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Abstract

This deliverable has been created as part of the work in the project Work Package (WP) 2. Based on the use cases, scenarios and applications for the design of the Proofs of Concepts (PoC) specified in D2.4, it enriches the analysis providing a current assessment of 5G market. Based on a rich analysis of the literature, complemented with interviews and a DELPHI study, four emerging trends are discussed and further contextualized for the three vertical markets of transport, public safety and rural areas. Finally, possible strategies are discussed to support market entry and development.

Keywords

Business models, verticals

Executive Summary

This deliverable reports the business assessment of 5G business models with particular attention to the value drivers and vertical markets firstly targeted withing the scope of the 5G-ALL-STAR project. This study develops the scenario analysis provided in D2.4 to contextualize the opportunities that it demonstrates for the target vertical markets.

To support decision makers and verticals in appropriating of the opportunity of multi-connectivity, the document proposes first provide an overall summary of the current state of 5G market, discuss the emerging configurations based on both a desk analysis of available literature and studies, and direct interviews we conducted with key informants.

After a discussion of the emerging changes in terms of value proposition, architecture and network, the analysis focuses on how the emerging business models are adapting to different market dynamics, customer needs, and partnerships.

All these changes will require organizations to adapt and to find new business model configurations to both address new market and defend current positioning. In particular, addressing vertical markets will require:

1. to understand and meet the needs and requirements in these new markets,
2. act on the internal resources and capabilities support the new business models,
3. develop and evolve partnerships and collaborations with verticals and in the 5G ecosystem,
4. reconfigure the business model to meet the new challenge.

Contents

List of Figures

List of Tables

1 Introduction

The key objectives of Work Package 2 (WP2) consists in the:

- Identification of potential use cases and Key Performance Indicators (KPIs) of 5G-ALLSTAR technologies,
- Definition of the service scenarios/applications and target KPIs for Proofs of Concepts (PoC) to be conducted in WP5,
- Definition of the architectural framework to provide other technical WPs with the design of system architecture, required interfaces, and key components,
- Business assessment for vertical markets empowerment.

The results of WP2 are then reported in the five deliverables D2.1 to D2.5.

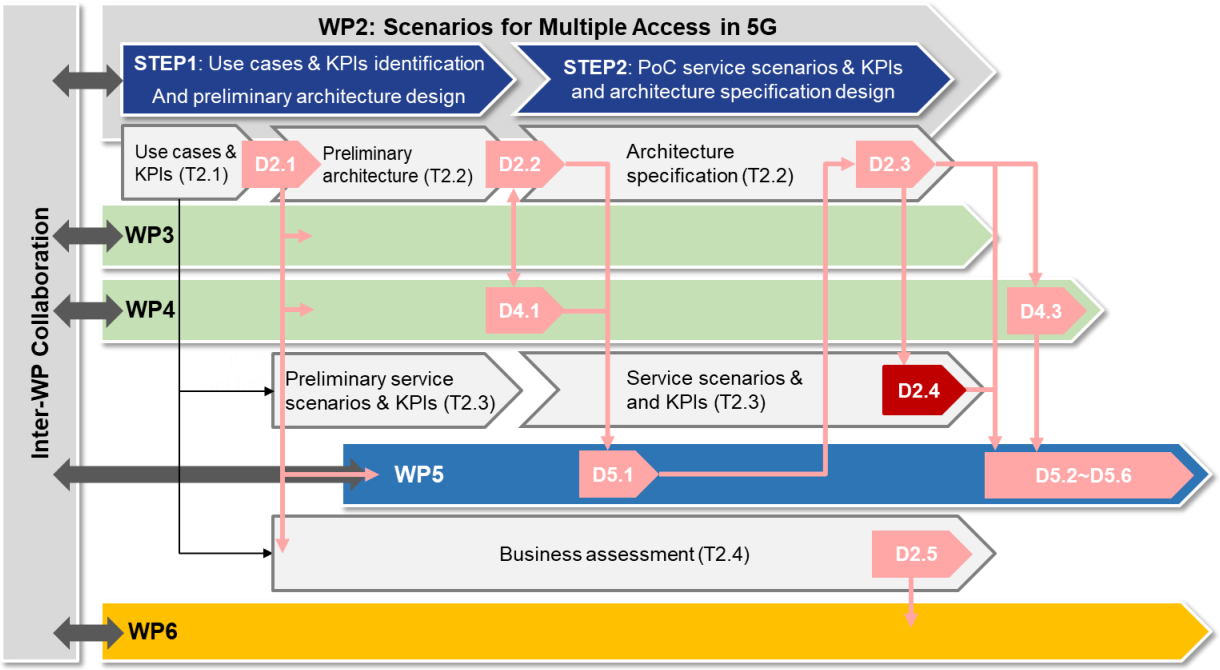

Figure 1.1: Relationship between WP2 and other WPs.

In this deliverable we then focus on the business assessment of the use cases instances in the different scenarios demonstrating all or part of a 5G-ALLSTAR concept. To this end, 5G ALL-STAR will develop selected technologies targeting a set of PoCs to validate and demonstrate in heterogeneous real setup and detailed in D2.4:

1. 5G cellular mmWave access system for providing broadband and low latency 5G services;
2. new radio-based feasibility of satellite access for providing broadband and reliable 5G services;
3. multi-connectivity support based on cellular and satellite access;
4. spectrum sharing between cellular and satellite access.

We then build on the scenario analysis to contextualize the opportunities that it demonstrates for the target vertical markets.

This document focuses on the business assessment for vertical markets empowerment.

The deliverable is organized as follow. We first provide an overall summary of the current state of 5G market, discuss the emerging configurations based on both a desk analysis of available literature and studies, and direct interviews we conducted with key informants.

Based on the joint analysis literature, available cases, and interviews we finally discuss the opportunities for 5G-ALLSTAR technologies in the identified vertical markets describing effects of the different dimensions of business models (BM), helping the definition of viable strategies.

2 Market assessment of 5G

In this section we provide an overview of 5G overall market and busines to discuss and relate the analysis to the opportunity of the scenarios and use cases demonstrated in the 5G-ALL-STAR project and described in D2.4.

2.1 The state of 5G in 2020

While the press and the public may consider 5G already deployed, to several accounts and despite regional differences, in 2020 its overall adoption is very limited, and the industry presents itself in its early stages. A current report from Gartner [1], highlight several shortcomings and issues that are structuring the current offering and market, of which some may concern possible applications emerging from 5G-ALLSTAR innovations :

- **The commercial focus on data speed**. The current deployments offered by telecom operators put the accent on the speed achievable through 5G. Our study point toward a different key driver in 5G developments that relates to connectivity. In the short term, then, 5G will matter only for organizations and applications for which speed is a key value driver.
- **Incomplete coverage.** In 2020, 5G coverage is very limited and assuming a comparable deployment time similar to that of 3G and 4G, coverage will require another 5 to 7 years to become pervasive. Furthermore, the global pandemic, had effects on 5G CAPEX investments that will probably result in further delays.

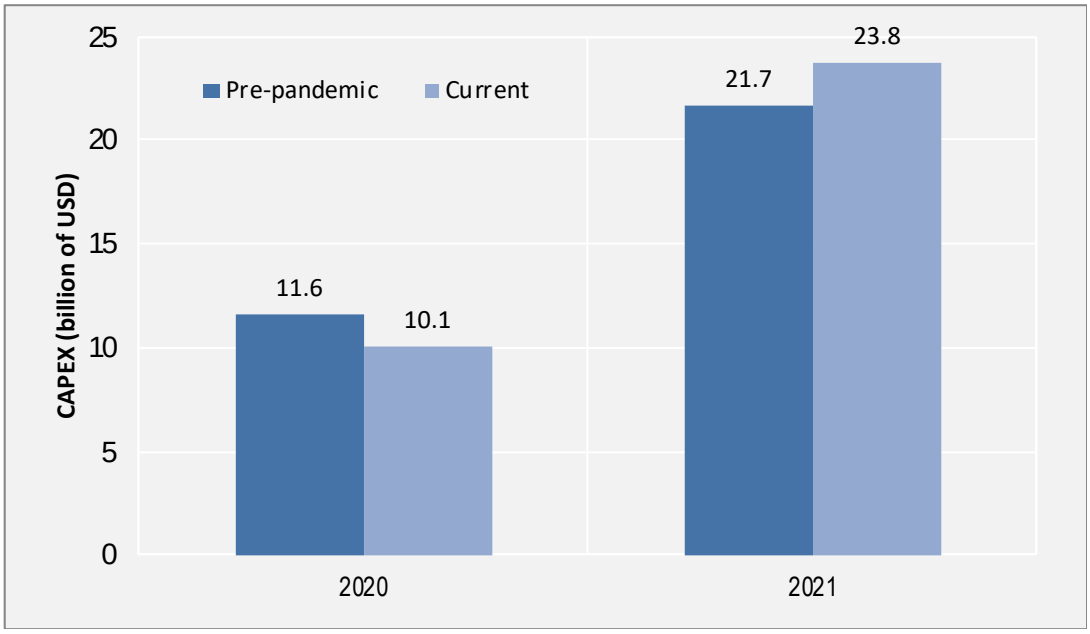

Figure 2.1 5G related CAPEX forecasts (Source: Analysis Mason)

Interestingly, the demand for 5G services will be in turn determined by the scale of busines demand, expected to be weaker compared to earlier forecasts, probably affecting the first two quarters of 2021. This aspect has potentially important consequences concerning the perspectives of new business models based on 5G-ALLSTAR multi-connectivity model. The impacts of the pandemic on business is still ongoing and the recovery will be persisting beyond the recovery from network deployments disruption. This may result in greater focus of business on cost reductions instead than free resources for the exploration and deployment of new business and revenue models.

- 5G edge computing is being defined. Current competitive moves are already suggesting a clear trend of convergence between leading cloud providers and telecom and network

operators to provide integrated models of edge cloud provision [2], leveraging the high bandwidth and low latency opportunities brought by 5G. These alliances may become structural in the market and oriented toward the appropriation of service value.

- **Challenging multinational strategies**. The current large spectrum interested by 5G deployments may limit the performance of solutions developed or available in pioneering markets. Early adopters' solutions developed in South Korea, United States, China, or Europe, may hardly follow in other countries. Therefore, while with 5G-ALLSTAR we specifically demonstrate intercontinental interoperability, the real solution interoperability may require specific adjustments or demand delays, potentially reducing the size of the addressable market, compared to the global scale some business may be used to operate.
- **5G range and performance variation**. mmWave, high bandwidth applications are set to be delivered over limited ranges, therefore multi-connectivity will play an important role to support performance consistency, reducing variability that may be influenced, additionally, from country and region-specific 5G deployments. Additionally, business have limited experience using these services, making it more difficult to make the value of these services apparent to potential customers.
- **Commercial immaturity**. Network operators are hardly addressing the enterprise market and the majority of their 5G offerings are not targeting the business needs of enterprise customers. A recent analysis from market research firm Omdia suggests that current 5G innovative projects are being carried out without the support of network operators. Interestingly, firms resort to solution providers or established partners and consulting firms for which telecom operators are just considered connectivity providers, relegating them to a competitive, low margin, commoditized business. While these data are only preliminary, it seems to confirm the trend that sees telecom operators incapable of appropriate of the more value-adding phases in 5G value chain.
- **Challenging device market**. The current offering of 5G devices is still limited to about 100 devices and for the moment these devices are targeting high market tiers. Midrange products targeting the 300-400 USD mid-market will be available only in the second half of 2020, along with enterprise devices. It is expected that some enterprise innovations may require the availability of later releases of 5G specifications. For example, the availability of devices supporting 3GPP R16 specifications are expected to hit the market not before Q1 2021. COVID-19 pandemic is set to impact on short and mid-term volumes, however little impact is expected concerning the overall development of 5G ecosystem (Ericsson, 2020). While then innovative devices (e.g., augmented and virtual reality headsets) integrating 5G are not market ready, however the increasing availability of fixed wireless terminals, modules, and connected computers may offer a temporary substitute to direct connections.
- **The development of private 5G networks**. Regulators are allocating specific frequencies for private use. From an enterprise perspective, this may realize the potential of network slicing enabling applications beyond current Wi-Fi implementations and over large surfaces like campuses, ports, airports, plants, rail network, and warehouses. Firms, leaders in their respective vertical markets including Airbus, Bosh, Siemens, BMW, Volkswagen, BASF, Lufthansa, Air France, SNCF, are all reported being awarded or requested 5G spectrum licenses (European 5G Observatory, 2020). A similar trend is observed beyond Europe, where private 5G networks licenses are being issues, primarily, on the 3.7, 26 and 28 GHz bands.
- **Innovations require latest 3GPP releases**. In accordance with their aim to expand the 5G ecosystem, large part of the 5G enterprise market potential will be realized leveraging the features specified in both R16 and R17 (e.g., V2x phase 3, industrial IoT, ultra-reliable, low-latency communications—URLLC). Enterprise and verticals involvement in

these phases is and will be fundamental for assuring that 5G release features and system architectures reflect the emerging requirements of current and innovative applications.

- **Limited 5G Internet of Things (IoT) current impact**. Despite the obvious benefits that 5G could bring to IoT applications and innovations current low-bandwidth, cellular IoT applications are well relying on currently widely available 4G NB-IoT and LTE-M. While these standards will then be later absorbed into 5G R16 competing technologies, including LoRa, Sigfox, with the first having become a sort of de facto standard for many applications in low-power devices networks, or Wi-Sun.
- **Cybersecurity is a concern**. It is obvious that the greater the diffusion of a particular standard and stated the growing complexity of 5G, and the richness of its ecosystem, the security of the 5G network is of primary concern not only for the enterprise market and applications, but for national security interests. While through network slicing and virtualization it is possible to tailor security requirements to specific applications, further research of both industry and academia is required to protect users and applications from both existing [3] and emerging threats [4].

2.2 Positioning the innovation potential of satellite 5G

Interestingly, the innovation potential of satellite 5G, based on 3GPP roadmap, is considered to mainly affect niche markets, at least in the short to mid-term (Figure 2.2). Interesting, R16 is bringing to the market a rich feature set probably holding more innovation potential than R17, where critical features will be mainly enhancement of what was established in R16 by June 2020.

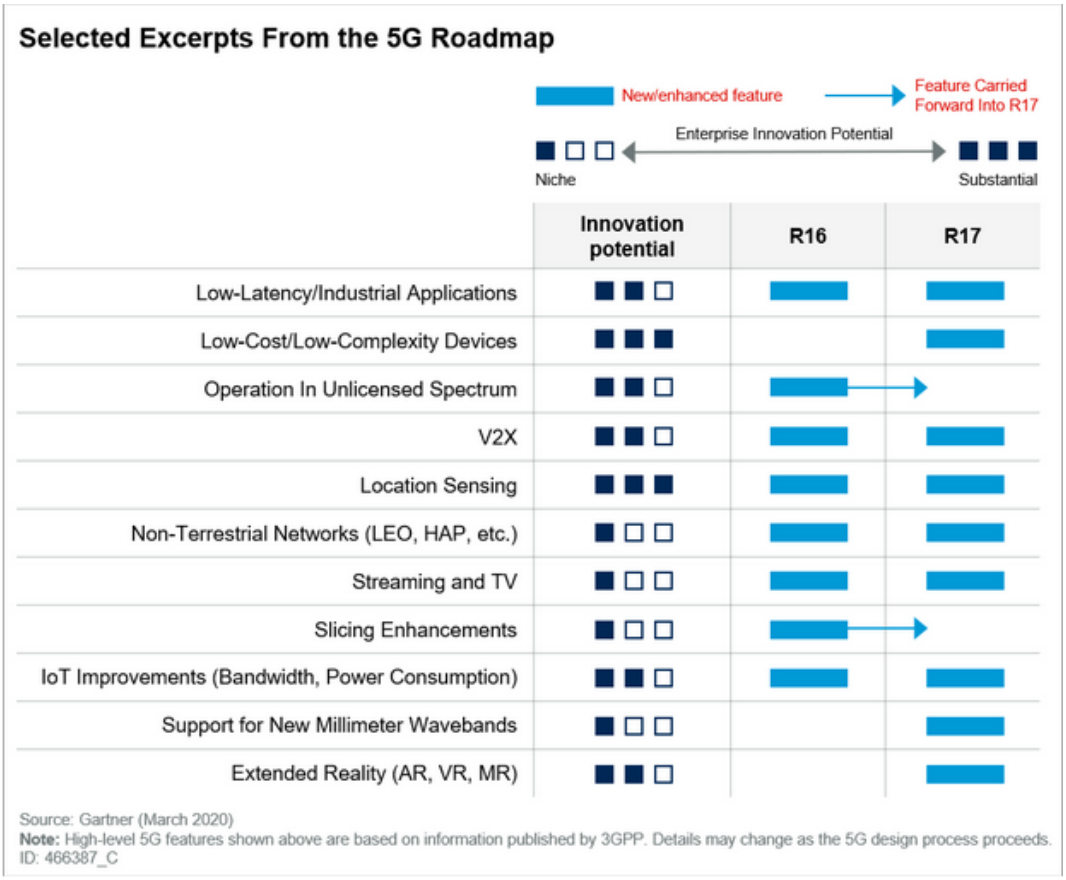

Figure 2.2 5G features expected innovation potential and development

Interestingly, while the opportunity of non-terrestrial network supported by Low Earth Orbit (LEO) satellites, Medium Earth Orbit (MEO), Geostationary Orbit (GEO), and Hight Altitude Platforms (HAP) like Thales' Stratobus may lay within a 3 years' timeframe, it may build up on the momentum that is currently building up concerning location services, and high bandwidth applications.

Therefore while current enterprise market opportunities may remain limited to applications leveraging speed including [1] : fixed wireless access, augmented and virtual reality applications, high-bandwidth mobile work, and Wi-Fi replacement, the development and maturity of 5G may leverage features relevant in 5G-ALLSTAR. In particular, low latency and multi-connectivity.

For business decision makers, this initial phase of 5G development if particularly critical as current offering is still evolving, and new opportunities or better terms may soon emerge. While initially, 5G connectivity may be available only through telecommunications operators, evidence is accumulating (see the Omdia's survey results) that enterprise customers are relying more on system integrators and specialized vendors for their developments. It becomes then imperative to focus on the application requirements avoiding selecting solutions or making decision that risk locking them in with a specific vendor.

In a five years' time, the maturity of 5G deployment, greater coverage, and device and modules availability may catalyze enterprises' interest toward solutions and opportunities leveraging 5G value-adding features.

We consider four of them promising for enterprise customers [1]:

- **Innovative mobile worker applications**. High bandwidth applications including high quality video streaming, augmented and virtual applications may provide novel opportunities in maintenance, safety, design, and collaboration.
- **Connectivity**. 5G is likely to become substitute of several existing communication technologies and superior to current offerings in all major KPI including latency and bandwidth. The current opening of regulators to the allocations of frequencies for private applications suggests the possibility for 5G to meet both economic and technical requirements, and with time, becoming competitive with current solutions. The specific work done within the 5G-ALLSTAR project to advance on multi-connectivity is an example on how to enable 5G to meet existing and emerging industry requirements. At the same time, multi-connectivity has the clear advantage to result in the opportunity to deploy resilient and temporary networks, both to meet exceeding demand or to fallback in case of major disruptions.
- **Location based services**. Multi-connectivity brings the opportunity of new levels of localization and tracking of the most disparate objects or entities. Covering both indoor and outdoor—and on large, urban and eventually low populated areas—allows new traceability services for object and assets. On a different scale, increases in resolution and latency may better support collision detection, real-time routing and services. In certain cases, and if cost-compatible devices become available, 5G may find implementations for sensor logging and monitoring.
- **IoT**. While current low-power, wide-area IoT applications will probably migrate to 5G new pplications exploiting higher bandwidth may open the road of new application supporting HAP, fleet of drones, streaming high quality video or sensors. This opportunity will be further enhanced by the availability of low-cost modules and device brought about by a maturing ecosystem. Additionally, by leveraging URLLC 5G characteristics enterprise and industrial application could emerge leveraging the new capabilities of the network infrastructure, together with the potential of edge cloud computing. The possibility of industrial automation and control, and large fleet or massive device coordination may result in a strong innovation spree of novel applications including AI-enhanced actuation, data streaming and analysis [5]. In this sense, possible application leveraging 5G con-

nectivity to realize a reliable and continuous monitoring and sensing of health and physiological parameters, may provide the additional opportunity for large-scale or population-wide medical applications. In times of COVID-19, the opportunity appears even more evident.

3 The business models

Business Models (BMs) depict the ways companies create and capture value [6]–[8].

The BM concept gained momentum during the dot-com era [9] with the emergence of a new stream of business models and ways to leverage the Internet infrastructure.

BM concept in three main domains [6], [8], [10](Al-debei & Avison, 2010; Burkhart et al., 2011; Osterwalder et al., 2005)(Al-debei & Avison, 2010; Burkhart et al., 2011; Osterwalder et al., 2005)[6], [8], [10]: its support for the strategic alignment of a firm's information systems with its strategy; its contribution in modeling the business processes; its role in IT-based innovation.

Concerning the *strategic alignment*, the BM serves as a high-level representation of a company's business, from which its business processes and engineering requirements are derived. Technological infrastructures support process activities that promote the development of particular products or services and the company's architectural structures and relationships. Therefore, understanding a company's BM facilitates infrastructure choices. To succeed, a company's strategy and business processes, along with its infrastructure and systems, have to be aligned to ensure the achievement of organizational goals and objectives. In this sense, the BM concept helps increase mutual understanding and integration between a firm's strategy and the technological infrastructure [6], [8], [10]–[12]. Recent strategy literature has also analyzed the co-existence of multiple BMs within the same company [13]–[16], reinforcing the role of BMs in facilitating strategic alignment.

Concerning *business modeling,* it allows the design of strategic objectives, decision support system implementation, and processes validation [12], [17].

Concerning *innovation*, the increasing appearance of the BM concept in literature since the early 2000s has mainly been caused by the growing pervasiveness of the Internet in business activities [6], [8], [18], therefore through technology giving birth to and shaping digital BMs [10], [19]. In recent years, information and communication technologies advances have been the primary drivers of BM innovation, affecting the fundamental logic of how organizations create, deliver and capture value [20], [21]. BMs have become critical for managers to understand how to exploit the technology to develop innovative BMs to better satisfy customers' demands and needs.

We identified four BM components: value proposition, value architecture, value network, and value capture. One definition of BM available in the reviewed literature is also very focused on highlighting these four components[22]: "The BM is a description of the value a company offers to one or several segments of customers, and of the firm and its network of partners for creating, marketing and delivering this value to generate profitable and sustainable revenue streams".

First, the *value proposition* which defines how value is created and delivered to the target customers through the offer of products and services. The *value proposition* is focused on customers' needs, and on the products or services offered to satisfy those needs. Value is created for *customers* and *users* by offering a desired *product* or *service* targeted towards particular market segment(s). The value proposition describes the products and services offered, and the customers with whom the company is engaged. The analyses by [7], [23] differ from others, linking the concept of *competitive advantage* to the value proposition, as a contribution to long-term business sustainability. The term competitive advantage formulates the extent to which a firm's BM differs from those of its competitors by being able to offer unique and different value compared to other firms, and how it can be sustained for strategic business growth.

Second, the *value architecture* deals with the key processes and resources necessary for the value proposition to be fulfilled. The key processes are all firm transactions, mainly input and output transformations, and product or service distribution, while the key resources include the company's people, assets and all the knowledge and competencies it has acquired during its business history. Technologies are part of the business resources and enable the firm's trans-

actions with external business constituents and product markets [24]. In the BM definitions considered in our analysis, the technological architecture comprises the service platforms and the devices and applications a business uses to create value [24], [25].

Three internal company elements are identified within the *value architecture* component: (1) activities and processes, (2) resources, and (3) competences. The *activities and processes* enable the development of the products or services offered and describe the most important things a company must do to make its BM work. The *resources*, tangible and intangible, describe the most important requirements to make a BM work. The *resources* include also the technology i.e. the technological architectures of the service platform, of devices and their applications, and of the development environment which a business needs to run [25]–[29]. Finally, the *competences* include the expertise, abilities and skills necessary to execute the company's BM. It is important to note that activities and resources together make up the so-called *value configuration* [22], [27], [30].

Third, the *value network* includes the external network of partners that the company mobilizes to deliver the value proposition to its customers. The *Value network* concerns what is external to the focal company, and is composed of three different elements: infrastructure management, customer interface, and communication flow. The *infrastructure management* includes the partner network [31] - the corporate agreements the firms have with other companies and the technological partners that are necessary to allow it to offer, distribute and commercialize the value it creates. The *customer interface* identifies the relationships and the types of links a company establishes, specifically between itself and its different customer segments, while the *communication flow* [7], [11] identifies the ways in which a company reaches its stakeholders to deliver its value proposition(s).

Fourth, the *value capture* concerns how organizations manage monetization, and relates to the financial value the company retains from its transactions. *Value capture* represents the financial aspects of the BM concept: the most frequently noted elements in this component are the company's cost and revenue models. The *cost model* sums up the financial consequences of the means employed in the BM to deliver value, while the *revenue model* describes how the company appropriates the value created through a variety of monetary revenue flows. Pricing, distribution, and investment and funding source models are less frequent in the definition of value finance. The *pricing model* covers the pricing of the product and the service offered [7], [23], [25], [27], [28], while the *distribution model* indicates how all the investments, cost and revenues are shared among value network participants to ensure the sustainable financing of value creation [7], [23]. *Investment and funding source models* indicate the sources of the capital used to operate the BM [7], [25], and the *profit model* defines the results of the pricing, revenue and cost models [7].

In the literature reviewed, the BM concept is leveraged to define and describe the different business components and their relationships. The structural relations of the business components are described at an abstract level, showing that almost every BM component is connected to the others, making all their inter-relations structural and indisputably important [23], [32]. Hence, without a thorough knowledge of the business components, and their relationships, it is difficult to optimize, transform or innovate the company's value creation and capture processes successfully.

The representation we develop (see Figure 2) synthesizes the elements of each BM component to form a complete structure of the concept. The framework presented here is generally applicable and does not focus on any one industry in particular—so researchers can use it as a solid base to design and describe BMs. From a practical perspective, this framework can enhance an organization's ability to manage its existing and future BMs. Our representation enriches the range of BM representations available in the literature.

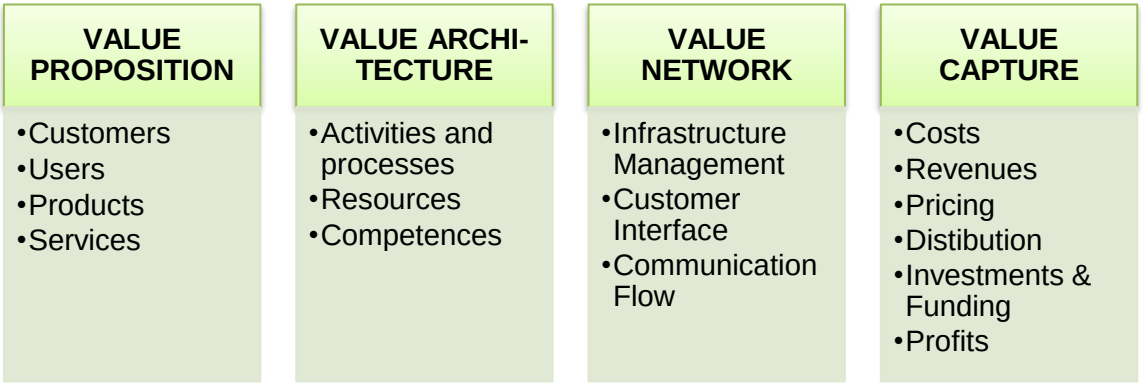

Figure 3.1 Elements of BM Components

3.1 The changing orientation of business customers

The available studies highlight that customer needs will aggregate around three main types of connectivity expectations. First, around the billions of devices and smart objects being introduced in the market and constituting the Internet of Things (massive machine type communication, mMTC). Second, the response to low latency needs for critical services (ultrareliable and low latency communications, URLLC) and finally, ultra-high-speed expectations for immersive services (enhanced mobile broadband, eMBB).

Accordingly, and mainly with reference to the business market, while experts' opinion converged toward connectivity expectations, we noticed an interest in business customers of "more complex connectivity systems" that they will try to source first from telecom operators. In turns, telecom operators and connectivity providers will have to move to a new generation or form of connectivity and network products and services. The industry is evolving and "they are forced to evolve in a rather critical way."

The members of the panel put forward four expectations or needs for business customers.

Firstly, a need to support potential business customers interested in 5G solutions both in terms of expertise and competences that they only partially have. In this sense, product and service provider will manifest an growing need for support in their 5G projects.

This need could be related to the complexity of networks and the addition of a telecom layer that is not mastered by customers. "To cite an example, Energy Providers are redesigning their energy distribution networks (Smart Grid) natively integrating telecoms and IT".

Secondly, new forms of "complex telecom solutions services" are emerging. Again, energy companies will need to implement both predictive solutions accounting for "climate changes that cause energy distribution disruptions on the network", but at the same time for issues emerging from the telecommunication network counterpart. The two networks will need to work on cross-resilience between energy and telecom and implement predictive solutions in relation to this configuration and what will happen in geographical areas. Therefore, while slicing may potentially open t

Thirdly, business customers expect confidentiality when working on 5G based innovative projects, manifesting the high stakes and opportunity that the technology provides. Partners capable to support 5G developments demonstrating their ability to maintain high confidentiality standards, may then be privileged compared to other forms of collaboration.

In the downstream, business customers have expectations concerning the 5G network deployment strategy underlying the necessity for the infrastructure to deliver on the promised performances and pervasive connectivity.

For the short-term, the panel highlighted the prominence of business-side opportunities than those oriented toward the general public.

4 The Emergent 5G Business Models

Enterprise customers have increasing expectations regarding the deployment of 5G networks. The hype and promises of the technology increase the market pressure on service and telecommunication providers to add value to existing value proposition. Therefore, beyond new developments, products or services specifically supporting the 5G infrastructure, deployment strategies will greatly influence the emergence of, and the emergent BMs.

Our analysis highlighted an interest beyond the consumer customers, for which 5G is set to be in most cases, and at least in the short term, as Benedict Evans at the venture capital firm Andreessen Horowitz said, just a "faster 4G."

> "The killer app for 5G is probably, well, 'faster 4G'. Over time, that will mean new Snapchats and New YouTubes - new ways to fill the pipe that wouldn't work today, and new entrepreneurs. It probably isn't a revolution - or rather, it means that the revolution that's been going on since 1995 or so keeps going for another decade or more, until we get to 6G."

Benedict Evans, Andreessen Horowits

Figure 4.1 The need to appropriate of the potential of the innovation

This point is crucial. 5G benefits or what investors generally look at as the "killer application" will emerge, with time, from the business experimentation and customers appropriation of the perceived value potentials brought to the market. In this sense, partnerships and contexts capable to favor experimentation and use may be critical for the diffusion and use of novel solutions.

As seen by the evolution of connectivity from 3G and 4G, software remains at the forefront of business model evolution and has allowed organizations to build value propositions where none existed before. Whereas this is beneficial for consumers in general, many companies have gone out of business because consumer's concept of 'value' continues to shift. With the rapidly increasing connectedness across devices and platforms in addition to the development of fast, highly available, and highly configurable 5G networks, this prediction is increasingly holding true.

Service providers are in the process of rethinking their business models in anticipation of large scale deployments of 5G. This has come about due to fear of vertical integration (between service providers and suppliers of network equipment for example), as well as a need to find alternative revenue streams resulting from falling average revenue per user (ARPU) in the absence of traditional customer behavior when serving connected sensors [1]. Additionally, operators must think about the return on investment (ROI) considering that establishing the 5G network would require significant monetary investments [1]. In the words of Dan Hays, analyst at PwC "The big question is whether or not 5G is going to be more of the same. This question of use cases is still lurking in the shadows… There is not a single driver that's creating a pull beyond a desire to continue to increase speeds and capacity and decrease latency" [1]. Therefore, in

order to justify investment into 5G, it becomes essential for telecommunication operators, vendors, service providers to understand—and let understand—the value they bring to enterprise and business customers, as well as consumers.

Therefore, instead of immediately targeting the mass-market or the consumer, we indeed observed a dynamic that is more oriented towards business and that revolves around new requirements, products and services.

4.1 New market dynamics

4.1.1 The requirements

In literature, customer reequipments are generally craved around the three types with connectivity expectations advertised as pillars for the 5G. The need of connectivity for 1) the billions of connected objects (mMTC), 2) the low latency needs for critical services (URLLC) and 3) the ultra high-speed expectations for immersive services (eMBB).

For the business and enterprise markets, and according to the available literature, our research showed an alignment with connectivity expectations but observed that customers *"also need more complex connectivity systems"* that they will source from traditional network operators.

The experts put forward four expectations or needs for enterprise and business customers.

Firstly, a need of the network operators' customers "*they need both an expertise that they partly have but for which they also need support and telecom operators have the opportunity to provide this support*".

This need could be related to the complexity of networks and the addition of a telecom layer that is not mastered by customers. *"To cite an example, several energy companies are redeveloping an energy distribution network (Smart Grid). In this network, it natively integrates telecoms and IT"*.

Secondly, "*complex telecom solutions services*". With, for example, for energy companies, the implementation of predictive solutions for "*climate changes that cause distribution disruptions on the network. Both in terms of energy distribution and in terms of telecom. They need to work on cross-resilience between energy and telecom and they also need to implement predictive solutions in relation to this configuration and what will happen in geographical areas*".

The lack of competences that enterprise and business customers may currently have in mastering 5G opportunities, clearly point toward an increasing need of partnership and collaboration. We noticed that in these regards, with announcements concerning 5G initiatives from service providers, network operators or verticals were highly publicized in press, the details of these initiatives and innovative project remained understated. Inquired specifically, we were able to identify a greater expectation of confidentiality concerning 5G initiatives, or as one of the experts put it "*innovation is more important*".

Finally, verticals have now increasing and more specific expectations regarding the 5G network deployment strategy. While in the mid-term connectivity is somehow considered as complete, in the sense that will be able to support the multitude of designed use cases, for verticals *"the way operators will deploy could pave the road toward the new value propositions."*

According to what appears to be the investors' vision that in the short term the benefits of 5G for consumers will appear as "*spatially-limited faster 4G*" the focus remain on vertical solutions and new devices *"we are in a dynamic that is more oriented towards BtoB than the general public."*

4.1.2 Products and Services

5G will respond with a single mobile network to a wide variety of needs, paving the way for innovative new products and services, for the consumer, business to business, and vertical markets.

The list of products and services that could stem from 5G and reported in the literature is massive including virtual reality headset, HD video, autonomous robots, and autonomous cars. What it is clear, is that new devices and applications will emerge with time and with the diffusion of 5G networks.

Interestingly, our analysis shows that the increasingly the notion of product and device is fading away in favor of services. This hypothesis is confirmed with the analysis of the gathered interview data: four quotes from the panel for products against thirty-one for services.

Today, customers are expecting "*hardware that can deliver functionality*". In this sense, devices should be embedded in a specific value system providing the expected functionality and meeting customer's requirements. For example, readily compatible sensors that will offer robust and easy to implement functionalities for verticals. Similarly, for equipment manufacturers, the product or service offered will be directly dependent on the associated infrastructure. Therefore, solutions should encapsulate end-to-end from the network to the 5G access network, providing end to end is both the access network part and the 5G access network solution.

Testing and experimentation platforms emerged as an important building blocks to facilitate 5G adoption and diffusion. The capacity to provide customers with ready-to-integrate 5G building blocks and prototyping platforms were suggested as essential for both established ventures and start-ups. In this sense, partnership and their consolidations become critical as testing may require the coordination and aggregation of different partners along the value chain. For example, coordinating those actors developing the antennas, those capable to perform and coordinate the tests, those that provide the hardware, or the power amplifier, and those providing the overall infrastructure. Deployments and innovations from verticals may be facilitated not only by the presence of vendors or brokers, but from the availability—in different forms—of field testing and (fast)prototyping platforms and testbeds capable to evolve as new 5G features are released and implemented. Innovators will need then to be supported both NR and core network functionalities (e.g., Open5GCore, Ericsson's 5G Core, or Nokia's core services).

We further advance that in this context the skillset of system integrators and vendors may engender a new market dynamic where telecommunication operators will face an increasing commoditization of their services for the lack of capacity to engage with enterprise customers in delivering innovation and solutions. The majority of 5G projects will emerge as natural consequences of the ongoing digitalization trend, therefore from innovation or IT units. Naturally, IT vendors, system integrators, networking companies and large consulting firms developed stronger ties with these entities and will likely prefer to experiment and innovate with trusted partners.

The flexibility of 5G network may easily accommodate the role of existing players tailoring a specific 5G service bundle for their customers, eventually providing them with a supporting ecosystem based on current and emerging network operators offering.

5G comes with a number of new features that will allow network operators to offer different services. Aligned with the observation of current 5G trends and reported 2.1, we identified proposals can be grouped into two main areas: cyber security and the Internet of Things.

4.1.3 Cybersecurity

There are two crucial points concerning cybersecurity that we observed. First, awareness and investments in cybersecurity are increasingly a priority for enterprise, business customers, and consumers and greater awareness of the risks related to massive connectivity are being met by the arrival of new players (see Figure 4.2).

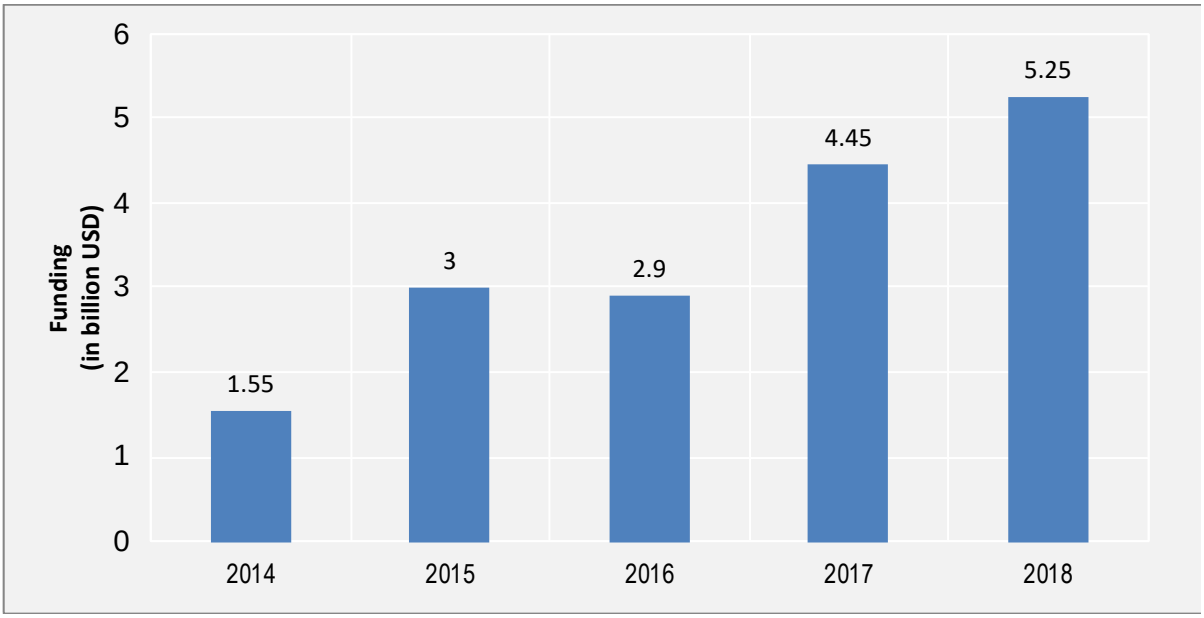

Figure 4.2 Venture capital investment in cybersecurity companies worldwide from 2014 to 2018 (Source: SCV, Statista estimates)

In 2018, according to market research company CBInsights, 617 venture capital investment deals went to cybersecurity companies, representing nearly a 40% increase compared to 2015.

Furthermore, at increasing rate, cybersecurity companies are reaching an estimated evaluation of 1 billion USD, through increasingly large financing rounds.

Second, the need to provide customers with end-to-end connectivity solutions, possibly radically changing network operators business "*from providing connectivity and service to providing an insurance box*." Therefore, while connectivity itself becomes infrastructural, leaving little space to differentiation, the connected ecosystem enabled by 5G lowers the barrier to entry into mobile business from the different actors in the market. New entrants coming from industries where they already developed expertise and reputation, may find the opportunity to contest new markets finally at reach. This possibility, coupled with the more strategic role played by cybersecurity in an increasingly digital economy and exacerbated by the COVID-19 [33], require network operators, vendors and service provider to properly partner or invest to meet customers' cybersecurity requirements and expectations. While 5G PPP and 3G PPP both deal with architectures and governance models accounting for specific aspects such as virtualization and network access, several challenges still remain open [3].

The strategic relevance of network infrastructure and application security has effectively become a geopolitical affair over the last year, leading to open criticism and restrictions applied by US government to Huawei. Other countries have followed suit [34], practically banning Chinese manufactures from their network infrastructure provisioning.

As a way forward, the European Union seems to be taking a carefully balanced approach between economic and security interests by defining strict security criteria for 5G.

The cybersecurity challenge is at the same time a critical opportunity and threat to network operators where their "*real role […] as long as the connectivity is provided*" is to leverage embed into the cost of their services a form of service insurance.

From a network operator point of view *"we are distributing more and more service. So, there are increasingly more elements that can participate in the 5G network, making it easier to attack the network*". This issue will then be an essential point when dealing with the growth of connected objects in form of both IoT, and more specifically for an increasingly mission-critical Industrial IoT. Indeed, "*We will have both an increase in the power of the IoT and various and*

varied attacks through its objects and the different computer systems that will be installed in and by all the verticals."

In this sense, network operators may differentiate and provide added value to their customers assuring a secure network and help customers to secure their devices, innovation, and ultimately digital data. However, 5G relies on the integration different networks, IT, and cloud technologies resulting in an evolving multitude of use cases. This represent a turning point for network operators which may leverage their technological strengths acting as secure data hub for their customers (an example in this sense Europe's Data Portability Cooperation project)

As cyber security becomes a critical and strategic value driver for both busines and consumers, the capacity to support and guarantee it constitutes an essential competence for competing in the 5G arena.

4.1.4 IoT services

Smart cities, smart grids, IoT, Industrial IoT platforms and solutions are proliferating, and against what could appear to be the overlying assumption, the market is not consolidating, yet. While the market is indeed concentrating with the top 10 providers holding around 58% of the market share, compared to the 44% of 3 years before [35], the number of platforms is increasing (Figure 4.3).

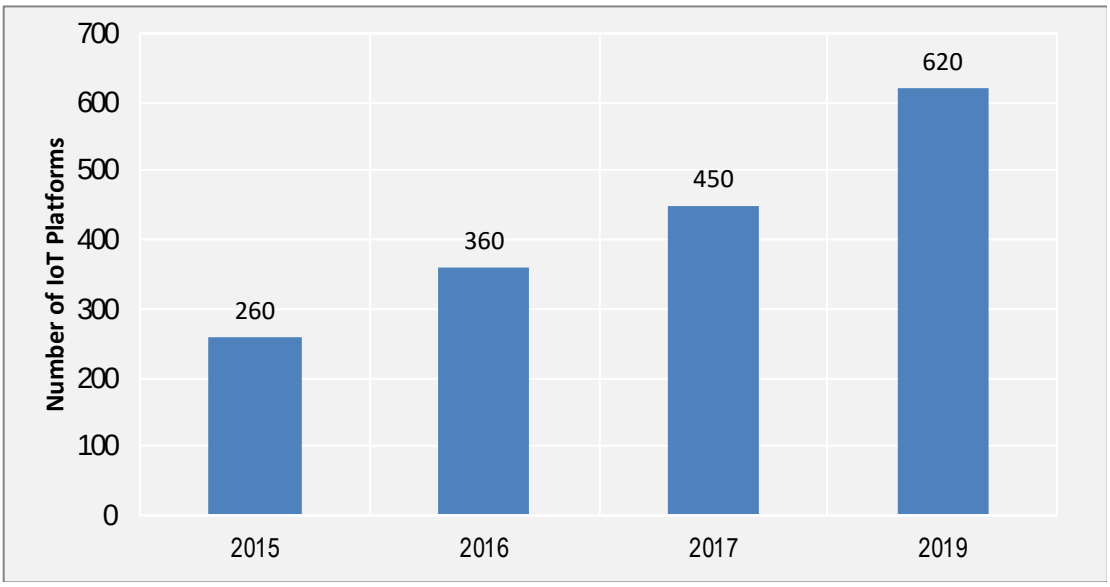

Figure 4.3 Number of IoT platforms (Source: IoT Analytics)

Among the different reasons explaining this phenomenon [35], two aspects are relevant to set possible trends in the 5G ecosystems. The possibility of small-scale IoT platforms seems to point to the existence of several profitable niche markets with enough mass to sustain the investments required for the deployment of the infrastructure. The emerging scenario illustrates the potential for new players and business solutions related to both the services and 5G network connectivity. As a network operator expert put it "*Among the services we are considering for 5G everything is related to IoT and broadband connectivity. We are creating needs, new boxes that will interact."* While difficult to estimate, the number of services supporting the IoT will be immense, affecting all industries.

On a greater scale, industry-wide platform initiatives including automotive for what concerns V2x communication and more broadly cooperative intelligent transportation systems are set to ultimately impact the whole transportation industry.

The greater availability of data, enabling the representation of complex systems bringing, through predictive solutions, simulations, and digital twins new levels of efficiency and optimization. While for traditional fleet management, location-based services have already proved to

affect their deployment efficiency, we observe broader opportunities materializing in different verticals of the transportation industry. Recent studies on the maritime transportation industry [36], for example, have preconized positive effects of assets information digitalization (digital twinning in particular) on fleet, port and terminals optimization, situational awareness, and container flows optimization. Similarly, the greater visibility that pervasive location-based solutions could provide, will directly affect supply chain visibility and transparency. The real-time flow of information accessible from the different supply chain stakeholders will enable multiple benefits [37].

In the case of network providers, the notion of service goes hand in hand with the enhancement of its assets: "*the essential question for me is how do we enhance our assets, our heritage? In this case, our assets are the network. And the question then is how do we set up connectivity services or network services or Infrastructure-as-a-Service from this heritage?*"

The challenge and the market opportunity for new players lays then into the choices and capabilities that network provider will make when deciding which services they will support and provide, determining how customers "*will use its 5G*".

4.2 New customers and business models

While we stated in several parts of this document that for the consumers, 5G would not represent a revolution, the impacts on business will be greater. This prediction is clearly stated in literature where the list of features enabled by 5G new players and verticals are set to disrupt the market.

Experts suggest that 5G will stimulate and somehow reshape requirements. Indeed, 5G will enable firms to question themselves on the emerging opportunities, firms "*who say to themselves, 'I'm going to have a technology that allows me to do things that today I can't do, or maybe I can do it but not necessarily with the right performance.*"

In this sense, we expect the configuration of markets to be partially affected stated the interest for major 5G players to support solutions and applications end-to-end. The comment of a telecommunication firm clearly shows that "*The customer is changing, the customer before for us was a base station manufacturer, was a telecom operator.*" Today the addressable market has moved directly to the vertical. For all the players in the ecosystem, *"today the real customer will be what we call the vertical industry, it will be the car manufacturer. And that's changing a lot because there is already a different corporate culture."*

While the interest on the impacts of corporate culture may appear relatively small, the need to adapt to a different market configuration provides the opportunity for new players to emerge. At the same time, and typical for network operators, several of the addressable vertical markets remained generally targeted only concerning connectivity or basic telecommunication services. 5G is seen then both as a challenge and as an opportunity as *"It allows to enter more into markets such as verticals that we did not address."*

With 5G, 5G ecosystem players will be able address new customers, mainly found in the addressable verticals, bringing deep changes in the current offering toward solutions and digital services requiring typical operators' packaged offer models will need to evolve "*because where until now we sold a connectivity package with the CPE, the router... connect all this to a VPN and tomorrow we will have to build this same VPN but on the basis of equipment that is not necessarily ours."*

4.3 Customer relationship and communication

For 5G ecosystem's actor the development of their vertical customer interfaces represents a critical point. The customer interface identifies the relationships and types of links a company establishes, particularly between itself and its different customer segments, while the communication flow they enact it, and identifies how a company reaches its stakeholders to deliver its value propositions [11], [38].

We observed a clear change in the way of connecting with customers and the emerging tutoring and partnering roles played. In particular, experts perceived the advantage in having the ability to directly address the vertical markets and have “a sales channel” to them. This was seen as particularly useful for addressing the different entry points of the public sector, and for addressing the growing industrial market and services.

Again, this is somehow challenging for traditional network operators that saw their 5G marketing evolving, *"There will be a 5G geomarketing. More related with the IoT, challenging the dominant position that the smartphone had until now. We can no longer market our 5G offer just around the Smartphone as we did for 4G, it won't work, we need something else. Furthermore, we will need to revise our offer segmentation in relation to customers and their devices depending on where we can effectively support specific features, and which vertical we address."*

No surprisingly, this change in their stance toward the potential customers makes 5G players to be very open with their communications even heavy leveraging social networks and online media with the objective "to inform about all the progress we are making in the 5G ecosystem from end to end, all the drivers, all the activities we are doing we communicate on the results."

More traditionally, then, best practices and customers’ success stories are shared *“so to show that we've done something in one place, we can replicate it elsewhere.”* This is a critical point when the provider still requires building trust in addressing new markets, or customers that do not expect the firm to have a specific expertise. This is especially relevant for SMEs willing to provide services to larger organizations and that will require to build this trust.

4.3.1 Partners and Organizations

Partners organizations represent all the actors in the value network that collaborate and contribute in the value creation, and how they organize to provide their value proposition to their customers. The competitive configuration that is emerging is increasingly suggestive of the need to extent current partnerships for both large organizations and SMEs in order to deliver and benefit from the opportunities provided by 5G. Beyond the actors of the value chain, the government play an essential role in facilitating, enabling, and supporting 5G initiatives. Additionally, the role of public-private partnerships to support research, development, and vertical and large-scale trials, with a particular attention to the business cases that could potentially emerge from the effective deployment of 5G networks and its advanced features.

The partners

We reached a general consensus on the expected increase in the size of partnerships, integrating different actors compared to current configurations: "*Today we work with three or four manufacturers for the network. The number of business and technology providers we work with is finally limited. However, we expect this to change when it comes to buying applications as the infrastructure become more virtualized and standardized.”* A clear business opportunity seems to emerge from the need for *“solution that will allow us to control and orchestrate this entire automated network.”*

Furthermore, a different approach to providing solutions that will probably respond to new customer needs, involving partners in defining and discovering new use cases. *"We are going to need the ecosystem more and more", "we incubate".*

Organization and skills

On a similar angle, partners may provide the additional skills required to complement those currently available, “*setting up new partnerships. Or having a solution provider of that type. We're going to need partners to have new skills."* Several comments emerged concerning the need for new skills and competences to deal with the *“shrinking boundary between software and hardware".*

According to the experts, there will be a transformation of organizations and skills.

First of all, there's a general shift in the way of working that is pushed by a "race for innovation" where all the 5G players try to exploit the best of the ecosystem.

Collaborations among network and technology providers, cloud providers, verticals, open innovation platforms were all element cited during the interviews. The coordination of larger partnerships will require firms to adopt a more systemic posture and approach the final customer with a clear value proposition advancing an end-to-end solution. To do so, then, it becomes imperative to be able to develop use cases and reliable trials that can provide a clear understanding of the capability of the technology to meet the requirements, and of the solution—emerging from the collaboration in the ecosystem—being developed or marketed.

For network operators, while changes were not expected in the short term: *"Once you're going to have a network with virtualized functions, you're going to have to review the organizational model. The build/run boundary will become more tenuous than what we have today.*

Therefore, while virtualization and automation will require new skills, more service-oriented need appeared evident as technologies like chatbots, artificial intelligence, or quantum computing emerged as necessary bricks in building the 5G ecosystem.

4.3.2 Monetization

In terms of monetization several considerations have emerged following the discussion on the evolving structure of the ecosystem. In particular, revenue sharing was evoked as a possible solution for coping with the growing pool of partners and mobilized competences *"We will have new partners in terms of equipment and in terms of service, and we talked about verticals. So, if these people manage to earn or save money with the 5G solutions we offer them they may also be more inclined to share part of their extra revenues with us. And so, it's perhaps on a sharing revenue model that we have room to maneuver."*

Revenue, profit, value sharing mechanism have been already been successfully adopted before. General Electric, for example, adopted an outcome-based approach for its jet engines, part of its Industrial Internet initiative. However, selling outcomes-based services implies risk sharing among participating partners [39]. The agreement appeared sustainable, as GE was able to precisely predict the revenue generated and therefore actualize the investment. However, this exposed the firm to risks determined by off-control variables (e.g., environmental, economic, political). Interesting, the switch to an outcome-based model required a cultural adjustment and customers' education.

We observe that revenue sharing models are typically supporting value capture in platform businesses where value creation and value capture are two distinct phases managed by different actors, in multi-sided transactions. Maintaining a fair share of value creation and appropriation becomes then an important aspect to manage for the sustainability of the platform itself. In a recent study, three core mechanism were observed to appropriate of the value created on the platform [40]: absorption, co-selling, and verticalization

Table 4-1 The mechanism of platforms value appropriation (source Schreieck et al, 2017)

Mechanism	Description	Manifestations
Absorption	The platform owner extends the product portfolio by providing complementary applications or functionalities that formerly were offered by third parties.	• Acquisition of third-party applications or the firms behind the applications • Imitation of third-party applications • Extension of the platform's core offering covering functionalities previously provided by third parties
Co-selling	The platform owner engages in joint activities with third-party developers to support them in selling their applications.	• Bundling of third-party applications and platform • Branding & certification of third-party applications • Customer enablement to support customers in marketing applications they developed for their own use

Verticalization	The platform owner defines and, together with partners, implements dedicated vertical use cases on the platform.	• Industry verticals to address specific industries with a pre-defined set of platform functionalities and third-party applications • Front-runners to illustrate the platform's potential in industry verticals early on

The observed mechanisms may be suggestive of possible configurations emerging from in the context of established platforms or within emerging IoT ones. Therefore, while in the discussion of the panel the co-selling, both verticalization and absorption represent feasible configuration at different moments of the partnership.

The service component has then been identified as the core source of revenues and complemented by the exploitation of the data. This interest in data exploitation reminds of the monetization strategies of big tech players, for which the actual service is a source of information for generation additional revenues. For example, Google exploits search data and navigation patterns to foster its advertising network effectiveness, Amazon analyzes consumer patters to identify profitable line of products, or Netflix leverages user consumption pattern to introduce and steer content. A network operator commented "*More and more we have to explain to our customers that the hardware, the device can provide a new service, and at the same time the fact that it provides information on how to make the service itself more efficient.*"

However, the monetization of the data represent by itself a challenge for every business and has been widely explored in big data literature [5], [41] *"In terms of network monetization, all that is connectivity capacity is something we already know how to do with 4G. But what's new is that we will be able to address these vertical markets where we will be able to address services in a business way and no longer in terms of providing simple connectivity.".*

4.4 The emerging business changes

With this study we aimed at discovering which business models of 5G, either as evolutions of existing ones and new BMs of 5G will be and what the new sources of revenue that may be generated.

To answer the question of identifying the direction of business model of 5G, we rely on the literature review and the performed interviews. First, the focus will be on customer needs and secondly on the expected services (Figure 4.4).

Value Proposition: In terms of value proposition, we identified a trend shift from a discussion about "products" to stress on "services". For B2B there was stress on confidentiality associated with competitors' ability to replicate services.

Value Architecture: includes functionalities required to develop the 5G network and support it like labs and means for testing. Respondents stressed that 5G business models would bring to the forefront the lack of end-to-end control on the operator's end and so value propositions would require adjustments. Moreover, network slicing would be an important tool for operators to be able to manage costs.

Value Network: the value network for 5G business models will primarily include vertical markets (e.g., PSA and Orange), then manufacturers (who supply network equipment and servers) and finally application suppliers. IoT markets and businesses will potentially disrupt the market lead of cell phone companies. Additionally, 5G services would be limited by geographical areas without the use of non-terrestrial networks and operators would have to adjust the value proposition to cater for the needs of vertical segments at first.

Value Appreciation: The process of monetizing the value proposition would evolve and will include bi and multi-lateral contracts and revenue sharing models that are inspired by process virtualization. New technologies like network function virtualization (NFV) and software-defined networking (SDN) would need to support these new schemes.

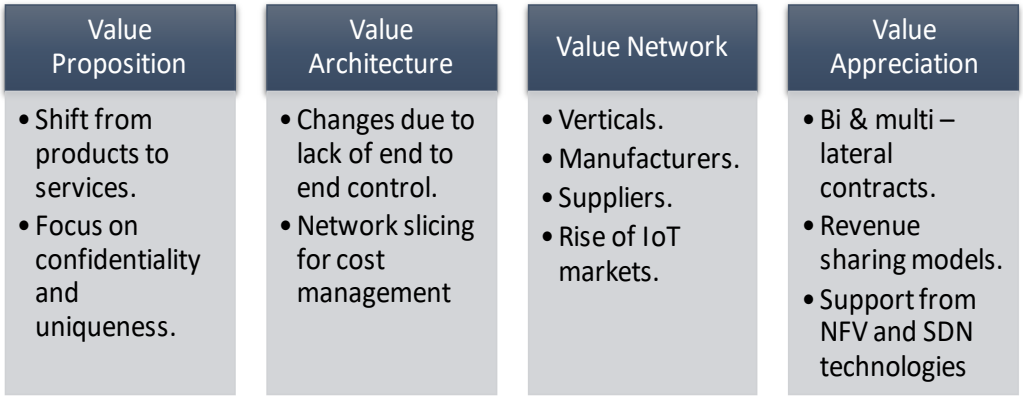

Figure 4.4 Main themes of future 5G business models.

5 Verticals analysis

5.1 The proposed use cases

Within 5G-ALLSTAR we identified several scenarios that enabled the demonstration of their technical feasibility and business opportunity based on existing vertical requirements.

- Use case 1: Broadband moving hotspot network
- Use case 2: cellular and satellite multi-connectivity for mmWave-band vehicular communications
- Use case 3: Public safety
- Use case 4: Intercontinental interoperability

5.1.1 Use case 1: Broadband moving hotspot network

The proposed scenarios are illustrative of the opportunity of multi-connectivity for vehicular communication.

The PoC focused on mmWave, broadband and reliable communication where V2I/N links can be maintained for moving vehicles and allows to determine the technological feasibility of a reliable multi-connectivity communication in mobility and in presence of obstacles in urban or highways areas. Transport and public safety are therefore the main vertical markets addressed.

The value driver demonstrated relates to the high service continuity offered and the high average data rate. In particular, we can demonstrate the emerging opportunity of vehicles as communication platforms. The focus on downlink enables the exploration of data-consumption scenario, complementary to the not explored data-creation one for which the uplink should be considered.

From a consumer market perspective, service continuity will enable for a constant access to information and services, increasing the opportunity for streaming-based or data intensive entertainment services (e.g., video and audio content). The growing data consumption per user and the increasing mobility of knowledge workers (e.g., digital nomads) will may entail the creation of new forms of work habits, yet to be explored.

From a business market perspective, the emergence of distributed backhaul platforms, opens to interesting scenarios of assets visibility, IoT coordination, and added value services relying on data link continuity being offered by transport services providers for internal efficiency of as new or improved services to their customers. While the proposed scenarios focus on buses, the multiplicity of vehicles that could act as platform (e.g., ships, UAVs) suggests the possibility for a wide range of application supporting currently envisaged V2X, UAV, or location based services (e.g., TR22.886, TR22.829, TR 22.872).

As already recognized, satellite 5G and multi-connectivity appear an ideal solution for public safety and in case of network degradation or failure in case of disaster. The deployment of mobile backhauls platforms enabling heterogeneous access links would be invaluable relief in case of emergency.

Table 5-1: Demonstrated opportunities for vertical markets for use case 1

Vertical	Customer Activity	Customer Profile	Demonstrated Value Driver
Transport	Entertainment	General public streaming service	Service continuity and data rate
	Work	Knowledge workers, digital nomads	

	Provide transport service	Bus company, taxy company, companies with large fleets of vehicles	
Public safety	Situational Awareness, Coordination	Public safety agencies Local administrations	
	Network resilience and recovery	Public safety agencies Local administrations	
Rural areas	Network access	Local administrations, general public	

5.1.2 Use case 2: cellular and satellite multi-connectivity for mmWave-band vehicular communications

This second series of scenarios illustrates a different aspect of 5G-ALLSTAR developments by focusing on link aggregation and intelligent traffic switching. The PoCs illustrate how both cellular and satellite networks can be combined for providing a higher bandwidth, how multi-connectivity can be purposely and leveraged for adapting to the requirements of the service.

The value driver demonstrated relates to the transparent link aggregation for meeting service demand. In particular, the PoC demonstrate the opportunity of higher bandwidth and QoS based traffic switching.

From a consumer market perspective, the scenarios demonstrate the opportunity for services to maintain the same user experience despite the heterogeneity of environments and network conditions. As already discussed, these scenarios well depict the opportunity for streaming-based or data intensive entertainment services (e.g., TR22.827). Link aggregation will then provide the ability to meet, under certain conditions, both objectives of low latency and broadband communication demonstrates entertainment opportunities aligned to the ongoing trends in the entertainment industry (e.g., cloud gaming, game streaming, and VR based entertainment), and open to new form of entertainment and information (e.g., augmented and mixed reality).

From a business perspective, the opportunities to reach customers with enhanced connectivity and with broadband and low latency supports distance and mobile scenario of existing services. The demonstrated opportunity for GEO satellite to deliver high bandwidth services to potentially a large number of connected devices, either fixed or mobile, untap the potential for services specifically addressing remote areas not reached or with limited connectivity.

Table 5-2: Demonstrated opportunities for vertical markets for use case 2

Vertical	Customer Activity	Customer Profile	Demonstrated Value Driver
Transport	Entertainment	General public, gamers	Data rate, low latency communication
	Work	Knowledge workers, digital nomads	
	Provide transport service	Bus company, taxy company, companies with large fleets of vehicles	
Rural areas	Network access	Local administrations, general public	

5.1.3 Use case 3: Public safety

This third series of scenarios illustrates a peculiar aspect of 5G-ALLSTAR developments demonstrating a different use of link aggregation and splitting. The two PoCs illustrate how both

cellular and satellite networks can be combined for providing service continuity and connection reliability, and how multi-connectivity can be purposely managed and leveraged through redundancy, for providing highly reliable services.

The value driver demonstrated relates then to the reliability of the connectivity, supporting high availability services and service continuity for public safety. The scenarios proposed well illustrate the need for reliable connections and services in cases of adverse conditions disrupting cellular and satellite communications.

From a market perspective, the scenarios demonstrate the opportunity to support public safety agents and assets in multiple tasks including surveillance, rescue, deployment, and intelligence. The market opportunity is however, larger than the direct support of public safety as a reliable infrastructure could be offered as a service by emerging specialized actors in both the connectivity and service space. The decreasing costs of deployment of privately managed and corporate drones fleets, for example, hits toward the potential for this actors to both act as novel infrastructure and service providers with novel value propositions in the consumer (e.g., surveillance of private properties, home healthcare/monitoring) and business (e.g., crop management, surveillance).

Table 5-3: Demonstrated opportunities for vertical markets for use case 3

Vertical	Customer Activity	Customer Profile	Demonstrated Value Driver
Public safety	Surveillance	General public streaming service	Service and communication continuity
	Communication	Public safety agencies Local administrations	
	Provide transport service	Bus company, taxy company, companies with large fleets of vehicles	
	Situational Awareness, Coordination	Public safety agencies Local administrations	
	Network resilience and recovery	Public safety agencies Local administrations	

5.1.4 Use case 4: Intercontinental interoperability

The scenarios demonstrated in the fourth use case are designed to illustrate the full extent of 5G-ALLSTAR developments demonstrating the possibility offered by a seamless, reliable and ubiquitous broadband service in an intercontinental setting based on multi-connectivity. The PoC illustrates the technological capabilities for immersive, VR and media applications.

The value driver demonstrated is a combination of those previously analyzed but focuses mainly on a seamless, reliable and ubiquitous broadband services, available in an intercontinental setting.

From a market perspective, the scenarios provided mainly focuses on usages in mobile settings and wireless broadband service needs. As previously introduced, the PoCs well illustrate the entertainment opportunities aligned to the ongoing trends in the entertainment industry (e.g., cloud gaming, game streaming, and VR based entertainment), but supporting the development of new forms of entertainment and information (e.g., augmented and mixed reality). VR, augmented and mixed reality have been traditionally constrained by the available contexts in which they could be valuable and provide a smooth user experience. The demonstrated technologies may further support high bandwidth remote controls and operations including cyber physical

systems such as smart grid, autonomous automobile systems, medical equipment for monitoring patients, industrial and robotics systems, and vehicles.

Table 5-4: Demonstrated opportunities for vertical markets for use case 4

Vertical	Customer Activity	Customer Profile	Demonstrated Value Driver
Transport	Entertainment	General public, gamers	Seamless, reliable and ubiquitous broadband services
	Work	Knowledge workers, digital nomads	
	Provide transport service	Bus company, taxy company, companies with large fleets of vehicles	

5.2 The emerging business model in Transport

The different use cases demonstrated in 5G-ALLSTAR provide a valuable source for determining possible value proposition emerging in the transport vertical. Maintaining in so diverse scenario conditions continuity of service and connectivity shows the potential for fleet management, asset tracking and overall location-based services. The possibility to maintain, enhance and switch connectivity depending on the available coverage is extremely encouraging and goes beyond what we observed from the market analysis.

The evidence we gathered concerning current 5G transport cases shows a primary focus on enhancing various means of transport with connectivity. The most common examples encountered are those concerning metropolitan transportation, bus and trains, high speed or otherwise. Indeed, the connectivity allows to conceive both services related to the vehicle as a platform and for the entity being transported (e.g., people, cattle, goods). The seamless, reliable and ubiquitous connectivity, either high or low bandwidth, represents a critical value driver in transportation. If people may experience better or new forms of entertainment, new opportunities of real-time monitoring and control appear equally important from a business perspective, directly enhancing supply chain visibility and overall efficiency.

Other important area of 5G application targeting transportation concerns airports spaces 5G enablement. While for the moment the focus seems to be on targeting consumers providing the ability to access high speed video streams, other applications may interest the cargo area of airports, for example robotic parking, check-in and boarding procedures, superfast speeds for surfing, and tracking mobility carts (e.g., in Gatwick airport in partnership with Vodafone. Wellington airport reports a key use case of 5G as fixed wireless access. Concerning airport logistics, air pallets localization on open storage area and traceability may experience a renewed interested leveraging similar solution developed for more traditional warehousing.

A scenario not directly addressed in 5G-ALLSTAR PoCs, examples of smart highways and roads (e.g., Finland, Germany autobahns by 2022, in Wuhan area in China) and ferries (e.g., Norway). For example, the 5G smart highway in Wuhan is meant to allow use of smart toll stations and collect real time traffic information.

Connected roads are then clearly related to the autonomous vehicle industry realizing V2x with 5G and instancing specifically V2V, V2I and Vehicle 2 Pedestrian eventually targeting their smartphones.

Interest in harbor areas for multi-modality is being experimented. Vehicles have been shown to be able to navigate obstacles to deliver containers to a loading vessel. Other test are taking place in Belfast harbor were 5G enabled AR-VR headsets provided to employees demonstrate the possibilities related to a smart and connected port.

The major benefit of 5G in transportation is reported for heavily congested areas experiencng heavy mobile traffic. The capacity to handle high density environment well beyond the 4 000 covered by current 4G, has been showed in the Hongqiao Railway Station of Shanghai, one of the busiest railway stations with 330,000 travelers each day.

Concerning transport business models, we observe specific opportunities concerning location related and vehicle related services.

5.2.1 On Location Services

Location services include 5G services available on particular public friendly locations like malls, university campuses, airports, metro, bus and train stations, highways and parking lots. For these locations, we identify streaming services and entertainment, high speed downloads and provide ubiquitous connectivity, thus mainly leveraging eMBB functionalities in the mmWave spectrum. We also identify the use of 5G as an alternative to Wi-Fi through both fixed and private Wireless Access Networks (WAN). Moreover, we identify the provision of location tracking services to facilitate parking and luggage management at airports. Similarly, for the case of smart toll stations on highways that facilitate traffic load management scenarios. These services are available in areas with heavy daily mobile traffic.

5.2.2 Vehicle Services

Vehicle Services include the provision of 5G network for vehicles that are manual or autonomous including trains, planes and metros. Here once again we identify the presence of eMBB in the mmWave spectrum for high-speed (4K HD) streaming and connectivity of travelers. We further note the availability of immersive experiences through extended reality AR/VR solutions where users partake in interactive movies and gaming sessions based on low latency yet high end graphics availability. These in vehicle extended reality scenarios also encompass virtual tours for tourists while they pass through various locations in an area.

Moreover, we identify the availability of V2X capabilities allowing announcements and marketing information to be pushed to travelers along with support for navigation and traffic management. These communications allow real time route hazard updates as well as emergency vehicles and traffic detection for autonomous transport.

Additionally, we identify the opportunity for specialized network slices supporting the essential connectivity for autonomous transport functioning, tracking and management. The provision of low cost/low complexity devices has received attention and pathway sensors (on road, rail tracks etc.) are able to communicate with vehicles to ensure safety, speed and reliability.

Finally, location-sensing services are available for obstacle detection for the navigation of autonomous vehicles.

5.3 The emerging business model in Public safety

5G-ALLSTAR PoCs provide a valuable insight in the essential value drivers for public safety supporting communication, situational awareness, surveillance, and network resilience and recovery. The demonstrated multi-connectivity with satellites, and by extension suggesting the opportunity of other non-terrestrial network and HAP, converge in supporting service and communication continuity and data rate value drivers. While these value drivers have been analyzed in isolation, the systemic effect of non-terrestrial networks supported multi-connectivity in the context of smart cities, opens to a massive set of use cases and related business opportunities.

In terms of public safety 5G is believed to fuel the development of smart cities, and at the same time be able to benefit from the availability of other connected sensor or devices enabling both a greater situational awareness, and control possibility. While not 5G based, the current use of the location capabilities of current smartphone, eventually enhanced by complementary sensors, has shown its potential to fight COVID-19, the most actual health emergency we are facing

worldwide. New, 5G based solutions are being rapidly developed by network and service providers in partnership to allow smart dispatching of patients, remote diagnostics, and patients monitoring. The emerging scenario try to consider the overall cycle from pre-incident and emergency response to treatment and recovery.

The analysis of current cases of 5G services for public safety coalescence around monitoring service and emergency services.

5.3.1 Monitoring services

We identify the use of extended reality (AR, VR, MR) for the improvement of video feed and live monitoring for smart cities. Scenarios and current test include the use of drones, smart city sensors and edge computing capabilities to provide greater visibility and situational awareness of crises scenes. Furthermore, data generated by location sensing technologies like wall penetrating radars may provide additional capabilities like the identification of trapped individuals within buildings, or to locate victims on wide impact areas (e.g., flood, earthquake, fire). Furthermore, the installation of low cost, low complexity devices like sensors improve surveillance and provide greater autonomy in identification of potential threats so that they can be neutralized ahead of time.

5.3.2 Emergency services

5G for public safety communication between the first responders on a scene this possibly corresponds with operation in spectrums that are more flexibly licensed like Land Mobile Radio networks used by first responders for rapid communication. Additionally, the presence of location sensing technologies allows identification of responding units and management of rescue operations. We further identify fixed wireless access provisioning to allow for location independence of mobile response units as well as use of 5G as wireless failover for primary network connected sites, a scenario of which 5G-ALLSTAR proves the feasibility. Finally, we identified specific efforts oriented toward the development of 5G Distributed Antenna System has the potential to reduce the cost per bit and improves the reliability, security and latency of the first responder network.

5.4 The emerging business model in rural area

The context of rural connectivity is particular interesting as analysts and experts seems to agree on the fact that successful businesses should first focus on the business opportunities offered by dense customers regions. Besides the overall limited coverage of mmWave, high-bandwith functionalities seems to imply that multiple services may not be available beyond densely populated regions. Within this context, it is essential to consider what new business opportunities allow the development of 5G connectivity in rural areas, which is a significant gap in the 5G application domain as of now.

In the context of rural connectivity, 5G will become valuable within the multi-connected network paradigm. This means that combining multiple networks like eMBB with non-terrestrial networks like satellites will allow rural connectivity to develop with greater ease and reliability. Throughput for key performance indicators (KPIs) such as peak data rate would thus be equivalent to a sum of the throughput of individual eMBB and satellite links. Latency in a multi-connected scenario would drop to become equivalent to the minimum latency of both links resulting from network optimization for delay sensitive traffic over low latency link. Service coverage would then include all areas under the eMBB and satellite coverage areas. Finally, combining both eMBB and satellite links would provide an extremely high performance and reliability for end users. Indeed, service continuity, data rate, and low latency communication are the demonstrated value drivers of 5G-ALLSTAR PoCs for this particular vertical.

Pervasive internet access is a particularly relevant aspect that is expected to finally bring an end to network “white zones.” Therefore, the best way forward within rural connectivity scenarios would be first through the provision of an effective ubiquitous connectivity despite, more realistically, depending on the features more economically interesting to provide.

While there is relatively less work being done for developing the rural 5G network connectivity compared to the other verticals, we discuss some upcoming evidence from industry. One of the bigger challenges being faced is that of high speed, low cost 5G connectivity in rural areas. Organizations are currently looking at ways to lower the total cost of ownership while deploying eMBB in rural areas. Research is underway on developing feasible business models within the rural areas considering key scenarios including:

- Industrial IoT for what concerns connected farms. These solutions typically use low cost, low complexity devices to improve management of farmland. This also includes smart location services that help in traffic management as well as asset management (where livestock is considered as assets).
- Broadcasting services that relate to operation in minimally licensed spectrum for information transmission.

6 Discussion and conclusion

We bring together our findings from the DELPHI interview technique as well as our literature review to identify four core dimensions (Figure 6.1) that would be relevant in understanding the development of new 5G business models.

Firstly, the most important aspect of 5G business models concerns the "What?" the value proposition 5G actors bring to their customers, the verticals in our case. The most important aspects of this value proposition would require them to consider the need to deliver complete solutions, bundles of product and services that end-to-end are capable to meet customer's requirements. Verticals will lack, in the majority of instances, the skills and understanding of the potential of 5G, and even less of satellite 5G, probably over-relying on the inflated expectations that characterize the early phases of diffusion of a new technology. Furthermore, considering that for the mass consumer market the 5G deployment will mainly provide higher bandwidth as core functionality, the focus on vertical business markets remains the most promising.

We identified 4 key value driver from 5G-ALLSTAR PoCs and enabled by the integrated multi-connectivity of cellular / terrestrial and satellite (or non-terrestrial) networks.

1. Service and communication continuity
2. Seamless, reliable and ubiquitous broadband services
3. Service continuity and data rate
4. Data rate, low latency communication

These demonstrated value drivers enable to extend the characteristics and functionalities of 5G typically associated to small areas availability, to larger zones, in mobility, and in case of absence of connectivity.

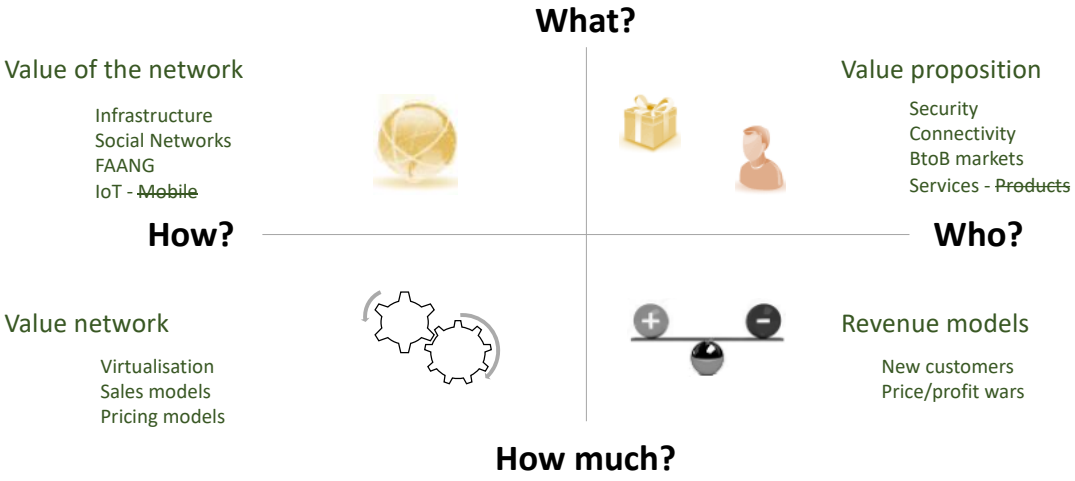

Figure 6.1 The emerging business models reconfiguration

Another important point to consider concern the security and the cyber security related at the development of the initiatives and the data hub that will be created at the edge of the network, in the cloud, or withing the network of the connectivity provider. While this aspect has received regulator's attention concerning individuals and their personal information, this aspect is increasingly sensitive and strategic for the business customer. Data security and ownership entails liabilities and responsibilities, in other words, risks. In recent years, the fear of the negative consequences of data breaches has raised to the attention of executive boards, becoming a priority in all CEO, CTO, or CIO agenda. Customers' trust in 5G stakeholder's capacity to operate in a secured context or environment has emerged from our analysis as a critical point for targeting vertical markets. This represent both an opportunity and a challenge for incumbents. With the evolution of the network and increased number of connected objects, cyber-attacks

are set to intensify. Network operators and service providers will be in the position to reassure/guarantee to customers a secure end-to-end network, eventually extending their offering to services related to security ranging from securing data on the network to securing customer data at the source, and eventually during the transfer to different entities. From a competitive point of view, will defendable position created through large capital investment will limit the possibility for new entrants to rapidly contest the market, incumbents may be challenged by new entrants that leveraging the commodization of the infrastructure may use their customer base or the fact that they act as gatekeepers of specific services (e.g., Facebook for social networks, Amazon for shopping, Netflix for video, Google for research, Spotify for music) to effectively control the network. In this respect, data and customer ownerships are the main strategic assets for value creation. The technology giant Amazon and the technological and space entrepreneur Elon Musk, have already showed interest in providing backhaul services for 5G in remote areas [42] through their LEO's constellation Amazon's Kuiper Systems and SpaceX Starlink. Both ventures have a track record of being capable to mobilize extreme capital investment to build scalable infrastructures that than they monetize through service. It's not far-fetched to see in their respective moves the intent to pioneer on one side, and directly offer end-to-end solutions on the other, to new and existing customers. Amazon in particular, appear well positioned when considering the synergy with its cloud infrastructure and massive customer access.

Next to 'What' would be the question of "Who?" to target as customers, this is a question about revenue models offered to customers. Indeed, the advent of 5G would bring forth the "new customers" in vertical markets. Whoever will be in a position to access and "control" the customer, would establish an upper hand. Additionally, if network operators will face difficulties in directly monetizing their offerings the resulting 'price or profit wars' may accelerate a scenario where connectivity becomes commoditized, a scenario that would favor new entrants or players positioned in parts of the value chain still providing greater value appropriation possibilities.

Following that is the question of "How?" which relates to the value of the network or alliances and partners outside the organization as well as internal resources and capabilities of an organization. A necessary requirement to compete in the 5G ecosystem consist in the orchestration of the partner network to deliver end-to-end solutions to customers and the development of the organizational skills necessary to integrate them and leverage new value adding technologies like chatbots, artificial intelligence, or in perspective quantum computing.

Finally, the question of "How much?" which refers to the value network employed with the service provider organization. This entails questions about "virtualization" of the network and various "sales" and "pricing models" leveraging network slicing in order to customize offerings based on the needs and data consumption rates rather than predefined packages. Additionally, the expected partnership will demand to develop appropriate revenue sharing models, that may require additional organization changes.

In summary, players in the 5G ecosystem will need to focus on four major axes, the first being the needs and expectations of verticals. The needs will mainly focus on the ubiquitous connectivity of both billions of objects and people, manifesting heterogenous requirements. For the moment, verticals are waiting for the deployment strategy of the network operators, but they are already collaborating with service providers, that may provide an alternative deployment based on private networks bring on the table a different value proposition. The services offered will then be linked to the deployment strategy. With for example specific services being offered by over the top (OTT) or specialized players. The observed proliferation of IoT platform is a signal in this sense.

The second axis concerns the evolution of activities and resources. The 5G network will support new functionalities and engender new competition requiring network operators and service providers to be more agile, more open, faster, more efficient in innovation. In turn, this will require changes in organizations and skills.

For example, an evolution in the way of working and in developing skills, with the ability to establish innovation platforms, open initiatives, or incubators. This change may require new

units, capable of real decision-making autonomy to improve market responsiveness, skill appropriation, and partnership development. Indeed, value will still lay into the ability of 5G players of appropriating of the value of the generated data.

The third axis concerns the evolution of partnerships and communication.

Being a stakeholder in the 5G economy means first of all working with others. We have observed that 5G will require new skills and new investments, but at the same time a network of partners capable to develop, offer and market end-to-end solutions.

Finally, the relationship with customers will change requiring a direct collaboration and access to verticals, so the channel, the link with the customer, will already be in place once the new service become ready.

The last axis concerns the new 5G business, new customers (verticals, OTT, etc.), with and for which develop new business models that require a use case approach. In other words, 5G will demand business models to reconfigure and evolve.

7 Conclusions

The present document reports the business assessment of 5G business models with a special focus on the value drivers emerged from the scenario analysis for the vertical markets mainly targeted by the 5G-ALLSTAR project.

The deliverable provides support to decision makers and verticals in appropriating of the value that 5G multi-connectivity enables. In the document we review the current state of the 5G market and discuss, the emerging trends and how they influence value proposition, value architecture and value network.

Then, it is discussed how the emerging business models are adapting to different market dynamics, customer needs, and partnerships.

Addressing vertical markets will require:

5. to understand and meet the needs and requirements in these new markets,
6. act on the internal resources and capabilities support the new business models,
7. develop and evolve partnerships and collaborations with verticals and in the 5G ecosystem,
8. reconfigure the business model to meet the new challenge.

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9 Annex A

Themes	Categories	Interview	In litera-ture	Managerial implication
Uses and users	Needs	Connectivity	Yes	Offer more and more
		Need low latency	Yes	
		Need ultra-high broadband	Yes	
		Expertise / Support	No	Accompanying customers
		Complex telecom solutions services	No	Upgrade existing systems
		Confidentiality	No	Protecting innovations
		Operator deployment strat-egy	Yes	Anticipate needs
	Products and services	Prototype-type product test	No	Sharing labs or equipment with start ups
		Sensors, Infrastructures	Yes	Offer a product that provides service
		Secure Network	No	Ensure secure network
		Data security	No	Offer cyber security services
		IoT-related services	Yes	Propose, innovate
		Offers application-depend-ent network quality	Yes	Valorize the network
Changes brought about by the arrival of 5G	New customers and busi-ness models	Little impact for the general public	Yes	Offer more speed, more coverage
		Verticals	Yes	Attacking new markets
		Operator becomes a digital service provider	Yes	Sell service
		Evolution of the sale of packaged models for oper-ators	Non	Understanding how to deal with not directly controlled network configurations
	Customer relations and communication	Discussing services with customers	Yes	Move toward packaged service in present-ing solutions
		Chatbots, robots for assis-tance	Yes	Interact with customers
		Geomarketing	No	Marketing study of the territory
		The IoT challenges the mo-bile	No	Marketing study customers, terminals

	Partners and organizations	Standardization of equipment and purchase of applications	No	Setting up partnerships
		Skill shortage	No	Develop partnerships
		Include partners in the reflections	No	Mastering your ecosystem
		Innovation platform, labs	Yes	Exploit the richness of the ecosystem
		Virtualization of equipment	Yes	Review organizational model
		New technologies	Yes	Develop skills
The conditions for success and the obstacles	The obstacles	Investments / ARPU	Yes	Controlling ROI and ARPU
		Fear of the waves	No	Proving the harmlessness of the waves
	Conditions for success	Being the first	Yes	Innovating and offering new services
		Deployment Strategy	No	Meet expectation and release accordingly
		Monetize new services	Yes	Grow revenue with new services and leverage data
		Services by business line	Yes	Develop revenues
		Application-linked network quality	Yes	Control monetization of uses

10 Methodology

To understand the importance of 5G network playes, we conducted a DELPHI study with the aim to explore 5G with the help of field experts. DELPHI techniques allow researchers to study and “integrate estimates of technological and market trajectories” [10]. These techniques allow for forecasts to be made in situations where data is lacking or incomplete and where human (expert) judgement is required [4, 11].

Two rounds of interviews were conducted from our panel of experts who were selected based on criteria such as relevant experience in field, expertise, knowledge of 5G and BMs and an insight of trends within 5G for B2B and consumer markets. Our first round of interviews included general, open ended, exploratory questions that were further improved upon within the second round based on responses received to the first set of questions [4]. This allowed us to understand 5G networks and frame our discussion around key dimensions of the business models in terms of balancing risks with promises while managing tensions and synergies [12] to provide a holistic overview of what we expect within the upcoming 5G business models in industry. For data analysis, we coded our interviews through Nvivo coding. These codes were re-assembled to develop concepts that led to the identification of the main themes of discussion elaborated within the findings.