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Towards Digital Transformation with 5G Technology

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***Abstract*—This paper presents a short review of recent research activities on 5G as the next generation of wireless technology, the requirements they are facing, user scenarios, functionalities, and KPIs (Key Performance Indicators) as a measure of assessing the performances of these systems. 5G technology also known as International Mobile Telecommunications 2020, (IMT-2020) will dramatically increase the capabilities of the Internet of Things, Vehicle-to-everything and will pave the way for massive machine-type communications. While it is not yet define how the ultimate 5G design will be, it is possible to identify the most important services, functionality and KPIs that will provide satisfactory solutions to innovative digital business models after 2020. It is expected that 5G standards be in focus of Regulation Agencies, mainly through socio-economic analysis. In emerging markets, socio-economic dimensions of wireless connectivity must be considered carefully since data will be basic asset in digital age. This paper also highlights the importance of changes in mindset of regulation framework in telecommunications sector. Strong understanding of digital transformation is crucial in order to stay competitive in dynamic changes in the future.**

***Keywords-component; 5G networks, DT (*Digital Transformation*) KPI (*Key Performance Indicator*), M2M (*Machine – to - Machine*), MTC (*Machine - Type Communication*), QoE (*Quality of Experience*), IoT* (Internet of Things), *V2E* (Vehicle-to-Everything).**

I. INTRODUCTION

Today one of the most dynamic sectors of our global economy is mobile wireless communications. The telecommunications and internet technology are now an essential part of everyday life. The rapid growth of internet has increased the demand for high speed data connections. This growth is taking place all over the world in both developed and developing countries. The coexistence of communication between people, people and machines, as well as M2M (Machine-to-Machine), leads to new technological demands placed on communication systems that are expected to be achieved with 5G technology. Currently, machine-type communications (MTC) facilitate conversations between smart objects. 5G will pave the way for massive machine-type communications (mMTC) as one of three emerging cases, which could support one million devices in a single square kilometer, far more than 4G's MTC capabilities even in ideal circumstances. 5G is a heterogeneous network operating in multiple frequency bands. The 5G millimeter wave network is expected to be able to support high definition (HD) applications, such as HD video, HD television and HD video games. Millimeter waves, massive MIMO, full duplex, beamforming, and small cells are just a few of the technologies that could enable ultrafast 5G networks [1].

International Mobile Telecommunications 2020, (IMT-2020) also known as 5G technology will dramatically increase the capabilities of the Internet of Things, Vehicle-to-everything and will pave the way for massive machine-type communications which could support 10^6 devices/km^2 connection density and 10^7 bps/m^2 area traffic capacity. This enabling technology for 5G should help wireless networks provide: more bandwidth, higher data speeds (up to 2x10^{10} bps peak data rate), 100 Mbps user experienced data rate, lower latency about 1 ms, mobility up to 500 km/hr, help every user to access the same large available spectrum and increase the coverage range of base stations within areas of cellular network having low population density.

There is a large number of different research projects and 5G initiatives, whose activity review is given in [2]. The goal is to set the foundation of the 5G system and to build consensus on standardization. They are focused on the evolution of existing technologies complemented by new radio concepts designed to meet the new demands and challenges that today's radio access networks cannot support.

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The aim of this paper is to present a review of research on 5G that has been done in the past and what will be the further directions of development with a special focus on the leading 5G projects of the European Union. In the first part we gave a brief overview of the 5G requirements and scenarios, as well as initial guidelines for the development of technological components and the most important 5G system functionalities that are anticipated to be able to meet the 5G scenario requirements. We then provided an overview of KPIs, designed to assess the performance of identified user cases. Finally, we briefly highlight the basic challenges that lie ahead in the further development of 5G technology. This paper also highlights the importance of changes in mindset of regulation framework in telecommunications sector. Strong understanding of digital transformation is crucial in order to stay competitive in dynamic changes in the future.

II. ENABLING TECHNOLOGY FOR DIGITAL SOCIETY

Software defined networking (SDN) and network functions virtualization (NFV), along with cloud and edge-fog computing, can be seen as different aspects of a systemic transition of telecommunications architecture, and called softwarization, [3]. The first impact will be at the edge of current telecommunications infrastructures, which are becoming intelligent network and service platforms. The edge operating system software architecture is to bring several service domains, such as cloud robotics, Internet of Things (IoT) and Tactile Internet, into convergence at the edge. SDN and NFV, together with cloud, edge and fog computing, can be seen as assets of a 5G architecture that brings the ongoing migration of "intelligence" towards customers. Softwarization represents a drastic change of mindset. Current CSPs architecture has been utilized with purpose-built equipment designed for specific assignment. In the future, network functions and services will be virtualized software processes achieved on distributed network elements mainly made of standard hardware resources. Standard hardware and open source software will have a main role in this complete transformation, by offering open innovation while reducing the costs. Cost reduction alone will not be enough to assure the future sustainability of the telecommunications industry: it is important to introduce innovative service mindsets.

The fifth generation (5G) network aims at converge mobile and fixed networks to support end-to-end (E2E) applications and services. 5G will be resilient, secure, and permanently available. It is unthinkable to build such a convergent network without slicing at all levels: from the physical to application levels, [4]. Slicing is enforced by the integration of several radio access technologies. It will be based on the service chaining: data processing will become a sequence of services, often managed by different stakeholders. This approach will ask for more collaboration between stakeholders and/or greater openness of the offered services. There are many open issues that make challenges to network service chaining (NSC). NSC will ensure massive concurrent connections in heterogeneous environment with different domains. Management has to support service chaining in multi-CSP environment and to ensure external access (separation of data storage and data processing). Offered services in NSC model have to support multi-vendor and multi-operator environment. Slicing in 5G will be twofold, at the physical and service domains. Almost every part of network will be self-managed with real-time management and control. All these requirements will have to support NSC model in abstract domain to ensure service chain orchestration due to all-slicing architecture in 5G, [5]. The NSC service model helps to automate the virtual resources by chaining in a series for fast computing in both computing technologies. The proposed architecture also supports data analytics and management with respect to device mobility.

Smart and connected devices can improve industrial processes, and generate innovative services. While this assumption is well understood within the ICT industry, there is a challenge in extending this potential to vertical industries. The potential of the IoT stand in the interaction among industries working together toward value co-creation. Each stakeholder in IoT ecosystem need to look beyond their internal business models and recognize value chains perspectives to define new business logic. Vertical cooperation in the area of IoT underline the need to develop new IoT chain that leverage this cooperation and generate the creation of new revenue streams and other benefits. The creation of sustainable IoT solutions needs coordinated interaction among industries. This leads to value co-creation among involved entities, which blurs the differentiation between providers and consumers, [6].

IoT ecosystem is different from traditional mobile broadband business, where communication providers usually interact directly with end users. In the IoT ecosystem, other industry verticals are directly involved in the value creation process, and in many cases have the direct relationship with end users. Hence, the ICT industry is facing a new set of actors between themselves and the end users. When discussing value creation in the IoT, companies need to collaborate and be aware of novel network-centric business models. In this process, the key concern is how each company can position itself within the IoT value chain in a way that guarantees its profitability as part of a larger group, not only a single company. The challenge is to accept these new market rules where they will individually perceive less control over the final customers and the entire value proposition.

The change is in shifting from a unilateral relationship among suppliers and consumers toward ICT experts, all interacting together in the IoT ecosystem. In the future, new IoT service model have to support these new ways of interaction among companies. Companies will need to define their own business value creation, but in connection with the value network in the IoT ecosystem. The variety IoT application and solutions-which is presently synonymous with almost any connected device-is perhaps the most contrary global technology trend. Despite of tremendous developments, the consumer IoT market still falls short of delivering its original economic value. While holding considerable promise, IoT business model remains divided and fragmented across the companies, industrial and consumers contexts. Furthermore, it has been widely recognized that price, security and ease of use constitute distinct adoption barriers for consumer IoT solutions. In IoT application market, SyMPHOnY platform has proposed as the key asset for CSPs willing to understand the true needs of their customer, [7].

There are two dimensions of IoT security in 5G era. The first is multi-scenario environment and network architecture including data processing for massive number of network elements and communication protocols and variety of security requirements of different players in IoT market. The second is limitation in running an advanced security protocols on network elements with limited computing and storage resources. The security requirements for IoT ecosystem is a complex challenge for every participants. It is important to have approach that ensures fast detection of malicious behaviors like DDoS attack. (level of data protection must ensure high priority for user location, health data etc.) . It is important that every participants support industry standards bodies to develop IoT security standards as well as to support regulation of IoT security. IoT security regulation will accelerate the successful development of IoT ecosystem. In [8], authors present an overview on security and privacy in smart IoT systems, with possible defense strategies Fast development of IoT systems introduce unprecedented security and privacy challenges. Given the massive number of IoT devices, plus their inherent weakness of protection, we believe IoT systems will be extensively invaded by hackers to organize and commit known and unknown attacks. Furthermore, effort from the theoretical perspective is also discussed. Given the complexity of IoT security and privacy, it is necessary to integrate knowledge of different disciplines to defeat cybercrimes. Moreover, we have to note that management and policy are essential to address security and privacy challenges of IoT ecosystem in 5G era.

III. 5G VISION

The 5G consists of new solutions, but also from sophisticated versions of existing solutions. There are three key features of the ITU IMT-2020 5G vision and research challenges such as: xMBB – Extreme Mobile Broadband, uRLLC – Ultra-Reliable Low Latency Communications, mMTC – Massive Machine-Type Communications.

xMBB – Extreme Mobile Broadband

a) Smart capacity: 1000 times more capacity/km^2 (10Tbps/ km^2)
b) Data rates exceeding UL 10 Gbps DL 20 Gbps
c) 1-10 Gbps connections
d) Indoor 10 Mbps/m^2
e) 100 Mbps for every user
f) Spectrum efficiency (2x/3x/5x).

uRLLC – Ultra-Reliable Low Latency Communications

a) Network latency under 1 ms
b) High reliability (99.99999%)
c) Perception of 100% coverage
d) High availability
e) High secure/resilient
f) Deterministic quality of service
g) Reduce cost per bit.

mMTC – Massive Machine-Type Communications

a) Extreme Density/connection density (10^6 nodes/km^2)
b) Sporadic access
c) Energy optimized (10 years)
d) Signaling reduction
e) 1000 times more connected devices.

These three key features emphasize the diversity of the 5G requirements and should be viewed as the basic functions that cover the 5G user scenarios space.

A. *Requirements and scenarios*

With a flexible combination of developing existing technology solutions and new radio concepts, and meeting the requirements for efficiency and scalability, the 5G network can respond to new user scenarios followed by a large increase in traffic and number of connected devices.

The METIS (Mobile and Wireless Communications Enablers for the Twenty-Twenty Information Society) project encompasses the development of user scenarios from which the requirements and corresponding KPIs are derived, as well as spectrum, network, radio links and technological concepts [9], [10]. This project defined as the basic 5G technological goals: 1000 times greater mobile traffic, 10 to 100 times higher user speeds, 10 to 100 times more users, 10 times longer battery life at massive M2M communications, 5 times reduced E2E (End - to-End delay. By analyzing the above mentioned requirements are selected the test user cases that are expected to be widely used in the future [11], [12], [13]. Selected applications are grouped in the following five scenarios:

- "Amazing fast" which focuses on providing very fast speeds for future mobile broadband users who expect "instant" connectivity. An example for this scenario is a "virtual office", where large volumes of data are expected to be transmitted at high speeds.

- "Great service in a crowd" focuses on providing a reasonable QoE (Quality of Experience) for mobile broadband services even in very crowded areas such as stadiums, concert halls, shopping centers, open-air public events where gathers a large number of people or in cases of traffic jams and congested public transport.

- "Best experience follows you" focuses on providing high level of user experience to mobile users on the move. Good coverage and high speed are expected in all parts of the network, even in remote rural locations.

- "Super real-time and reliable connections" focuses on new user applications with very strict requirements for delays and reliability, as it is M2M-based applications. These applications should enable new functionalities related to traffic safety, efficiency and critical process control in industrial applications. The key technical challenge is to reduce the E2E delay by providing high availability and reliability.

- "Ubiquitous things communicating" focuses on efficient management of a very large number of devices. This scenario refers to the need for communication as a machine of small complexity such as sensors and actuators, as well as many more complex devices such as medical devices. Therefore, the requirements are different in terms of size, frequency, complexity, cost, energy consumption and delays. A mapping between the different use cases and the 5G scenarios is illustrated in Table I. There is an overlapping area of scenarios of use cases that belongs to several different scenarios, but it does not reflect the importance of it.

TABLE I. MAPPING THE USE CASES AND THE SCENARIOS [14].

Scenario / **Use case**	***Amazing fast***	***Great service in a crowd***	***Best experience follows you***	***Ubiquitous things communicating***	***Super real-time and reliable connections***
Virtual reality office	■				
Dense urban information society	■	■	■	■	
Shopping mall		■		■	
Stadium		■			
Teleprotection in smart grid network				■	■
Traffic jam		■	■		
Blind Spots			■		
Real-time remote computing			■		
Open air festival		■		■	
Emergency communications			■	■	■
Massive deployment of sensors & actuators		■	■	■	
Traffic efficiency and safety			■		■

B. Technological components

By introducing a new concept that scalable utilizes the advantages of developed technological components, it is working on their further development that will ensure fulfillment of the wide range of services and applications imposed by social development for the post 2020 period. The METIS has defined so-called Horizontal Topics (HT) to build a system concept, whereby one subject integrates several technological components to provide an optimal solution for one or more user cases. Potential overlaps, compromises and interdependencies between technological components are identified and analyzed in view of their impact on overall performance [11].

- D2D (Direct Device-to-Device) communication refers to direct communication between devices. The use of direct connections minimizes interference, increases coverage, provides backup links, increases spectrum utilization, and capacity.

- MMC (Massive Machine Communication) provides scalable connectivity for a large number of devices.

- MNs (Moving Networks) extend and enhance coverage for a potentially large population.

- UDNs (Ultra Dense Networks) refer to networks that are subject to high traffic load requirements. The goal is to increase the capacity, energy efficiency and use of spectrum.

- URC (Ultra Reliable Communication) refers to scalable and affordable solutions for networks that support services with extreme demands on availability and reliability.

To effectively support identified user scenarios, the radio interface for future mobile systems needs to be more flexible, providing different solutions for each specific user case and application within a common umbrella framework. With UDN, which supports a wide spectrum, flexibility is obtained through the radio interface of scalable structure, providing the optimum solution for adapting the signaling conditions specific to the utilized bands. At the physical level, the challenge is efficient support of a wide range of speeds, ranging from slow-motion sensor applications to ultra-fast multimedia services. For this reason, the research focuses on coding, modulation, and the appropriate structure of advanced design transceivers. Non-orthogonal and quasi-orthogonal approach techniques are being studied, with the number of users not limited by a set of orthogonal resources. Improvements in Multi-Input Multiple-Output (MIMO) technologies relate to achieving better performance and 5G system capabilities such as high speed and spectral efficiency, link reliability, increased coverage and energy efficiency.

The 5G wireless systems provide for the coexistence of existing and new access technologies, as well as the existence of different size cells in multilayer UDN networks. Both aspects represent a challenge in terms of interference and mobility management. There are also investments in the development of radio resource management, ranging from highly centralized to distributed or fully decentralized concept.

As far as the spectrum is concerned, the focus is on frequency band analysis to identify new resources, their characteristics, 5G scenario analysis, and spectrum demand requirements, spectrum sharing, and flexible spectrum management. Special attention is paid to the requirements of UDN networks at high frequencies as well as spectrum management in D2D communication.

The METIS-II project has defined a comprehensive 5G radio access network design and identified key RAN (Radio Access Network) design concepts:

- holistic architecture spectrum management,
- radio interface harmonization framework that enables efficient integration of new and existing radio interfaces,
- multi-radio interface framework/multi-slice resource management,
- cross-layer & cross-air interfaces,

- dynamic traffic management,
- energy efficient radio access control,
- interference management in fixed and dynamic radio topologies,
- innovative "inactive UE" (User Equipment) state that will enable battery reduction, including D2D and self-control as integral parts of the 5G design,
- a common control box and user plan framework that provides the means to provide efficient support for a range of new services, and
- future-efficient 5G integration.

C. 5G functionalities

The METIS 5G system concept enables a set of 5G functionalities that differ from previous generations and allow new services and new ways of communication [12], [13]. These functionalities are essential to support a large number of 5G use cases. Some of the new functionalities were in some way present in previous generations, but in 5G they reached their maturity.

- Dual role of mobile devices: In modern telecommunications networks, as a consequence of densification, which leads to a reduction in the complexity of network nodes and the increasing process capabilities of mobile devices, the difference between terminal and network devices is becoming more and more reduced. Therefore, dual-role devices with D2D capabilities, depending on the usage, can work either as terminals or as infrastructure devices.

- Ultra-reliable links with low latency: Traffic Safety Applications require a very reliable packets delivery at the exact time. This allows technology that includes D2D/V2X (Vehicle-to-Everything) communication and hybrid automatic retransmission. Industrial process control requires ultra-reliable MTC (Machine-Type Communication), which is capable of managing different types of traffic. For reliable connections it is necessary to achieve low latency (less than 10ms), which is achieved by D2D communication and localized cache content.

- Very high peak rates and moderate guaranteed rates: Under very good conditions, it will be possible to achieve Gb/s speeds in very demanding scenarios. From the perspective of the end user, it is more important to provide a guaranteed speed of 50 to 100 Mbps with high percentage of availability at all points, rather than achieving maximum peak values. This enables the development of new services designed under the assumption that wireless conditions are always available. This is achieved by fundamentally different exploitation of the radio interface, which involves: densification of the network, massive MIMO, adapted access and more efficient spectrum usage.

- Self-Organized Networks follows the crowd: The 5G SON Network consists of traditional and new types of network nodes that will be activated depending on the need for coverage and speed. Each network element can be deactivated to reduce interference and power consumption. As traffic hotspot locations change over time, a large number of network elements will have the ability to adapt to current traffic requirements and then it will be possible to find that the 5G network "follows" large-traffic locations.

- Localized traffic offloading include local caching of popular content and traffic offloading from mobile to Wi-Fi, which reduces delays and the load of the transport network. This is achieved by direct D2D communication. Shorter distance allows high speed transmission with reduced battery consumption.

- Unprecedented spectrum flexibility: Increased demand for large volumes of data implies the need for new solutions to meet customer requirements. One way is to achieve spectral flexibility in the given regulatory framework through a primary user mode, unlicensed mode, or licensed shared access (LSA)/ spectrum access system (SAS) mode. An additional spectrum at high frequencies is necessary to provide the required capacity, for example, for external hotspots, such as stadiums, campuses, business zones, and indoor hotspots such as airports, fairs, shopping centers, concert halls etc.

- Energy efficiency can be viewed on the side of the device or on the network side by taking into account the dual role of mobile devices in the 5G network. The Internet of Things (IoT) with mass communication devices supports Power Saving Mode (PSM) and extended discontinuous reception. A big challenge is to provide long battery life and extended coverage at the same time.

D. 5G Key performance indicators

As we mentioned before the 5G concept consists of three generic services: Extreme Mobile Broadband Approach xMBB (Extreme Mobile Broadband), Massive Machine-Type Communication Mass Communication (mMTC) and Ultra Reliable Low-Latency Machine-Type Communication (uRLLC). These three generic services should be considered as the basic characteristics that cover the 5G user scenarios. For each of these services, specific requirements for KPI values are typical, such as data rate for xMBB, number of mMTC devices, and latency and reliability for uMTC, shown in Fig. 1.

The end user can be a person or device that communicates with other devices or people over their devices. Key Performance Indicators which from the perspective of the end user take as the basis for assessing the performance of defined scenarios are: traffic volume density, experienced end-user throughput, latency, reliability, availability, retainability, energy efficiency and security [14], [15].

- Traffic volume density represents the total volume of user data that is transmitted to/from end user devices during a defined time divided by the area size covered by the radio nodes belonging to the RAN. It refers to the goal of supporting 1000 times more traffic volume compared to today's networks. This goal is the result of a large increase in the number of mobile devices, capacitive demanding applications and multimedia services.

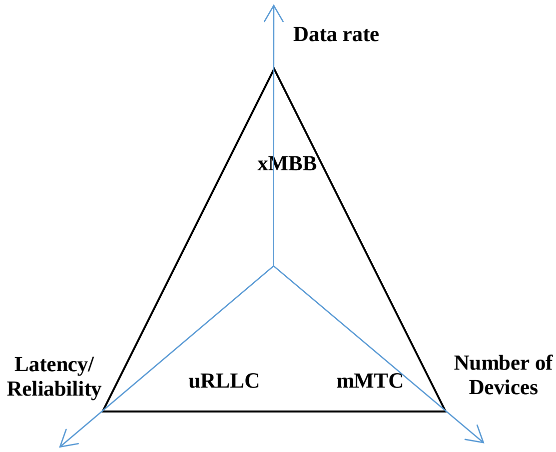

Figure 1. 5G generic services [7].

- Experienced end-user throughput represents the average data flow that the end user's device reaches during the defined time. It targets the goal to support 10 to 100 times the typical user speed. This KPI depends on the environment, but also on the number of users and the amount of data they generate. It can be used as an indicator of user satisfaction (QoE - Quality of Experience).

- Latency refers to the goal to support 5 times less E2E delay than existing services, which is especially important for services requiring reliable connection in real time. Although all network entities are included in the E2E connection, delay enhancement is expected in the radio access network because of introduction of new functionalities.

- Reliability is a metric that describes the quality of radio connection that achieves a certain level of service. This KPI is important for all user scenarios. When reliability has a value below the expected QoE level, the service becomes unavailable to the user.

- Accessibility is the KPI which in the planned coverage area represents the measure of service availability to the end user.

- As a special aspect of availability, the retainability of the connection is considered, which is a measure of availability of the services during the time required by the end user. This KPI is important for all user scenarios and is important from the point of view of network optimization, which is especially apparent during the handover process between adjacent cells when users move between different frequency layers and / or access technologies.

- The energy efficiency is the KPI defined by the need to increase the capacity of resources to meet new requirements in terms of traffic load and therefore energy consumption.

- The security is the KPI defined by the need for extremely secure communication, and the protection of privacy and user integrity.

There is no user scenario that can be viewed uniquely, but as a combination of different scenarios presented from the perspective of the end user. Accordingly, the appropriate KPI are defined in [14] and [15]. As an illustration for the selection of appropriate KPIs we selected two scenarios:

- As the first example for selecting the most important KPIs we took a virtual reality office. In this case, end users transmit large amounts of data at high speeds, where users can be located at different locations and have the impression "as if they are in the same room".

- As the second example we have taken a dense urban information society where at all locations at any time people communicate at high speeds with each other or with devices. Expected values of observed KPIs vary greatly depending on the observed user case, Table II.

TABLE II. THE EXAMPLE OF 5G KPIS FOR TWO USER-CASES [14].

KPI	User scenario: *Virtual reality office*	User scenario: *Dense urban information society*
Traffic volume per user	36 Tbyte /user, month , DL i UL	500 Gbyte /user month, DL i UL
Average user speed in BH	0.5 Gbps, DL 0.5 Gbps, UL	5 Mbps, DL 1 Mbps, UL
Traffic volume per area	100Mbps/m^2, DL i UL	700Gbps/km^2, DL i UL
Experienced user speed	1 Gbps DL i UL with availability 95% 5 Gbps DL i UL with availability 20%	300 Mbps DL with availability 95% 60 Mbps UL with availability 95%
Reliability	99% in busy hour	95%
Latency	10 ms (*Round Trip Time* - RTT)	1ms (D2D) - 0.5s (*web browsing*)

As mobile networks increasingly become the primary means of connecting people to other people, machines, as well as M2M communications, these networks will have to reach the reliability, security and quality of the services that have fixed networks [16]. In order to address the issue of interference and mobility management, the 5G comprehensive framework deals with a complete redesign of control and user functionality, as well as changes in infrastructure and user equipment.

Results and conclusions obtained during METIS projects are used in further research and work on standardization [17]. At the strategic level, standardization will ensure the cooperation of partners from all regions with strong 5G development initiatives, major international equipment manufacturers, leading operators and universities. The creation of global consensus, the consolidation of industry needs, and the distribution of results by relevant national and regulatory bodies, forums and standardization groups in all regions will be of crucial importance.

IV. REGULATION FRAMEWORK IN PROCESS OF ENABLING TECHNOLOGY FOR DIGITAL SOCIETY

A. Standardization of 5G and new radio spectrum

Although 5G is in process of standardization, the 5G standards are expected to be in focus of Regulation Agencies, mainly through socio-economic analysis. To fulfill vision of 5G and to deliver three generic services: extreme mobile broadband, massive of machine type communication and a spectrum toolbox, new radio (NR) specifications are expected to be set according IMT-2020 (International Mobile Telecommunication – IMT), both below (sub-6 GHz) and above 6 GHz (mm-wave), [18].

New 5G architecture consists of new channel coding schemes for NR such as low-density parity-check (LDPC) coding for data and polar coding for control, which needs to address the broadband requirements, [19]. Spectrum toolbox above 6 GHz in USA can be found in [20]. The subcarrier spacing and bandwidth per carrier for different frequency ranges (Sub-6 GHz and mmWave) are given in Table III. Regulation framework in digital era will have huge impact on foster innovation and service delivery, as well as on development of society as a whole. An adequate digital ecosystem requires the participation of all stakeholders, because fragmented development inhibits digital transformation. First role of governance is considering the latest technological trends, especially in 5G, and entrance of new stakeholders in Internet ecosystem (platform based Internet model).

TABLE III: THE SUBCARRIER SPACING AND BANDWIDTH.

Standardization forums: 3GPP	
Frequency range: 3GPP Rel-15 FR1: 0.45 GHz to 6.0 GHz (sub-6 GHz) Subcarrier spacing: 15/30/60 kHz Maximum bandwidth: 5/10/15/20/25/40/50/60/80/100 MHz	**Frequency range:** 3GPP Rel-15 FR2: 24.25 GHz to 52.6 GHz (mmWave) Subcarrier spacing: 60/120/240 kHz Maximum bandwidth: 50/100/200/400 MHz 200/400 MHz
Channel bandwidth:	
Network operators: 100 MHz/CC (Component Carrier), Max. 800 MHz (8CC)	**3GPP:** max. 100 MHz/CC (Sub-6 GHz) max. 400 MHz/CC (mmWave) Peak data rate: >20 Gb/s (DL)

Furthermore, it is important to identify new stakeholders and characterize their inter-relationships especially in novel NSC architecture. Furthermore, with appropriate regulation rules in place, digital transformation can have huge benefits on society, resulting in improved efficiency and productivity. Reforms are essential to capture the ongoing technology changes and ensure their integration in society as a whole to achieve max transformation impact. The entrance of new stakeholders with disruptive power is further complicate current Internet ecosystem. An adequate ecosystem ensures the sustainable growth of ICT industry in emerging markets. However, with undeveloped broadband (BB) infrastructure and a weak business environment in emerging markets, ICT sector faces many challenges. The healthy Industry 4.0 ecosystem includes building ICT infrastructure, regulatory support, industry participation and collaboration from regulators, stakeholders, industry representatives, CSPs and academia.

B. Importance of regulation framework in digital society

Digital transformation is a process every country has to accomplish. Building healthy Industry 4.0 ecosystem based on digital mindset will bring huge opportunities and challenges and transform the way we communicate, live and work. Without strategies, opportunities can be lost, perhaps for good. Regulation Agency needs to orchestrate future framework to ensure spectrum accessibility, service delivery and improve digital perception. As the impressive developments in the telecommunications domain have lately brought new stakeholders to the market, the purpose of this paper is to identify the main roles and their relationships in the evolving Internet ecosystem. Lack of governance participation in technology adoption must be overcome (technical, procedural, legal and cultural challenges, especially in emerging markets). Different initiatives worldwide are addressing the need for specifying a stable IP-based next generation emergency communications framework, [21], [22]. Emergency communication is based on legacy telecommunication services. Future regulatory requirements have to migrate to IP infrastructure to adjust with new service models that mobile users already using.

Telecommunication companies are often regulated more than Internet players and this asymmetry represents a problem in terms of competitiveness and capability to deliver innovative services. Telecommunication markets face the following challenges:

- Growth and profits: This would be most demanded challenge; the increase of the amount of data transferred does not mean an increase in revenues from data based services.
- Customer experience: Analysis of customer behavior and manage customer experience have become priorities for telecommunication companies, and investments are focused on improving the user experience higher than ever.
- Reconciliation: The technological change and broad influence of DT means that CSPs, governments and regulators are being challenged on extreme level, and for the most part cannot cope.
- Security: Diversity of the services and complexity make designing the reliable security solution a challenging task.
- New technologies: Users are quickly adopting new technologies, pressuring CSPs into deploying digital solutions in user-centric terms. But, not all CSPs are agile enough to do so quickly and become an intelligent service provider.

To accommodate their customers digital requests, CSPs are experienced their own mindset shift to be transformed into market of services. CSPs often find it difficult to acquire BB infrastructure and fiber optic network, and spectrum fees are extremely expensive. Furthermore, CSPs must build an intelligent network that can accommodate customers' requirements in real time and dynamically configure network elements based on service demands. These improvements will help ensure E2E network functions on the management, control and forwarding layers as well as support dynamic on demand of capacity and QoS.

V. Conclusion

Digital transformation is a process that every country has to accomplish especially in emerging markets. Novel 5G network architecture and network service chaining as enablers of digital transformation will allow existing and new stakeholders to flexibly integrate resources, fast innovate, and accept new business opportunities. CSPs however, face challenges with uncertain services, business models, regulation approach and technical standards. In these terms, the digital transformation goals are always unique, while the overall external and internal digital transformation challenges are very similar across countries. This paper, identify the new roles and describe interrelationships, as an effort to outline new perspective on the regulation environment in digital society.

A short review of recent research activities on 5G as the next generation of wireless technology which is just two/three years away from its first commercial service, the requirements they are facing, user scenarios, functionalities, and KPIs (Key Performance Indicators) as a measure of assessing the performances of these systems have been presented in this paper. The most important services, functionality and KPIs that will provide satisfactory solutions to innovative digital business models after 2020 have been identified.

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