements need to be interconnected
- machine to machine communication needs to be interrelated
- needs to support interactivity with assisted operators
- convergence of IoT, adaptive robots, 3D printing, and other enabling technologies

Specific factory of the future requirements, as exemplified by several use case, include, among others, the following:

- Identification of objects/goods
- Traceability of objects/goods
- Automated/Remote quality inspections and measurements
- Remote diagnosis of failures
- Personalization of products

As there will be more and more smart customized products in an Industry 4.0 scenario, the challenge is to pre-provision the products. Another challenge is to effectively coordinate the interaction of humans and robots.

There will be a new network scope in the Industry 4.0 world beyond the current connection of providers, manufacturers and customers around smarter products.

Business models based on the factory of the future

The factory of the future will revolutionize business models in the manufacturing sector. There is a trend towards global manufacturing networks, with strong integration of customers, manufacturers and network providers.

A new business model emerging is 'Manufacturing as a service', where design is completely decoupled from production. In this context, crucial questions in regard to responsibility and liability emerge, e.g.: Who is the owner of the infrastructure? How will co-ownership of network and manufacturing infrastructure be managed? Who will be liable, in case of failure along the communication/production chain? In general, Industry 4.0 and manufacturing in general pose the challenge of a mission-critical environment with high liability.

As production becomes network-centric, information will be the main source for value creation in manufacturing. This means information as value driver leads to new business models: competition will be driven by use of information.

Technical requirements for 5G

Based on the trends and sectoral needs as well as the novel business models of Industry 4.0 and the Factory of the Future, a number of technical requirements for 5G were identified.

- Easy management of hybrid manufacturing architecture
- Location of data processing; this has an impact on latency. up to 30ms
- Outdoor as well as indoor provisioning of 5G
- Real-time communication requirements of some machines for a short time
- Low jitter (30ms) and short latency times, where latency is also about the processing time
- Embedding of 5G technology into shipped machines and products
- Service continuity through integration of short-range radio with wide-area protocols

Open questions in the discussion were:

- Should 5G go down to the sensor level?
- Which standards should be adopted?

The participants agreed that a big shift in standards is required, as the old standards don't reflect new technologies; 3GPP only provides incremental changes on top of outdated standards.

Particular technical challenges identified by the participants:

- Flexibility of the network while allowing a sufficient level of control
- Service continuity and seamless handover across heterogeneous networks
- Management of co-existing communication protocols

Furthermore, participants identified the following aspects:

- Support of end-to-end supply chains, SMEs are part of supply chain and need to be able to adopt 5G solutions in global networks

- 5G should enable more flexibility.
- Focus should not only be on manufacturing, but also on design.
- Simulation and forecasting are also an important factor in the whole chain; which adds to amount of data.
- We need to look for good points for data aggregation.
- Management of security vs usability and cost. Security should be in-built from the start and not added later.
- Safety must also be in place in addition to security.
- Migration paths from the current manufacturing world to the 5G smart factory world need to be considered. What are the product life cycles of different elements in the process?
- Network slices were discussed in terms of network slicing vs data slicing.
- Liability: who is liable for networked services for industry 4.0? And how should this be translated into SLAs?

In general, the participants expressed that they do not know yet what is 5G. It is, for example, not clear, whether 5G will cover time-critical and mission-critical applications. Thus, a better understanding of 5G services is needed.

Next steps

The session concluded with suggestions for next steps to be taken in the coming weeks and months. It was agreed to jointly work on a White Paper on the Factory of the Future and 5G, which should be presented in September.

Energy

Introduction

The main challenges for the energy supply system and energy sector at large are:

- To ensure safety, security, and reliability of entire energy supply and consumption chain, including involved communications networks
- To ensure sustainability of the energy supply chain and business created around the energy sector
- To contribute to environmental issues and reduce sectorial impact on the climate change
- To ensure competitiveness of solutions for reliable energy supply and among all involved actors in the energy supply chain

The challenges are addressed by establishment of needed energy storage, demand/response based energy consumption management, corresponding controllable energy generation, and new transmission lines. To ensure it, increased usage of communications and cooperation with ICT sector will be needed as well as involvement of vertical sectors (in this case energy sector) in trials on new communications technologies in development, such as 5G networks.

Provision of energy as service will be a consequence driven by changes in the energy sector, mainly driven by distributed energy generation, which will significantly increase in the upcoming period, and new requirements of the critical infrastructures, due to their increased importance, where energy supply chain represents a significant part of these infrastructures.

Time scale for implementation of the new generation of the energy services in smart grids is five years. Therefore, definition of requirements on 5G has to start now. The most important related service groups are:

- Metering Related Applications
- Distribution Automation or Feeder Automation Applications
- Management and Control of distribution network components incl. DERs and SCADA
- Auxiliary data transfer like Communication Network, such as management or CCTV

Requirements on 5G network infrastructure from energy sector

Application of 5G network infrastructure in the energy sector concerns all voltage levels and related energy distribution networks; low-, medium-, high, and extra-high-voltage levels. The main focus is given to backhaul communications networks, connecting medium-voltage supply sub-stations and medium-voltage control centres, and in the backbone network, connecting control centres and energy generation sites on the higher levels of the energy supply system.

On the other hand, the smart metering services and access networks, which directly connect the end customers in low-voltage supply networks, are not the main scope now. However, direct connections and relations with the end consumers are important assets of energy utilities, where also the local energy generation might be an issue in the future, including the energy consumption balancing challenges. Thus, the access area must be supported by overall communication infrastructure developed in the scope of 5G activities.

Concrete requirements on communications networks (data transmission rates and latency) supporting energy distribution at different voltage levels are:

- 1kbps per residential user, 1s latency - for the low-voltage level,
- 500kbps, 50ms - for the medium-voltage level,
- 1-2 Mbps, 50ms - for the high-voltage level, and
- 0.1-1 Gbps, 5ms - for the extra-high-voltage level.

Furthermore, needed failure recovery times are below 1s for all levels as well as a general requirement on network capability to serve a very large and increasing number of nodes in the energy communications network accordingly. In principle, requirements from the energy sector on the communications networks and the 5G are similar to requirements of the automation sector.

Critical requirements from the energy sector are summarised below:

- Support for deployment of real time applications and short service provision time
- Security, as one of the main enablers ensuring safety of the energy supply, is identified as a mainly IT security issue. Open question is who takes the main role and responsibility here – 5G operators? — because of needed guarantees, which is also relevant for other vertical sectors
- Security and all other QoS features have to be guaranteed and fulfilled. Measures such as penalties for not keeping the SLAs (Service Level Agreement) do not help
- 3G/4G ensures DOS requirements for minor disturbances, but for major disturbances (>50% sub-stations down) 5G must find solution

None of the mentioned requirements can be fulfilled today, but technically should be possible in 5G. However, appropriate business frameworks still need to be explored, particularly for the rural areas.

Dedicated wireless networks for purposes of the energy sector only, such as CDMA -45 concept, represent a solution providing supply over long period, guaranteed costs, high level of control on security, security, etc. However, with deployment of the 5G network infrastructure, the dedicated networks will move to virtual networks solutions within the 5G.

The main **regulation constrains** identified are different regulation and different interpretation of respective EU rules on the Member States level, representing a serious barrier for innovation. Here, an industry driven action at the European level is needed to avoid situation where the required changes are rather possible outside Europe.

Another important issue is interpretation of network neutrality concept, which does not enable establishment of the future applications, based and supported by communications, in the energy sector. Net neutrality has to allow priorities and fulfilment of further requirements in networks, as needed by the energy as well as other vertical sectors.

From the **business perspective**, business to business interfaces will provided at all levels of the energy supply chain. Particular in interfaces needed for local/alternative/distributed energy generation entities. Also, old communications technologies seem to be sufficient for realisation of the needed services but not commercially efficient enough, which opens a room for successful deployment of 5G based services for the energy sector. Here, outsourcing of communications services from energy utilities is considering as one of the most efficient solutions.

Main conclusions

- Smart Energy Grids will be organised as distributed systems, supported by communications network infrastructure as a distributed system as well. The main focus for the communications infrastructure for the energy sector will be on backbone and backhaul networks.
- Wireless systems offer utilities flexibility and lower costs. Cost efficiency, availability and reliability of the connectivity and services are of high importance, especially in rural areas. Furthermore, short provisioning times for remote services are needed to be ensured.
- Mission- and business-critical applications can use 5G networks only, if strong service guarantees can be given.
- Continuous cooperation between technology providers (ICT and energy) and network operators (telecoms and energy distribution operators) is of a high importance.
- Regulatory issues have to be addressed by joint industry actions at all required levels.

Media & Entertainment

Introduction and organisation

The Media & Entertainment workshop was organised around four key discussions, each introduced by a *firestarter* speaker, followed by lively 20 - 30 minute discussions with the participants:

- "5G – Game changer for Media & Entertainment?" - Maziar Nekovee, Samsung
- "Towards new business models?" - Vincent Bonneau, IDATE
- "Broadcast/multicast – le must for 5G?" - Ralf Neudel, IRT
- "5G cross-vertical opportunities - Media & Entertainment in the Automotive vertical" - François Fischer, ERTICO

Main conclusions

- Video is a major component of mobile data and growing. Scalability of networks important, 5G must support many more users per cell than 4G. Network deployment capabilities and costs need to be assessed
- Devices are becoming personal rather just only mobile. The personal device creates a first screen user habit and usage
- Use cases and requirements vary widely: virtual reality, gaming (low latency, low bandwidth), event related video on-site requires low latency and very high bandwidth. All other video services do not require low latency. Ubiquitous coverage is definitively a requirement
- Video content is not only linear TV, especially for the younger generation. 220 min average daily linear TV viewing time per household but only 70 min for households age 40 years and younger
- Roaming fees and country specific content rights would be potentially hurdles for 5G as people and cars usually cross country borders
- Business models and revenue sources and network costs are still rather unclear at this point in time. Further work is required here. OTT business model seems to be rather marginal
- Viable 5G for media solution requires integrated network capabilities (using all types of technologies: terrestrial, fibre, satellite, caching and storage)
- Sound conclusion that broadcast must be a mandatory feature of 5G. A mobile unicast only solution may not be commercially viable
- The role of the car as yet another space for media and entertainment has still to be further developed in cooperation with the automotive vertical. It is necessary to mandate a specific interface and/or protocol to link a media device with the automotive system
- Discussion with content owners and network operators required

Next steps

After the Workshop, it was agreed to jointly work on a White Paper on the Media & Entertainment and 5G, which should be presented in September. SES will take the lead on this initiative, in close coordination, within the 5G PPP WG Vision, with the other verticals.

Agreed action points – workshop follow-up activities

In order to proceed with a detailed definition of requirements for the 5G network infrastructure, all sector representatives from the workshop agreed to work together on this definition in the upcoming period. By the end of September 2015, each of the involved industry sectors will provide white papers with detailed requirements following a common table of contents which will be harmonised across the verticals. Afterwards, an action will be taken to synchronise the defined requirements among the involved sectors and probably reduce the number of final requirements for 5G.

The findings of the discussion groups will be reflected in the Horizon 2020 Work Programme 2016/2017 and the upcoming Call for Proposals within the 5G PPP (submission deadline in November 2016).

The 5G Infrastructure Association will coordinate the above-mentioned activities with support from the 5-Alive project (active until October 2015) in terms of document editing and provisioning of communication means and repositories, as required by all involved sectors and discussion groups.

Annex

List of presentations and session organisers

1) Health

Convenor: Prof. Christoph Thuemmler, Napier University

5G Association caretaker: David Soldani, Huawei; EC/E1 caretaker: Achilleas Kemos

Speakers:

- Cindy Fedell , UK NHS, NHS Trust IT Director
- Stefano Micocci, Cup 2000
- Anastasius Gavras ,Eurescom
- Alex Hryniewicz, Maverick Television
- Philippe Cavallo, Scuola Superiore Sant'Anna, Pisa
- Denis Abraham, Mines Telecom

Rapporteur: Milon Gupta, Eurescom

2) Automotive

Convenor: Markus Dillinger, Huawei

5G Association caretaker: Jean Sebastien Bedo, Orange; EC/E1 caretaker: Eric Gaudillat

Speakers:

- François Fischer, ERTICO
- Alain Servel, PSA
- Bernd Rech, Volkswagen
- Muthanna Abdulhussein, Volvo
- Jean Sebastien Bedo, ORANGE

Rapporteur: Halid Hrasnica, Eurescom

3) Factory

Convenor: iMInds, Haerick Wouter

5G Association caretaker: Isabelle Korthals, Deutsche Telekom; EC/E1 caretaker: Jorge Carvalho

Speakers:

- Silvia Castellvi, ATOS
- Guillermo Gil Aguirrebeitia, TECNALIA
- Tom Van der Horst, TNO

Rapporteur: Milon Gupta, Eurescom

4) Energy

Convenor: Linus Thrybom

5G Association caretaker: Benoit Miscopein; EC/E1 caretaker: Ari Sorsaniemi

Speakers:

- Johannes Riedl, Siemens
- Jani Valtari, ABB
- Gilles Robichon, Alliander / Utility Connect
- Fiona Williams, Ericsson

Rapporteur: Halid Hrasnica, Eurescom

5) Media & Entertainment

Convenor: Thomas Wrede, SES

5G Association caretaker: Alexander Geurtz, SES; EC/E1 caretaker: Philippe Lefebvre

Speakers:

- Maziar Nekovee, Samsung
- Ralf Neudel, IRT
- Vincent Bonneau, IDATE
- François Fischer, ERTICO

Rapporteur: Alexander Geurtz, SES

Document editorial

Milon Gupta and Halid Hrasnica, Eurescom / 5-Alive project