Comparative Analysis in Between HSPA+ and LTE

Publisher: IEEE

M. Shashidhar ; M. Ranjeeth ; B. Santosh ; V. Manohar **All Authors**

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Publisher: IEEE

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Orthogonal multiple access (OMA) technology was utilised in wireless communication networks from the first generation (1G) through the fourth generation (4G) [1]. For achieving higher data rate with a simpler system an appropriate option is orthogonal approach. However, because to the exponential rise in demand for services with higher data rates is necessary. Researchers have focused on non-orthogonal multiple access (NOMA) in 5G because compared to OMA spectrum efficiency, outage probability, energy efficiency, and capacity are greatly enhanced [2]. As a result, NOMA is playing a crucial role in meeting the 5G standard outlined in IMT-2020 study [3]. The rapid expansion of mobile internet and Internet of Things (IoT) has imposed a number of problems in 5G and Beyond 5G (B5G) technologies. Such difficulties include a 1000-fold increase in capacity, data speeds in excess of 10 Gbps, a 10-year battery life for machine-to-machine (M2M) connection and network latency of less than 1 ms [1 – 3]. Several NOMA systems are presently being investigated, and they are categorized into two types: power domain NOMA and code-domain NOMA [4]. The performance of NOMA systems has garnered a large body of study, the majority of which focuses on outage probability and capacity. In [5], outage attainable rate area is investigated, and the results indicate that NOMA outperforms OMA under identical situations.

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Withdrawal Notice

WITHDRAWN: Public key authentication schemes in asymmetric cryptography

P. Kumaraswamy [a], V. Janaki [b], K. Srinivas [c], D. Naveen kumar [c]

[a] *S R University, Warangal, India*
[b] *Vaagdevi College of Engineering, Warangal, india*
[c] *KITS, Warangal, India*

This article has been withdrawn as part of the withdrawal of the Proceedings of the International Conference on Emerging Trends in Materials Science, Technology and Engineering (ICMSTE2K21). Subsequent to acceptance of these Proceedings papers by the responsible Guest Editors, Dr S. Sakthivel, Dr S. Karthikeyan and Dr I. A. Palani, several serious concerns arose regarding the integrity and veracity of the conference organisation and peer-review process. After a thorough investigation, the peer-review process was confirmed to fall beneath the high standards expected by Materials Today: Proceedings.

The veracity of the conference also remains subject to serious doubt and therefore the entire Proceedings has been withdrawn in order to correct the scholarly record.

Secure Architecture for 5G Network Enabled Internet of Things (IoT)

Chapter · February 2021

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Chapter 52
Secure Architecture for 5G Network Enabled Internet of Things (IoT)

Voore Subba Rao, V. Chandra Shekar Rao, and S. Venkatramulu

1 Introduction

The 5G network enabled internet of things (IoT) is an important technology includes component for developing the concept of industrial internet of things (IIoT). Present system architecture could not be support for upcoming new IoT applications. The proposed next-generation IoT architecture for 5G network enabled IoT is design for upcoming applications service support and secure involvement in internet of things [1].

This paper proposed 5G based on new technologies like machine-to-machine (M2M) communication, 5G-IoT, multi-access edge computing (MEC), network functions virtualization (NFV), and mobile cloud computing (MCC). This security architecture design to manage un-believable network attacks that protect the layers of 5G-IoT architecture. The proposed 5G enable IoT architecture is flexible, simple, effective, layered and more secure for upcoming application technology support, user service demand support, huge data support, and also upcoming industrial internet technology application support [2].

Fourth industrial revolution (4IR) represents industry 4.0 for popular and innovative technology services and huge data management and highly demand services [3]. Industry 4.0 technically represents for recent applications like industrial internet of

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things (IIoT) [4], cyber physical systems (CPS) [5] and big data and data analytics [6], and many more innovative applications.

The importance and enormous services IoT supports the communication of connected-oriented nodes, that should be planning to configure near about for future in the year 2025, will planning to enhance greater quantity than 75 billion nodes [7]. According to upcoming applications, the present IoT architecture should be modified for reliable and responsive for future challenges. In IoT-based security issues, such as authentication, authorization, data confidentiality, and secure data protections of clients are the major challenges. A secure taxonomy must be implemented to manage cyber-attacks to prevent un-authorized issues [8]. This research paper proposed security architecture for the next-generation 5G enabled IoT architecture for manage billions and millions network devices. The authors also introduced layer security design protect from cyber attacks that affect different layers of the architecture.

This paper is organized as follows. In Sect. 2, overview of fourth generation (4G) and fifth generation (5G) enable IoT Applications. In Sect. 3, literature review of authors about various architecture. In Sect. 4, comparison of architectures with proposed architecture. In Sect. 5, proposed architecture for next generation. In Sect. 6, conclusion and future work followed by references of this paper.

2 Overview of Fourth Generation (4G) and Fifth Generation 5(G) Enabled IoT Applications

The features of present fourth generation (4G) technology represents wireless communication support with long term evolution (LTE) technology. The innovative characteristics of the 4G networks are accessing information with a flawless connection anytime, anywhere with a wide range of services and also receiving greater amounts of information, pictures, data, video, etc. 4G services are support user traffic, air interfaces, quality of service, radio environment are major characteristics. 4G support with end-to-end QoS and high security services with effective and efficient connection with the network applications with different levels capable to provide 100 Mbps for high mobility and 1 Gbps for low mobility in anytime and anywhere with affordable cost.

But, there will be a high volume of data increasing day by day that occurs in wireless communicative technology for future coming year's discussions by annual visual-network-index (VNI). The same information is informed by CISCO [9]. As per VNI report, it is stated that 4th generation of networking is not support for future applications and for handling network-load, application load, computer system load with incremental approach for upcoming years. There must be introduced new technology for fast, reliable, and affordable for services.

5G Network is upcoming fifth-generation wireless broadband technology based on the IEEE 802.11ac standard. Long term evolution (LTE) technology of 4G becomes advanced or LTE-A for 5G is the evolution of the original 4G LTE technology

and design and implemented for higher bandwidths. 5G is the next generation of mobile broadband that is being true enabler of the internet of things (IoT), artificial intelligence (AI), industry 4.0. 5G uses higher radio frequencies to achieve speeds up to 1000 times faster than its predecessor, 4G. Ex:- Downloading a two-hour movie would have taken 26 h on 3G, and 6 min on 4G. Now, it will take just 3.6 s on 5G. [10]. Another big difference is the number of devices 5G can support. Current 4G networks support around 4000 devices per square kilometer where in comparison, 5G can support up to 1 million [11]. Latency for 4G is around 20–30 ms, whereas but for 5G, it will reach well below 10 ms [11]. Wireless networks till 4G mostly focused on the availability of raw bandwidth, while 5G is aiming on providing connectivity fast and resilient access to the Internet users. The 5G networks will be built a combination of technologies like 2G, 3G, LTE, LTE-A, Wi-Fi, M2M, etc. In other words, 5G will be designed to support a variety of applications such as the IoT, connected wearable, high graphical video gaming support. 5G network will offer the ability to handle a various types of connected devices and a support different traffic types. For example, 5G will provide ultra-high-speed links for HD video streaming as well as low-data-rate speeds for sensor networks. And also, 5G will support use of cognitive radio techniques dynamically to allow the infrastructure to automatically decide about the type of channel to be offered and adapt conditions in a reasonable given time.

5G is the next generation of wireless communication. The most experienced wireless communication professionals agree that when 5G replaces 4G LTE, it should support three key needs: A decreased latency of less than one second, increased data rates of at least one gigabit per second for tens of thousands of users simultaneously and increased energy efficiency, fast, and reliable connectivity.

3 Literature Review

In the literature review of various authors about existing IoT architectures are reviewed. There are as follows.

1. Three-level architecture—In this, IoT architecture is having sensing-layer, network-layer, and application-layer. The perception-layer or physical-layer for sensing objects is the started from layers, i.e., bottom-layer of IoT architecture. Of all these layers, network-layer level is the middle-layer in internet of things architecture [12] for accessing network. The application layer is the top layer in IoT architecture [13] for user support layer.
2. Three-Level Architecture—In this IoT architecture having sensing-layer, network-layer, and application-layer. The perception-layer or physical-layer for sensing objects is the started from layers, i.e., bottom-layer of IoT architecture. Of all these layers, Network-layer level is the middle-layer in Internet of Things architecture [12] for accessing network. The application layer is the top layer in IoT architecture [13] for user support layer.

3. SDN-Based Architecture—Qin et al. [14] design IoT architecture having heterogeneous wireless network environments provide reliable quality of service (QoS) to manage internet of things processes.
4. Quality of Service-Based Architecture—Jin et al. [15] proposed 4 types of internet of things architecture about smart-city innovative applications. First one is autonomous, which used for internet disconnected networks; Second one is ubiquitous, in this, smart-things-networks (STN) are related to super-network, i.e., internet; Third one is application-level-overlay used for network functions virtualizations (NFV) to reduce latency and congestion in the network for all of nodes present in the network [16]. Fourth type is service-oriented-task, in that, specific-gateways are communicated to the internet of things for heterogeneity features.
5. SOA-Based Architecture–This is a service oriented architecture (SOA) that is four layered architecture are 1—perception-layer, 2—network-layer, 3—service-layer, and 4—application-layer. In SOA-based architecture, the perception-layer service is for sense, storage, analyzation, and finalize the process and that data attached with physical-devices [17].
6. Mobility-First-Architecture—J. Li, Y. Zhang [18] introduced upcoming of future-internet-architecture (FIA), it is known as mobility-first architecture. It is for smartphones belongs to gateway of WSANs in internet of things systems.
7. Cloud-Things-Architecture—Zhou et al. [19] proposed cloud of things architecture for the cloud-type IoT application area. In [20], research author Hao et al. proposed data clouds architecture for the purpose of information-centric networking (ICN) to improve application-oriented-services for the upcoming generation of the internet.
8. Internet of Things Architecture—Pohls et al. [21] got encouraged by IoT-A to designing a platform-oriented-framework for RERUM-FP7 European-Union-project [15] which will accept for internet of things applications processes for authentication procedure and also security for first design. Social internet of things (S—IoT) architecture. Atzori et al. [22], proposed and merge internet of things of social networks and also given information about actually what the social internet of things (S-IoT). This S-IoT allows the combined of things in a social network that process by software-simulations analyzes-execute the components for proposed network-structure.

As per literature given above for implementation of various IoT architectures are used present in industries. But they are not supported for future upcoming challenges and problems arises in new applications and user demand service support in Internet of Things (IoT).

4 Comparison of Architectures with Proposed Architecture

In Sect. 4, comparison of various literature of reviewers about the literature survey of architectures. The current IoT architectures not affordable for support upcoming application IoT service requirements [15]. 5G communication technology focus on important things like having simple of manage-capability, most-reliable, most-securable, high bandwidth, flexible for fast for trouble-shooting, support for wide area network-coverage, low-deployment-capability for costing, and reliability. As per literature survey of architecture of IoT, in Table 1 shows the comparison criteria of various architectures with proposed-architecture that described in graph representation in Fig. 1 for bar graph representation.

5 Proposed Architecture for Next Generation

5G network enabled IoT proposed security architecture—The 5G architecture for applying security methods, security analysis, security services, and the attacks to protect internet of things applications for upcoming 5G technology architecture [23].

Application Layer—Applications layer performs on heterogeneous applications. The application-layer services like user access, network access that process heterogeneous applications. It provide security features like authentication, authorization, trust establishment, manage various types of resource methods, etc. Service-based architecture (SBA) has been proposed for the 5G core network for essential security services. Security services by application layer in 5G as …

The security anchor function (SEAF) is in a serving network and is a "middleman" during the authentication process between a UE and its home network. It can reject an authentication from the UE, but it relies on the UE's home network to accept the authentication.

The authentication server function (AUSF) is in a home network and performs authentication with a UE. It makes the decision on UE authentication, but it relies on backend service for computing the authentication data and keying materials when 5G-AKA or EAP-AKA is used.

Network Layer—The current IoT systems based on generalized architecture for that reason attacker can easily threat devices in a network. In 5G establish a particular authentication mechanism and key adjustment mechanism, wireless public key infrastructure (WPKI), private routing, interference detection, etc.

Network functions virtualization (NFV) addressing for dedicated network of virtualization for utilizing of operate on hardware services. By applying NFV, network routing, load balancing, firewall security is useful for virtual machines (VMs).

Next generation network (NGN) is a packet-based network that can be used for both telephony and data and that supports mobility. Sometimes a NGN is referred

Table 1 Comparison between various embedded os-architecture with proposed architecture

Application-type	Architecture-type					
	Three level architecture	SDN architecture	Qos architecture	SoA-based architecture	IoT-A-based-architecture	Proposed-architecture
Low latency	Not-support	Not-support	Not-support	Not-support	Support	Support
Robustness of connection	Not-support	Support	Support	Not-support	Support	Support
Data types-support	Not-support	Not-support	Not-support	Not-support	Not-support	Support
Re-configurability	Not-support	Support	Support	Support	Not-support	Support
Wide coverage	Not-support	Support	Support	Not-support	Support	Support
S-IoT-architecture	Not-support	Not-support	Not-support	Not-support	Not-support	Support
Security	Not-support	Not-support	Not-support	Not-support	Not-support	Support

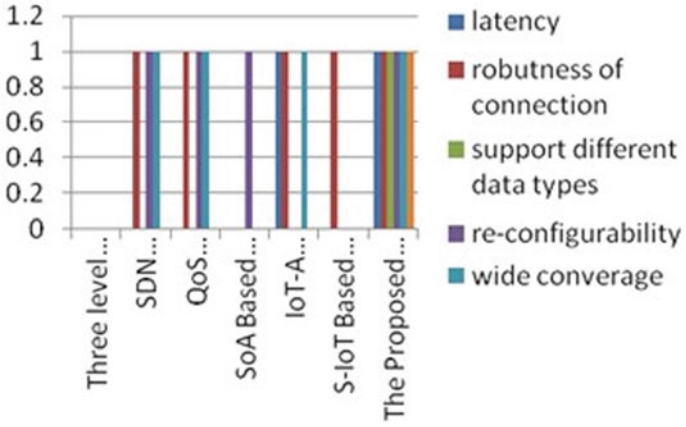

Fig. 1 Bar chart representation for comparison of various architectures

to as an all-IP network. The fundamentals aspects of NGN is packet-based transfer, generalized mobility, broadband capabilities with end-to-end QoS, etc. (Fig. 2).

Data link layer—In data link layer, applications are available via shared resource. The security measures in data link layers are trust and privacy protection for personnel users' data protection is essential.

Communication Layer—It is the main channel between the application layer and different operating activities in the IoT system. The communication layer is considered as the backbone of the IoT systems. The whole physical system is loaded with amounts of data and information that need to be shared with other computer nodes in a network.

Key Management—The key management security is an important concept of wireless sensor networks for authentication. The exchange of shareable key between wireless sensor networks and cloud environment.

Secret Key Algorithms—In wireless sensor network, the frequently used symmetric key algorithms. The useful symmetric key and asymmetric keys algorithms used are skipjack, RC5 and RAS, ECC.

Security Routing Protocol—The popular routing protocols for security routing purpose the techniques are using as algorithms like data fusion mechanism, multiple hopes mechanism, and also key mechanism algorithms.

Secure network encryption protocol (SNEP) guarantees the integrity, freshness, and point to point authentication.

Micro timed efficient streaming loss-tolerant authentication protocols (μTESLA) is a time-based protocol that supplies multipoint broadcast authentication. The lightweight public key authentication technology, pre-shared key (PSK), and random key pre-distribution authentication technology are the main authentication techniques.

Perception Layer—The perception layer also known as physical layer in IoT. First layer denoted for the strength of wireless signals. The signals are transmitted

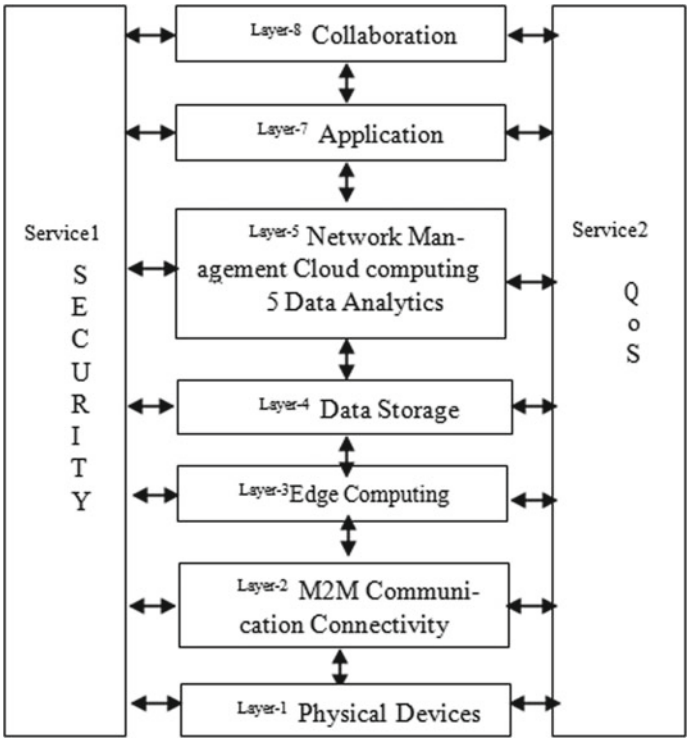

Fig. 2 Proposed architecture for 5G enable

between sensor nodes of internet of things using wireless technology by disturbing waves. Second layer, the sensor node in the IoT operate in external and outdoor environments, leading to physical attacks in which an attacker can tamper the hardware components of the device. Third layer is the inherent nature of topology that is moved around different places. The IoT perception layer mostly consists of sensors and RFIDs. These sensors and RFID are less storage capacity and less power consumption and less computation capability for that frequently threats and attacks generally happened [23, 24]. Radio frequency in perception layer [25] is to identification of security measure such as access control, data encryption, and cryptography technology. This layer's main responsibility is to collect useful information/data from things or the environment. Access control is the part of security that constraint the actions that are performed in a system based on access control rules. As access control part of view, IoT devices preserve the information by RFID tags like processor certainty, analysis of antenna energy and label failures, etc. Data encryption is the process of translation of data into secret key code. Encryption is the effective way to achieve data security. To read an encrypted file, must have access to secret key or password that enables to descript it. The unencrypted data is plain text, and encrypted data is referred as cipher text. The data encryption in RFID by using secure non linear

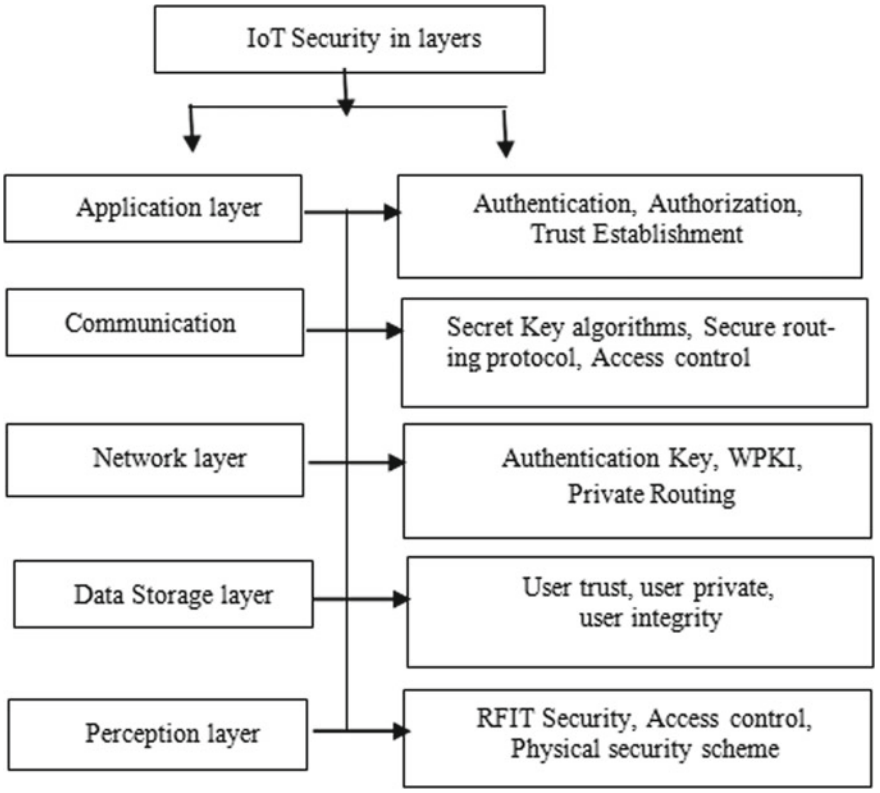

Fig. 3 Proposed IoT layers with security

key algorithm for security [26]. By using RFID system supports for user privacy protection like authenticity, integrity, and confidentiality security features (Fig. 3).

5.1 Security Services of 5G—IoT

The data in the network that sent by 5G radio network security possible by international mobile subscriber identity (IMSI) encryption method. The data encryption, integrity, and protected in the form of device to network. The most security impact on 5G technologies like software defined network (SDN), network function virtualization (NVF), and edge computing are integrated with 5G technologies for further enhance of security levels. 3rd generation partnership project (3GPP) is an interface to communicate physical devices as well as virtual devices to communicate with radio access network (RAN), core networks are used to remotely connected devices for core network technologies.

In 5G, network slicing [27] is used manage user network traffic and smooth flow of dedicated path for routing and enable virtual connectivity over physical connection. The subnetwork, core networks are being created by network slicing. The network slicing useful for providing security channels for shareable resource technologies. Every slice having its manageable security policies for providing authentication for shareable resource technologies. The network slices are designed like that it can manage shareable resources in critical services as per conditions. The most design aspects of critical services access for reliability, safety, timeliness, security, and also privacy. The security policies approaches autonomously must protect the communication devices for their secure connections.

3GPP's technology of 5G are proved best services for security in 4G systems. The security mechanisms of 3GPP system are encryption, authorization, authentication, and user integrity. The 3GPP is useful for security purpose, but these networks provide reliable access links for non-threaten security data. But especially protect from distributed denial-of-service (DDoS) attacks by implementation services and deployment services. For example distributed denial-of-service (DDoS) and jamming attacks happened these 3GPP services managing like re-routing traffic through other base stations whether jamming traffic.

5G applies a security mechanism privacy is threat to end users that protect user identifiers. The feature of 5G network is protect the authentication and privacy of end-user system by using internet applications. The 3rd generation partnership project (3GPP) cannot solve every privacy threats of the outside of the 5G network. Even, the 5G network can protects whatever the messages have been send the social media user. The 5G network protect from these threats when social media user traversing through mobile radio access network (RAN) and also 5G network system. At this movement, social media know that messages have been protected end-2-end service and it goes through internet and once it leaves the 5G network system. The social media know that the protected privacy of the user's data reached their network servers and ultimately stored and further processed.

In Fig. 4 shows providing the importance of horizontal security system. This system provides security controls for various domains like telecommunication-networks, radio-unit, baseband-units, and transport-networks, network support services like domain name system, dynamic host configuration protocol, security

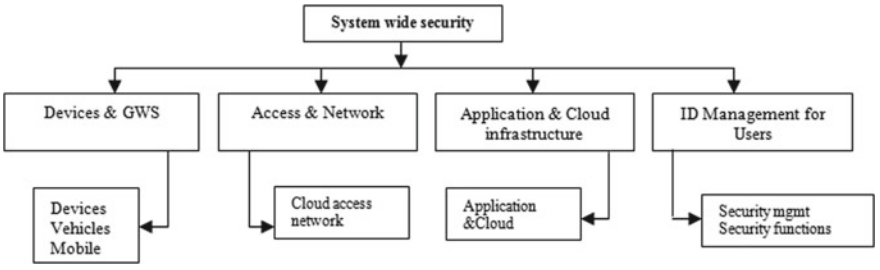

Fig. 4 System-wise security by 5G

management systems. 5G network horizontal security systems provide a target of services available and also confidentiality, integrity of data send by network.

5.2 *Quality of Services (QoS) of 5G—IoT*

5G requires higher values of QoS parameters to meet the objectives of 5G mobile networks to fullfil increased speeds, capacity of mobile networks, and growth of wireless devices. QoS refers to the technologies that manage data traffic by reducing latency, packet loss, and jitter on the network.

Role of QoS in 5G network services are according to the professional leading to 5G area, video-technologies, like HD and UHD videos, are the dominate services among all services of 5G technologies. Additionally, the quantity of mobile devices, YouTube and CCTV-monitoring for M2M communications improves near about billion in 2016 to 6.1 billion in 2021 shows in Fig. 4. By the year 2022, mobile-devices users are approximately improves 2.6-billion machine-to-machine (M2M) connections. There must be an importance of improving the quality management mechanism and algorithms that affects video-technologies and machine-to-machine (M2M) network communication size.

Considering the growth in video and M2M connections, quality of service (QoS) in 5G-networks will be able to prioritize video and voice over internet protocol (VOIP) traffic over web-based searching and also applications used to improve to quality to maximization of packet-delay with confidence.

The main idea of this paper is to focus on internet of things security architecture design for the purpose of upcoming applications support and client demand services in heterogeneous environment. In this focusing on upcoming architecture for 5 g enabled internet of things (IoT) and also proposes the security services and quality of

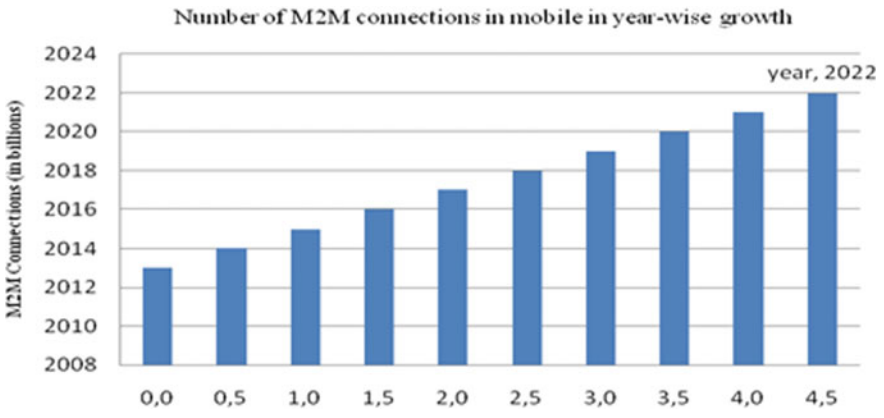

Fig. 5 Quantity of M2M connectivity in mobile

services (QoS) for full-fledged layered technology for newly upcoming applications services and also customer satisfaction service oriented architecture.

6 Conclusion and Future Work

5G network technology based on IoT architecture is upcoming security that need for upcoming processes of high process tasks as per industry internet of things (IIoT). These technology supports for client demandful services for time to time providing and availability of services with effectively. And also, this new architectural model support new technologies for 5G enable internet of things (IoT) like device to device (D2D) connectivity for communication oriented network, machine type communication (MTC), wireless network function virtualization (WNFV), wireless software defined networks (WSDN), mobile edge computing (MEC), mobile cloud computing (MCC), machine-to-machine (M2M)communication, etc. The proposed architecture design for 5G enabled IoT security platform for protecting various attacks for data protection, system protection and various wireless sensor network tiny devices. The proposed architecture is flexible, efficient, layered, reliable and most effective and capable to interact, enhance, and execute future large processing of applications that contains demand of data and also technology support. The authors also added the security and quality of service (QoS) mechanisms for 5G–IoT layered technology that gives end-to-end security and quality of service (QoS) features to make full-fledged layered architecture to enhancement and enable services for IoT systems as per the need of time-to-time customer oriented satisfactory service support. In future work, we are planning to develop efficient algorithms for security services and quality of service (QoS) for 5G network enabled IoT for enhance the services for upcoming applications support.

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2nd International Conference on Computational Intelligence and Energy Advancements (ICCIEA-2021), September 11-12, 2021 Virtual Format

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International Conference on Computational Intelligence and Energy Advancements (ICCIEA-2021) is a prestigious event organized with a motivation to provide an excellent platform for the academicians, researchers, engineers, industrial participants and budding students around the world to share their research findings with the global experts. The conference aimed to provide researchers and attendees with prospects for global collaboration and networking among universities and corporate organizations for promoting research. ICCIEA-2021 was conducted in virtual format owing to the pandemic situation during 11th to 12th September 2021. It involved all classes of academia having research orientation.

The conference was organized jointly by departments of ECE and ME, Vaagdevi College of Engineering and King Abdulaziz University, Rabigh, Saudi Arabia. As it was an event conducted in cyber form, the presentations were delivered using an online platform. Five different and parallel technical sessions were scheduled based upon the tracks of the articles and a Best Paper was awarded in each session. A total of 38 articles were selected for presentation after double blind peer review process. This proceeding issue compiles oral presentations that were presented by the authors and rigorously reviewed by a special committee designated by the editor team of the conference.

The organizing and editorial committee of the ICCIEA-2021 hopes you enjoy reading the articles published in this volume of the JPCS. Besides, we wish to thank all the authors and participants for providing their valuable contributions for this proceeding as well as the reviewers for their constructive recommendations and criticism aiding to improve the presented articles. We are confident that this issue will serve as a reference for computational intelligence, industrial automation, energy advancements and sustainable technologies in the world of scientific research, engineering and technology.

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RESEARCH ARTICLE | APRIL 24 2023

Implementation of FPGA based hardware/software co-design SoC for median filter

Bharati B. Sayankar ; Pankaj Rangaree; M. Shashidhar

+ Author & Article Information

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Nowadays, video and image processing has become the vital part of the system used in each and every field such as medical, Military, Security etc Generally pre-processing filtering is the first and most important task in the systems, hence the speed of the filters is an important parameter. As the Median filter is a nonlinear digital filter often used to reduce the random noise especially Salt and pepper noise from images without damaging the edges, and it is also used for background estimation in video surveillance. In this project a new code for implementation of median filter based on efficient hardware/software co-design is introduced and applied to image filtering problems. In this design the implementation of the hardware and software is achieved simultaneously on programmable chip. The software implementation is achieved using NIOS-II and microClinux as operating system. And hardware part is implemented on EP4CE115F29I8L FPGA device. The execution time of the whole filtering process is evaluated and part of process having higher execution time is implemented on hardware. The results of the software solution alone, and hardware solution alone, the software / hardware co-design solution are reported and compared, emphasizing the computation speed.

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Performance of Generalized $\alpha - \mu$ Fading for Energy Detection Based Spectrum Sensing in Presence of Channel Errors

Publisher: IEEE

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Abstract: This current research, the performance of a general-ized α - μ fading for the energy detection based spectrum sensing (ED-SS) in existence of channel errors is studied... **View more**

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Abstract:

This current research, the performance of a general-ized α - μ fading for the energy detection based spectrum sensing (ED-SS) in existence of channel errors is studied. Accurately, cognitive radio (CR) senses a primary user (PU), receives the sensing information, then it takes a binary-decision about active or inactive status of PU with the help of energy detector. So as to achieve, first the expression for novel-analytic is derived for probability of detection which is concerned to noise also for $\alpha - \mu$ fading. Next, based on the derived expression the frame works which are analytic to evaluate the total error rate (TER) and the complementary receiver operating charac-teristics (CROC) performances of a CR for all the parameters of channel and network are elaborated. Additionally, the ED-SS performance for various parameters namely as probability of channel error, detection threshold and signal-to- noise ratio (SNR) is investigated. Optimal detection threshold for several channel and network parameters are also determined. Finally, the numerical analysis of ED-SS without channel errors is also presented for comparison purpose. Analytical results are achieved using MATLAB numerical simulation.

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Contents

Among the wireless communication technologies, cognitive radio (CR) is the auspicious technology. It was created to allow unlicensed CR users to take use of licensed primary user's (PUs) vacant spectrum bands in the most opportunistic and efficient manner [1]. In [2], authors studied the importance of accurate and efficient spectrum hole identification for the implementation of protocols of CR in wireless networks for future generation. High data transfer rates, universal connection, minimal end-to-end latency, significantly high system capacity and enhanced energy efficiency are all expected from 5G wireless networks. The CR networks share spectrum dynam-ically for achieving spectrum's efficiency, which is necessary in 5G design [3]. It is difficult to make an accurate conclusion on PU status (inactive or active) when the format of PU's information signal is unclear. Energy detection (ED) approach is one of the reasonable alternatives for those restrains [4]. A single CR decision using an ED in occupancy of Rayleigh fading/shadowing is studied in [5]. In [6], the performance of a CR network in existence of imperfect reporting channels is studied.

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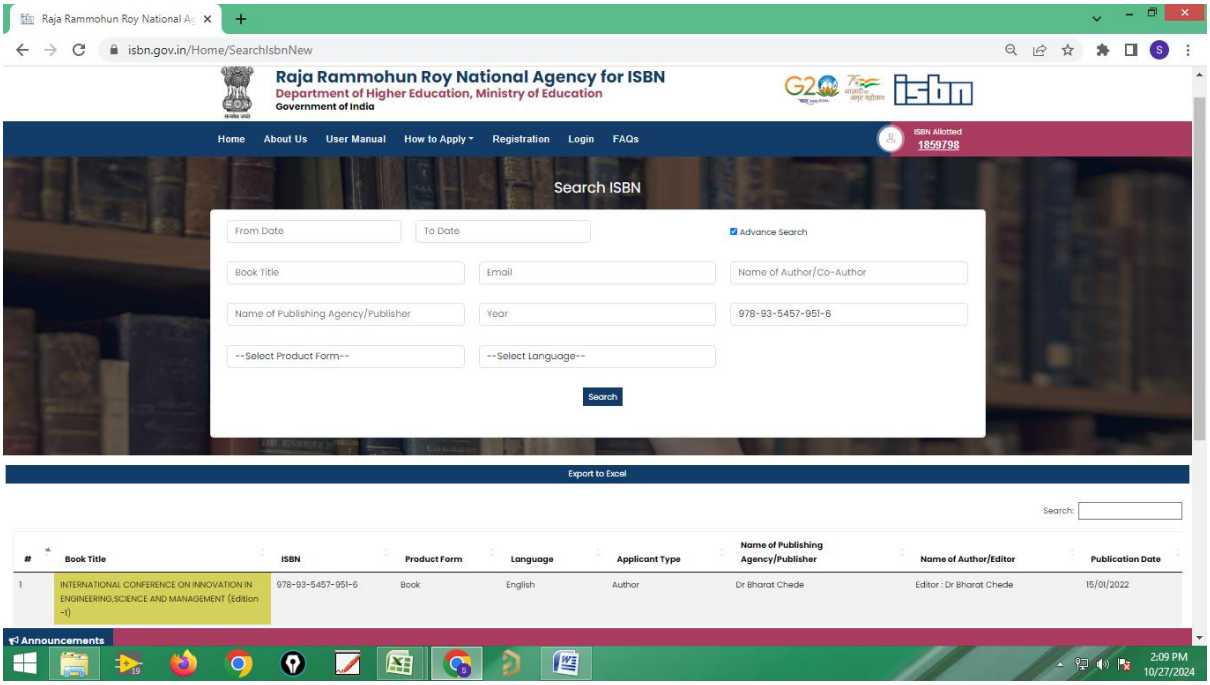
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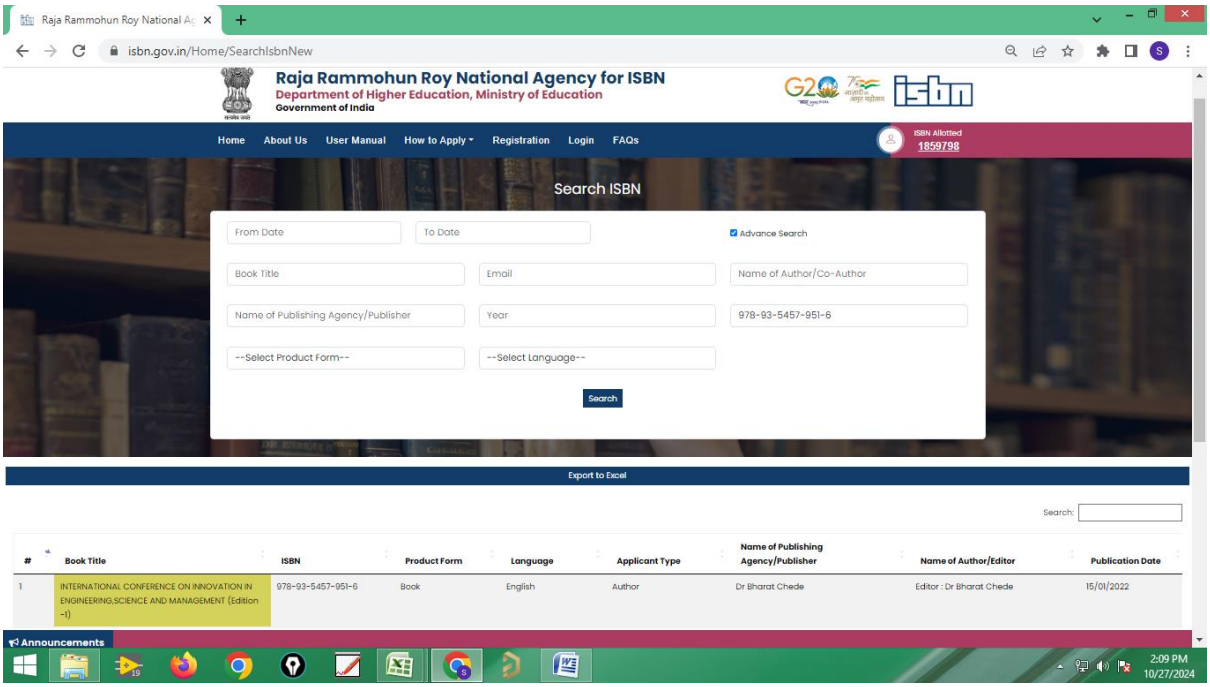
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