www.idosr.org Xiao and Lu
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International Digital Organization for Scientific Research ISSN: 2550-794X
IDOSR JOURNAL OF SCIENTIFIC RESEARCH 5(2) 40-46, 2020.

5G Network: An Overview of the Pros and Cons

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ABSTRACT

In the twenty-first century, some of the prime objectives or demands that need to be addressed are increased capacity, improved data rate, decreased latency, and better quality of service. To meet these demands, drastic improvements need to be made in cellular network architecture. Emerging 5G mobile services are investigated and categorized from the perspective of not service providers, but end-users. The development of 5G mobile services is based on an intensive analysis of the global trends in mobile services. 5G technologies will change the way most high bandwidth users access their phones. With 5G pushed over a VOIP-enabled device, people will experience a level of call volume and data transmission never experienced before.5G technology is offering the services in Product Engineering, Documentation, supporting electronic transactions (e-Payments, etransactions) etc. As the customer becomes more and more aware of the mobile phone technology, they will look for a decent package all together, including all the advanced features a cellular phone can have. Hence the search for new technology is always the main motive of the leading cell phone giants to out innovate their competitors. The ultimate goal of 5G is to design a real wireless world that is free from obstacles of the earlier generations. This requires an integration of networks. In this article, the authors review 5G network, looking at the merits and the demerits to ascertain if 5G network is actually worth it.

Keywords: 5G network, 5G technology, Mobile technology, Telecommunication, Network.

INTRODUCTION

5G Technology stands for 5th Generation Mobile technology. 5G technology has changed the means to use cell phones within very high bandwidth. 5G is a packet switched wireless system with wide area coverage and high throughput. 5G wireless uses OFDM and millimeter wireless that enables data rate of 20 mbps and frequency band of 2-8 GHz. 5G is going to be a packed based network . The 5G communication system is envisioned as the real wireless network, capable of supporting wireless World Wide Web (www) applications in 2010 to 2015 time frame.

There are two views of 5G systems: evolutionary and revolutionary. In the evolutionary view, the 5G (or beyond 4G) systems will be capable of supporting www allowing a highly flexible network such as a Dynamic Adhoc Wireless Network (*DAWN*). In this view advanced technologies including intelligent antenna and flexible modulation are keys to optimize the adhoc wireless networks.

In revolutionary view 5G systems should be an intelligent technology capable of interconnecting the entire world without limits. An example application could be a robot with built-in wireless communication with artificial intelligence. Users never experienced ever before such a high value technology [1] [2]. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future.

Amazingly, isn't it such a huge collection of technology being integrated into a small device. The 5G technology provides the mobile phone users more features and efficiency than the 1000 lunar module. A user of mobile phone can easily hook their 5G technology gadget with laptops or tablets to acquire broadband internet connectivity [3]. Up till now following

features of the 5G technology have come to surface- High resolution is offered by 5G for extreme mobile users, it also offers bidirectional huge bandwidth. 5G technology's excellent quality service is based on policy in order to evade errors.
It provides transporter class type gateway that has unequalled steadiness. The 5G technology's billing interface is highly advanced making it efficient and appealing. It offers huge quantity of broadcasting data, which is in Giga Bytes, sustaining more than 60,000 connections [4] [5]. This technology also provides remote diagnostic feature. It provides up to 25 megabytes per second connectivity. Also it supports the private virtual networks.
The exact definition of 5G has always been debated. In a recent report published by GSMA Intelligence, they portray that there are two views of 5G technology that exist today: the hyper-connected vision and the next-generation radio access technology [6]. The first one, the hyper-connected vision, is described as a new technology where all the useful features from the existing generations like the 2G, 3G, and 4G are scraped out to create a better system that can provide the users with broader implications than the 4G and LTE that exist today [7].
Even though this technology provides a better service than any other existing technology, this cannot be considered a true "generational shift". This is where the concept of a next-generation radio access technology comes in [8]. The idea is to provide the users with the bandwidth throughput of over a gigabit per second and a sub one millisecond response time (latency). Currently, there exists a standard that has to be met by a technology to be considered 5G [9].

Benefits of 5G Network

- **Massive Contents Streaming**

The development of digital and telecommunication technologies increases the demand for multimedia content. Such demand has been rapidly expanding over the past years in the form of broadcasting, movies, Internet and personal media. The continuous development of display technologies means that 5G technologies should be able to stream 4-K and 8-K ultra-high-definition (UHD) contents [10]. It is anticipated that 5G will support expanding multimedia services such as multi-view interactive 3D, personal multimedia broadcasting, massive content sharing and 3D holograms as shown in Figure 5. Multidimensional realistic media offers information that can be seen, heard and felt through the five senses, and hence, it overcomes spatial and time constraints [11].
5G is required to support such multidimensional realistic media services. For example, the user can enjoy a big sports event through a real-time hyper-realistic mobile hologram table. Moreover, holographic short message service (SMS) information can be transferred through 5G in conjunction with hologram technology [12]. Though the current technology offers HD video call services, user experience is still far away from face-to-face conversation. Hence, this gap in the user's experience is expected to decrease significantly with 5G massive content streaming services [13]. To achieve realistic services for users, hologram generation and delivery is the most desirable feature of 5G technology.
4G offers a 1-Gbps transmission rate, but it is still not able to provide holographic telecommunication services. Thus, it is important to ensure that 5G wireless technology and core networks are able to provide real-time hyper-realistic mobile holographic telecommunication services. However, hologram services require a bandwidth of several terabytes per second, and it is not possible to process holograms even with the 5G bandwidth [14]. Still, restrictive hologram services with the minimum rate are possible. Future 5G research should concentrate on improving compression efficiency and decoding algorithms.

- **Energy-efficient and green networking**

Both human- and machine-centric communication require efficient mechanisms to improve energy efficiency over the current levels due to the limited battery lifetime of mobile handheld devices [15]. Whereas spectral efficiency has been the dominant topic in network optimization over the past decades, the focus of the recent optimization efforts has been shifting toward "bits-per-Joule" and "throughput-per-Joule" metrics, as demanded by small form-factor user equipment, where wireless power consumption contributes the most to the overall power budget [16]. Correspondingly, the emphasis of the latest research has been put onto accounting for the transmit power consumption, together with the associated circuit power expenditures, across a multi-radio multi-cell wireless environment to improve over existing power allocation mechanisms and approach green networking [17].

- **User-Centric Computing**

The user receives content after recognizing, interpreting and inferring on big data-based situational information collected through various sensors. Intelligent health services, such as personal health care, psychotherapy, de-stressing, business coaching, etc., are based on the big data analysis of life-logs. Future networks are expected to be more congested due to the increasing number of devices and data traffic. Consequently, this increases network delay and may hamper connectivity to cloud computing servers.

The use of mobile edge computing is handy to reduce network delay and maximize efficiency when utilizing network resources [18]. Moreover, it is also useful for mobile services like smart cars, smart health care, industrial automobiles, augmented reality and gaming. Mobile edge computing and accurate big data analysis of data coming from sensors are essential to provide prompt and timely response in the case of any disaster. They are also helpful to counteract climate change and industrial accidents.

The increasing demand of data traffic requires future 5G technology to increase the data rate and decrease latency. Energy efficient actuators and sensors are necessary to support green communication. Moreover, low-power telecommunication technology is another desirable 5G feature. In short, 5G must provide efficient big data processing and rapid big data transmission with minimum latency [19]. Additionally, accurate localization of mobile terminals is required to provide these services in a timely manner.

- **Network-assisted device-to-device Communications**

Whereas deploying an increasing density of multi-radio small cells becomes the mainstream direction toward the 5G, network densification naturally implies considerable capital and operational expenditures to install and manage the extra base stations. Therefore, dense HetNets may sometimes require prohibitive investment from the network operators thus making them seek for alternative methods to offload cellular network traffic. Moreover, handling a network with multi-RAT small cells of different sizes may incur significant challenges in cross-cell interference coordination, as well as result in very complex control procedures for network assistance.

Fortunately, there is an alternative solution to offload some of the cellular traffic onto direct device-to-device (D2D) radio links as these are typically shorter and thus more spectrally efficient than the conventional small cell connections [20]. With much of the current mobile traffic growth coming from peer-to-peer applications and services, which typically involve people in close proximity, the benefits of D2D communications for data offloading are becoming increasingly attractive [21]. While D2D-based operation does not employ broadband infrastructure for transferring user data, cellular connectivity may still help by providing assistance with device discovery, D2D connection establishment, and service continuity. All in all, D2D technology can alleviate cellular congestion without the cost of additional networking infrastructure thus having the potential for new service revenues [22].

Direct connectivity may potentially exist in two different forms: as licensed-bands D2D (a.k.a LTE-Direct), when direct links

between devices employ cellular spectrum, and unlicensed-bands D2D, utilizing other RATs than cellular for direct connections (e.g., over WiFi-Direct). The former solution is attractive as the cellular network has full control over the in-band D2D links [23], but it also requires significant intelligence to coordinate simultaneously running user transmissions and mitigate harmful interference between them, which does not exist in the standards today. Given the slow progress of respective study and work items in 3GPP (as the result of numerous technical challenges), we do not expect LTE-Direct technology on the market for several years to come. However, research on this topic becomes very timely and is steadily getting momentum worldwide.
An alternative to licensed-bands D2D communications is to connect proximate devices over the unlicensed frequencies, that is, by employing WiFi or Bluetooth technologies. Whereas there is a possibility to communicate over WiFi/Bluetooth also without centralized assistance, there are numerous ways in which cellular infrastructure may help improve otherwise uncoordinated connectivity [24]. Indeed, given that the lion's share of current user equipment is multi-radio devices capable of running simultaneous LTE and WiFi connections, the control coming from the cellular network may improve session continuity, reduce user contention, and facilitate security procedures. Therefore, investigation of unlicensed-bands D2D connectivity remains an attractive research area.

- **Internet of Things**

5G introduces many heterogeneous devices with different characteristics as compared to 4G. The introduction of wearable devices and network-connected home devices that often communicate with each other generates much exchange of information. These information exchanges generate huge volume of information in various dimensions that are saved in storage devices and are later processed using big data technologies. Internet of Things (IoT) can be categorized into smart personal networks, smart buildings and smart cities, depending on its application and network size.
Smart personal networks contain smart watches, smart glasses, various healthcare devices and motion detection devices. A feature of smart personal network services is monitoring personal health conditions and suggesting exercises or medicine. The market volume of these devices is expected to increase to 162.9 million units in 2020 [25]. Smart buildings contain various sensors, light and temperature controllers, efficient energy controllers and crime prevention systems. In smart cities, efficient traffic light control systems can be deployed using various types of traffic sensors. This will eventually help to control traffic smartly while communicating with vehicles and road side units (RSUs).
IoT is helpful in establishing efficient city infrastructure by using big data technologies to process information about traffic flow. Then, it is possible to inform users of the recommended transportation and the estimated arrival time according to traffic conditions. However, a network with low latency is a prerequisite or an otherwise serious problems in traffic safety might take place. The massive increase in network connected devices will soon exhaust the International Mobile Subscriber Identity (IMSI) and IPv4.
In future IoT scenarios, a tremendous amount of connected devices will be present compared to current 4G network scenarios. Therefore, 5G technologies for transmission and networks have to be able to maintain multiple network connections with many devices using limited resources. Currently, the pricing policy of mobile services is applied per terminal or connection. The number of terminals is expected to increase exponentially; therefore, a new criteria of billing is required.

Disadvantages of 5G Network

Health Effects

The potential 5G adverse effects derive from the intrinsic nature of the radiation, and its interaction with tissue and target structures. 4G networking technology was associated mainly with carrier frequencies in the range of ~1-2.5 GHz (cell phones, WiFi). The wavelength of 1 GHz radiation is 30 cm, and the penetration depth in human tissue is a few centimeters. In its highest performance (high-band) mode, 5G networking technology is mainly associated with carrier frequencies at least an order of magnitude greater than the 4G frequencies. Penetration depths for the carrier frequency component of high-band 5G wireless radiation will be on the order of a few millimeters [5]. At these wavelengths, one can expect resonance phenomena with small-scale human structures [26].

Additionally, numerical simulations of millimeter-wave radiation resonances with insects showed a general increase in absorbed RF power at and above 6 GHz, in comparison to the absorbed RF power below 6 GHz. A shift of 10 % of the incident power density to frequencies above 6 GHz was predicted to lead to an increase in absorbed power between 3–370 % [4]. The common 'wisdom' presented in the literature and media is that, if there are adverse impacts resulting from high-band 5 G, the main impacts will be focused on near-surface phenomena, such as skin cancer, cataracts, and other skin conditions. However, there is evidence that biological responses to millimeter-wave irradiation can be initiated within the skin, and the subsequent systemic signaling in the skin can result in physiological effects on the nervous system, heart, and immune system [15].

CONCLUSION

Wireless radiation offers the promise of improved remote sensing, improved communications and data transfer, and improved connectivity. Unfortunately, there is a large body of data from laboratory and epidemiological studies showing that previous and present generations of wireless networking technology have significant adverse health impacts. Therefore, more research and testing of potential 5G health effects under real-life conditions is required to ensure that the adverse health effects does not outweigh the numerous benefits.

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