RESEARCH PROPOSAL FOR PHD APPLICATION	
Title	**A Study on 5G and Next Generation Technologies**
Research Area	**Wireless Communication**

Executive Summary

The evolution of 5G right from 1G leads to glorious development in the current wireless communication. The fast development and requirement of mobile data network and in parallel, the evolution of Internet of things have diversified the strategy for implementing the 5G and beyond it. It is not just the high data rate and efficiency of spectrum usage satisfies the need for 5G as previous generations. To implement the 5G network communication IMT-2020 has standardized the key performance indicators (KPI's) and suitable technologies for different scenarios. This proposal presents such different scenarios applicable for today's requirement and the suitable technologies individually or jointly improve the overall performance of the 5G and beyond networks. Methods like Massive MIMO, millimeter wave communication (mm-Wave), Non-orthogonal Multiple Access (NOMA), Intelligent Reflecting surfaces (IRS), Internet of Things (IOT) are key research topics for implementing next generation wireless communication. These technologies will enable us to have a more efficient network that can handle large number of connections, low latency, improving the capacity, Traffic density, spectral efficiency, energy efficiency. In conclusion, this article also examines the potential difficulties and pitfalls of 5G technology.

Applicants

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Introduction

Wireless Communication has travelled along a long way and continues still. Started from 1G to 5G, wireless communication has seen a tremendous growth that leads to the invention of numerous technologies that uplifted the human life in many ways. Started from voice calls to internet gaming and finally IOT devices communication, the new wireless technologies are getting introduced in every aspect and everywhere in the world. 5G exiting as a global standard and many countries are already had a detailed study on projects like IMT-2020 China and 5G forum of Korea [1]. The wireless era has a continuous improvement in which each generation provides us with fast data connection and enormous data transfer. The 1G technology introduced in 1980s and was limited to voice calls only. Digital data transmission and text messages were started in 2G period. 3G brought us mobile broadband, allowing faster internet access on our phones. 4G further improved high-speed experience that allows us to stream videos and download bulk files with ease. Nowadays, 5G provides us with ultra-speed, more reliable and ultra-low latency network that can serve more coverage and denser networks that improves the user experience [1] – [4].

Application Scenarios and Key Indicators

As discussed in the introduction, mobile networks and internet of things are the game changing techniques in the field of 5g networks that were driven by markets, end users, cellular applications and various other applications [1]. These applications can be categorized into different scenarios.

1. LARGE COVERAGE IMPROVEMENT SCENARIO
2. MACHINE-TO MACHINE COMMUNICATION SCENARIO
3. ULTRA-DENSE COMMUNICATION SCENARIOS
4. DELAY-SENSITIVE SCENARIO

Based on above mentioned situations and requirements, many type of key performance indicators and key existing technologies are identified which can be achieved through 5G and beyond networks as shown in figure 2. Those are (i) User experienced data rate in downlink and uplink (15Mbps to 1024Mbps),(ii) Density of connections (number/km^2) – (10^5 – 10^6 connections) , (iii) Traffic density (bps/km^2) – 100 GHz – 15 THz , (iv) End-to-End Delay (less than 5ms – 20ms)and (v) Total number of Connections (10^3 – 10^6 connections) [1].To attain these performances, 5G network has developed some popular existing technologies (i) Massive MIMO, (ii) Non-orthogonal frequency division multiple access, (iii) High frequency communication. (iv) Device to Device Communication and (v) Intelligent Reflecting Surfaces [28]-[31].

Literature Review and Analysis of Related Work

The traditional concept of Multiple-Input, Multiple-Output introduced in 3G predominantly executed in 4G. MIMO with OFDM almost satisfied the requirements of 4G. But in 5G, the required data rate up to 10Gbps can be achieved using Massive MIMO which uses several hundreds of antennas at BS only not altering the antenna configuration at the user side. Massive MIMO has the advantage of providing data rate up to 10Gbps, latency of 1ms, Number of devices connected more than 100 times of previous generation, more coverage and low power consumption [5]-[7]. The potential of Massive MIMO in 5G are (i) Increased capacity by exploiting the spatial multiplexing by using large number of antenna arrays, (ii) Low power components with lesser cost amplifiers. (iii) Problem of accuracy and linearity availed in linear amplifiers and RF chains has been removed, (iv) Large number of antenna leads to beam forming that reduces latency due to fading [6].

When bandwidth and power resources are limited, multiple access schemes where multiple users share the same resources are used to improve spectral efficiency. Users with poor channel gain have to wait for transmission due to uneven sharing amongst users. Particularly for 5G networks with high data rates and beyond 5G that require 10Tbps/km^2, the traditional multiple access schemes will not be suitable [9] – [11]. NOMA is a compelling 5G technology that supports diverse environments, massive connectivity improves spectral efficiency and provides low cost and low latency (1ms). It is applicable to different situations like IoT massive environments, Mobile Broadband and mission-critical services where delay is not acceptable. It removes the other user's signal which act like an interference and the corresponding user signal will be retrieved and decoded and performs better than other OMA. Development of simple power allocation strategies and better precoding algorithm which reduces the complexity level is still a problem. Deep learning-based NOMA performs better than other variant NOMA eliminating these issues to a certain level.

To overcome the demand of above 30GHz, the unused spectrum from 30 GHz to 300 GHz, wavelength is 1-10mm and total bandwidth range of 252 GHz called millimeter frequency spectrum is used. It provides improved spectral efficiency, improved spectrum reuse, increased data traffic capacity and increased bandwidth and hence mm-Wave is one of the promising technologies in 5G networks [13]. This high frequency spectrum also has some drawbacks such as high path loss, high penetration loss, reflection and absorption, rain fading etc. Mm-Wave

communication is a short-range wireless system so that massive MIMO along with these can improve the capacity of system. MIMO with smart antenna can improve the Degrees of Freedom [15]. The Estimation methods are based on PLL based oscillators and upgrading the chances of coverage in mm-Wave communication. Also, beamforming techniques are used to progress towards nullifying the interference effect to improve the diversity order and Degrees of freedom (DoF) [14].

One of the significant technologies in 5G that enables the IoT applications in a broader way is the Device-Device communication. Large number of devices can be provided wireless connectivity by this key technique. It provides the connection of massive number of devices, low latency, fast speed and low-cost devices. Real time applications made possible with more reliable condition without delay which is a crucial factor for D2D communication [16] – [21]. D2D applications include smart cities, smart homes, healthcare related applications, smart grids, M2M video streaming and emergency network etc. Privacy and Security, Device lifetime, Device network Coverage, Device discovery, resource allocation, mode selection, interference management are some of the related issues to be addressed. D2D can be integrated with different technologies like C-RAN, mm-Wave, IoT, VLC and UDN networks. In future, 6G is expected to be licensed by 2030 which is comprised for Internet of Everything (IoE). D2D aligned with Artificial Intelligence (AI) could be a promising solution which leads to Intelligent D2D communication (ID2D).

Objectives

1. To learn about different future wireless technologies.

   There are many technologies available in wireless communication. From those optimizing techniques need to be identified or proposed to meet out the research gap identified.
2. To identify suitable methodology for the proposed system.
3. To identify and demonstrate suitable software for implementing the proposed methodology
4. To analyse and compare the proposed technique with the existing technique with the results obtained.
5. To publish the result and work in peer reviewed journals

Time Line

Month	**4**	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**
Literature survey, Background study	*	*										
Course Work and Comprehensive Viva		*	*	*								
Problem Identification and Methodology				*	*	*						
Simulation & Publication						*	*	*				

Drafting Thesis									*	*		
Review and Final Submission											*	*

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