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# EMERGING WIRELESS TECHNOLOGIES AND ITS SOCIO-ECONOMIC EFFECT

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## Abstract

During the last 2 decades, wireless communications were the fastest growing segment of the modern technology. In fact, Smart phones have become a handheld device are vital part of billions of people, throughout the world. Starting from first generation 1g technology to upcoming 5G technology the trend of applications and uses are diversified. By 2025 with the cognitive use of Artificial Intelligence (AI) and Internet of Things (IoT) the applications will impact all human-machine interfaces in the society. The paper reviews and examines the trend of evolution of wireless technologies and its social-economic impacts. More specifically, it gives an overview on technological innovation trend with its all-round impacts on society. It also represents various aspects of challenges and actions.

**Keywords**—component; formatting; style; styling; insert (key words)

## INTRODUCTION

IN recent years, preliminary interest and discussions about a possible next generation 5G, IoT with AI technology which evolved into a full-fledged conversation that has captured the attention and imagination of researchers and engineers around the world. As the long-term evolution (LTE) system embodying 4G has now been deployed and is reaching maturity, where only incremental improvements and small amounts of new spectrum can be expected, it is natural for researchers to ponder "what's next?" [1]. However, this is not a mere intellectual exercise. released by Cisco, we have quantitative evidence that the wireless data explosion is real and will continue. Driven largely by smartphones, tablets, and video streaming and forecast makes plain that an incremental approach will not come close to meeting the demands that networks will face by 2020.

In just a decade, the amount of IP data handled by wireless networks will have increased by well over a factor of 100: from under 3 exabytes in 2010 to over 190 exabytes by 2018, on pace to exceed 500 exabytes by 2020. This deluge of data has been driven chiefly by video thus far, but new unforeseen applications can reasonably be expected to materialize by 2020.

In addition to the sheer volume of data, the number of devices and the data rates will continue to grow exponentially. The number of devices could reach the tens or even hundreds of billions by the time 5G comes to fruition, due to many new applications beyond personal communications [3]–[5]. It is our duty as engineers to meet these intense demands via innovative new technologies that are smart and efficient yet grounded in reality. Academia is engaging in collaborative projects such as METIS [6] and 5GNOW [7], while industry is driving preliminary 5G standardization activities (cf. Section IV-B). To further strengthen these activities, the public-private partnership for 5G infrastructure recently constituted in Europe will funnel massive amounts of funds into related research [8].

This article is an attempt to summarize and overview many of these exciting developments, including the papers in this special issue. In addition to the highly visible demand for ever more network capacity, there are a number of other factors that make 5G interesting, including the potentially disruptive move to millimeter wave (mm Wave) spectrum, new market driven ways of allocating and re-allocating bandwidth, a major ongoing virtualization in the core network that might progressively spread to the edges, the possibility of an "Internet of Things" comprised of billions of miscellaneous devices, and the increasing integration of past and current cellular and Wi-Fi standards to provide a ubiquitous high-rate, low-latency experience for network users. This editorial commences with our view of the "big three" 5G technologies: ultra-densification, mm Wave, and massive multiple-input multiple-output (MIMO). Then, we consider important issues concerning the basic transmission waveform, the increasing virtualization of the network infrastructure, and the need for greatly increased energy efficiency. Finally, we provide a comprehensive discussion of the equally important regulatory and standardization issues that will need to be addressed for 5G, with a focus on needed innovation in spectrum regulation. The different generations of wireless communication systems are represented in Table-1. The swift changes of communication technologies have been evolved in each decade starting from 1980s. The applications of wireless communication have been slowly diversified to touch every aspect of life, starting from voice, video, multimedia to IoT. Each generation equips

more mobility, lower latency and higher data rates. The CAPEX and OPEX are also significantly reducing, which facilitates the end user a better quality of service and quality of experience. With 5G coming in with IoT, the applications will be not limited to only means of people to people communication, rather the application will be diversified to connect all devices which we are using in our daily life. Starting from connected car, smart home, smart office, smart city etc.

The paper is organized as follows, in section II the communication technology evolution with various applications are discussed, section III the socio-economic effects are represented with various statistical data, in section IV the challenges and solutions are discussed. The section V concludes the discussion followed by the references.

**Table 1 Comparison of Mobile Communication Generations**

| Generation→ Features↓ | 1G | 2G | 3G | 4G | 5G |
|---|---|---|---|---|---|
| Deployment | 1970 – 1981 | 1980 - 2001 | 2001-2010 | 2011 | 2015-20 onwards |
| Data Rates | 2kbps | 14.4-64kbps | 2Mbps | 200 Mbps to 1 Gbps | 1Gbps and higher |
| Technology | Analog Cellular Technology | Digital Cellular Technology Digital narrow band circuit data Packet data | Digital Broadband Packet data CDMA 2000 EVDO UMTS EDGE | Digital Broadband Packet data WiMax LTE Wi-Fi | wwww Unified IP seamless combination of broadband LAN PAN MAN WLAN |
| Service | Analog voice service No data service | Digital voice with higher clarity SMS, MMS Higher capacity packetized data | Enhanced audio video streaming video conferencing support Web browsing at higher speeds IPTV support | Enhanced audio, video streaming IP telephony HD mobile TV | Dynamic Information access, Wearable devices with AI Capabilities |
| Multiplexing Switching | FDMA | TDMA, CDMA | CDMA | CDMA | CDMA |
| Core Network | PSTN | PSTN | Packet N/W | Internet | Internet |
| Standards | MTS AMTS IMTS | 2G-GSM 2.5-GPRS 2.75-EDGE | IMT-2000 3.5G-HSDPA 3.75G-HSUPA | Single unified standard LTE, WiMAX | Single unified standard |
| WEB Standard | | www | www(IPv4) | www (IPv6) | www (IPv6) |
| Handoff | Horizontal only | Horizontal only | Horizontal & Vertical | Horizontal & Vertical | Horizontal & Vertical |
| Shortfalls | Low capacity, Unreliable handoff, Poor voice links, Less secure | Digital signals were reliant on location & proximity, required strong digital signals to help mobile phones | Need to accommodate higher network capacity | Being deployed | Yet to be implemented |

# TECHNOLOGY EVOLUTION

The incremental benefits of next generation mobile communication technologies such as 5G, IoT and AI, on economic growth have not fully explored yet. A 5G concept, along with relevant technology components, is being developed to address those future requirements (e.g., [1, 3]). These aspects are also translated to 5G propagation modeling requirements. To achieve higher data rates, radio frequencies above 6 GHz have been attracting attention as one of the promising solutions because of their potential to allow wider bandwidths than legacy radio systems operating below 6 GHz. Ultra-dense networks (UDNs) using small cells can take advantage of the propagation properties of the high frequencies, showing higher path loss in the surrounding environment for improving multi-user and multicell interference management over space.

To more concretely understand the engineering challenges facing 5G, and to plan to meet them, it is necessary to first identify the requirements for a 5G system. [5,8] The following Items are requirements in each key dimension, but it should be stressed that not all of these need to be satisfied simultaneously. Different applications will place different requirements on the performance, and peak requirements that will need to be satisfied in certain configurations are mentioned below. For example, very-high-rate applications such as streaming high-definition video may have relaxed latency and reliability requirements compared to driverless cars or public safety applications, where latency and reliability are paramount but lower data rates can be tolerated.

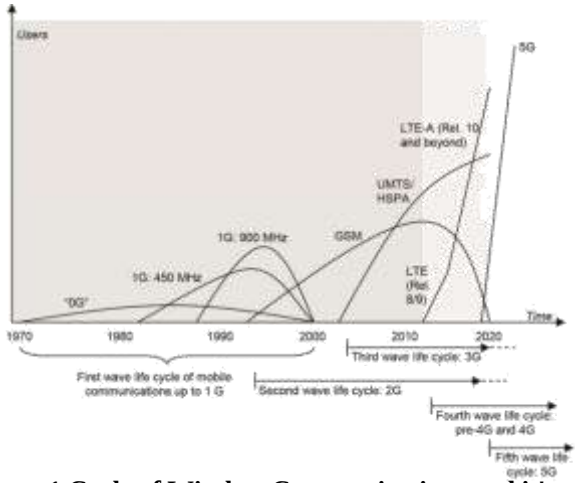


**Figure 1 Cycle of Wireless Communications and it's Generations**

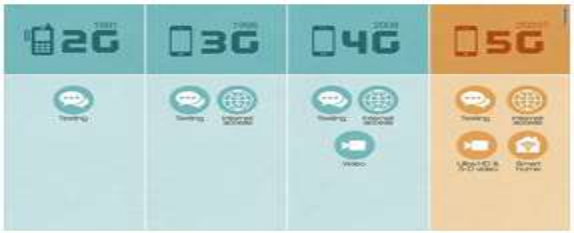


**Figure 2 Applications of different generations of wireless communication**

As per the demonstration of the survey the two aspects of the changes are significantly visible, one is the increasing trend of the data rate per second and other is the versatility of the uses of digital technology in almost every aspect of our daily life. The cycle of the data rate is shown in figure 1. For the end users the applications are more than the horizon of today's imagination, starting from social networking to health care, transport, smart home, city, office and putting intelligence to the systems used on our day to day life. The increasing trend of diversified applications of 5G networks are shown in figure-2.

# SOCIO-ECONOMIC IMPACTS

The economic impact of wireless mobile communication is obvious. In the following, the reasons for higher penetration rates, as well as industry investments. The next generation technology with higher penetration is becoming the catalyst for changing the behavior of the society. Now the society is becoming more virtual and highly connected world.

The Nearly every sector of the society commences the digital revolution has tuned long standing business model's upside down. The speed of transformation is governed by the advances in connectivity technology, changes in consumer behavior, the emergence of new business models, environmental trends and regulatory practices. As per the survey the trend of data uses shown in figure-3 & 4 are in increasing trend, not only that, the users penetration for adopting new technology of high speed data are increasing and the conventional data services are in decreasing trend. [9, 10] So, the legacy economy and society to become agile, data services will influence all decisions.

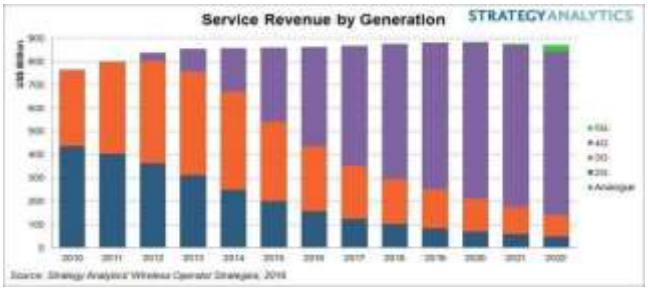


**Figure 3 Service Revenue Trend**

The world population today appx 7 Billion, but the number of mobile phones hit at 7.2 Billion, the world has never been so connected. With the current evolution of 5G and IoT its expected by 2020 the number of connected devices will reach at 28.1 Billion. [10] The challenges for the other industries to adopt, thrive and stay relevant in such connected flux.

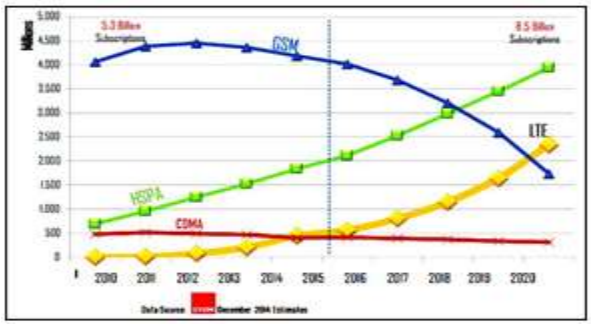


**Figure 4 Prediction for the status of adaptation of new technology.**

# CHALLENGES AND SOLUTIONS

The leadership must be comfortable in working with new technology and must adopt a faster changing technology arena. Competitive advantage gained when data and analytics are aligned and used as a business tool throughout the organization. In dynamic industry where digital data is a new concept, getting the basic right is essential for long run. Need to create digital talent strategy to support data driven digital skill requirements. [10]. The industry's traditional value chain of original equipment manufacturers (OEMs), suppliers, retailers and the aftermarket has been disrupted by new, digitally astute entrants in both the existing and extended value chain. New technologies have propelled business model innovations that have challenged and extended the standard value chain in offering new products and services to the evolved market.

# CONCLUSION

In this paper, the discussion on wireless technology evolutions are made very abstract level. In the consequent sections the trend of technology changes, applications are presented through statistical representations. The challenges are possible future directive solutions are analyzed from various economic and social forums and presented collectively. Therefore, in the light of the emerging wireless potential of next generation technology. As vision becomes reality, it will be luxury for being present at an area where we will be not connected at any means.

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