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Strategic Positioning of Emerging 5G Technology - Barriers and Perspectives

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ABSTRACT

Since its introduction in the late seventies of the last century, mobile wireless communication has undergone significant stages of development, from analogue voice calls to nowadays latest state-of- the-art digital technology. The intense development of mobile communications networks, the increasing number of new types of mobile devices resulted in a large number of new applications being used and will increasingly be used in mobile connectivity and the expected growth of network traffic. The emerging and most promising one, the 5G technology, will probably not appear in the market until 2020 as a full scale commercial platform. 5G platform is expected to significantly improve customer service quality in the context of increased data volume in mobile networks and the growth of wireless devices with different services. In the near future, some of the main goals or requirements to be addressed by the 5G network are increased capacity, improved data transfer rates, reduced latency, and improved service quality. As per technological innovation theory taxonomy and strategic innovative positioning 5G technology is considered as game changer and disruptor. This paper displays how the global level key players, are preparing to introduce and boost the 5G network operability by using an inductive method, where broader EU arena with specific Croatian environment are used as a practitioners show cases.

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1. INTRODUCTION

For over four decades, speed mobile communications increased by around 100 million times thanks to the development and implementation of new technologies and the improvement of network infrastructure. When it comes to this network advantages, experts predict really impressive opportunities, and one of the most important is the data transfer rate, so the introduction of new technologies in Communications Infrastructure is expected to speed up to 100 Gbps. In that regard, 5G technology emerges as a mobile communications forefront, and technology will allow connectible emerging technologies, such as IOT (Internet of Things) technology experience real expansion as a result of significantly faster communication between all connected devices and the ability to exchange and store unimaginable quantities of data.

Such a scenario is particularly predicted in the industry, but in all other areas as well, especially when it comes to the autonomy of machines, cars and virtual and augmented reality. The Real expansion of applications for managing and communication with individual devices via the mobile phone, especially when it comes to a smart city and smart home solutions is to be expected.

As a result of the intensive implementation of the 5G technology, it is expected to increase the cost of infrastructure investments, as well as increased consumption of electricity. Those who first started with its introduction, game changers and the world global leaders such as South Korea, China, USA and Japan will be quickly convinced that this is the case of disruptive technology. Since this is still emerging technology, and its wider global application is expected only after 2020, the question of which countries will become leaders, and whether their approach will be an example of good practice and successful implementation in other countries, which applies to Croatia is arising. This is reason enough for the individual states to wait for the implementation of 5G technology, accepting the follower role. Therefore, this paper goal is to present strategic business review on economic, business and other benefits that 5G network brings, which are the opportunities that may be realized by introducing such technology, the interdependence and connectivity between technologies, and finally noticed disadvantages and barriers for its implementation. More specifically, this paper aims is to analyse how the global level key players, with particular focus on EU operating arena and Croatian operating environment, are preparing to introduce and boost the 5G network operability by use of an inductive method.

Following this introduction, a theoretical background and a literature review on current available research is presented. It includes the history of mobile communication development, presents the characteristics of 5G technology and its interaction as well as synergic potential with other emerging technologies and concludes with global perspective and barriers in its implementation. The third part presents obtained results based on the research of secondary sources on which strategies selected countries have undertaken, their implementation strategies, the barriers that telecommunication operators meet at local levels when it comes to implementation. Furthermore it analyses legal frameworks and standards required to enable equal conditions for all, both service providers on the one hand and users of services. Paper ends with resulting discussion on results and brief conclusions.

2. THEORETICAL BACKGROUND

2.1. History of mobile communication development

The history of mobile communication and its development is presented through various 'G' denominated mobile network technologies evolution phases. The first generation of G networks appeared in the early 80s. It had a data transfer rate of up to 2.4 kbps. The main disadvantages of such a network are lower capacities, misleading communication, weaker voice associations, and insecurity.

In such a network, voice calls are stored and played in radio towers, therefore increasing the vulnerability of these calls from unwanted eavesdropping.

The second generation was introduced at the end of the 1990s. Global Mobile Communications Systems (GSM) was the first generation system mainly used for voice communication and data transfer rate of up to 64 kbps. The 2G mobile phone battery lasted longer due to low power radio signals. It also provides services such as short message service (SMS) and email. Vital eminent technologies are GSM, Code Division Multiple Access (CDMA) and Interim Standard 95 (IS-95).

The 3G generation was established at the end of 2000. It reached the speed of 384 Kbps to 2 Mbps. The third- generation (3G) systems have joined the fast mobile access with the help of Internet Protocol (IP). Additional features such as global roaming and improved voice quality have made 3G a tremendous generation. The main disadvantage of 3G devices is the requirement of more power than most 2G models.

4G technology is considered the successor to 3G and 2G standards. Long Term Evolution (LTE) Advanced as the upcoming 4G standard, along with Mobile Worldwide Interoperability for Microwave Access (WIMAX) provides a reliable IP-based solution. The speed of this network ranges from 100 Mbps to 1 Gbps. Content such as voice, data, and multimedia will be assigned to subscribers every time and everywhere and at significantly higher data transfer rates compared to earlier generations. Applications using the 4G network include multimedia messaging (MMS), digital video broadcast (DVB) and video chat, highresolution TV content and mobile TV (Furht and Ahson, 2009). Summary table of data transfer rate evolution is presented in appendix 1.

2.2. Characteristics of 5G technology

5G is a brand new network concept combining the benefits of fixed and mobile communications. Although it will be considerably faster than currently available networks, the 5G not only provides faster speed, but also its built-in network intelligence and ability to interoperate with other technologies (Knezović, 2018). The GSM Association set out a number of technology related criteria that should serve as a standard which are not easy to reach, while some will certainly need to be further clarified or upgraded. The download time for high definition movies lasted five to six minutes, depending on the quality of the signal, but 5G networks will take up to five seconds, while resolutions, sound quality and other aspects will surely increase with time, so more time will be needed for this kind of content. It is plausible that manufacturers will initially launch only certain models with the 5G support in order to test the network, and 5G as a mobile phone standard may start from the next year or in 2020, when the networks become commercially available (Blažev, 2018).

The introduction of the 5G network requires the upgrading of existing technologies, as well as the introduction of completely new communication technologies. The first challenge is to design new network architecture and protocols for ultra-thin cellular applications.

The strategic approach to introducing new technologies implies a significant breakthrough in performance that previous models have failed to realize. It is commonly assumed that 5G mobile networks must address six challenges that 4G does not address effectively. These challenges are: higher capacity, higher data rate, lower End to End latency, massive device connectivity, cost reduction, and consistent quality experience (Fallgren and Timus, 2013).

2.3. Interaction and synergies with other emerging technologies

The upcoming 5G wireless network technology promises to be fast and efficient. And companies, in most cases, have been forced to upgrade their networks to remain competitive, even though they still do not see a persuasive case of using the 5G technology. The IoT device is a simple piece of technology, with a small computer unit, memory, an option to read / display communication and power. When used in large numbers, internet of things can simplify operations, improve the safety and security of people, enable more efficient use of energy, and even track our health. For decades, factories have used temperature sensors for temperature measurements, counting and production monitoring, and quality assurance. Only recently, sensors are connected to wires to provide greater flexibility in implementation, monitoring, and proactive maintenance.

5G will enable wireless sensors through the factory or warehouse, and smarter robots. Operators highlighted out the connectivity of phones, tablets and other devices, but connecting and managing more and more cars, meters, machine sensors and consumer electronics will profitably require innovative business models. Today, the vast majority of Internet affiliate revenue comes from connectivity, but in the next 5 years, revenue will also come from platforms, applications, and providing services. Operators capable of creating and managing the ecosystem of service partners, processing data from their IoT platforms and converting data into smart data will be able to generate incremental revenue based on data value, not just volume. Ericsson is already collaborating with more than 27 leading mobile operators around the world in 5G networking and usage cases, including 5G field testing. Deutsche Telecom has created IoT Solution Optimizer, a scalable online tool that provides technical consulting services and customers for reliable and cost-effective IoT solutions. This enables companies around the world to model and optimize the performance of IoT applications in a number of vertical industries such as intelligent city services, security or asset tracking.

Internet of things solutions optimizer is currently available for applications based on IoT's (NarutoBand IoT) mobile technology. NB-IoT solutions can be analysed and optimized for eight markets with Deutsche Telekom's networks: Austria, Croatia, the Czech Republic, Germany, the Netherlands, Poland, Slovakia and Hungary (Kirchhof, 2019). Like Device to Device (D2D) communications, Machine to Machine (M2M) communications are also expected to have the genuine support of the 5G wireless network. The main features of M2M communication include automatic generation, processing, transfer and exchange of data between intelligent machines, with minimal

human intervention (Zhang et al, 2012). Internet of things for operators and industries is a fertile ground for innovation and new ways of engaging the end-customers. Key success factors will be the ability to launch new short time services to the market from the idea to the commercial offer combined with the right business models and the access to the rich offer of complementary proposals of the ecosystem partners (Colella, 2017). In addition to the IOT, there is an inevitable functional connection with Big Data, Cloud and SDN in 5G Mobile Broadband Services (5G MBS). First, IoT is capable of generating Big Data with four Vs: Volume, Velocity, Variety and Veracity. Then Cloud gets to Big Data for storage and processing. Finally, the SDN is used to provide more efficient and flexible data transfer networks between the clouds. From large data, cloud and SDN, advanced technologies such as machine learning analytics, Cloud (Lin, Lin and Tung, 2016).

American companies are currently encouraged to be as efficient and productive as possible. These priorities have resulted in speeding up cloud acquisition and creating data from both the server and on the edge. Data will continue to transform the enterprise, developing IoT technology and artificial intelligence (AI) will enable companies to gain better insight into their business infrastructure through data analysis more than ever before. It is anticipated that until 2025, the public cloud will hold 55% of American data stored by organizations and consumers (Bayern, 2019).

IoT's services will spread through the industry and continue to develop through unique and innovative ways around us - seeking retail, housing, public sectors, businesses, cities, healthcare, food and beverage, industry and manufacturing. In the coming years, it is expected that the 5G technology will be scalable and energy-efficient and a pioneer in the massive internet of things world. Much attention will be directed to extreme simplicity, low energy consumption, and comprehensive coverage for challenging locations as well as increased link density so that networks can handle a large number of devices deployed for IoT applications. Connection density is the ability to support a successful certain size message delivery at a specific time, even in restricted space spaces such as a football stadium. It is expected that 5G will support up to 1 million connected devices at 0,80 square miles, compared to approximately 2,000 connected devices at 0,80 square miles of 4G.

Since 5G is becoming a reality, we will begin to see its full potential - for example life-saving applications that require low latency, high reliability, and constant availability. Robust latency-like applications can become a regular practice, saving valuable lives. 5G will be more productive than anything we've seen before. This will bring an increase in bandwidth (multi-gigabits per second) and incredibly low latency. Today, the entire mobile industry works together to ensure that 5G can support Massive IoT. But one thing that has also gone up on that road is the huge surface of the attack on hackers that IoT is creating (Notwey, 2017).

2.4. Global perspective and communication technology development barriers

In 2017, Korea Telecom announced the launch of a 5G test network ahead of the 2018 Winter Olympics in Seoul, South Korea, and they are considered the main promoters of the 5G network. The following are China, estimated to account for 40% of the world's 5G networks by 2025. According to the China Academy of Information and Communication Technology, the Research Department of the Ministry of Industry and Information Technology (MIIT), 5G could account for 3.2% of total Chinese GDP in 2025. Japan mobilizes its communications industry in the hope of being among the top 5G network players. The United States already has some advantages in the 5G network race. Namely, the US already has a leading role when it comes to the existing 4G network, thanks to its infrastructure. DELOITTE Global predicts that 2019 will be the year of the fifth generation (5G) broadband wireless network. By the end of 2018, 72 operators have already tested the 5G network, and by the end of 2019, 25 operators will be expected to start using the 5G network. It is expected that by 2020, at least 20 mobile device manufacturers will produce 5G ready mobile devices. One million 5G modems will be sold (also known as packets or hot spots), and about one million 5G fixed wireless access devices will be installed. During 2019 and 2020, 5G wireless technology will have three major applications. 5G will be used for mobile connectivity, mostly with devices such as smart phones.
5G will be used to connect "less mobile" devices, mostly 5G modems or hot spots: dedicated wireless access devices, small enough to be mobile, to connect to the 5G network and then connect to other devices via Wi-Fi technology. Fixed wireless access point (FWA) devices with permanently mounted antennas on the buildings or windows provide home or business network with broadband instead of wired connections (Duncan and Lee, 2019).

3. RESEARCH

As aforementioned, in reaching our research goal, which is to present the current status of 5G technology opportunities, barriers and project several plausible strategic developments on EU wide and Croatian environments we applied an inductive research approach methodology. It is mostly based on qualitative methods of data collection and data analysis of available secondary research sources.

1.1.EU wide challenges and strategies

European Commission in 2013 has set out significant resources to enable the 5G network in 2020 confirming by the fact that 5G technologies really represents an important direction in strategic positioning and orientation. This research starts with analysis of the frames within which the standards and guidelines for the introduction of the 5G network at the international and European level are regulated. There are also possibilities for individual operators when it comes to optimizing the costs of introducing the 5G network, as revenues are largely uncertain. The allocation and identification of a

globally harmonized spectrum in the frequency range require coordination between the global community, regional telecommunication organizations and national regulatory bodies.

ITU plays a key role in the development and adoption of these global regulations and standards. ITU is working to ensure that the 5G networks are secure, stable, reliable, interoperable, safe for human health and energy-efficient, and that they work without interference. The role of ITU in managing globally harmonized radio spectrum and standards for 5G is a key factor in the development and implementation of 5G. According to ITU's IMT-2020 program, ITU membership is developing international standards for achievement of ITU standards support networking innovations, such as software-defined networking, network virtualization, network-oriented networking, as well as advanced networking. These innovations will play a crucial role in making 5G networks faster, smarter, and more costeffective. These ITU standards also enable telecommunications companies to provide innovative services because they adapt to changing customer needs at a time of major change. These innovation-related software networking standards are expected to achieve their full potential in the 5G environment (ITU, 2018).

The Regulatory Body in Europe is the Body of European Regulators for Electronic Communications (BEREC). BEREC, the European telecommunications regulator, has released the final guidelines on how to strengthen network neutrality by requiring Internet service providers to treat all web traffic equally without favouring some services over others. However, 17 mobile operators, including Deutsche Telekom, Nokia, Orange, Vodafone and BT, are arguing for a more relaxed interpretation of the rules, as it is about returning investment returns to 5G. These operators agreed not to implement high-speed 5G networks unless BEREC does not take a smoother approach to network neutrality. In the European Digital Single Market Strategy Connectivity to a Competitive Single Digital Market - To meet the European gigabit society, the importance of a very high capacity network, such as 5G, is a key value for Europe's competitiveness in the world market. At the world level, 2025 revenue from 5G technology should reach a value of 225 billion euros (Knezović, 2018).

In 2013, the Commission established a public-private partnership (5G-PPP) with the support of 700m euros in public funding to ensure that 5G technologies become available in Europe by 2020. The European Commission has defined the basic guidelines for the introduction of 5G into Europe.

- Adjust the plans and priorities for the coordinated introduction of 5G technology in all EU member states
- Set the target of introducing the first network by 2018 and transition to commercial mass introduction no later than until the end of 2020
- Provide temporary frequency bands for 5G prior to the World Radio communication Conference 2019 (WRC-19), and to provide additional bands within the fastest possible time, and to establish the recommended approach for approval of special frequency bands for 5G above 6 GHz

- Promote the early introduction in large urban areas and along the main traffic routes
- Promote pan-European studies involving a large number of stakeholders, which will speed up the conversion of technical innovations into complete business solutions
- Facilitate the implementation of a venture capital fund aimed at supporting innovation based on 5G technologies, led by industry
- Unite leading stakeholders in effort to promote global standards (EC, 2015).

Many elements of current 5G technology are built on 4G networks rather than representing a complete departure - which means that mobile operators can take the evolutionary approach to infrastructure investments. In the implementation of the more efficient solution, operators will opt to upgrade their 4G networks to cope with the rising demand. It is expected that capital expenditure associated with the network will increase by 60% from 2020 to 2025, which will roughly double the total cost of ownership of telecom operators (TCOs) over that period. For example, operators could begin upgrading the capacity of their existing 4G macro network by overwriting part of their 2G and 3G spectrums, or by gaining additional spectrum when possible. This way, they can defer investments in 5G, or Long Term Evolution LTE and LTE-Pro features, such as 4x4 or MIMO (multi-input, multiple output technology). This evolutionary approach will be a natural path for most operators, allowing them to minimize investments, while the potential of 5G revenue remains uncertain. When network upgrades are not sufficient to support increased traffic, operators will have to build new macrocells or small cells. In rural and suburban areas, as well as on the roads, operators will set up macro objects. By contrast, many densely populated urban areas will have to rely on small cell solutions for two reasons: higher traffic concentration and higher bandwidth usage (Grijpink et al, 2018).

Apart from the high costs of deploying or changing the existing infrastructure, telecommunications operators such as Crown Castle, AT & T, Sprint, T-Mobile and Verizon also point out potential problems with local authorities - overcompensation, ban on small cells accommodation, unreasonable aesthetic constraints and long-lasting licensing processes (1824 months). Total Capital Expenditure CAPEX, which is incurred for each operator, will vary depending on the population, population density, current coverage of 4G, and the proposed coverage area. In addition, the cost of fibre implementation will be lower in cities with high availability and easy access to dense networks or fibres. Where the wireless backhaul is more costeffective than fibre, aggregation costs will be significantly reduced. In cities where the density of an existing macro network is high (eg. in Madrid), there will be less need for small cells. Similarly, mobile operators with large spectrum tasks do not have to reduce their networks with small cells (ITU, 2018).

Energy consumption and greenhouse gas emissions are two imminent world problems. Information and Communication Technologies (ICT) are responsible for a significant portion of global energy consumption. Power consumption by the grid (routers, fibre, and transmission) is about 12% of

electricity consumption in countries with broadband access enabled. It is estimated that by 2020, it will increase to about 20% (Xia et al, 2010).

Figure 1. The framework for applying 5G technology to practice

In 2013, The European Commission launched the 5G Public Private Partnership (5G-PPP) in order to accelerate the 5G technology research development. The EU has also launched international co-operation with Brazil, China, Japan and South Korea. The strong commitment of the European Commission for 5G led to the adoption of a challenging target for deployment of 5G (and generally a very large capacity network); defining detailed measures for the implementation of goals; and a proposal of legislative measures aimed at facilitating 5G development. In September 2016, the EC adopted a series of initiatives and legislative proposals for the telecommunications regulatory framework reform, including:

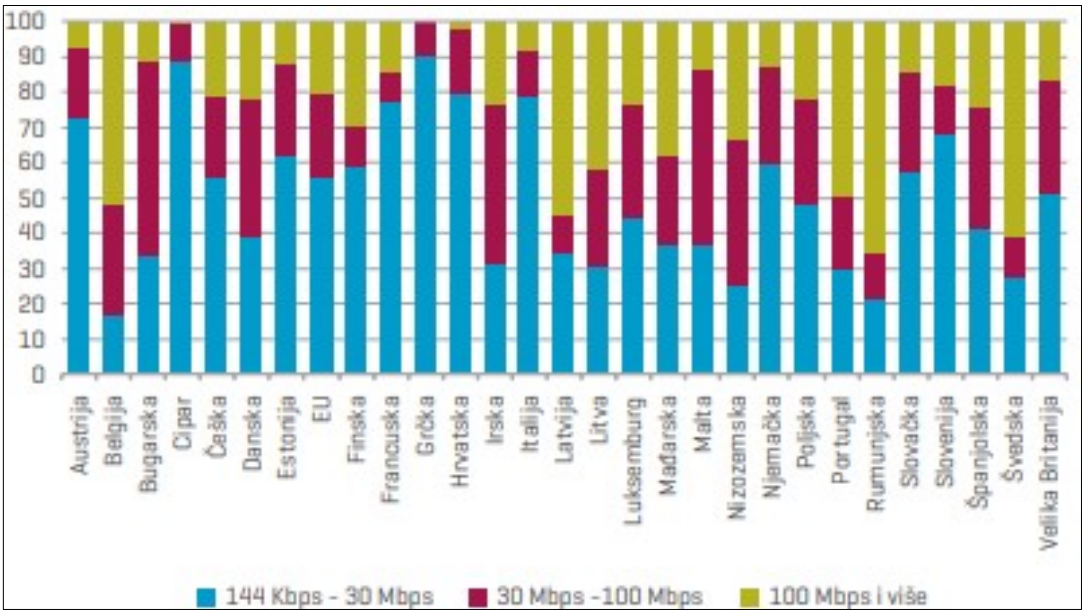
- Communication "Towards a European Gigabit Company", defining strategic goals for 2025: Europe's competitiveness, economic growth, jobs and cohesion;
- Communication "European Action Plan 5G", defining a joint plan and schedule for the introduction of 5G;
- The proposal of the Directive "Establishing a European Code of Electronic Communications", which ensures new harmonized rules on the communication network and services.

The European Commission has introduced the CE marking. It is needed for the electrical and electronic devices commercialization in Europe. The CE marking is based on the directives and proves that the product is rated and meets the EU safety requirements and health and environmental protection. The Directives define the essential requirements that products must meet. For electrical and electronic equipment, the European Standardization Organization (ESO) must develop coherent

European standards: the European Telecommunications Standards Institute ETSI, the Coinsuper Ecosystem Network CEN and the European Committee for Electrotechnical Standardization CENELEC. Standards set the requirements in order to ensure the co-existence of various communication services, the use of security and the absence of harmful substances (Bargis and Romano, 2017).

1.2. Case of Croatia, fragmented approach

In the case of the 5G technology in Croatia, one thing is certain, it's needed to define a strategy, build or adapt the infrastructure in accordance with the standards, and respect the guidelines of the Croatian Agency for the Management of Network Operations (HAKOM).



Graph 1. Broadband Approach

According to the latest available data from the European Commission, Croatia is at the mercy of Europe regarding broadband access, especially regarding the access to higher data rates. This situation is partly due to the high prices paid by Croatian citizens for broadband internet access.

Leading domestic operator Hrvatski Telekom (HT, subsidiary of Deutsche Telecom), as well as other operators, announced the additional mobile network upgrade investments in order to increase capacity for data traffic growth and faster Internet access, and investment in creating the foundation for the introduction of 5G technology. Second largest operator, VIPnet points out that good business results at the beginning of this year are related to investments of EUR 13.8 million in the expansion of the optical network and the development of mobile and fixed networks. In June this year, an agreement was reached between the Council of Europe, the European Commission and Parliament on the European Code of Communication, which will lead to EU citizens international calls price reduction (EIZG, 2018). HT has expanded its coverage with its most advanced 4G network based on

LTE technology. The availability of fast internet is the strategic direction of the Croatian Telecom which increases the coverage of 3G and 4G networks on a daily basis and offers the highest availability of both networks in Croatia. The project of Croatian Telecom network in cooperation with Ericsson Nikola Tesla started in Istria and will continue in remaining parts of Croatia. It is about introducing the SRAN (Single RAN) concept, which ensures the coexistence of 2G, 3G, 4G and 5G using the same equipment, enabling the 4G network capacity doubling and the latest functionality features like IoT. All available HT users will have access to increased capacity, which will ensure the smooth use of HT mobile services even in the most frequent period of the day. For this demonstration, a new Ericsson 5G radio station has been implemented, a 5G active antenna system that includes MIMO technology with multiple receiving and transmitting aerials.

4. CONCLUSIONS AND IMPLICATIONS

4.1. Discussion and Conclusions

This paper presents in detail the potential of this new technology that will definitely disrupt numerous business models and practices. However, there are also barriers in terms of investment capability as well as infrastructure and investment challenges when it comes to introducing this technology. New applications, such as D2D and M2M communications, internet content, vehicle communications, and healthcare applications are driving force behind 5G technology. Important challenges to be addressed by 5G networks are following: higher capacity and data rate, lower End to End latency, great connectivity of devices, reduced capital and operating costs, and QoE's quality of experience.

However, after the research carried out, it remains to be seen how the world will change with the 5G network, as the introduction of this new technology is still in the experimental phase, which is valid also for EU and Croatian areas. Although chronically lagging in technology innovation (Vlacic, Dabic and Aralica, 2018) and absorptive capacity (Vlacic et al, 2019) Croatia as a part of EU Digital Single market needs to boost 5G technology introduction momentum, to maintain its national competitiveness. We believe our research will serve as a guideline for future research when it comes to 5G networks, either at local or global scale. Results from this paper shell contribute in better understanding of 5G technology and its fields and intensity of influence, as well as guide and focus potential future research efforts particularly in the economies where it wasn’t evaluated sufficiently.

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