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CHALLENGES THAT NEED TO FACED BY IOT DEVICES WHILE IMPLEMENTING 5G

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Abstract: The Internet of Things (IoT) is a promising technology which tends to revolutionize and connect the global world via heterogeneous smart devices through seamless connectivity. The current demand for machine-type communications (MTC) has resulted in a variety of communication technologieswith diverse service requirements to achieve the modern IoT vision. More recent cellular standards like long-term evolution (LTE) have been introduced for mobile devices but are not well suited for low-power and low data rate devices such as the IoT devices. To address this, there is a number of emerging IoT standards. Fifth generation (5G) mobile network, in particular, aims to address the limitations of previous cellular standards and be a potential key enabler for future IoT. In this paper, the state-of-the-art ofthe IoT application requirements along with their associated communication technologies are surveyed.In addition, the third generation partnership project cellular-based low-power wide area solutions to support and enable the new service requirements for Massive to Critical IoT use cases are discussed in detail, including extended coverage global system for mobile communications for the Internet of Things, enhanced machine-type communications, and narrowband-Internet of Things. Furthermore, 5G new radio enhancements for new service requirements and enabling technologies for the IoT are introduced. This paper presents a comprehensive review related to emerging and enabling technologies with main focus on 5G mobile networks that is envisaged to support the exponential traffic growth for enabling the IoT. The challenges and open research directions pertinent to the deployment of massive to critical IoT applicationsare also presented in coming up with an efficient context-aware congestion control mechanism.

Index Terms - Internet of Things, long-term evolution, machine-type communications, 5G new radio.

I. INTRODUCTION

The Internet of Things (IoT) is associate in Nursing rising and promising technology that tends to revolutionize the worldwide world through connected physical objects. IoT deals with low- power devices that act with one another through the web. The idea of the IoT has drawn the eye of the analysis community with the top goal of making certain that wearables, sensors, good appliances, laundry machines, tablets, smart-phones, good facility, etc., and different entities are connected to a typical interface with the flexibility to speak with one another. IoT interconnect ''Things'' and allows machine-to-machine (M2M) communication, a way of knowledge communication between heterogeneous `devices while not human intervention. in step with, this could be achieved through a seamless communication medium. IoT is anticipated to change a contributing setting which will impact and influence many aspects of everyday-life and business applications and contribute towards growing the world's economy, through huge and demanding IoT, counting on the character of applications to be deployed. huge IoT applications need that big variety of good devices are connected that can be deployed in shipping environments, smart-homes (buildings) and smart-cities, good power systems, and agricultural observation environments, etc., which needs frequent updates to the cloud with low end-to-end value.

In step with forecasts from Ericsson, it's calculable that concerning twenty eight billion of good devices are going to be connected across the worldwide world by 2021, with quite fifteen billion of those devices to be connected through M2M and consumer-natural philosophy devices. Realizing the IoT vision will solely be achieved through the combination of assorted facultative telecommunication technologies to supply property solutions for MTC. The bulk of IoT devices weren't designed or designed to inter- face with high-bandwidth networks, since these devices were in the main designed with low-power operation in mind. It's value mentioning that facultative trendy IoT property within the authorised approved spectrum bands are going to be a key enabler for large to important IoT use cases since it offers various applications with totally different service opportunities inside one network. The challenge but, is however the fifth generation (5G) mobile network can meet the varied needs of the IoT.

Next generation 5G mobile networks ar envisaged to confirm that huge devices and new services like increased Mobile Broadband (eMBB), huge Machine- sort Communications (mMTC), vital Communications and Network Operations ar expeditiously supported. it's hoped that basic needs like high outturn, low latency in terms of information delivery, high quantifiability to modify huge range of devices, economical energy consumption technique and also the provision of omnipresent property answer for end-users are expeditiously supported exploitation the 5G mobile network for the IoT. Consequently, considering the protection mechanism of existing cellular networks that ar supported protective basic property and privacy of end-users, the 5G cellular system is predicted to confirm that increased security mechanism is established on the complete network to deal with problems on authentication, authorization, and accounting (AAA) for heterogeneous interconnected IoT devices. M2M communications are extensively reviewed within the literature. Pereira and Aguiar dis- obstinate on European Telecommunication commonplace Institute (ETSI) commonplace and application protocols whereas considering mobile devices like smartphones to be used as mobile gateways for alternative connected devices with affected capabilities and also the method of aggregating knowledge from embedded sensors in M2M spec. Biral et al. given {the problems|the problems} of radio resource allocation that ar associated with huge Machine-Type Devices and profile solutions to deal with these issues whereas considering major challenges that ar related to presently deployed cellular networks to accommodate M2M Communications. Ghavimi and Chen given the field of study enhancements needed to deploy M2M applications for 3GPP LTE/LTE-A network. The article additionally highlighted problems on numerous random access overload management to forestall congestion that ar primarily caused by random channel access of M2M devices in LTE-A networks. Condoluci et al. mentioned numerous communication standards. within the literature, 5G network is given for MTC considering style choices that might be used for femtocells. in keeping with, presently deployed and future cellular technology ar promising to deploy and modify M2M communication. Palattella et al. in their analysis, offer a close investigation of rising 5G technologies to modify international IoT, whereas considering each the standardization and technological situations and additionally given the market read for globally deployed scheme. Ali et al. [36] given a survey on M2M communications architectures, with connected technologies, protocols and application development for the IoT.

IoT APPLICATION REQUIREMENTS

A.EMERGING IoT APPLICATIONS

Given recent advances in ubiquitous computing, there are currently a myriad of diverse IoT applications for many different environments which are expected to enhance and improve the quality of everyday-life for the end-user community.

1. SMART HOME

The idea of a wise house is wherever devices are connected to the net and might create selections autonomously supported data originating from sensors, thereby conducive and rising on the non-public manner of end-users that makes it easier to watch and management home appliances and systems. sensible homes are expected to speak often with their environments (internal and external). the interior surroundings may be thought-about as all Internet- connected sensible devices and residential appliances.

2. INTELLIGENT TRANSPORTATION SYSTEM

Intelligent transportation systems (ITS) square measure accustomed make sure that the transportation network is with efficiency monitored and controlled. ITS is meant to create use of the subsequent network elements as well as vehicle system (which square measure world position system (GPS), frequency identification (RFID) reader, on board unit (OBU), and communication), ITS observance unit, station subsystems (such as road-side equipment) and security subsystems to make sure that system dependability, accessibility, potency and safety of the transportation network square measure secured.

3. SMART CITY

There is an in depth range of applications (ubiquitous services) that are envisaged to enhance and enhance the standard and mode for town residents through gathering relevant info that are relevant to their desires. this can modify sensible technologies to be interconnected so as to make sure that basic services needed by residents are provided together with (transportation, health, homes and buildings etc.,) that fall into this class, with the foremost in style being environmental observation, smart grid, traffic jam (which includes vehicle to vehicle communication) and waste management system, amongst others.

4. SMART HEALTHCARE

The IoT is anticipated to powerfully impact and influence the medical and care system. Recent developments in wearables arena have unfolded opportunities for connected care, wherever advanced device devices area unit hooked up to patients to gather medical information and important signs (including force per unit area, blood heat, steroid alcohol level, rate etc.,) from a patient and be able to diagnose conditions, track progress and indicate anomalies on to the care supplier, while not vital human involvement.

A. IoT DESIGN REQUIREMENTS

In order to make sure that the cellular LPWA technologies area unit ready to give associate degree economical property resolution for the various use cases across each large IoT to crucial IoT, this section presents a number of the key necessities that area unit required once considering large readying of those ser- vices as well as low readying price, long battery life, low device price, extended coverage space, support for enormous variety of connected devices (scalability) and security and privacy.

1) LOW DEVICE COST

IoT connectivity is expected to serve very low average revenue per user (ARPU) which is a reduction in revenue generation when compared to mobile broadband subscriptions. Thisimplies that reduction in the device complexity will at the same time be a key enabler for massive-volume, mass-market applications, which will therefore enable most of the IoTuse cases. Considering cellular LPWA solutions for businessperspective, it is expected that the total cost of production ofdevices including that of ownership should be extremely verylow to aid the massive deployment of IoT use cases.

2) LOW DEPLOYMENT COST

To achieve Massive IoT applications, the entire networkof IoT connectivity, including both the Capital expenditure (CAPEX) and the annual Operational expenditure (OPEX) should be kept at a minimum cost. This can be achievedby using software upgrades on existing cellular networks to deploy LPWA IoT connectivity solution which will reduce the entire cost of new hardware and site planning, thereby maintaining both CAPEX and OPEX to the best minimum inorder to deploy massive IoT use cases.

3) LONG BATTERY LIFE

Energy efficiency is perhaps the most important aspect of IoT, in particular because most IoT devices are battery powered and are expected to be operational for a very long period without human intervention. Energy efficiency has to be consideredin the design of both hardware and software. There are several medium access control (MAC) protocols which supportduty cycling, allowing the radio to be put to sleep (i.e. low power mode) for periods when it is not expecting to receive data, therefore extending battery life. Energy management techniques also play an important role in low power operation through the use of lightweight protocols and schedulingoptimization, for instance [59] as well as energy harvesting,where IoT devices have the capability of harvesting ambientenergy from various sources. Moreover, this would also allow the connectivity of new smart device applications which are not currently deployed and also a minimum of 10 years battery life span of operation will be achieved for daily connectivity of these devices.

4) EXTENDED COVERAGE

Extended coverage is a major design requirement for Massive IoT connectivity when considering applications such as smart metering which are installed in basements with very low coverage and other indoor applications such as elevators. The end goal is to ensure that deeper indoor coverage is provided as an equivalent of signal penetrating a wall or floor, which wouldat the same time increase the indoor coverage to support massive deployment of IoT use cases. A promising techniquefor IoT connectivity link budget for coverage enhancement is being targeted to increase the existing Maximum CouplingLoss (MCL) between the device (UE) and the base station toa maximum of 164 dB.

5) SECURITY AND PRIVACY

Several aspects regarding security and privacy are major design requirements to be considered in IoT applications. The mobile IoT user's real identity should be well protected fromthe public but should be traceable by authorities if the need arises and location privacy is of utmost importance as this can reveal the physical location of the IoT device. Additionally, forward and backward security should be supported for effective deployment of IoT use cases.

6) SUPPORT FOR MASSIVE NUMBER OF DEVICES

It has been envisaged that by 2025, the number of connectedheterogeneous smart devices will reach seven billion over cellular IoT technologies. This shows that IoT connectivity will grow faster compared to legacy mobile broadband connections. This is a clear indication that some cell stations willhave more densely connected number of devices. Therefore,it is hoped that LPWA IoT connectivity solutions shouldbe able to handle most of these connected smart devices simultaneously.

EXISTING IoT COMMUNICATION TECHNOLOGY

Although there is still no unified solution for IoT at this point,there have been a number of different communication technologies that have been proposed and are currently in opera-tion, having been deployed in a number of devices worldwide.Both fixed and short-range communication standards willbe utilized for most connections to achieve both MassiveIoT and Critical IoT connectivity through either traditionalcellular IoT or Low Power Wide Area Networks (LPWAN).

LPWA technologies are for IoT applications because of their unique features which include wide-area coverage, high energy efficiency, channel bandwidth, data rate, and lowpower consumption. This technology is a representation ofthe various technologies which are currently being used inconnecting both sensors and controllers to the Internet with-out the intervention of existing traditional Wi-Fi or cellularnetworks. This section briefly discussthe main features of currently prominent technologies for IoTand categorizes them into long-range networks, short-rangenetworks and cellular technology.

A. LONG-RANGE NETWORKS

LPWA technologies ar among the promising technologies to produce low-power and long-range property resolution for IoT applications. This section discusses a number of the popular LPWAN to support long-range MTC like SigFox, LoRa, Ingenu RPMA, Weightless, and DASH7 that ar relevant to realize MTC use cases for the IoT.

1) LoRa

LoRa is a physical layer protocol [30] that has emerged asa promising technology for low-cost, low-power and long- range communication. LoRa wireless technology is based onLoRaWAN, a media access control (MAC) layer protocol based on ALOHA [61] for wide coverage area network. LoRa network are based on a star-to-star network topology where each node (i.e. end device) has a direct single-hop connectionto a LoRa gateway.

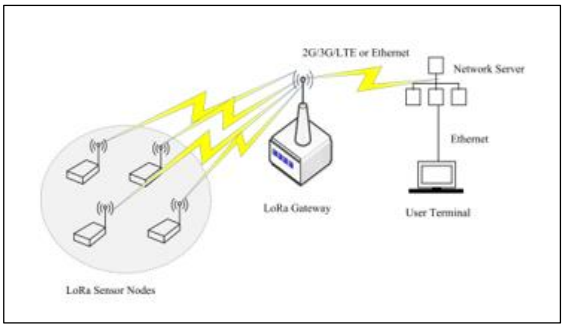

FIGURE 2 : Architecture of a LoRa network.

1) SigFox

SigFox low power wide area network technology offersa complete end-to-end connectivity solution which is based on their patented technologies by using ultra-narrowband (UNB). Since M2M communications requires a small amount of data to be transferred efficiently on a low bandwidth, SigFox suits such type of communication. SigFox end devices connect to the network base stations by using a unique modulation scheme called Binary Phase Shift keying (BPSK) in anultra-narrowband of 100Hz Sub-GHz Industrial, Scientific and Medical (ISM) band carrier. With UNB, SigFox technology provides higher sensitivity, ultra-low power consumptionand long ranges by efficiently utilizing its bandwidth at the expense of limited data rates, which is adequate for IoT sincemost applications do not require high throughputs. SigFox networks use the unlicensed ISM band and as such its frequency of operation varies accordingly between 868 MHz and 915 MHz and enables wide coverage using line-of-sightcommunication. The SigFox network supports up to 12 bytes of packet size for each message using typical modulation including Gaussian Frequency-Shift Keying (GFSK) for downlink and Differential Binary Phase.

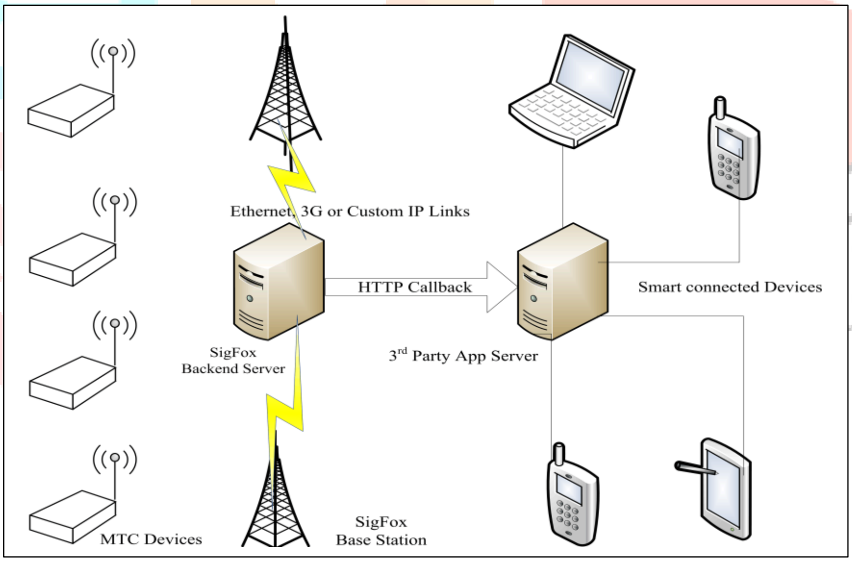

Figure : 3 Overview of SigFox MTC network

1) INGENU-RPMA

Unlike other LPWA technologies which have been previously mentioned that use the 2.4 GHz ISM band for communication, Ingenu-RPMA is a proprietary LPWA technology withmore flexible regulations on the use of spectrum across different regions. This means that higher throughput and more capacity can be achieved when compared to othertechnologies which are also operating in SUB-GHz band.At the core of the wireless technology, Ingenu uses RandomPhase Multiple Access (RPMA) Direct Sequence Spread Spectrum (DSSS), which is used for uplink communication,and allows multiple transmitters to share a single timeslot asa variation to Code Division Multiple Access (CDMA). Thisis achieved by adding a random offset delay to each transmitter within the timeslot, consequently reducing overlapping between transmitters, and thereby increasing the signal to interference ratio for each individual link. Ingenu also pro-vides bi-directional communication. For downlink communication, signals are continuously being spread by base stationsto individually connected end devices and broadcast such signals using CDMA.

Ingenu RPMA is capable of achievingup to 142 dBm receiver sensitivity and a link budget of 168dB. This technology is made compliant to legacy IEEE802.15.4k specifications.

2) DASH7

DASH7 may be a long vary low-power wireless technology that operates within the 433 rate philosophy band associated is an extension of active Radio-frequency Identification (RFID) supported the ISO/IEC 18000 commonplace, wherever communication will happen directly between devices and that they is used for non-RFID applications. DASH7 employs slim band modulation victimization two-level GFSK in SUB-GHz bands. This technology is aimed toward low-rate applications with bursty nature, and offers information rates up to 167 kbps. It additionally supports multi-hopping, albeit restricted to a pair of hops by default, however is extended to a lot of hops. Ranges up to a pair of kilometers square measure doable with DASH7.

3) WEIGHTLESS

Weightless is a new wireless technology which was introduced by the Weightless Special Interest Group (SIP) with three open LPWA standards known as Weightless-W, Weightless-N, and Weightless-P, which operate in both license-free and licensed spectrum for different ranges and low power consumption. This technology uses cognitiveradio and TV white-spaces which enable devices to utilize these bands as opportunistic users without causing interference to the primary user devices as licensed owners. Fig. 4 depicts the architecture of a Weightless Network.

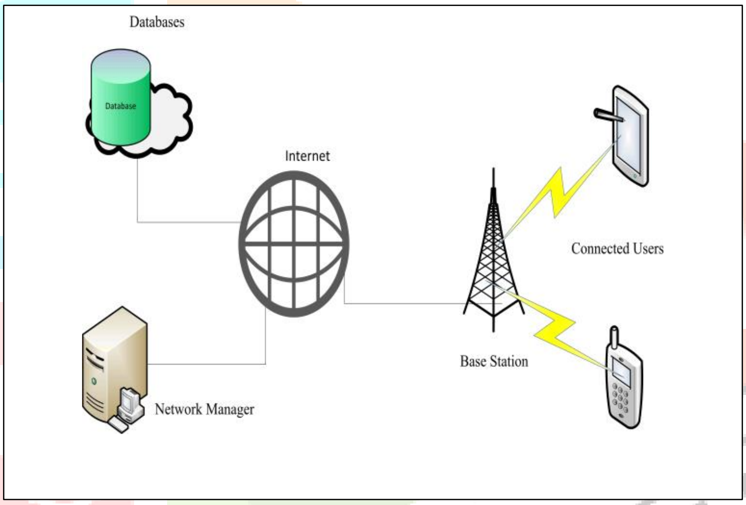

Figure 4 : Architecture of a weightless network provider

a: WEIGHTLESS-N

This is a UNB standard which supports only one-way communication (i.e. from end devices to the base station) using DBPSK modulation scheme. It exploits TV white-space(SUB-1GHz) in the region of 470 to 790 MHz.

b: WEIGHTLESS-W

This commonplace supports completely different modulation schemes like Differential -BPSK and 16-Quadrature AM (16-QAM) with an information rate up to ten mbps that depends on the link budget [73]. so as to boost energy consumption, finish devices ar enabled to transmit at a lower power level to the bottom stations during a slim band.

c: WEIGHTLESS-P

This standard, on the other hand, uses GMSK and QPSK modulation and achieves data rates of 100 kbps using narrowchannels (12.5 KHz). The main drawback of Weightless-N isthat it supports one-way communication, therefore limiting the number of IoT applications it can be used for. However,the fact that bidirectional communication is not supported extends the battery life for several years more than both Weightless-P and Weightless-W.

B. SHORT-RANGE NETWORKS

This subsection presents some legacy short-range wireless network technologies which are currently being used to sup-port short-range M2M communication applications including Bluetooth, ZigBee and low power Wi-Fi. These technologiesare viable and best-fit for consumer use cases of the IoT,but may not be able to support for civic, industrial and otherrelated IoT applications for which the demands are beyond the capacity of their characteristic features.

1) BLUETOOTH

Bluetooth was designed based on the IEEE's 802.15.1 wire-less personal area communication standard to be used for short-range ad-hoc communication (i.e. Master and Slaveconfiguration) between devices operating in the 2.4 GHz ISM bands with achievable data rates in the low mbps. Bluetooth technical specifications and developments are currently being managed by Bluetooth Special Interest Group (SIG). Bluetooth Low Energy (BLE) [Smart Blue- tooth Low Energy], which is also called Bluetooth 4.0 was introduced to improve energy consumption. The most recent amendment to the standard uses 40 channels with a width of 2 MHz channel spacing. The modulation scheme used is Gaussian Frequency Shift Key (GFSK) modulation. To make it more robust to interference, and multi-path fading, Bluetooth uses a frequency hopping spread spectrum (FHSS) scheme where the signal switches carriers over a pre- determined pattern of channels . Although, Bluetooth was originally aimed as a replacement for wires in mobile devices, it has evolved to be used in many different applications.

2) IEEE 802.15.4 AND ZigBee

This standard is currently the *de facto* standard for low-rate wireless personal area networks (LR-WPAN). Three different frequency bands can be used with IEEE 802.15.4: 868 MHz,914 MHz and 2.4 GHz supporting 1, 10 and 16 channels respectively, each with a 2 MHz bandwidth. The maximum supported data rate is 250 kbps. Direct Sequence SpreadSpectrum (DSSS) is used as a modulation scheme for IEEE802.15.4. This standard only defines physical (PHY) and data link layers (DLL). ZigBee uses the PHY and DLL as definedby IEEE 802.15.4, and builds on it by adding a network layer. A drawback of the original version of IEEE 802.15.4 is the fact that a single static channel is used for communication when the network is established, which is susceptibleto interference. It uses Carrier sense multiple access with collision avoidance (CMSA/CA) for channel access. This isone particularly important from the IoT perspective, given that a massive number of connected devices might attempt to communicate concurrently. The main differences between ZigBee and LoRa are the communication ranges and topology options, as the latter supports star, mesh and cluster tree topologies. Figure 5 shows the differenttopologies - star, peer-to-peer and cluster tree – of a ZigBeenetwork.

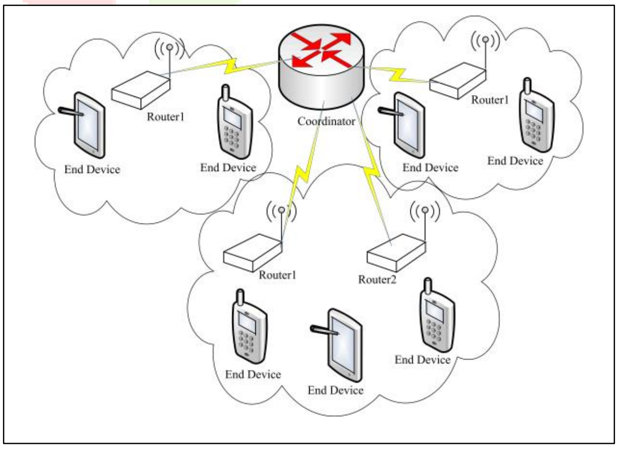

Figure 5. ZigBee mesh network.

3) Wi-Fi

The early version of Wi-Fi was proposed by the IEEE for localarea wireless communication which was released without considering the application of modern IoT connectivity. Thistechnology was intentionally designed for high bandwidth communication between devices which are located within a short-range with the basic aim of providing high throughputconnectivity. This technology is also called wireless local area network (WLAN) and belongs to the IEEE 802.11 standard series . In order to provide Internet connectivity through wireless network access points, the network operateswithin 5 GHz and 2.4 GHz ISM spectrum bands. The accesspoints operate within a coverage area of up to 1 Km, which can be increased by using multiple overlapping hotspots.

C. CELLULAR TECHNOLOGY

Future necessities of IoT applications area unit a significant key drive towards increased growth in cellular technology. Cellular LPWA technologies area unit expected to confirm that numerous services or applications like peddling Machines, good Metering, Automotive Systems (i.e. good traffic, fleet, management, security police work and coverage, real time traffic data to the vehicle), Secure/Smart home (Smart heat, Smoke detector, good appliances) etc., area unit provided. This section presents the assorted paradigm shifts that have evolved within the new mobile generation that has been extensively accustomed enhance the standard of voice communications similarly as facultative the chance for a brand new international property resolution for end-users with the target of guaranteeing that omnipresent communication is achieved with new service necessities

1)2G CELLULAR NETWORKS

Second Generation (2G) digital cellular systems were introduced because of their low-band digital data signaling. Global System for Mobile Communications (GSM) remains one of the most popular technology of 2G wireless systems. This technology was designed to use 25 MHz frequency spectrum in the available 900 MHz band with Frequency Division Multiple Access (FDMA), which allows the operation of multiple users to access available radio frequency band and eliminate the occurrence of interference of message traffic by splitting the available 25 MHz bandwidth into a total of 124 carrier frequencies of 200 kHz each. With the implementation of Time Division Multiple Access (TDMA), each of these frequencies were further divided into eight time slots, which allows for eight simultaneous voice calls to be accessed within the same frequency band. This technology allows for a massive number of subscribers to be connected to a single radio frequency and to allocate time slots to multiple users at the same time. 2G cellular technologies were designed based on circuit- switched system, digitalized and to extend the coverage of applications beyond the normal voice services. This technology can be used for services including short message applications and fax systems which can support a data rate of about 9.6 kbps, which makes it not reliable for applications such as multimedia and web browsing.

1) 3G CELLULAR NETWORKS

The third generation (3G) cellular evolution started when it was foreseen that one of the most useful applications was the Internet, as this would lead to massive connectivity of things beyond its initial focus on multimedia applications such as video conferencing for smart connected devices suchas mobile phones. With the massive increase of personal wireless smart devices (mobile phones, tablets, Ipads etc.), itis clear that there will be need for Personal Wireless InternetAccess (PWIA) that will ease the broadband connectivity ofsmart devices wherever mobile users roam to. However, thetremendous growth of the Internet (smart connected devices)affects both wired and wireless communications, and there isa need for evolution to support the rapid growth of the mobilecommunication industry.The International Mobile Telecommunications-2000 (IMT- 2000) [88] which is the official International Telecommunication Union (ITU) name given to 3G systems with theintention of providing wireless accessibility to the globally connected telecommunication infrastructure, utilizing both terrestrial and satellite systems for serving connected users either through private or public network operators. Its objective was to ensure that a globally harmonized system was created for mobile communication that could be used tofacilitate global interoperability between different network providers and for the provision of lower cost.

3GPP CELLULAR SOLUTIONS FOR THEINTERNET OF THING

Cellular technologies such as 3G, 4G and most especially the legacy 3rd Generation Partnership Project Long-Term Evolution (3GPP LTE) networks are among the current and promising technologies which are being considered as amajor landscape connectivity solution to achieve modern IoTapplications. These promising and appealing technologies are capable of offering wide coverage area, relatively low cost of deployment, high security, dedicated spectrum allocation and efficient management system. However, having been deployed for the interest of optimized broadband networks, they are not suitable for current MTC.The current IoT landscape comprises different solutions ofconnectivity which need to be harmonized among the various key industry players in order to ensure that the requirements of IoT technical key performance indicators (KPIs) are achieved. 3GPP in its desire to ensure that M2M applicationsare efficiently supported on 4G broadband networks including UMTS, and LTE have been working tremendously to make sure that M2M communications are efficiently evolvedin future and promising 5G New Radio systems which is being envisaged for Massive IoT applications. 3GPP in its current standardization of Release-13, recently introduced three main key standards that will enable and enhance the deployment of massive smart connected devices and servicessuch as smart cities, smart grid, wearable devices and connected homes.

5G NEW RADIO ENHANCEMENTS FORTHE INTERNET OF THINGS

Research has shown that the future 5G mobile networks have to cater for the massive deployment of IoT with billions of connected smart objects and sensors that will be a global representation of the real world and to support the provisionof mission critical IoT use cases, which will require real-timeresponses and automation of dynamic processes across different field of operations including vehicle-to-infrastructure(V2I), high speed motion, vehicle-to-vehicle (V2V), and as well as process control system.The 5G new radio network which is currently under consideration is expected to cater for both Massive and Critical IoTuse cases as the demand for machine communications continue to grow extensively for connecting a massive numberof smart devices with the benefits of using cellular networks.In light of this, further enhancements are currently beingintroduced in M2M and NB-IoT systems as specified in thecurrent 3GPP Release-14 for cellular IoT, being the first normative phase for 5G standards. Currently, 3GPP standardization is working towards ensuring that further enhancements ofKPIs are introduced into existing 4G networks to ensure that the 5G mobile network is designed from scratch in order toaccommodate the growing span of the IoT use cases into themarket, and minimizing the cost of developing new networks.

NETWORK ENABLER FOR THE INTERNET OF THINGS

5G mobile networks are envisaged as a promising next generation technology to support the massive deployment of simultaneously connected heterogeneous devices with newservice requirements based on wearable things, improvedbetter coverage edge, low latency, high versatility and scalability for efficiently enabling the Massive to Critical IoTapplications. However, it is obvious that the conventionalnetwork infrastructure is continuously becoming outdated tosupport these features for the IoT architecture with the existing conventional networking system. Consequently, the net-work management complexity continue to increase becauseof the manual process which is used in network configurations owing to the limitations of conventional hardware-based networking. Moreover, a network system should beable to enable the ever-evolving networking technologies forfuture network infrastructure. In addition, the current traditional networks cannot enable the ever-growing networking technologies demand for future next generation networks. To achieve these objectives, emerging technologies includingSoftware-Defined Wireless Sensor Networking (SDWSN),Network Function Virtualization and Cognitive Radio (CR) are among the few network enablers to be discussed brieflyin this section to overcome such limitations of the legacynetworks by 5G mobile network for the IoT.

A:SOFTWARE-DEFINED WIRELESS SENSOR NETWORK

SDWSN is a new promising paradigm to achieve Low-RateWireless Personal Area Networks (LR-WPAN). This network paradigm is achieved by the infusion of Software-Defined Networking (SDN) model into existing Wireless Sensor Networks (WSNs). SDN was primarilyintended to be used in wired communication systems suchas data centers and for next-generation Internet connectivity but has recently emerged in most wireless communication networks, and is envisaged as a future technology enabler for the next generation 5G mobile networks. This intelligent network paradigm provides a centralized network abstraction for programmability of the entire network.

A.NETWORK FUNCTION VIRTUALIZATION

Network Function Virtualization (NFV) is highly complementary to SDN, envisaged as an enabling network technology for next generation service requirements for the IoT applications but are both not dependent on each other. This means that NFV can be successfully implemented without considering SDN and vice–versa. In addition, it is possible that both solutions can be combined to achieve optimal performance output. According to, NFV technology can be used to virtualize a set of network functions which can be further implemented into software packages to be configured in order to efficiently provide related service requirements like existingnetwork infrastructure. The concept of NFV came into reality from the perspective of Virtual Machines (VM) which can be installed to run on various operating systems on the same server machine.

A. COGNITIVE RADIO NETWORKS

Cognitive Radio (CR) technology is a key network enablerfor 5G mobile networks to utilize the limited and scarce spectrum resources in order to support the increasing and high demand for new service requirements of emerging and promising IoT applications. CR supports the capability of using or sharing the licensed spectrum in an opportunistic manner [121]. Dynamic spectrum access techniques allow the CR to operate in the best available channel. CR technology enables the identification of available free spectrum and also enables the detection of licensed users present in the system(spectrum sensing), the ability to select the best available channel (spectrum management), the ability to coordinate accessibility to the available channel with other users (spectrum sharing) and finally the ability to vacate the accessed channel on arrival of the licensed or primary user (spectrummobility).

LITERATURE SURVEY

Waleed Ejaz, Alagan Anpalagan, Muhammad Ali Imran, Minho Jo and Muhammad Naeem conduct a research on “Internet of Things (IoT) in 5G Wireless Communications” and make a decision During the past decade, the Internet of Things (IoT) has revolutionized the ubiquitous computing with multitude of applications built around various types of sensors. A vast amount of activity is seen in IoT based product-lines and this activity is expected to grow in years to come with projections as high as billions of devices with on average 6-7 devices per person by year 2020. With most of the issues at device and protocol levels solved during the past decade, there is now a growing trend in integration of sensors and sensor based systems with cyber physical systems and device-to-device (D2D) communications. 5 th generation wireless systems (5G) are on the horizon and IoT is taking the center stage as devices are expected to form a major portion of this 5G network paradigm. IoT technologies such as machine to machine communication complemented with intelligent data analytics are expected to drastically change landscape of various industries. The emergence of cloud computing and its extension to fog paradigm with proliferation of intelligent `smart' devices is expected to lead further innovation in IoT. These developments excite us and form a motivation to survey existing work, design new techniques, and identify new applications of IoT. Researchers, scientists, and engineers face emerging challenges in designing IoT based systems that can efficiently be integrated with the 5G wireless communications.

Mohammad Wazid, Ashok Kumar Das, Sachin Shetty and Prosanta Gope make a research on “Security in 5G-Enabled Internet of Things Communication: Issues, Challenges, and Future Research Roadmap” and make a conclusion 5G mobile communication systems promote the mobile network to not only interconnect people, but also interconnect and control the machine and other devices. 5G-enabled Internet of Things (IoT) communication environment supports a wide-variety of applications, such as remote surgery, self-driving car, virtual reality, flying IoT drones, security and surveillance and many more. These applications help and assist the routine works of the community. In such communication environment, all the devices and users communicate through the Internet. Therefore, this communication agonizes from different types of security and privacy issues. It is also vulnerable to different types of possible attacks (for example, replay, impersonation, password reckoning, physical device stealing, session key computation, privileged-insider, malware, man-in-the-middle, malicious routing, and so on). It is then very crucial to protect the infrastructure of 5G-enabled IoT communication environment against these attacks. This necessitates the researchers working in this domain to propose various types of security protocols under different types of categories, like key management, user authentication/device authentication, access control/user access control and intrusion detection. In this survey paper, the details of various system models (i.e., network model and threat model) required for 5G-enabled IoT communication environment are provided. The details of security requirements and attacks possible in this communication environment are further added. The different types of security protocols are also provided. The analysis and comparison of the existing security protocols in 5G-enabled IoT communication environment are conducted. Some of the future research challenges and directions in the security of 5G-enabled IoT environment are displayed. The motivation of this work is to bring the details of different types of security protocols in 5G-enabled IoT under one roof so that the future researchers will be benefited with the conducted work.

Quy Vu Khanh,Nam Vi Hoai,Linh Dao Manh, Anh Ngoc Le,and Gwanggil Jeon make a research on "Wireless Communication Technologies for IoT in 5G: Vision, Applications, and Challenges" and described that Communication technologies are developing very rapidly and achieving many breakthrough results. The advent of 5th generation mobile communication networks, the so-called 5G, has become one of the most exciting and challenging topics in the wireless study area. The power of 5G enables it to connect to hundreds of billions of devices with extreme-high throughput and extreme-low latency. The 5G realizing a true digital society where everything can be connected via the Internet, well known as the Internet of Things (IoT). IoT is a technology of technologies where humans, devices, software, solutions, and platforms can connect based on the Internet. The formation of IoT technology leads to the birth of a series of applications and solutions serving humanity, such as smart cities, smart agriculture, smart retail, intelligent transportation systems, and IoT ecosystems. Although IoT is considered a revolution in the evolution of the Internet, it still faces a series of challenges such as saving energy, security, performance, and QoS support. In this study, we provide a vision of the Internet of Things that will be the main force driving the comprehensive digital revolution in the future. The communication technologies in the IoT system are discussed comprehensively and in detail. Furthermore, we also indicated in depth challenges of existing common communication technologies in IoT systems and future research directions of IoT. We hope the results of this work can provide a vital guide for future studies on communication technologies for IoT in 5G.

CONCLUSION

The current expectation and future evolution of the IoT is promising to enable new services and quality of experience (QOE) across the users community and very challenging at the same time because of the resource constrained-nature of the network which has compelled research community toensure that the requirements for massive deployment of MTC applications are achieved for globally connected things.This paper has reviewed the unique features of the cur- rent state-of-the-art of IoT standard infrastructure, includingthe cellular-based LPWA eMTC, EC-GSM-IoT, NB-IoT, andnon-cellular LPWA technologies including LoRa, SigFox,and Ingenu-RPMA with main focus on 5G mobile networksas next generation network for enabling the new servicerequirements. The requirement of 5G mobile network willbe massive to enable mission–critical services, and will be software driven including SDWSN, NFV, and CR to supportdynamic data control, provide a centralized network systemand to enable the adaptation of new service requirementsfor enabling Massive to Critical IoT use cases with efficientcoverage and high capacity targets for lifetime MTC devices.However, there still exists open research challenges for effective control and management of the IoT networks. Forfuture evolution of the IoT, it is therefore recommended todevelop a context-aware congestion control (CACC) schemefor lightweight CoAP/UDP-based IoT network as a multi-objective function that would support the exponential trafficgrowth pattern of the envisaged 5G mobile networks for MTC applications.

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