Divide and conquer: a business model agenda for beyond-5G and 6G actors

Meroua Moussaoui, Emmanuel Bertin, Noel Crespi

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Meroua Moussaoui[1,2] Emmanuel Bertin[1,2] Noel Crespi[2]
[1] Orange Innovation, 14000 Caen, France
[2] SAMOVAR, Telecom SudParis, Institut Polytechnique de Paris, 91120 Palaiseau, France.
Emails: {meroua.moussaoui, emmanuel.bertin}@orange.com and noel.crespi@it-sudparis.eu

***Abstract*— Research has already shifted to identifying the requirements and use-cases for beyond-5G (B5G) and 6G networks. However, business models (BMs) should also be investigated to effectively address the opportunities promised by B5G/6G. Traditional telecom roles could either disappear or transform, while new ones will appear. In this paper, we focus on the telecommunications ecosystem to highlight the major BM changes introduced by 5G, derive perspectives for B5G/6G BMs, and propose business opportunities for the involved actors.**

***Index Terms*— business models, stakeholders, operators, telecommunications ecosystem, 5G, 6G.**

I. Introduction

A Business Model (BM) is a series of technical, financial and strategic designs that enable a company or an ecosystem (i.e., a business environment where several stakeholders coexist and interact) to cooperatively and/or competitively create, capture, and deliver value to customers through the conceptualization and monetization of their needs.

B5G/6G networks are aiming to fully realize the potential of virtualization and Cloud technologies, unlock new spectrum bands and leverage Artificial Intelligence (AI), to enhance sustainability while delivering more customized and automated services [1]. These concepts will completely reshape the telecom BMs and ecosystem. However, the telecommunications ecosystem is a complex system with many interdependent stakeholders, and is subject to many constraints and requirements (e.g., regulations and sustainability) [2]. In this paper, we offer our insight on this forthcoming ecosystem shift for the B5G/6G era.

Since 2020, numerous research papers and books have enriched the 6G literature. Co-authors' book [1] has discussed 6G use cases, technology actors, and standardization, but with limited insight on BMs. Stakeholder and BM evolution is, however, the emphasis of this paper, which provides a thorough extension to our previous work [3]. The present paper aims to answer the following research questions: What are the main changes that the ecosystem is progressively witnessing with 5G, with a specific focus on Mobile Network Operators (MNOs)? What are the prominent constraints and requirements framing these evolutions? What are the BM perspectives for B5G/6G?

The rest of the paper is organized as follows. First, we present a timeline of MNOs' and other key actors' evolution, and describe the emerging 5G/B5G roles and BMs. Second, we present the main telecom regulatory frameworks and discuss the growing requirement for sustainability. Lastly, we discuss business perspectives and opportunities for B5G/6G and conclude with a discussion of our findings.

II. The evolution of telecommunication Actors and Business Models

A. The evolution of Mobile Network Operators (MNOs)

MNOs play a central role in telecommunications. Their evolution in the United States (US) and Europe can be summarized into three technologically conditioned phases

The first phase, "*The rise of MNOs"* (90s-2000s). MNOs emerged in the 1990s as corporations that provided 2G wireless mobile voice and message services. At the end of the 90s, MNOs expanded further and metamorphosed (in Europe, from state-owned organizations to private corporations, becoming global market leaders). MNOs extended their portfolio to include internet access with the launch of 3G in 2001. They offered cross-border services covering a variety of facets: spectrum ownership, managing network operations, selling user devices, etc. [4].

The second phase, "*The decline of MNOs*" (the 4G decade, 2010-2020). MNOs continued to expand their network infrastructure as well as their offerings related to voice (e.g., IP Multimedia Subsystem "IMS") and messaging (e.g., Rich Communication Services "RCS"). However, digital platform companies, such as Google and WhatsApp, started offering a variety of digital services with free voice and messaging communications. This has pushed MNOs to provide more abundant phone and messaging plans in their mobile internet offerings. However, they were constrained by a smaller footprint (i.e., their subscribers) and lacked the technological and operational capabilities necessary for offering cutting-edge digital services. They eventually transformed into connectivity providers for these digital providers' customers. In Europe, more MNOs and Mobile Virtual Network Operators (MVNOs) emerged, increasing market competition, and driving down the cost of mobile services and mobile Internet access [4], while in the US, mergers and acquisitions consolidated MNOs' position.

The third phase, "*The rebirth or the fall of MNOs?*", started with the launch of 5G and will probably cover the decade 2020-2030. To hold their ground in this volatile market, MNOs should seize the opportunities offered by 5G/B5G and later by 6G, by seeking other types of value [5]. MNOs should adapt their architecture to accommodate the disruptive impact of 5G/B5G on telecommunications, aiming to enhance energy efficiency, coverage, and bandwidth while also enabling tailor-made networks. To reach these targets, they can monetize their long-term spectrum licenses, by sharing or leasing portions of their spectrum to other small-scale MNOs. They can also completely rethink their network through virtualization and decentralization, and invest in edge computing infrastructure, to deliver latency-sensitive services. MNOs can also seek new opportunities by acquiring

technological and management skills through collaboration and outsourcing, to provide value-added services for the Business-to-Business (B2B) market. Will MNOs succeed to "monetize" 5G/6G by creating profitable BMs in addition to best-effort connectivity [4]? To address this question, we need to consider the whole mobile network ecosystem.

B. Associated evolutions of the mobile networks ecosystem

Besides MNOs, conventional key roles in the telecommunications ecosystem:

- *Network Equipment Providers (NEPs)*, which provide telecom equipment ranging from radio and network equipment to end-devices (e.g., cellphones), as well as the software for operating them;
- *Content & Application Service Providers (CASPs)*, which develop and provide digital services and content; and
- *End-users*, who consume the services provided by CASPs/MNOs via MNOs' connectivity offers, using dedicated end-devices. They range from mass market users seeking merely connectivity to verticals with customized Quality of Service (QoS).

In the 2G/3G era, NEP dominated a significant portion of the market, by developing end-to-end hardware from end-devices to carrier networks, in addition to the embedded software necessary for their operation (e.g., Ericsson, Nokia). They provided solutions that often contained proprietary features, which resulted in a degraded interoperability between the different manufacturers, leading MNOs to collaborate with a small number of them for infrastructure construction and end-device retail. MNOs played a pivotal role in this era, by conducting end-to-end interoperability tests and shaping the standardization process among NEPs.

In the 4G era, this paradigm continued, however, CASPs gained more momentum (and revenue), while device providers (e.g., Apple, Samsung) progressively marginalized legacy NEPs on the smartphone segment. As MNOs were pushed by competition to reduce their costs, NEPs became more challenged on their costs, leading to massive mergers and acquisitions in the US and Europe (e.g., Lucent acquired by Alcatel, Alcatel-Lucent absorbed by Nokia) and to the rise of Chinese NEPs (e.g., Huawei, ZTE). To generate higher value, some NEPs started providing Network-Infrastructure-as-a-Service (NIaaS) to MNOs (esp. newcomers), which in turn led some of them to restrict their operations to spectrum license ownership and connectivity offers while coordinating outsourced resources for network operation [4].

New technologies and actors are progressively changing the game for the 5G/B5G era, leading to the transformation of existing players and the emergence of new ones.

C. Emerging stakeholders and BMs in the 5G/B5G era

Network function providers. The softwarization of network equipment and the widespread market availability of Cloud services has led NEPs to investigate new BMs, like offering Cloud-native network functions instead of physical equipment. They are also serving more enterprise customers (private 5G networks and Network-as-a-Service). NEPs are actively contributing to the development of standards and outlining the technological framework for B5G/6G.

Network infrastructure providers. In the 2G/3G era, network infrastructure was owned and operated by MNOs. With the introduction of 4G, infrastructure owners have progressively evolved into a gradient of players. Passive mobile infrastructure operators, known as "TowerCos", are specialized in installing, leasing, and selling tower infrastructures to operators and other companies to install their Radio Access Network (RAN) equipment. Currently, most MNOs are monetizing their towers to boost their revenue and fund the rollout of 5G/B5G. They are progressively selling their towers mainly on lease-back contracts to TowerCos. Some companies are also creating subsidiaries to manage this asset (e.g., "Totem", an Orange Telecom subsidiary holding more than 26k towers across France and Spain). Furthermore, several TowerCos extended their BMs to active radio assets (antennas and baseband units (BBUs)) by renting and selling fully operational RANs, morphing into "InfraCos". By further extending their assets to own spectrum, they may also deliver Network-as-a-Service, or collaborate with MNOs as "neutral hosts".

Edge and Cloud providers. They are expanding their BMs to platforming many parts of the MNOs' networks, providing services like Networks-as-a-Service and Platform-as-a-Service. This role is, today, mainly endorsed by hyperscalers (e.g., Amazon Web Services (AWS) with its private 5G offer). However, MNOs are also trying to keep a position at the edge: the GSMA initiative "Telco Edge Cloud" (TEC) is gathering operators and providers to create an interoperable and portable ecosystem for edge platform deployment.

Next-generation service providers. B5G/6G is expected to deliver "zero-touch networks" [6], that can automatically manage the heterogeneity of components on several levels while also accomplishing self-orchestration of resources, self-diagnosis, and self-healing. This could introduce new specialized actors, such as Network Automation Providers that would offer on-demand Cloud AI services that have been trained over vast amounts of MNOs' data. Moreover, the fine-grained specialization paradigm that the ecosystem is witnessing could result in the introduction of highly specialized service providers (e.g., Trust/Security Providers [7], Mobile Identity Providers, etc.).

Micro-operators (μOs) are an emerging category of network operators. They operate local 5G networks and offer customized services and fine-grained QoS, for a specific category of users in a geographically restricted region. They may also collaborate with MNOs, helping to extend coverage to rural zones and improve network capacity in congested areas.

Next-generation network providers. B5G/6G connectivity is expected to also occur (at least in part) via non-terrestrial means, mostly satellites. For instance, in late 2020, China started the first 6G satellite test in the world. This may result in the emergence of Non-Terrestrial Connectivity Providers as a new role. Moreover, the advent of Reconfigurable Intelligent Surfaces (RISs) [8] has the potential to introduce new radio-level players, that will own and operate RISs in certain locations. TowerCos can add this technology to their portfolio. This would open the connectivity market to businesses outside of the telecommunications sector to serve as local TowerCos, by installing and operating RISs on their buildings.

Figure 1 synthesizes the impact of the above-mentioned evolutions on the MNOs' layered model.

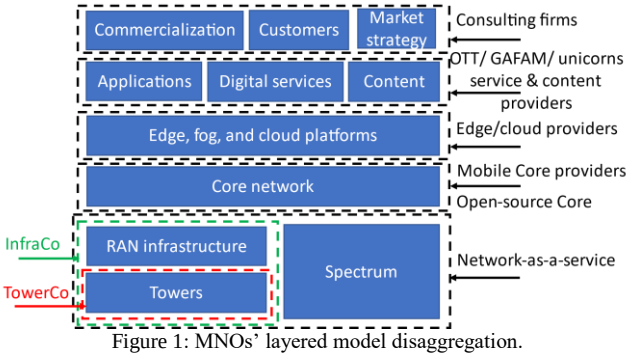

Figure 1: MNOs' layered model disaggregation.

III. Regulations and Policies' Evolution

Regulations and policies have a major effect on the evolution of the different BMs as they frame the interactions and activities within the ecosystem. They can be seen as a push factor that encourages businesses to relocate for a better value delivery. The telecom ecosystem is regulated at different levels: national, continental and international (e.g., International Telecommunication Union). Additionally, MNOs are subject to both telecom-specific policies (e.g., spectrum attribution) and general market policies (e.g., competition and antitrust). We focus here on the continental level, especially within the European Union (EU), China, and the US.

A. Spectrum regulation and Authorization

Once the spectrum is allocated (bidding/administrative procedures), incumbents can sublease their available spectrum resources to secondary users via "Spectrum markets". Unlicensed bands are also made accessible to the general public and are governed by guidelines that control their access and restrict interference. For instance, 5G New Radio, has been extended to unlicensed bands via NR-U (New Radio Unlicensed) [9].

In the US, the Federal Communications Commission (FCC) recently issued the Citizens Broadband Radio Service (CBRS) band for unlicensed spectrum access. In the EU, spectrum attribution is managed by member countries' National Regulatory Agencies (NRAs), but to remove regulatory barriers across the union, NRAs are subject to coordination and harmonization. The LSA technology was adopted by the EU for spectrum sharing between licensees and incumbents. Some NRAs (e.g., in Germany) recently attributed 5G spectrum to non-MNO actors, to develop industrial and private 5G/B5G. Moreover, in 2020, China allowed spectrum sharing between China Telecom, China Unicorn and China Broadcasting network for 5G indoor access.

In the forthcoming decade, spectrum policies are expected to evolve towards a wider offering of unlicensed spectrum, as well as to authorize the acquisition of spectrum by new players (non-MNOs). New spectrum bands will also be licensed for B5G/6G networks (e.g., Terahertz bands, TV White Space).

B. Net neutrality (NN)

NN states that MNOs should refrain from Internet traffic discrimination (e.g., by providing priority routing, better bandwidth or latency) [10]. This requirement differs according to the continental area [11], leading to different BM possibilities.

In the US, NN was considered as an FCC policy only between 2016-2017. In the EU, NRAs have been subject to NN since 2015, under the Open Internet Regulation. In China, NN is not considered as a policy.

For B5G/6G, NN will probably progressively vanish with the rise of connectivity customization.

C. Competition and anti-trust policies (CASPs)

These policies aim to prevent dominant players from abusing their position and to democratize market access to small players. At the world scale, the competitive environment of MNOs is today more open than that of CASPs that is dominated by a few Big Tech companies. This has urged governments to regulate platform activities more effectively, with for instance, the Platform Accountability and Consumer Transparency Act (PACT Act) in the US, the Digital Markets Act (DMA) in the EU, and the Antitrust Guidelines on Platform Economy in China.

In the forthcoming decade, the regulation of global platforms is expected to grow, while sectorial regulation targeting MNOs is expected to continue.

D. Privacy, data protection and AI regulation

The US, China, and the EU provide laws governing privacy and data protection, but they vary in the degree of the promised protection and in the rights granted to authorities for the use and manipulation of user data. Recently, AI has also been targeted by regulations to ensure its conformity to ethics.

For example, in the US, the National AI Initiative (NAII) ensures the reliability of AI for usage in governmental entities and public services, and its compliance to data privacy policies. In the EU, the General Data Protection Regulation (GDPR) contains a set of laws including the right to erasure and de-listing, privacy by design, and consent conditions. It is extended by the AI Act to regulate AI usage and mitigate its eventual risks. As for China, the Ethical Norms for New Generation Artificial Intelligence frames the usage of AI regarding personal information and ethical behavior.

These regulations are expected to expand in the coming years, which could impact the BMs of platforms exploiting users' data and AI.

E. Critical infrastructure protection

The telecommunications infrastructure is considered as a critical infrastructure that provides support and facilities to other critical infrastructures (e.g., civil safety, police, or hospitals) and therefore must be protected through specific rules that mainly address cybersecurity and physical infrastructure protection.

Concerning cybersecurity, the Cybersecurity Information Sharing Act (CISA) promotes collaboration between US governmental and non-governmental entities in cyberattack investigation, the EU Cybersecurity Act provides a unified cybersecurity policy for all NRAs, while the Cyber Security Law (CSL) aims to safeguard the Chinese cyber assets.

Moreover, the US, the EU and China have set specific frameworks to protect telecom infrastructures, promote their resiliency, and inhibit threats (e.g., the National Infrastructure

Protection Plan in the US, and the European Program for Critical Infrastructure Protection).

In a context of growing cyber and physical threats, these frameworks are expected to be strengthened in the forthcoming years, encouraging telecom players to maintain a high level of skills and processes, to monitor and circumvent attacks against their infrastructures. This aspect may discourage smaller actors from entering this market.

F. Sovreignity and geopolitical conflicts

Being considered as the digital backbone of any country, the telecommunications sector is thus a crucial sovereignty issue, sensitive to geopolitical tensions.

For example, in the US, the Cloud Act decrees that all information held on American digital platforms and Clouds, inside and outside the nation, is accessible to the US government for security investigations. This can go against the privacy regulations of the countries using or hosting these platforms, leading to regulatory disputes. For example, in 2020, the EU supreme court invalidated the EU privacy shield (aiming at protecting the privacy of EU-US data transfer and storage), due to EU-US laws incompatibility (the Cloud Act vs GPDR). In China, the Chinese Cybersecurity Law mandates that both domestic and foreign companies who keep information on the Chinese territory grant authorities access to that information.

In the forthcoming years, this push for continental sovereignty is expected to grow, likely leading to a more hermetic partition between the American and Chinese ecosystems, with the EU attempting to develop its own ecosystem on specific verticals (e.g., industrial Internet of Things).

G. Digital Innovation

Digital Innovation [12] is continually reshuffling the constructed norms and challenging the established regulations. While established businesses tend to conform to regulations, more aggressive ones may use regulatory gaps to sidestep the constraints placed on innovation.

Various continental areas are addressing this issue in slightly different ways. In the US, the Bureau of Economic and Business Affairs has established "Innovation Roundtables" to encourage business and technological innovation opportunities outside the US. In China, the government is shaping a working group gathering 37 universities, research institutes, and businesses dedicated to 6G research and innovation. Currently, China is leading 6G research in terms of patents (40,3% of the 20,000 surveyed patents are Chinese, survey by Nikkei Asia). In 2021, the EU Council approved the Single Basic Act's "Joint Undertaking on Smart Networks and Services", which seeks to expand European leadership over 5G technologies and 6G research and innovation. While the EU's digital market is highly regulated, innovation in the area is still slow, and the majority of the EU companies find it challenging to expand globally. Most digital platforms serving European users are provided by the US companies (e.g., Meta).

This highlights the necessity for regulation to increase its adaptability, flexibility, and responsiveness to maintain a framing function over the ecosystem.

IV. THE COMMON REQUIREMENT FOR SUSTAINABILITY

Many 6G working groups have defined sustainability as a principal requirement (e.g., Hexa-X), as have the United Nations Sustainable Development Goals (UN-SDG), making the creation of sustainable BMs a common prerequisite for telecommunications [13]. This represents a comprehensive vision that links durable economic growth to environmental and societal capital preservation, since economic development cannot persist if environmental and human resources are depleted, while societal and environmental development cannot be achieved without efficient economy. Sustainability can also be seen as a pull factor, that attracts companies to areas enforcing such policies, as well as with more environmentally aware customers.

A. Environmental viewpoint

The goal of environmental sustainability in telecommunications is to minimize its environmental footprint while improving its handprint. A viable direction would be to reduce the sector's energy consumption by developing energy-efficient BMs, such as leveraging resource sharing (e.g., RAN sharing between T-Mobile and Orange in Poland reduced energy consumption by 5.4% and CO2 emissions by 4.7% between 2019-2020), green energy harvesting, and renewable energy.

Equipment and devices are accounting for the greatest part of the sector's environmental impact (between 65%-92%, according to a 2022 study by the French telecom regulation body). These devices and equipment may be made from recyclable materials with sustainable designs (e.g., the EU's circular economy action plan 2020). Another option to minimize the number of wasted devices, is the creation of backward compatible technologies that can operate over older generation devices. Additionally, new BMs should be developed to allow the processing of toxic networking devices' components and e-waste recycling (e.g., the European Green Deal). The telecom sector can potentially develop BMs with environmental handprints (in Italy, 2016, MNOs collaborated to respond to an earthquake).

Regulation also plays an important role in enforcing sustainability by engaging businesses for more disclosure and transparency about their footprint and providing precise indicators to measure this (e.g., France has mandated that MNOs publish metrics related to their environmental strategies).

B. Societal viewpoint

Public acceptance is an important facet of societal sustainability and a constraint for the rollout of a technology. It requires conducting extensive research to ensure the safety of the technologies (e.g., electromagnetic fields (EMF)). Another facet is digital inclusion. It can be achieved by providing connectivity and services for isolated and underserved populations, as well as opening the market to small scale players. Such broader acceptance may unlock new business opportunities in developing countries (e.g., Orange raised €1bn with its "Orange sustainability bond" for financing digital inclusion, energy efficiency and circular economy).

C. Market and Economic viewpoints

Sustainability can challenge the marketing model of MNOs. The market competition between MNOs has been based for years on "abundance" (offering the greatest number of Gigabits, with the highest quality and the lowest price), leading customers to higher consumption (more bandwidth, more devices, etc.). Such a paradigm needs to be altered to ensure a more cautious use of resources. This could be achieved with a pay-as-you-use BM, or by giving the customers the freedom to customize their pre- and post-paid plans with personalized QoS and number of data units. This can help in curbing the "rebound effect", which means, a decrease in resource consumption is annihilated by a global increase of usage [1].

Sustainability may also increase revenue. For instance, investing in renewable energy harvesting and resource sharing will result in reducing operational expenses. In this matter, the telecom industry's challenge will be to sustain economic growth, while offering services encouraging a careful use of resources, keeping reasonable costs, and globally reducing their environmental footprint.

V. Discussion of BM perspectives for B5G/6G

A. Emerging 5G BMs that may shape B5G/6G ecosystems

In this section, we present new BM opportunities for actors to seize in the B5G/6G era, and that are challenging the current MNO BMs.

Small-scale networks. This concept was introduced in 5G, and represents a real opportunity for µOs to strengthen their position in the market by endorsing a "neutral host" BM and collaborating with MNOs to propose three main types of value: a) MNO small-cell network densification, especially with the use of higher bands for 6G (e.g., Terahertz) b) Supplying connectivity in congested MNO networks, and c) Expanding MNOs networks to rural areas (low-revenue areas). These goals can be achieved through subleasing MNOs licensed spectrum, micro-licensing and collaborating with TowerCos.

In this context, micro-licensing procedures need to be regulated, including aspects like the licensing period, transmission parameters, and pricing [14].

Resource sharing. As stated before, many factors (e.g., sustainability, regulation) are converging to incentivize MNOs to share their infrastructure, especially in non-dense areas. This is being done today through case-by-case agreements. However, we anticipate B5G/6G networks to be able to share any kind of infrastructure and network resource (e.g., spectrum, towers, RAN equipment, etc.), leveraging virtualization and Cloud technologies. A key BM is resource pooling which allows resource owners to contribute to a shared resource pool. Such sharing may constitute an alternative or a complement to the rise of major InfraCos, and can open the market to different actors allowing them to monetize their assets. This sharing model implies the emergence of marketplaces or consortiums to consolidate the shared pool and dynamically manage the availability of resources (e.g., sharing idle spectrum, subleasing unused network and infrastructure capabilities, etc.). However, this calls for harmonization between the different entities to prevent the over- or undervaluation of resources.

Since resource sharing primarily relies on resource brokering, the usage of Distributed Ledger Technologies (DLTs) is a promising way to avoid the costly and time-consuming interventions of brokers and intermediaries. The different interactions with the shared pool can be modeled as transactions inside a distributed ledger to allow ownership and usage history traceability. Moreover, DLTs enable novel payment models. For instance, a universal payment system based on digital tokens could support cross-border BMs.

Crowdsourcing. It is a more distributed form of resource sharing, that includes actors of different sizes and capitals. Individuals are incentivized to invest in network equipment and operate them (e.g., Helium/Nova Labs and Pollen Mobile in the US). These networks leverage DLTs to create globally distributed networks, by crowdsourcing the underlying RAN/edge infrastructure. Since 2022, Helium/Nova Labs has been progressively enabling 4G/5G roaming through an agreement with T-Mobile. These evolutions are expected to morph Helium into a new generation of MNOs that rely on blockchain for access control and billing, with a crowdsourced underlying infrastructure and opens the possibility of creating national distributed MNO BMs. However, it is still early to consider globalization perspectives, due to the regulatory framework that changes from one country/region to another (Helium today relies on the US CBRS spectrum for crowdsourced connectivity).

Private and vertical-specific networks. The concept of "verticals" was originally introduced in 5G, and will be further developed in B5G/6G to enable the efficient integration of telecommunication into the various vertical sectors. Vertical-specific networks range from local networks (e.g., for factories) to global networks (e.g., for worldwide supply-chains), all requiring fine-grained definition of network parameters and perfectly fitting QoS. These needs can be fulfilled by a "Private B5G/6G" BM, that exclusively serves a single costumer (e.g., an enterprise or a factory) with perfectly tailored networks. Many actors can provide this BM, such as: µOs, MNOs, NEPs, or even hyperscalers (e.g., AWS' private 5G).

MNOs can connect the different local private networks of a specific vertical company to create a global vertical-specific private network. Furthermore, MNOs can engage in roaming agreements with µOs' vertical customers, to ensure their seamless connectivity outside of their coverage zone. MNOs can sublease their spectrum to actors providing private networks, or even define specific spectrum bands for specific vertical sectors, following their requirements. Verticals represent a revenue-generating opportunity for MNOs to change their BMs from generic centralized and national-level activities to specific local or global multi-actor activities.

All these potential BM opportunities are depicted in Figure 3. By expanding their infrastructure and collaborating with different actors, MNOs can transition towards global and multi-actor models. They can also seize the opportunity to create global private networks, by connecting the different vertical-specific networks. In addition, they can participate in national-level crowdsourcing, and if the regulation allows, they may expand internationally.

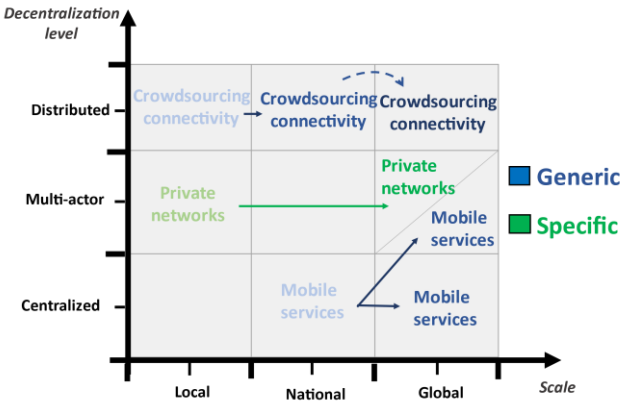

Figure 2. The potential evolutions of MNOs BMs.

B. Future directions for new B5G/6G BMs

In the 2G/3G and 4G eras, MNOs have been mainly operating according to the following practices:

- Over-dimensioning the network capacity (from radio to routing) to absorb traffic peaks (e.g., Dec 31st SMS).
- Commercializing connectivity through mobile plans (inc. a certain – sometimes illimited – number of calls, SMS and data), which are paid for, whether used or not.
- Deploying a general-purpose network without deep customization (one-size-fits-all), even for B2B customers.

The emerging market directions are challenging these practices, that used to be part of the MNO DNA, in several directions.

Platform-based. The Big Tech Players have promoted the concept of platformization (a BM where a company opens up its structure to third parties for collaborative value generation in "two or multi-sided markets" [15]), creating a platform-driven ecosystem and evolving to include end-users in service creation (e.g., Airbnb). How MNOs can transform into platforms, especially on the B2B market, appears to be a still under-explored direction.

Servitization. This concept has been widely used for Cloud computing services (e.g., PaaS), where the provider manages the infrastructure, hosting, and maintenance of these services, and offers them to consumers for virtual integration, under subscription-based pricing plans (e.g., pay-as-you-go).

On-demand. This concept means that service providers provision the resources for a given service only after its subscription by a customer. This process is enabled by the virtualization and softwarization of the previously physical resources. The services can be provisioned "on-demand" in a few seconds by configuring and activating the needed software resources. For instance, 6G is promising the delivery of on-demand services at the edge.

Tailored connectivity. To remain competitive, many players are trying to expand their revenue, from improved connectivity to highly customized services, leading to a B2B-driven BM shift from a "horizontal" paradigm, in which services are provided independently of their end-users, to a "vertical" paradigm, in which services are customized according to their final use-cases.

Openness. This concept seeks to democratize the market for entrants of all sizes. One example of this is Open RAN, which builds RAN as a set of disaggregated, softwarized and cross-vendor components linked via standardized interfaces.

Open source. The emergence of open source 5G RAN and Core Network solutions (e.g., Magma and Open Air Interface (OAI)) allows the establishment of specialized networks with high dependability, quick service delivery, and expanded coverage. They are interesting options for small and innovative players to set up private 5G networks; or for the Big Tech players and NEPs to construct fully virtualized networks (Ericsson is actively participating in OAI).

VI. Conclusive Remarks

The telecom ecosystem is being disaggregated into a complex system with many interactions and diverse players. Companies are increasingly moving towards a sharp specialization of value delivery, which takes us away from the "global dominant player" pattern seen in the 2G/3G period for MNOs. Players are also leveraging platformization to outsource parts of their BMs to other players, progressively becoming nodes in a web of interconnected BMs and thereby encouraging innovation and powering the rollout of new technologies.

This disruptive transformation is not expected to decrease in the B5G/6G era, as BMs will be even more fragmented, decentralized and highly customized. MNOs should target a solid place in the ecosystem, while continually adapting their BMs and strategies to the ever-changing telecom markets. MNOs are progressively *dividing* their organizational structure, disaggregating their BMs and monetizing their assets to *conquer* new markets and generate more value. This ongoing shift will result in the emergence of new BMs, keeping the ecosystem in flux and far from stability. Nonetheless, this merely means that we will see new entrants and maybe the comebacks of declining players.

Figure 4 sums up the most prominent evolutions of the ecosystem.

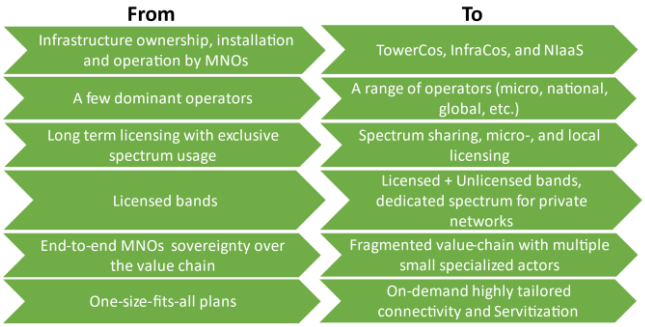

Figure 3. The evolutions of the telecommunications ecosystem.

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Meroua MOUSSAOUI is a Ph.D. student with Institut Polytechnique de Paris (Telecom SudParis) and Orange Innovation, working on blockchain and B5G/6G.

Emmanuel BERTIN (Senior Member, IEEE) is an Expert Community Leader with Orange and an Adjunct Professor with the Institut Mines-Telecom, France. He works on 5G/6G, blockchain, and service engineering.

Prof. Noel CRESPI is Professor and Program Director at Institut Polytechnique de Paris, Telecom SudParis, leading the Data Intelligence and Communication Engineering Lab.