Business Models for Local 5G Micro Operators

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***Abstract*—5G will change the mobile communication business ecosystem by introducing location specific high-quality wireless networks that can be operated by different stakeholders. This development will change the traditional business models and ecosystem roles, as well as open the market for new local mobile network operators. These operators, such as recently introduced micro operators, can target specific customers in different vertical sectors with closed 5G networks, serve mobile network operator's (MNO) customers in high-demand areas on behalf of the MNO as a neutral host with open 5G networks, or mix different types of customers and offerings through various hybrid platform business models. This paper discusses business model options for local 5G micro operators, addressing also the different network deployment options and ecosystem constellations. Three generic 5G business models and respective value ecosystems are presented: Vertical business model and ecosystem, Horizontal business model and ecosystem, and Oblique business model and ecosystem. These business models are compared against the opportunities they address, drivers and boundaries of value they may generate, and sources and sustainability of advantages they represent. Finally, scalability, adaptability and sustainability of the business models and ecosystems are examined.**

***Index Terms*—5G, micro operator, mobile network operator.**

I. Introduction

Today, 5G is considered to represent a disruptive technology for providing local context-specific connectivity and content services for various end users ranging from humans to machines. For this kind of highly localized and heterogeneous environments, the novel micro operator concept recently discussed in several papers [1] – [4], shows promise as a means for speeding up the adoption of the 5G technology, while at the same time boosting local businesses and ecosystems to new growth areas. The two most important drivers toward local and private networks in connection with 5G are operations in higher carrier frequencies and the virtualization and componentization of the network infrastructure. The local micro operator concept has been discussed in [2], [3] and [4] as an entity that combines connectivity with specific content services in spatially confined domains, being dependent on the availability of spectrum resources. However, appropriate business models are needed for micro operators to realize the innovation and growth potential embedded in this concept.

Future 5G business models have not been widely discussed in extant research. The existing few examples focus on traditional mobile network operator (MNO) business models and discuss 5G in rather general terms, mostly at the industry level. For example, authors in [5] introduced collaborative business models, [6] applied the brokerage business model to 5G businesses and [7] discussed a cloud-assisted business model. Beyond technicalities, all the three models mentioned can be seen to represent two basic mobile operator business models, "bit-pipe" and "differentiation" [8] [2]. These papers build on the assumption that MNOs are only to a limited degree interested in disrupting the dominant logic of their business, even if it would open new growth opportunities. It is also worth noting that the localized nature of the 5G services was not seen a key characteristic in these studies. Some literature can be found, however, to discuss the antecedents to business models, i.e., the success factors [9] and perspectives to be considered regarding 5G networks [10].

Four key business opportunities for locally confined micro operators have been presented in [4]: a) offering hosted local connectivity to all MNOs in specific locations, b) providing secure local networks for vertical-specific needs, c) providing locally tailored services and d) acting as a Mydata operator for various customers. The first of these seem appropriate in locations where it is neither feasible nor cost efficient that all MNOs would build their own infrastructure. The second could be a working solution in environments with highly specialized needs, such as factories. Local tailoring of services may be needed when providing premium or personalized content, such as VR/AR services, or relevant context-specific or locally generated data or information. A key element in this opportunity is to manage and tailor the local infrastructure. Finally, Mydata operators might govern application or user-specific data and provide connectivity services on top of data that forms the central element of the business opportunity.

The traditional MNO-centric way of delivering mobile/wireless services to end users locally is based on centralized infrastructure platform and control over the radio spectrum. Looking from the local perspective, especially in

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indoor environments and when using higher carrier frequencies, the new 5G ecosystem may include entirely new actors: facility owners, those who build and maintain the required infrastructures locally, and various content and equipment providers. This will open new roles for mobile operators, mobile network vendors and local micro operators of various kinds, as discussed in [3] – [4].

Building on what is said above, this paper aims at identifying and discussing what kind of generic business models can be identified for emerging local 5G micro operators enabled by technological development, and especially, from the mobile/wireless operations business perspective. The key research questions that this paper seeks to answer are as follows. 1) What could be the generic business models and ecosystem positions for micro operators to provide local services? and 2) How could the micro operators' business models differ from general MNO business models in local services?

The rest of the paper is organized as follows. First, 5G networks and new local operator approaches are introduced. Section III addresses the conceptual foundations of business models. Section IV presents the research methodology adopted and the developed business models for local 5G micro operators. New 5G value ecosystems for the developed business models are derived in Section V. Discussion is presented in Section VI, followed by conclusions and future directions in Section VII.

II. 5G Micro Operators

Upcoming 5G networks are expected to offer reliable wireless connectivity to serve the versatile needs of different vertical sectors, as well as to provide even higher quality mobile broadband connections. Different 5G enabled services will have many and partially conflicting requirements in terms of quality and reliability, which must be met with the new system architecture and deployment models.

Provisioning of a high-quality connectivity infrastructure in specific locations such as schools, transport hubs, public service providers' units and enterprises has become an important societal objective as an enabler for new applications and services, see [11]. The context driven and location specific needs for wireless connectivity in different facilities have received increasing attention. Drastically new services that cannot even be predicted today may emerge. Different business cases for the deployment of 5G networks will arise in specific high-demand locations, including e.g. being a neutral host that provides connectivity services to traditional MNOs' customers in specific sites instead of all MNOs deploying their indoor networks separately, as discussed in [12]. Additionally, there is a growing interest towards local closed 5G networks that can be deployed and operated by different stakeholders to serve their own restricted sets of customers, for example in a factory environment.

Development of 5G networks aims at meeting increasingly stringent requirements for higher capacity, higher data rate, lower latency, massive device density, and reduced capital and operational costs. Moreover, 5G networks are planned to be deployed in a wide range of frequency bands, such as 3.5 GHz and 26/28 GHz in addition to the existing bands for mobile communications mainly below 3 GHz, which all have different deployment related characteristics. From a technical viewpoint, 5G is expected to lead to [13]:

- a shift to ultra-dense small cell deployments,
- flexible network deployment and operation,
- multi-connectivity,
- security and privacy (data),
- dynamic traffic steering and resource management,
- intelligent use of network data,
- users participating in the storage,
- relaying,
- content delivery and computation within the network,
- coexistence of heterogeneous networks and local stand-alone 5G systems,
- the use of smart antennas to help in capacity and interference mitigation, and
- operations in higher (millimeter wave) frequencies.

On the network infrastructure side 5G is expected to take a leap from traditional network sharing between MNOs aimed at cost reductions, towards the on-demand multi-tenancy for hosting totally new services of specific customer segments. Network slicing functionality will be a critical new technical feature to enable multi-service and content-aware adaptation of the network to different applications, especially through dynamic creation of network slices on top of a common shared infrastructure [14]. Slices including both radio access networks and core network sides could span across the administrative domains of several stakeholders and be operated separately for the provisioning of services for specific customers.

Moreover, 5G developments have the potential to change the existing stakeholder roles and open up new roles in the future mobile communication business ecosystem. Several authors have proposed local high-quality 5G wireless networks to expand the traditional mobile broadband service offerings [4], [15] – [16]. In particular, the new micro operator role for locally deployed and operated small cell radio access networks is expected to emerge [1] – [4] to offer context-driven services and content with business models that will complement the known MNO offerings and business models.

III. Business Models

Business models have become a contemporary paradigm for designing, visualizing and communicating different business and service concepts and their implementations. This section has two parts. First, it introduces the business model as a concept and approach and second, discusses how to assess business models' growth potential.

A. The Business Model

Generally, business models help to answer the question what companies are offering to their customers in terms of products/services and value proposition, how and where they are planning to do that in practice, and why and how do they think they can do it profitably. A business model can be defined as a boundary-spanning unit of analysis [17] from the

conceptual perspective or, practically, as a vehicle to exploit a business opportunity [18]. In a simplistic sense we may claim that a business model is an explanation of how an organization or an ecosystem of organizations carry out their business(es). Business models connect abstract strategies to their implementation on a practical level, and all business models should meet three key requirements; they should be scalable, adaptable to new business contexts and sustainable. A business model is thus related to three fundamental strategic business processes; exploration and exploitation of opportunities, co-creation and co-capture of value, and exploration and exploitation of competitive advantages [18] – [21].

All business model definitions address either how firms do business, how the way firms do business is interpreted by the (ecosystem) stakeholders, or how a business model could be represented by the means of formal conceptualizations [22]. In due course, ecosystems and business models within ecosystems are emerging as a new scope of strategy research. The content of a business model is reflected in its subcomponents. Yet, there is no unanimity between scholars what are the most essential business model components. For instance, a business model framework can include the customer interface, core strategy, strategic resources, and value network [23]. Also, one can distinguish between the design of the business transaction's content, structure and governance in the business model [18]. Moreover, the technology, offering and network architecture can be considered the major constituent parts of a business model [24].

Noteworthy is that the traditional approach towards business model research focuses largely only on the supply side of value creation, not considering the demand side [22]. Authors in [25] suggest that when working together, business ecosystems allow companies to create such value that no single company could have created alone. Business model conceptualizations are often created at the company level only, thus being less suited for analyzing the interdependent nature of businesses in ecosystem contexts. An ecosystemic business model incorporates the ideas of open innovation, expanding the boundaries of a company toward collaboration and coopetition, i.e., parallel collaboration and competition. A business model wheel concept introduced in [26] has widely been used in ecosystemic and future-oriented contexts [27]. The authors see the business opportunity at the heart of a business model, a model that comprises what (customers, offering, value proposition, differentiation), how (selling and marketing, delivery, key operations, basis of advantage), why (basis of pricing, way of charging, cost drivers, cost elements) and where (internal or external to a focal firm) elements (Fig 1.).

Attempts made to look at ecosystemic business models can be found in software, web/e-business, cloud, Internet-of-things (IoT), platform business, and wireless communications contexts. The well-known cloud/IoT classification of "as-a-service" business models from infrastructure-as-a-service (IaaS) to platform-as-a-service (PaaS) and software-as-a-service (SaaS) is widely used in various ICT domains, too. A typology presented in [28] suggests four types of business models for the Internet age to make the business model analysis

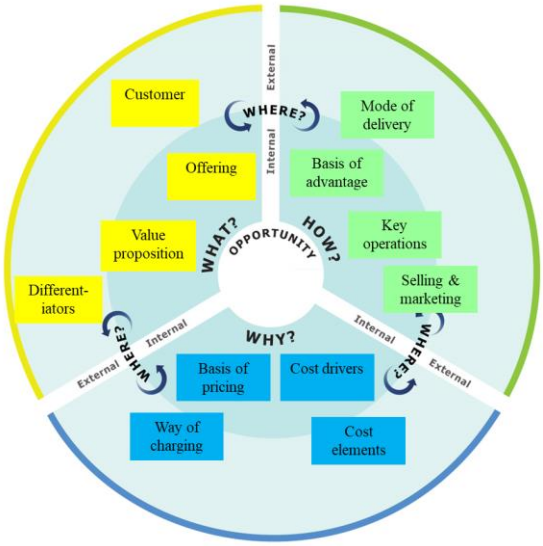

Fig. 1. The ecosystemic business model concept.

easier and more structured. Each of the four types of business models have varying value propositions and revenue models: connection (e.g., wireless), content (e.g., data), context (e.g., search or location), and commerce (platforms). From the ecosystem perspective, the typology can be interpreted as a set of nested layers, where lower layer business models are required as enablers and value levers for the higher layers to exist [29].

A transformation of business models as well as entire industries can be seen to have happened [30] from vertical or horizontal linear to two-sided and networked. It can be pointed out that in two-sided business models also users create value. Taking a step further, with the emergence of platforms, [31] claimed that business models have started to turn "oblique", i.e., having a focus on value sharing through value co-creation and co-capture, while the traditional control-oriented vertical business models have aimed at controlling value creation, and the horizontal business models controlling value capture. In other words, value sharing oriented ecosystems are emerging, focusing on co-creation of new services. In this co-creation, the key issue according to [32] is the openness of the business model. They see the openness of a business model starting from closed and extending toward open edge, open core and open source.

B. Assessing Business Models' Growth Potential

Business model assessment is one of the key elements of successful business creation. Traditionally, features such as novelty value to customers, potential for customer lock-in, synergy with complementarities, efficiency, potential for value appropriation (capture), adjustability and ability to mitigate risks [33] have been highlighted in the business model literature. In future 5G context with ecosystemic platforms, multisided markets, changing actor roles, both direct and indirect network externalities [34], and in markets dominated either by push or pull forces [35] depending on the situation, business models are exposed to more complex challenges. In these circumstances business models should be modular [36];

i.e., adopt a stance toward openness [31] interaction, structuring and governance [37].

Traditionally the key control point in mobile operator business has been control over spectrum and the network infrastructure. However, in local operations and services the control point could be the space, service, equipment, distribution channel, or customer in question. From practical point of view, several possible means to achieve the exploitation of growth potential and scalability has been presented for business models. These may include factors such as enriched value propositions, removed capacity constraints, regulation/standardization influenced, changed stakeholder ecosystem roles, platforms created, new channels found, new revenue models, shifted capital requirements to partners, and exploited network effects [38]. All these may relate to opportunities, value, advantages or scalability, adaptability and sustainability of the business models in question.

IV. The Developed 5G Business Models

This section presents the developed 5G micro operator business models using the data generated by a series of workshops. Three generic micro-operator business models were identified in the analysis. These models are labeled as Vertical, Horizontal, and Oblique, building on the classification presented in [31]. In addition to these business models, we will analyze the ecosystems behind the micro operator business models and end the analysis by comparing the business models by their respective opportunities addressed, key value processes and core advantages, and their scalability, adaptability and sustainability. In the following, we will briefly introduce our research methodology and present the three generic business models identified. In this paper we have not focused on traditional MNO roles or business, as these are discussed for example in [5] – [8] and [27].

A. Research Methodology

In this research, we apply the anticipatory action learning (AAL) methodology for exploring complex and uncertain future businesses. The AAL method attempts to facilitate learning in a social system [39] through a democratic and collaborative visioning process that connects inquiry, anticipation and learning with action, assessment and decision-making [40]-[41]. The method aims to make multiple levels of understanding merge openly and progressively during the process. AAL emphasizes the pluralistic reciprocal adjustment of research and reflects the exploration of alternative futures [42]. Both action research and action learning underline the necessity of experimenting, reflecting and learning form the exercises [43] which all are best reached through collaborative workshops where participation of various stakeholders becomes possible. This kind of participatory approach is useful for futures-oriented workshops to design innovative ideas by utilizing conceptual models, such as the business model wheel. The selected approach provides insights into alternative and plausible micro operator business models and ecosystem descriptions. The selected method enabled us to trigger business model innovation in the AAL-based workshops and laid a foundation for the creation of the respective business ecosystems.

The business model creation process that was utilized involved a series of facilitated face-to-face and online workshops that comprised representatives from major stakeholder groups identified within the micro operator ecosystem; researchers, MNOs, possible micro operators, network infrastructure vendors, and network infrastructure constructors. The business model design processes were facilitated by the researchers by using the business model wheel as the conceptual model and practical tool. Cross-model reviews and comparisons by the workshop participants were used to deepen and clarify the designed business models and the ecosystem descriptions created based on the business models. The systematical evaluation and comparison of the business models was based on the dimensions presented in the theory section: the opportunity, value and advantage dimensions and the bases for scalability, adaptability and sustainability. All data and the presented arguments in the paper is based on workshop discussions.

B. The Vertical Business Model

When following the generic Vertical business model depicted in Fig. 2, the micro operator addresses the opportunity to provide tailored end-to-end services in restricted areas. Typical customers in the Vertical model include industry automation verticals that may be segmented based e.g. on production type or industry, local utilities such as companies focusing on smart grid management, or local facilities from infrastructures to operational arenas such as mining areas. The Vertical business model builds on long-tail projects; each project is different, but scalability can be found by focusing on similarities across use cases. In other words, opportunities for creating a solutions business emerge from tailored offerings that bear similarities. Machine-to-machine communications needed in IoT-enabled local industrial services is a good example of a use case in this model. Security and privacy, reliability and the management of local data may constitute important elements of such services, accompanied with smart means to analyze and ma.ke use of the transmitted and gathered data.

What comes to the network life cycle and its management, running the Vertical business model may comprise network planning, deployment, operation and maintenance, and it differentiates in competition with its fast time-to-air and plug-and-play features.

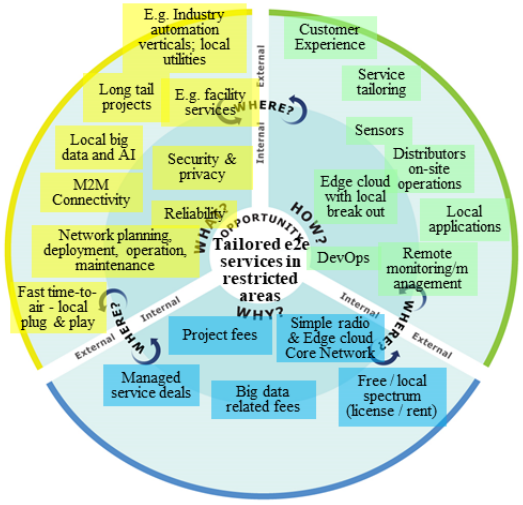

Fig. 2. The generic Vertical business model.

Sales in the Vertical business model is based on direct business-to-business selling, and delivery on the continuous DevOps/tailoring logic, where services are being flexibly developed or changed based on local customer needs to maintain customer experience and provisioned from the edge cloud with a local break-out. Typical services supported locally by the micro operator may include remote monitoring and management of operations or equipment and sensors, local applications run at the mobile edge, and various third-party operations ongoing in the facility/area of operation.

Charging of customers in the Vertical business model may be done to some degree through project fees, to cover the costs of building or taking in use the tailored network. However, pricing of the operation of the network may then be agreed through managed service deals. Additionally, it can also be based on the data sold to the stakeholders present in the facility/area of operation. Capital and operational expenses are tried to be minimized by using simple radios, the edge cloud, and the core network at the edge of the cloud. Local free or rented spectrum is utilized in communications. In other words, the cost of local connectivity is kept very low.

We identify four possible ecosystem stakeholders that could act as the micro operator with the Vertical business model: a factory or utility owner, an important factory machine vendor or a utility equipment provider, an MNO, a network constructor, or such a public network provider as a city. Should an MNO be the micro operator, we face an interesting spectrum-related question: would the local (possibly low cost) or MNO's own exclusive spectrum be used, when providing the service.

C. *The Horizontal Business Model*

The Horizontal micro operator business model, Fig. 3, builds on very different grounds compared to the Vertical business model, namely the opportunity to provide local hosted connectivity for MNOs. In various public and restricted local places, it might not be feasible that different MNOs would build their own networks. In such cases, e.g. at campuses, hospitals or shopping malls, it might be the case that a micro operator hosts MNOs' services locally to their customers and charges the MNOs for the service. The services hosted locally could comprise MNOs' standard services to their customers, but also bring MNOs additional capacity to them, ensure service continuity in an MNO's network, or provide improved network availability. Mass event organizers illustrate well such needs.

The selling logic for the micro operator in this case is direct business-to-business sales toward MNOs – typically in a white label format, where only the MNO's service brand would be visible to end users. We expect that MNOs' motivation to buy the service from a micro operator is the guaranteed end-user experience. The micro operator could possibly provide the infrastructure as-a-service offering to the MNO, and take care of the design, implementation, maintenance, and the removal of the network, should the need be a temporary one. Pricing could be based on capital and operational expenses of the service, managed through certain service level agreements and charged from the MNOs' utilizing the service. Spectrum could come from the MNOs served or be provided as a local low-cost/shared spectrum.

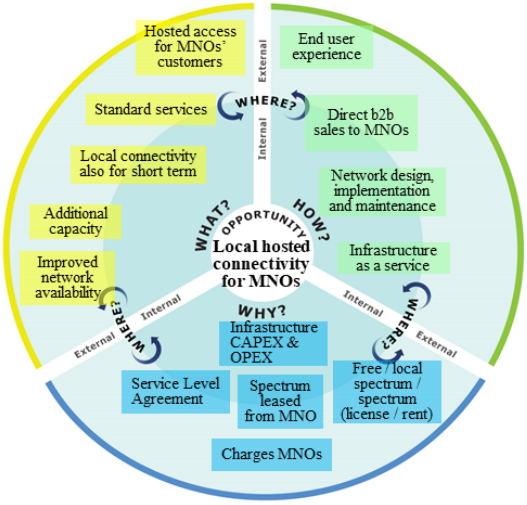

Fig. 3. The generic Horizontal business model.

Again, we identify several potential stakeholders that could adopt the micro operator role: a network constructor, a facility owner, such a completely new actor as a capable third party, a cable or other operator or a joint venture established by a group of MNOs. Finally, various mass event organizers or site managers, and even construction companies might provide ad-hoc or other shorter-term 5G network operator services with the Horizontal business model.

D. *The Oblique Business Model*

The Oblique micro operator business model, Fig. 4, is based on an opportunity to provide mass-tailored end-to-end services to various segments. If in the Vertical business model scalability is based on similarities among use cases, in the Oblique model it is based on a platform that supports mass-tailoring. However, in this model, also, the micro operator

offers connectivity with guaranteed security and privacy, local data and optimized quality of service. The platform should also support fast time-to-air and plug-and-play implementation across segments. Because the platform approach supports higher scalability compared to the Vertical model, with less need to take into consideration of the local specificities regarding e.g. the stakeholders present, MNOs and network infrastructure vendors could play the micro operator role locally. Both are capable of providing edge clouds with a local break-out, run cloud native services and provide automated management and orchestration of local services.

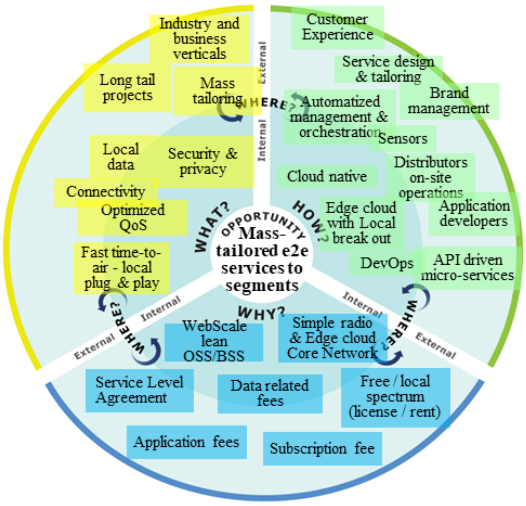

Fig. 4. The generic Oblique business model.

What makes a difference and provides for transparency in the Oblique business model, compared to the Vertical model, are the micro operator's capabilities to build application programming driven micro services, and support application developers' activities and various on-site operations managed by third parties, i.e. to bring in customers' customers. The micro operator's brand creation and management is important in this. Webscale and lean operations support systems and business support systems (OSS/BSS), as well as simple radios with the edge cloud and the core network from the cloud could be utilized, bringing cost efficiency but providing also the possibility to monetize on data, application services and software. Finally, local spectrum could be utilized locally, through licensing or renting.

V. New 5G Value Ecosystems

Business models need always to be calibrated to the respective business environment. A part of this environment consists of the surrounding ecosystem. The next step in the analysis involved mapping the ecosystem around the three designed business models for local micro operators.

The Vertical ecosystem is depicted in Fig. 5 (read the figure from bottom to top). It is characterized by the stakeholders' attempt to control value creation, delivery and capture. The local micro operator may try to exercise control by combining its local operator activities closely with application/content providers', end user equipment manufacturers', and network infrastructure constructors' activities through a project logic that may be extended with a long-term service contract.

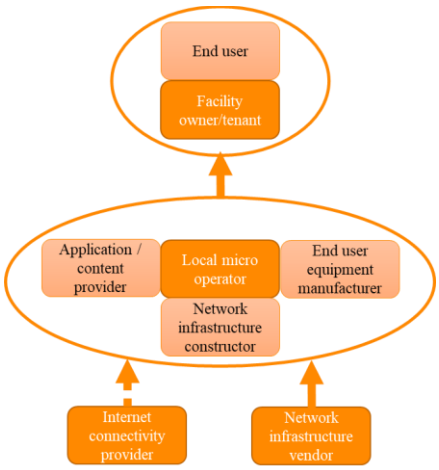

Fig. 5. The Vertical ecosystem.

Network infrastructure vendors and Internet connectivity providers can be utilized in a supplier mode, and the key customers are the facility (e.g., factory) owner under which the end users, whether machine or human, use the service. In the Vertical ecosystem, the local micro operator role can be adopted by any stakeholder that possess advantages in the project that the facility owner needs, or in longer term in processing the data required in the facilities. For example, the IT department of the factory could adopt the micro operator role.

The Horizontal ecosystem is depicted in Fig. 6 (read the figure from left to right) and is very straightforward. The dominant player is the MNO, whose services the local micro operator delivers locally to the operator's customers. It may be stated that this ecosystem represents the logic with which mobile operators may extend their services to localized domains. The facility owner may collaborate closely with or even subsidy the local operator, but the network infrastructure vendor may collaborate even more closely with the local micro operator, as it can even adopt the local operator's role. Additionally, in this case the facility owner could be the micro operator.

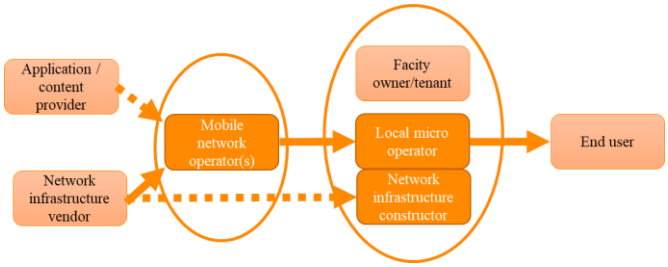

Fig. 6. The Horizontal ecosystem.

The Oblique ecosystem depicted in Fig. 7 (reading the figure can be started form anywhere) is the most complicated of the business ecosystem structures. To begin with, the network infrastructure constructor may help the local micro operator to build a platform that can be used to deliver services locally. At

the same time, the local operator may closely collaborate with the application and content providers, whose services may be run on its infrastructure. From this platform the local micro operator may target several types of end-user or prosumer customer segments, while also selling their service to facility owners and third-party application and content providers that serve the end customers. It is noteworthy that the customer relationship between the local micro operator and the end user/prosumer segments may well be bidirectional, the same way as the relationship between the latter and third-party application and content providers. In this ecosystem, the mobile infrastructure vendors' role may increase due to core network slices that they could offer. Furthermore, management and orchestration of the virtualized network is required.

In the Oblique ecosystem, any stakeholder willing to invest in designing, building, or maintaining local 5G infrastructures and services may adopt the local micro operator role. This provides an opportunity for genuinely new players, such as a cloud service provider, to enter the market.

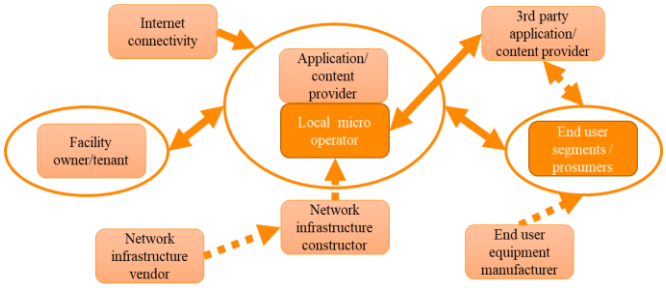

Fig. 7. The Oblique ecosystem.

VI. Discussion

To examine the designed business models and the respective ecosystem structures, we pay attention to the opportunities they address, the drivers and boundaries of value generation they represent, and the sources and sustainability of advantages they have. After that we discuss the scalability, adaptability and sustainability of the business models in their ecosystem setting.

The key driver for any business model is the opportunity addressed. When compared across the three cases analyzed, the nature of the opportunity varies from customer specific, variable and changing needs in the Vertical case as in providing tailored service packages, including also context-specific content over a reliable closed network for factories, via a generic but segmented need to allow consumers to continue enjoying existing MNOs' services beyond normal coverage in the Horizontal case cost efficiently, finally to an opportunity to utilize mass tailoring when offering premium or personalized content or other specialized application- or user-specific data locally to various segments in the Oblique case. Along with the change in the opportunity, also the type of the customer and the way how the local service is realized changes. A similar transformation may be observed regarding the way how value is created and delivered across the three cases – i.e., from projects to outsourcing and mass tailoring – and what kind of advantages are needed in providing local services – i.e., from technical competences to an existing customer base and a platform. Table 1 provides an overview of the key business model related discussions presented.

The presented ecosystem architectures indicate the logic and direction of potential scalability, adaptability, and sustainability in the respective business models. The Vertical business model does not indicate any substantial scalability potential over various customer cases but may open for existing project companies a potential to extend and upgrade their current offering, provided they possess the capability to adapt to various customer needs and that the customers' needs base is big enough to retain sustainability. Factors such as size of the vertical (number of customers), similarities across use cases served, availability and quality of data transmitted, volume of local projects, possibility to share assets and potential for long-term contracts may limit scalability. As the Vertical business model follows the single or point product/service provider approach, scalability comes through generalization towards a solution provider, but possibly with neither explicit own and branded platform nor supply-side partner networks and systematic sharing of business assets among the micro operator's customer portfolio. Turn-key solutions may, however, provide for quite high-level profits, and earning may also be tied to subsequent use of the developed solutions. Upgrading and maintenance contracts could offer longer-term business opportunities and strengthen the micro operator's position in a particular vertical market. The sources of advantages needed for Vertical business model is customer intimacy, and the sustainability of the advantage rests on various local activities developed over the customer relationship life-cycle.

The Horizontal business model's scalability potential rests on the competition among existing mobile operators and their subsequent need to increase cost-efficiency in revenue generation. A micro operator could be in a position to utilize MNOs' network operation synergies and willingness to cooperate and share assets, but at the same time, all micro operators running the Horizontal model are highly dependent on the MNOs they serve. In competitive environments the scalability potential of local micro operators increases, providing an opportunity for micro operators to build their own services and infrastructure (IaaS) solution on-demand. This may open new opportunities also to network constructors and mobile infrastructure vendors. Local micro operators do not need high adaptability regarding end customer services, but competences to design, build and manage local services in an efficient way become crucial.

In the Horizontal model scalability is limited by the number of customer MNOs and their need to guarantee service continuity or improve service availability. The higher the number of locations and the number of end-users in these locations served by the micro operator, the bigger the opportunity. Also, there might be additional revenue potential

TABLE I
OVERVIEW OF THE VERTICAL, HORIZONTAL AND OBLIQUE BUSINESS MODELS

	The Vertical business model	The Horizontal business model	The Oblique business model
Opportunity	**Key opportunity:** To provide tailored service packages for highly specialized case-specific needs in restricted areas such as a factory. **Ways of serving the opportunity:** By providing reliable connectivity, higher quality of service (QoS) combined with specialized content/context services through a local closed network.	**Key opportunity:** To provide local hosted connectivity for MNOs in a feasible and cost-efficient way. **Ways of serving the opportunity:** By providing services to MNOs customers in locations where it is not feasible for MNOs to build own networks.	**Key opportunity:** To provide mass tailoring of service across various locations to connect demand and supply of selected segments. **Ways of serving the opportunity:** By providing premium or personalized content or other specialized services across locations by enabling context specific, locally generated, application or user-specific data.
Value	**Driver for scalability:** Scalability based on micro-operator's capability to understand customer specific vertical needs and fulfill the needs case-by-case. **Boundaries of scalability:** Size of vertical cases served (number of customer cases, similarity of use cases served, degree of similarity across cases served). Availability and quality of data transmitted. Volume of local project and network operations, possibility to share assets. Possibility for long-term contracts to guarantee revenues.	**Driver for scalability:** Scalability based on MNOs' network operation synergies and willingness to cooperate and share assets. **Boundaries of scalability:** Number of customer MNOs to be served. MNOs' need to guarantee service continuity or improved availability. Number of locations controlled or owned. Number of users in served locations. Location owners' benefit. Possibility to provide on-demand multi-tenancy. Interoperability between local and national networks.	**Driver for scalability:** Scalability based on the volume of unmet local service needs. Utilization of a platform that enables mass-tailoring for selected segments. **Boundaries of scalability:** Availability, management and tailoring of local infrastructures. Possibility to provide data access to third parties. Availability and volume of third-party services. Possibility for dynamic creation of network slices. Possibility for plug-and-play / fast time-to-air e.g., through micro service APIs.
Advantage	**Sources of advantage:** Customer intimacy and capability to serve specialized needs combined with local control over the network. **Sustainability of advantage:** Based on security, privacy, management, analysis and utilization of local data. Services provided over network's life-cycle, continuous tailoring as a means to maintain/renew advantage. Low connectivity cost with a turn-key solution together with local partners.	**Sources of advantage:** Ability to provide end-user experience locally through a standardized Infrastructure-as-a-Service (IaaS) solution. **Sustainability of advantage:** More options and flexibility for MNOs. Local mobile network availability on-demand. High dependence on MNOs.	**Sources of advantage:** Platform that connects demand and supply in a segment to provide specialized services. **Sustainability of advantage:** Development of the micro operators own brand. Utilization of webscale and lean OSS/BSS. Depends on platform flexibility and competitiveness.

coming from the owner of the location/facility, especially if interoperability across national and local networks are needed.

The Horizontal business model rests ultimately on quite a straightforward supplementary offering to bigger MNOs in the same market and can be seen as a professional supplier or service provider business. The situation might be competitive among several MNOs or even towards a single MNO interested in investing to serve specific verticals, such as growing niche segments, or expanding its offerings through differentiation in its existing customer base. Compared to the MNOs', the local micro operator has not the power of directing the services of the end users in its possession but may still have special capabilities to bring them to the reach of the MNOs.

The scalability of the Oblique business model rests in the local micro operator's platform that enables mass tailoring better than those of the existing MNOs, especially when serving such specific needs as ones related to security, or the ability to run customer-specific local applications. Thus, the volume of unmet local needs become crucial as the platform connects supply and demand of services. To succeed, local micro operators need to combine platform flexibility with high adaptability to the local needs. This business model is limited by the availability, management and tailoring potential of local network infrastructures in plug-and-play manner, but it also may open up possibilities to provide data access to third parties and their services through micro-service APIs.

The sustainability of the Oblique model may depend on the type and extent of local services requiring the 5G infrastructure.

For example, VR/AR and high capacity AI based services may provide opportunities for genuinely new actors to start as local micro operators. An example of such could be an IT webscale company that utilizes network function virtualization and aims at reaching control over the network at its edges, thereby turning it from a telco market to an IT-centric market.

The Oblique business model is obviously the most interesting one among the three and has the promise to include the best characteristics of the other two models. It is neither a plain local infrastructure-as-a-service for branded MNOs nor the heavily tailoring based and only gradually scalable business for many verticals. Instead, it represents a more elaborated platform approach, where the upstream supply side is opened to partners, but the downstream customer side kept in own hands. We have witnessed the general developments in digitalization, which are also supported by standardization and platformization via open interfaces, exactly to this direction. However, micro operators utilizing the Oblique model need to develop their own brand. Whether the results will lead to "unfair" competition that "kills good existing businesses", or to a more effective use of under-utilized resources, remains to be seen.

Our analysis indicates, that the Vertical and the Horizontal models could in principle utilize also 4G technology, whereas the Oblique model requires 5G technologies to exist and it has the highest novelty value of the models. Customer lock-in and complementary offerings appears most effectively safeguarded in the vertical model, whereas dependency on MNOs is the biggest risk in the Horizontal model. However, all models presented enable increased efficiency of operation, although that efficiency may stem from a different source, as discussed. Platform thinking and modularity can be seen as central elements for all discussed micro operator business models, but especially important it is for the Oblique model as opens up the possibility to create a real multi-sided market.

Regarding micro operators, the shift from the traditional MNOs' control points, spectrum and infrastructure, to location specific control points such as enriched value proposition in terms of extended coverage as in the case of the Horizontal model and premium or personalized services as in the case of the Oblique model, exemplify future development. In addition, it appears evident that in local services the ecosystem roles are in transition, which in turn, may lead to shifted capital requirements among the partners in the ecosystem. Who owns or leases infrastructure or spectrum for local services in the future is indeed a good question.

VII. Conclusions

In this paper, we have explored alternative generic business models and the respective ecosystem constellations for local 5G micro operators including Vertical, Horizontal, and Oblique business models. We have proposed a framework for approaching and examining ecosystemic business models and applied the approach through the anticipatory action learning methodology. The designed alternative business models for locally deployed 5G networks differ from the traditional MNOs' business models and are based on different business opportunities and value propositions. In addition, the life cycle focus of 5G networks – plan, build, operate – is different in the models. New ecosystem roles were identified, roles that might be adopted by several alternative but also completely new stakeholders. Also, the cost drivers and elements, as well as pricing and charging vary remarkably among the business models. In sum, they represent very different types of businesses, as opposed to the presently dominant and rather homogeneous traditional MNO businesses.

It might not be exaggerated to claim that 5G will represent disruptive changes and create new growth opportunities in network operation businesses especially at the local level. Albeit, provided that the remaining regulatory challenges of local spectrum availability can be solved. Because 5G is still emerging as a technology, the actual development of business opportunities, business models and respective ecosystem alternatives remain to be seen. Especially, it is yet difficult to foresee which business model or what kind of market will start growing first and fastest, and if there will be some dominant stakeholders or a plethora of versatile micro operators around.

We acknowledge that regulation or spectrum allocations do not necessarily support the developments outlined in this paper everywhere yet. However, we have built our arguments on the assumption that necessary spectrum can be made available for local 5G networks. Indeed, further research is needed to validate and evaluate the business models and ecosystems presented in this paper also from spectrum perspective, identify the key capabilities needed for running each of the models, examine and compare in detail the value creation logic of each model, and consider regulatory barriers and enablers for each model in their ecosystemic contexts.

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