

COMPREHENSIVE SURVEY OF WIRELESS COGNITIVE AND 5G NETWORKS

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Abstract: The tremendous progress in the wireless mobile communication devices and the continuous growth in the data rates and the usage with the entailment of enhanced performance in the network in the terms of the throughput, delay, energy utilization, data capacity, bandwidth utilization and the cost have led to the emergence of the 5G networks. The flexible transmission empowered by the cognitive radio networks make them prominent in the transmission of the applications that are significant and sensitive to latency. The paper surveys the details of the 5G network, the cognitive radio networks and the impacts in the network by having the cognitive radio in the 5G mobile wireless networks.

Keywords: 5th Generation Network, Cognitive Radio Networks, Data Traffic, Quality of service and Radio spectrum

1. INTRODUCTION

The rapid developments in the mobile communication devices and the wireless communication systems causes multitudes of issues that are related to the rates of the data that are very high and the crowded users and the entailment of the users regarding the peer to peer performance and the user acquaintance. In the recent decades the wireless network based on the mobile communication have undergone momentous modifications in the mechanism of the operation such as data capacity, technology, latency frequency and the speed. Many issues come up with the newly arising application that demand for the lower energy consumption, with diminished latency and reduced cost even when equipped with huge set of devices, and data rates pave way for the 5G wireless networks. The requirement of the wireless network on the terms of delay, throughput, energy consumption and cost has resulted to

the development of the 5G wireless systems. The 5G being the fifth generation of the wireless communication systems pave way for the simultaneous transmission of the data from both the devices that mobile as well stationary without the necessity of plugging. The emerging 5G would result with a significant leap in the mobile based wireless technologies. The fifth generation network has the capability of working perfectly in the low frequency networks and the frequencies that are unlicensed. They even provide greater benefits when working with the higher frequencies so they are compatible operating with the millimeter wave and capable of transmitting huge amount of data, the fig 1 below shows the millimeter wireless access

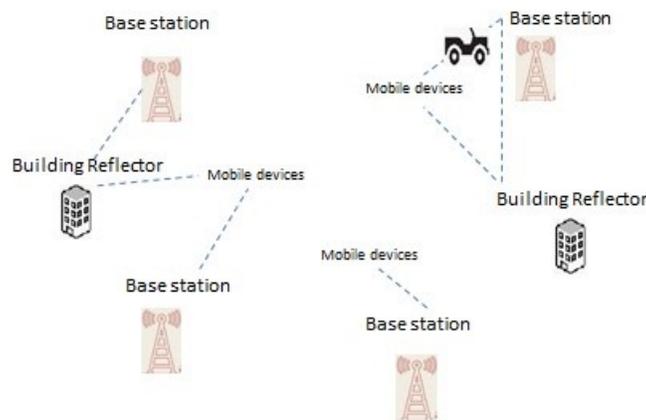


Fig .1 Millimeter Wireless Access

The fifth generation network complements the traditional cellular networks utilizing the smaller cells (portable base stations) and huge number of antennas in the source and the destination to heighten the speed of the transmission and its efficiency. The employing multitudes of antennas lead to the beam forming to frame the trail of the data-delivery effectively and help the multiple antennas to utilize the spectrum in a more efficient way. The 5G makes use of the full duplex strategy to multiply the speed in the wireless communication. The signal interference caused by the full duplex, necessitates the SDN and the NFV to lay as the foundation for the detailing the deployment of the 5G networks. The fig.2 details the essential requirements of the 5G networks.

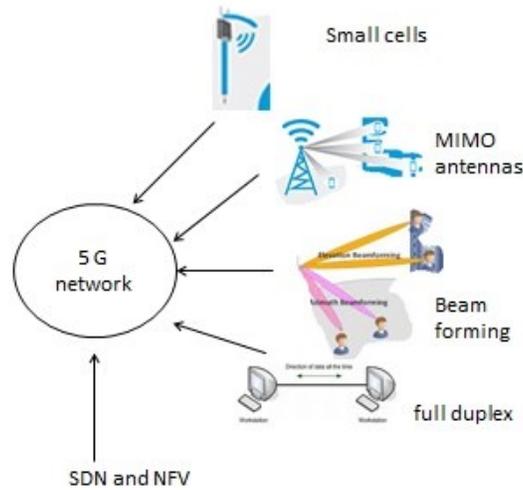


Fig.2 The Essential Requirements of 5G

The cognitive radio network that allows a flexible transmission of the delay sensitive and the significant applications could improve the usage of the congested spectrum in the mobile network by allowing a flexible and a dynamic access of the spectrum and enable the sharing of spectrum with the licensed system. The cognitive radio networks in the 5G would pave for improvement in the 5G networks.

The paper is a survey on the significance of the 5G and the cognitive radio networks and the network enhancements that could be enabled with the cognitive in the 5G.

The remaining of the paper proceeds with the details on evolution of 5G in the section 2, Significance of the CRN in the section 3 and the impacts in the network caused by the CRN in the 5G networks in the section 4 and conclusion in the section 5.

2. EVOLUTION OF 5G NETWORKS

The evolution of generation in the wireless networks, usually means the alterations or the modification in the fundamental mannerism of the network such as, their improved capabilities in handling the data rates, the speed in

transmission at a reduced cost and the power consumption and even more, usually the high data rates and the increased number of the users lead to the evolving of generations. This all happened to start with the initiation of the first generation network in the 1972, that was purely dependent on the analog to analog networks. The speech services using the analog transmission introduced by the NTT from Tokyo and the advanced mobile phone system introduced by the USA, this mobile telephony service, was supported with the frequency division multiplexing and had a 2 kilobits per second and was very useful in the smaller reuse. In the 1980 the next generation emerged with the digital multiple accesses ensuring a higher bandwidth access and an enhanced efficiency than the first generation later, in the third generation evolved with the even improved clarity by utilizing the wide band wireless network. The fourth generation in the year 2005 emerged with the capability of packet transmission at the real time, the 4G engaging with the heterogeneous networks faced major problems and complexities due to the increasing data rates and the number of the users, so this lead to the emergence of the fifth generation, that paved way for a limitation less, wireless connections that are complete. The technology would likely expected to offer an higher speed, higher bandwidth, heightened capacity and a larger broadcasting of data with a better coverage and lower latency compared to the previous generations[11][17]. The fig .3 below shows the evolution of generations from the first to the fifth.

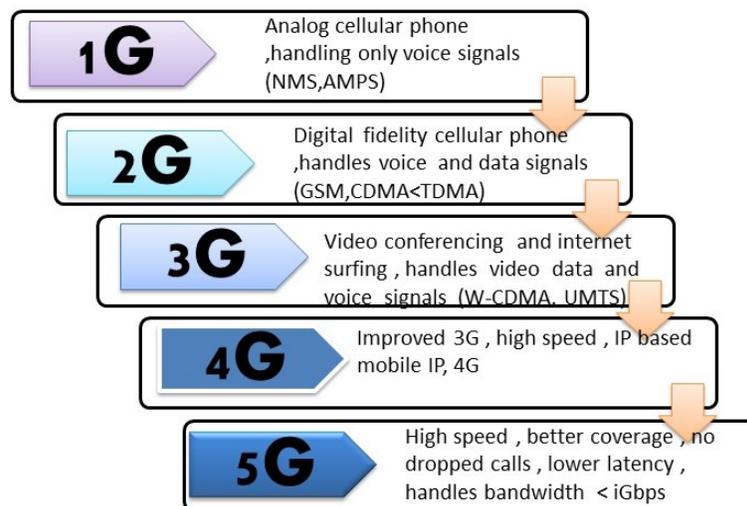


Fig.3 Evolution 1G to 5G

The Fig. 3 gives the evolution of the 1G to 5G based on the survey conducted [11] [17]. The complexities of the 4G heterogeneous system, in broadcasting the intimation messages of service confirmation or subscription , challenges in the mobility of the terminals and the inefficiency in the utilization of the spectrum is the cause for the evolution of the next generation that is the 5G, the table below provides the features of the generations from first to the fifth is presented in the table .1 below [11][17][4][2][9][15]

Generations	Descriptions	Merits	Demerits
First	Founded on the year 1970-1980, operates at 2Kbps , with the analog cellular technology based on FDMA, circuit switching and PSTN as Core network , used in the analog phone call services	The Mobility in the provision of service	faced challenges in the utilization of the spectrum and the security
Second	Founded in the year 1990-2004, with a bandwidth of 64 kbps , framed with digital technology , TDMA/CDMA, circuit and packet switching and used in the digital phones supporting messaging and the calls with a core network of PSTN	the services provided were secured and led to a mass adoption	suffered from limited data rates and found complications in handling the request for the internet and email
Third	Founded in the year 2004-10, as an improvement of 2G with the bandwidth of 2 Mbps, utilizing the CDMA 2000, UMTS EDGE, operating taking packet network as the core, and was well suited for phone calls and the messaging of data.	Provided with a better experience for the internet services	showed up with the failures in the internet access
Fourth	Emerged from 2010 and used till date, is supported by the core network Internet and is based on the technology Wi-Max, Wi-Fi, LTE, with CDMA and was compatible for all IP applications.	Provided a better performance with the lower latency in the internet.	consumes more energy , Very costly (hardware)

Fifth	Yet to be deployed , provides a higher bandwidth more than 1Gbps, based on the technology of WWW and the core network –internet , functions using the CDMA , very supportive for the high data rate applications	Enhanced coverage, no calls dropping, negligible latencies and improved performance.	As the system is still in design process, would face certain challenges in the designing.
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Table .1. Features of the Generations from 1G to 5G [11][17][4][2][9][15]

3. ESSENTIALITIES OF COGNITIVE RADIO NETWORKS [18, 19]

The cognitive radio network operating with the assistance of multiple of technologies and also involving the adaptive radio that enables to modify the performance according to the necessities and the intelligent software that replaces the traditional hardware is an intelligent radio network which is adaptive and automated in the detection of the availability of the channels in the wireless spectrum paving way for a simultaneous communication by altering the parameters utilized in the transmission to have a better performance.

It is capable of being configured and programmed according to the availabilities, to have an optimal usage of the channels in the wireless medium and assists in eluding congestion and the user interference. It effectively monitors the radio outputs and its own performance and provides the adjustments in the radio settings based on the changes and offers a better quality of service.

The cognitive radio based on parameters engaged with the transmission and the reception is classified into two main types as fully cognitive observing the changes of all possible parameters and the next one is the spectrum,-sensing cognitive radio that considers only the radio frequency spectrum. They are few other types which depend on the components of the spectrum of the cognitive radio network such as spectrum mobility, spectrum sharing (based on license and sensing and data based), licensed and unlicensed band etc.

The main functioning of the cognitive radio is not limited to spectrum sharing, spectrum sensing, spectrum mobility, spectrum management on the decision in order to ensure an optimal spectrum access [18] where the spectrum sensing is used in determining the spectrum holes and capturing their information. The management on the decision

support in selecting the optimal spectrum. Sharing co-ordinates the access of the spectrum with the other users and the mobility ensures channel to be vacated on the reappearance of the licensed users. [19] Based on the survey the table 2 below gives the details of the spectrum sensing sharing and the mobility.

Functionalities of cognitive radio networks	Types	Description
Spectrum Sensing	<ol style="list-style-type: none"> 1. Energy detection 2. Matched filter detection 3. Feature detection (cyclo-stationary) 	<ol style="list-style-type: none"> 1. Easy implementation Does not require prior knowledge 2. Acts within shorter time 3. Easily detects the signal types
Spectrum sharing	<ol style="list-style-type: none"> 1. Licensed and unlicensed 2. Centralized and distributed 3. Underlay and overlay 4. co-operative and non-co-operative 	<ol style="list-style-type: none"> 1. Free usage and increases spectrum usage 2. Easy to develop and flexible 3. Increased spectrum usage and minimum interference 4. Increased throughput and suited for small size network
Spectrum Mobility	<ol style="list-style-type: none"> 1. Reactive 2. Proactive 3. Hybrid 	<ol style="list-style-type: none"> 4. Compatible for short sensing 5. Compatible for long sensing 6. Compatible with general network (PU)

Table .2 Functionalities of Cognitive Radio [19]

4. THE COGNITIVE RADIO INCORPORATED WITH THE 5G

This section provides the survey on the cognitive radio in the 5G networks. Form the review made it was noted that the cognitive radios can enhance the usage of the congested network. Its capability of integrating the cellular radio that are licensed and cognitive radio into an adverse system has made the cognitive radio network prominent in the fifth generation networks [14] it partially address the issues faced by the fifth generation networks. [2]. they enable the dynamic leasing of the un-utilized spectrums without leading to a harmful interference to its users [15]. They enable to work with the additional spectrum outside the cellular band that is licensed [21] through this dynamic spectrum allocation and their heterogeneous wireless structure they can ensure higher bandwidth utilization to the mobile users [13] they capability of monitoring its own performance and all possible component network to make the radio setting s adaptive according to the parameter alteration make them even more significant among the fifth

generation networks, their efficiency in licensed spectrum as well as the unlicensed spectrum to its primary users through the wideband access become a cost and time saving methodology for the 5G networks. The 5G mobile network that has to become proficient in the handling of the very high data traffic, with higher base station densities, equipment's with the capacity to hold variety of communication devices has the necessity of being designed with the agile spectrum reuse for which the embedding of the cognitive radios in it would be an efficacious approach. Despite the advantages of the cognitive radio in the 5G networks, it faces few challenges on regard to the antennas, so it is necessary that the cognitive radio network have to ungraded to facilitate the advanced antenna requirements of the fifth generation mobile networks.

5. CONCLUSION

The paper providing the comprehensive survey of the fifth generation network and cognitive radio networks and the impacts it created in the network by having a cognitive radio in the fifth generation mobile technology, is presented with the details of the evolution of the 5G networks, followed by the essentialities of the cognitive radio networks and the impacts created in the network by having the cognitive radio networks in the 5G network based on the survey proceeded form different literatures , in future they paper is to proceed with the difficulties faced in deploying of the 5G networks.

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