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Business opportunities in 5G mobile technology

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1. Introduction

The question of how actors perceive business opportunities has puzzled both researchers and practitioners for decades. In the era of artificial intelligence, machine learning, and the Internet of things, many actors of the technology-intensive industries question how to use new technology to create value, and how to monetize new service concepts. In this paper, we focus on the next mobile communications technology, 5G, as one of the potential value-creators for the future that holds business opportunities for its utilizers and deployers.

The concept of business opportunities is strongly associated with research on entrepreneurship (cf. Carlsson et al., 2003). Entrepreneurial opportunities consist of a set of ideas, beliefs, and actions that enable the introduction of goods, services, raw materials, and organizing methods in the absence of current markets for them (Sarasvathy et al., 2003). The research stream of entrepreneurial opportunities (cf. Alvarez & Barney, 2007, 2010; Dimov, 2007, 2011; Eckhardt & Shane, 2003) can offer new insights into the development of opportunities in high technology-intensive fields, and especially as regards the development of 5G. Strategies for opportunity identification, exploitation, and value creation are vital in the 5G era, as non-ICT traditional business sectors begin to deploy wireless technologies (e.g., factories, automotive, etc.). Researchers expect that 5G will change the business models and business ecosystems; it will also better address the evolving needs of customers (cf. Kliks et al., 2018). Unlike already existing mobile communications systems, 5G allows integration of vertical industries, e.g., energy, media, health, factories, and the automotive industry (5G–PPP, 2016). Thus, specialized companies will be able to provide services and establish positions in the value chains and actor networks. This is a major transformation compared to an environment dominated by bilateral relationships between mobile operators and their customers.

5G aims at serving a wide range of industry verticals, not only tap into mass consumer markets (cf. Zikria et al., 2018); 5G is designed for very low latency applications, high travelling speeds of its users, high accuracy in, e.g., determining user location, higher data rates, and lower energy consumption. Nevertheless, there is still uncertainty concerning the shaping of the market and the emerging ecosystem (actor roles, choice of communication technologies in different environments, etc.). Entering new territories, i.e., vertical industries such as agriculture, automotive and transport, education, financial services, health, manufacturing, energy, and so forth, where communication and connectivity do not necessarily constitute the core, 5G aims at creating an ecosystem able to meet technical needs emerging in these vertical industries. This will allow for innovative business models and services. A major challenge for the ICT industry, as well as vertical industries, thus lies in identifying application areas and deployment opportunities that create value for different stakeholders.

We, therefore, study the emergence of the 5th generation of mobile communication systems and perceptions of business opportunities in this new setting. The purpose is to generate information on

how the 5G market is perceived to emerge through the identification and/or creation of business opportunities. Our research questions are

1. What kind of business opportunities does 5G mobile technology enable?
2. Which business opportunities in 5G do industry actors perceive?

The setting for our study is a project, WIreless for VErticals (WIVE), funded by Business Finland, the Finnish funding agency for innovation, in 2017-2018 as one of several concurrent national projects advancing 5G and deploying established 5G test networks. We explore how this consortium consisting of organizations representing various industry areas engage in value co-creation to explore, identify, and create business opportunities. We do this by identifying potential business opportunity categories and analysing the ways 5G developers interpret the business opportunities of 5G. The paper advances our knowledge of business opportunities in high technology fields.

The paper is structured as follows. First, we elaborate on research on business opportunities and opportunity identification and creation. Second, we present the method for collecting and analysing data. Third, we discuss the results and provide suggestions for further research as well as managerial implications.

2. Business opportunity identification and exploitation

This section introduces the research stream on entrepreneurial opportunities, as well as opportunity recognition and exploitation. Companys and McMullen (2007) summarize the literature on business opportunities into three schools of thoughts, namely the *economic school*, the *cultural cognitive school*, and the *socio-political school*, which we will present next.

2.1 Entrepreneurial opportunities

In the *economic school*, entrepreneurial opportunities are perceived as objective but most actors are generally ignorant of their existence. This is because the knowledge of what and how to produce is dispersed among actors; each possessing some, but no one full knowledge (Alvarez & Barney, 2010). Therefore, individuals and firms must experiment with available resources, capabilities, and information to discover and exploit opportunities (Companys & McMullen, 2007). Shane and Venkataraman (2000) differentiate between *technological* and market opportunities. *Technological opportunities* allow for the creation of new goods and services, while *market opportunities* assist in commercialising them. The economic school thus attributes competitive advantage to discovering and exploiting new solutions to existing problems or the new information about the means of production.

In contrast to the economic school, the *cultural cognitive school* perceives entrepreneurial opportunities as subjective phenomena. For instance, a technology's value lies not in its material properties, but in cultural meanings that users develop and attach to it. Opportunities are classified according to their source in the value chain, namely as *producer opportunities* and *consumer opportunities*. In order to interpret and define the subjective phenomena as opportunities, social actors must have abilities to develop mental models. In other words, they must be able to construct opportunities by borrowing and combining cultural schemas and templates to develop new meanings and understandings (Companys & McMullen, 2007). Only those who possess the relevant cultural knowledge and experience are capable to utilize opportunities successfully. This perspective attributes competitive advantage to discovering and exploiting new interpretations of existing data made possible through shifting preferences (Companys & McMullen, 2007).

Similar to the economic school, the *socio-political school* emphasizes that opportunities are objective, and they exist in complex webs of social relationships that regulate economic activity. These opportunities can be *network opportunities* and *political opportunities*. An example of *network opportunities* is the variety of knowledge, information, and expertise available to an individual through his or her interaction with a particular social network. These individuals can recombine the knowledge to discover and exploit new valued means-ends relationships. Another example of network opportunities is structural holes. An individual, who acts as a mediator between two or more closely connected groups of people can combine all the ideas he or she receives from different sources and come up with the most innovative idea among all (Comanys & McMullen, 2007).

Political opportunities require that network participants leverage different ideological frames to interpret and act upon perceived opportunities in the socio-political landscape. Changes provoked by exogenous events, such as wars and revolutions, result in changes to prevailing governance mechanisms and generate uncertainty. Some individuals take advantage of this uncertainty and engage in skilful political bargaining to alter the governance mechanisms to their advantage (Comanys & McMullen, 2007). An entrepreneur must not only recognize entrepreneurial opportunities but also mobilize and organize others to exploit them. He or she should act with significant political skill and process sources of information and form coalitions and alliances (Comanys & McMullen, 2007). The school attributes competitive advantage to discovering and exploiting new data or new interpretations of existing data made possible through the involvement of new individuals or increased involvement of existing individuals.

School of thought	Approach	Opportunity	Definition
Economic school	Objective	Technological	Enable the creation of new goods and services
		Market	Assist in commercializing new products and services
Cultural cognitive school	Subjective	Producer	Actors construct opportunities by borrowing and combining cultural schemas and templates to develop new meanings and understandings. Opportunities exist in the various stages of the value chain.
		Consumer	
Socio-political school	Objective	Network	Opportunity identification depends on the variety of knowledge, information, and expertise available to an individual through his or her interaction with the particular social network
		Political	Network participants leverage different ideological frames to interpret and act upon perceived opportunities in the socio-political landscape.

Table 1. Overview of entrepreneurial opportunities

2.2 Opportunity recognition and exploitation

Literature reveals several theoretical perspectives to the study of entrepreneurial opportunity recognition and exploitation, namely, *the cognitive approach*, *the social perspective*, and *the environmental perspective* (Riquelme, 2013). Different views on entrepreneurial opportunity formation emphasize the importance of different factors. According to the cognitive framework, the mind creates patterns and schemas helping individuals to recognize connections between apparently unrelated events (Baron & Ensley, 2006; Riquelme, 2013). Kirzner (1973) summarizes the differences between entrepreneurs and non-entrepreneurs by using the term of “alertness”. Alertness is a quality to be sensitive to information about accidents, objects and patterns of behaviour in the environment with special awareness of user problems, unmet needs and innovative usage of resources (Riquelme, 2013). Kaish and Gilad (1991) suggest that entrepreneurs discover

opportunities through searching and analysing the data (Short et al., 2010). The cognitive and personality approach, however, has been criticized for reducing opportunity recognition to a single person, single action, single insight, and any other single factor (Dimov, 2007). Moreover, the aim in the cognitive focus is to identify the mental models or representation entrepreneurs possess and use to invent new products, while such representation is still not clear. It is also unrealistic to think that entrepreneurs develop their ideas in isolation; there is, in fact, evidence that this is not the case. Another criticism of the cognitive perspective comes from Alvarez and Barney (2007), who concluded that cognitive work fails to show whether cognitive differences exist before the entrepreneurs begin engaging in entrepreneurial actions or if these differences emerge as a result of the experiences of entrepreneurs while forming opportunities (Riquelme, 2013).

Social-cognitive theory suggests that past and current learning environments influence the individual's emotional, cognitive and behavioural reactions. According to this view, opportunities exist in an institutional, social and cultural context and arise for those, who stand in particular relation to the context. In this context, individuals respond to entrepreneurial opportunities by incorporating their pre-existing work experience and knowledge (Riquelme, 2013). According to Shane (2000), knowledge about existing markets and ways to serve them, and knowledge about what problems customers have, influence the opportunity recognition. Ardichvili, Cardozo, and Ray (2003) agree with this idea by suggesting that general industry knowledge and specific interest; prior knowledge of markets; prior knowledge of consumer problems; and prior knowledge of ways to serve markets increases the likelihood of successful recognition of entrepreneurial opportunity (Corbett, 2007).

Davidsson and Honig (2003) found that specific human capital is important for opportunity recognition and exploitation (Corbett, 2007). Specifically, McMullen and Shepherd (2006) highlight the importance of the specific knowledge of technology in combination with motivation. On the first stage of their conceptual model, potential entrepreneurs use their domain-specific knowledge and motivation to notice the third-person opportunities created by the technological changes in an environment. On the second stage, they evaluate the potential costs and risks by taking into account the others' encouragements (McMullen & Shepherd, 2006). Shane (2000) studied how the specific knowledge and experience influence the discovery of opportunities created through technological changes, and confirmed that specialized knowledge and experience are important. Moreover, those who possess this knowledge through their education or work experience are more likely to discover technological change opportunities than others are who search for such knowledge (Shane, 2000).

Saemundsson and Holmen (2011) looked at the importance of domain-specific knowledge for opportunity recognition in web development before and after the web administration tool was introduced. As they expected, technological change influences the founders' educational background and experience. Certain knowledge, which was important to have before the technology had been put in place, became less important later on. In this stage, another type of knowledge gained significance (Saemundsson & Holmn, 2011).

After entrepreneurs identify or create opportunity they should exploit it. Shane and Venkatyaran (2000) describe two ways of exploitation: the creation of new firms (hierarchies) and the sale of opportunities to existing firms (markets). Common assumption though is that most entrepreneurial activity occurs through *de novo* start-ups (Shane & Venkataraman, 2000). As Shane and Venkataraman (2000) stated the choice of mode depends on the nature of the industrial organization, the opportunity, and the appropriability regime (Shane & Venkataraman, 2000).

Researchers identify three broad categories of the theories of the choice of exploitation mode. The first emphasizes the costs (transaction and agency costs), the second emphasizes speed and market power (strategic behavior) and the third emphasizes appropriability (resources and capabilities view of the firm). The drawback of these categories is that they focus on a single issue and develop it to its logical conclusion ignoring the other two issues (Venkataraman, 1997).

3. Methodology

The specific empirical context of our research is Wireless for Verticals (WIVE, 2017-2018), one of three national 5G development consortia funded by Business Finland, the main Finnish funding agency for innovation. The WIVE consortium consists of technology and network developers, research institutes, as well as actors from different vertical industry sectors including media, energy, and logistics. Industry partners are Nokia Bell Labs, Telia Company, ABB, Kalmar Cargotec, Teleste, Digita, Magister Solutions and Nordic Semiconductor. The aim set for WIVE was to build the foundation for innovative wireless solutions in the spirit of open innovation by bringing new experiences to end-users and to advance 5G by focusing especially on developing machine type communication (MTC) and ultra-reliable low latency communication (URLLC). Eventually, the consortium sought to contribute to developing IoT, which largely depends on fast and reliable mobile technology networks. While the focus on one project in a national setting imposes limitations, it also allows for a deep and longitudinal analysis of the developments associated with the development phase of 5G technology. Thus, the WIVE project functions as a case study, through which preliminary results on 5G business opportunities are derived.

We conducted interviews (n=36) with the project partners' representatives at three different points in time during 2017 and 2018. The interview guide was built using theory on entrepreneurial opportunities. In addition, seven whole-day workshops were held and run by one of the authors during 2017-2018 focusing on 5G-related topics, e.g., future scenarios, actor networks and roles, and use cases for piloting in the 5G test networks. Both interviews and available workshop conversations were transcribed verbatim. The workshop discussions serve as support in analyzing the perceived business opportunities. The data obtained was coded (using the data analysis software tool Nvivo) into business opportunities (technological, market, producer, consumer, network, and political). Also, the data analysis focused on narratives on how the informants perceive business opportunities in order to identify the degree of activity in creating business opportunities through the use of 5G.

4. Findings

An opportunity is generally defined as a time or set of circumstances that makes it possible to do something. It can also indicate that as humans, we view opportunity as a situation, in which we can do something we want to do. The economic definition of an opportunity indicates that any idea for a new product, service, raw material, market or production process can be successfully exploited in order to generate economic benefits for the stakeholders (Landström & Lohrke, 2010).

Opportunity recognition is often about pattern recognition, i.e., noticing meaningful patterns in events, trends, or changes. In the following sections, we summarize the thoughts by the project partners according to the opportunity categories identified in the theoretical framework. Due to informants asking to remain anonymous, no specific companies are mentioned, nor are quotes from the interviews used in summarizing the narratives on business opportunities of 5G.

Technological opportunities

One of the novel features of 5G relates to URLLC. URLLC refers to services and applications that require reliable data communications from one end to another, fulfilling sub-millisecond latency. Examples of deployment areas are remote surgery, intelligent transportation (automated driving, road safety, traffic efficiency services), or industry automation. Naturally, as the project focus was on URLLC, the project partners mentioned URLLC as an opportunity generating aspect to 5G. The informants, however, recognize that the development of the technology is still ongoing as is the actor network or ecosystem arising around these benefits of 5G, which entangle business opportunity identification and creation. A much-discussed issue is the use of frequencies and who will be the provider or owner of the needed frequencies to execute low latency in the 5G network, allowing for applications and new services in the different vertical industries. Nevertheless, the promise of low latencies is becoming reality, and therefore also potential business around it.

A few project partners also rely on experience: instead of immediately investing largely into new technology, they create position through experimenting and conducting pilots jointly with, e.g., research institutes and other companies in the same ecosystem. Pilot activities allow the project partners to envision the future and technological features in order to make decisions related to technology at a later stage. Concurrently, the customers are taken into account, e.g., end-user preferences and trends in mobile media consumption, specific industry trends, and development of business relationships with business-to-business customers.

Market opportunities

Market opportunities are largely based on technological opportunities and focus on commercializing services and products based on the developed, enabling technology. A major business of 5G relates to the network components, which are produced by technology vendors and solutions providers and implemented by, e.g., mobile operators, with the aim of updating their mobile networks. However, in 5G, the field is much broader as we include sensors, low latency applications, etc. and move towards the Internet of Things (IoT) era. 5G is, in a sense, in a stage of hype, as many may view the opportunities brought by 5G as endless. An uncertainty, however, is the emerging actor network because of the envisioned business opportunities; who will the competitors be in which field, will micro-operators overtake some of the business, and which new actors will emerge close to the consumer interphase, for instance.

The project partners see great value in joint piloting activities, as they provide references for future business. This is mentioned frequently in the interviews. In addition, being in the forefront of technology development and being able to be among the first providing innovative solutions to customers is frequently mentioned; concurrently, this denotes firms creating opportunities by themselves, as it may be too late to implement new technology at that point, when customers ask for specific features, such as 5G connectivity bundled or integrated in the product. The market opportunities are thus created based on knowledge and experience of technology testing, piloting, and development, both in-house as well as jointly in public-private projects. Joint piloting activities allow for the analysis of business potential and validation of products and services, which refines the offerings among firms.

Producer opportunities

The different stages of the value chain and reaping the benefits of technology introduction signal that firms know their customers and can direct them towards the future. Again, the joint piloting activities are important for the development processes (knowhow, competences, business relationships, etc.), as smaller and/or local tests allow for validation and scalability into products, services, and solutions aimed at a wider market area (or preferably global markets).

Consumer opportunities

Consumer opportunities are viewed as at the other end of the value chain (compared to producer opportunities) and allow for configurations at the end-user interphase. As regards consumers, 5G allows for the personification of services which may relate to specific content or an event area (offering additional information or metadata to participants in e.g. a sports event, or similar). Another noteworthy issue arising from the interviews, is the fact that business-to-business customers of the project participants do not necessarily talk about 5G, but rather about wireless connectivity as a feature in the bundled service or coupled with the hardware or product. This puts pressure on the early birds reaping 5G opportunities to “invent” or “design” how 5G technology can be used and implemented in their services, products, and solutions, and which language to use with their customers. In this way, they are able to produce added value to their customers, and the use of 5G is expected to outweigh the competing wireless solutions in terms of efficiency, capacity, and costs.

Network opportunities

Business opportunities in 5G are sometimes seen as local (e.g., harbour area, factory area). Nevertheless, the service-producing network is still a question mark, i.e., who will offer connectivity in such an area. Will, for instance, the harbour operator act as connectivity provider and maintain the 5G network, should mobile operators take the role, or should the technology equipment provider also maintain the 5G network in such areas? The questions are many, and as the technology is maturing and network brought to commercial use, business network formation including a search for roles and positions will rapidly take off. The issue of focusing on core competencies or expanding competences into covering a new field thus becomes important. Some view this process as ecosystem development, while others see it as normal actions on the markets (new players emerging and competing with established actors). Nevertheless, firms must navigate the ecosystem and various buyer-seller networks in order to establish their positions and choose which competencies need development as well as which tasks to outsource to other network members.

One way of early navigating the networks is establishing interaction between actors of different industry areas, in order to learn more about the problems and issues in a specific industry area. A dialogue between the service and technology providers and the potential customers allows for networking and network formation, in which value is created mutually for all participants. One strategy is to work closely with start-ups in various fields, in order to learn from the potential disruptors. Value-creating networks also allow for opportunity creation, according to the informants.

Network formation and dynamics are also confirmed by project firms' aim to co-create value together with their customers. It is not only important to network with ecosystem actors, providing and testing wireless connectivity jointly in various projects and initiative, it is also important to leverage that knowledge into customer relationships and initiate piloting activities or developmental processes together with customers. The project partners highlight this dual view of joint innovation and development, which allows for both the creation and identification of business opportunities. Businesses are dependent upon each other also in the emergence of 5G markets. The project partners also stress membership in different organizations and decision-making forums foremost related to standardization. This also allows for opportunity recognition, as firm representatives are participating in discussions that per se form the markets and prerequisites for business.

Political opportunities

As mentioned in the previous section, project partners actively participate in discussions and forums depicting the future of wireless connectivity, both as an overall topic (e.g., 5GPP) and related to vertical industry sectors. In some cases, the government decides on actions that are obliged to ICT actors, which in itself can become business opportunities for some actors in the 5G ecosystem (but may also become burdens, i.e., do not generate business). Regulation also affects, for instance, foresight and trend analysis conducted within the companies, and thus acts as a moderating factor in opportunity analysis.

Additional effects of 5G: organizational opportunities

The project partners also mention additional aspects to business opportunities in 5G, that affect both opportunity creation and identification processes. Internal and organizational issues play a role, and in some cases, innovation and business development are assigned to a specific unit within the organization. Communication between this specific unit and other organizational units thus becomes a key factor, providing input on technology trends and development trajectories as well as using customer intel in order to make decisions for the future. In addition, some units within the firms are required to act similar to start-ups, embracing uncertainty and acting rebelliously on the market (or at least with the aim to disrupt the market). In some cases, service-based business models are created for reaping the benefits of 5G. In other words, there are *organizational opportunities* linked to 5G markets, as firms find a need to change the way they innovate, organize and capture value-creation processes internally, what kind of capabilities are needed, and engaging in business model innovation in order to exploit the potential business opportunities (such as moving from a product-based sales model to a service-based one).

5. Concluding discussion

This paper aimed at investigating how business opportunities are perceived by a unique consortium furthering 5G technology and 5G markets. The business opportunities previously identified within the entrepreneurial opportunities research stream were identifiable in the narratives of the informants. In addition, we identified organizational opportunities as a category that allows for new business, and may even be seen as a prerequisite for exploiting other kinds of business opportunities. As firms restructure their organizational processes and innovation activities, they are at a better position to identify, create, and exploit potential business opportunities of 5G.

In addition, the findings indicate that there is a specific pattern related to opportunity identification, noticing links between events in the field of mobile communications that at first may seem unconnected. The informants largely view themselves as creating business opportunities through participating in a unique consortium, aiming at testing, verifying and developing the 5G technology (latency and reliability). In addition, testing and piloting activities take place in parallel projects, internally, as well as in buyer-seller relationship constellations (i.e., jointly with customers). All of these activities produce pieces of information that are puzzled together, forming a larger learning pattern that provides an overview of the development within the own field of business, the role of wireless connectivity through 5G technology and subsequently, potential business opportunities.

Concurrently with knowledge of technology increasing, the informants also report a broader picture of customer value created through deploying wireless technology in different areas of their business. Their mental models on the business opportunities, however, contain questions as regards actor roles in the new value networks and emerging ecosystem. As 5G networks are being commercially introduced, uncertainty is associated with new actors and their value-creating logic. Understanding the business opportunities other and new actors in the ecosystem are tapping into provides established actors with information on the development of the market as well as a possibility to position and navigate own activities in relation to the emerging ecosystem. Each actor

seeks to create value for itself and others, and the value-creating processes of 5G markets are yet to be developed. Social-cognitive theory suggests that past and current learning environments influence the individual's emotional, cognitive and behavioural reactions. Accordingly, opportunities are situated in an institutional social and cultural context; therefore, they arise for some people, who stand in particular relation to the context. The established players thus are at the forefront of the development, able to create value and business opportunities for themselves. They are also actively partaking in piloting activities, which allows them to extend networks and integrate into the ecosystem.

The impact of 5G is far-reaching. The uncertainty provoking questions concern how 5G services are rolled-out and who provide services to customers. Concurrently to the emergence of 5G-enabled vertical industry sectors, changes will occur in the traditional change telecommunication markets, which according to Rendón Schneir et al. (2018) forces telecommunication companies in less lucrative roles than was previously the case. The key to success with 5G is building can be identified in early market momentum (cf. Lemstra, 2018), which is visible in the case project. In addition, generational changes in mobile wireless technology have been proven to provide opportunities for new market niches (Nam et al., 2008), but also to lead to failure (Park et al., 2015a; Park et al., 2015b). The informants acknowledge the existence of business opportunities, which are currently concretely linked to technological opportunities. This is a natural outcome, as 5G technology is still being developed and deployed mostly on a test and piloting basis. However, the previously identified business opportunity categorizations are noticeable in the narratives of the informants, even though there are not so many examples among the vertical industry sector representatives of implementing the new technology as far as to actually generating business. The business opportunities are foremost associated with technology developers as well as mobile operators, i.e., traditional telecommunications actors. Nevertheless, a learning pattern is visible and occurs via testing and piloting activities.

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