32. Possibilities of 5G and its Application in Rural India: A Short Survey

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ABSTRACT

Ultra-high-resolution 3D videos can be downloaded with 5G technology that is nearly 100 times faster than 4G technology. With this technology, high data can be handled as it has larger bandwidth. Internet of Things (IoT) is a physical network, which comprises namely, Bluetooth, Wi-Fi, and cellular on a single platform.The healthcare industry is transforming with the growth of the Internet of Things (IoT) and result inthe development of the Internet of medical things. IoMT for the healthcare industry requires big data, high speed, large bandwidth, and reliable connectivity, which will be fulfilled with 5G technology. In this paper, we present the current development and future perspective of Unmanned Ariel Vehicle (UAV) for providing 5G technology in rural India and the Internet of Medical Things (IoMT), as application of 5G. UAV based 5G architecture is explained along with its application in real-time. Real-time application of 5G can be applied asIoMT is also illustrated in this paper.

Index Terms— *Unmanned aerial vehicle, 5G, Internet of medical things, IoT, dedicated HardWare, commodity HardWare.*

INTRODUCTION

The crosstalk and poor connectivity were the common problems in the lower generation of technology but 5G technology will improve connectivity, cloud-based storage, and an array of connected devices and services. 5G technology enables us to download 3D ultra-high-resolution videos within a few seconds [9]. It can support data speeds of more than 100 Mbps, more bandwidth, and fewer delays due to built-in computing intelligence. Computing capability combined with virtual system architecture will open up a mobile internet of things (IoT). By 2020, the 5G network is expected to support 50 billion connected devices and 212 billion connected sensors as well as enable access to 44 zettabytes (ZB) of data. Fig. 32-1 shows the roadmap towards 5th generation (5G) wireless communication systems.

Nowadays, cellular networks are extensively deployed in urban areas, where the user's density is high. Thus, the forthcoming 5G technology is "urban" in nature. The key features of 5G are to provide multiple data transfer rate with very high speed to users, energy efficient and high security. On the other hand, more than one third of people in rural areas are still experiencing a lack of mobile broadband connectivity. One of the major challenges impairing the Sustainable Developing Goals is mobile broadband connectivity. In whole world, around 4.1 billion people are using the Internet in 2019, with a 5.3% increment compared with 2018. From 2005 to 2019, the number of Internet users increases by 10 percent every year. In India, 100-200 kbit/s per Internet user bandwidth usage [1].On the other hand, it is clear that traditional network operators are not keen to invest in such zones, which have of potentially low revenues. Clearly, the lack of 5G deployments in rural zones will inevitably increase the digital divide for the users living in such areas [2].In this situation, solutions regarding the mobile broadband connectivity in the rural areas are becoming of great importance. To cope with this situation, the Global Access to the Internet for All (GAIA) Research Group has been established by the Internet Research Task Force (IRTF) to design alternative networks for serving rural and/or low income zones [3]. 5G networks specifically to serve rural zones, is rapidly gaining attention by the research community [4], [5], [6]. With 5G technology, it is possible to study innovative solutions to go afar the unbending structure of previous known technologies, and to include the GAIA standard in design and management phases of 5G. In this scenario, numerous questions may come in our mind, such as: a) How to cover up rural areas with a network of UAV-based Base-Stations b) How energy

consumption will be efficiently managed through the UAV-based BSs? c) How the available energy from the Solar Panels (SPs) and recharge sites will be managed at the ground? d) Is it feasible to provide a high level overview of a sustainable 5G cellular model to consider all the aforesaid aspects for rural areas? Is it economically feasible to provide 5G connectivity to rural areas user of India? What is the periodical subscription cost that should be charged to users of rural areas/ low income areas to compensate the installation and operational costs of the sustainable 5G network? One of the objectives of this paper is to identify the challenges and available facilities in rural India for launching 5G services at the earliest.

The Internet of things (IoT) is the physical networks in which different technologies combined together e.g Wi-Fi, Bluetooth and Cellular on a single platform [12-14]. The IoT for medical healthcare, which is IoMT requires high data, high speed and long battery life with reliable connectivity. The 5G fulfils these requirements with its superfast capabilities and supports IoMT for human health such as, diagnosis and treatment [16-18]. This paper also presents the detailed survey about how 5G has revolutionized the medical healthcare with the help of IoT for enhancing quality and efficiency of the wearable devices.

This paper is divided into 7 sections. Introduction is given in section 1. UAV based 5G structure and IoMT for future healthcare in rural areas are explained in section 2 and 3 respectively. Various applications of IoMT explained in section 4 and section 5 illustrates the benefits and challenges of Ultra Aerial Vehicle (UAV) and IoMT. Available solar power capacity in Indiaexplained in section 6 and summary of paper is illustrated in section 7.

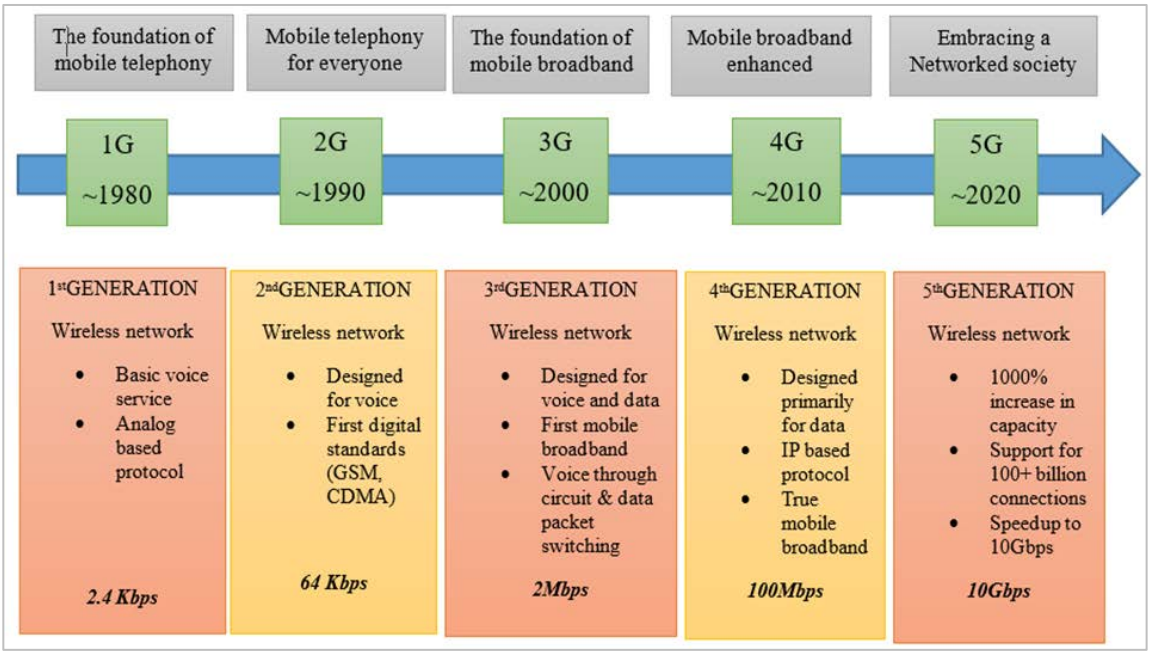

Figure 32-1 Time line towards 5G wireless communication [9]

5G ARCHITECTURE: UAV BASED

Researchers have laid out architecture for providing 5G services using UAV [7]. It mainly consists of dedicated HardWare (dHW) and commodity HardWare (cHW). dHW is planted over the UAV while cHW is installed at ground sites. dHW is responsible for low-level functionalities whereas cHW carries out high-level virtual functionalities. This decoupling reduces the weight that UAV have to carry for providing lag-free 5G network. UAV has constraint of power of supply. For this reason, UAVs have to be recharged time and again. UAV is responsible for covering the region of interest. The most important constraint for Quality of Service (QoS) is the movement to cover an area and recharge scheduling at site has to be planned efficiently. Fig 32-2 represents the working strategy of UAV for recharging, moving and covering action. Since, UAV is power supply constrained device, time and again recharging is necessary. While charging the UAV will not be able to cover area of interest,

thus required amount of UAV is needed by dividing the time into slots and accordingly mapping the working and recharging schedule of each UAV. Fig 32-3 gives a view of dHW and cHW location. Radio link keeps the UAV connected with ground station.

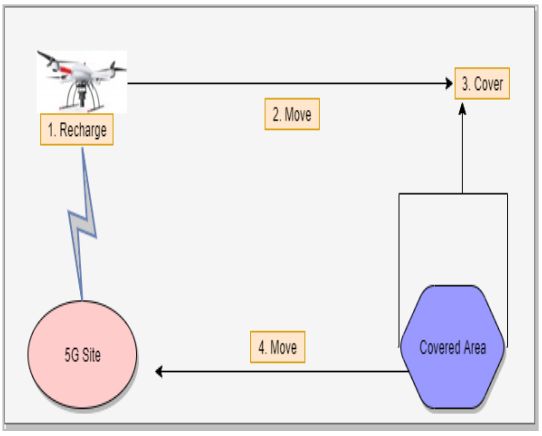

Figure 32-2 Recharging, moving and covering action.

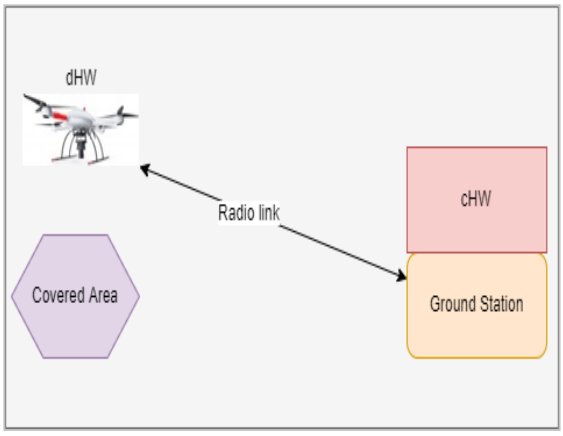

Figure 32-3 dHW and cHW decoupling

INTERNET OF MEDICAL THINGS (IOMT) OR HEALTHCARE IOT-THE FUTURE OF HEALTHCARE

Nowadays, to connect medical devices with networks and patients is of utmost importance in various research groups. As per experts forecast, by 2021 Internet of Medical Things (IoMT) market will surpass by $136.8 billion [10]. The IoMT will serve the sector by providing more accurate and quicker diagnoses, efficient healthcare services delivery, and reduced costs etc [11]. The IoMT deals with only medical devices with internet connectivity, however IoT includes all the ranges of web enabled devices from smart cars to smart kitchen. IoMT technology facilitates the medical device to process (collection, analysis and transmission) the healthcare data across the Web. In addition to the digital medical devices (like heart monitors), the non digital things like hospital beds and pills need to be connected over the internet. The basis of IoMT is machine-to-machine (M-M) communication, which is possible by Wi-Fi enabled medical devices [13]. To store and analyze the captured healthcare data, the IoMT devices link to cloud platforms like Amazon Web Services. The healthcare IoT is another term which is also used in place of IoMT [15]. Examples of IoMT include monitoring of remote patient with chronic conditions; medication orders and location tracking of patients; and mHealth wearable devices to communicate the data to caregivers [13]. Now many of the mobile devices come with Near Field Communication (NFC) radio frequency identification (RFID) tags, which allow the sharing of the healthcare data over IT systems. This gives way for more possible applications and developments of IoMT as IoT. The awareness of the available medical equipment and supplies among the hospital staffs can also be managed by deploying RFID tags on the healthcare items [11]. The telemedicine is the most common word used in connection with the remote monitoring of patient at home by the use of IoMT [10]. This technology helps the patient from unwanted travelling to the hospital and physician's door for their regular change in condition and the medical questions. It also helps the doctor to get the data of their patients anywhere. Primarily the protection to sensitive data of the patient is governed by Health Insurance Portability and Accountability Act. These days the protected data passes through the IoMT is of great concern among healthcare providers.

INNOVATIVE DEVELOPMENTS FOR THE INTERNET OF MEDICAL THINGS (IOMT)

The IoT in medical domain fast-growing area with several innovations being developed frequently [15]. Analysts showing main change in health care industry with IoT with the introduction of Machine Learning and

artificial intelligence (AI). Deloitte consulting work suggests that the Internet of Medical Things (IoMT) market is set to reach $158.1 billion in 2022, owing to the rise in demand for better-quality medical technology [13]. Additionally, increased access to patient data is making it easier to incorporate IoMT devices seamlessly. For immobile patients it is essential to detect the slightest of movements on the body [11]. That is why smart monitors and sensors are placed on the clothing, bed, or skin of the patient to monitor their movements. This can also help with tracking involuntary movements to provide better insights into proper diagnosis management [10]. Apple launched its Movement Disorder API to help monitor patients with Parkinson's disease. The data captured is encrypted from end to end, giving greater privacy to patients. IoMT-based technologies also have the potential to locate patients, medical staff, and visitors that further enhances the concept of smart hospitals [13]. IoMT can improve healthcare quality while reducing cost. MRIs, X-ray machines, CT scanners, and other equipment can be remotely monitored for performance issues [15]. Long before hospital staff notices a problem; the manufacturer or service vendor can detect issues that need to be corrected. GE, Siemens, Philips, and other companies use IoMT for remote diagnostics, predictive maintenance, and performance upgrades to their imaging products [10-11].

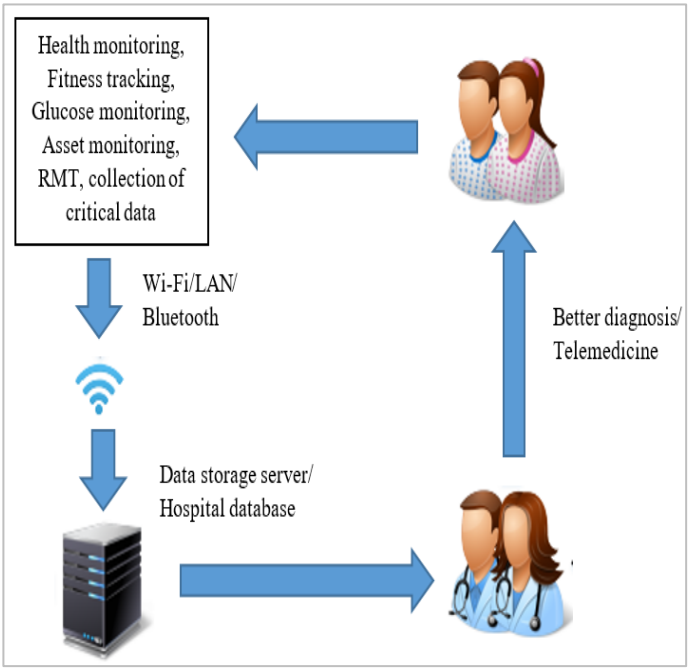

Figure 32-4 Healthcare Monitoring and diagnosis using Internet of medical things (IoMT)

A. REAL-TIME PATIENT HEALTH MONITORING

Due to advancements in biosensor technology there are many wearable smart devices are available which monitor the user's health [15]. These devices are fixed inside apparel, attached to the skin, or implanted; on-the-body IoMT sensors give patients freedom, and maintain close watch on their physical conditions. A critical feature of IoMT is to track the patient health across various parameters. Different sensors can help to track distinct areas of information such as heart rate, glucose level, respiration, etc. to provide a complete picture [13]. DocBox is a most important example of a patient monitoring platform that works with physical conditions directly [11]. The information is accepted directly through an API which is connected to a larger telehealth system.

B. FITNESS TRACKING AND DIAGNOSTICS

Now a day's fitness trackers are a specialized area which is in high demand [10]. This fitness tracker helps to diagnose primary conditions through a lifestyle analysis. Starts with sleeping quality to patient heart rate tracking, all the information's can be used by various insurance agencies and health care specialists [11]. This also helps to understand the patient conditions and also provide the status of progress report, especially in the case of rehabilitation and recovery.

C. SMART GLUCOSE MONITORING

Smart glucose monitors helps in providing information related to glucose fluctuations that will ultimately help to act accordingly in real time [10]. Combination of non-invasive glucose bio-sensors and wearable technology helps in tracking the insulin level effectively [13]. MINIMED 670G is one of the monitoring device that maintains the insulin in optimized way according to the core parameters.

D. ASSET MONITORING AND MAINTENANCE

The monitoring of health is important in the B2B side of health care systems. This includes the usual maintenance of machines, technology, and data systems where manufacturer of medical devices install IoMT devices to share asset data [15]. To ensure the functionality of machines, all assets can be tracked remotely and key trends can be mapped to enhance NPD and research.

E. VIRTUAL HOME SYSTEMS

Virtual home system is designed for getting the right treatment for seniors and homebound patients suffering from chronic illnesses. It introduces a interactive and a faultless mechanism to communicate with health care provider [13]. Lenovo Health and Orbita Health jointly developed a chronic and post-acute care system that worked fully on voice-inputs [11]. Smart sensors and AI technology solutions will provide greater connectivity at the patient's home.

F. REMOTE PATIENT MONITORING (RTM)

Medical connectivity technology is known as telemedicine which extends healthcare services instead of going the hospital [10]. Remote Patient Monitoring (RTM) avoid frequent visit to doctors, to patients suffering from chronic disease. Diabetics and heart patients can benefited from RTM technology. Patients' glucose level and activity of heartcan be monitored thought handy RTM devices and if any problems found it can automatically alert the doctor [13]. Virtual Home Assistants designed for many elderly patients, it can interact and remind with the patient for taking medications. It can also be accessed remotely by physicians and family.

G. COLLECTION AND INTEGRATION OF CLINICAL DATA

Many technologies are required for Collection and integration of clinical data. This procedure is becoming moreand more efficient and effective with IoHT. The generatedmedical data from the observations can be collected and communicated as not done before which savemoney and time by encouraging technology for the future. The use of IoT in healthcare is new technology as it developed with the development of healthcare software [12]. The demand of wearable devices is increasing day by day as it is programmed with such software, as use of mobile applications and healthcare solutions become easy to access to all [15]. The applications of IoT in the healthcare industry are bringing anexcess of applications for public healthcare.

BENEFITS AND CHALLENGES OF UAV AND IOT IN HEALTHCARE: INDIA'S RURAL PERSPECTIVE

Cost of UAV, recharging facility and solar power grid is one of the challenges, which will affect the acceptance of 5G network using UAV in rural areas. 25 UAVs are required [7] to provide 24 hrs 5G network. Since, UAV has limitation of altitude; buildings with more than 4 floors will create obstructions in network availability. Efficient scheduling of UAV for the purpose of recharging at site, moving from site to covering area and moving from covering area to site.

The applications of IoT in the healthcare industry are enormous with cheaper medical cost, improved patient experience, and better control over wastage in the healthcare sector, Dramatic reduction in errors, Better outcomes of medical treatments, Enhanced manageability of medical drugs and medicinal adherence. Although IoT is technology has proven its mark in the improvements pertaining to the field of medicines, it does not come without

a downside. The primary challenges to patient privacy is serious concern, this can be resolve with the blockchain technology in the near future. Hacking of data and data corruption or manipulation also can be diminished with blockchain technology. Activity monitoring and management of IoT devices that consists of Electronic Medical Records (EMR) system is also a challenge for current medical infrastructures.The Fig. 32-5 has illustrate the increasing number of IoTs devices in the future years [10].

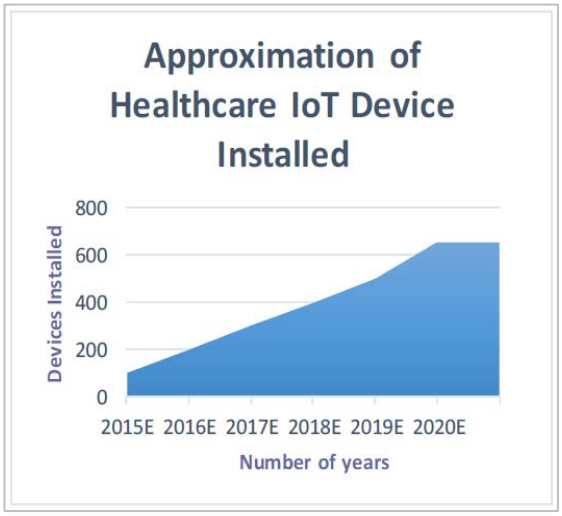

Figure 32-5 Growth in IoMT devices [10]

AVAILABLE FACILITIES FOR 5G IN INDIA

India has 28,181 MW solar power capacities as on 31st March 2019 [8]. Most of the solar power grids are located near rural areas. Fig 6 proposes that India's solar power capacity is increasing exponentially year by year. Thus, installing 5G network near available solar power grid will be easy and cost efficient. Indian rural areas rarely have 4-storey building or more than that. Therefore, the hindrance to UAV due to high rising buildings will not be experienced in rural areas. Thepopulation capacity of each village can be identified by the National Population Register. Accordingly, small cell 5G services and large cell 5G services can be provided for small area and large area respectively. Year wise growth of solar power has shown in fig.32-6

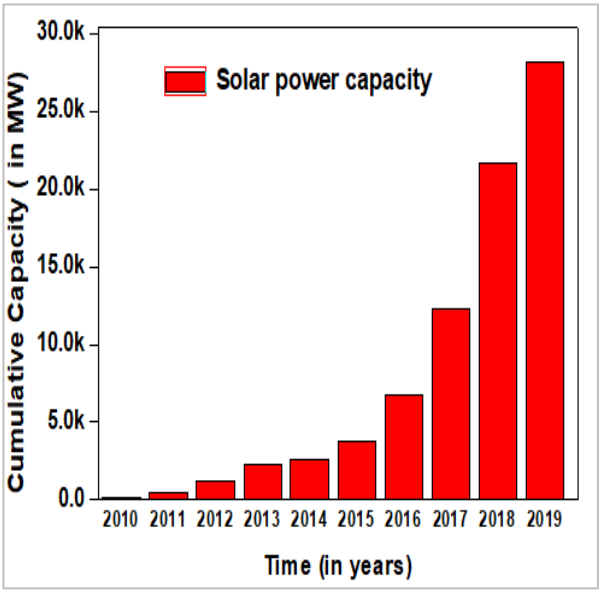

Figure 32-6 Solar Power Capacity in India year wise growth

CONCLUSION

With respect to India, it is observed that enough solar power facility is available for initiating 5G technology. Besides that, the need of the hour is scheduling the UAV according to rural area or low income zone(s) and population. In the context of 5G application, IoMT is one of the preferable and demanding areas. It reduces the physical presence of patient in the city hospitals. Real-time analysis of patients can be handled. Consequently, remote monitoring can be done due to the availability of ultra-high speed 5G network.

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