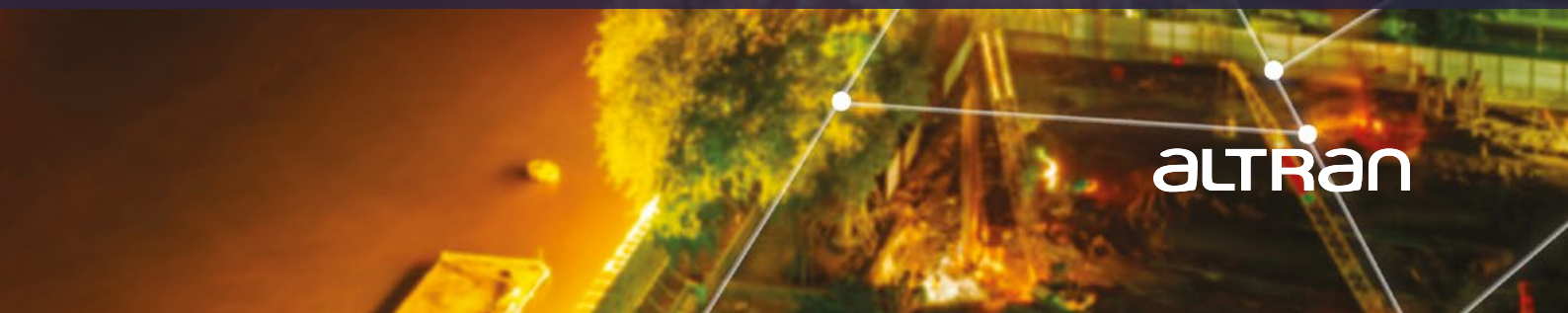
5G
as the enabler of cross-industry convergence



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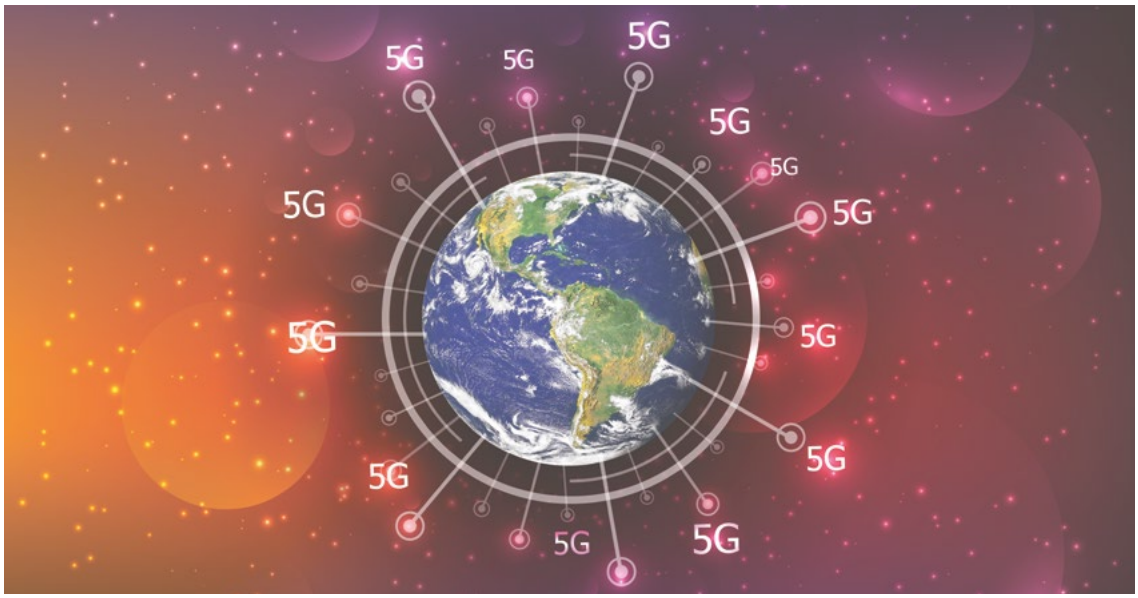

Boosted by joint advances in domains such as virtualization, IoT technologies and the enablement of new cross-industry business models, the next generation of mobile networks (5G) demonstrates potential for hugely disruptive performance and capabilities. Thanks to the unprecedented service-oriented connectivity approach, 5G networks will bring a disruptive transition from today's "Siloed" industries to "Connected" industries in terms of synergic services and operationalization - making the Internet of Humans and Things a reality. More than ever, concluding the right cross-industry partnerships will be key to Network Operator success.

Introduction

Recent advances in standardization and the number of trials and initiatives bringing together vendors, operators and stakeholders from diverse vertical industries demonstrate that the fifth generation of mobile networks (IMT-2020, aka 5G) will lead mobile communications and businesses to new grounds. 5G is expected to shift from previous generations' goal of ubiquitous connectivity of "People" to that of "Everything", acting as the ultimate Internet of Things enabler. To fulfil expectations, 5G will have to efficiently support a large variety of devices (e.g. sensors, drones, cars) and associated services with very distinct requirements, involving and reaching all "connectable" industries (ranging from health, transportation and manufacturing industries to the well-known entertainment sector).

In this White Paper, we provide our insights into why 5G is needed, the inherent key concepts and technologies and how it can be successful, specifically considering the role of cross-industry cooperation and partnerships.

1 Why do we need 5G?

Until very recently, the use cases that 5G is supposed to implement were considered futuristic or "utopian," reinforcing the fact that the increase in overall capacity and network ultra-densification is insufficient. Considering target services such as remote surgery, 4K-based augmented and virtual reality or "tactile" Internet, the reasons for the need to develop an enhanced mobile system are multifaceted and include [1] :

→ Increasing mobile traffic consumption & creation [2] driven by both the availability of more demanding services (e.g. 360° 4K video or holographic transmission) and the massive number of connected devices

→ Limitations of current systems to support the upcoming generation of services and associated throughput, latency and reliability requirements (e.g. 1ms latency, multi-GB throughput)

→ Lack of flexibility and efficiency to support a large diversit y of service and device requirements

→ High dependency on the mobile core and centralized resource placement, associated with scalability limitations, transport inefficiency and inability to cope with very low latencies

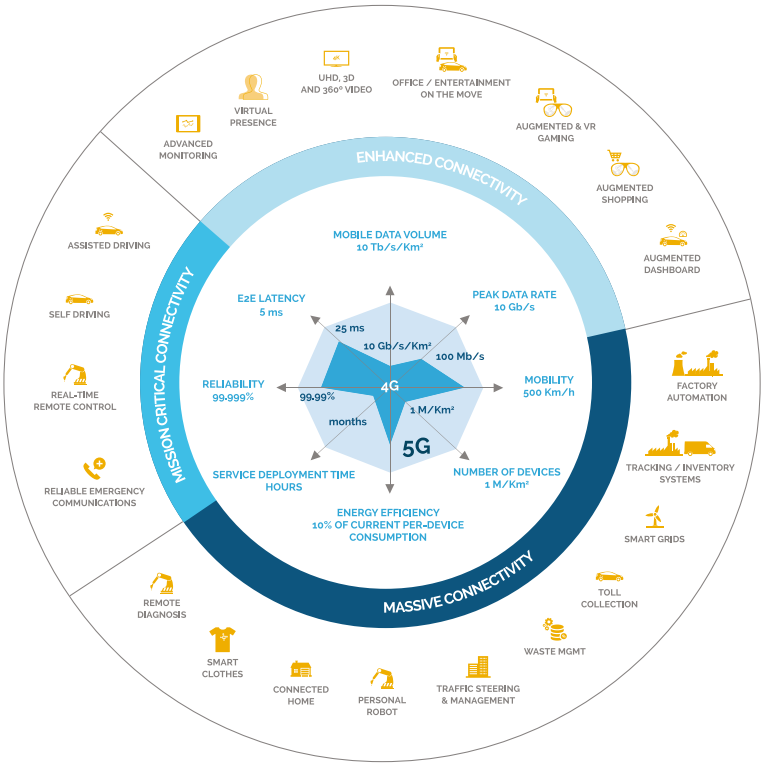

FIG 1:
5G USE CASES AND ASSOCIATED REQUIREMENTS OVERVIEW

[1] While most probably not all of the advertised use cases will be supported, these serve as a reference for establishing target connectivity requirements

[2] Trending uplink-specific topics such as slow time to content and live video streaming are listed in the "Ericsson Mobility Report", November 2016

Key 5G technologies

Besides the multiple radio-related improvements and the definition of a New Radio (NR), 5G will leverage a new SDN and NFV-influenced architecture (NextGen) capable of interworking with multiple radio access technologies. A set of the most disruptive technologies comprising future 5G networks include (but are not limited to):

→ HIGH-FREQUENCY (I.E. MMWAVE) RADIO will have a key role in supporting both enhanced Mobile Broadband and Mission-Critical services over shorter (indoor and outdoor) ranges, delivering extreme bandwidths and mobile services such as smart office or UHD and 3D video, as well as UAV / drone surveillance.

→ LICENSED (AND POTENTIALLY UNLICENSED) LPWAN, already available in pre-5G stages, will support low-power and low-throughput IoT scenarios connecting millions of devices in the last mile. The main question is whether there will be space for more than one winner in the NB-IoT, Lora and Sigfox space.

→ Benefitting from advances in NFV and SDN [3] technologies, VIRTUALIZED CLOUD RAN enables the configurable split of the radio access protocol stack, e.g. centralizing and virtualizing higher asynchronous layers while distributing the lower layers, allowing for flexibility and scalability.

→ MULTI-ACCESS EDGE COMPUTING (MEC) is a complementary technology to NFV, which makes it possible to execute virtualized applications (but not network functions) at infrastructures located in the network edge (e.g. at the eNodeB), thus offloading the traffic and heavy processing from the network.

→ NETWORK SLICING refers to the partitioning of a single physical network and its resources into several isolated logical networks with specific network functions and resource requirements. The owner of a network slice "sees" and manages it as a dedicated, physical resource. Network Slicing will be key in achieving the much-desired network utilization efficiency in 5G.

The combination of the aforementioned technologies will be the essential layer on which 5G will support the diverse and most demanding requirements, drastically changing the infrastructure and the way it is operated.

[3] Refer to Altran's White Paper "Why SDN and NFV will be key for the evolution of mobile networks"

2 5G challenges

In order to realize the vision predicated by IMT-2020, a set of different challenges must be overcome, some of which are listed below.

Technological Challenges

→ REALIZING THE "TACTILE INTERNET": the enablement of manually and remotely controlled real-time experiences such as remote drone or robotic control requires system feedback of about 1 ms in order to avoid "cybersickness." This places strict requirements on the speed at which processing and the network transport is realized. Besides the dependency on faster RAT (i.e. NR) and infrastructure-impacting (e.g. SDN, NFV, MEC) technologies, the maximum distance between end points for such services must take into account one essential physical limit: the speed of light. This makes for a maximum transmission distance of 150 km [4].

→ TRANSITION TO SOFTWARIZED NETWORK AND LEGACY SUPPORT: SDN / NFV technologies are being progressively integrated into existing networks, pushed by open-source platforms such as OpenStack, facilitating the transition into a softwarized 5G architecture. However, challenging aspects such as physical and virtualized network function integration, NFVI Infrastructure performance, workload configuration or multi-vendor integration, interoperability and standards must be dealt with. Initiatives such as OPNFV, Open Source MANO and OPEN-O represent a first step in addressing some integration and interoperability issues. However, the expansion of virtualization to the radio access network (e.g. with virtualized Small Cells and Cloud RAN) demands additional care due to the multiple function split options, i.e. between the physical (radio resource head) and virtual (baseband unit) parts.

→ FRAGMENTATION: the differently-timed Operator agendas – and the race to be first - may lead to the deployment of non-standardized networks, interfaces, and end-user equipment, recalling previous generations' cost, battery and interoperability issues. This time around, the magnitude of the problem is proportional to the many vertical industries affected – and the diverse connected drones, smart sensors, robots, etc.

Work Process & Culture Challenges

→ TOWARDS THE TELCO CLOUD: The adoption maturity of programmable software-defined and virtualization technologies by mobile operators is still well behind that of web-based companies (e.g. Google, Netflix); a mentality and cultural change is required to fully absorb the SDN & NFV concepts before reaching a cloud-native operation. Among others, the inclusion of DevOps automation-oriented workflows and Agile methodologies will be necessary, along with the integration of network and IT operational tasks.

→ EVOLVED CROSS-INDUSTRY RELATIONSHIPS: The integration of connectivity within new sectors [5] poses multiple challenges, one of which is the need for expressing industry-specific KPIs as network requirements. For instance, the automotive industry [6] expects high safety which must not be compromised by the network. Thus, cross-industry collaboration and development throughout the whole technological lifecycle is mandatory.

[4] In 1ms, light travels about 300 km, thus the Controller – Controlled distance must be half

[5] One 5G Empowering vertical Industries", 5GPPP White Paper

[6] http://5gaa.org/

Business Challenges

→ BUSINESS POSITIONING AND VALUE PROPOSITION: With 5G, the network will become an integral part of the business model in diverse vertical industries – opening the door to new actors in the resulting ecosystems. Operators must assess the relationships with new and existing partners to optimally position themselves in the local and global markets, defining their role in the ongoing IoT and Industry 4.0 evolutions through the establishment of innovative synergies with vertical industries.

→ VIRTUALIZATION AND XaaS BUSINESS MODELS: The advances in Cloud technologies led to the success of Anything as a Service (XaaS) business models (e.g. IaaS, PaaS, SaaS). The emergence of market propositions such as Network as a Service (NaaS), where a third-party sells services relying on a Telco-owned network, will reshuffle the value chain and create intermediate, non-bipolarized business offerings. Examples include car companies, which by paying for a 5G "network slice" will be able to offer guaranteed connectivity services to their driver customers.

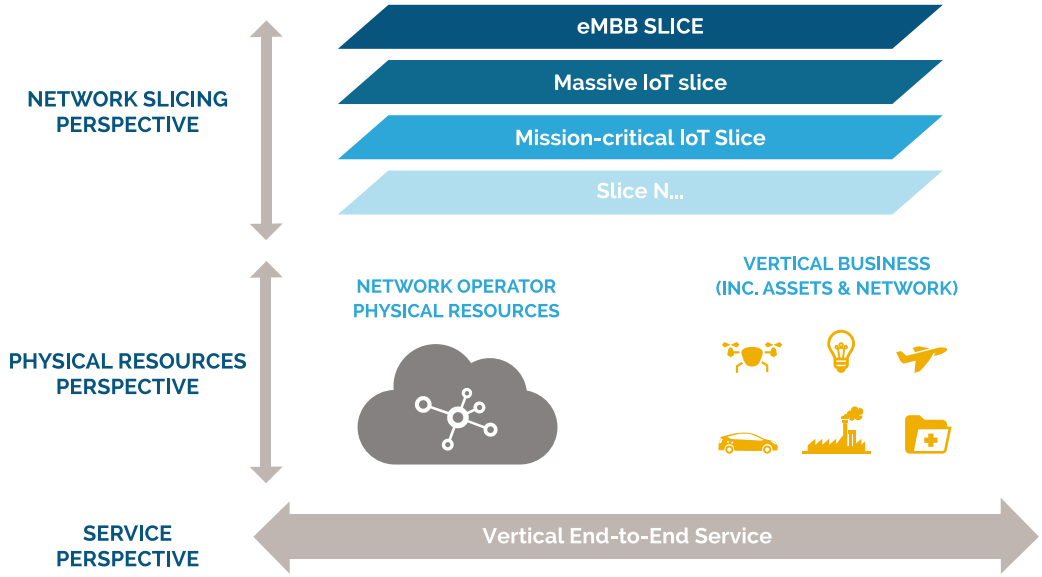

FIG 2:
END-TO-END SERVICE DELIVERY WITH NETWORK SLICING CONCEPT

3 The need for cross-industry convergence

5G will be highly disruptive to currently "mostly disconnected" industries and companies, making the Internet of Humans and Things a reality. Establishing the right cross-industry partnerships will be more essential than ever to companies' success, especially Network Operators.

The development of IoT in 5G will expand the reach of Mobile Networks to new and demanding environments, each with different connectivity requirements (e.g. automotive vs. health industry). Any desirable networking solution and business offering (B2B. B2B2C, B2C) requires deep understanding of each specific context. The following are guidelines for successfully bringing 5G use cases to life:

→ Interaction between Telecom and per-industry standardization bodies, regulators and even governments

→ Cooperation among stakeholders throughout the Technological Life Cycle

→ Definition and standardization of layers / APIs, capable of translating vertical industries requirements into Network Service configuration

→ Leveraging of End-to-End Network Slicing, necessary for both Multi-tenancy & abstraction of underlying physical resources and the different domains' (datacenter, operator, enterprise, industry) characteristics. By enabling the provisioning of service-tailored, "network as a service" offerings delivering the custom service requirements (e.g. in terms of throughput, availability, reliability, latency, security), network operators look at Network Slicing as the ultimate concept unlocking new business models across the multiple vertical sectors.

About Altran and 5G

As mentioned above, addressing the cross-industry scenario, namely the IoT use cases, is a fundamental step in the process of creating the business cases needed to sustain the huge investments in 5G.

Considering existing Telecom market needs in terms of IoT, ubiquitous connectivity, decreased network complexity and efficient management of multiple technologies, Altran has launched two complementary World Class Centers [7] (WCC) that address the challenges of the emerging 5G networks:

→ **ALTRAN WCC IOT SOLUTIONS:** it develops, integrates and operates end-to-end IoT solutions including connectivity, platforms and applications. It brings together unique expertise on the full technology value chain to support customers in reaping all the benefits of the IoT and big data revolution. Its domains of activity include:

→ Technology consulting on IoT solutions,
→ End-to-end IoT applications,
→ Development of customized IoT solutions.

It is a key contributor to VueForge® – Altran's end-to-end offering to support enterprises and vertical industries in the IoT revolution, transforming business & organizations, connecting machines, objects, people and environments, creating value from data for business and customers.

→ **ALTRAN WCC ADVANCED NETWORKS:** it designs, integrates and manages the introduction of new network technologies and addresses the entire network lifecycle, i.e. from design to deployment & optimization, along with dedicated support for the transition to mature operations in three main offering streams:

→ Network consolidation and modernization
→ Virtualization and software-defined networking
→ Transition to 5G

In "Transition to 5G" stream, Altran WCC Advanced Networks is complementing the traditional value proposition to support Telecom Operators in entering the IoT cross-industry context with new methodologies, tools and technologies aligned to envision 5G reality. In particular, for 5G network design, planning and optimization (NPO), iNP&O is a dedicated offering to effectively introduce 5G radio coverage complementing the legacy radio engineering practice with parametrization / configuration to finally target the specific use case.

On the road to 5G, Altran will actively enable the communication and translation between Telecom Operators and Industry, leveraging its expertise in the multiple (Connectable / Connectivity-demanding) Industries and sectors such as transportation, utilities or health. Combined with its R&D efforts in crucial 5G technologies such as SDN/NFV, MEC, LPWAN RATs or SON, Altran is well positioned to aid its clients journeying into unknown fields and contexts, from definition to validation of new use cases and services.

About Altran

As a global leader in Engineering and R&D services (ER&D), Altran offers its clients a new way to innovate by developing the products and services of tomorrow. Altran works alongside its clients on every link in the value chain of their project, from conception to industrialization. For over thirty years, the Group has provided its expertise to key players in the Aerospace, Automotive, Defense, Energy, Finance, Life Sciences, Railway, and Telecoms sectors, among others. In 2016, the Altran group generated revenues of € 2.120 bn. With a headcount of more than 30,000 employees, Altran is present in more than 20 countries.

[7] In Altran, a World Class Center (WCC) is a center of expertise delivering a "world-class" offering internationally.

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