How could 6G Transform Engineering Platforms Towards Ecosystemic Business Models?

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***Abstract*—Developing products, services and vertical applications for the future digitized society in the 6G era requires a multidisciplinary approach and a re-imagining of how we create, deliver and consume network resources, data and services. This development will change the traditional business models and ecosystem roles, as well as open the market for new stakeholders like micro-operators, cloud operators and resource brokers. Paper discusses unprecedented opportunities of enabling and stimulating multiple stakeholders to have a more active participation in the future 6G ecosystem via platform-based ecosystemic business models. The research extends the product platform and service modularity concepts beyond connectivity innovations towards multisided transactional ecosystem platforms.**

Keywords— business models, ecosystems, platform, service modularity, 5G, 6G

I. Introduction

Novel digital era business models have been transforming and disrupting traditional industries in an unprecedented speed, and the telecommunications industry is no exception. The wireless network technology evolution will transform industries through wireless services provided at gigabit speeds, millisecond latency, support of wide range of novel applications connecting devices and objects, and versatility by virtualization enabling innovative business models across multiple sectors [1][2]. Present 5G connectivity market continues to be characterized by incumbent network operators whose business is structured around service mass provisioning with high advance investments in infrastructure and exclusive long-term licenses granted by the regulators [3]. At the same time, the responsibility of delivering resources is being transformed from centralized mobile network operator (MNO) centric system into a dynamic mode of operation. This development is due to the 5G deployment of software defined networks (SDN), Network Function Virtualization (NFV) and network slicing, cloudification, the diffusion of novel local micro operator edge service business models, and the development of vertical service and application ecosystems [4].

The application of big data, artificial intelligence and cloud computing at the edge of the network with ubiquitous near real time wireless connectivity will change many aspects of our personal and working lives and the structure of the economy. In particular, the diffusion of information and communication technologies into the physical industries is poised to increase stagnated productivity growth. Furthermore, the future of 6G telecommunications will be shaped by the growing societal requirements like inclusivity, sustainability and transparency [5]. As basic connectivity service continues to be commoditized, telecommunication industry is exploring new ways to better position itself for digital transformation and going beyond the traditional role of connectivity provisioning [2]. Access to data and data ownership are increasingly the major factors in value creation, and limiting such access is a means of control. Creating a system that transforms how data is collected, shared and analyzed in real time can create strong drivers for future value, introduce novel stakeholder roles, but may also lead to serious privacy and ethical concerns over the location and use of data. The pervasive influence of artificial intelligence will not just reflect what something looks like but also its context, meaning and function, creating Internet of skills and digital twins.[5]

The preceding discussion is indicative of increased importance of platforms from both engineering and economics perspectives. Engineering research, stemming from product and manufacturing platforms and lately service modularity [6], is focusing on components and interfaces aiming at creating economies of scale. In parallel, the economics research discusses how to connect demand and supply in order to grow in sustainable manner and enter or create new markets [7]. What both of these streams agree on is that platforms create an ecosystem around them, paving the way to see platforms and ecosystems as intertwined [8]. Furthermore, recent study [9] discusses how the transformation from current network-for-connectivity business models towards network-of-services model builds on platform with data and algorithms.

The existing 5G business studies focus on traditional MNO business models and discuss 5G in rather technical and general terms, mostly at the industry level, and platform business models have seldom been examined [1][4]. Collaborative business models were introduced in [10] and related system integrator, neutral host and brokerage roles in [11] [12] and [13]. Operators capabilities to expose network functionalities through adopting web-based service models is analyzed in [14] and utilization of cloud in the business model in [15]. Moreover, the localized nature of the 5G services has emerged as a characteristic in these studies [16] and introduced the micro operator concept [17]. Beyond technicalities, the discussed business models can be seen to represent two basic mobile operator business models, connectivity service provider and its differentiation [3][16]. As an emerging field, 6G business models have not been discussed in literature to date, however vision papers on enabling technologies, the role of AI and emerging use cases and applications have been recently published [5] [18]-[20].

Building on the above discussion, with roots in engineering and economics research, the main research question of this paper is: *How could the evolution of 5G business models transform from innovation platform based towards novel transaction platform based ecosystemic model in 6G?* This research follows the future-oriented action research method [21]. The paper introduces 5G ecosystemic platform and identifies 6G platform elements and scenarios. The data utilized in this paper is based on the future-oriented workshop [22] held at 6G Wireless Summit 2019. The paper is structured as follows. Section II, describes the research methods and theory frameworks adopted. Section III presents and discusses the results of the analysis and finally, section IV draws conclusions and highlights perspectives for future studies.

II. Methods and Theory Frameworks

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

A. Future Oriented Action Research

This study applied qualitative research strategies and methods. The 5G evolution and 6G platform elements analyzed in this study were created using the anticipatory action learning approach that is a particular action research (AR) method conducted in a future-oriented mode [23]. AR is an iterative and participatory 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 [24]. The 6G Wireless Summit [22] event was organized by Finnish 6G Flagship Program in Levi, Finland, March 2019. In conjunction with the summit, a 6G white paper workshop was organized with 60 participants including major infrastructure manufacturers, operators, regulators and academia to launch the process for drafting the first 6G white paper [5]. Workshop was run in 6 groups: use cases, societal and business drivers, radio hardware and spectrum bands, new air-interface, new network technologies and enablers for new services.

B. Business Model

The analysis in this paper is based on the business model concept [25] that centers on value creation processes [26]. Business models are seen to connect to three strategic choices by companies [27]: 1) business opportunities explored and exploited [28], 2) value created and captured [29], and 3) competitive advantages explored and exploited [30]. In [31], the major constituent of a business model was considered to be technology, network architecture and service offering. Furthermore, the information and communication technologies-based infrastructure platforms have become the basis for ecosystems allowing to orchestrate and organize resources and activities of companies [32]. For the digitalized context four types of business models is proposed [33]: 1) supplier model that works in a value chain of another company, 2) the multichannel model that makes firms to restructure across several digital and physical touchpoints to serve their customers, the 3) modular model that builds on plug-and-play interfaces to complement their offerings, and 4) the ecosystem model that builds a customer-centric platform to facilitate interactions.

This study utilizes a typological 4C business model framework [34] to structure the business model analysis. Each of the four business models architypes have varying value propositions and revenue models: *connection* enables interaction, *content* e.g., data can be transferred over the available connections, *context* pertains to provide situational awareness e.g., search or location regarding the context of activity, and *commerce* offers e.g., marketplace and platforms of data, information or context over the available connectivity. 4C 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. Furthermore, models supporting two or more types are called hybrids [35].

C. Platform and Service Modularity

Platform can be categorized [7] as 1) a company and its internal units, i.e., platforms, 2) a network of company and its suppliers, i.e., the supply chain and manufacturing platforms, and 3) an ecosystem keystone actor and its supplement actors in a technology or business ecosystem, i.e., the ecosystem platform. [36] partitions ecosystem platform architecture into a relatively stable platform, a complementary set of varying modules, and the design rules binding on both. Interfaces as specifications and design rules describe how the platform and modules interact and exchange information using well-documented, and predefined standards and application programming interfaces (APIs) [37]. This decomposition of a platform ecosystem minimizes interdependence among the evolution processes within components of the ecosystem, supports change and variation and helps to cope with complexity. Furthermore, modularity decreases coordination and transaction costs across the module boundary [36], while interface standardization decreases asset specificity [38].

Two main characteristics that differentiate service modularization from the product modularity and engineering platforms are that the heterogeneous services are composed by a process dimension i.e., interactions among service providers and customers as well as activities involved in transforming the customer inputs into outputs, and by an outcome dimension i.e., services offered by the company [6]. [39] developed a conceptual review of service modularity and defined service architecture as the decomposition of the functionalities of a service system into individual functional elements to provide the overall services delivered. Furthermore, the service architecture can be decomposed into modules, interfaces, boundaries, standards, and resources that are shared and remain constant from service to service within a given service family [40]. The service modularization can be used in composing a new service offering, or for the decomposition of an integral service in a modular service. The modularization focuses on managing demand heterogeneity, complexity, service customization, and efficiency of functional units [39].

In the digital services domain, the most widely deployed digital as-a-service business models are infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS) and software-as-a-service (SaaS). Everything-as-a-service (XaaS) [41] enables a large number of digital service providers to offer a variety of cloud-based services across the cloud stack layers. Furthermore, with the emergence of platforms, an oblique business model having a focus on value sharing through value co-creation and co-capture have emerged to challenge the traditional vertical value creation control-oriented business models, and the horizontal business models controlling value capture [42]. In these emerging co-creation and value sharing oriented ecosystems openness of the business model is considered as key antecedent [43].

III. 5G Ecosystemic Platform

This section discusses essential technology enablers in 5G evolution and the analysis of empirical findings through the ecosystemic platform and the 4C business model framework lenses. This integrated framework is employed to discover how could the evolution of mobile communication business models transform from innovation engineering platform based towards novel transaction ecosystem platform-based models as summarized in Fig. 1.

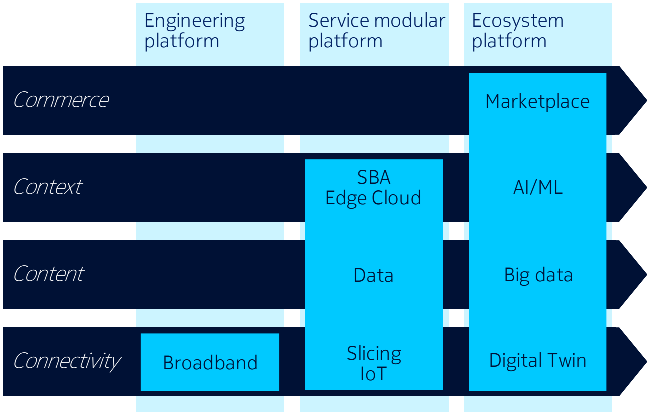

Fig. 1. The transformation of mobile communication business models from from network-for-connectivity and network-of-services towards ecosystemic platforms.

The standardization of wireless technologies has been essential for the global success of the wireless ecosystems ensuring global multi-vendor interoperability between networks, devices and operators and economies of scale. The 4G and its evolved packet core architecture were standardized utilizing a reference point approach in which the interfaces and protocols between network entities were standardized in 3rd Generation Partnership Project (3GPP) [44] representing traditional engineering product and manufacturing platform approach and focal firm centered pipeline business model.

In the 5G system standardization, 3GPP deployed the service-based architecture (SBA) [45] for 5G core network that utilizes service-based interfaces between network functions (NFs). This approach supports virtualization of NFs that can be independently implemented on dedicated hardware or on the cloud. Moreover, virtualization of network entities enables selection and configuration of NFs based on the specific service requests. Together with distributed cloud infrastructure this provides modularity, flexible and scalable resource sharing, while reducing cost.

Management and orchestration of 5G networks and network slicing [46] can be seen as one of the key features of 5G that allow enterprises and vertical industries to take advantage of 5G networks and services. Network slicing is about transforming a single connectivity-based network to a network where logical partitions are created, with appropriate network isolation, resources, optimized topology and specific configuration to serve various service requirements [47][48][45].

Introduced new key functionalities in 5G follow a supply-demand relationship in managing the network slices. This allows NFs to discover other functions and find the required functions based on their capabilities and offered services (NRF); network slice selection and lifetime management of the instance domains of the network based on the slice requirements (NSSF); and management and orchestration (MANO) functionalizes of network slice and subnet instances including translation of communication requirements to network slice requirements (CSMF, NSMF and NSSMF) [46].

Network slices consisting of NFs, physical resources and server resources can also be allocated for different use cases and applications running on the sliced server infrastructure. In addition to traditional approach where incumbent MNO manages and controls network slices novel 5G architecture enables control and management to extend to various communication service providers, micro-operators, mobile virtual network operators, and customers depending on the agreed level of exposure to resources and management interfaces. The level of exposure can occur at communication service level, network slice instance or sub-slice instance level. In the SBA, network slices can be created from different domains of the network, and further one service can use several slices and a slice can be used by multiple services. MANO enables tailored network function placement and network slice allocation to match, use case specific services under Service Level Agreement (SLA) [49].

Introduced flexibility and scalability in utilizing virtualized shared resources over standardized interfaces enables different stakeholders in different roles to enter the connectivity business and to expand it to *service modularity*-based business models.

IV. Proposed 6G Platform Elements and Scenarios

In 6G, the utilization of edge cloud computing elements and interfaces will be expanded in a local and instant information service e.g., for a fast discovery of people, services, devices, resources and any local information near the user that cannot be collected by centralized search engines. Such edge ”connecting intelligence” service platform could be used in creation of a highly local and dynamic market place for resources, information and services. Extreme case for edge computing would be a pervasive thin user client, a light low-energy device capable of interacting with human senses or neural system, with all user specific computing decentralized occurring in edge cloud.

Moving from pipelines to marketplace for the connectivity and underlying network resources can more efficiently match supply and demand, raise the utilization of infrastructure and ultimately maximize economic value within the industry. Data markets offer a natural new business opportunity, where data ownership is a source of value creation and access control. Data ownership is evolved from content to distinct context data further towards big data with large volume of detailed data with real-time velocity and high variety in types and sources. The pervasive influence of AI and digital twins will not just reflect what something looks like but its context, meaning and function. Therefore, creating a big data system that transforms how data are gathered, organized, prioritized, synthesized and distributed can create strong initial controversy, e.g., through raising privacy concerns over location and data. The contractual policies between the actors will define the relative strengths of information and data ownership between parties, for example how the trust and access will be established in the autonomous smart device and service entities.

Artificial intelligence and machine learning was seen to play a major role in linking network services to business level solutions via self-configuration, optimization and orchestration of virtual resources to meet dynamic content, contextual and event defined needs. Building on the platform-based and value-creation-centric conceptualization, novel sources of value creation may be supported in 6G and can be categorized as identification, matching and bridging [50], as depicted in Fig. 2. Continuous testing and sourcing have means for *identifying* new needs or underutilized resources, gathering and structuring them together in order to reach a scale for a use case and business. Sorting and prospecting, in turn, via ML for, e.g., dynamic user segmentation, bundling resources to form capabilities, categorizing and predicting needs, and valuating resources aim at *matching* the needs and resources in a more efficient manner. Moreover, the microservices, grafting and streamlining, contain the procedures for making completely new resource combinations and this way *bridge* and leverage the needs and resources within novel platform-based ecosystemic 6G business models.

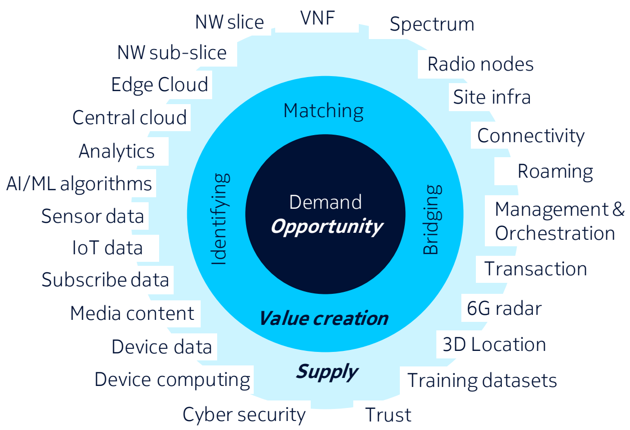

Fig. 2. Value creating processes identify, match and bridge supply and demand in platfrom-based ecosystemic 6G business.

Building on the discussion, the stakeholder roles in 6G are expected to change compared to the current mobile business ecosystem and totally new roles will emerge. Demands and supply are brought together through the resource orchestrator stakeholder roles including different kinds of operators (local or vertical-specific operators, fixed operators, mobile network/satellite operators), resource brokers, and various service/application providers such as trust/security providers. Distributed ledgers technologies are attracting high hopes complementing AI/ML. Without central authority in a distributed manner, this technology allows storing and sharing information that does not change too often such that the full record of the changes is kept as well. This may give rise to e.g., new ways of organizing data and resource markets or helping to maintain trust in an inter-stakeholder setting. The matching and sharing of resources to meet the demands will take place through new kind of activities to ensure inclusion, sustainability and transparency. Ultimately, the emergence and shape of the new wireless ecosystem models are dependent on regulations which promote or hinder the developments.

V. Conclusions

With roots in economics and engineering research, this paper looks at 5G architecture evolution through the lenses of platform-based ecosystemic business model framework utilizing 4C business model typology. Study shows that the transformation from current network-for-connectivity product platforms towards service modularity-based business models builds on 5G service-oriented architecture allowing exposure of resources and network slice provision for novel service-oriented stakeholders in different roles. Moreover, 5G evolution towards 6G highlights the importance of a transaction ecosystem platform, a marketplace for all the virtualized 6G network resources, and particularly, access to data and related analytics. Creating a system that transforms how resources are orchestrated and data is collected, shared and analyzed in real time can create strong drivers for future value and introduce novel stakeholder roles. The pervasive influence of artificial intelligence will not just reflect what something looks like but also its context, meaning and function, in creating and connecting digital twins. Distributed ledger technologies may give rise to new ways of organizing and configuring resources and data markets and helping to maintain trust, privacy and transparency. Themes discussed in this paper are worth further study to assess alternative 6G business strategies and business models with and around platforms of various types.

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