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Exploring the Applications of 5G Mobile Communication Networks: A Comprehensive Tutorial

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Abstract

Recently, the researches on Mobile 5th Generation (5G) networks have significant developments. All new 5G mobile technology will be around by 2020. The fifth generation (5G) cellular networks are expected to meet high requirements. Large amount of traffic data and enormous number of wireless connections is supported by the Fifth generation (5G) network. 5G mobile network seeks to address the limitations of previous cellular standards (i.e., 2G/3G/4G) and be an approaching key responsible for future Internet of Things (IoT). This paper presents a comprehensive overview of 5G applications which are obtained through information coming from various papers. 5G stakeholders will open up new frontiers of services and applications for next-generation wireless networks. In this paper, the main objective is to present 5G network; it's applications and also focusing on the Internet of Medical Things (IoMT).

1.INTRODUCTION:

The world has a rapid progress of cellular communication technologies from 2G GSM system to 5G. This new wave of technological revolution is changing the way we work, live, and communicate with each other. 5G mobile network aims to address the limitations of previous cellular standards (i.e., 2G/3G/4G). The Fifth generation (5G) network is projected to support large amount of data traffic and massive number of wireless connections. Different data traffic has different Quality of Service (QoS) requirements. The fourth industrial revolution is depended on digital revolution and noticeable by evolving technology breakthroughs in quantum computing, artificial intelligence, robotics, biotechnology, nanotechnology [1]. In the near future, mobile communication will break through every part of society and create a multi-dimensional, user-centric information ecosystem. In addition, connected society and a fully mobile is expected, which will be characterized by an unbelievable amount of progression in

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traffic volume, connectivity [2]. 5G networks provision a wide range of applications such as health and mission critical applications, smart home, entertainment and multimedia, autonomous driving, and Industrial IoT (IIoT), [3]. In 2020, accompanying the large-scale commercialization of 4G, the fifth generation of mobile communications (5G) is predictable to be commercialized and has come to be a main issue for worldwide research and development. Regardless of advanced 4G network, it is difficult to support mobile services that need high reliability, high speed, fast response, and energy efficiency. Instant cloud services, Internet of Things (IoT) [4], and enhanced Vehicle-to-Everything [5, 6] cannot be delivered by the Current 4G networks. Comparing with existing 4G, 5G networks involve novel wireless interfaces to provide spectrum efficiency and higher frequencies as illustrated in table 1. There is remarkable development in terms of management, signaling and accounting procedures, at the 5G core networks to harmonize the requirements from various ranges of new applications that are traditional category of mobile broadband [7].

Table 1. Comparison of 4G and 5G technologies

Specifications	4G	5G
Full form	Fourth Generation	Fifth Generation
Data Bandwidth	2 Mbps to 1Gbps	1Gbps and higher as per need
Frequency Band	2 to 8 GHz	3 to 300 GHz
Standards	OFDMA, MC-CDMA, network-LMPS	CDMA and BDMA
Service	Dynamic information access, Wearable devices, HD streaming, global roaming	Dynamic information access, Wearable devices, HD streaming, any demand of users

The deployment of 5G will provide extensive connectivity through its heterogeneous wireless access, ranging from macrocell (long range) to femtocell (short range). The coverage will span across, municipal area and metropolitan area down to sites and buildings as shown in figure 1. This widespread connectivity is the key to availability of service and seamless mobility which was centered in the cellular system. Given the new requests from autonomous driving, IoT and services of smart city [8], matching 5G capacity to the scale and progression of various 5G driven applications in sustainable manner and an economical is one important pursuit for 5G.

This task covers communication techniques, network architecture, ecosystem design and real deployment. Latest efforts have required the network function virtualization utilization, edge computing, software-defined networking and offloading, in addition to analyzing of distributed data [9]. Promising results have been shown from those technical innovations [10–20].

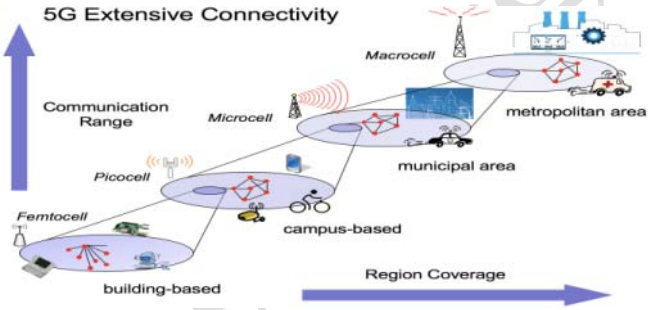

Figure 1: Envision of 5G Network Connectivity

In specific, vertical application domains was focused, which were built for objective enterprise and entities with certain requirements. As a strong step to clarify the requirements in the context of smart cities and IoT, the target is to answer the major question:" How the 5G applications can be merged through several vertical industries to reveal 5G full potential?"

And also highlights the 5G applications in different vertical domains, which can shed light on the development for engineers, researchers and policy makers from industry, academia, and government in the future. It's noticed that although this work presents an extensive sampling of current and emerging 5G applications, the study does not try to cover every nuance.

The rest of this paper is organized as follows. Section 2 provides an overview of application domains in 5G. Section 3 illustrates Internet of Medical Things (IoMT). Section 4 highlights on deployment 5G. We conclude our work in Section 5.

1. 5G Applications

A myriad of diverse applications in mobile networking have been created to develop the life quality of end users, containing digital commerce, social networking, smart

mobility and health care. Mobile applications are part of the Internet services, from a broader perspective, which have observed a quick development over the previous decades. As shown in Figure 2, the services of Internet have improved from world wide web, conventional point-to-point data exchange, mobile and social applications, to the current IoT services [21–23]. The applications are specified by the requirements for a network having ultra low latency, high reliability, availability and security.

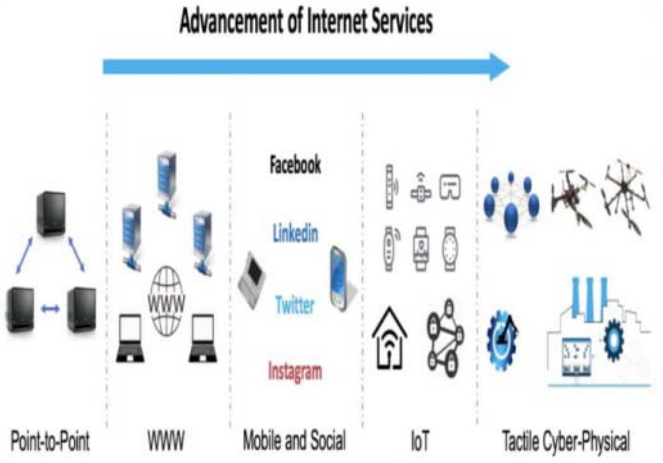

Figure 2: Advancement of Internet Services

Five domains are highlighted which can benefit from a tight integration with infrastructure of next generation cyber-physical and 5G. Figure 3 shows the application groups empowered by 5G.

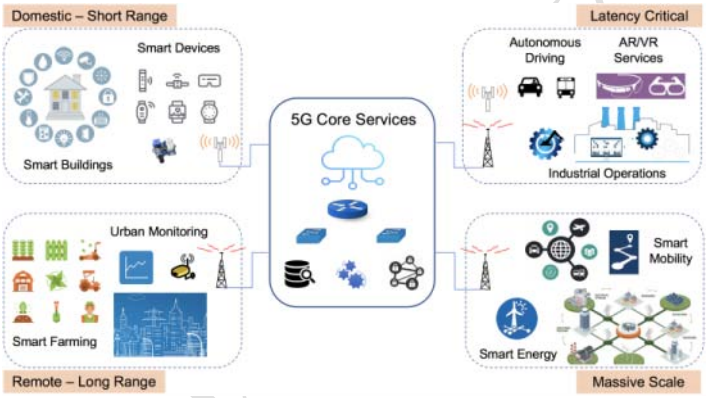

Figure 3: Application groups empowered by 5G

a- Smart Mobility: Mobility applications in 5G ranges changed from traditional planning route to the autonomous driving services and expanded sharing economics for smart transportation. The benefits of smart mobility include traffic balancing, routing, energy saving, emission reduction and cost [24].

From these applications, there is a strong request for 5G in order to provide pervasive connectivity, high speed, low latency, security, link reliability, security and low power consumption as shown in figure 4.

Figure 4: The strong requests for 5G

b- Smart Energy: This applications category involves power plant observing and management, smart network, power failure determination and response, new low Consumption services for office buildings and homes, energy marketplace and smart charging stations for electronic vehicles as shown in figure 5. Smart energy is predicted to improve reliability and efficiency of power systems by renewable energy and accomplish smart distribution. The 5G main demands are on link reliability, privacy and security [25, 26].

Figure 5: Smart Energy

c- Smart Health: applications of health are becoming well known among mobile users in order to widening the awareness of fitness and well-being as shown in figure 6.

Figure 6: Smart health

Together with the development of advanced wireless wearable's, uses of this classification have secured versatile based condition checking and finding the quality examination. With more information gathered from sensors conveyed on wearable gadgets, more advanced health will emphatically impact the medicinal and social insurance frameworks [27].

d- Industrial Applications: Applications, for example, Industry IoT 4.0 [28] demonstrate the up-and-coming age of digital physical administrations as far as assembling, machine-to-machine (M2M) correspondence, 3D printing and Artificial intelligence upheld development. The effect of those mechanical applications will stretch out past manufacturing plants, straightforwardly profiting the whole society. the real requests for 5G incorporate basically high unwavering quality, latency that are extremely low, deployment of massive scale, protection and security.

e- Consumer Applications: The huge measure of purchaser applications (Apps) illustrates the capability of 5G portable business and innovation advancements. As we know about ordinary versatile applications running on new phaplet and tablets, the rising applications incorporate ultra-HD (4K/8K), blockchain based financial innovation (FinTech), inescapable gaming (like Pokemon GO 1), versatile AR/VR blended reality administrations by UAV (unmanned aerial vehicle), and holographic innovation, for example, HoloLens.

Each one of those advanced services is requesting 5G to help broad network, high data transmission, low inertness, connect dependability and security.

2. Internet of Medical Things (IoMT)

The fundamental issue of new advancement computerized therapeutic is distant access to imaging and capability that how quick these pictures share data crosswise over locale with low distance and delay as shown in figure 7. Taking a model if a specialist is in one city of any locale, he needs any guidance from another specialist the he needs to move the medicinal pictures or results to that specialist and get its input at the ailment.

Figure 7: IoMT in Healthcare system [29]

These advices will help specialists to access most experienced people and empowers the medicinal services framework more productivity by improving troubles dependent on income and geography. This is the condition particularly in country zones or rural populaces [30]. In rural territories patients don't have the office to contact with modern medical specialist. With regards to the advanced digital world how these patients can get to specialists who are far away from them. It will link the urban/rustic individuals together which exists in separated countries. The patients won't need to travel long distance for therapeutic services. Today they won't constrain to their local specialists but they will approach a universal system of expert specialists. The Figure 7 has been demonstrated that 5G will satisfy the demands of network among patients and specialists. The IoMT will supply the medical devices and combined them together in one system for obtaining highly efficient system and facilitate on the patient.

There are a few security issues and genuine obstacles with information sharing, protection to take concerns so the 5G technology will be compensated with the issue. The 5G technology get evolutional steps that will be valuable to everyone. Though there is a remained issue to get over in the future of IoMT could be developed [31].

3. Deployment of 5G

Regarding to our main principle of this paper, how we can combine the 5G driven applications through multiple vertical industries to reveal the full potential of 5G?" we agree that this answer is non-trivial and this answer will reveal from improving a comprehensive piloting testbed including the

verified technologies and vertical industries. In this envisioned network testbed pilot require to merge various technologies and be compliant to governance and regulation. Shedding light on the 5G pilot, which will collect the efforts with Green Village 7, comparing it against TorontoWaterfront 9 and the Singtel 5G initiative 8. The summary of overall observations is in Table 2 in terms of experiment scale, operation model, driven technology, and project focus [32]. Given defies we defined, this pilot project must link the gap among research community, governmental institutes and industrial stakeholders. Specifically, from technical point of view, the imagined 5G pilot ought to enable us to: 1) analyze novel radio access advancements and their achievability for various 5G applications; 2) promoting novel applications by making a trail infrastructure before mass market entering; 3) show an unexpected limitations of network configurations; and 4) outline how to reduce unimportant replacement costs by a feasible migration path, which can prompt huge deployment scale. We should take note of that in spite of the fact that our work gives comprehensive sampling of existing and rising vertical applications, this investigation does not endeavor to cover each subtlety. Also, piloting can uncover new difficulties and be used to know the challenges nature. Other than that, the demands analysis and technologies discussed about can be executing to a wide range spectrum over 5G setting.

Table2: Comparison of 5G Pilot Initiatives

Pilots	Experiment Scale	Technology	Operation Model	Focus
Envisioned 5G Pilot	City Scale	5G driven	Public-Industry hybrid	Consumerand publicservices
Singtel 5G	Regional (Buona Vistaarea, Singapore)	5G driven	Company driven-Ericsson (vendor)	Network services
Toronto Waterfront	Regional (Portarea in Toronto)	Fixednetwork	Company-Google (cloud serviceprovider), and partiallypublicsector	Infrastructure oriented

4. Conclusion

The machine and human coexistence will diversify the future services of wireless environments with challenging cost. The appearance of the exceptional applications and services such as smart home, smart cities, artificial intelligence, autonomous vehicles, drone-based delivery systems, smart factories. we will concentrate in the near future on the energy, battery charge development and extension of the life time of the resource-constrained IoT-based wearable devices throughout patient's dynamic sign signals or video image transmission over 5G networks.

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