

Impact of 5G Technology in Efficient M-Education

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Abstract— Today’s economy becomes more and more knowledge based, and education is a dynamic process of gaining and updating knowledge for individual to mass people throughout the globe. Education now a day’s required not only for the growing up and carrier oriented student but also for the qualified person who are in a very crucial position, for regular refreshing their present knowledge. To meet these requirements, the latest technology should be utilised for all round development of the present e- education system. So learning anytime anywhere, any one, and for anything, is required to be available through some mobile devices using efficient secured cloud computing integrated network. All these user requirements force to modify the present network architecture with the currently innovated 5G technology. In this paper we explore the mobile education scenario with 5G technology under design and implementation aspect.

Keywords—OFDM Orthogonal Frequency Division Multiple Access, TDMA Time Division Multiple Access, VR Virtual Reality, AR Augmented Reality, CCN Content Centric Network, ICNInformation Centric Network, NREN- National Research and Education Network, GEANT Pan European Network, eduroam world wide education roaming for research and education, RAT Remote Access Trojan, LTE Long Term Evolution, RTT Round Trip Time, 3GPP 3rd Generation Partnership Project, MOCN Multi Operator Core Network, PLMN Public Land Mobile Network

I. INTRODUCTION

In India the distance between persons seeking education and the education institutes for transferring knowledge to them, is still very high and it is seen particularly in rural sectors. So for rapid education to all we need some distant learning system at anytime and anywhere. Here the sources of education system and the education seekers may not be in the same fixed place. Mobile learning is the only possible method to overcome all the present difficulties to be educated. Education through mobile network using some

mobile gadget is M-Education. Now a days 4G mobile network [1] penetrates throughout metro and urban cities including many rural areas. 4G technology uses OFDM instead of TDMA access.[1] The data exchange capacity of 4G is about 100 Mbps, which is at this moment is insufficient to handle the live communication of multiple information simultaneously. It is the essential requirement of M-education. So in coming 5G technology can be used in M-education due its faster data transfer, which is 1000 times faster than 4G technology.[2] 5G Mobile network architecture is described in Fig – 1 below :

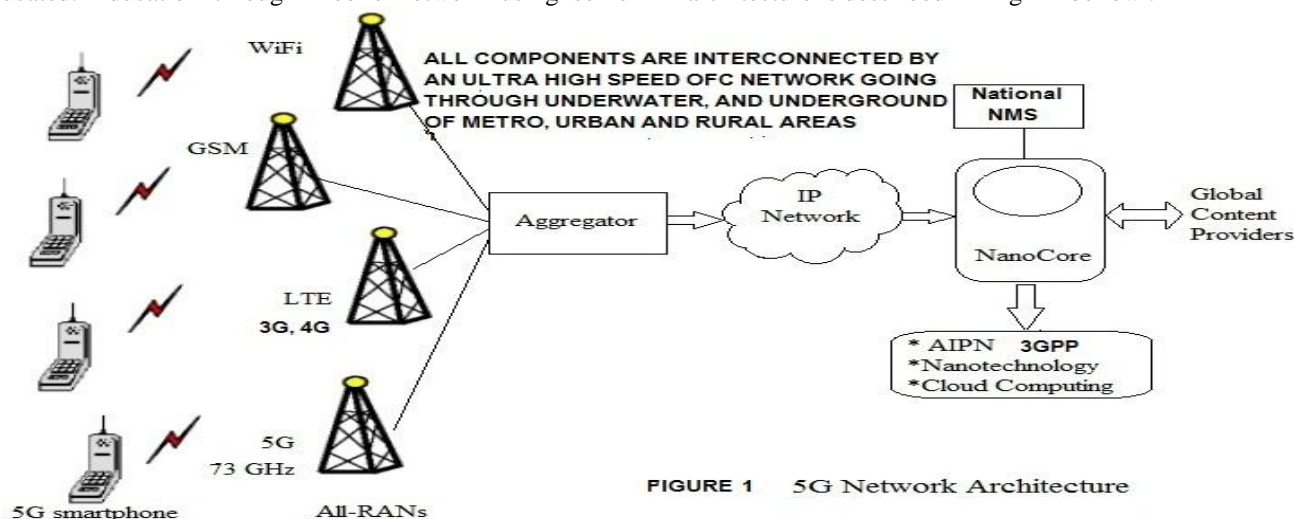


FIGURE 1 5G Network Architecture

5G offers not only faster download speed but also had features we have not been led to expect from previous generations of upgraded data speeds.[3] These include reduced power, low latency, which improves on current wireless network responsiveness. With 5G, for example, when a user makes a request from their phone, the network will respond about 10 times faster than the blink of an eye, nearly less than 1 millisecond (That is, network response times will be approximately 1 millisecond.). Human cannot feel the delay. At present many classrooms are using WiFi, a service to which many classrooms of Indian scenario currently have access. The question is then, in what way 5G is better than WiFi? 5G is much faster than WiFi. It is potentially up to 10 times faster. It is possible to download an hour high-definition video in less than five seconds. In 4G, the same content could have taken a minute to download.[3]

Recent development in mobile access technology provides the higher availability of the rich digital resources beyond the physical confines of the classroom and in the hands of learners. The ubiquitous learning and teaching require unlimited access to information. Advances in mobile technology, IoT and Tactile Internet, can open a new chapter in education. The future learning model will be an international, immediate, virtual, and interactive environment which enables learners to learn and interact in much different ways that we do today. The new model will be learner-centric, skill-centric, on-demand and personalized. It will improve student development in the areas of critical-thinking and collaborative learning. In order to reach this model embracing mobile technology seems indispensable. Applications such as Virtual Reality (VR) and Augmented Reality (AR) will play a big role in quality education and understanding-based learning. By combining Tactile Internet with VR and AR, the learning experience will go far beyond today's one, bringing new definition to Tele-teaching, Tele-mentoring, virtual university, virtual classroom, virtual team-working, etc. New mobile technology and connected devices will give students the opportunity to learn with minimal intervention from teachers and mostly through exploration, discovery and peer coaching.

Similarly, 5G puts access speeds into the real time basis, where they are faster than the time taken for people to realize delay. The content for many university degrees, including some at Harvard, are now largely free. To these, 5G will add new types of content, from Augmented Reality to Virtual Reality tools whose bandwidth requirements are

currently beyond commonly-available WiFi/4G technology. Similar libraries of content will be created in formats appropriate to these technologies. 5G will provide "immediate" access to internet-based educational content. These can be used to the student learning, and even these can supply to disenfranchised children. 5G will shift the location and cut the cost of classroom technology. At this moment, it makes sense to keep processing power and data storage especially of large files. With zero perceived delay in access, even for those large files, 5G will make it more sensible to have cheaper equipment in schools and expensive facilities like storage networks. 5G will cut short the complex and wide processing done in the cloud. 5G will allow every classroom with phone, hard drive, and smart TV.

5G won't solve all the problems that schools face, but it could have a real impact on the way students learn and the devices they used on. Regarding 5G projects in India,[4] backed by Department of Telecommunication calls bright minds from five IITs in the country have come together to join hands in the development of 5G technology and its uses in India with a special drive in education. For which Rs 300 crore was already invested by Government of India. Talking about India's opportunity in the global market, Prof R David Koilpillai IIT Madras, mentioned, "India is poised to take advantage of the internet of things and the connectivity because there are number of initiative in terms of smart city program and we see as the opportunity for India really be the player in the global market not only in the terms of technology but also the products that we will develop." [4] 5G is a window for us to compete globally. The government has initiated a very large multi institutional project. IIT Madras will be nodule point along with the center of excellence and wireless technology. The said project is exploring not only by IIT Madras but also they are coordinating the works which are going on globally.

5G technology could be revolutionary improve the instruction process in a variety of ways. In schools where teachers lack subject-matter expertise, shortage of the number of teachers, the technology could support holograms of educators with strong in the topic or experts from a field augmenting the instruction in the classroom. For students with special needs, the immersive capabilities of 5G could allow them to have a tactile experience and "touch things" that are otherwise beyond their grasp.[5] A high-touch solution could deliver a one-to-one learning experience via virtual reality. Universal prototype diagram of 5G application in M – Education described in Fig 2.

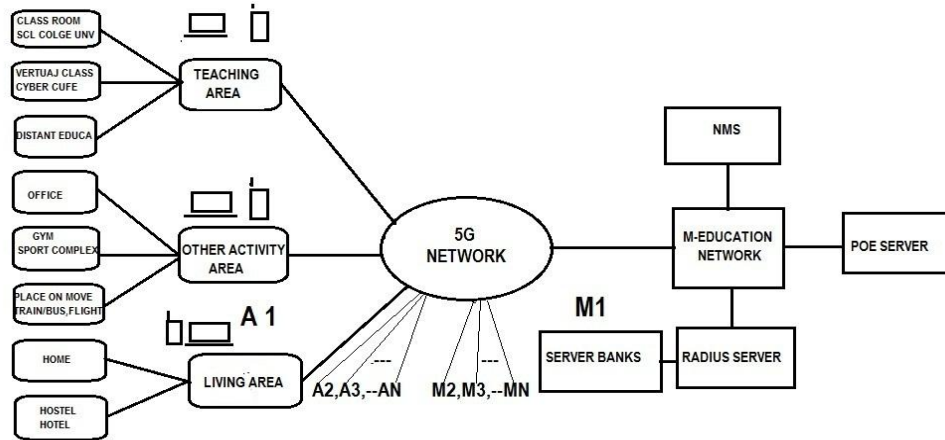


FIGURE 2 UNIVERSAL 5G APPLICATION ON M-EDUCATION

II. CHALLENGES AND POTENTIAL USES

Some of possible use cases related to Connected Education can be listed as follows:

•**Information Security & Skillset communication** Network should be capable of transferring secured communication through Internet.[6] It will help us to move from content information delivery to a manual skillset delivery in internet. This will also create smart way of Tele-teaching and Tele mentoring, especially for manual training and skill development. The use of Tactile Internet in education can bring a new definition and experience for distance learning and distance team-working. Indemand video and audio feedback, the response time of service should be very low, i.e. delay time cannot be realized.

•**Virtual Reality & Augmented Reality in education** VR will have a big role in providing quality education and improving understanding-based learning among students. By tailoring these services to education, the learning process can be more fun and much more interesting. This also can bring new experiences for distance learning, enabling the virtual presence of students of different places in the classroom. This type of service needs very high bi directional bandwidth and very low latency, less than 4 m.s.

AR can be an efficient way of providing the right amount of information at the right time to the right audience. Also, immersive AR can enable new ways of learning and team working in education through services such as mobile cloud classroom and Virtual Presence. It can also help teachers to get necessary information about each student and be aware of their particular needs and capabilities. Optimized routing, seamless wide-area coverage, virtual presence, low delay speech & video coding, are essentially required.

•**Isolated classroom** By combining Tactile Internet, VR and AR, the future experience in teaching and learning could remove the physical location constraint for experimental

practices. The sharing of resources between larger numbers of students irrespective of their current location is also available.

•**Customaries learning:** Individual access to a mobile device holds the promise to connect each learner into intelligent personalized systems. The learning pathways, aggregated analysis and better data capture of experience learner, enable much better decision making about all aspects of a students' education. Categorizing students in different groups. and suggesting different multi-media contents can increase the load on the network. CCN and ICN can be used with improve efficiency by reducing the service response time and bandwidth consumption.

•**Smart Wireless Device:** Due to the centralized architecture of cloud providers there is a notable delay in access to the content even with a relatively fast internet connection. 5G mobile technology will enable single device content access anywhere by using distributed cloud and mobile edge computing. Using this feature, students can resume their work at a convenient time and place through different devices with an impression of immediate response time.

•**Education for Physically challenged Persons** Advances in mobile technology and robotics can open new opportunities to assist students with special needs, making learning easier for them. Cloud-based robots can be considered as a full-time assistant for disabled students. This will avoid to call a teacher for help.

•**Virtual Centre for Education Activity** One of the fast growing area of IoT applications is in education. It can improve our teaching, learning and campus operating experience. Now a teacher cannot concentrate the individual activity of the student. IoT applications can change the role of teachers in the classroom. Administrative burden can be reduced and the teaching processes will be optimized according to individual requirement. Student losing concentration during lecture can be evaluated automatically

by sensors used in the network and keep the lecturer to be informed for further necessary action. Real time analyses of a lecture can be done in a particular area and required modification of the teaching and learning process are determined.

III. REQUIREMENTS AND EXPECTATION FROM 5G

The following technical requirements essentially needed for m-education system in global scenario:

- **Smart Network:** A core network, which can relay traffic with the required QoS and security [7] without any recognizable delay is required. In global scenario, National Research and Education Network (NREN) [8] is a specialized service provider dedicated to support the needs of the research and education communities within a country. NAREN peers with different mobile operators and internet service providers. It is a high-speed backbone network, often offering dedicated channels for individual research projects. Different NRENs across European countries are interconnected with each other via GÉANT1. Together, GÉANT connects over 50 million users at 10,000 institutions across Europe. Operating at speeds of up to 500Gbps. The use of Network Slicing in 5G can help to meet the need of different project and services [8]

- **Smart Access Network:** A federation-based Wi-Fi service called education roaming service. Eduroam is a hugely popular worldwide network access service which is implemented on a federated basis. Participating organizations, using their existing infrastructures, connect to national NREN-operated RADIUS [8] systems. Based on the requirements outlined in the 3GPP technical documents, the next generation system architecture must support new RAT(s), the evolved LTE, and non-3GPP access types. As part of non 3GPP access types, WLAN access and Fixed access shall be supported.

- **Network coverage in education premises:** Present quality of the coverage in education premises is not good. It is still controlled by some outside organization. It is determined by the operators commercial priorities and roadmap. This leaves many educational organizations poorly served by cellular services, either through rural location or through signal strengths. The NREN makes them a good candidate for piloting multi-operator based solutions such as Multi-operator core network (MOCN). It is sharing/pooling frequency, using common PLMN and aggregated gateway. [1]

- **Speedy Multi Processing:** Since Students are mostly categorized as heavy users among service providers. It is expected that the throughput requirement of most education use cases would be considerably high. 5G promises to offer

20Gbps peak data rate in special scenarios in indoors and dense areas. Whereas it offers several 100Mbps everywhere.

- **No delay performance:** The required response time for each application depends on the context of the service. Due to the diversity of use cases in education, the target latency requirement varies significantly between them. For applications needing tactile interaction through the Internet, latency of 1ms is required. Other use cases can leverage their delay-tolerant. The crucial and challenging part is meeting a round trip time (RTT) of few milliseconds. The investigation for changes in access and core networks is already underway in 3GPP SA1 and 3GPP RAN.

- **Diversity:** Integrated wired and wireless systems in the education sector are rapidly changing. Mobile devices entering and leaving a single wireless collision domain. There is the need for wireless technologies that can adapt to these changing. A heterogeneous network architecture is required for making it possible to have an optimized use of all resources without any harm to any of the services.

- **Content Management:** There is a need for efficient content tracking and handling with accurate location. Higher Education (HE), Further Education (FE), Skill Education (SE) sectors and Research Council Establishments (RCE), there should be a trusted protocol [6][7] and service provider which will provide trusted advice and support. It reduces sector costs across shared network, digital content, IT services and procurement negotiations. It should ensure to keep space for future research and development.

IV. CONCLUSION

A great research effort is needed to overcome the important technological challenges to fulfill the basic need of the society through education. The research project will involve a huge amount of investment required to introduce them. However, due to the enormous socioeconomic benefits that it will lead to, all of the necessary human and economic resources are already in motion. 5G will lead to a great race among the most advanced regions in the world. The 5G networks will take us to a world where distance doesn't exist, and where our existence and perception will merge with those of our fellow beings and with that of the objects that surround us. It is also expected that, these scientific developments and smart use of m-education in the advanced countries, results future precipitate developments of poor and backward countries.

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Authors Profile

Sri Pradip Kumar Samanta was the Deputy General Manager Department of Telecom. Govt. of India (BSNL) Kharagpur (Last working area Midapore East & West Districts in Mobile and Data Networks) and also Research Scholar in Burdwan University. He was the officer I/C for QPN project implementation in IIT Kharagpur in 2011. He has been born on 1st day of January 1952 in village Srirampur, East Midnapore. He completed graduation degrees in Science, Economics and Education from Calcutta University. He obtained MCA degree from IGNOU in 2002. Sri Samanta has 37 years of experience and many specialization training in Telecommunication and Data Communication Networks. His research interest is in "A Complete E-Education Networks."

