Novel Context and Platform Driven Business Models via 5G Networks

Seppo Yrjölä
Nokia
Oulu, Finland
seppo.yrjola@nokia.com

Petri Ahokangas, Marja Matinmikko-Blue
University of Oulu
Oulu, Finland
firstname.lastname@oulu.fi

***Abstract*—Despite the advancement of technologies and novel use cases that are labeled as belonging to the next generation of mobile communications known as 5G, the future of 5G business models remains unclear. In this paper, we explore how the evolution of future 5G business could unfold. We construct a framework for analyzing 5G business models by combining resource configuration and 4C - commerce, context, content and connection - business model typology framework views, and offer an overview of 5G business model evolution. Specific attention is paid to four themes: resources, value creation, value capture, and the role of platforms. This paper tackles today's unprecedented challenges of enabling and stimulating multiple cross industry stakeholders to have a more active participation in the 5G market. The results derived from the data collected from an expert workshop identify two transformations in the development of future 5G business: from connectivity towards context and from value chain integration towards platform orchestration. The developed resource configuration framework provides a dynamic framework for analyzing and developing the 5G enabled novel use cases and business models.**

***Index Terms*— Action research, business model, resource configuration, 5G.**

I. Introduction

New 5th generation (5G) wireless network technologies are foreseen to transform industries through wireless services provided at gigabit speeds, milli-second latency, support of wide range of novel applications connecting devices and objects, and versatility by virtualization enabling innovative business models across multiple sectors [1] and [2]. Present connectivity market is characterized by incumbent mobile network operators (MNO) whose business model is to offer services to the masses with high upfront infrastructure investments and long-term exclusive licenses granted by the regulators [3]. While growing amount of mobile traffic originates from local indoor usage and dedicated digital era use cases, serving the high-traffic, high-value hot spots with traditional cellular networks will become insufficient. Today's model where operators build their separate countrywide networks becomes deficient to support development of various verticals and services and to respond to use case specific, versatile and advanced performance requirements especially in terms of latency, resilience, coverage, and data rates. Furthermore, local service demand is expected to grow to enable the digitalization of different verticals in constrained locations such as campuses, factories, hospitals, sports arenas, and shopping malls [4].

From architecture perspective, 5G will become a part of heterogeneous networks (HetNet) to allow distributed and flexible allocation of network functions to connect billions of devices to the Internet [2]. 5G with new high frequency bands [5] combined with software defined networks and virtualization to provide end-to-end network slices [6] can unbundle investments in spectrum, infrastructure and services, and will open the mobile broadband business ecosystem towards new application and service providers. Vertical industries need optimized wireless edge networks where both the connectivity and the cloud services must meet specific industrial requirements which is enabled by edge computing [7]. Furthermore, 5G networks are expected to disrupt the mobile communications business ecosystem by full-scale introduction of as-a-service (aaS) platform and sharing economy approach [8] that allows new entrants to the market by sharing of required resources with technical advances.

The literature regarding 5G related business models is still at its early stages. For example, authors in [9] discuss network densification by providing open access to small cells with cloud assisted business model.

Collaborative business model in the context of HetNet infrastructure sharing is studied in [10]. In [11] collaboration models are further developed through incentive and reputation business model to support cooperative network architecture and revenue generation as well as new cooperative or innovative services enabled by brokerage. Resource provider, connectivity provider, and service provider business models supporting various levels of collaboration and customer segments are discussed in [12]. Authors in [3], focus on sharing models between an incumbent MNO and a novel challenger MNOs, and present simple rules for the utilization of the sharing based business opportunities. Commonality between these business scenarios is the

possibility to share resources, enable software defined virtualized capabilities, service orientation logic providing anything-as-a-service (XaaS), support self-configuration of the network, and service integration with the provision of combined service offerings.

Building on the above discussion, a practical challenge in 5G business transformation is to discover how the different change drivers in technology and use cases interact, are related to each other, and how the future of 5G business models unfold, as paced based on identified drivers. Thus, the research question of this paper is as follows: *How could the evolution of future 5G business models unfold?* Regardless of the focus on business aspects adopted for the paper, we acknowledge and embrace the influence of regulatory and technological developments.

The rest of the paper is organized as follows. In Section II the research methods, materials and theoretical analysis framework are reviewed. Section III presents an analysis of the results and their implications to build a framework for analyzing 5G business. Finally, conclusions are drawn in Section IV.

II. METHODS

This section reviews the research methods, materials and theoretical foundation for the purpose of this paper.

A. Action Research and Anticipatory Action Learning

In this paper, the business model that centers on value creation processes [13] act as a boundary spanning unit of analysis, and qualitative research strategies and methods were applied. The use cases of the 5G and related business model elements analyzed in this study were created using the anticipatory action learning (AAL) approach that is a particular action research (AR) method conducted in a future-oriented mode [14]. AR is an iterative, participatory and collaborative method developed to address the management of change and to develop foresight utilizing cross-disciplinary knowledge, involving practitioners and researchers, and which impacts participants and organizations beyond the research project [15].

The data presented in this paper is based on the future-oriented *World Cafe* workshop held at Nokia RadioActive! user group event in Espoo in November 2017. World Café is a structured conversational, AAL process intended to facilitate open and intimate discussion, and link ideas within a larger group to access the collective intelligence represented by the participants [16]. The participants representing business and technology management of the 32 MNOs worldwide were divided into 10 heterogeneous groups that moved between a series of roundtables where they continued discussion moderated by the organizers in response to a set of questions. The five groups were focusing on 5G opportunities that have potentially significant techno-economic impact on mobile industry: *technology innovations on architecture, telco cloud, artificial intelligence (AI), use cases, and business models*. The ideas presented by the participants were written down on post-it notes and placed on the whiteboards. Also, numerous connections were drawn between the items written or drawn on the whiteboard. The objective was that each subsequent group would build on the results of the previous group and themes. The World Café ended with a wrap-up summary of each of the tables so that the participants got also an opportunity to provide responses on their collective results. Participants were encouraged to create new, shared knowledge through a set of questions with specific focus on the timeframe of next three to five years. The moderated questions were: *What are the major emerging architecture and technology triggers that can have significant techno-economic impact on the 5G industry? What are the business drivers for Telco cloud? What are the 5G business opportunities and use cases that will generate most revenue? How to capture the value? – How and why do business models change due to 5G?*

After the workshop, all the systematically documented raw data, as well as outputs in forms of use cases and business opportunities were analyzed, using the theoretical framework of the widely appreciated futures research methodology, the causal layered analysis (CLA) [17]. The integral futures four-quadrant method within the business model framework was applied for deepening the foresight, and to ensure the quality of the research [14]. In this method, the futures were backcasted against the past and present experience and knowledge of the participants through discussing alternatives and transforming the futures to identify elements in technologies, use cases and business model that will connect the future to the present.

B. Business Model

Business model has been traditionally researched as a system of inter-dependent components such as resources and competences, organizations [18], customer value proposition [19], and cost and revenue [20]. Recently, a converging conceptualization, incorporating key processes for business models that connect them to the context, opportunity processes, value processes and advantage processes [21] and [22], has emerged. In parallel, business model analysis discussion has focused on the design of successful business models. Viability [13], sustainability [23], scalability [24] and profitable growth [25] are essential to business model success.

1) 4C Business Model Typology

Wirtz [26] developed coherent 4C business model typology to help managers in business transformations to structure different types of the Internet era business models, and analyze how, and to what extent, they create and capture value, and should be adapted. The

typology introduces four prototypical models, each with varying value propositions models. *Commerce* initiates, negotiates, and/or fulfils online transactions, and enables low transaction costs for buyers and sellers of goods and services; *Context* sorts and/or aggregates available online information, and provides structure and navigation for users to increase transparency and reduce complexity; *Content* collects, selects, compiles, distributes, and/or presents various types of personalized content; and *Connection* offers virtual and/or physical network infrastructure and related services needed to exchange information and users' participation.

The 4C typology can be interpreted as a layered model where antecedent business models are required as value levers for higher layers [27]. Introduced prototypical business models can exist alone or as a hybrid deployed by different stakeholders of the ecosystem. The business potential of the whole ecosystem depends on the ecosystem players' synergies when providing their services, which is an important aspect in relation to resource configuration.

2) Resource Configuration

In the digitalization era, the scope of resources that a company can access and utilize has expanded. A holistic approach is required to enhance value creation and capture [28] to the latest business model discussions on value centricity and systemic value for digital business models [29]. *Resource Configuration framework* is system-based, value-creation-centric perspective for designing and organizing firms' resources. The framework considers needs and resources of value co-creators when conceiving of resource configuration, and provides the foundation for conceiving of and designing novel ways to link heterogeneous resources with heterogeneous needs in a digitally enabled world [29].

In this study, the resource configuration framework consisting of four business model prototypes was applied, as depicted in Fig.1. In the *integrator* prototype the focal firm *identifies* and transforms resources to create value for customers, which has been the predominant type of resource configuration for traditional companies like manufacturers. *Collaborator* prototype means that focal firm collaborates with partners who have *identified* to have complementary resources as a value-creating resource configuration. The third *transaction enabler* prototype associated with platform economy business models, means that broader and easier access to resources allows focal orchestrating firm to build multi-sided markets to *match* resources and needs. The *bridge provider* business model prototype shows that the proliferation of virtual resources, particularly data, creates the opportunity for an orchestrating focal firm to *bridge* certain groups of market participants that are not connected before based on the data, and benefiting from bridging unconnected needs, such as e.g., Google's advertising model.

Discussed prototypes of resource configuration are based on the number of value creating *micro processes* depicted in Fig.1. In *continuous testing*, firms with their value co-creators continuously test their offerings and adjust them accordingly. *Resource crowdsourcing* creates value by bringing together largely distributed, under-utilized resources to reach a scale. *Sorting* process creates value by categorizing resources in a more efficient way that enables more effective matching between needs and resources. *Prospecting* process predicts resource needs and resource controllers' expectations and disseminate these forecasts to value co-creators so that they in turn can adjust their business efforts. *Grafting* tries to couple hereto unconnected resources and needs to produce novel complementarity. Finally, *streamlining* further supplements, e.g., the grafting process by mitigating the incompatibilities that bridging process generally entails [29].

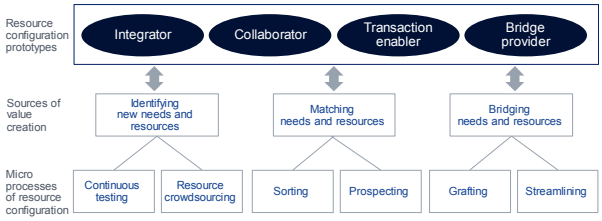

Fig. 1. Resource configurations framework.

III. Results

The analysis of the workshop results is summarized two-fold. First, an analysis of the data by theme is presented, and second the construction of the model and positioning of business models is done by using the resource configurations and 4C typology, presented in Section II, as a framework for the analysis.

A. Technology Enablers

The roles of network slicing, edge computing, AI, 5G new radio (NR) flexibility enablers, opening the interfaces, and management and orchestration (MANO) within the 5G architecture were seen by the World Café participants as becoming more pronounced enablers for new business opportunities as depicted in Fig. 2, [30].

Dynamic *network slicing* enables the design, deployment, customization, and optimization of different network slices running on a common network infrastructure. It leverages innovations in telco cloud mobile access and core, stemming from the capabilities of software-defined networking (SDN), network function virtualization (NFV), end-to-end orchestration, network applications, and analytics. A network slice can span across multiple stakeholders' domains where for example a mobile virtual network operator (MVNO) or a novel micro operator could deploy an ultra-dense private radio access network (RAN) in a specific location [30]. Slicing allows operators to provide

services by abstracting the slice functionality, and expose capabilities to service providers through open application programming interfaces (APIs).

The 5G network was seen to consist of a combination of existing and novel telco and IT WebScale technologies. Particularly, with maturing cloud computing and virtualization, there is a growing need for *edge computing* capabilities to address specific service demands including bandwidth management, latency, sensitivity, security and privacy, local control and service continuity, analytics and digital automation, and support for constrained environments. Moreover, edge computing has emerged as the dominant locale for Internet of things (IoT) analytics. Network technology platform opening through Open source and APIs, and integration between technology provisioning for NFV, slicing and cloud RAN and end user applications and services was see as major technology and business challenge. In the security and privacy layer, security functions will be more and more applied at the network edge to protect the network by reacting locally.

Access to new wide contiguous bandwidth spectrum bands for 5G was foreseen to be needed by 2020. As most of the identified bands are already in use by the incumbents, in order to gain access to new spectrum on time, 5G should make the best use of all types of spectrum bands and types. E.g., a new 3GPP study is starting in 2018 for 5G NR to operate in *unlicensed spectrum*, both NR-based licensed assisted access (LAA) and NR-based MulteFire standalone in unlicensed spectrum. Furthermore, flexible 5G NR framework with scalable OFDM-based interface, TDD self-contained and flexible slot-based structure, network MIMO and mobile mmWaves will enable introduction of new spectrum sharing innovations that can provide significant benefits, both in term of increased spectrum efficiencies, and higher perceived user data speeds while guaranteeing bandwidth and quality of service (QoS). Novel *spectrum sharing* techniques holds the promise of enabling more operators to offer fiber-like 5G experiences with limited spectrum assets driven by the use case and business needs.

Cloudification of the network with advances in analytics and machine learning was observed to enable high level of automatization in development, operations and optimization, improve agility and accelerate time to market by reducing service creation and activation times. *Management and Operations* will need to radically change to manage and maintain decentralized integrated telco/IT networks, build new competences and skills and develop new processes. As networks evolve, MANO with AI and analytics can include cognitive features for network management and spectrum coordination to dynamically reconfigure network deployments according to local spectrum availability and will evolve to dynamic orchestration of network slices across multiple stakeholders' domains.

The workshop participants noticed that digital value platforms and related business support systems will evolve to platforms extended to the local edge cloud, and ultimately to an aggregator and broker of various network resources. To take full advantage of the 5G architecture enabling integration with north bound applications and over-the-top (OTT) services, a MVNO, micro-operator, or a joint venture formed by service providers or participating operators can act as a resource broker. This role can serve customers to procure and provision the type and number of the required virtual network elements and slices from one or multiple infrastructure providers based on the customer's requirements defined in the negotiated service level agreement (SLA).

Blockchain (BC) [31] enablers were identified as future options in the following four use case categories. In *lightweight transaction*, scarce assets are transacted and exchanged between limited numbers of participants utilizing a BC shared ledger marketplace. *Provenance tracking* tracks the origin and movement of high value items and assets across a supply chain utilizing virtual "certificates of authenticity". In *inter-organizational record keeping*, BC acts as an authoritative final "transaction log" mechanism for collectively recording and notarizing any type of data of high importance or financial meaning. Finally, *multiparty integration* writes data to a collectively managed record in order to overcome friction while proving redundancy.

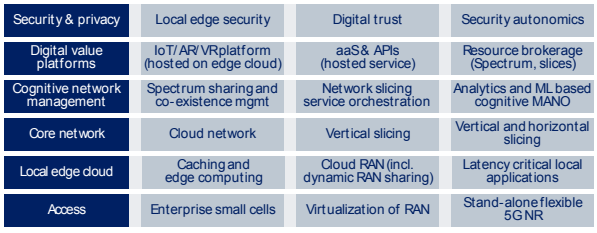

Fig. 2. Identified key technology enablers by network layer [30].

B. Use Case Triggers

With subscriber penetration and revenues peaking, 5G comes at a time when many operators are being forced to diversify and expand beyond their traditional business of connecting consumers. At the same time, many other industries are also facing fundamental disruptions that demand transformation of their underlying business model. From media and entertainment to manufacturing and transportation, companies must find new ways of working to increase their efficiency and performance to remain competitive in dynamic markets, where the lifecycle of new products and service introductions is constantly shrinking.

Novel 5G use cases leveraging extreme broadband, ultra-reliable low latency, and massive machine communications are widely discussed in the literature [6]. Workshop reiterated these use cases including automotive, transportation, supply chain, manufacturing,

energy and utility services, retail, agriculture, health, education, and the enterprise. Short term opportunities were seen particularly on use cases were efficiency improvement have clear business case, and at condensed environments like private enterprise/industrial networks with specific requirements necessitating project tailoring. For example, IoT projects were merely seen to be first inward-facing, with optimizing operations, maintenance and reducing risks. 5G capabilities to augment consumers' lifestyles by improved quality of experience (QoE) and differentiating services enabling automated interaction with things was seen important for competition, customer retention and upselling.

To summarize, three assets were seen essential in capturing value: the new differentiating performance level of networks, the billions of transactional and control data points produced by networks, and dedicated virtual sub-networks and resources, which can be offered aaS that provide tailored capabilities required for different industries and their diverse use cases.

C. Developed Business Models

Developed business model archetypes are marked with alphabets (a) and positioned in the resource configuration framework in Fig. 3.

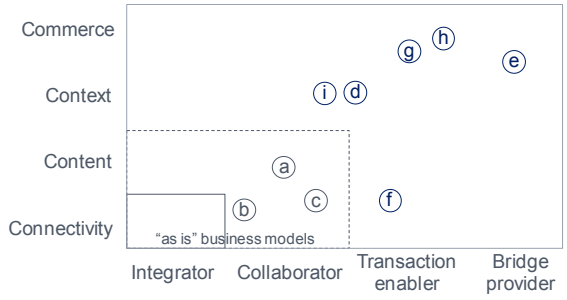

Fig. 3. Strategic development of 5G business models.

Using 5G to provide *fixed wireless access* (a) and *extreme mobile broadband* (b) to meet booming traffic demand were seen as the early use cases with "as is" business models. Key longer-term themes observed from the business model roundtables were the triggering role of the enterprises and verticals, enabling role of the platforms, and need for openness and collaboration in resource orchestration and services.

On *connectivity* and *content* layers, new business opportunities mainly stem from differentiation on quality and performance opportunities. 5G fixed wireless access bundled with content and differentiated through chargeable QoS and SLA (leveraging possibly changes in net neutrality regulation) can serve *mission critical* (c) applications for industrial, vehicle connectivity, and health domains, and extreme mobile broadband enhancements for special events services with augmented reality (AR) and virtual reality (VR).

5G was not only considered as a platform for the connectivity but as an enabler for *context* and *commerce* based business models build on network assets and data. Networks produce millions of transactional data every second that can be utilized as-a-Service (*DaaS*) (d) in traffic, logistical and manufacturing systems to increase the accuracy and speed of these processes. From operator perspective, this business can be wholesale or retail (operator brand visible to the end user). In data brokering model operators can *bridge* (e) the right partners with each other at the right point in time exploiting their assets such as customer knowledge, trust, customer relationship and the channels. Furthermore, analytics and machine learning can be applied to anonymous and aggregated network signaling data for deriving insights useful for the third-party services or enterprises. For example, augmented retail applications that can benefit from information about the user's location, device and current movement pattern, all of which the operator can provide anonymously through a DaaS platform. Similarly, smart city systems, logistics and manufacturing need to be fed with data about the accurate location of vehicles and goods but also with data about movement pattern to, e.g., provide better steering of the traffic on the roads.

Operators can offer entire virtual subnetworks to any kind of service provider or industry. This *network-as-a-service* (NaaS) business model (f) is an extension of existing cloud business models such as infrastructure, platform and software-as-a-service. NFV and network slicing were emphasized as key enablers for a variety of novel private network and microservice business models. For example, in *multi-tenancy* (g) mobile network tenants could share the same network infrastructure with vertical industry tenants, and each tenant could operate and manage their corresponding network slice by exploiting built-in network slice customization and optimization capabilities. With this approach, the network could be sliced per customer service when an operator wants to optimize dedicated services for end users (e.g., tactile internet or ultra HD video) or wants to address industry-specific customer needs (e.g., e-health, sensor network, high speed train) and/or per tenant when an operator wants to share network costs (e.g., network platform as a service, network infrastructure as a service). Several new value propositions and/or supporting process based multi-service, multi-tenant business models, and stakeholder roles and relationships are enabled in this kind of environment including, e.g., provision of network assets, connectivity or managed services, data collection or its pre-processing as-a-service for factory tenants.

New roles of *aggregators and brokers* (h) will emerge in moving from long term contracts to transaction driven on-demand platform model, the connectivity and underlying network and IT resources (e.g., spectrum, slices, computing, storage,

microservices) can more efficiently balance supply and demand, raise the utilization of infrastructure and ultimately maximize economic value within the industry. Application provider will be able to use sub-set of the network capabilities in a flexible, configurable and programmable manner, and to use network resources depending on their service preference. From traditional MNO perspective, this is wholesale business as the application provider handles the customer relationship management and is visible with his brand.

Network operators are well positioned to capitalize on *edge computing* (i), since it brings intelligent functionality closer to the network allowing software applications to tap into local content and real-time information about local access network conditions. Cloud and network providers' edge computing can become natural pivotal points, representing the source and destination of much of the demand combined with context analytic-enabled optimization capabilities. This can create a new competitive advantage over OTT through new vertical business segments and services for consumers and enterprise customers including: content caching, optimized local content distribution, location services, location services, video analytics, AR and IoT.

Security continues to be the primary technical barrier for enterprises embarking on digital transformation and IoT. Digital trust is needed for creating brokerage across multiple stakeholders' elements which could be accomplished with e.g., blockchain technology. Nomadic cloud service for *security and safety* (j) can allow the networks to monitor and adjust network slices and virtualized elements according to detected security threats without human intervention.

D. Discussion

5G enablers including cloud, virtualization and service integration will lead to an overall shift from hierarchies towards more use of markets to coordinate economic activity related to network assets. This transition is triggered by *platform economy* antecedents that reduce asset specificity and complexity of product description. *Transaction enabler* resource configuration prototype associates with platform business model that enables value-creating interactions between external producers and consumers. Platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform identifies and consummate matches among users and facilitate the exchange of information, goods, services, and currency, thereby enabling value creation for all participants.

At resource level there was seen a clear transition from controlling all the resources toward *sharing* of infrastructure and *contextual* data assets. At the business model level, it could be expected that that the role of openness in business models would gain in importance, and the sharing appears to conform more the "value from service" -approach than what traditionally has been the case in the industry. A shift from the purely competitive model of today towards one where more emphasis is placed on converged cooperation and collaboration within ecosystem and across domains was found. The theme trust was seen to play a crucial role in future 5G business ecosystem. The security and privacy concerns remain in providing 5G services from the customers' perspective, but the role of transparency within the ecosystem was seen (by the World Café participants) as becoming more pronounced. From conceptual perspective, frameworks give a layered view on value creation and capture, as depicted in Fig. 3.

Accepting that business models are the devices for creating and capturing value, sharing of resources, whether infrastructure or data, influences both integration of different players' business models and the required degree and type of openness of these business models, and in turn having an impact of the value creation and capture within the ecosystem. Traditionally, centralized businesses have overseen resource and service production, aggregation and distributing, searching efficiency gains by integrating both horizontally and vertically. As a future option, BC technology could assist the progression of different value-creation microprocesses. The role of companies and smart contracts deployed by them may change closer to *decentralized* fifth resource configuration prototype.

IV. CONCLUSION

In this paper, we outlined the development of 5G business opportunities based on the action research World Cafe workshops, and present a framework that can be used to analyze future 5G business evolution. The resource configuration approach explains how a company can create and capture value through strategically configuring the resource, which is further embodied in business model studies with the latest classification of four business model archetypes. Three assets were seen essential in capturing value from the use cases: the new differentiating performance level of networks, the billions of transactional and control data points produced by networks, and dedicated virtual sub-networks and resources, which can be offered as a service that provide the exact tailored capabilities required for the diverse use cases of different industries. Results shows that 5G enablers cloud, virtualization and service integration will lead to an overall shift from hierarchies towards more use of markets to coordinate economic activity related to network assets. Furthermore, two transformations in the development of future 5G business were identified: from connectivity towards context and from value chain integration towards platform orchestration.

In the future, 5G business modelling studies will need to be expanded to cover novel ecosystem roles in resource orchestration and configuration. Co-operative

business model with traditional operators and local micro-operators will be an important aspect to research.

ACKNOWLEDGMENT

The work is done in micro-operator 5G (uO5G) project supported by Business Finland and Academy of Finland's 6Genesis Flagship (grant 318927). The author would like to thank T. Ahava, D. Banjo, M. Davidson, W. Hasiwar, A. Hazon, Z. C. Honkasalo, M. Kristensson, A. Kynaslahti, K. Leppä, P. Lukander, K. Ostonen, J. Sipila, and H. Straulino for co-moderating the workshop.

REFERENCES

[1] European Commission, "5G for Europe: An Action Plan." Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2016)588, Brussels, Sept. 2016.

[2] 5GPPP, "5G empowering vertical industries: Roadmap paper," The 5G Infrastructure Public Private Partnership, Brussels, Feb. 2016.

[3] P. Ahokangas, M. Matinmikko, S. Yrjölä, H. Okkonen, and T. Casey, ""Simple rules" for mobile network operators' strategic choices in future cognitive spectrum sharing networks," IEEE Wireless Communications, vol. 20, no. 2, pp. 20-26, April 2013.

[4] M. Matinmikko, M. Latva-aho, P. Ahokangas, S. Yrjölä, and T. Koivumäki, T. "Micro operators to boost local service delivery in 5G," Wireless Personal Communications, vol. 95, pp. 69-82, 2017.

[5] C. X. Wang et al., "Cellular architecture and key technologies for 5G wireless communication networks," IEEE Commun. Mag., vol. 52, no. 2, pp. 122-130, 2014.

[6] T. Chen, M. Matinmikko, X. Chen, X. Zhou, and P. Ahokangas, "Software defined mobile networks: Concept, survey and research directions," IEEE Commun. Mag., vol. 53, no. 11, pp. 126-133, 2015.

[7] ETSI GS MEC 003 V1.1.1: Mobile Edge Computing; Framework and Reference Architecture, 2016.

[8] C. Koopman, M. D. Mitchell, and A. D. Thierer, "The sharing economy and consumer protection regulation: The case for policy change," The Journal of Business, Entrepreneurship & the Law, vol. 8, no. 2, 2015.

[9] N. Zhang, N. Cheng, A. T. Gamage, K. Zhang, J. W. Mark, and X. S. Shen, "Cloud assisted Hetnets toward 5G wireless networks," IEEE Commun. Mag., vol. 53, no. 6, pp. 59-65, 2015.

[10] J. G. Andrews et al., "What will 5G be?" IEEE J. Sel. Areas Commun., vol. 32, pp. 1065-1082, Jun. 2014.

[11] T. Rasheed et al., "Business Models for Cooperation," in Energy Efficient Smart Phones for 5G Networks: Signals and Communication Technology. Springer International Publishing Switzerland, 2015.

[12] R. E. Hattachi and J. Erfanian, 5G White Paper. NGMN Alliance, 2015.

[13] R. Amit and C. Zott, "Crafting business architecture: the antecedents of business model design," Strategic Entrepreneurship Journal, vol. 9, pp. 331-350, 2015.

[14] S. Inayatullah, "Anticipatory action learning: Theory and practice," Futures, vol. 38, pp.656-666, 2006.

[15] D. Coghlan and T. Brannick, Doing Action Research in your own organization. 3rd edition. London, Sage, 2010.

[16] L. Carson, "Designing a public conversation using the World Café method," Social Alternatives, vol. 30, no. 1, pp. 10-14, 2011.

[17] S. Inayatullah, "Causal layered analysis: Poststructuralism as method," Futures, vol. 30, no. 8, pp. 815-829, 1998.

[18] B. Demil and X. Lecocq, "Business model evolution: In search of dynamic consistency," Long Range Plann., vol. 43, pp. 227-246, 2010.

[19] M. Johnson, C. M. Christensen, and H. Kagermann, "Reinventing Your Business Model," Harv. Bus. Rev., pp. 50-60, 2008.

[20] A. Osterwalder and Y. Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley, Hoboken, 2010.

[21] H. Chesbrough, "Business model innovation: Opportunities and barriers," Long Range Plann., vol. 43, pp. 354-363, 2010.

[22] C. Zott and R. Amit, "The business model: a theoretically anchored robust construct for strategic analysis," Strateg. Organ., pp.1-20, 2013.

[23] R. Biloslavo, C. Bagnoli, and D. Edgar, "An eco-critical perspective on business models: The value triangle as an approach to closing the sustainability gap," J. Clean. Prod. Vol. 174, pp. 746-762, 2017.

[24] S. Moqaddamerad, Y. Xu, M. Iivari, and P. Ahokangas, "Business models based on co-opetition in a hyper-connected era-The case of 5G-enabled smart grids," In: PRO-VE 2016, Porto, 2016, pp. 1-10.

[25] L. Holzner and R. Bohnsack, "Business model adaptation mechanisms in the internationalization process: The case of energy firms," in 43rd European Int. Business Academy Conference, Milan, 2017, pp. 1-39.

[26] B. Wirtz, O. Schilke, and S. Ullrich, "Strategic development of business models - implications of the web 2.0 for creating value on the internet," Long Range Planning, vol. 43, pp. 272-290, 2010.

[27] D. Messerschmitt and C. Szyperski, Software Ecosystem: Understanding an Indispensable Technology and Industry. Cambridge, MA, MIT Press, 2003.

[28] A. M. Brandenburger and H. W. J. Stuart, "Value Based Business Strategy," J. Econ. Manag. Strateg., vol. 5, pp. 5-24, 1996.

[29] R. Amit and X. Han, X, "Value Creation through Novel Resource Configurations in a Digitally Enabled World," Strateg. Entrep. J., vol. 11, pp. 228-242, 2017.

[30] M. Matinmikko-Blue, S. Yrjölä and M. Latva-aho, "Micro operators for ultra-dense network deployment with network slicing and spectrum micro licensing," in Proc. IEEE 87th Vehicular Technology Conference: VTC2018-Spring, Porto, Portugal, 2018, 6 p.

[31] J. Backman, S. Yrjola, O. Mämmelä, and K. Valtanen, "Blockchain Network Slice Broker in 5G - Slice Leasing in Factory of the Future Use Case", in 13th IEEE CTTE conference, Copenhagen, Nov. 2017.