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Business Models in 5G/6G Mobile Communications

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A process cannot be understood by stopping it. Understanding must move with the flow of the process, must join it and flow with it.

Frank Herbert, Dune

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The Importance of Business Models in Mobile Communications

Mobile networks have become the backbone for the digitalization of society, making mobile network operators (MNOs) one of the key players of the modern digitalized society (Li & Whalley, 2002). One of the modern tools for making sense of and communicating digitalization is the business model (Timmers, 1998), which explains how a business creates and captures value (Amit & Zott, 2001) as a *process*. For MNOs, the traditional business model has been to monetize mobile connectivity for consumer and corporate end users—bundled with dealership of digital content and/or equipment, also installed—and differentiated by the quality of service, coverage, or data rates/quotas, based on exclusive use of spectrum (Ahokangas et al., 2021a). The business models employed by MNOs to offer ubiquitous mobile connectivity radiate their impact on all current digital services. Without connectivity, no digital content could be sent or received. Without the abundance of content, digital context services such as search engines or combined data, user, and location information would be of low value; and commerce platforms would lack merchandise. Additionally, without connectivity, the value of artificial intelligence cannot be realized. However, the above-described primary business models of the mobile network operators will be disrupted by the fifth generation of mobile communications (5G) currently being introduced. One example of this disruption is the emergence of the local (or micro) operator concept that complements the

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traditional nation-wide MNO services through local and often private networks for tailored use (Matinmikko et al., 2017).

Adding to the enhanced mobile broadband of the present 5G technology, the increasing softwarization and cloudification of 5G networks will help in future to serve the varying needs of new types of users such as machines, autonomous vehicles, drones, robots, and communities in critical and massive machine-to-machine communications, also using shared spectrum. With a service-centric approach, 5G was originally defined through three technical usage scenarios: enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC), and massive machine-type communications (mMTC) (ITU-R, 2015). With higher frequencies and higher bandwidth, 5G means smaller cell sizes that enable local and private 5G networks for different verticals that have specific requirements (Ahokangas et al., 2021b), also indoors. Consequently, it has been argued that the whole MNO-centric ecosystem, its stakeholders, and the business models therein will change in future 5G (Matinmikko et al., 2018), giving the floor to a variety of new operator concepts.

Indeed, the term, 'telecommunications service provider,' as used for mobile network operators providing telecommunications services, is subject to specific regulatory rights and obligations (Matinmikko et al., 2017) that might not exist in all cases of local networks and may vary between countries. Consequently, in this chapter, we use the generic term *mobile operator* when discussing future business models. These disruptive changes call for exploring and understanding what 5G and later 6G will mean in the mobile communications business model context and what the implications are for the business model content, structure, and governance (Amit & Zott, 2001).

Strategy and Technology at the Core of the Business Model

The phenomenon of a business model has conceptually matured by drawing insights, among others, from the field of strategy and technology. Practically, technological development and the subsequent emergence of e-commerce in the mid-1990s brought the term business model into the vocabulary of managers and scholars. Back in the day, the term was actively used in electronic markets to describe and explain how value could be captured by buying and selling products and services over the electronic network. One of the first definitions of the business model concept developed in the technological field is the iconic definition by Timmers (1998, p. 4) who explains a business model as "*an architecture for the product, service and information flows including a description of the various business actors and their roles, the potential benefits for the various business actors, and the sources of revenues.*" Over the years, scholars have debated the definition of the business model concept and nowadays increasingly converge on the idea that value creation, delivery, and capture mechanisms constitute the backbone of the concept (Ritter & Lettl, 2018). Further, proliferation of the Internet and subsequent emergence of the new competitive market structures have created fertile ground for the formation of a magnitude of various value-related mechanisms.

To systematize the growing palette of the digital activities, Wirtz et al. (2010) developed the 4C typology of Internet business models. In the content business model, value creation, delivery, and capture mechanisms are organized to provide users access to various types of digital content. The commerce business model can be viewed as a predecessor of a platform business model, in which the main value proposition is to provide an exchange place for buyers and sellers. Context-oriented business models focus on aggregating information for the users to ensure seamless navigation and reduce the complexity and non-transparency of the digital environment. Connection-oriented business models, as the

name suggests, are aimed at providing physical or virtual network infrastructure. In this, connectivity enables stronger inter-firm collaboration and supports the development of digitally enabled ecosystems (Miehe et al., 2022).

The Concept of the Business Model

Theoretically, the concept of a business model is deeply rooted in the strategic management field and therefore, the evolution of the business model definition reflects the increasing importance of the strategic components of business models (Morris et al., 2005). Strategic management research enriched the business model discourse with the concepts of opportunity, value, and advantage, wherein a business model serves as a vehicle for a coherent implementation of strategy (Dahan et al., 2010). For instance, Morris et al., (2005, p. 727) define a business model as "*a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets.*" A strategy and technology orientation are fundamental in the business model research field and several attempts have been made to bridge the divide. Chesbrough and Rosenbloom (2002, p. 529) explain the concept of a business model as "*the heuristic logic that connects technical potential with the realization of economic value.*" The phenomenon of platformization and the emergence of platform business models have further integrated the strategic and technological roots of the business model concept (Nambisan et al., 2019).

Overall, the business model has become a contemporary paradigm for exploring and exploiting different business-related ideas and conceptualizations (Wirtz et al., 2016). Even in the absence of a commonly accepted definition, the extant literature depicts the business model as a boundary-spanning, multi-purpose, and futures-oriented vehicle for designing, doing, and making sense of digital business (Zott et al., 2011). For example, Massa et al. (2017) see business models as addressing how firms do business, how this is interpreted, or how a business model could

be represented through formal conceptualizations. However, regardless of the lack of a common definition, there are an abundance of business model templates and tools that can be used to describe and design business models. The business model scholars appear to be unanimous that the primary function of a business model is to explore and exploit a business opportunity. In turn, the opportunity sets the logic for the organization of the value-related processes. Together, the opportunity and value processes set the stage for formulating competitive advantage (Chesbrough, 2010; Zott & Amit, 2010). In turn, the sustainability of competitive advantage is contingent upon its replicability (Chaharbaghi & Lynch, 1999). Additionally, digitalization and proliferation of the ecosystemic approach in the business model literature have brought business model scalability into the discussion (Nielsen & Lund, 2018).

Regulation, Technology, and Business

The traditional way to look at businesses in mobile communications has been to explore the changes in the regulative and technological domains, both having a significant impact on business decisions, especially the business models employed by the operators (Ahokangas et al., 2013). Spectrum and competition regulations have played a pivotal role regarding the business models applied by operators, either allowing, delimiting, or protecting/safeguarding certain business models. Technology, in turn, has been the business model enabler and a driver for competitive edge and competition with new and improved services, while also 'pushing' the operators to innovate and diversify their offerings. However, up to the fourth generation of mobile communications (4G) networks, the primary business models applied by leading operators have remained surprisingly unchanged (Lehr et al., 2021), although they have been seriously challenged by the content-owning, cloud-based over-the-top (OTT) Internet giants. Being challenged by the OTTs, many operators' margins and revenue have started to deteriorate. As operators are struggling with whether and how to innovate their business models in practice, the question arises as to what kind of an approach would be

appropriate to understand future operators' business models in 5G and 6G and what these novel business models would look be. As new forms of operators are expected to emerge in future (Matinmikko et al., 2017), it is crucial to map the factors according to which the emergence of these operators and their respective business models could be outlined.

Internationalization of Business Models in Mobile Communications

Related to business models, an astonishingly little researched topic in mobile communications is the internationalization of mobile operators. The direction and extent of mobile operators are defined by national regulations and policies, in Europe also by the EU-level regulations, which have a direct impact on the business models used in the industry. Although being a global business, the mobile communications business is highly regulated at the national level. The internationalization of the industry started in developed countries with the liberalization of markets in the 1990s when traditional state monopolies were transformed into business entities. The period 1990–2010 could be characterized as the era of emergence and rise of MNOs and seen as a period of rapid internationalization of connectivity (Gooderham et al., 2022). During 2010–2020, the OTTs overran MNOs with their content-based business models. After 2020, Gooderham et al. (2022) envisioned MNOs to face marginalization unless they paid serious attention to their business models.

Dike and Rose (2017) carried out a systematic analysis of the internationalization of mobile telecommunications and summarized the key motivations for internationalization in the sector:

- Business-friendly regulatory regimes in potential host countries.
- Increased competitive pressure in home countries associated with decreasing domestic growth potential.
- Increasing subscriber acquisition costs; and shrinking average revenue per user (ARPU).
- Previous internationalization experience.

- Strategic factors related to scale and scope advantages of business.

In Europe, major MNOs such as Deutsche Telekom (Germany), Telefonica (Spain), Orange (France), and Vodafone (UK) are examples of highly international operators with a presence mostly through mergers and acquisitions in several European countries but also in Africa, South and North America, and Africa. Other MNOs such as Telia (Sweden) have also entered East European and former Soviet Union markets. Within Africa, the internationalization patterns of African operators have not followed traditional internationalization theory in terms of location choices (i.e., not prioritized neighboring countries) or country characteristics (i.e., selected countries with the highest growth potential; see Dike & Rose, 2019). African companies have also tended to adjust their strategies to local conditions rather than trying to leverage their firm-specific competencies (Jahanbakht et al., 2022).

For years, the Non-Terrestrial Network (NTN) satellite communication has remained standalone global technology, independent of national mobile terrestrial communication networking. Recently, the R&D interest in NTNs in academia and industry has increased (Rinaldi et al., 2020), and commercial solutions are emerging with worldwide deployments associated with internationally applied business models. With the next generation of satellites, initially based on 5G architecture, NTN will integrate with terrestrial networks with the main objective to provide ubiquitous global coverage to user devices for consumers and industries, particularly in unserved and underserved areas. The NTN component is envisioned to become essential within the 6G ecosystem to ensure service availability, continuity, ubiquity, and scalability.

An emerging new model for internationalization is currently taking place in the context of local and private networks. The real challenge for local networks is their international scalability and replicability as many of these networks require considerable tailoring and in-depth understanding of customers' needs. Therefore, integrators and cloud companies that are specializing in specific industries and their needs—and with the capabilities to plan, install, and maintain local networks—and that have an extensive international presence and local partnerships, are

building efficient replication-based internationalization strategies in this fast-growing new niche.

Building on earlier research, we see operators' business models accumulating value on platforms and ecosystems as enabled by technology and delimited by regulation. From a business model perspective, we consider the future mobile communications system as a dynamic connectivity platform converging with various (other) digital platforms, thus forming a platform ecosystem comprised of complementary business models that are not necessarily hierarchically controlled by any of the stakeholders of the emerging ecosystem. As superior business models can help successfully commercialize mediocre technologies (Chesbrough, 2010), technology can be considered as an antecedent to the business model. From these starting points, this chapter aims to contribute by analyzing current and future mobile operator business models.

Business Models for 5G Mobile Operators

In the mobile communications context, Al-Debei and Avison (2010) present a business framework comprising the dimensions of the value proposition, architecture, network, and finance. As one of the early works on this topic, the paper followed the traditional business model approach of the time. The classification of connectivity, content, context, and commerce business models (4C) made for the internet 2.0 business models (Wirtz et al., 2010) helps to characterize mobile communications businesses. Within mobile communications, the 4C typology of business models can be interpreted as nested layers, where the lower layer business models of connectivity and content are required as enablers and value levers for the higher layers of the business models, the context and commerce, to exist. Traditionally, MNOs have offered connectivity in a mass-produced mode, with price, data rates, quotas, or coverage as differentiation (Ahokangas et al., 2021a). Additionally, some operators have started to offer bundled content—such as entertainment—or equipment as a dealer. Personalized or tailored services such as context (i.e., location-based, service-specific, or data-based) or commerce (i.e., platform-enabled ubiquitous services) business models have often been

separated from the connectivity business. The only exception to tailored services have been big enough industrial customers with vertical-specific needs, and these have often been served in collaboration with network equipment vendors, network constructors, and service integrators. There also exist operators that specialize in servicing industrial customers and their IoT (internet-of-things) needs.

Mobile networks can be regarded as connectivity platforms or ecosystems, depending on the perspective. Technically a platform can be divided into a centralized core and geographically distributed access networks. The core network takes care of the services and billing, while the access networks—which can currently comprise several technology generations from 2G up to 5G—provide the radio access from a variety of user devices to the networks. With 5G, mobile platforms are increasingly becoming combined or converged with various digital platforms of cloud services and OTT internet service providers, while enabling platform ecosystems (Gawer & Cusumano, 2014) or the sharing economy (Ahokangas et al., 2021a). This relationship between business models builds on platforms, and several researchers have addressed the networked or ecosystemic nature of the business environment.

A Technology-Dominated View of Business Models

A review of earlier research on MNOs' business models reveals the fundamental technical starting points of the extant research (Yrjölä et al., 2022). A widely used business model approach within mobile communications is the 'as-a-service' logic (Ives & Learnmonth, 1984) that can be divided into scalable infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), software-as-a-service (SaaS), and data-as-a-service (DaaS) up to everything/anything-as-a-service (XaaS) models (Duan et al., 2015) with the extensive use of algorithms. In this technical line of research, Noll and Chowdhury (2011) introduced technology-enabled collaborative business models, while Rasheed et al. (2015) presented the brokerage business models, and Zhang et al. (2015) discussed a cloud-assisted model. Beyond technicalities, these all represent two primary

mobile operator business models, that of a *connectivity service provider* and its *differentiation toward content services*.

Rao and Prasad (2016) identified the mobile broadband (MBB) business model, the target expansion business model with a focus on other than consumer customers, and the outsourced managed services business model, where the network infrastructure providers offer the network as a service (NaaS). Rao and Prasad (2016) also identified the mobile virtual network operator (MVNO) business model, where a separate entity, often a mobile network operator's subsidiary, offers segmented services by using the infrastructure of a 'real' operator. Furthermore, they predicted the evolution of business models toward digital business models in the forms of various connectivity providers and partnership business models. Lindgren (2016) discussed persuasive business models by paying attention to their physical, digital, and virtual dimensions.

Camps-Aragó et al. (2019) examined MNOs' business models. They presented a classification to a micro-operator, the cloud-based XaaS/NaaS, the use case enabler for business-to-business customers, the ecosystem orchestrator, and the pervasive platforms business model. Kukliński et al (2018) discussed business models for network slicing, proposing technical role-based business models for infrastructure brokers, network slice brokers, and service brokers. Hmoud et al. (2020) discussed mobile network operator business models targeted for two-sided markets and presented big data-driven (i.e., based on crowdsourced data), advertising application (i.e., based on advertising platform), and mobile sensing (i.e., monitoring users' equipment for location or activity) based business models. Finally, Sacoto-Cabrera et al. (2020) analyzed the monopolistic and strategic business models of mobile network and mobile virtual network operators using game-theoretic modeling, concluding that both business models were economically sustainable.

The Strategic Approach to 5G Mobile Network Operator Business Models

Another stream of literature on business models has adopted a more strategy-oriented approach, classifying mobile network operators

(MNOs) based on their scale and scope and looking at their scalability, replicability, and sustainability. Matinmikko et al. (2017) proposed that local 5G micro-operators could run bundled connectivity (i.e., local connectivity), content (e.g., locally tailored services), context (e.g., secure local networks for vertical-specific needs), or commerce (e.g., 'my data' operator services) business models. Ahokangas et al. (2021a) identified two types of future mobile network operator BMs: the general bit-pipe and segmented specialized service business models, thus drawing a line between connectivity- and content-based BMs. In addition, the authors identified the wholesale service, retail service, context service, and vertical service business models for local operators. The resulting 5G mobile operator business models can be presented as follows:

- *The General Bit-Pipe MNO* business model is a future projection of today's dominant nation-wide MNO model with a large installed base who utilize a variety of mobile communication technologies from 2G to 5G, often complemented by Wi-Fi and IoT technologies to provide general mobile broadband connectivity to all in a mass-production bit-pipe mode. This business model can be used to offer public commercial networks or public commercial virtual network services.
- *The Segmented Specialized Service MNO* business model builds on offering mobile connectivity bundled with specialized content to selected segments nation-wide or regionally. These operators are the challengers to dominant MNOs and have a smaller installed base and attempt to compete where the general bit-pipe operators are less competitive serving the long tail of customers through higher value-added services. This business model can be used to offer services such as public commercial networks, public commercial virtual networks, neutral hosts, or private local networks.
- *The Wholesale Service Local Operator* business model builds on the opportunity to offer local hosted connectivity to MNOs' customers as a neutral host. This is an opportunity in public, but restricted places, such as campuses and hospitals where it is not feasible that all MNOs build their own network infrastructure but outsource it from a local operator. The local operator would then directly charge the MNOs, not the end users, for the service.

- *The Retail Service Local Operator* business model is based on offering local connectivity and complementary data services to end users in venues such as shopping malls, hotels, or sharing workplaces/offices independent of MNOs. This business model may serve MNOs to provide private local networks or public network integrated non-public networks.
- *The Vertical Service Local Operator* business model is about offering private local networks, i.e., connectivity, content, and context services for verticals like factories, campuses, and ports independent of MNOs. The users of the service could be either humans or machines.
- *The Context Service Local Operator* business model builds on offering personalized consumer services (via private local networks) or networks including connectivity and content and context data on-demand using, e.g., network slicing technology.

The above business model examples are indicative of a new kind of business ecosystem that is expected to emerge around 5G including not only the MNOs and their users, but also mobile network infrastructure vendors, facility owners and tenants, network infrastructure constructors, data and other content providers, and end user and other equipment manufacturers will be able to adopt new business roles. This ecosystem can be vertically, horizontally, or obliquely structured. In vertically structured ecosystems, value accumulates from the suppliers toward the demand-side customers, conceptually separating value creation, delivery, and capture. In horizontal structures, value is co-created and co-captured in stakeholder interaction in two-sided markets. Oblique ecosystem structures indicate the emergence of a multisided platform ecosystem, where value co-creation and co-capture can take place through multiple roles in the ecosystem with value spillovers to upstream and downstream players (Iivari et al., 2016). In the above categorization, the four first can be labeled as horizontal models, the fifth a vertical model, and the last one an oblique model.

A Strategy-Technology View

Up to now, most of the above-presented 5G-enabled business models call for future development and deployment. However, the discussion gives rise to a framework that depicts (Fig. 6.1) the business model discussions in the mobile communications context from the strategy and technology viewpoints. The strategy viewpoint comprises two perspectives: the traditional opportunity and value creation elements of business models, which highlight the role of novel advantages required for mobile communications businesses, and the traditional connectivity element that is complemented by the novel content, context, and commerce elements of mobile communications businesses. The technology viewpoint comprises the need to consider the scalability and replicability of business models, giving rise to the increased importance of sustainability aspects in future business models. The technology viewpoint emphasizes the increasing role of technology in supporting, fostering, and driving the scalability and replicability of business models. The greater scalability and replicability of the business models help to incorporate and further realize sustainability goals such as energy savings and decreased CO2 emissions/environmental pollution. In addition, the technology viewpoint considers the platform perspective that traditionally covers components and interfaces to also include data and algorithms (Yrjölä et al., 2021). Overall, it can be concluded that mobile communications business models are not easy to depict in simple terms. Making sense of the technology-oriented business model literature requires an understanding of the technological concepts—like cloud stacks and platforms or network slicing—used in the discussion.

Envisioned Future 6G Business Models

The modern 5G business model context can increasingly be characterized as a VUCA environment: volatile, uncertain, complex, and ambiguous (Bennett & Lemoine, 2014). This implies that to deal with the VUCA challenges, it has become increasingly crucial to deal with the dynamism of business models in their respective changing business environments.

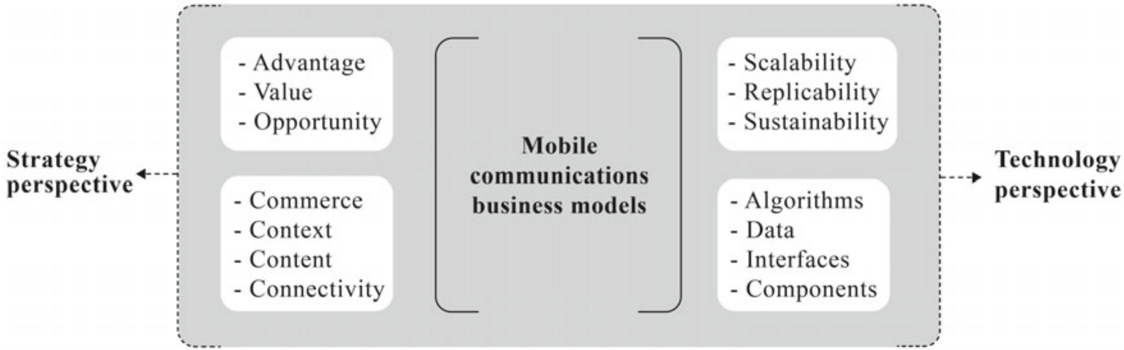

Fig. 6.1 A strategy-technology view on mobile communications business models

Business models always function in a context and therefore need to be calibrated to their respective business context (Teece, 2010). For future 6G, this means that business model innovation needs to be extended from the business model level to the ecosystem level (Snihur & Bocken, 2022), emphasizing sustainability. The first 6G white paper on 6G (Yrjölä et al., 2020) envisioned interactive business model configurations based on differing *needs and demands* of humans, machines, organizations, and communities and the various *assets, resources, and capabilities* residing in the ecosystem, thereby identifying *matching*, *bridging, brokering,* and *sharing*-based business models for the future 6G ecosystem(s). Generally, it can be considered that digitalization is driving toward converging multi-platform ecosystems, where business models may be reconfigurable, and firms may run several business models in parallel.

Business Model Innovation Toward 6G

The compound effects of various technology enablers, emerging regulatory delimitations, and integrated triple bottom line economic, environmental, and social sustainability on business models call for a discussion of business model innovation in 6G. Currently, 6G is still in the research phase. However, 6G has been envisioned as a general-purpose technology platform or infrastructure that necessitates ecosystemic innovation, as no single firm can alone develop it. Up to now, the telecommunications industry has followed the *define-standardize/implement-deploy/use* cycle of technology generation commercialization based on standard releases (Ahokangas et al., 2023a).

For business model innovation—especially related to finding scalable business opportunities—this implies new societal and environmental requirements, regulations, and stakeholders to be considered at each of the stages and releases of technology. For sustainable value creation, the diverging field of standardization and new integrated technologies with diverse development trajectories and competing implementations set increasing pressures for foresight-based strategies for technology deployment and use. Further, for replicating the technology-based competitive

advantages in different markets or customer segments, the ubiquitous mobility of 6G sets demands for novel kinds of collaboration.

Already today, regulation and sustainability go hand in hand influencing mobile operators' business models in two ways. First, policymakers are concerned about the energy efficiency of mobile networks. In times of increasing energy costs, the need to make 5G and 6G more energy efficient is an economic motivator for mobile operators to save costs, especially operating expenses (OPEX), but also to reduce CO2 emissions. Although the ICT industries have been so far excluded from CO2 compensation requirements, it could be considered that in future this may change. Further, there are increasing concerns regarding the electromagnetic fields (EMF) caused by mobile communications and the consumption of critical and rare raw materials, that indirectly and directly set demands and limitations on business model innovation. Additionally, the critical role of mobile communications sets demands on developing and maintaining the security and resilience of networks to ensure societal sustainability. Trustworthiness via security considerations needs to cover all the aspects of cybersecurity, including resilience against attacks, preservation of privacy, and ethical, safe application of automation to network operations and applications. For the same reason, regulations related to strategic autonomy and sovereignty have been introduced in many countries.

Envisioned Business Models in 6G

Research on 6G business models is yet scarce. The present literature mostly emphasizes 5G and beyond business models from a technology perspective (Yrjölä et al., 2022). Following the ITU-R use cases presented for 5G, one starting point for 6G comes from the European Hexa-X project that has identified five use case families for 6G: sustainable development for both environmental and social sustainability; massive digital twinning of physical reality; immersive telepresence in human-to-human communications; from robots to cobots (enabling collaborative robots); and local *trust zones* for trustworthy communications between humans

and machines (Hexa-X, 2021). Following the trends of converging platforms and the increasing importance of data and artificial intelligence-driven digitalization, four novel 6G use cases or service categories have been presented: connecting the unconnected, connecting intelligence, sensing for sustainability, and immersive communications (Ahokangas et al., 2023b).

The different versions of the future metaverse—consumer, enterprise, or industry—can be seen at the core of future 6G solutions. However, it can be expected that the metaverse will spread to all areas of human life. Thus, from technology, business, and regulation perspectives, the metaverse may emerge through different trajectories and be applied in various domains. From a technology perspective, the metaverse needs integrated 6G and AI as the basis for immersive communications. Barrera and Shaf (2023, p. 6) defined the metaverse as: "*the technology-mediated network of scalable and potentially interoperable extended reality environments merging the physical and virtual realities to provide experiences characterized by their level of immersiveness, environmental fidelity, and sociability*." The authors also list the key technological building blocks of the metaverse: networks, computing, 3D modeling, extended reality, the Internet of Things, blockchain, and artificial intelligence—which show the closeness and interdependence of 6G-based services and the metaverse discussions.

We envision the following 6G-enabled mobile operator business models:

- As an evolution of incumbent MNOs, the *6G MNO* business model will be building on end-to-end value chain controlled by the 6G MNO and supported by *specialized* firms tethered to the 6G MNO's connectivity-centered platform. This model will aim at monetizing interaction by 'matching' the needs or 'bridging' the customers via the connectivity platform. Automated network slicing will be used to offer differentiated service to segmented customer groups, private and public customers, and critical infrastructure providers. 6G MNOs are also expected to offer connectivity from a multi-technology platform that will consist of a selection of connectivity platforms that vary from low-earth-orbit, drone, and terrestrial 6G to hyper-local networks with a special focus on components and interfaces in the system. 6G MNOs

will be designed to serve the masses, whether humans or machines. Additionally, 6G MNOs are envisioned to support the human and enterprise metaverses by providing the basic connectivity for them. For traditional MNOs, the network neutrality principle may constrain value capture in providing the long-tailed distribution of differentiated future services. 6G MNOs will rely on their existing infrastructure assets on top of which 6G will be built.

- *The OTT operator* business model will build on content that the over-the-top (OTT) service provider wants the end user to connect to. Connectivity, acquired from other types of operators, will be bundled as free or subsidized with content to provide a 'full service' that enables combined customer attraction and locked-in-based value creation with a focus on maximizing demand to monetize content. Generally, OTT refers to digital service providers that bypass the traditional MNO's network to deliver audio, video, and other media over the Internet, utilizing the possibly revisited net-neutrality principles, affordably expanding their reach to the bottom four billion. In this model, the OTT operator as a *platform owner* builds on its' own cloud platform and content, leveraging connectivity from other types of operators, preferably from bit-pipe operators, tailored for their needs, and will be able to benefit from its large customer base in 'bridging' between customers or 'sharing' contents mode. Any content that the *complementors*' offer can flexibly be added to platform-owning OTTs' offering in this model. Data and algorithms will play a central role in the functioning of this business model. OTT operators will focus on human users and are envisioned to be the consumer or enterprise metaverse providers.
- *The edge operator* business model will build on the openness of ecosystems and modularized technology to provide tailored localized or zone-specific connectivity, content, computing (i.e., use the available hardware to process data), and context services, and in multiple locations or zones to scale the service. Edge operators can be seen as the future versions of vertical service local or context service local operators of 5G who can specialize in serving customers at the edge of data and connectivity platforms. The key to understanding edge operators is their context-specificity. Depending on the type of customers

and use cases they serve, they will develop specific sets of capabilities 'matching' customer needs and 'sharing' data or information between them while leveraging cloud infrastructure assets. Edge operators will drive the value chain in the edge application context and even create new revenue sources with hyper-local cloud infrastructure services with scalability, required availability, and almost unlimited flexibility. The diminishing value share of MNOs in edge cloud deals will trigger the number of private wireless deals of edge operators bypassing MNOs leveraging their infra-assets and creating a service layer to limit their value capture. Webscale born edge operators particularly are driving their successful transactional platform business model into new/adjacent domains where winning platforms cover innovation and transaction. The edge operators can be seen either as *complementors* or *disruptors*, depending on their role in the business ecosystems. The edge operators' business focus is on organizations and communities with either human or machine users. The edge operators may be expected to be the supporters of industrial metaverses.

- *The telco broker* business model offers connectivity or other resources or assets needed for mobile services. It can be seen to emerge from specialized data, artificial intelligence, and interface-control based services in the converging multi-platform ecosystem of future 6G. The telco brokers lean on the additionality of disruptors, complementors, and specialized service providers in the multi-platform ecosystem to match and bridge the differing needs and resources together by 'brokering.' The key to understanding the telco brokers' business model is the way they combine algorithms, ready-made components and existing resources, interfaces, and data residing in the multi-platform ecosystem for the needs of their customers. The telco brokers' business focus may take many forms and is primarily defined by the needs of organizations and communities. Telco brokers may serve any kind of metaverses as a service enabler.

The Pervasiveness of Platforms

The open questions of the 6G business models relate to what the assumptions and starting points are in 6G. Up to 5G, mobile network services have been defined and approached as top-down from networks toward the users, and most often from a technology-dominated point of view. However, with human-centricity that has been adopted as one of the starting points for future 6G, there might be a need and opportunity to define and approach 6G from the bottom up, from the user toward the network. This kind of conceptual and architectural disruption would require seeing the 6G network services as *focal to the user and user needs* rather than local or nation-wide—or representing a certain technology generation. This disruption would allow for a higher degree of business model innovation and variation in services within the ecosystem. Specifically, edge operators and telco brokers could benefit from this kind of approach as new value and spillover effects could be created in other than consumer-focused businesses.

Seen as platform-based, the 6G ecosystem may include new types of stakeholders, apart from the traditional MNOs and local operators, network constructors, system integrators, developer ecosystems, content owners and dealers, device, equipment, and technology vendors such as semiconductor technology vendors, operating system providers, application interface developers, or human–machine interface providers, cloud platforms and data centers and marketplaces prevalent already in 5G. These new types of stakeholders could include trust or security service providers, brokers of different resources like data, spectrum, or infrastructures, and digital twins, just to mention a few. It is also conceivable that the emerging human–machine interfaces may give rise to a new kind of service-centric and complementary service-flow business model:

- *The service-flow* business model integrates focally for the user, whether human or a machine—or a swarm of them—a set of on-demand services that the user needs ubiquitously regardless of location or connectivity provider. Future metaverses are examples of services requiring a service-flow business model in the background. The shift to cloud-based services has changed how enterprises purchase software

and its development. Application developers have more control than before over what is being purchased. Companies build their products to make it easy for developers to adapt and shift their expensive top-down go-to-market motion to bottom-up product-led growth, where customers can easily try out the product and expand usage over time. A decentralized platform will distribute value between the players while open-source software will lower market entry barriers, promote interoperability, and expedite development cycles based on shared knowledge. These service-flow business models may require enhanced privacy and security via integrated trust-services, specified network capabilities and resources, specialized human-machine interfaces that replace traditional devices or equipment, and advanced AI capabilities. The service-flow business model will disrupt the other envisioned 6G-enabled mobile operator business models by shifting the focus from platform and infrastructure-centric offerings to human-centric service demand.

Discussion and Conclusions

The same way as with 5G, modifying the approach by Teece et al. (2022), we may find three types of business model and business ecosystem configurations in the 6G context: 1) the *vertical* supply-side incumbent connectivity platforms represented by the 6G MNOs, 2) the *horizontal* demand-side adjacent and content platforms represented by the OTT operators, and 3) the *oblique* multisided and multilayered newborn commerce platforms represented by the edge operators and telco brokers. These three groups are depicted in Fig. 6.2.

Miehé et al. (2022) analyzed strategies in relation to how complementors used connectivity to join existing ecosystems and by looking at whether they attract or replace stakeholders with a deepened or broadened value proposition. First, the vertical supply-side incumbent connectivity platforms, exemplified by the 6G MNOs, build on connectivity and cloud technologies with specialized partners that are tightly tethered to the connectivity platform with a deepened value proposal and

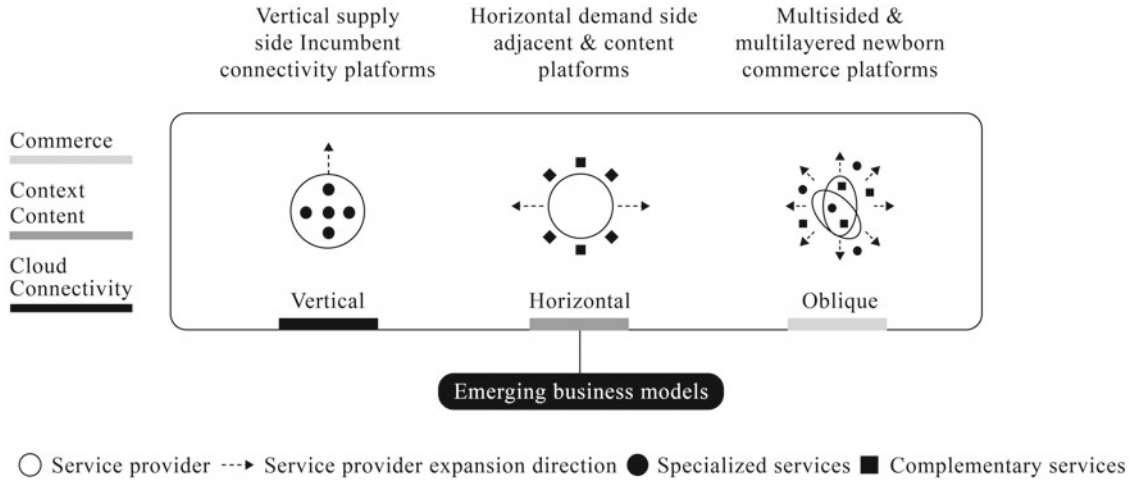

Fig. 6.2 Three types of business model and ecosystem configurations in 6G

with exploration strategy. Because it is connectivity-centric, this configuration aims to grow toward supporting content services or acting as a dealer of content such as media.

Second, the complementors of the horizontal demand-side adjacent and content platforms, exemplified by the OTT operators, broaden the value proposal of the configuration, with the aim to expand and exploit to new content areas, but also to new context businesses. The combination of content and context business models bundled with connectivity dealership creates a strong value proposition. In this configuration, the complementors are loosely coupled with the OTTs and may face fierce competition with other complementors.

Third, the oblique multisided and multilayered newborn commerce platforms, exemplified by both the edge operators and telco brokers, resemble the currently emerging division into service and tower companies in the telecommunications sector. Typical MNOs of today can be seen as focusing on services and may buy their network infrastructure from the 'tower' companies or infrastructure vendors that specialize in owning and managing the connectivity platform infrastructure and sell it as-a-service to the service operators. This configuration calls for a multitude of disruptions, but also complementary and specialized players, who may be in any area or combination of value creation with connectivity to cloud, content, context, or commerce business models. The service-flow business model is an example of the disruption of the whole mobile operator ecosystem, not only the new complementors' possible business models. Ecosystem stakeholders in this kind of configuration may have disruptive impacts on both up and downstream customer sectors as the traditional platform/infrastructure-centric ecosystem transitions via service-centricity to human-centric service flows. The vertical, horizontal, and oblique business models and their respective ecosystem structures coexist within the converging, multilayered multi-platform ecosystem of future 6G.

As a summary of the presented discussion, we may see the mobile communications business models as units of analysis to have developed *from technology-enabled and regulation-protected* national monopolies to *platform-based and regulation-delimited* international ecosystems. In parallel, we have witnessed the mobile communications

market becoming more collaborative, ecosystemic, and having novel stakeholders serving transient positions and roles within the evolving ecosystem. In future, we can also expect the role of artificial intelligence to play a central role in assisting mobile communications and its use cases. As indicated in the discussion on platform business models, there is indeed a tendency in the extant research to see technology as a business model. However, business models need to be understood as devices used for sense making and commercializing technology—also future technology.

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