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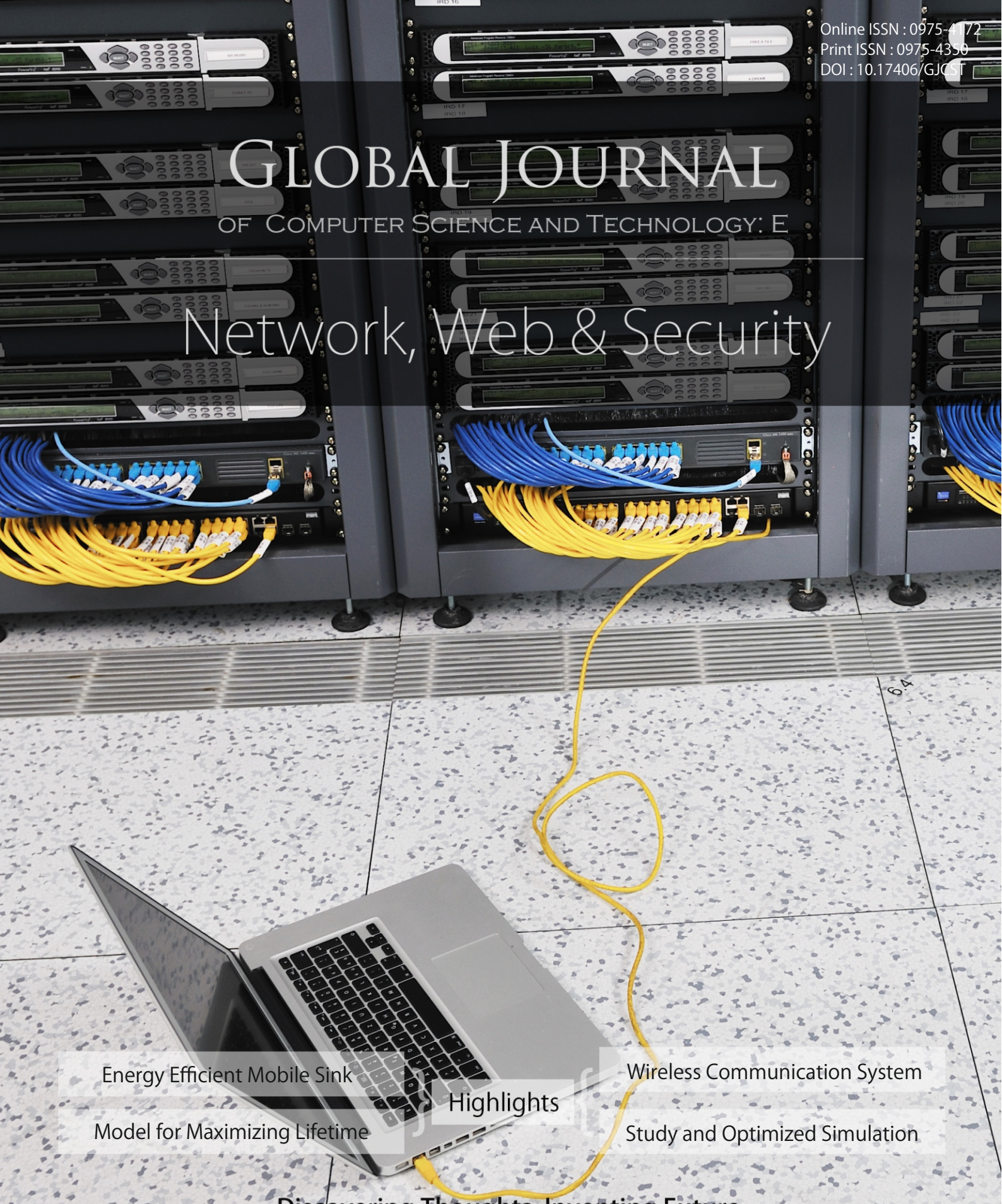

Energy Efficient Mobile Sink Model for Maximizing Lifetime

Highlights

Wireless Communication System Study and Optimized Simulation

Discovering Thoughts, Inventing Future

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Energy Efficient Mobile Sink based Routing Model for Maximizing Lifetime of Wireless Sensor Network

By Naveen Ghorpade & Dr. Vijayakaryhik. P

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Naveen Ghorpade [α] & Dr. Vijayakaryhik. P [σ]

Abstract- Recently, wide adoption of wireless sensor networks (WSNs) has been seen for provision real-time and non-real-time application services. Provisioning these application service requires energy efficient routing design for WSN. Clustering technique is an efficient mechanism that plays a major role in minimizing energy dissipation of WSN. However, the existing model are designed considering minimizing energy consumption of sensor device considering homogenous. However, it incurs energy overhead among cluster head. Further, maximizing coverage time is not considered by exiting clustering approach considering heterogeneous network affecting lifetime performance. For overcoming issues of routing data packets in WSN, mobile sink has been used. Here, the sensor device will transmit packet in multihop fashion to the rendezvous and the mobile sink will move towards rendezvous points (RPs) to collect data, as opposed to all nodes. However, the exiting model designed so far incurs packet delay (latency) and energy (storage) overhead among sensor device. For overcoming research challenges, this work present energy efficient mobile sink based routing model for maximizing lifetime of wireless sensor network. Experiment are conducted to evaluate the performance of proposed model shows significant performance in terms of communication, routing overhead and lifetime of sensor network.

Keywords: clustering, energy efficiency, mobile sink, rendezvous point, routing, WSNs.

I. Introduction

The increased growth of sensor technologies has led to increased adoption of wireless sensor network (WSN) across various organization for provisioning both non-real-time and real-time application requirement of future wireless sensor network based services [1], [2], [3], and [4].A primary operation of wireless sensor network is to perform accurate sensing and collect resourceful information such as temperature, humidity, etc. for further examination [5]. Further, cloud computing based model, such as Fog-RAN (Fog-Radio area network) [6] and Cloud-RAN [7] enable wireless sensor network with capability of massive storage [8] and processing capability [9]. The senor device are placed in hazardous location where physical monitoring is near impossible such as in oil refinery, space etc. Thus, replacing and recharging of battery of the sensor device [SD] are difficult/impossible. The sensor device sensing operation can either be time driven or event driven where energy loss exponential in nature. The sensory information are generally transmitted directly through base station or through intermediate/neighbouring device. In some case, same sensory information is transmitted toward base station. As a result, affect network energy performance. For addressing data redundancy issues, [10] presented a data aggregation method. Further, [11] showed accurate gathering and routing [12] is needed for provisioning real-time requirement of industrial and commercial application. Performing data aggregation possess several energy efficiency challenges [13]. In [14] presented energy conservation (efficient) model for performing efficient data aggregation. Further, [15] presented hierarchical cluster based routing model namely Hybrid Energy-Efficient Distributed (HEED) and Low Energy Adaptive Clustering Hierarchy (LEACH) for preserving energy of sensor network. However, both LEACH and HEED are not efficient under large density network as they induces energy overhead among cluster head (CH) [16]. Along with, routing data from CH to the base station (BS) is not a feasible solution for such environment [16]. Thus, to minimize overhead among CH and enhance lifetime of sensor network, [17] presented a hop based routing model under clustered network. However, adopting hop based transmission induces communication among CH device and hop device due to channel contention. Further, optimizing channel contention is NP-deterministic.

Number of energy efficient clustering based method for large wireless sensor network is been presented in recent times. In [18] presented fuzzy based clustering model for large network. However, energy of CH closer to BS drains very rapidly. Thus, affecting lifetime performance of WSN. For addressing, [19] presented type-2 fuzzy logic (T2FL) based clustering model. The T2FL distributes packet load among sensor nodes (SN) aiding lifetime performance improvement of WSN's. However, T2FL cluster model are not designed heterogeneity real-time application requirement of WSN's [20], [21], [22], and [23]. For meeting real-time application requirement [24] presented a data collection method, [25] proposed an energy efficient clustering

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based routing model, [26] proposed data prediction model, and [27], [28] proposed a energy efficient clustering routing design using cross layer design. Recently, many approach has been presented to minimize energy dissipation of sensor device [24], [25], [26], [27], and [28]. However, these model suffers from network coverage issues. Further, [29] presented cluster formation considering coverage problem using evolutionary computing model. However, extensive survey presented in [30] shows using evolutionary computing model under heterogeneous network incurs computation overhead among wireless sensor nodes. in [31], proposed an energy efficient routing model considering packet loss rate and link quality under clustered based heterogeneous sensor network. However, they did not considered improving coverage time. Thus, affecting lifetime performance of WSN's.

For improving network coverage for large heterogeneous network, mobile sink (MS) based routing (data collection) have attained much attention in recent times [34], [35], [36], and [37]. Here, MS will move through the WSN area to gather sensory information from SN. As it is practically impossible (i.e., not efficient) for MS to visit all SN. Recently, number of methods using rendezvous point (RP) selection method is presented. The RP collect the sensory information from sensor node which later send it to MS when the MS visit near them. In [34], [35] presented a fixed rendezvous point. As a result, mobile sink path is very restricted. In [36], [37] presented an unconstrained method where MS can move freely within region of WSN's. In [4], mapped SN to region on a Halin graph (HG) for choosing rendezvous point considering given to the residual energy availability status of the SNs. Similarly, [37] presented a rendezvous point section scheme using weighted rendezvous planning (WRP). The WRP aid in selecting appropriate rendezvous point devices (RPD) while assuring the delay requirement by limiting the travelling distance of the MS. To establish the rendezvous point device, a weight is assigned to each SN. The SN with maximum weight is selected as RPD only if the TD of the MS is smaller than a predetermined threshold. However, throughout the RPD selection process of the state-of-art method [4] and [5], computation of the weight parameter of SN is done using data of preliminary routing paths, whose directions are headed towards a solitary starting point of a MS. Thus, the state-of-art routing model induces higher routing length and affect overall performance of WSN. For overcoming research challenges, this work first present energy efficient mobile sink based routing model for maximizing lifetime of wireless sensor network.

The contribution of research work are as follow. Presenting an optimal rendezvous point selection model for minimizing energy dissipation of sensor nodes and maximizing lifetime of WSN. The proposed model attain significant performance improvement over state-of-art model in terms of communication, routing overhead and lifetime of sensor network.

The manuscript is organized as follows. In section II the proposed energy efficient mobile sink based routing model for maximizing lifetime of wireless sensor network model is presented. The penultimate section presents an experimental study of proposed model over exiting method. The conclusion and future work is discussed in the last section of the manuscript.

II. Energy Efficient Mobile Sink based Routing Model Formaximizing Lifetime of WSN

This section present an energy efficient routing model using mobile sink for minimizing energy consumption sensor device, and maximize lifetime of sensor network. Firstly, we describe the system and channel model of heterogeneous wireless sensor network architecture. Then, we describe the optimal rendezvous point selection and routing model to enhance lifetime of wireless sensor network.

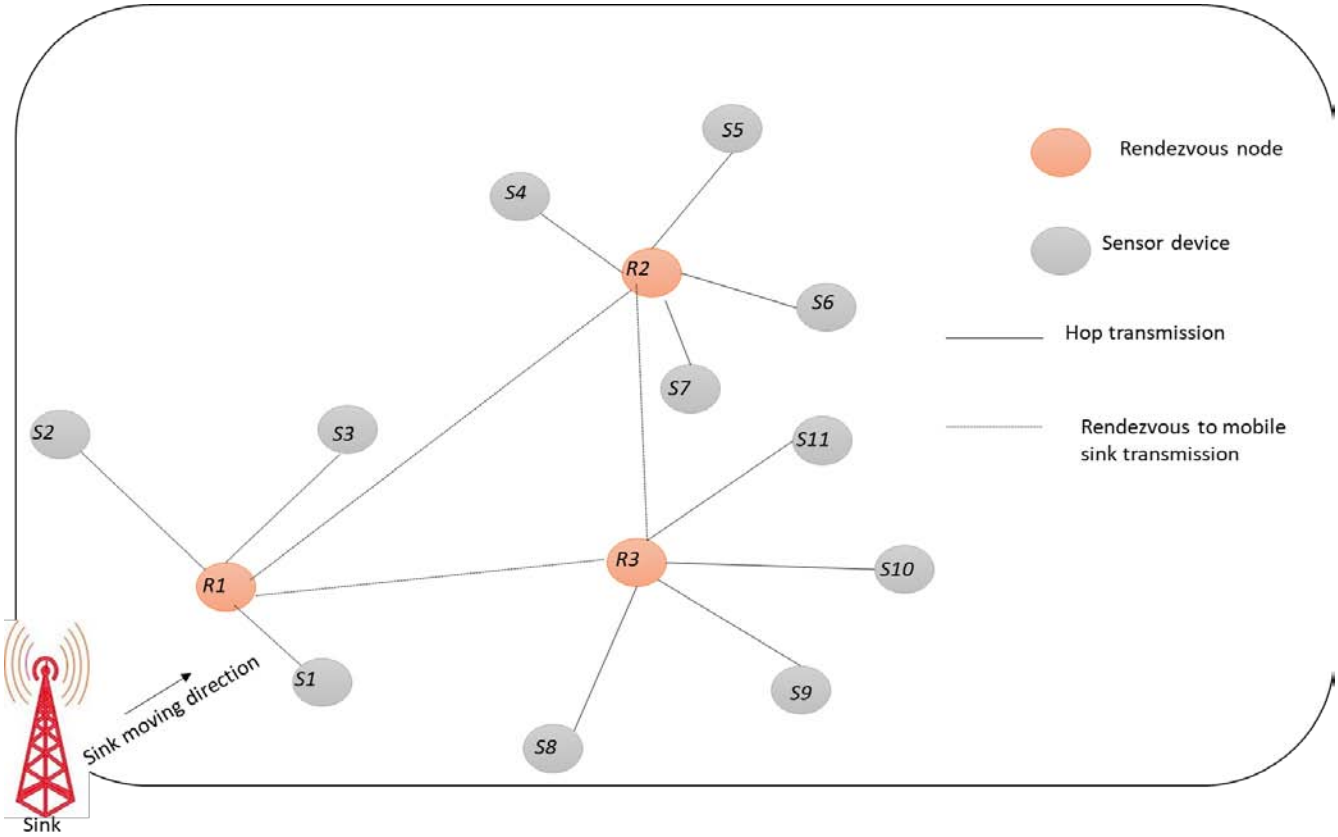

Fig. 1: The Architecture of proposed energy efficient

a) System architecture, channel and transmission optimization model

The architecture of proposed model is show in Fig. 1. From Fig. 1 it can be seen that the rendezvous point closer to base station is composed of less number of rendezvous member we call this as level 1 and rendezvous point little far away from rendezvous node has more number of rendezvous member we call this has level 2. This way the far rendezvous point nodes will have large density of rendezvous member. This deployment method aid in minimizing energy consumption of rendezvous node. Especially, the rendezvous node closer to sink. Thus enhancing coverage time and lifetime of sensor network.

This work considers heterogeneous WSN i.e., let's consider classes of sensor device such class A, class B. Class A are represented as sensor device that performs operation such as sensing. These device are low cost and tiny devices which are deployed across sensing region. The sensor are grouped together to form a rendezvous points. Class B sensor device is more powerful and has higher computing capability than Class A device which depicted as rendezvous node. The class B device collects and aggregates sensory data from its member and transmit toward sink/base station through set of hop/intermedia rendezvous node device.

Let consider there are N and O nodes that are randomly deployed in a network and their position are known. Each sensor device are connected/associated with one rendezvous node device and generates mean packet load of α bits/sec and transmit to the rendezvous node, which further routes to the mobile sink nodes (which in this work we considers as the $(M+1)^{th}$ rendezvous node directly or through intermediated rendezvous node devices. Further, this work considers the rendezvous node consumes much higher energy than its sensor devices. Since, rendezvous node is active all the time and at the same time the member device are in sleep state. As a result, this work aimed to minimize energy consumption of rendezvous node device. As it aid in enhancing network coverage resulting in better lifetime of wireless sensor networks.

This work considers Rayleigh fading model to characterize the channel among rendezvous node and also among rendezvous node and the base station. Therefore the channel gain y among sender and receiver for communication is obtained as follows

$$i(y) = M(e_0)\left(\frac{y}{e_0}\right)^{-o}\beta \quad (1)$$

where $M(e_0)$ is the path loss component of e_0 which can be computed as follows

$$M(e_0) = \frac{H_u H_s m^2}{16\pi^2 e_0^2} \quad (2)$$

where H_u is the antenna gain of the sender, H_s is the antenna gain of the receiver, β is a normalized arbitrary

parameter that depicts the variation in the fading process, m is the wavelength of the frequency carrier, o is the path loss exponent. The β is arbitrary and is considered to be exponentially distributed, and the received signal is also arbitrary. Therefore, perfect reception of a signal is assured through probabilistic manner. Hence we needed that $P\{f_s \geq \delta\} \geq \gamma_m$ for ideal reception, where f_s is the energy of obtained signal, δ is predetermined energy threshold, and γ_m is the expected link ideal parameter.

Let consider d_j as the cumulated hop routing load attained by the j^{th} rendezvous node (bit/seconds) for $j = 1, \ldots, O$. The rendezvous pointing optimization vector is expressed as follows

$$d = (d_1, \ldots, d_O). \tag{3}$$

An important to be seen here is that the number of sensor device associated with rendezvous node ji.e., the size of rendezvous point j, is expressed as follows

$$\frac{d_j}{\alpha}. \tag{4}$$

For $j \in \{1,2,3, \ldots, O\}$ and $k \in \{1,2,3, \ldots, O+1\}$, with $j \neq k$, let w_{jk} be the rendezvous routing load that is transmitted from rendezvous node j to rendezvous node k. The routing optimization matrix $\boldsymbol{S}$is the $O * (O+1)$ matrix of elementw_{jk}, $j = 1, \ldots, O$ and $k = 1, \ldots, O+1$. This work considers$w_{jj} = 0$. The objective of this work is to maximize coverage time by establishing an optimized routing matrix $\boldsymbol{S}'$ and rendezvous point vectord'. Let consider Q_j as the mean energy consumption of the j^{th} rendezvous node. Then, the Q_j is expressed as follows

$$\begin{aligned} Q_j \;=\; & f_{recv}\left(d_j + \sum_{1\leq k\leq O, k\neq j} w_{kj}\right) \\ & + f_{trns}\left(\sum_{1\leq k\leq O+1, k\neq j} w_{jk}\right) \\ & + \sum_{1\leq k\leq O+1, k\neq j} w_{jk}\, f_{ujk}, \quad j \\ & = 1, \ldots, O \end{aligned} \tag{5}$$

where f_{trns} are the circuit energy per bit dissipated in transmitting data, f_{recv} are the circuit energy per bit dissipated in receiving data, and f_{ujk} is the energy dissipated from rendezvous node j to rendezvous node k. Let us assume that e_{jk} as the distance among rendezvous node j and k, therefore using Eq. (1) the received energy per bit can be expressed as follows

$$f_{recvjk} \;=\; f_{trnsjk}\; M(e_0)\left(\frac{e_{jk}}{e_0}\right)^{-o} \beta. \tag{6}$$

By using Rayleigh channel model, the link ideal parameter can be described as follows

$$\begin{aligned} \gamma_m &= \mathcal{P}\{f_{recvjk} \geq \delta\} \\ &= \mathcal{P}\left\{\beta \geq \frac{\delta}{f_{trnsjk}\, M(e_0)}\left(\frac{e_{jk}}{e_0}\right)^{o}\right\} \\ &= f^{\frac{\delta e_{jk}^{o}}{f_{trnsjk}\, M(e_0) e_0^{o}}} \end{aligned} \tag{7}$$

From Eq. (7), we can describe f_{trnsjk} as follows

$$f_{trnsjk} = \varphi e_{jk}^{o}, \quad j \neq k \tag{8}$$

where φ is a constant that can be expressed as definition as follows

$$\varphi = \frac{-\delta}{M(e_0) e_0^{o} \log \gamma_m} \tag{9}$$

The Eq. (5) can be written considering for $j = 1, \ldots, O$, as follows

$$\begin{aligned} Q_j \;=\; & f_{recv}\left(d_j + \sum_{1\leq k\leq O, k\neq j} w_{kj}\right) \\ & + \sum_{1\leq k\leq O+1, k\neq i} w_{jk}\,(f_{trns} \\ & + \varphi e_{jk}^{o}) \end{aligned} \tag{10}$$

Let $F_j$depicts the initial energy of the j^{th} rendezvous node, $j = 1, \ldots, O$. This work consider an optimization problem to maximize coverage time as follows

$$max_{\{d,S\}} min\left\{\frac{F_1}{Q_1}, \frac{F_2}{Q_2}, \ldots, \frac{F_O}{Q_O}\right\}. \tag{11}$$

When rendezvous nodes are deployed with equal energy, that is,

$$P_j = P \;\forall\; j, \tag{12}$$

The optimization problem of Eq. (11) can be rewritten as follows

$$min_{\{d,S\}} max\{Q_1, \ldots, Q_O\} \tag{13}$$

For solving optimization problem of Eq. (13), packet load composed by all the rendezvous node considering certain instance period of time must be identical to load produced by all the sensor devices in the same instance period of time.

b) Optimal rendezvous point selection and routing model

This section present rendezvous point optimization technique for wireless sensor network. Let $d' = (d_1', \ldots, d_O')$ be the optimal rendezvous pointing vector outcome. For $j = 1, \ldots, O$, rendezvous node j is given $N_j' = d_j'/\alpha$ sensor devices. The sensor device allocation is carried out in sequential manner, i.e., one at

a time. A corresponding sensor device is allocated to the nearest rendezvous node j, provided that number of SD to rendezvous node j is not greater than$N_j^{'}$. If it exceed then next nearest rendezvous node is considered and so on. The algorithm for obtaining optimal rendezvous pointing is presented in algorithm 1.

Algorithm 1: Optimal rendezvous pointing selection algorithm
Input:$d^{:} = d^{'} = (d_1^{'}, \dots, d_O^{'})$
Expected outcome:$V_1, \dots, V_O$
Initialize:$V_1 = \cdots = V_O = \emptyset$ (rendezvous point sets)
Start: For$j = 1$ to N
For$k = 1$ to O
Sety_{jk} to distance among sensor device j and rendezvous node k
End for
Iteration:$l = arg_{\{k\}} \min\{y_{jk}, k = 1, \dots, O\}$
If$d_l^{'} > 0$

$$d_l^{'} = d_l^{'} - \alpha$$
$$V_l = V_l + \{l\}$$

Else

$$y_{jl} = \infty$$

go to iteration
End if
End for
End:

This work consider routing considering shortest path root towards rendezvous node device to mobile sink through number of hop devices. For minimizing hop count which varies for different transmission. As a result, this work considers quality of communication using parameter γ_q for computing probability of positive end-to-end reception. Fordifferent roots of L paths experience different fading, the root reliability γ_u must be at least $\gamma_q^{\frac{1}{L}}$. Considering the shortest hop case, the packets are routed through nearest rendezvous node closer to the next level j towards the base station. This work considers energy balanced rendezvous point based routing design that balance energy of different rendezvous nodes. The communication radius of rendezvous point can be obtained as follows

$$\frac{1}{2}(s_1 - s_0), \dots, \frac{1}{2}(s_L - s_{L-1}), \tag{14}$$

is the important to energy dissipation at different level rendezvous nodes. Thus, by purposely regulating the size of rendezvous point in different levels, a more balanced energy dissipation at different rendezvous nodes is attained, which aided in enhancing coverage time of WSN. Thus improving lifetime of WSNs which is experimentally proven below.

III. Simulation Result and Annalysis

This section present performance evaluation of proposed model over exiting method considering lifetime, communication overhead and routing overhead. The experiment is conducted using windows 8 operating system, I-7 Intel Pentium processor, 64-bit, 8 GB RAM. Experiment evaluation is done using SENSORIA simulator [32] for proposed and existing model. Here we compared our result with base LEACH protocol [11]. The LEACH and proposed model is modelled using Dot Net framework 4.5 and C# programming language. The LEACH has been widely used comparison protocol across various exiting approaches [11]. As a result, this work consider LEACH protocol as a case study for comparison. The simulation parameter used for experimental analysis is described as follows, the network size is set to 100m × 100m, the sensor device is varied from 500, 1000, 1500 and 2000, one base station is consider which is placed at the edge of the network, initial energy of sensor device is set between (heterogeneity) 0.1 to 0.2 Joules (j), Idle Energy Consumption (Eelec) is set to50 nj/bit, and Amplification Energy (Emp) is set to100 pJ/bit/m2. The range of transmission is set to 5 m and sensing range is set to 3 m, Data Packets Length is set to 5000 bits, Transmission Speed is set to 100 bit/s, Bandwidth is set to 10000 bit/s, Data processing delay is set to 0.1 s.

a) Lifetime performance analysis considering total sensor node death

This section describes performance attained by proposed model over existing model considering total sensor device death. Here the sensor device is varied from 500, 1000, 1500, and 2000 and experiment are conducted to evaluate lifetime performance and the result is graphically represented in Fig. 2. The result shows proposed model improves lifetime performance by 69.09%, 76.22%, 82.96%, and 83.83% over existing

protocol considering 500, 1000, 1500, and 2000, sensor device respectively. An average lifetime performance improvement of 78.02% is attained by proposed model over existing considering total sensor device death. The overall result attained shows scalable lifetime performance considering varied network density.

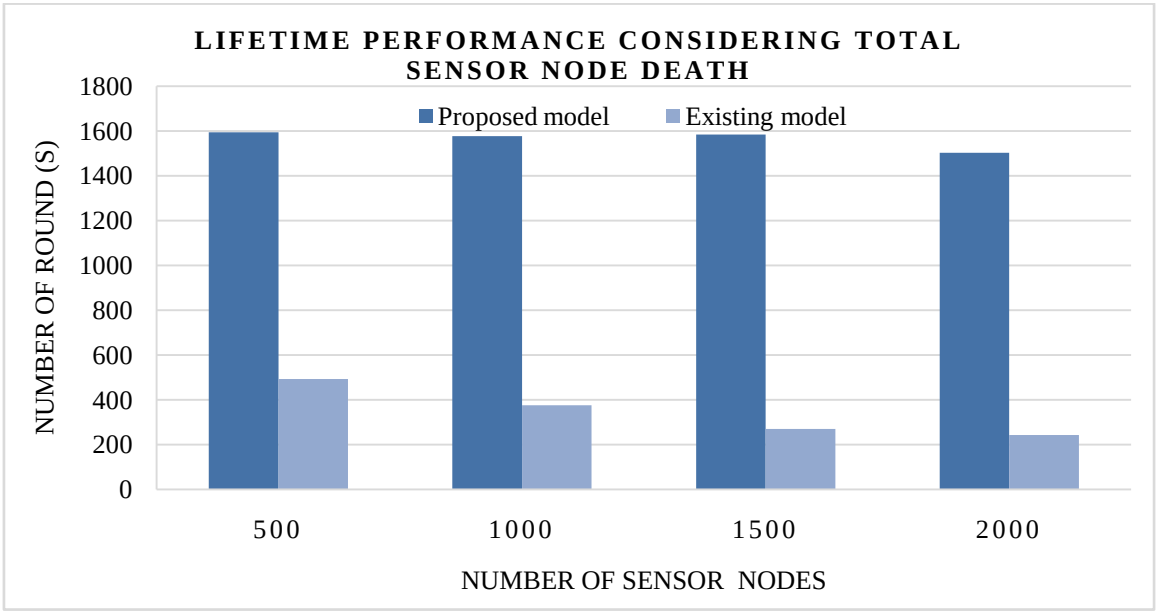

Fig. 2: Lifetime performance considering total sensor node death

b) Communication overhead and Routing/transmission overhead performance evaluation considering varied sensor device

This section studies communication overhead and routing overhead performance attained by proposed model over existing model [11]. For experiment analysis, the sensor device is varied from 500, 100, 1500, and 2000 and experiment are conducted and the result is graphically shown in Fig. 3. The outcome shows, proposed model reduces computation overhead by 32.74%, 26.25%, 48.644%, and 41.88% over existing model considering 500, 1000, 1500, and 2000 sensor device, respectively. An average communication overhead reduction of 37.37% is attained by proposed model over existing model. Similarly, experiment are conducted to evaluate routing overhead performance by varying sensor device from 500, 100, 1500, and 2000 and result is graphically shown in Fig. 4. The outcome shows, proposed model reduces routing overhead by 51.62%, 44.06, 45.08%, and 51.93% over exisitng considering 500, 1000, 1500, and 2000 sensor device, respectively. An average routing overhead reduction of 48.17% is attained by proposed model over existing model.

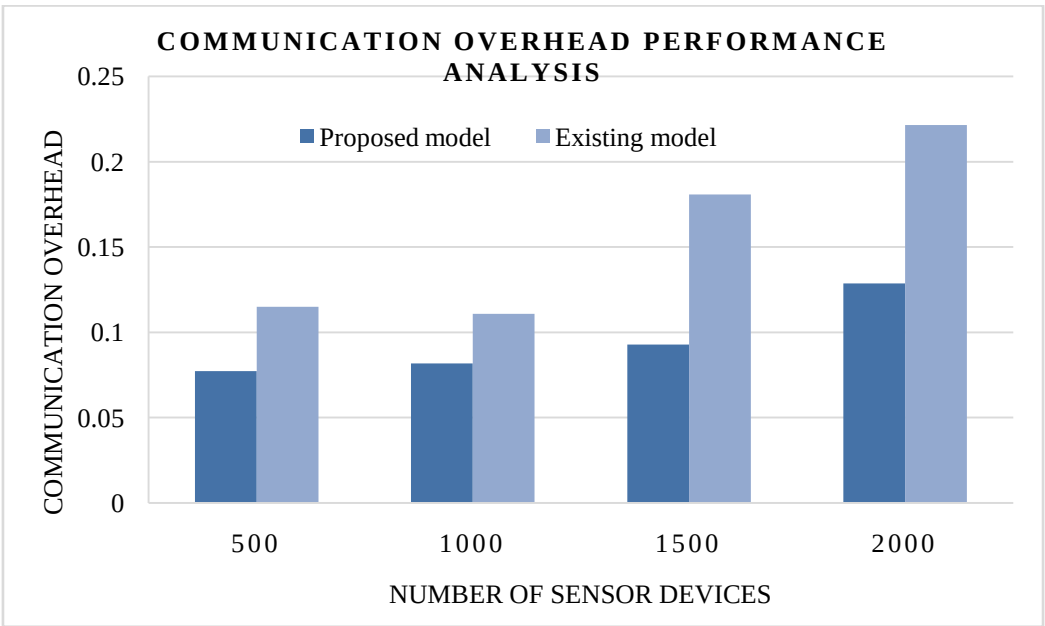

Fig. 3: Communication overhead performance evaluation for varied wireless sensor nodes

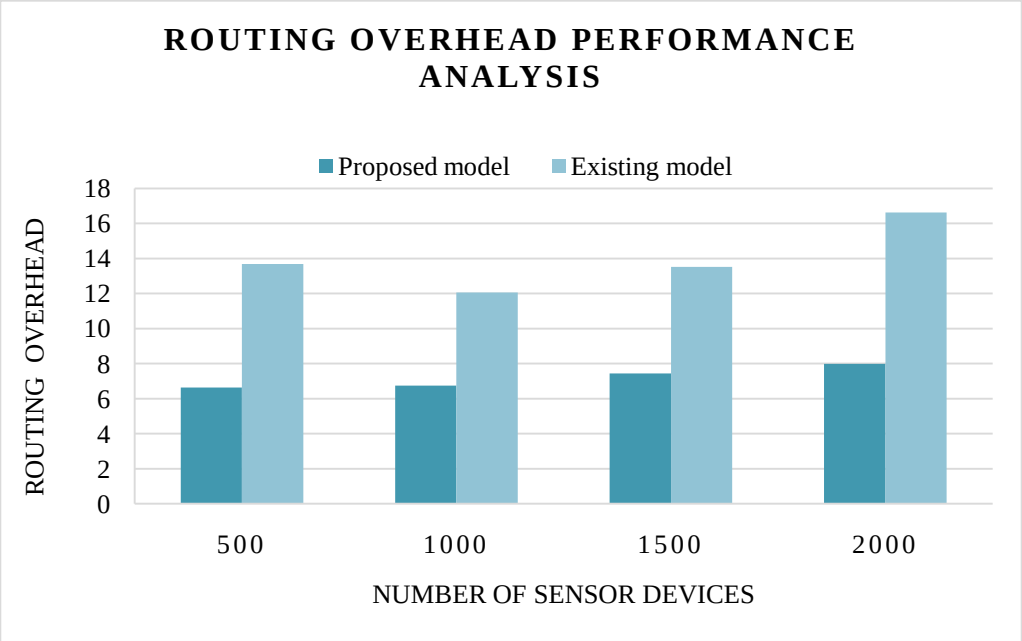

Fig. 4: Routing overhead performance analysis for varied wireless sensor nodes

c) Result and discussion over state-of-art technique

This paper conducted experiment evaluation considering various performance parameter such as communication overhead, routing overhead, and network lifetime considering total sensor device death. This section particularly evaluate lifetime performance attained by proposed and various state-of-art technique over LEACH protocol [11].The model presented in [18] attain a lifetime performance improvement of 25.0%, [19] by 50.0%, [29] by 55.0%, [31] by 44.0%, [33] by 15.0%, and proposed model by 78.02% over LEACH [11]. From overall result attained shows proposed model attain significant lifetime performance enhancement over various existing model [18], [19], [29], [31], and [33]. Our model brings minimize energy consumption of rendezvous node, enhancing coverage time aiding in lifetime performance improvement of WSNs. Thus will aid in provisioning real-time application service that requires energy efficient design.

IV. Conclusion

Building energy efficient design for provisioning real-time and non-real-time application services in WSN is challenging. Extensive survey carried out shows number of approaches has been presented lately to enhance energy efficiency of sensor network. Among them mobile sink based routing design play an important role in enhancing performance of sensor network. However, design mobile sink based routing model with minimal latency and higher energy efficiency is challenging. To overcome research challenges, this manuscript presented an Energy Efficient Routing Optimization model using mobile sink. Further, routing optimization is carried out and shortest path based routing is considered for attaining good trade-off between minimizing energy and maximizing lifetime of sensor network. Experiment are conducted to evaluate performance of proposed model over exiting model. The result shows proposed model improves lifetime performance of 78.02% considering total sensor device death. Further, the proposed model reduces communication overhead and routing overhead over exiting model by 37.37%, and 48.17% respectively. The overall result attained shows scalable lifetime, communication overhead and routing overhead performance considering varied network density.

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Study and Optimized Simulation of OSPFv3 Routing Protocol in IPv6 Network

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Abstract- Routing is a design way to pass the data packet. User is assigns the path in a routing configuration. A significant role played by the router for providing the dynamic routing in the network. Structure and Configuration are different for each routing protocols. Next generation internet protocol IPv6 which provides large address space, simple header format. It is mainly effective and efficient routing. It is also ensure good quality of service and also provide security. Routing protocol (OSPFv3) in IPv6 network has been studied and implemented using 'cisco packet tracer'. 'Ping' the ping command is used to check the results. The small virtual network created in Cisco platform .It is also used to test the OSPFv3 protocol in the IPv6 network. This paper also contains step by step configuration and explanation in assigning of IPv6 address in routers and end devices. The receiving and sending the packet of data in a network is the responsibility of the internet protocol layer. It also contains the data analysis of packet forwarding through IPv6 on OSPFv3 in simulation mode of cisco packet virtual environment to make the decision eventually secure and faster protocol in IPv6 environment.

Keywords: *OSPFv3; cisco packet tracer; simulation of OSPFv3; IPv6 address.*

GJCST-E Classification: *C.2.2*

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Study and Optimized Simulation of OSPFv3 Routing Protocol in IPv6 Network

Md. Anwar Hossain [α] & Mst. Sharmin Akter [σ]

Abstract- Routing is a design way to pass the data packet. User is assigns the path in a routing configuration. A significant role played by the router for providing the dynamic routing in the network. Structure and Configuration are different for each routing protocols. Next generation internet protocol IPv6 which provides large address space, simple header format. It is mainly effective and efficient routing. It is also ensure good quality of service and also provide security. Routing protocol (OSPFv3) in IPv6 network has been studied and implemented using 'cisco packet tracer'. 'Ping' the ping command is used to check the results. The small virtual network created in Cisco platform .It is also used to test the OSPFv3 protocol in the IPv6 network. This paper also contains step by step configuration and explanation in assigning of IPv6 address in routers and end devices. The receiving and sending the packet of data in a network is the responsibility of the internet protocol layer. It also contains the data analysis of packet forwarding through IPv6 on OSPFv3 in simulation mode of cisco packet virtual environment to make the decision eventually secure and faster protocol in IPv6 environment.

Keywords: OSPFv3; cisco packet tracer; simulation of OSPFv3; IPv6 address.

I. Introduction

The Internet is growing throughout the world, and different kinds of devices are becoming part of the internet every day. IP (Internet Protocol) is the most used routing protocol for communication over the network .The data packets are selecting the path of routing which mainly depends on the devices attached to the network. Packet destination address (IP) must be known from one device to another so that they can easily communicate with each other also wanted the neighboring devices information. Network topology studies the path for that region we can use OSPF technique. IPv4 and IPv6 are two categories of internet protocol. The IPv6 protocols represent an advance version of the IPv4 *(Oliveira, De Sousa, et al. 2011).* IPv6 uses 128 bits addressing scheme which is more complicated than IPv4. IPv4 provides 32-bit addressing space in which 4.3 billion internet protocol address *(Hinds, Atojoko, et al. 2013).* A study report shows that (10-15) % IPv6 replaces IPv4 around the world after 25 years later *(I.v.Beijnum. 2016).* Routing protocol of IPv6 is OSPFv3, EIGRPv6, BGPv4, RIPng *(C.carthern, W.wilson, et al. 2015).* The issue is the ability to exchange and use information with utility for OSPFv3 routing protocol of IPv6 environment. Now, corporate and enterprise networks area uses OSPFv3 routing protocol. We deploy and configure this mechanism on virtual environment of cisco packet tracer. It provides the idea and capability of next-generation network with IPv6 protocol.

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II. Routing Protocol

IPv6:

IETF (Internet Engineering Task Force) in 1990 designed IPv6 protocol (S.E.Decring and R.Hinden 1998). IPv6 makes use of 128-bit addresses and so the next address space supports 2^128 addresses (Hui and Thubert 2011). The 128-bit addresses subdivide into eight groups. Further four digits hexadecimal number divide among eight groups and separate in colons. The resulting representation of hexadecimal is called colon-hexadecimal (Sarma 2015). It makes of 128 bits, the IPv6 address subdivides into eight 16-bits blocks. 4-digit hexadecimal numbers contain each block and each block separates by a colon (Nisha Devi, Er.Brijbhushansharma, et al.2016). Types of IPv6 addresses are Multicast addresses, Anycast address and Unicast address. Now, Multicast address format of IPv6 shows below in bits:

8	4	4	112

Fig. 1: Multicast Address Format of IPv6 (128 bits)

III. OSPF(Open Shortest Path First)

OSPFv3:

For IPv6 environment, OSPFv3 has been designed. It follows the shortest path first algorithm and OSPFv3 is a dynamic routing protocol *(R.Coltun, O.Fergusonet al.2008).* OSPFv3 incorporates some changes essentially operating an IPv6 network. OSPFv3 contains packet header. It is more complex than the OSPFv2 .It includes instance ID fields. In this point routing protocols for IPv6 are more concernment about links and nodes they are enabling on. Multiple addresses are concerning to be connected in the same

interfaces and are establishing neighbourship using an IP subnet mask. To establish adjacencies OSPFv3 uses link-local addresses. In OSPFv3 HELLO packet structure has been changed because of IPv6 **(Anibrika, Ashigbi, et al.2016).**OSPFv3 provides security mechanisms for protecting routing update. IPv6 environment gets these services through IPsec.

IV. Packet Tracer

Training, Education, and Research for computer network simulations can utilize through packet tracer which is Cisco router simulator. The tool creates Cisco systems. It provides free for distribution to faculty, alumni and students who participate in the Cisco networking academy. Users can create of visualizations animation and simulations of networking phenomena to use packet tracer. The tool of packet tracer relies on a specific simple model of networking device and protocols for simulation. Simulation is processed by different kinds of networking devices like as routers, switches, and wireless access points. Computers and various end devices visualize with animations. It is easy to describe. The main principle of networking depend on Cisco technology. Its development makes skill for learning. It also offers students and teachers a tool for learning networking environment.

V. Topology Simulation for OSPFv3

Now, we considered the model of the network for OSPFv3 that contains three routers, two switches, four computers (mainly, end devices) for using the simulation of OSPFv3 routing. Serial DCE cables establish connection among routers. The automatic and copper straight through cable use to establish connection between switch to end devices. The network model gives below:

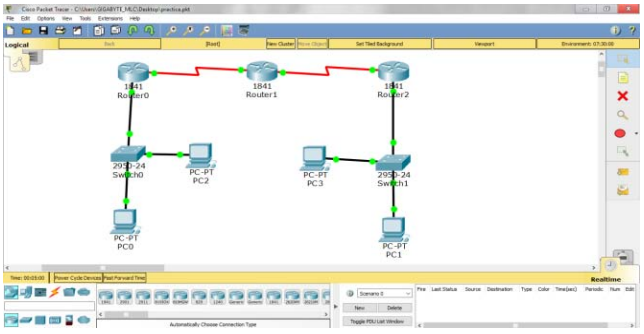


Fig. 2: OSPFv3 network model for simulation

VI. Configuring OSPFv3 Network Model

IPv6 assigning for end devices (pc) following two ways:

1. Static & Auto-configuration:

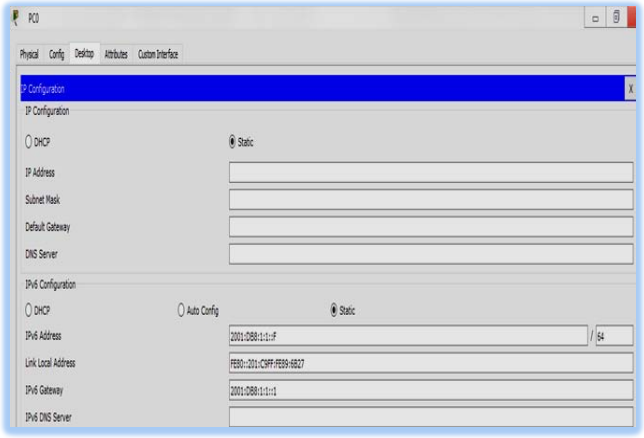


Fig. 3: IP address assigning in pc0 with Static configuration

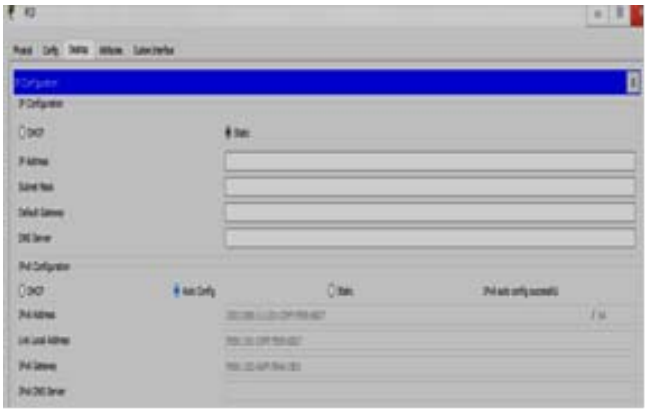


Fig. 4: IP address assigning in pc0 with auto configuration

In this way, we can adjust and assign IPv6 in Pc's of this virtual configuration.

2. In the all Pc's the gateway is the router physical device view serial connection between routers. Routers are connected with switches by Fast Ethernet with copper straight through cable. Pc's also connect with switches.
3. Firstly, connect the router physically. Then, configure the routers. In Fig: 2, router 0 are configured as follows using CLI (command line interface)

```
continue with configuration dialog?[yes/no]:
no
press RETURN to get started !
Router>enable
Router#config terminal
Enter configuration commands,one perline.End with CNTL/Z
Router(config)#ipv6 unicast-routing
Router(config)#int fa0/0
Router(config-if)#ipv6 address 2001:db8:1:1::1/64
Router(config-if)#no shut
Router(config-if)#
% LINK-5-CHANGED:Interface FastEthernet 0/0,
changed state to up
%LINKPROTO-5-UPDOWN:Line protocol on interface
Fast Ethernet 0/0,changed state to up.
Router(config-if)#int se0/0/0
Router(config-if)#ipv6 address 2001:db8:1:a001::1/64
Router(config-if)#no shut
% LINK-5-CHANGED:Interface serial 0/0/0,
changed state to down
Router(config-if)#clock rate 64000
This command applies only to DCE interfaces
Router(config-if)#end
```

Fig. 5: Configuration of the 1st router

```
press RETURN to get started !
Router>enable
Router#config terminal
Enter configuration commands,one perline.End with CNTL/Z
Router(config)#ipv6 unicast-routing
Router(config)#int fa0/0
Router(config-if)#ipv6 address 2001:db8:1:2::1/64
Router(config-if)#no shut
Router(config-if)#
% LINK-5-CHANGED:Interface FastEthernet 0/0,
changed state to up
%LINKPROTO-5-UPDOWN:Line protocol on interface
Fast Ethernet 0/0,changed state to up.
Router(config-if)#int se0/0/0
Router(config-if)#ipv6 address 2001:db8:1:a001::2/64
Router(config-if)#no shut
% LINK-5-CHANGED:Interface serial 0/0/0,
changed state to up
Router(config-if)#int se0/0/1
Router(config-if)#ipv6 address 2001:db8:1:a002::1/64
Router(config-if)#no shut
%LINK-5-CHANGED:Interface serial 0/0/1,
changed state to down
Router(config-if)#clock rate 64000
This command applies only to DCE interfaces
Router(config-if)#end
%SYS-5-CONFIG-I:configured from console by console
```

Fig. 6: Configure of 2nd router

```
continue with configuration dialog?[yes/no]:
no
press RETURN to get started !
Router>enable
Router#config terminal
Enter configuration commands,one perline.End with CNTL/Z
Router(config)#ipv6 unicast-routing
Router(config)#int fa0/0
Router(config-if)#ipv6 address 2001:db8:1:3::1/64
Router(config-if)#no shut
Router(config-if)#
% LINK-5-CHANGED:Interface FastEthernet 0/0,
changed state to up
%LINKPROTO-5-UPDOWN:Line protocol on interface
Fast Ethernet 0/0,changed state to up.
Router(config-if)#int se0/0/1
Router(config-if)#ipv6 address 2001:db8:1:a002::2/64
Router(config-if)#no shut
% LINK-5-CHANGED:Interface serial 0/0/1,
changed state to up
Router(config-if)#end
Router#
%SYS-5-CONFIG-I:configured from console by console
%LINKPROTO-5-UPDOWN:Line protocol on Interface serial 0/0/1,
changed state to up
```

Fig. 7: Configure of the 3rd router

4. A link – up line protocol makes according to the above code. As a result, the OSPF v3 has done.
5. Fa0/0 is the Fast Ethernet, and serial 0/0/0 is the serial port of the router.

```
Router#enable
Router#config terminal
Enter Configuration Commands,
one per line.End with CNTL/Z
Router(config)#ipv6 router ospf 1
%OSPFv3-4-NORTRID:OSPFv3
process 1 could not pick a router-id,
please configure manually
Router(config-rtr)#router-id 1.1.1.1
router(config-rtr)#exit
router(config)#int fa0/0
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#int se0/0/0
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#end
router#
%SYS-5-CONFIG-I:Configured from console by console
```

Fig. 8: Area defining and manually configure router 0 in OSPFv3

```
Router#enable
Router#config terminal
Enter Configuration Commands,
one per line.End with CNTL/Z
Router(config)#ipv6 router ospf 1
%OSPFv3-4-NORTRID:OSPFv3
process 1 could not pick a router-id,
please configure manually
Router(config-rtr)#router-id 2.2.2.2
router(config-rtr)#exit
router(config)#int fa0/0
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#int se0/0/0
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#int se0/0/1
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#end
router#
%SYS-5-CONFIG-I:Configured from console by console
```

Fig. 9: Area defining and manually configure router one in OSPFv3

```
Router#enable
Router#config terminal
Enter Configuration Commands,
one per line.End with CNTL/Z
Router(config)#ipv6 router ospf 1
%OSPFv3-4-NORTRID:OSPFv3
process 1 could not pick a router-id,
please configure manually
Router(config-rtr)#router-id 3.3.3.3
router(config-rtr)#exit
router(config)#int fa0/0
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#int se0/0/1
router(config-if)#ipv6 ospf 1 area 0
router(config-if)#end
router#
%SYS-5-CONFIG-I:Configured from console by console
```

Fig.10: Area defining and manually configure router two in OSPFv3

6. Router OSPFv3 '1' the '1' gives the area 0 which same for all router in the same domain. In IPv6

router-id is manually set up for the domain and area specification. But it can be any number.

VII. Exiting Configuration of ospfv3 with ipv6

The model of the network that is implemented and verified using 'ping' command from any pc's that attached to the router. Now, the result shows below are using the pc0 and pc1 through pinging the address to another. Now, show in the below:

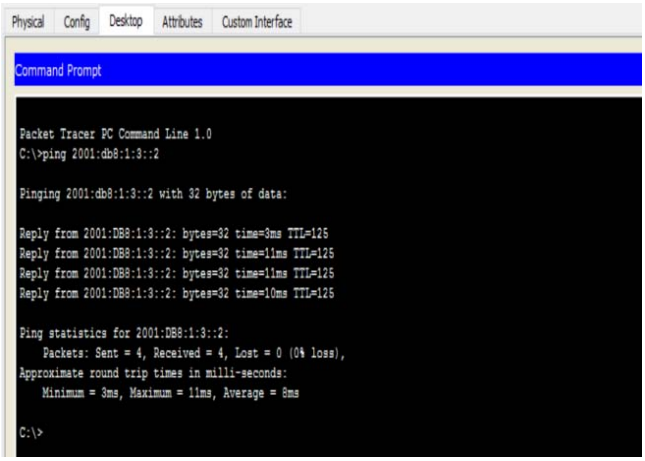


Fig. 11: Checking result using 'ping' command.

VIII. Data Collection

Ping command is used to check the configuration results in different routing protocols. Fig. 2 shows the small network model design for OSPFv3 in IPv6 protocol and packet transfer calculated for the time taken by it to travel from sender to receiver node. These data obtained by ping command and the traffic generator using the simulation for auto/capture/play button. It mainly shows the time to travel and reach the packets from source to destination nodes. Now Fig. 12 shows the simulation mode of cisco packet tracer environment for OSPFv3 in IPv6 protocol.

Fig. 12: Simulation environment for data collection of OSPFv3 in IPv6 network

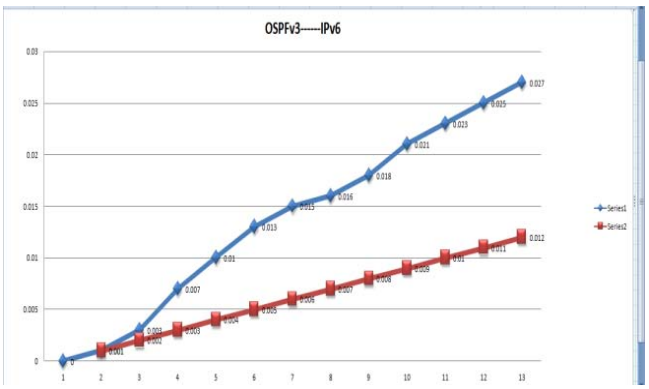
Data notes down which mainly indicates that the packet takes the destination shown below:

Table 1: pc0 to pc1 while taken to travel OSPFv3 in IPv6 routing protocol and reference message with no constant delay that is ICMPv6

Time(sec)	Last Device	At Device	Type
0.001	PC 0	Switch 0	ICMPv6
0.003	Switch 0	Router 0	ICMPv6
0.007	Router 0	Router 1	ICMPv6
0.010	Router 1	Router 2	ICMPv6
0.013	Router 2	Switch 1	ICMPv6
0.015	Switch 1	PC 1	ICMPv6
0.016	PC 1	Switch 1	ICMPv6
0.018	Switch 1	Router 2	ICMPv6
0.021	Router 2	Router 1	ICMPv6
0.023	Router 1	Router 0	ICMPv6
0.025	Router 0	Switch 0	ICMPv6
0.027	Switch 0	PC 0	ICMPv6

Table 2: pc0 to pc1 while taken to travel OSPFv3 in IPv6 routing protocol and reference message with the constant delay that is ICMPv6

Time(sec)	Last Device	At Device	Type
0.001	PC 0	Switch 0	ICMPv6
0.002	Switch 0	Router 0	ICMPv6
0.003	Router 0	Router 1	ICMPv6
0.004	Router 1	Router 2	ICMPv6
0.005	Router 2	Switch 1	ICMPv6
0.006	Switch 1	PC 1	ICMPv6
0.007	PC 1	Switch 1	ICMPv6
0.008	Switch 1	Router 2	ICMPv6
0.009	Router 2	Router 1	ICMPv6
0.010	Router 1	Router 0	ICMPv6
0.011	Router 0	Switch 0	ICMPv6
0.012	Switch 0	PC 0	ICMPv6



Graph 1: Comparison figure of the OSPFv3 routing protocol in IPv6 with time zone (from table 1, 2) and travels the stations during packet transfer with constant delay and without constant delay

IX. Data Analysis

The simulation process which indicates the impact of the traffic sent and received in the network. It generates through a ping command method from pc0 to

pc1 which shows the connectivity, justification, testing, and transfer of the packet from source to destination. It also verified the simulation and packet transfer time with the observed parameters is checked from pc0 and pc1 with constant delay and without constant delay which constructed from the simulation time. The graph shows the simulation time vary from node to node when a packet travels through the network and finally the IPv6 network finds out the performance of the routing protocol OSPFv3.

X. Conclusion

This paper demonstrated that Cisco tracer could be used by network planners to select and to design various networks and optimal routing topology. In a network, routing is used to trace the path. In this paper, we used cisco packet tracer for implementing a routing protocol. We use OSPFv3 routing protocol in IPv6 network due to the usage and area of necessity though there are many different types of routing techniques. OSPFv3 are used for small and large enterprises and other business organization for IPv6 network environment. The time zone (second) in each station mainly packet take to travel one station to another, check the destination address to plot these generated time zone to show how fast data packet flows through a network of OSPFv3 in IPv6 environment with and without constant delay. It used for security, unlimited hop count, low overload, authentication. OSPFv3 uses area concepts which mainly eases management, route and packet traffic control.

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Performance Evaluation of Encrypted Text Message Transmission in 5G Compatible Frequency-domain Subband Superposed Scheme Implemented MIMO OFDM Wireless Communication System

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I. Introduction

In scenario of high out-of-band emission (OOBE) with relatively low spectrum efficiency and little flexibility, Orthogonal frequency division multiplexing (OFDM) cannot meet up the diverse layouts of the future fifth generation (5G) networks.

In 2017, Wang and et al., proposed a non-uniform subband superposed OFDM (NSS-OFDM) scheme based on a variable granularity (VG) spectrum allocation technique with the utilization of a multistage poly-phase sub-filtering architecture.

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In their works, the authors demanded significant reduction of OOBE with enhanced spectral efficiency in terms of spectrum utilization rate and minimization of the frequency guard intervals between subbands[1]. At[2], the authors made a comprehensive study on significant performance degradation of the traditional OFDM system in high-speed mobile scenarios. They proposed a subband superposed oversampled OFDM (SS-OOFDM) scheme for accommodating the diverse synopsis with the inclusion of the scenarios with high mobility and development of the time-domain channel estimation method to track the fast-varying mobile channel. In their work, a subband decision feedback and feed forward equalizer for exploiting the Doppler and multipath diversity gains was designed, and the simulation results showed that the SS-OOFDM, especially in high-speed mobile channels outperformed the traditional OFDM receiver in terms of the bit-error-rate (BER) performance.

The enhanced multicarrier transmission scheme implemented subband superposed OFDM(SS-OFDM) system achieves narrower guard bands and flexible subband division through subband partitioning and filtering. Allowing for the multiple accesses, the superposition schemes of the signal from the users sharing the transmission channel in both frequency and time domains are considered at[3].

In our study, we have considered Frequency-domain subband superposed scheme aided the OFDM system to study its system performance on encrypted text message transmission.

II. Review of Signal Processing Techniques

In this sub-section, various channel coding and signal detection techniques are implemented. A brief observation of each technique has been outlined below:

a) LDPC Channel Coding

In 1962, Gallager invented low-density parity-check (LDPC) code. Such LDPC code is a linear block

code and its generated parity-check matrix H_o contains only a little 1's with the comparison of 0's (i.e., sparse matrix). The LDPC codes have been graphically represented by the bilateral Tanner graph, and their nodes have been grouped into first set of n bit nodes (or variable nodes) and another set of m check nodes (or parity nodes). Check node i has been connected to bit node j in case of any elemental value of unity in the parity matrix. The decoding is operated alternatively on the bit nodes and the check nodes to find the most similar codeword c which is satisfy the condition $cH_o^T=0$. In the iterative Log Domain Sum-Product LDPC decoding under the consideration of AWGN noise channel of variance σ^2 and the received signal vector r, LLR (log-likelihood ratios) instead of probability have been defined as:

$$\begin{aligned} &L(c_i)\triangleq \ln[P(c_i=0|r_i)/P(c_i=1|r_i)] \\ &L(P_{ij})\triangleq \ln[P_{ij}^{\ 0}/P_{ij}^{\ 1}) \\ &L(Q_{ij})\triangleq \ln[Q_{ij}^{\ 0}/Q_{ij}^{\ 1}) \; L(P_j)\triangleq \ln[Pj^0/Pj^1) \end{aligned} \quad (1)$$

Where in equation(1), (ln) illustrates the natural logarithm operation. The bit node j is initially set with an edge to check node i:

$$L(P_{ij})=L(c_i)=2r_i/\sigma^2 \quad (2)$$

In message passing from the check nodes to the bit nodes for each check node i with an edge to bit node j; L(Q ij) has been updated as:

$$\begin{aligned} &L(Qij)=\prod_{j'}\alpha_{ij'}\,\phi[\sum_{j'}\phi(\beta_{ij'})] \\ &(j'=1,2.....n \;\text{ and }\; j'\neq j\;) \\ &\text{where, } \alpha_{ij}\triangleq \text{sign}[L(P_{ij})] \;\text{ and }\; \beta_{ij}\triangleq[L(P_{ij})]. \end{aligned} \quad (3)$$

The ϕ function has been defined as:

$$\phi(x)=-\ln[\tanh(x/2)]=\ln[(e^x+1)/(e^x-1)] \quad (4)$$

From bit nodes to check nodes for each bit node j with an edge to check node i; L(Pj) has been updated as:

$$\begin{aligned} &L(Pij)=L(c_i)+\sum_{i'} L(Qij) \\ &(i'=1,2.....m \;\text{ and}\; i'\neq i\;) \end{aligned} \quad (5)$$

Decoding and soft outputs: for j=1,2,3…,n; L(Pj) is updated as:

$$L(Pj)=L(c_i)+\sum_i L(Pij) \qquad (i=1,2.....m) \quad (6)$$

$$c_i=\begin{cases} 1 \;\text{ if }\; L(P_j)<0 \\ 0 \qquad \text{else} \end{cases} \quad (7)$$

If $cH_o^T=0$ or the number of iterations reaches the maximum limit [4]

b) Repeat and Accumulate (RA) Channel Coding

The RA is a mighty advance error-correcting channel coding scheme. In this type of channel coding scheme, all the extracted binary bits from the text message are arranged into a one block and the binary bits of such block has been repeated 2 times and reorganized into a single block with contains binary data which is double of the number of input binary data [5].

c) Cholesky Decomposition based ZF Signal detection(CDSD)

In $N_R \times N_T$ MIMO system, the signal model can be represented by

$$y=Hx+n \quad (8)$$

Where, H is a channel matrix with its $(j,i)^{th}$ entry h_{ij} for the channel gain between the j^{th} receive antenna and the i^{th} transmit antenna, j=1,2,…….N_R and i=1,2,…….N_T, $x=[x_1,x_2,.....x_{N_T}]^T$ and $y=[y_1,y_2,.....y_{N_R}]^T$ are the transmitted and received signals and $n=[n_1,n_2,.....n_{N_R}]^T$ is the white Gaussian noise with a variance of σ^2_n. By Using the Equation (8), the matched filtering (MF) based detected signal is given by

$$\hat{x}_{MF}=H^H y=H^H Hx+H^H n \quad (9)$$

Where, H^H is the Hermitian conjugate of the estimated channel. In the interference limit scheme, the more advanced ZF detector has been required which operates on the MF data by

$$\hat{x}_{ZF}=(H^H H)^{-1}\hat{x}_{MF} \quad (10)$$

In Cholesky Decomposition (CD) base ZF detection, Equation (10) has been written in modified form as:

$$\hat{x}_{ZF}=(H^H H)^{-1}\hat{x}_{MF}=(LL^H)^{-1}\hat{x}_{MF} \quad (11)$$

With forward and backward substitution, the detected signal in CD-based ZF detection would be[6].

$$\hat{x}_{ZF}=L^{-H}L^{-1}\hat{x}_{MF} \quad (12)$$

d) Group Detection approach aided Efficient Zero-Forcing (GDEZF)

Group Detection (GD) approach based Efficient Zero-Forcing (ZF) detectors reduce the computational cost of the conventional linear detectors. In such a technique,

Equation (8) can be rearranged as:

$$y=\begin{bmatrix}\overline{H}_1 & \overline{H}_2\end{bmatrix}\begin{bmatrix}s_1\\ s_2\end{bmatrix}+n=\overline{H}_1 s_1+\overline{H}_2 s_2+n \quad (13)$$

Where, $\overline{H}_1 \in C^{N_R\times L}$ and $\overline{H}_2 \in C^{N_R\times(N-L)}$ are composed of first L and the remaining (N-L) columns of

H respectively, where the total number of columns of H is N. Similarly, $s_1 \in C^{L\times 1}$ and $s_2 \in C^{(N-L)\times 1}$ are the two sub-symbol vectors that have been made by taking the first L rows and the remaining rows of x. A weight matrix can be defined, $W_1 = (\overline{H}_1^{\ H}\ \overline{H}_1)^{-1}\overline{H}_1^{\ H}$, where (•) H denotes Hermitian transpose operation. Multiplying each side of the equation (13) by W_1, we obtain

$$W_1 y = s_1 + W_1\overline{H}_2 s_2 + W_1 n \tag{14}$$

Or equivalently, we can write

$$s_1 = W_1 y - W_1\overline{H}_2 s_2 - W_1 n \tag{15}$$

Substituting equation (15) into equation (13) and after some small manipulation, we get

$$y_2 = \tilde{H}_2 s_2 + n_2 \tag{16}$$

Where, $y_2 \in C^{N_R\times 1}$, $\tilde{H}_2 \in C^{N_R\times(N-L)}$, and $n_2 \in C^{N_R\times 1}$. The y_2, $\tilde{H}_2$ and n_2 can be rewritten as:

$$y_2 = (I - \overline{H}_1 W_1)y \tag{17}$$

$$\tilde{H}_2 = (I - \overline{H}_1 W_1)\overline{H}_2 \tag{18}$$

$$n_2 = (I - \overline{H}_1 W_1)n \tag{19}$$

Where I is the identity matrix. By estimated $\tilde{H}_2$, another weight matrix W_2 can be defined as

$$W_2 = (\tilde{H}_2^{\ H}\ \tilde{H}_2)^{-1}\tilde{H}_2^{\ H} \tag{20}$$

The sub-symbol vector s_2 is estimated using $\hat{s}_2 = Q(W_1 y_1)$, where the symbol Q is indicative of quantization. The effect of s_2 is canceled out from y to get $y_1 = y - \overline{H}_2\hat{s}_2$. The sub-symbol vector s_1 is estimated using $\hat{s}_1 = Q(W_1 y_1)$. Here x is transmitted signal vector, which has been approximated as [7]:

$$\hat{x} = \left[\hat{s}_1^{\ T}\ \ \hat{s}_2^{\ T}\right]^T \tag{21}$$

e) Lanczos method based efficient signal detection

The signal model is presented in Equation (8), the Minimum mean square error (MMSE) weight matrix can be represented as:

$$W_{MMSE} = (H^H H + \sigma_n^{\ 2} I)^{-1} H^H \tag{22}$$

and the detected desired signal from the transmitting antenna is given by[8]

$$\tilde{X}_{MMSE} = W_{MMSE} y \tag{23}$$

In the Lanczos method based efficient signal detection technique; Equation (22) and Equation (23) are considered to write down a new signal model as:

$$b = A\vec{x} \tag{24}$$

Where, $\vec{x} = W_{MMSE} y$, $b = H^T y$ and $A = H^H H + \sigma_n^{\ 2} I$

From Equation (24), a quadratic function can be considered as

$$\phi(\vec{x}) = \frac{1}{2}\vec{x}^T A\vec{x} - \vec{x}^T b \tag{25}$$

Where $A \in \mathbb{C}^{k\times k}$ is a symmetric positive definite matrix, $b \in \mathbb{C}^k$ is a non-zero vector. Taking partial derivatives of $\vec{x}$, we obtain that $\nabla\phi\left(\vec{x}\right) = A\vec{x} - b$. Therefore $\vec{x} = A^{-1}b$ is the unique minimum value of function presented in Equation (25).

Assuming $Q_k = [q_1, q_2, q_3, \ldots, q_k]$ is a group of a standard orthogonal basis of Krylov subspace $\mathcal{K}(A, B, k)$, we can overwrite solution $\vec{x}$ as:

$$\vec{x}_k = \vec{x}_0 + Q_k y_k \tag{26}$$

Substitute equation (26) into the function of the Equation (25) and take the partial derivative of y_k, we can acquire that y_n is the minimum solution to the equation set:

$$Q_k^T A Q_k y_k = Q_k^T (b - A\vec{x}_0) \tag{27}$$

Which lead $\vec{x}_n = \vec{x}_0 + Q_n y_n$ as the approximated minimum point of function Equation (25). It is obvious that equation (27) is not easy to solve, and the computation of $\vec{x}_k$ would be storage inefficient if $[q_1, q_2, q_3, \ldots, q_k]$ was used at the last iteration. Here, Lanczos vector was adopted to overcome these two problems instead of q_k. The tri-diagonal matrix as T_k can be written as:

$$T_k = Q_k^{\ T} A Q_k = \begin{bmatrix} \alpha_1 & \beta_1 & \ldots\ldots\ldots\ldots 0 \\ \beta_1 & \alpha_2 & \\ & & \\ & & \beta_{k-1} \\ . & & \\ 0 & \beta_{k-1} & \alpha_k \end{bmatrix} \tag{28}$$

Lanczos method is an iteration method to convert symmetric definite positive matrix A into tri-diagonal matrix T as a function (28). At the k^{th} step of the iteration, we have

$AQ_k = Q_k T_k + r_k e_k^T$ w here r_k is the residual error vector and e_k is the unit vector with the k^{th} element

equals 1. Decomposing the tri-diagonal matrix as $\mathbf{T_k}=\mathbf{L_k D_k L_k^T}$, where:

$$L_k = \begin{bmatrix} 1 & 0 & \ldots\ldots\ldots\ldots 0 \\ \mu_1 & 1 & 0 & 0 \\ & & & \\ 0 & & \mu_{k-1} & 1 \end{bmatrix},$$

$$D_k = \begin{bmatrix} d_1 & 0 & \ldots\ldots\ldots\ldots 0 \\ 0 & d_2 & 0 & 0 \\ & & & \\ 0 & & 0 & d_k \end{bmatrix}$$

Compared $\boldsymbol{T_k}$with $\boldsymbol{L_k D_k L_k^T}$, we can easily get:

$$\begin{cases} \mu_{k-1} = \beta_{k-1}/d_{k-1} \\ d_k = \alpha_k - \beta_{k-1}\mu_{k-1} \end{cases} \quad (29)$$

Combine equation (26), (27) and (28), and assume that $\mathbf{r_0} = \mathbf{b} - \mathbf{A}\,\vec{\vec{x}}_{\mathbf{0}}$, we can derive Equation (26) as

$$\vec{\vec{x}}_k = \vec{\vec{x}}_0 + Q_k T_k^{-1} Q_k^T r_0$$

$$= \vec{\vec{x}}_0 + Q_k (L_k D_k L_k^T)^{-1} Q_k^T r_0 \quad (30)$$

matrix $\mathbf{C}_k \in \mathbb{C}^{N\times k}$and vector $\mathbf{p_k} \in \mathbb{C}^{k}$ which satisfy:

$$\begin{cases} C_k L_k^T = Q_k \\ L_k D_k p_k = Q_k^T (b - A\,\vec{\vec{x}}_0) \end{cases} \quad (31)$$

From (31) we can deduce that $\mathbf{C}_k = [\mathbf{C}_{k-1}, \mathbf{c}_k]$ and $\mathbf{p}_k = [\mathbf{p}_{k-1}, \boldsymbol{\rho_k}]^T$,, where

$\mathbf{c}_k = \boldsymbol{q}_k - \mu_{k-1}\mathbf{c}_{k-1}$ and, $\boldsymbol{\rho_k} = (\boldsymbol{q}_k^T \boldsymbol{r}_0 - \mu_{k-1} d_{k-1} \rho_{k-1})/d_k$

Finally we can obtain the iteration function as[9]

$$= \vec{x}_0 + \mathbf{C_{k-1}}\mathbf{p_{k-1}} + \boldsymbol{\rho_k}\mathbf{c}_k$$

$$= \vec{x}_{\boldsymbol{k-1}} + \boldsymbol{\rho_k}\mathbf{c}_k \quad (32)$$

III. System Model

The conceptual block diagram of 5G compatible frequency-domain subband superposed (FDSS) scheme implemented MIMO OFDM wireless communication system has been shown in fig.1. In such a system, it is considered that three users are sending their encrypted text messages. The binary data extracted from each user's text message are encrypted with a secret key of bit length 8[10]. The encrypted binary data are channel encoded and subsequently digitally modulated [11]. Before IFFT implementation for each user, the number of complex digitally modulated symbols subbanding for the user#3, user#2 and user#1 are128, 256 and 512 respectively in symbol mapping. The proper designed symbol mapped complex digitally modulated data have been undergone multicarrier modulation, and subsequently cyclic prefixed and digital to analog (D/A) converted. The output for all the three users are sum up and feed into spatial multiuser encoding sections. Each output is sent up in two layers where baseband to RF conversion is made before transmission from each of the two transmitting antennas. In receiving section, each user has been equipped with two receiving antennas where primarily RF to baseband conversion is made with detection of the transmitted signal. The detected signal is feed into a spatial multiplexing decoder to extract the respective signal. The extracted signal is A/D converted with the removal of cyclic prefixing and subsequently undergone OFDM demodulation. The demodulated complex symbols are demapped, digitally demodulated, channel decoded, decrypted and eventually users own text messages is retrieved.

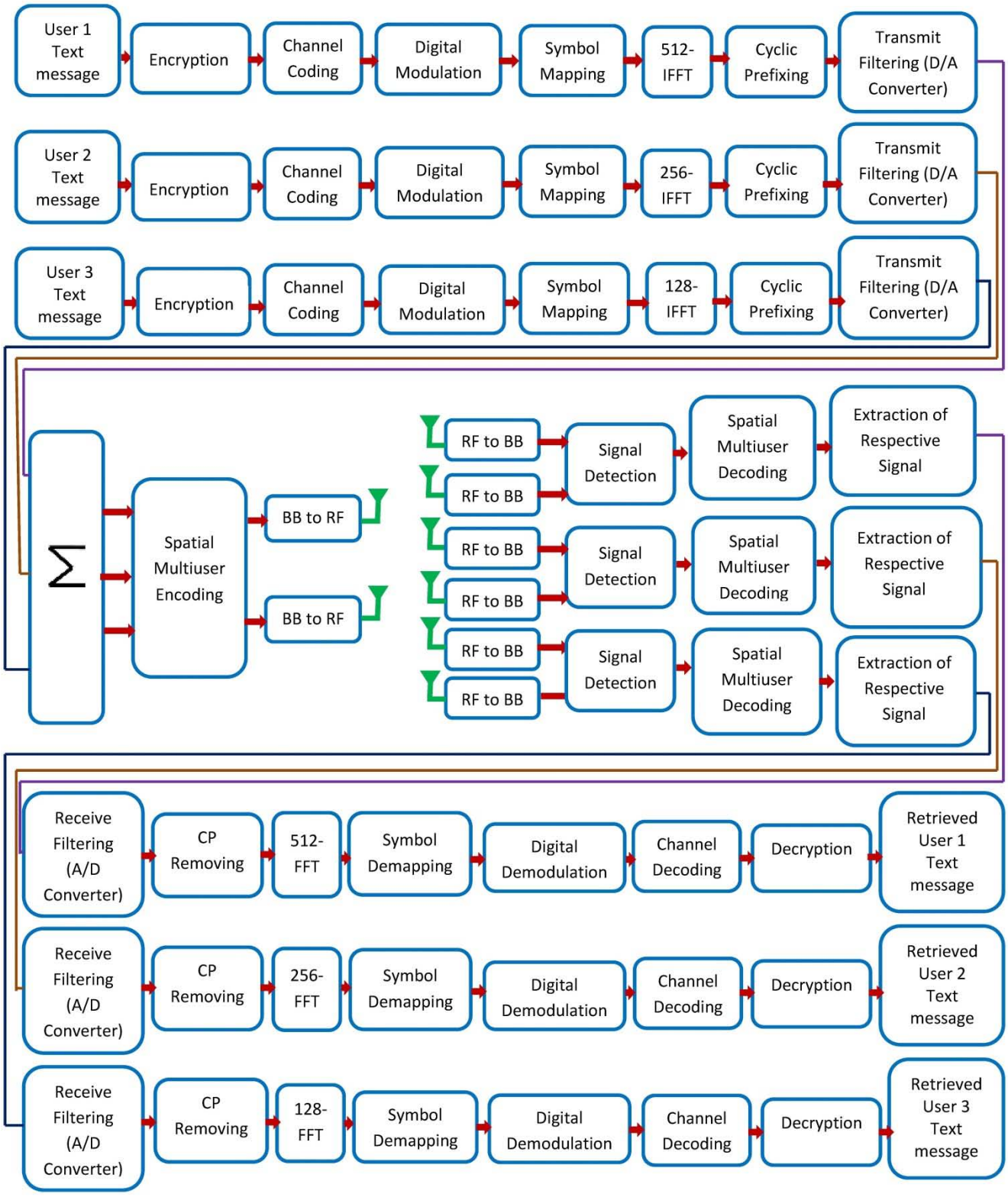

Fig. 1: Block diagram of encrypted text message transmission in 5G compatible frequency-domain subband superposed (FDSS) scheme implemented MIMO OFDM wireless communication system

IV. Results and Discussion

In this section, simulation results using MATLAB R2017a have been presented to illustrate the significant impact of various types of channel coding, signal detection and higher order digital modulation techniques on performance investigation of encrypted text message transmission in 5G compatible frequency-

domain subband superposed (FDSS) scheme implemented a MIMO OFDM wireless communication system in terms of bit error rate (BER). It is also considered that the channel state information (CSI) of the cmWave MIMO Rayleigh fading channel is available at the receiver and the fading channel coefficients are constant during simulation. The proposed model is simulated to evaluate the system performance under consideration of parameters presented in Table 1.

Table 1: Summary of the Simulated Model Parameters

Text messages with number of binary bits for user#1, user#2 and user#3	1776, 864 and 432
Bandwidth for subband 1, subband 2 and subband 3 (MHz)	6.66, 6.48 and 6.48
FFT_size for user#1, user#2 and user#3	512, 256 and 128
Subcarrier_spacing for user#1, user#2 and user#3 (KHz)	15, 30 and 60
CP length for user#1 user#2 and user#3	64, 32, 16 samples
Signal detection techniques	Cholesky Decomposition (CD) based ZF detection, Group Detection (GD) approach aided Efficient Zero-Forcing (ZF), Lanczos method based efficient signal detection
Channel coding	LDPC and Repeat and accumulate (RA)
Symbol mapping	16-QAM and 16-PSK
Pulse shaping filter with Rolloff factor	Raised cosine with 0.25
Number of Transmitting or Receiving antennas	2/2
Channel	MIMO fading channel
Signal to noise ratio (SNR)	0 to 10 dB

In analyzing estimated BER values from graphical illustrations presented in Figure 2 through Figure 7 for evaluating the performance of the simulated system, an SNR value of 2 dB is assumed typically. On critical observation, it is also noticeable that in all cases, the simulated system shows better performance in case of user#3 with 16-QAM digital modulation as the efficient transmission bandwidth for user#3 is lower as compared to the scenario for user#1 and user#2. It can be seen from Figure 2 in case of utilizing Repeat and Accumulate Channel Coding, Cholesky decomposition based signal detection techniques, the performance of the simulated system is very much well defined. For user#1, the estimated BER values are 0.0949 and 0.2315 with 16-QAM and 16-PSK digital modulations which ratifies system performance improvement of 3.87 dB.

For user#2, the estimated BER values are 0.0674 and 0.2044 for identical consideration 0f 16-QAM and 16-PSK digital modulations; the system shows the system performance improvement of 4.82 dB. For user#3, the estimated BER values are 0.0398 and 0.1171 with 16-QAM and 16-PSK digital modulations which is indicative of system performance improvement of 4.69 dB. At 5% BER, an SNR gain of 6.2 dB is achieved in 16-QAM as compared to 16-PSK for user#3. From Figure 3, the estimated BER values are 0.0757 and 0.223 with 16-QAM and 16-PSK digital modulations which ratifies system performance improvement of 4.69 dB in case of user#1. For user#2, the estimated BER values are 0.0743 and 0.1905 which confirms that the system shows system performance improvement of 4.09 dB.

In case of user#3, the estimated BER values are 0.0281 and 0.1194 which is indicative of system performance improvement of 6.28 dB. At 5% BER, a SNR gain of 5.6 dB is achieved in 16-QAM as compared to 16-PSK for user#2. In Figure 4 in case of user#1, the estimated BER values are 0.0977 and 0.2242 with 16-QAM and 16-PSK digital modulations which ratifies system performance improvement of 3.61 dB.

In case of user#2, the estimated BER values are 0.0662 and 0.2102 for identical consideration 0f 16-QAM and 16-PSK digital modulations, the system shows the system performance improvement of 5.02 dB For user#3, the estimated BER values are 0.0211 and 0.1054 with 16-QAM and 16-PSK digital modulations which is indicative of system performance improvement of 6.98 dB. At 10% BER, an SNR gain of 6.1 dB has been achieved in 16-QAM as compared to 16-PSK for user#1.

In Figure 5 for user#1, the estimated BER values are 0.2083 and 0.3350 with 16-QAM and 16-PSK digital modulations which ratifies system performance improvement of 2.06 dB. In the case of user#2, the estimated BER values are 0.1806 and 0.3067 for

identical consideration 0f 16-QAM and 16-PSK digital modulations, the system shows the system performance improvement of 2.29 dB. In the case of user#3, the estimated BER values are 0.0764 and 0.1991 with 16-QAM and 16-PSK digital modulations which is indicative of system performance improvement of 4.16 dB. At 5% BER, an SNR gain of 4.1 dB has been achieved in 16-QAM as compared to 16-PSK for user#2. In Figure 6 in case of user#1, the estimated BER values are 0.2218 and 0.3238 with16-QAM and 16-PSK digital modulations which ratifies system performance improvement of 1.64 dB. In the case of user#2, the estimated BER values are 0.1447 and 0.2743 for identical consideration of 16-QAM and 16-PSK digital modulations; the system shows the system performance improvement of 2.78 dB. In the case of user#3, the estimated BER values are 0.0602 and 0.2384 with 16-QAM and 16-PSK digital modulations which is indicative of system performance improvement of 5.98 dB. At 5% BER, an SNR gain of 4.2 dB has been achieved in 16-QAM as compared to 16-PSK for user#3. In Figure 7 for user#1, the estimated BER values are 0.2224 and 0.3378 with 16-QAM and 16-PSK digital modulations which makes confirmation of the system performance improvement of 1.81 dB. In the case of user#2, the estimated BER values are 0.1725 and 0.3264 for identical consideration 0f 16-QAM and 16-PSK digital modulations, the system shows the system performance improvement of 2.77 dB. In the case of user#3, the estimated BER values are 0.0764 and 0.2338 with 16-QAM and 16-PSK digital modulations which implies a system performance improvement of 4.86 dB. At 5% BER, an SNR gain of 6.1 dB is achieved in 16-QAM as compared to 16-PSK for user#3.

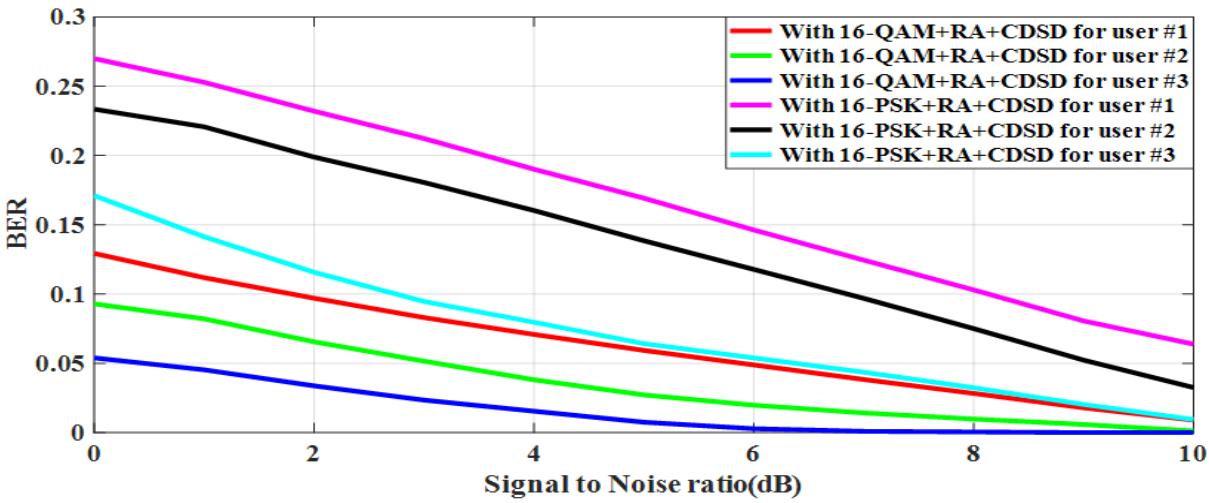

Fig. 2: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of Repeat and Accumulate Channel Coding, Cholesky decomposition based signal detection and higher order digital modulation schemes.

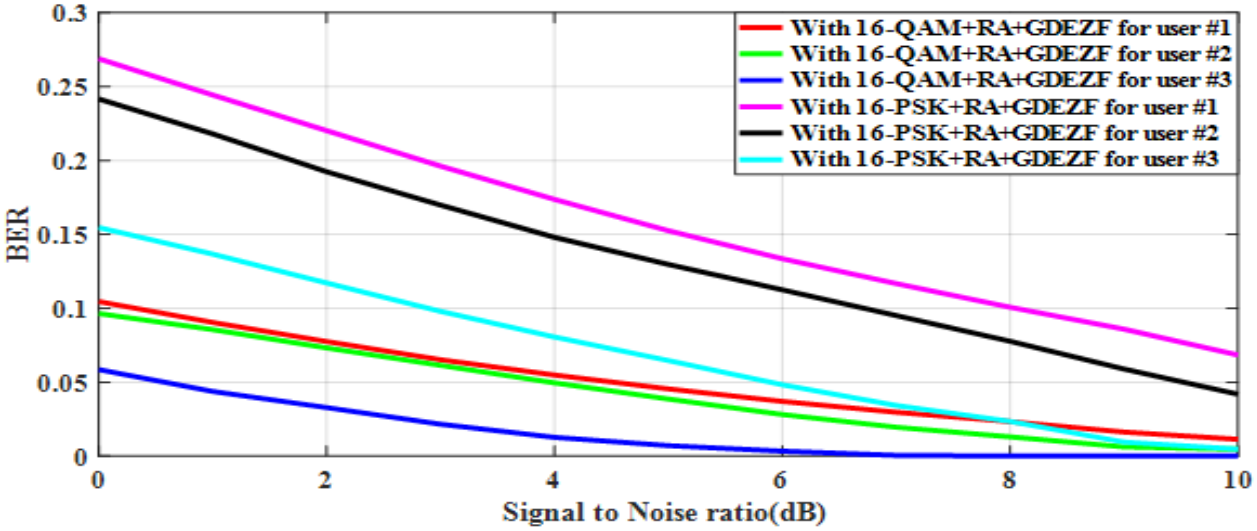

Fig. 3: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of Repeat and Accumulate Channel Coding, Group Detection (GD) approach aided Efficient Zero-Forcing (ZF) signal detection and higher order digital modulation schemes

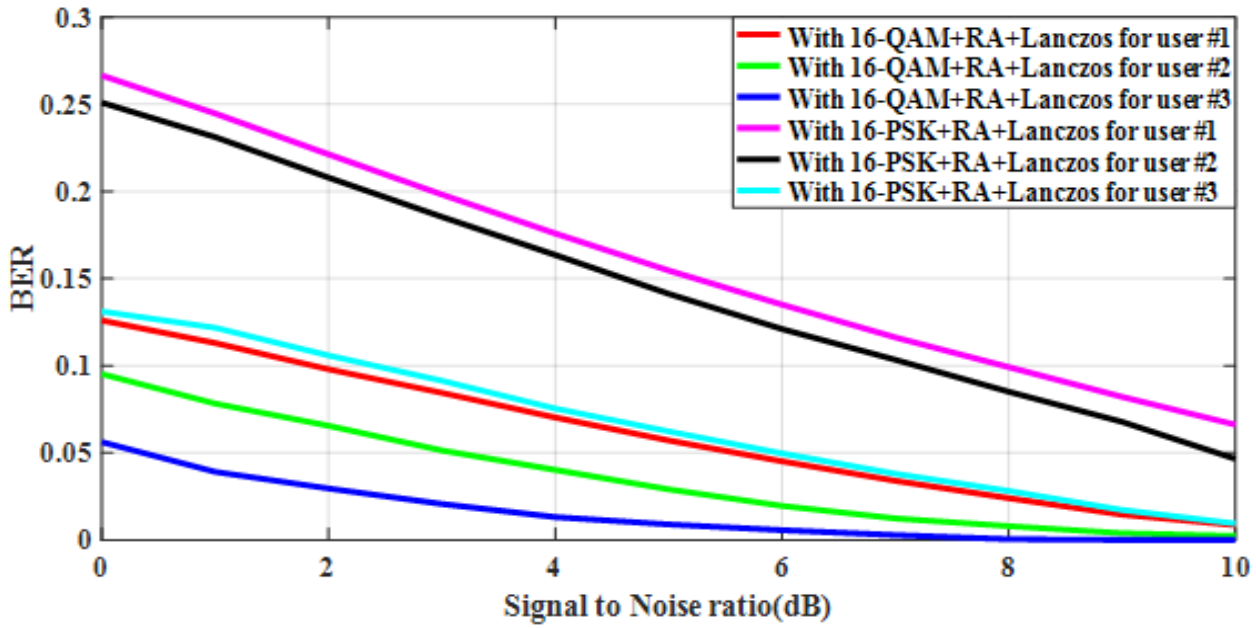

Fig. 4: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of Repeat and Accumulate Channel Coding, Lanczos method based efficient signal detection and higher order digital modulation schemes

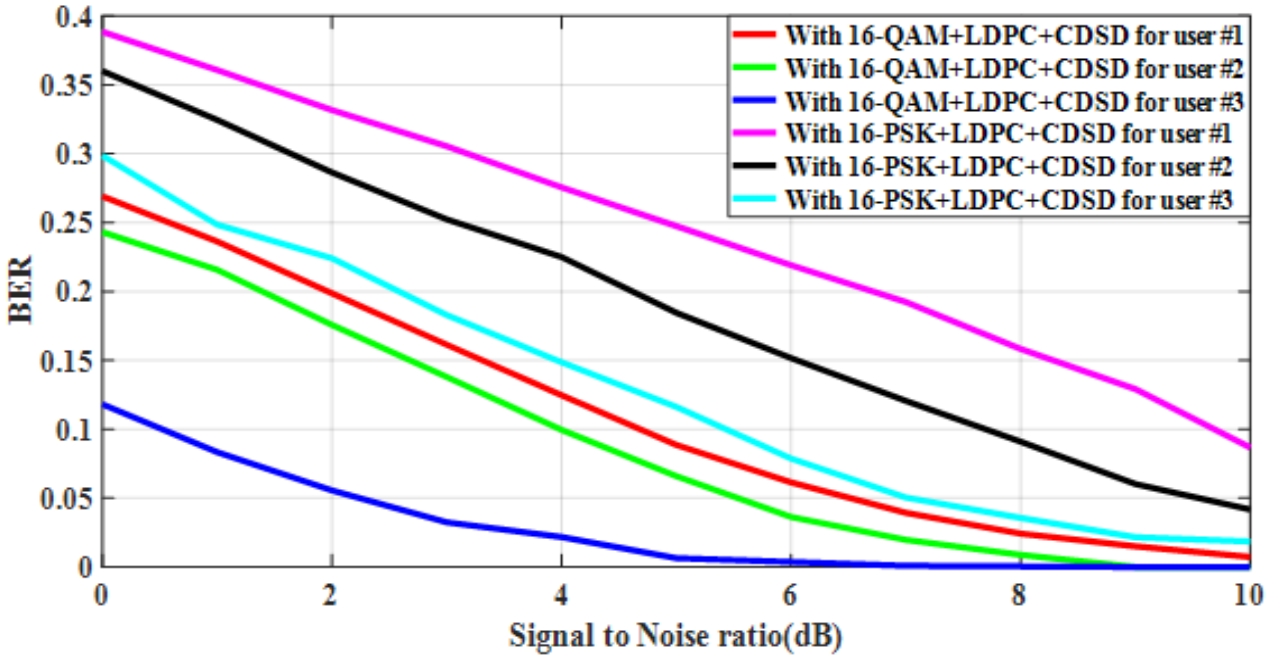

Fig. 5: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of LDPC Channel Coding, Cholesky decomposition based signal detection and higher order digital modulation schemes

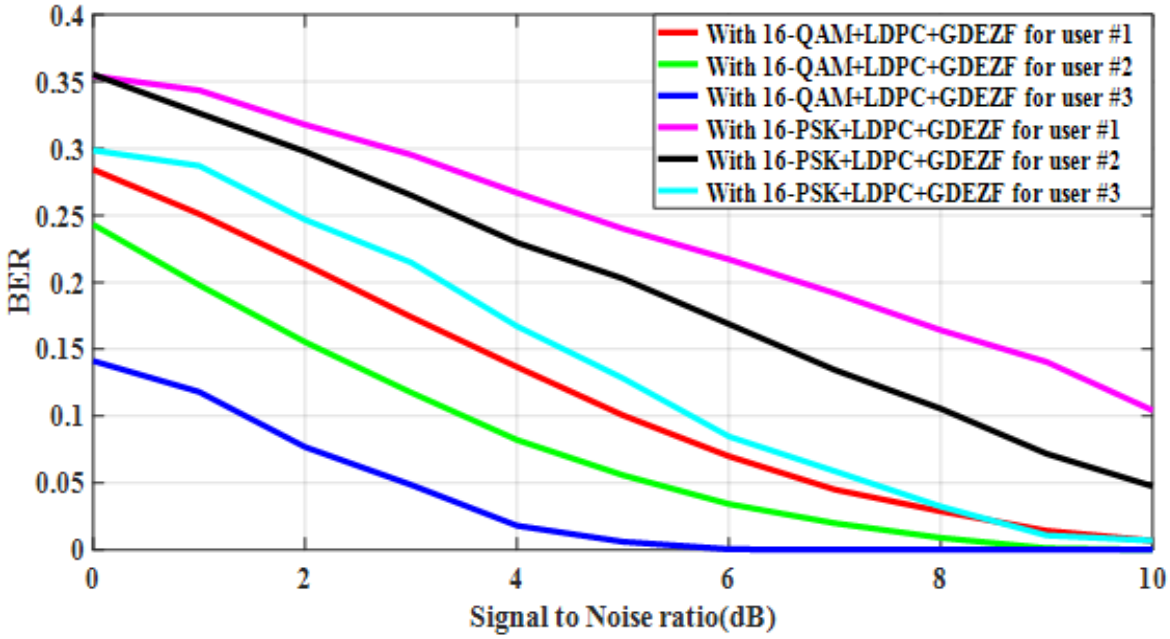

Fig. 6: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of LDPC Channel Coding, Group Detection (GD) approach aided Efficient Zero-Forcing (ZF) signal detection and higher order digital modulation schemes

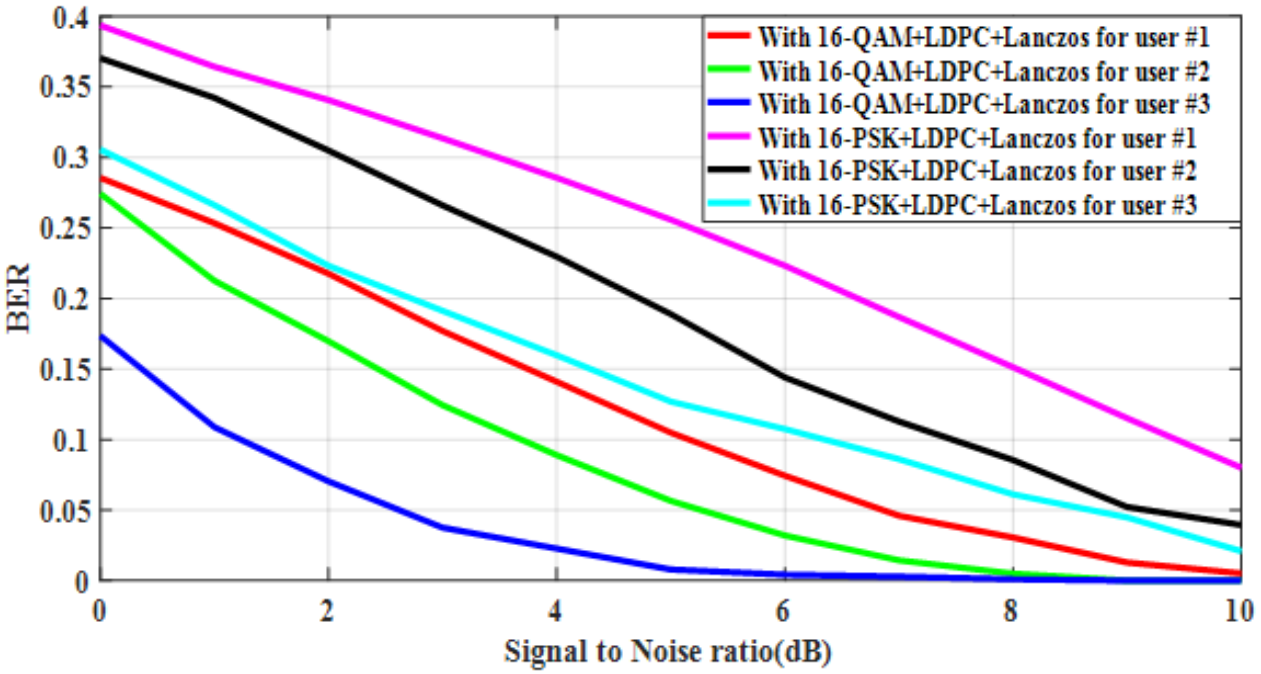

Fig. 7: BER performance of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system with the utilization of LDPC Channel Coding, Lanczos method based efficient signal detection and higher order digital modulation schemes

It is quite manifest from Figure 8 that the active subcarriers containing data symbols for all of the three users occupy a significant part of the frequency band as compared to null subcarriers. The estimated values of OOB power reduction are found to have values of 18.3431 dB, 18.5560 dB and 19.5358 dB relative to in band-power for user#1, user#2 and user#3 respectively.

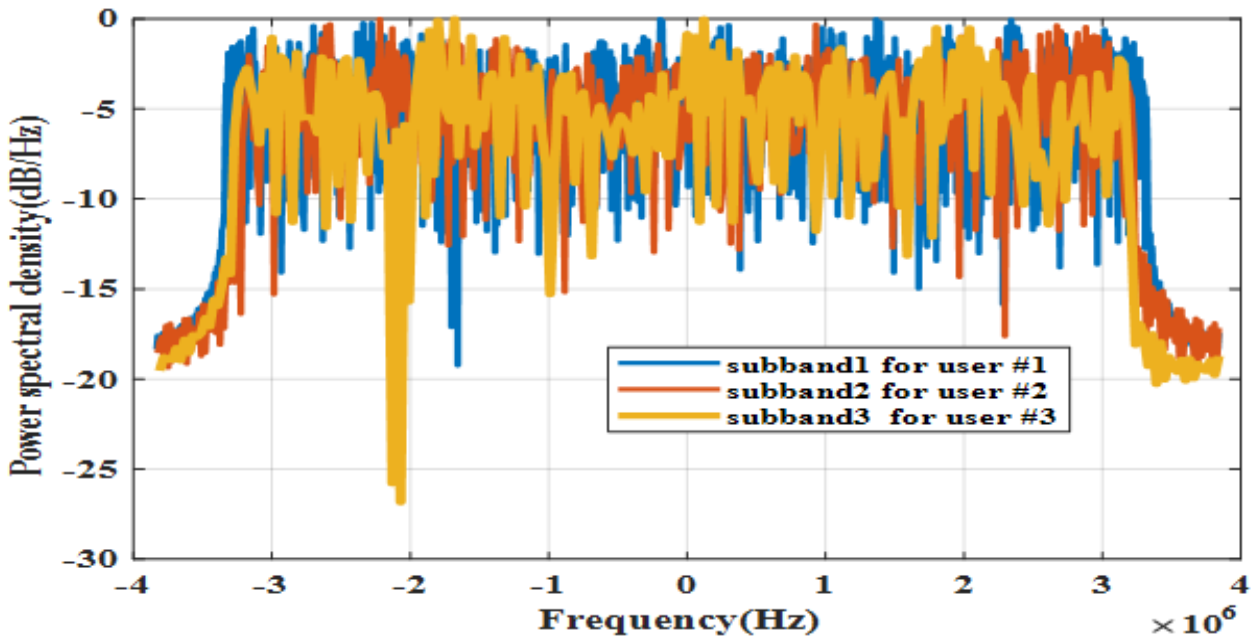

Fig. 8: Estimated Power spectral density of subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system for different sub banded OFDM signal waveforms

In Figure 9, Transmitted and Retrieved encrypted text messages for different users at SNR value of 10 dB in subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system are presented. The red marks indicate the erroneous part of the retrieved text message.

Original transmitted text message for user #1:
Pattern Division Multiple Access (PDMA) is a novel non-orthogonal multiple access technology based on the total optimization of multiple user communication system.
At the receiver, multiple users are detected by SIC on detection method.

Retrieved text message for user #1:
Pattern Division Multiple Access (PDMA) is a novel non/orthogonal multiple access technology `based on the! tot`l optimization of multiple user communication system.
At the receiver, multiple users are detected !by SIG on detectioN(eetlod.

Original transmitted text message for user #2:
Pattern division multiple access(PDMA) was proposed in 2014.
It is a type of non-orthogonal multiple access technology.

Retrieved text message for user #2:
Pattern division multiple access(PDMA) was proposed in 2014.
It is a type of non -orthogonal multiple access technology.

Original transmitted text message for user #3:
D2D technology allows direct communications between devices.

Retrieved text message for user #3:
D2D technology allows direct communications between devices.

Fig. 9: Transmitted and Retrieved encrypted text messages for different users at SNR value of 10 dB in subband superposed scheme implemented multi-user 5G compatible MIMO OFDM system

V. Conclusions

In this paper, we have depicted our simulation work on the suitability of 5G compatible frequency-domain subband superposed (FDSS) scheme implemented a MIMO OFDM wireless communication system in encrypted text message transmission. In our proposed desirable design implemented MIMO simulated system, we have tried to show system performance in terms of its BER and OOB reduction. From the simulative work, it is seen that the system shows better performance in retrieving transmitted text message with the implementation of Repeat and Accumulate Channel Coding with Group Detection (GD)

approach aided Efficient Zero-Forcing (ZF) signal detection techniques.

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Mobile Edge Computing

By Matthew N. O. Sadiku, Chandra M. M. Kotteti & Sarhan M. Musa
A&M University Prairie View

Abstract- Mobile applications are becoming increasingly computationalintensive, while many mobile devices still have limited battery power and cannot support computational intensive tasks. Mobile edge computing (MEC) computing is an extension of edge computing, and it refers to computing at the edge of a network. In mobile edge computing, computing and storage nodes are placed at the Internet's edge near mobile devices. It places the edge clouds at the candidate locations. This paper presents a brief introduction to MEC.

Keywords: mobile edge computing, edge computing, multi-access edge computing.

GJCST-E Classification: C.2.1

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Mobile Edge Computing

Matthew N. O. Sadiku [α], Chandra M. M. Kotteti [σ] & Sarhan M. Musa [ρ]

Abstract- **Mobile applications are becoming increasingly computational-intensive, while many mobile devices still have limited battery power and cannot support computational intensive tasks. Mobile edge computing (MEC) computing is an extension of edge computing, and it refers to computing at the edge of a network. In mobile edge computing, computing and storage nodes are placed at the Internet's edge near mobile devices. It places the edge clouds at the candidate locations. This paper presents a brief introduction to MEC.**

Keywords: mobile edge computing, edge computing, multi-access edge computing.

I. Introduction

The technological evolution of mobile devices, such as smartphones or laptops, has an impact on mobile and wireless networks worldwide. An increasing number of applications are routinely installed on a mobile device. Mobile devices have become the most natural devices for multimedia consumption, production, computation, and human-computer interaction [1]. Due to limited size, battery capacity, energy consumption, and latency of the mobile devices, one is constrained to run the computationally demanding task on them.

To address this problem a new emerging concept, known as mobile edge computing (MEC), has been introduced. MEC is recently known as multi-access edge computing. This is a new paradigm of cloud computing, which provides low-latency service by moving cloud resources to the edge of the network rather than a remote central cloud data center. In other words, MEC has emerged as an effective way to mitigate the problem of long latencies and improve the current network architecture.

The European Telecommunications Standards Institute (ETSI) introduced the concept of MEC, where mobile users can utilize computing services from the base station [2]. Since MEC is an extension of edge computing, it is expedient to give some background information on edge computing.

II. Overview of Edge Computing

The proliferation of the Internet of things (IoT), the success of cloud services, and the 5G communication technologies have led to the emergence of a new computing paradigm, edge computing, which calls for processing the data at the edge of the network, as opposed to a data center or cloud. Edge computing is essentially the computing infrastructure that exists close to the sources of data. Edge computing enables data produced by the Internet of things (IoT) devices to be processed closer to where it is created. This allows organizations to analyze their data in real-time.

Edge computing covers a spectrum of technologies such as cloudlets, fog computing, and mobile edge computing. A combination of edge and cloud computing is referred to as fog computing because it combines centralized and distributed computing resources into a single architecture. Physical proximity is the essence of edge computing since it improves latency, bandwidth, trust, and survivability. While the cloud revolutionized the way we deal with data, the next wave of that revolution will happen at the edge [3]. Edge computing is instrumental in enabling edge processing to deliver on the promise of the industrial IoT.

III. Concept of Mobile Edge Computing

Mobile edge computing (MEC) is a network concept that enables cloud computing capabilities at the edge of the cellular network. The edge of a network refers to the edge of a mobile network, hence the term "mobile edge computing." It mitigates the problem of long latencies. It is an integration of cloud computing and mobile computing. It is an emerging architecture where cloud computing services are extended to the edge of networks. MEC is regarded as one of the key components for technologies for 5G systems [4]. Its main motivation is that processing tasks closer to the cellular customer will reduce network congestion. It is characterized by a low latency, proximity, high bandwidth, and agile mobile service. It provides ubiquitous and efficient cloud services to mobile users.

Mobile edge servers are co-placed with the mobile network base station at the edge of the mobile network. Mobile edge computing represents a key technology and architectural concept to enable the evolution to 5G. MEC can offer a service environment with ultralow latency, high-bandwidth, and direct access to real-time network information [5]. A typical mobile edge computing architecture is shown in Figure 1 [6].

IV. Applications

As a promising edge technology, it can be applied to mobile, wireless, and wireline settings, using software and hardware platforms that are located at the network edge in the vicinity of end-users. MEC providers can improve the efficiency and resources utilization for

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IoT applications. Applications, such as smart grid, content delivery networks, crowd sourcing, augmented reality, traffic management, and healthcare will greatly benefit from mobile edge computing. Some of these are covered here in detail [7].

- *Healthcare:* MEC can help healthcare professionals assist their patients, independent of their geographical location. MEC enables smartphones to collect patient physiological information. For example, to detect and prevent falling accidents, human-computer interaction devices, such as a smartphone, smart watch, and Google glass, can be introduced.
- *Video Analytics*: MEC will be beneficial by implementing intelligence at the device itself which is programmed to send data to the network. MEC enables surveillance cameras to be beneficial for several applications, such as traffic management applications.
- *Connected Vehicles:* Mobile edge computing supports connected cars to ensure real-time, interactive, services for users. Deploying MEC environments along the road can enable two-way communication between the moving vehicle. Connected vehicles have access to the Internet and can sense the physical environment around them and interact with other vehicles [8].
- *Smart Grid*: A smart grid infrastructure consists of several components, such as smart appliances and smart meters that are distributed over the network. When the smart meters and micro grids integrated with MEC, SCADA systems can be supported.

V. Benefit and Challenges

Mobile edge computing (MEC) offers a wide range of benefits for equipment providers and system integrators. It puts the services and resources of the cloud closer to users and delivers low latency. It aims to reduce end-to-end latency, ensure better service delivery, and offer improved user experience. MEC facilitates the leveraging of available services and resources in the edge networks, closer to the users, instead of in the cloud. It significantly reduces the energy consumption of user equipment.

MEC faces some challenges which include the administrative policies and security concerns, i.e., secure data storage, secure computation, network security, data privacy, usage privacy, location privacy, etc. [9]. In MEC, service latency is the main concern, which brings in new challenges to live virtual machine (VM) migration. In conventional cloud computing, users normally do not have a high requirement for service latency.

Compared to cloud computing, resource provisioning in MEC is challenging. Standards for MEC are being developed by ETSI.

VI. Conclusion

Mobile edge computing is emerging as a novel computing platform that overcomes the problem of limited resources of mobile devices and meets the ever-increasing computation demands from mobile applications. It provides cloud computing capabilities at the edge of the network, near the mobile devices. It is envisioned as a promising approach to improving the computation capabilities and energy efficiencies of mobile devices.

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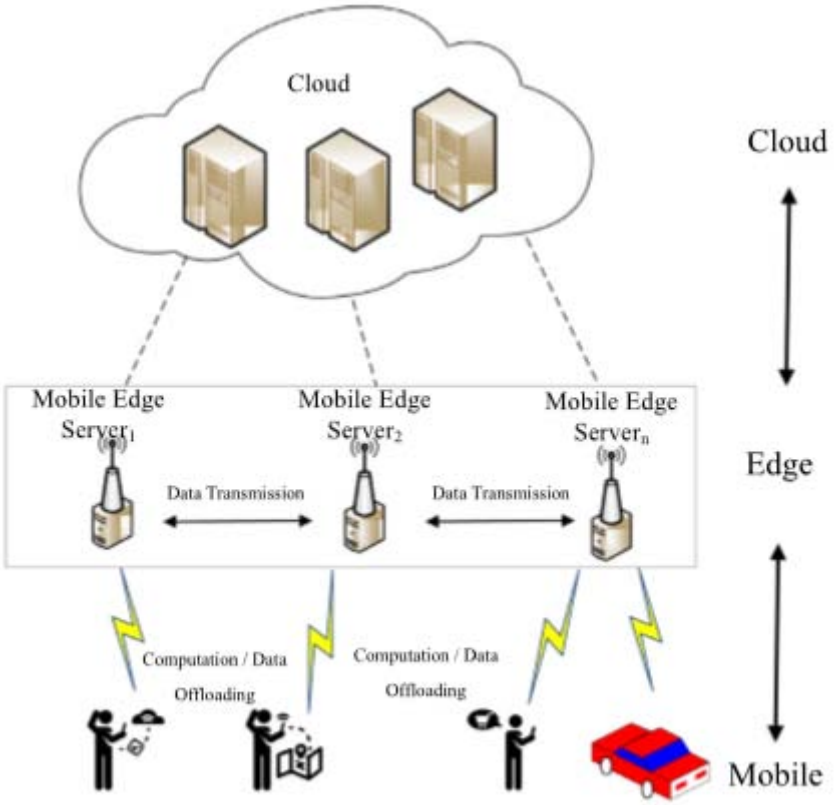

Figure 1: A typical mobile edge computing architecture [6].

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Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Computer Science Research Paper

Techniques for writing a good quality computer science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of computer science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10.Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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