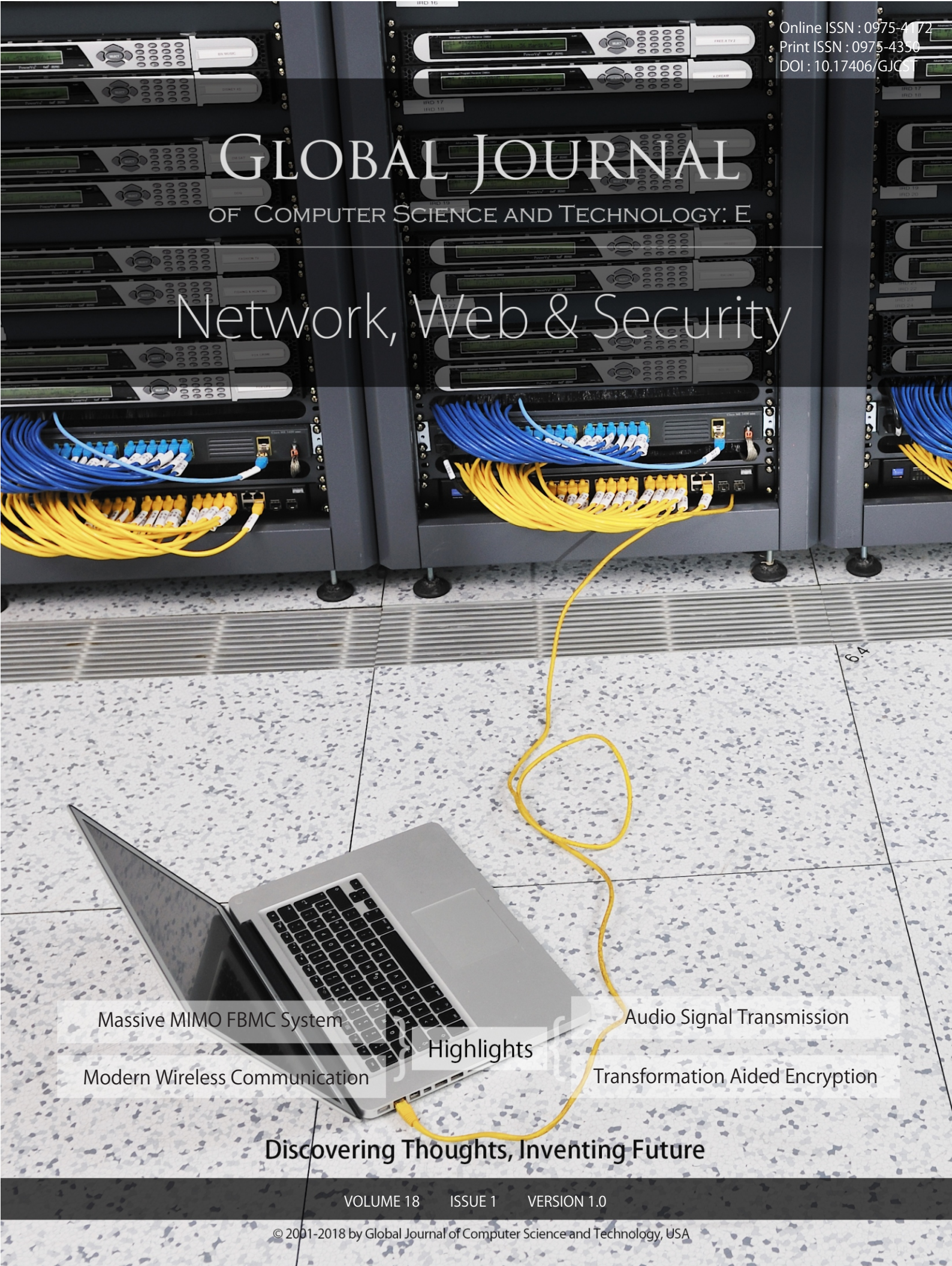
Online ISSN : 0975-4172
Print ISSN : 0975-4350
DOI : 10.17406/GJCST

# Global Journal

## of Computer Science and Technology: E

# Network, Web & Security



Highlights

Massive MIMO FBMC System

Modern Wireless Communication

Audio Signal Transmission

Transformation Aided Encryption

Discovering Thoughts, Inventing Future

VOLUME 18 ISSUE 1 VERSION 1.0

Global Journal of Computer Science and Technology: E
Network, Web & Security

Global Journal of Computer Science and Technology: E
Network, Web & Security

Volume 18 Issue 1 (Ver. 1.0)

Open Association of Research Society

**Incorporation No.: 0423089**
**License No.: 42125/022010/1186**
**Registration No.: 430374**
**Import-Export Code: 1109007027**
**Employer Identification Number (EIN):**
**USA Tax ID: 98-0673427**

## Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

*Sponsors: Open Association of Research Society*
*Open Scientific Standards*

### *Publisher's Headquarters office*

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
*USA Toll Free: +001-888-839-7392*
*USA Toll Free Fax: +001-888-839-7392*

### *Offset Typesetting*

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

### *Packaging & Continental Dispatching*

Global Journals Pvt Ltd
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

### *Find a correspondence nodal officer near you*

To find nodal officer of your country, please email us at *local@globaljournals.org*

### *eContacts*

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

### *Pricing (Excluding Air Parcel Charges):*

*Yearly Subscription (Personal & Institutional)*
250 USD (B/W) & 350 USD (Color)

# Editorial Board

## Global Journal of Computer Science and Technology

### *Dr. Abdurrahman Arslanyilmaz*

Computer Science & Information Systems Department
Youngstown State University
Ph.D., Texas A&M University
University of Missouri, Columbia
Gazi University, Turkey
Web: cis.ysu.edu/~aarslanyilmaz/professional_web

### *Dr. Chutisant Kerdvibulvech*

Dept. of Inf. & Commun. Technol.,
Rangsit University
Pathum Thani, Thailand
Chulalongkorn University Ph.D. Thailand
Keio University, Tokyo, Japan

### *Dr. Sukhvinder Singh Deora*

Ph.D., (Network Security), MSc (Mathematics),

Masters in Computer Applications

### *Dr. Sotiris Kotsiantis*

Ph.D. in Computer Science, University of Patras, Greece
Department of Mathematics, University of Patras, Greece

### *Dr. Ramadan Elaiess*

Ph.D.,

Computer and Information Science

### *Dr. Manpreet Singh*

Ph.D.,
(Computer Science)

### *Nicla Romano*

Professor in Cellular and Developmental Biology;
Cytology and Histology; Morfogenesis and Comparative Anatomy

### *Dr. Muhammad Abid*

M.Phil,
Ph.D Thesis submitted and waiting for defense

### *Dr. K. Venkata Subba Reddy*

Ph.D in Computer Science and Engineering

### *Loc Nguyen*

Postdoctoral degree in Computer Science

### *Faisal Mubuke*

M.Sc (IT), Bachelor of Business Computing, Diploma in Finanicial services and Business Computing

### *Jiayi Liu*

Physics, Machine Learning,
Big Data Systems

### *Dr. Yuanyang Zhang*

Ph.D in Computer Science

### *Asim Gokhan Yetgin*

Design, Modelling and Simulation of Electrical Machinery;
Finite Element Method, Energy Saving, Optimization

### *Anup Badhe*

Bachelor of Engineering (Computer Science)

### *Dr. S. Nagaprasad*

M.Sc, M. Tech, Ph.D

# Contents of the Issue

Global Journal of Computer Science and Technology: E Network, Web & Security
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# ACO based AODV Method for Detection and Recovery of Misbehaving Node in MANET

By M. Sumathi & Dr. M.Gunasekaran

*Abstract-* Mobile ad-hoc networks (MANETs) can be described as a set of a huge variety of mobile nodes. MANET has the kind of applications such navy, disaster stuck regions and the characteristics of dynamic topology, no constant infrastructure, and many others. Nevertheless, there are a few protection issues and challenges in it. MANET is vulnerable to numerous attacks because of its open medium. As a result, there's need to examine in detail about the way to discover malicious or misbehaving node present inside the network. Ant algorithm is a set of rules this is most appropriate to be carried out in MANET environments than other algorithms. It can discover a most effective route, independent, decentralized, rapid adaptation, and multiple routes. Due to this motive, we use ant algorithm to enhance the overall performance of the proposed comfortable protocol. in this paper, Ant-primarily based Misbehavior node detection approach is carried out with ad-hoc On-demand Distance Vector (AODV) protocols and it figuring out the misbehavior node properly evaluate the parameters of packet delivery ratio, throughput and so on.

*Keywords:* *AODV, ACO, misbehavior detection and recovery, MANET.*

*GJCST-E Classification:* *C.2.1, C.2.m*


*Strictly as per the compliance and regulations of:*

# ACO based AODV Method for Detection and Recovery of Misbehaving Node in MANET

M. Sumathi[α] & Dr. M.Gunasekaran[σ]

*Abstract-* Mobile ad-hoc networks (MANETs) can be described as a set of a huge variety of mobile nodes. MANET has the kind of applications such navy, disaster stuck regions and the characteristics of dynamic topology, no constant infrastructure, and many others. Nevertheless, there are a few protection issues and challenges in it. MANET is vulnerable to numerous attacks because of its open medium. As a result, there's need to examine in detail about the way to discover malicious or misbehaving node present inside the network. Ant algorithm is a set of rules this is most appropriate to be carried out in MANET environments than other algorithms. It can discover a most effective route, independent, decentralized, rapid adaptation, and multiple routes. Due to this motive, we use ant algorithm to enhance the overall performance of the proposed comfortable protocol. in this paper, Ant-primarily based Misbehavior node detection approach is carried out with ad-hoc On-demand Distance Vector (AODV) protocols and it figuring out the misbehavior node properly evaluate the parameters of packet delivery ratio, throughput and so on.

*Keywords: AODV, ACO, misbehavior detection and recovery, MANET.*

## I. Introduction

Wireless communication nowadays surrounds us in many colors and flavors, each with its specific frequency band, coverage, and variety of applications. It has matured to a large volume, and standards have advanced for personal area Networks, local area Networks in addition to Broadband wireless access. In Ad-Hoc networks, every node is inclined to forward data to different nodes, and so the determination of which nodes forward data is made dynamically based totally on the network connectivity. Minimum configuration and brief deployment make Ad-Hoc networks suitable for emergency situations like natural or human-caused disasters, navy conflicts, emergency medical situations and many others.

### a) *Routing in Ad Hoc Networks*

Mobile ad-hoc Networks alternate their topology frequently and without previous observe makes packet routing in ad-hoc networks a difficult assignment. The cautioned procedures for routing can be divided into topology-based and position-based routing. Fig 1.1 represents the right category of ad-hoc routing Algorithms. Topology-based routing protocols use the information about the links that exist in the network to carry out packet forwarding. They may be further divided into proactive, reactive, and hybrid strategies.

Proactive algorithms rent classical routing strategies which include distance-vector routing (e.g., DSDV) or link-state routing (e.g., OLSR and TBRPF). They preserve routing facts about the available paths within the network even though those paths are not presently used. In response to this observation, reactive routing protocols had been evolved (e.g., DSR, TORA, and AODV). Reactive routing protocols maintain only the routes which are presently in use, thereby decreasing the load at the network when most effective a small subset of all available routes is in use at any time. however, they nonetheless have a few inherent barriers. Hybrid ad-hoc routing protocols along with ZRP integrate local proactive routing and international reactive routing with the intention to obtain a higher level of efficiency and scalability.

Position-based routing algorithms remove a number of the constraints of topology-based routing by using extra information. as a result does now not require the establishment or maintenance of routes. The nodes have neither to store routing tables nor to transmit messages to maintain routing tables updated. As an in addition benefit, position-based routing supports the delivery of packets to all nodes in a given geographic region in a natural way. This kind of provider is referred to as geocasting.

### b) *Attacks on Ad Hoc Networks*

Wireless the structure of an Ad-Hoc network, or lack thereof, leads to a few special kinds of attacks. Especially attacks at the connectedness of the network which means that attacks on the routing protocol. A number of those attacks are Routing Loop, Black hole, gray hole, Partitioning, Blackmail, Wormhole, rushing attack, resource consumption, dropping Routing traffic, location disclosure and so forth.

*Author α: Research Scholar, PG and Research Department of Computer Science, Government Arts College, Dharmapuri.*
*e-mail: sumathi.vedha26@gmail.com*
*Author σ: Assistant Professor & Head, PG and Research Department of Computer Science, Government Arts College, Dharmapuri.*

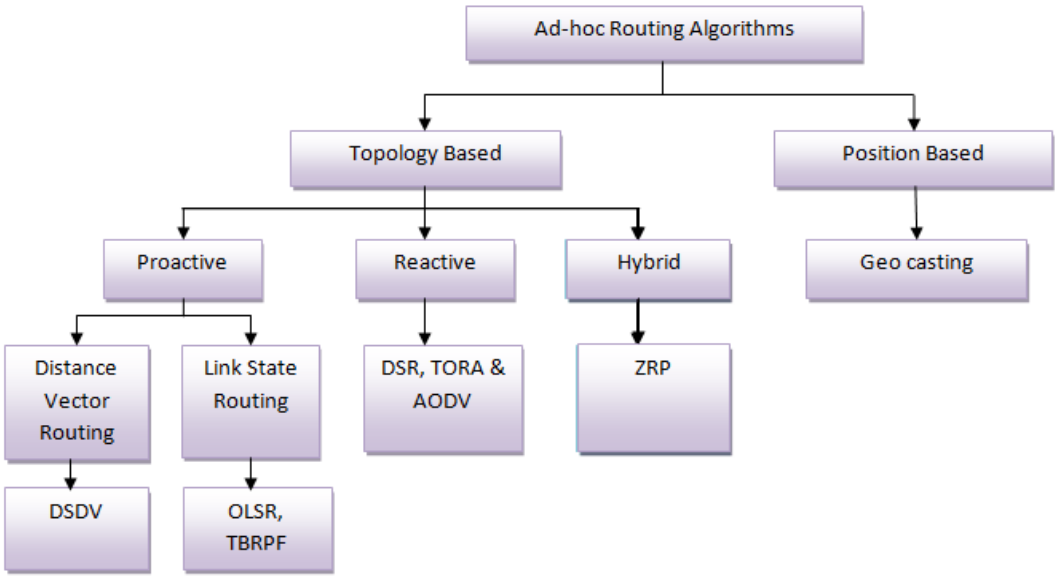



*Fig.1.1:* Classification of AD-Hoc Routing Algorithms

*c) Security Model and Attributes*

The sector of security is big and a few model to apply for attacking the problem is needed. Some of the attributes need to be considered for classifying the one of kind security desires of the applications of an Ad-Hoc network. Which can be Confidentiality, Authentication, Availability, Integrity, Non-Repudiation, fact of discovery, Isolation, lightweight computations, location, Self, Byzantine robustness and many others.

*d) Security of Ad-Hoc Networks*

Security vulnerabilities in ad-hoc networks are:

*Limited computational capabilities:* generally, nodes in ad-hoc networks are modular, independent, and restricted in computational functionality and consequently can also grow to be a source of vulnerability after they take care of public-key cryptography at some point of normal operation.

*Limited power supply:* due to the fact nodes generally use the battery as power supply, an interloper can exhaust batteries by developing extra transmissions or excessive computations to be performed by means of nodes.

*Challenging key management:* Dynamic topology and movement of nodes in an Ad Hoc network make key control difficult if cryptography is used within the routing protocol.

## II. Review of Literature

Farid Bin Beshr et.al (2016), reveal about Adopting Intrusion Detection system (IDS) that allows the routing protocol to avoid misbehavior nodes and links. The IDS have to characteristic low overhead controlling packet, excessive accuracy degree and low price of both false alarms and missed detection rate. The proposed system primarily based on assigning a few nodes called "guard nodes" the obligation of overhearing and reporting the misbehaving nodes. The scheme is proposed to conquer the majority of the drawbacks related to the Watchdog strategies.[1]

Chinthanai Chelvan.k et.al (2014), describes EAACK(enhanced Adaptive Acknowledgement) demonstrates better malicious-behavior-detection rates in positive instances while does not greatly have an effect on the network performances. The Intrusion Detection systems named EAACK protocol in particular designed for MANETs and compared to different famous mechanisms includes, Watchdog scheme .The effects confirmed positive performances towards Watchdog in the cases of receiver collision and fake misbehavior record.[2]

A Al-Roubaiey et.al(2010) illustrates Adaptive ACKnowledgment (AACK), for fixing great issues: the limited transmission power and receiver collision. This mechanism is an enhancement to the TWOACK scheme where its detection overhead is decreased even as the detection efficiency is increased. The AACK mechanism may not work well on long paths with the intention to take a significant time for the end to end acknowledgments. This problem will deliver the misbehaving nodes more time for losing more packets.[3]

P.Nandhini Sri et.al (2016) decides that during this selfish node detection, data packet transmission among the nodes the routing path is mounted and maintained so long as it's far wished and routing overhead is substantially decreased. The simulation end result shows that the detection of the selfish node with a massive delay. Therefore shortcut tree routing (STR)

protocol has been proposed in future work that is used for improving the overall performance of the selfish node and also route discovery overhead with low memory consumption and it provides the most appropriate routing path.[4]

Usha Sakthivel et.al (2011) finds out's selfish behavior of a node impacts the throughput of the network. The nodes may additionally choose a back down value of shorter duration. An algorithmic technique for misbehaving node detection and isolation in ad hoc networks by way of enhancing the protocol getting used inside the lower layers which consequently improves the performance of the network have been proposed. Similarly, studies can verify the practicality of the proposed concept.[5]

Kashyap Balakrishnan et.al (2005) defines network-layer acknowledgment-based schemes, termed the TWOACK and the S-TWOACK schemes, which can be honestly introduced-on to any source routing protocol. The TWOACK scheme detects such misbehaving nodes, after which seeks to relieve the problem with the aid of notifying the routing protocol to keep away from them in future routes. The schemes detect selfish nodes (links) so that other nodes may also avoid them in future route selections, with the goal of universal improvement in end-to-end packet delivery ratio.[6]

Suganya.N.R et.al(2013) evaluates, from the angle of reproduction allocation, we have a look at the effect of selfish nodes in a mobile ad hoc network that is termed as selfish replica allocation. In our method, every node computes credit risk facts on different related nodes personally to appraise the degree of selfishness. Our method can detect two unique kinds of routing manipulation even as keeping a low rate of false positives when showing the simulation effects.[7]

Rasika Mali et.al (2015) present different techniques for detection of misbehavior of nodes such as Watchdog, ExWatchdog, TWOACK, S-TWOACK, 2ACK and Adaptive ACKnowledgment (AACK), CONFIDANT, Record and Trust Based Detection. All techniques are analyzed with parameters like type of misbehavior, key mechanism used, advantages, limitations an performance evaluation using Packet Delivery Ratio (PDR) and throughput. Still the problem of receiver collision, limited transmission power and partial dropping are unsolved.[8]

## III. Misbehaving Node Detection in Manet

An individual mobile node can also attempt to benefit from other nodes, however, refuse to proportion its own resources. Such nodes are known as selfish or misbehaving nodes and their behavior is termed selfishness or misbehavior. One of the main sources of energy consumption inside the mobile nodes of MANETs is wireless transmission. A selfish node can also refuse to forward data packets to other nodes that allow you to conserve its very own energy.

*a) Misbehavior Detection and Mitigation*

To mitigate the unfavorable consequences of routing misbehavior, the misbehaving nodes need to be detected in order that these nodes can be avoided with the aid of all properly-behaved nodes. on this paper, we attention on the subsequent problem.

- Routing Misbehavior Model
- Detecting Router Misbehavior
- Detecting Flooding Attacks
- Packet Dropper Detection
- Path Tracing Algorithm
- Black hole attack Detection
- Hardware Assisted Detection
- Watchdog and Path rater
- Nodes Bearing Grudges

*b) Intrusion Detection in MANET*

An Intrusion Detection System (IDS) agent runs at each mobile node, and performs local data collection and local detection, while cooperative detection and international intrusion response may be triggered when a node reports an anomaly. Taken into consideration two forms of attack scenarios one at a time:

1) Abnormal updates to routing tables.
2) Detecting abnormal activities in layers other than the routing layer.

Each node does local intrusion detection independently, and neighboring nodes collaboratively work on a larger scale. individual IDS agents positioned on every and each node run independently and monitor local activities (which include consumer, structures, and communiqué activities within the radio range), locate intrusions from local traces, and provoke responses. Neighboring IDS agents cooperatively participate in global intrusion detection actions whilst an anomaly is detected in local data or if there's inconclusive proof.

i. *Resurrecting Duckling*

This mechanism can be adapted for node authentication in ad-hoc wireless networks. During the imprinting technique, the devices can trade cryptographic keys for signing messages. it is able to be possible to use the resurrecting ducking method to enforce a key distribution protocol to be used with IP sec or another security protocol.

ii. *Packet Dropping*

The concept of packet dropping committed via the misbehaving nodes. There are kinds of packet dropping carried out by using the misbehaving nodes, simple dropping, and selective dropping. As pointed out earlier than, the simple dropping is typically devoted to the aid of the selfish node, whilst the malicious node includes both simple dropping and selective dropping.

In simple dropping, the misbehaving nodes drop all of the packets now not to or from them; even as in selective dropping, the misbehaving nodes only drop data packets no longer to or from them while forwarding the control packets, including route request, route reply, and many others.

iii. *Packet Misrouting*

Within the MANET, a malicious node can misroute the data packets to its colluding partner or a randomly selected destination with the intention to mount further attacks to the networks or disrupt the regular communication. Throughout the detection process, the detection hardware can pay no attention to the destinations which receive misrouted data packets. All that the detection hardware cares is the misbehaving node misrouting data packets. If the detection hardware identifies that the node is committing packet misrouting, it's going to send out the warning message.

## IV. Proposed Methodology

The proposed system is used to detect the misbehavior routing using 2ACK and additionally take a look at the confidentiality of the data message in MANETs environment. here, we used a scheme referred to as 2ACK scheme, wherein the destination node of the following hop link will send lower back a 2 hop acknowledgment known as 2ACK to suggest that the data packet has been acquired efficiently. The proposed work (2ACK with confidentiality) is as follows.

- If the 2ACK time is much less than the wait time and the original message contents are not altered at the intermediate node then, a message is given to sender that the link is working well.
- If the 2ACK time is more than the wait time and the unique message contents are not altered on the intermediate node, then a message is given to sender that the link is misbehaving.
- If the 2ACK time is more than the wait time and the original message contents are altered at the intermediate node, then the message is given to sender that the link is misbehaving and confidentiality is lost.
- If the 2ACK time is less than the wait time and the original message contents are altered at the intermediate node then, a message is given to sender that the link is working properly and confidentiality is lost.

At the destination, a hash code can be generated and in comparison with the sender's hash code to test the confidentiality of the message. Consequently, if the link is misbehaving, sender to transmit messages will now not use it in future and loss of packets may be avoided.

*a) System Model*

In the existing system, there is a possibility that when a sender chooses an intermediate link to send some message to destination, the intermediate link may give problems such as the intermediate node may not forward the packets to destination, it may take very long time to send packets or it may modify the contents of the packet. In MANETs, as there is no retransmission of packets once it is sent, hence care is to be taken that packets are not lost.

Noting that a misbehaving node can either be the sender or the receiver of the next-hop link, we have focused on the problem of detecting misbehaving links instead of misbehaving nodes using 2ACK scheme. In the next-hop link, a misbehaving sender or a misbehaving receiver has a similar adverse effect on the data packet. It will not be forwarded further. The result is that this link will be tagged. Our approach is used to discuss the significant simplification of the routing detection mechanism and also checking the confidentiality of the message in MANETs environment.

*Module 1:* Sender module (Source node). The task of this module is to read the message and then divide the message into packets of 48 bytes in length, send the packet to the receiver through the intermediate node and receive the acknowledgement from the receiver node through the intermediate node. After sending every packet the "Cpkts" counter is incremented by 1. 2ACK time is compared with the wait time. If 2ACK is less than the wait time, "Cmiss" counter is incremented by 1. The ratio of "Cmiss" to "Cpkts" is compared with the "Rmiss" (a threshold ratio). If it is less than "Rmiss", the link is working properly otherwise misbehaving.

*Module 2:* Intermediate module (Intermediate node). The task of this module is to receive a packet from the sender, alter/don't alter the message and send it to the destination. Get 2ACK packet from the receiver and send 2ACK packet to the sender.

*Module 3:* Receiver module (Destination node). The task of this module is to receive a message from the intermediate node, take out destination name and hash code and decode it. Compare the hash code of source node and the destination node for security purpose. Send 2ACK to source through the intermediate node.

*b) Algorithm of 2ACK Scheme and Ant Implementation*

We have used the triplet of N1 → N2 → N3 as an example to illustrate 2ACK's pseudo code. Where N1 is assumed as the source node, N2 is the intermediate node and N3 is the destination node. Note that such codes run on each of the sender/receivers of the 2ACK packets.

*Nomenclature:* {Cpkts = the number of the message packets sent, Cmiss = the number of the 2ACK packets missed, d = the acknowledgment ratio. WT = waiting time, i.e., the maximum time allotted to receive 2ACK packet}

*Algorithm:*

*Step 1:* Start the algorithm.

*Step 2:* Deploy the node 1000 x 1000 areas.

*Step 3:* If the node is failure in deployment move to Step 4.

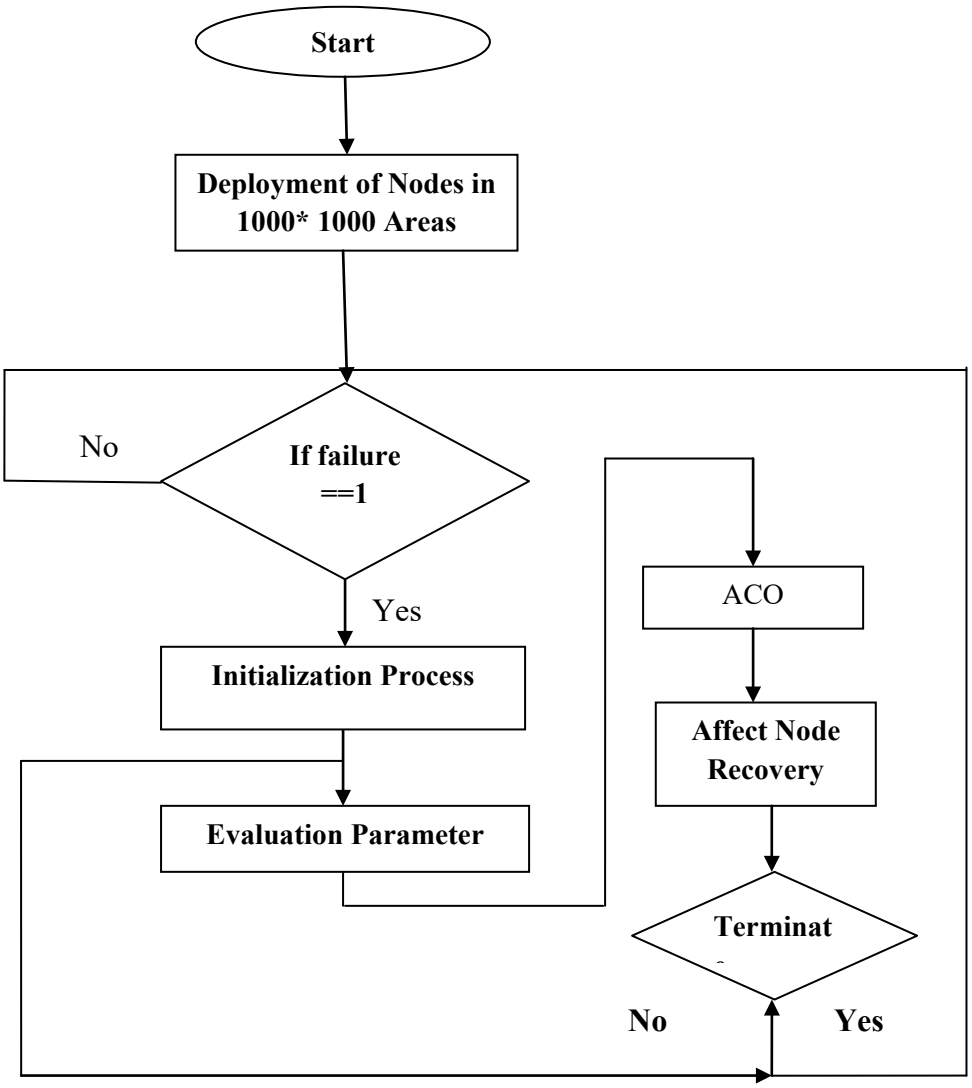
*Step 4:* Initialization of node failure identification.

*Step 5:* Evaluate the parameter for node identification.

*Step 6:* Perform ACO for node detection and routing.

*Step 7:* If the node is affected node then recover the node otherwise Step 8.

*Step 8:* Terminate the process.




i. *Ant node N1*

**while** (true) **do**
Read the destination address;
Read the message;
Find the length of the message. Cmiss=0, Cpkts=0, WT=20 ms, d=0.2.
2ACK Time=Current Time (Acknowledgement accepted time) – Start Time.
**while** (length > 48 bytes) **do** Take out 48 message packet; Length = length – 48;
Encode message using hash function; Send message along with the hash key; Cpkts++;
Receive 2ACK packet;

```
    if (2ACK time > WT) then
        Cmiss++;
 end
 end
if (length < 48 bytes) then
        Encode message using hash function; Send message along with the hash key; Cpkts++;
    Receive 2ACK packet;
   if (2ACK time > WT) then
    Cmiss++;
end
end end
     Routing Misbehavior Detection in MANETs Using 2ACK.
```

ii. *Ant node N2*

```
while (true) do
    Read message from source N1
if (Alter) then
    Add dummy bytes of characters;
    Process it and forward to destination N3; Receive 2ACK from N3 and send it to N1;
else if (Do not Alter) then
    Process it and forward to destination N3; Receive 2ACK from N3 and send it to N1;
End end
```

iii. *Ant node N3*

```
while (true) do
     Read message from N2;
     Take out destination name and hash code; Decode the message; Send 2ACK packet to N2;
end
```

iv. *Ant N1 and N3 parallel*

```
while (true) do
   if ((Cmiss/Cpkts)>d and (hash code of source msg) ! = (hash code of destination msg)) then
   Link is misbehaving and the confidentiality is lost;
end
if ((Cmiss/Cpkts)<d and (hash code of source msg) ! = (hash code of destination msg)) then
Link is working properly and the confidentiality is lost;
end
if ((Cmiss/Cpkts)>d and (hash code of source msg)
=(hash code of destination msg)) then Link is misbehaving;
end
if ((Cmiss/Cpkts)<d and (hash code of source msg)
=(hash code of destination msg)) then Link is working properly;
end end
```

## V. Result and Discussion

We have used NS2 in our evaluation. We have selected 1000 * 1000m in AODV and 2500*2500m in Ant-Based AODV as our network size and generate 50 mobile nodes in both networks. To explain the various performance metrics required for evaluation of protocols, to reiterate the black hole attack, we begin with the overview of performance parameters that includes End-to-end delay, Throughput, Bit Error Rate and Packet Delivery Ratio. The parameters have to be measured against iteration.

*Table 5.1:* Simulation Parameters

| Property | Value |
|---|---|
| Routing Protocols | AODV, Ant Based AODV |
| Area Covered(DSR) | 2500*2500m |
| Area Covered(OLSR) | 1000*1000m |
| Coverage Set | 250m |
| No. of Nodes | 50 |
| Observation Parameters R | Throughput, End-to-End Delay, Bit Error Rate,Packet, Delivery Ratio and Iteration |
| Network Simulation | NS2 |
| Optimization technique | ACO |
| No. Of Iteration | 10 |
| Population Size | 500 |

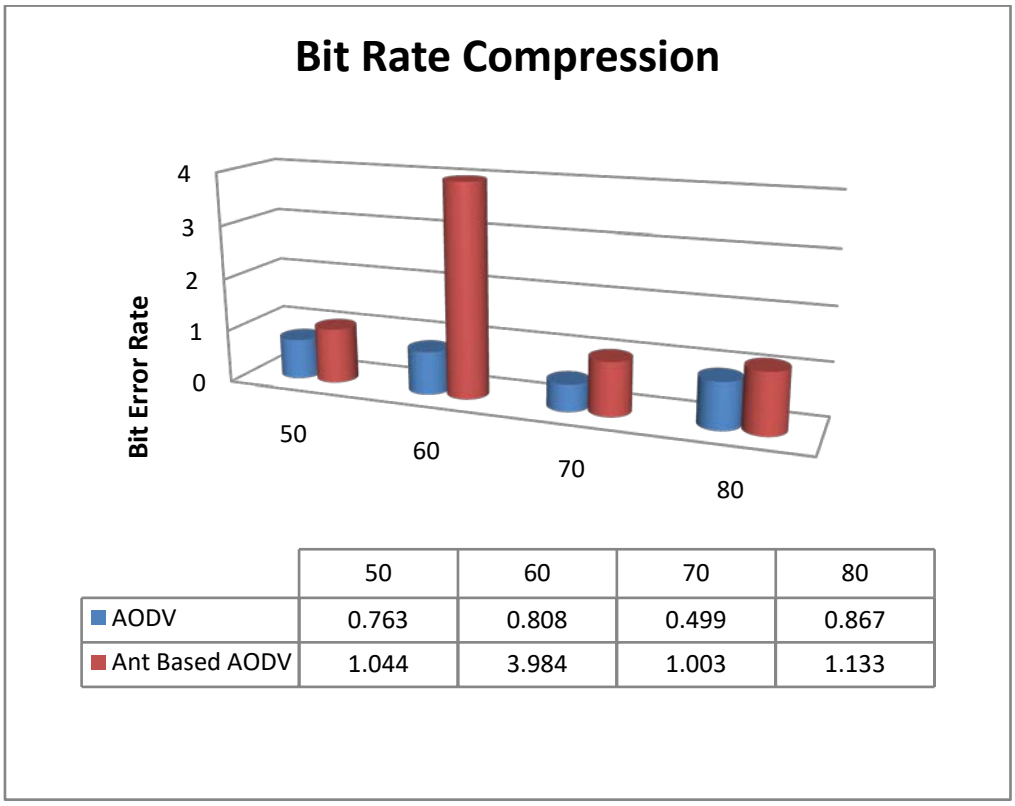
*a) Results*

The Result part is divided into two parts for two different protocols AODV and Ant-Based AODV and finally, their results have been analyzed in tabular form in table.

i. *Bit Error Rate*

Bit error rate is the percentage of bits with errors divided by the total number of bits over a given time period.

$$BER = \tfrac{1}{2}\,erfc\sqrt{\frac{EB}{No.of\ nodes}}$$




| | 50 | 60 | 70 | 80 |
|---|---|---|---|---|
| AODV | 0.763 | 0.808 | 0.499 | 0.867 |
| Ant Based AODV | 1.044 | 3.984 | 1.003 | 1.133 |

*Figure 5.1:* Comparative Relation of Bit Error Rate

In Figure 5.1 shows the comparative relation of bit error rate in the presence of misbehaving attack and with optimization using ant colony optimization algorithm and shows that bite error measure is less with optimization as compared to the effect of attack in the network. This measure should be less for the efficient network.

ii. *Throughput*

The amount of data transferred from one place to another or processed in a specified amount of time.

Throughput = (Total No. of Bytes received/ Simulation time) * (8/1000)kbps.

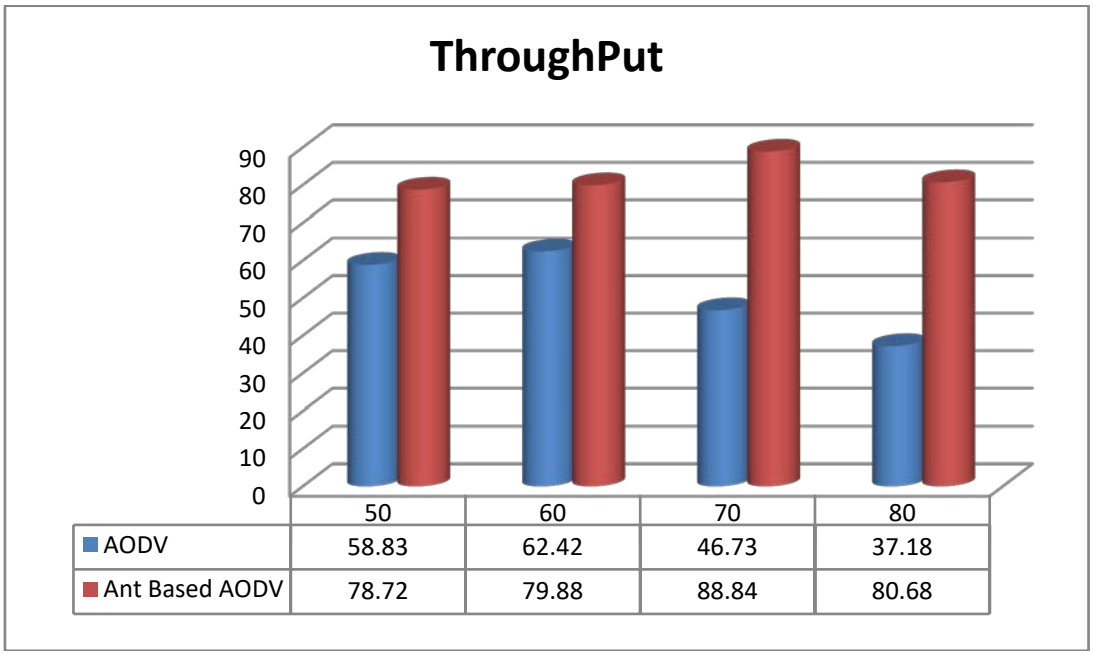



*Figure 5.2:* Throughput Measure with Attack and After Optimization

In Figure 5.2 shows the throughput measure with attack and after optimization and shows that this measure is having high throughput after optimization. The throughput is defined as the network performance with the successful delivery of the packets from source to the destination in an efficient manner.

iii. *End to End Delay*

End to End Delay refers to the time taken for a packet to be transmitted across a network from source to destination.

$$EED = \sum_{i=1}^{p} \text{Received} \frac{(\text{T Received} - \text{T Trasmission})}{\text{P Received}}$$

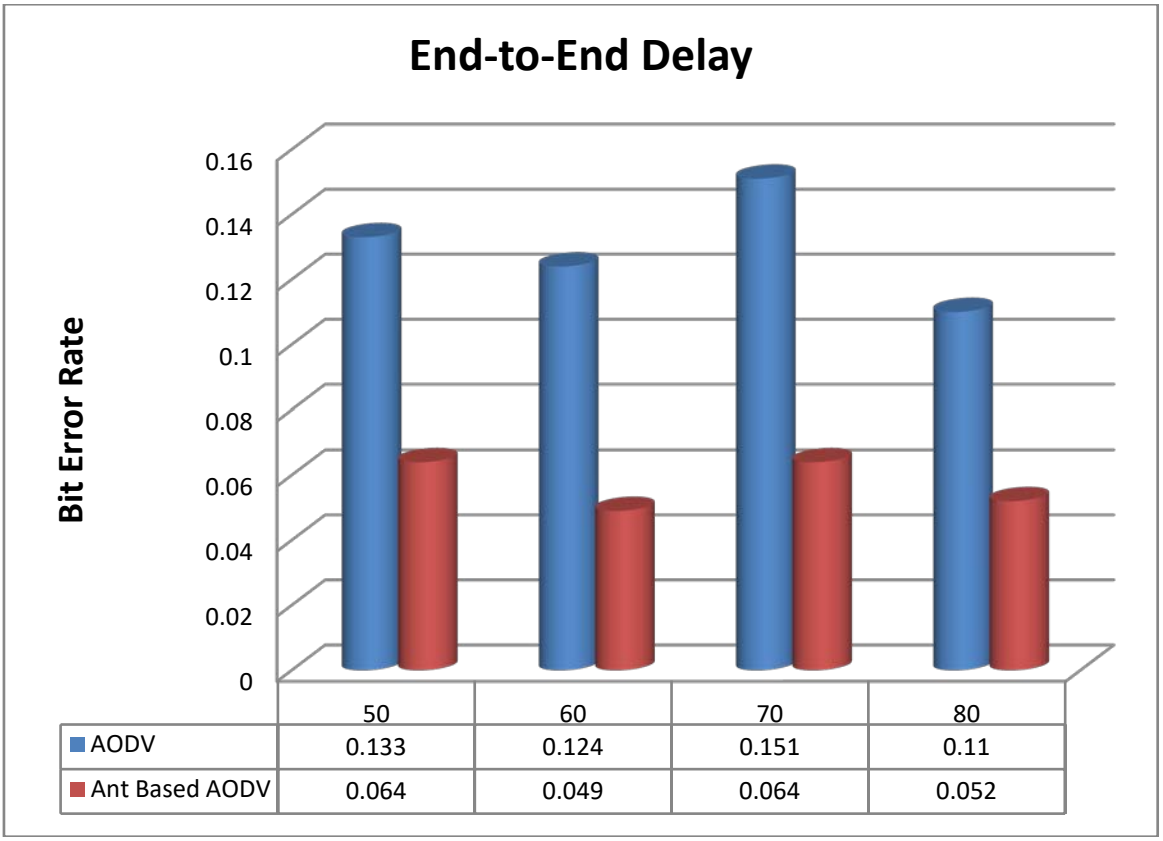



*Figure 5.3:* End To End Delay Measure with Attack and After Optimization

In Figure 5.3 shows the End to End delay measure with attack and after optimization and shows the packets are delivered in less interval of time to increase the network lifetime. The end delay is defined as the number of packets received to the destination at fewer intervals of time with less error rate.

iv. *Packet Delivery Ratio*

Packet Delivery Ratio is defined as the ratio between the received packets by the destination and the generated packets by the source.

$$PDR = P\ received * 1000 / \sum_{i=1}^{n} P\ generated$$

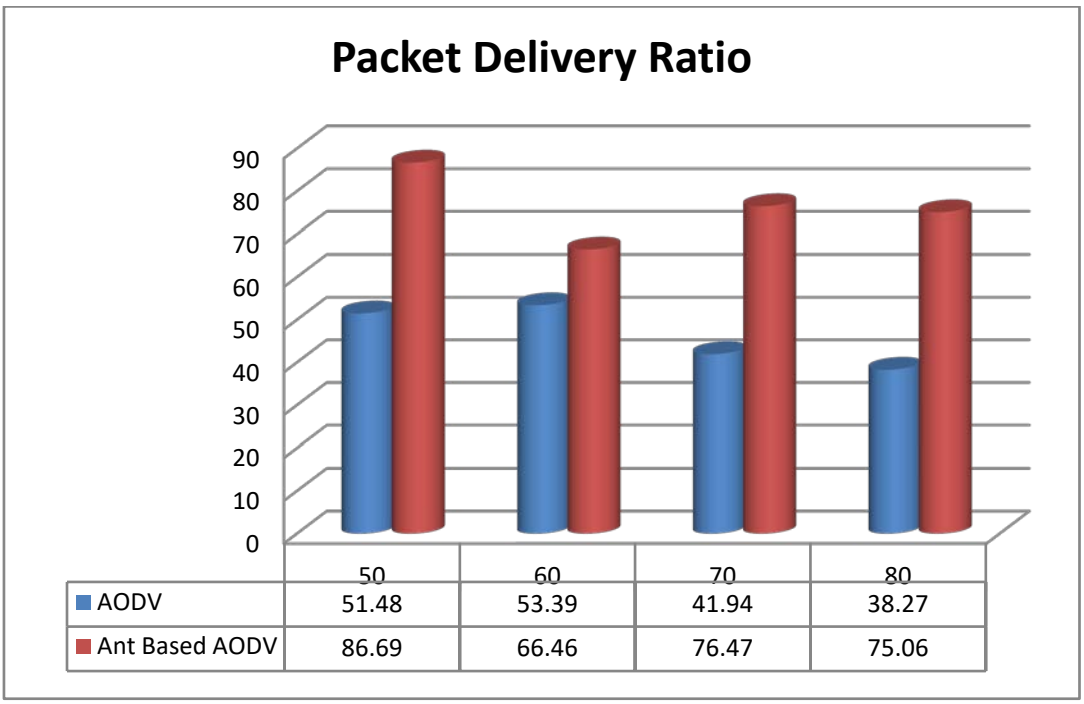



*Figure 5.4:* Packet Delivery Rate in the Presence of Attack and After Optimization

In Figure 5.4 shows the packet delivery rate in the presence of attack and after optimization with ant colony optimization and shows that the more packets are delivered in an efficient manner.

The packet delivery rate is defined as the number of packets successfully received to the destination node and the resulting graph of Ant AODV shows that the 15% more packets are delivered than the network in the presence of an attack.

*b) Comparison of Aodv Routing Protocol using Aco*

In table 1 we have compared the average values of AODV and AODV with ACO. In this, we have used the four different no. of nodes 50, 60, 70 and 80, and then we count the average value of all four parameters with 10 iterations for those nodes. At last the proactive and reactive routing protocols parameters with their nodes have been compared.

*Table 5.2:* Comparison of simulation Results

| PARAMETERS | No. of Nodes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 50 | | 60 | | 70 | | 80 | |
| | AODV | ANT AODV | AODV | ANT AODV | AODV | ANT AODV | AODV | ANT AODV |
| Throughput | 58.83 | 78.72 | 62.42 | 79.88 | 46.73 | 88.84 | 37.18 | 80.68 |
| End-to-End Delay | 0.133 | 0.064 | 0.124 | 0.049 | 0.151 | 0.064 | 0.110 | 0.052 |
| Bit Error Rate | 0.763 | 1.044 | 0.808 | 3.984 | 0.499 | 1.003 | 0.867 | 1.133 |
| Packet Delivery Ratio | 51.48 | 86.69 | 53.39 | 66.46 | 41.94 | 76.47 | 38.27 | 75.06 |

For throughput on 50, 60, 70 and 80 no. of nodes the AODV performs 25%, 21%, 47% and 53% better results than the ANT BASED AODV Overall gives 36% improved results.

For end-to-end delay on 50, 60, 70 and 80 no. of nodes the AODV shows 51%, 60%, 57% and 52% better results than AODV. Overall ANT BASED AODV shows 50% better performance.

For Bit error rate on 50, 60, 70 and 80 no. of nodes the ANT BASED AODV shows 51%, 60%, 57% and 52% better results than AODV. Overall ANT BASED AODV shows 50% better performance. So AODV has high bit error rate.

For packet delivery ratio on 50, 60, 70 and 80 no. of nodes the ANT BASED AODV shows 41%, 19%, 45% and 49% better performance than AODV. The ANT BASED AODV deliver packets 34% faster.

## VI. Conclusion and Future Enhancement

Node Misbehavior in MANET a serious issue in Mobile Ad-hoc Network. In the issue produce communication delay in Packet Delivery Rate, Throughput, and Overhead. We have investigated the performance degradation of the network because of a misbehaving node in MANET.

The AODV protocol with the Ant Optimization is used to detect the misbehaving node. The 2ACK scheme provides the detecting mechanism of misbehavior node from sender to receiver. The 2 ACK scheme tagged on the misbehaved node in the network. The receiver module identifies the 2 ACK has been tagged packet for retransmission. The retransmission has been performed in ACO optimized routing path. So the ACO Based AODV protocol performing better than AODV.

We have investigated the performance degradation caused by such misbehaving nodes in MANETs. We have analyzed and evaluated a technique, termed ACO, to detect and mitigate the effect of such routing misbehavior. We intend to simulate and analyze the effect of the attack in other routing protocols and can use ACO for better path detection with max-min optimization. In feature misbehaving node recovery with other optimization technique to be performed. There are many more other optimization techniques which perform better in future.

## References Références Referencias


1. Farid Bin Beshr, Ahmed Bin Ishaq, Saeed Aljabri, and Tarek R. Sheltami, "A Guard Node (GN) based Technique against Misbehaving Nodes in MANET", Journal of Ubiquitous Systems & Pervasive Networks Volume 7, No. 1 2016 pp. 13-17.
2. Chinthanai Chelvan.K, Sangeetha.T, Prabakaran.V, Saravanan.D, "EAACK-A Secure Intrusion Detection System for MANET", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, Issue 4, April 2014.
3. A Al-Roubaiey, T. Sheltami†, A. Mahmoud, E. Shakshuki, H. Mouftah, "AACK: Adaptive Acknowledgment Intrusion Detection for MANET with Node Detection Enhancement", 24th IEEE International Conference on Advanced Information Networking and Applications, 2010.
4. P.Nandhini Sri, D.Karthikeyan, "Improving The Performance of Selfish Node Detection Using Watchdog Method in Manet" ,International Journal of Innovative Research in Technology, Science & Engineering (IJIRTSE), Volume – 2, Issue – 2. February 2016.
5. Usha Sakthivel and S. Radha," Misbehaving Node Detection in Mobile Ad Hoc Networks using Multi Hop Acknowledgement Scheme", Journal of Computer Science, 2011.
6. Kashyap Balakrishnan, Jing Deng, Pramod K. Varshney, "TWOACK: Preventing Selfishness in Mobile Ad-Hoc Networks", IEEE-2005
7. Suganya.N.R, Madhu.S Priya, "Detecting Selfish Nodes in a MANET through Fragmentation in Distributed Environment", International Journal of Science, Engineering and Technology Research (IJSETR),Volume 2, No 6, June-2013.
8. Rasika Mali, Sudhir Bagade, "Techniques for Detection of Misbehaving Nodes in MANET: A Study", International Journal of Scientific & Engineering Research, Volume 6, Issue 8, August-2015.

This page is intentionally left blank

Global Journal of Computer Science and Technology: E Network, Web & Security
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# Secured Audio Signal Transmission in 5G Compatible mmWave Massive MIMO FBMC System with Implementation of Audio-to-Image Transformation Aided Encryption Scheme

By Jinia Rahman, Joarder Jafor Sadique, Md. Sarwar Hossain & Shaikh Enayet Ullah
*University of Rajshahi*

*Abstract-* In this paper, we have made comprehensive study for the performance evaluation of mmWave massive MIMO FBMC wireless communication system. The 16×256 large MIMO antenna configured simulated system under investigation incorporates three modern channel coding (Turbo, LDPC and (3, 2) SPC, higher order digital modulation (256-QAM)) and various signal detection (Q-Less QR, Lattice Reduction(LR) based Zero-forcing(ZF), Lattice Reduction (LR) based ZF-SIC and Complex-valued LLL(CLLL) algorithm implemented ZF-SIC) schemes. An audio to image conversion aided chaos-based physical layer security scheme has also been implemented in such study. On considering transmission of encrypted audio signal in a hostile fading channel, it is noticeable from MATLAB based simulation study that the LDPC Channel encoded system is very much robust and effective in retrieving color image under utilization of Lattice Reduction(LR) based ZF-SIC signal detection and 16- QAM digital modulation techniques.

*Keywords: MIMO-FBMC, chaos-based physical layer security, digital precoding, mmwave geometrical channel, SNR.*

*GJCST-E Classification: C.2.1, D.4.4*


*Strictly as per the compliance and regulations of:*

# Secured Audio Signal Transmission in 5G Compatible mmWave Massive MIMO FBMC System with Implementation of Audio-to-Image Transformation Aided Encryption Scheme

Jinia Rahman [α], Joarder Jafor Sadique [σ], Md. Sarwar Hossain [ρ] & Shaikh Enayet Ullah [ω]

*Abstract-* In this paper, we have made comprehensive study for the performance evaluation of mmWave massive MIMO FBMC wireless communication system. The 16×256 large MIMO antenna configured simulated system under investigation incorporates three modern channel coding (Turbo, LDPC and (3, 2) SPC, higher order digital modulation (256-QAM)) and various signal detection (Q-Less QR, Lattice Reduction(LR) based Zero-forcing(ZF), Lattice Reduction (LR) based ZF-SIC and Complex-valued LLL(CLLL) algorithm implemented ZF-SIC) schemes. An audio to image conversion aided chaos-based physical layer security scheme has also been implemented in such study. On considering transmission of encrypted audio signal in a hostile fading channel, it is noticeable from MATLAB based simulation study that the LDPC Channel encoded system is very much robust and effective in retrieving color image under utilization of Lattice Reduction(LR) based ZF-SIC signal detection and 16-QAM digital modulation techniques.

*Keywords: MIMO-FBMC, chaos-based physical layer security, digital precoding, mmwave geometrical channel, SNR.*

## I. Introduction

In perspective of rapid increase in the number of subscribers of the existing cellular networks (WCDMA/CDMA 2000, HSPA$^+$ aided 3G through LTE-Advanced4G), it is being observed that nearly 50% of the traffic is based on video signal transmission. The commercially deployed 3.9G LTE and 4G LTE-Advanced wireless networks are trying to meet up explosive demand for high quality video through sharing with social media such as YouTube and ultra HD (UHD) and 3D video from mobile devices (e.g., android tablets, smart-phones etc.) [1]. In consideration of exponential growing demand on data rates of our existing wireless networks, we are giving emphasis on the designing and implementation of WWW(Wireless World Wide Web) supportable 5G technology implemented future generation/5G cellular system. The 5G system has not yet been standardized. The 5G mobile communications system is targeted at higher spectrum efficiency. Mobile Internet and IoT (Internet of Things) are the two main market drivers for 5G.There will be a massive number of use cases for Mobile Internet and IoT, such as augmented reality, virtual reality, remote computing, eHealth services, automotive driving and so on. All these use cases can be grouped into three usage scenarios, i.e., eMBB (Enhanced mobile broadband), mMTC (Massive machine type communications) and URLLC (Ultra-reliable and low latency communications)[2] In future 5G wireless networks., various modulation schemes such as Filter-bank Multicarrier(FBMC), Generalized Frequency Division Multiplexing, Bi-orthogonal Frequency Division Multiplexing(BFDM, a generalization of the classical CP-OFDM scheme capable of providing lower intercarrier interference (ICI) and lower ISI)., Universal Filtered Multicarrier (UFMC), Time-frequency Packing(TFP) are being considered for adoption. In FBMC, the transmission bandwidth can be exploited at full capacity using OQAM(Offset-QAM)[3] The Offset-QAM-based filter bank multicarrier (FBMC-OQAM) can be considered as a promising alternative to cyclic prefix-orthogonal frequency division multiplexing (CP-OFDM) for the future generation of wireless communication systems. The FBMC-OQAM provides more robustness to channel dispersion with respect to conventional CP-OFDM. The FBMC-OQAM does not require the use of acyclic prefix (CP) causing an increase in its spectral efficiency [4]

## II. Review of Related Works

A significant amount of research is being carried out in different academic institutions and industries on identification of key benefits of FBMC as 5G compatible radio interface technology and its effective implementation. In this paper, a brief idea on the works of few researchers is outlined In 2012, Şahin et. al at [5]reviewed and emphasized the key benefits of filter bank multicarrier (FBMC) technology

*Author α ω: Department of Applied Physics and Electronic Engineering, University of Rajshahi, Rajshahi, Bangladesh.*
*e-mails: jinia4944@gmail.com, enayet_apee@ru.ac.bd*
*Author σ : Department of Electronics and Telecommunication Engineering, Begum Rokeya University, Rangpur, Bangladesh.*
*e-mail: joarder@brur.ac.bd*
*Author ρ: Department of Information and Communication Engineering, Pabna University of Science and Technology, Bangladesh.*
*e-mail: sarwar.iceru@gmail.com*

and provided a comparative study of different FBMC prototype filter designs under practical channel environments. In 2014, Schellmannet.almadereviewing work on the waveform design of 4G (based on OFDM) and motivated the need for a redesign for 5G in consideration of rendering unfeasibility of OFDM with the advent of the Internet of Things (IoT) and moving to user-centric processing. The authors designed a new waveform called Universal Filtered Multi-Carrier (UFMC) collecting the advantages FBMC[6]. In 2015 at [7], Taheriet. alargued that channel estimation in FBMC was not a straightforward scheme as used in OFDM systems especially under multiple antenna scenarios. The authors proposed a channel estimation method which employed intrinsic interference pre-cancellation at the transmitter side. The outcome of their work showed that their method needed less pilot overhead as compared to the popular intrinsic approximation methods (IAM) in terms of better BER and MSE performance. At[8] in 2015, Bazziet. al mentioned that Vehicle-to-vehicle (V2V) communications was anticipated as one of key future services imposing challenging requirements on the air interface such as supporting high mobility and asynchronous multiple access. The authors discussed on the design and performance tradeoffs of two 5G targeted waveforms (filter bank multi-carrier with offset quadrature amplitude modulation (FBMC/OQAM) and filtered OFDM (FOFDM) with focusing specifically on V2V communications by utilizing a realistic geometry-based stochastic V2V channel model. They showed that FBMC/OQAM outperformed F-OFDM approaches in some severe V2V scenarios. In 2016 at[9], Weitkemperet.alconducted real hardware experiments to investigate the performance of three waveform families: CP-OFDM, filter bank multicarrier with offset quadrature amplitude modulation (FBMC/OQAM) and universal-filtered OFDM (UF-OFDM). FBMC/OQAM. The outcome of their experimental work ratified that the FBMC/OQAM had the benefit of very low side lobes leading to less inter-carrier interference in asynchronous and high mobility scenarios. At[10] in 2016, Gorganiet. al proposed a high-performance and flexible Peak-to-Average Power Ratio(PAPR) reduction algorithm for FBMC-OQAM signal model and showed that their proposed algorithm had no degradation as compared to OFDM. In 2017 at [11], Lizeagaet.alfocused on the lacking of robustness of the existing IEEE 802.11, IEEE 802.15.1 or IEEE 802.15.4 standard based industrial wireless communications in perspective of real-time requirements for factory automation. The authors analyzed FBMC-OQAM, GFDM-OQAM and WCP-COQAM modulation candidates for 5G in terms of bit error rate, power spectral density and spectral efficiency over highly dispersive channels and assessed the suitability of these modulation systems for industrial wireless communications based on cognitive radio. Additionally, they provided additional details on windowing that affecting the protection against highly dispersive multipath channels and the spectral efficiency in WCP-COQAM. In 2017 at [12], Wang et. al, demonstrated experimentally a digital mobile fronthaul (MFH) architecture using delta-sigma modulation both one-bit and two-bit) as the new digitization interface for transmission of digital signals over on-off keying (OOK) or 4-level pulse-amplitude-modulation (PAM4) optical intensity modulation-direct detection (IM-DD) links. The authors demanded that delta-sigma modulators were supportable of high-order modulations (256QAM/ 1024QAM) and such modulators were 5G compatible with filter-bank-multicarrier (FBMC) signals.

## III. Signal Processing and Detection Techniques

In this section, various signal processing and signal detection techniques have been outlined briefly.

*a) Massive MIMO Fading Channel Estimation*

In estimation of ray path geometry based 16×256 sized mmWave massive MIMO fading channel $\mathbf{H}_{\text{mmwave}}$, it is assumed that the $N_t$(=256) transmitting and $N_r$ (=16) receiving antennas are arranged in uniform linear array (ULA).Such MIMO channel has limited scattering with Lu (=6) scatterers. Each scatterer is assumed to contribute a single propagation path between the base station (BS) and mobile station (MS). The geometrical channel model $\mathbf{H}_{\text{mmwave}} \in C^{N_r \times N_t}$can be written as:

$$H_{mmwave} = \sqrt{\frac{N_t N_r}{\rho L_u} \sum_{l=1}^{L_u} \alpha_{u,l} a_{MS}(\theta_{u,l}) a^*{}_{BS}(\phi_{u,l})} \quad (1)$$

where, $\alpha_{u,l}$ is the complex gain of the lth path including the path loss, $\rho$ is the path loss between base station (BS) and mobile station (MS). The variable $\theta_{u,l}$ and $\phi_{u,l} \in [0,2\pi]$ are the lth path's angle of arrival and departure (AoAS/AoDs) respectively. Finally, $\mathbf{a}_{BS}(\phi_{u,l})$ and $\mathbf{a}_{MS}(\theta_{u,l})$ are the antenna array response vectors of the BS and MS respectively.

With available knowledge of the geometry of uniform linear antenna arrays, $a_{BS}(\phi_{u,l})$ is defined as:

$$a_{BS}(\phi_{u,l}) = \frac{1}{\sqrt{N_t}}[1, e^{j\frac{2\pi}{\lambda}d\sin(\phi_{u,l})}, \ldots\ldots\ldots e^{j(N_t-1)\frac{2\pi}{\lambda}d\sin(\phi_{u,l})}]^T \quad (2)$$

and

$$a_{MS}(\theta_{u,l}) = \frac{1}{\sqrt{N_r}}[1, e^{j\frac{2\pi}{\lambda}d\sin(\theta_{u,l})}, \ldots\ldots e^{j(N_r-1)\frac{2\pi}{\lambda}d\sin(\theta_{u,l})}]^T \quad (3)$$

where, $\lambda$ is the signal wavelength and d is the distance between two consecutive antenna elements.

The massive MIMO mmWave fading channel $H_{mmwave}$ is further normalized to get a modified form of fading channel matrix as:

$$\hat{H} = S \odot H_{mmwave} \quad (4)$$

where, $\odot$ is indicative of Hadamard product, S is the 16×256 sized matrix whose each element is inverse of magnitude of each complex element of $H_{mmwave}$. The squared value of the Frobenius norm of the normalized channel matrix $\hat{H}$ is given by[13, 14]

$$[\|\hat{H}_F\|^2] = N_t N_r \quad (5)$$

*b) Digital Precoding*

Digital precoding is generally used to control both the phases and amplitudes of the original signals to cancel interferences in advance. In consideration of designing digital precoding for single-user mmWave massive MIMO system, it is assumed that the base station (BS) employs $N_t$ antennas to simultaneously transmit $N_r$ data streams to a user with $N_r$ antennas ($N_r < N_t$). The BS applies an $N_t \times N_r$ digital precoder D and the transmitted signal prior to D/A conversion can be presented by-

$$x = Ds \quad (6)$$

where, s is the $N_r \times 1$ original signal vector before precoding with normalized power as $E(ss^H) = (1/N_r)I_{Nr}$, To meet up the total transmit power, D satisfies

$$\|D\|_F^2 = trace(DD^T) = N_r \quad (7)$$

In terms of geometrical channel presented in Equation (4), the digital precoder is given by[15]

$$D = \sqrt{\frac{N_r}{tr(FF^H)}}F \quad (8)$$

where, $F = \hat{H}^H$

*c) Lattice Reduction(LR) based Zero-forcing(ZF) Detection*

In our16×256 simulated system, the received signal in terms of transmitted signal, fading channel H and white Gaussian noise n with a variance $\sigma_n^2$ can be written as:

$$Y = \hat{H}Ds = Hs + n \quad (9)$$

where, $H = \hat{H}D$ is the 16×16 sized equivalent channel matrix. In LR based ZF signal detection scheme, the equivalent channel matrix H is considered to be consisted of 16×16 sized lattice reduced orthogonal matrix **G** and a 16×16 sized unimodular matrix **U** such that

$$H = GU \quad (10)$$

The unimodular matrix U is estimated using the following relation:

$$U = \overline{H}H^T \quad (11)$$

where, the matrix $\overline{H}$ is the Moore-Penrose pseudo-inverse of matrix H and $(.)^T$ is indicative of Hermitian transpose in all cases as presented in this paper.
The equation (10) can be rewritten as:

$$U^T G = H^T \quad (12)$$

From equation (12), the orthogonal matrix G can be estimated as:

$$G = (U^T)^{-1}H^T \quad (13)$$

The LR-based ZF signal detection linear filter, $W^H$ can be written in terms of orthogonal matrix **G** as:

$$W^T = (G^T G)^{-1}G^T \quad (14)$$

Equation(9) can be rewritten as

$$Y = GUs + n = Gc + n \quad (15)$$

where, $c = Us$, Multiplying equation (15) by $G^T$

$$G^T Y = G^T Gc + G^T n \quad (16)$$

Neglecting noise contribution to expected signal from equation (16), we can write:

$$\tilde{c} = (G^T G)^{-1}G^T Y = W^T Y \quad (17)$$

The estimated transmitted signal can be written as:

$$\tilde{s} = U^{-1}\tilde{c} = U^{-1}W^{T}Y \quad (18)$$

*d) Lattice Reduction(LR) based ZF-SIC Detection*

In LR based Zero-forcing Successive interference cancellation (ZF-SIC) signal detection scheme, the lattice reduced orthogonal matrix **G** is QR factorized as:

$$G=QR \quad (19)$$

where, **Q** is the 16×16 sized unitary and **R** is the 16×16 sized upper triangular matrix . Premultiplying $Q^{H}$ to **Y** in Equation (15), we have

$$Q^{T}Y=Q^{T}Gc+Q^{T}n=Q^{T}QRUs+Q^{T}n=RUs+Q^{T}n=\overline{R}s+Q^{T}n \quad (20)$$

where, $\overline{R}=RU$, neglecting noise contribution to expected signal from equation (20), the estimated transmitted signal can be written as[16,17]:

$$\tilde{\tilde{s}} = (\overline{R}^{T}\overline{R})^{-1}\overline{R}^{T}Q^{T}Y \quad (21)$$

*e) Complex-valued LLL(CLLL) Algorithm implemented ZF-SIC Detection*

In complex-valued Lenstra–Lenstra–LovKasz (LLL) algorithm implemented ZF-SIC signal detection scheme, the CLLL-reduced orthogonal matrix $\tilde{H}$ is estimated using the CLLL reduction algorithm. In such case, the matrix $\tilde{H}$ is QR factorized as:

$$\tilde{H} = \tilde{Q}\tilde{R} \quad (22)$$

The equation (22) satisfies the following two conditions:

$$|\Re[\tilde{R}_{i,k}]| \le \frac{1}{2}|\Re[\tilde{R}_{i,i}]|, |\Im[\tilde{R}_{i,k}]| \le \frac{1}{2}|\Re[\tilde{R}_{i,i}]|, \forall i < k,$$

$$\delta|\tilde{R}_{i-1,i-1}|^{2} \le |\tilde{R}_{i,i}|^{2} + |\tilde{R}_{i-1,i}|^{2}, \forall i \in [2,N], \quad (23)$$

where, $\delta$ is arbitrary chosen from $(\frac{1}{2},1)^{2}$ and $\tilde{R}_{i,k}$ is the (i, k)th entry of $\tilde{R}$ .

The detailed pseudo-code of the CLLL algorithm has been presented in Table I. In table 1, $(\alpha)^{*}$ is indicative of complex conjugate value of $\alpha$. As the equivalent fading channel matrix H 16×16 sized, the value of N considered in Equation(23) is 16 and the value of $\delta$ has been considered to 0.75. A comprehensive MATLAB source code for estimating CLLL-reduced orthogonal matrix $\tilde{H}$ and complex-valued unimodular matrix T with assumption of a typically assumed 16×16 sized channel matrix is presented in the Appendix.

*Table 1:* Complex LLL Alogorithm (Using MATLAB Notation)

**Input: H; Output: $\tilde{Q}, \tilde{R}$ , T**

(1) $[\tilde{Q},\tilde{R}]$ = QR Decomposition (H) ;
(2) $\delta \in (\frac{1}{2}, 1)$ ;
(3) m = size ( H , 2 ) ;
(4) $T=I_m$ ;
(5) k =2 ;
(6) while $k \leq m$
(7) for n=k-1: -1 : 1
(8) u= round ($(\tilde{R}(n, k) / \tilde{R}(n, n))$) ;
(9) if u ~= 0
(10) $\tilde{R}(1:n, k) = \tilde{R}(1:n, k) - u \cdot \tilde{R}(1:n, n)$ ;
(11) $T(:, k) = T(:, k) - u \cdot T(:, n)$ ;
(12) end
(13) end
(14) if $\delta |\tilde{R}(k-1, k-1)|^2 > |\tilde{R}(k, k)|^2 + |\tilde{R}(k-1, k)|^2$
(15) Swap the (k-1)th and kth columns in $\tilde{R}$ and T
(16) $\Theta=\begin{bmatrix} \alpha^* & \beta \\ -\beta & \alpha \end{bmatrix}$ where $\alpha = \frac{\tilde{R}(k-1,k-1)}{||\tilde{R}(k-1:k,k-1)||}$ ;

$$\beta = \frac{\tilde{R}(k,k-1)}{||\tilde{R}(k-1:k,k-1)||} \ ;$$

(17) $\tilde{R}(k-1:k, k-1:m) = \Theta \tilde{R}(k-1:k, k-1:m)$ ;
(18) $\tilde{Q}(:, k-1:k) = \tilde{Q}(:, k-1:k)\Theta^H$ ;
(19) $k = \max(k-1, 2)$;
(20) *else*
(21) k = k + 1 ;
(22) end
(23) end

The estimated CLLL reduced orthogonal matrix $\tilde{H}$ can be written in terms of estimated complex-valued unimodular matrix T and equivalent fading channel matrix H in different form as[18]:

$$\tilde{H} = HT \tag{24}$$

Equation (24) can be written as:

$$T^T H = \tilde{H}^T \tag{25}$$

From Equation (25),equivalent fading channel matrix H can be written in terms of CLLL reduced orthogonal matrix and complex-valued unimodular matrix as:

$$H = (T^T)^{-1} \tilde{H}^T \tag{26}$$

Equation (9) can be rewritten in case of CLLL algorithm implemented ZF-SIC signal detection scheme as:

$$Y = (T^T)^{-1} \tilde{H}^T s + n = G_1 s + n \tag{27}$$

where, $G_1 = (T^T)^{-1} \tilde{H}^T$ , the matrix $G_1$ is QR factorized as:

$$G_1 = Q_1 R_1 \tag{28}$$

Premultiplying $Q_1^H$ to Yin Equation (27), we have

$$Q_1^T Y = Q_1^T Q_1 R_1 s + Q_1^T n = R_1 s + Q_1 n \tag{29}$$

Neglecting noise contribution to expected signal from equation (29), the estimated transmitted signal can be written as:

$$\tilde{\tilde{s}} = (R_1^T R_1)^{-1} R_1^T Q_1^T Y \tag{30}$$

*f) Q-Less QR Decomposition Scheme*

With Q-less QR Decomposition scheme, the detected signal $\tilde{\mathbf{x}}$ can be found based on the least squares approximate solution to $\tilde{\mathbf{H}} * \tilde{\mathbf{x}} = \tilde{\mathbf{y}}$ where, $\tilde{\mathbf{H}}$ and $\tilde{\mathbf{y}}$ are the channel matrix and received signal respectively. From $\tilde{\mathbf{H}}$ channel matrix, an upper triangular matrix $\tilde{\mathbf{R}}$ of the same dimension as $\tilde{\mathbf{H}}$ is estimated and using the following steps, the detected desired signal $\tilde{\mathbf{x}}$ is computed[19] .

$$\begin{aligned}\tilde{\mathbf{x}} &= \tilde{\mathbf{R}} \setminus (\tilde{\mathbf{R}}^{\mathbf{H}} \setminus (\tilde{\mathbf{H}}^{\mathbf{H}} * \tilde{\mathbf{y}}))\\ \tilde{\mathbf{r}} &= \tilde{\mathbf{y}} - \tilde{\mathbf{H}} * \tilde{\mathbf{x}}\\ \tilde{\mathbf{e}} &= \tilde{\mathbf{R}} \setminus (\tilde{\mathbf{R}}^{\mathbf{H}} \setminus (\tilde{\mathbf{H}}^{\mathbf{H}} * \tilde{\mathbf{r}}))\\ \tilde{\mathbf{x}} &= \tilde{\mathbf{x}} + \tilde{\mathbf{e}}\end{aligned} \quad (31)$$

*g) Turbo Channel Coding*

In Turbo channel coding technique, two recursive systematic convolutional (RSC) encoders separated by an interleaver are concatenated in parallel. The turbo encoder produces three code bits for every input bit viz., its coding rate is $1/3$. To avoid excessive decoding complexity and code generator polynomials of 13 and 15 in octal numbering system, the turbo channel encoder has a short constraint length of 4 of its RSC encoders. The number of memory elements of each RSC encoder is 3.The turbo encoded binarydata are iteratively decoded using MAP decoding scheme. In such scheme, log likelihood ratio(LLR) for maximizing a posteriori probability (APP) are computed iteratively. In turbo encoding, it is assumed that $\bar{\mathbf{C}} = \mathbf{C}_0, \mathbf{C}_1, \mathbf{C}_2, \mathbf{C}_3 \ldots\ldots\ldots\ldots \mathbf{C}_{N-1}$ is a coded sequence produced by the $1/2$- rated RSC encoder and $\bar{\mathbf{r}} = \mathbf{r}_0, \mathbf{r}_1, \mathbf{r}_2, \mathbf{r}_3 \ldots\ldots\ldots\ldots \mathbf{r}_{N-1}$ is a noisy received sequence where the code-word is $\mathbf{c}_k = \left(\mathbf{c}_k^{(1)}\ \mathbf{c}_k^{(2)}\right)$ with the first bit being the message bit and the second bit being the punctured parity bit. The corresponding received word is

$$\mathbf{r}_k = \left(\mathbf{r}_k^{(1)}\ \mathbf{r}_k^{(2)}\right)$$

The coded bit 0/1 is converted to a value +1/-1. The maximum a posteriori(MAP) decoding is carried out as:

$$\mathbf{c}_k(1) = \left\{\begin{array}{l} +1, \text{if } P(\mathbf{c}_k(1) = +1 \mid \bar{\mathbf{r}}) \geq P(\mathbf{c}_k(1) = -1 \mid \bar{\mathbf{r}}) \\ -1, \text{if } P(\mathbf{c}_k(1) = +1 \mid \bar{\mathbf{r}}) < P(\mathbf{c}_k(1) = -1 \mid \bar{\mathbf{r}}) \end{array}\right\} \quad (32)$$
$$\mathbf{k} = 0,1,2.. \ldots N-1$$

A posteriorilog likelihood ratio(LLR) of $\mathbf{c}_k^{(1)}$ is given by

$$\mathbf{L}\left(\mathbf{c}_k^{(1)}\right) \triangleq \ln\left[\frac{P(\mathbf{c}_k^{(1)} = +1 \mid \bar{\mathbf{r}})}{P(\mathbf{c}_k^{(1)} = -1 \mid \bar{\mathbf{r}})}\right] \quad (33)$$

The MAP decoding rule in Equation (26) can be presented alternatively as:

$$\mathbf{c}_k(1) = \mathbf{sign}\left[\mathbf{L}(\mathbf{c}_k(1) \mid \bar{\mathbf{r}})\right] \quad (34)$$

The magnitude of LLR, $|\mathbf{L}(\mathbf{c}_k(1) \mid \bar{\mathbf{r}})|$ measures the likelihood of $c_k(1) = +1$ or $c_k(1) = -1$. The LLR can be expressed as a function of the probability $\mathbf{P}(\mathbf{c}_k(1) = +1 \mid \bar{\mathbf{r}})$[20,21]

$$\begin{aligned}\mathbf{L}\left(\mathbf{c}_k^{(1)}\right) &= \ln\left[\frac{P(\mathbf{c}_k^{(1)} = +1 \mid \bar{\mathbf{r}})}{P(\mathbf{c}_k^{(1)} = -1 \mid \bar{\mathbf{r}})}\right]\\ &= \ln\left[\frac{P(\mathbf{c}_k^{(1)} = +1 \mid \bar{\mathbf{r}})}{1 - P(\mathbf{c}_k^{(1)} = +1 \mid \bar{\mathbf{r}})}\right]\end{aligned} \quad (35)$$

*h) Low-density parity check (LDPC)*

Low-density parity check (LDPC)is an emerging new technique that gets even more closer to Shannon rate with long code words. LDPC codes are linear block codes showing good block error correcting capability and linear decoding complexity in time. A (n, k) LDPC encoder operates on an m ×nsized$H_1$ matrix where m = n-k. It is low density because the number of 1s in each row $w_r$is « *m* and the number of *1s* in each column $w_c$is « *n*. A LDPC is regular if $w_c$is constant for every column and $w_r = w_c(n/m)$ is also constant for every row. Otherwise it is irregular. In LDPC encoding, the codeword ($c_0$, $c_1$, $c_2$, $c_3$, …,$c_n$) consists of the message bits ($m_0$, $m_1$, $m_2$,...,$m_k$) and some parity check bits and the equations are derived from $H_1$ matrix in order to generate parity check bits. The solution in solving the parity check equations can be written as:

$$H_1 c^T = 0 \quad (36)$$

where such mathematical manipulation can be performed with a generator matrix $G_1$. $G_1$ is found from $H_1$ with Gaussian elimination which can be written as follows:

$$H_1 = [P^T : I] \quad (37)$$

And $G_1$ is

$$G_1 = [I : P \quad (38)$$

Hence, ccodeword is found for message word *x* as follows $c = xG_1 = [x : xP]$.

The graphical representation for a typical (8, 4) LPDC encoding is shown in Fig. 1. The graphical representation utilizes variable nodes (*v*-nodes) and check nodes (*c*-nodes). The graph has four*c*-nodes and eight*v*-nodes. The check node $f_i$is connected to $c_i$if $h_{ij}$of $H_1$ is a 1. This is important to understand the decoding. Decoding tries to solve the (n-k) parity check equations of the $H_1$ matrix. There are several algorithms defined to date and the most common ones are message passing algorithm, belief propagation algorithm and sum–product algorithm [20]. In this paper, we have employed sum-product decoding algorithm as presented in [21].

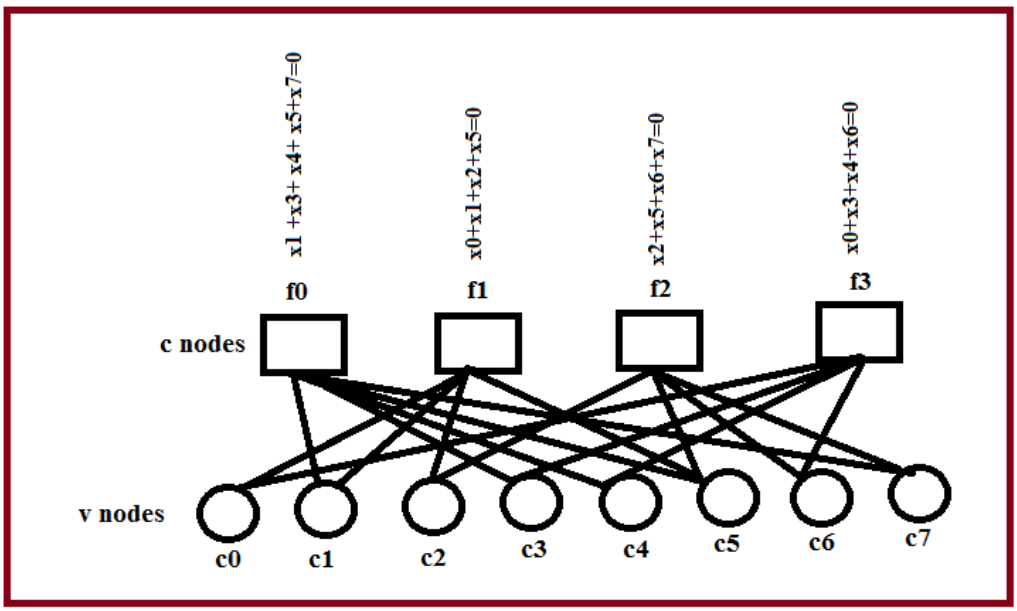



*Figure 1:* Graphical representation of a (8, 4) LDPC code

*i) (3, 2) SPC Channel Coding*

In SPC channel coding, the transmitted binary bits are rearranged into very small code words consisting of merely two consecutive bits. In such coding, (3, 2) SPC code is used with addition of a single parity bit to the message u = [u0, u1] so that the elements of the resulting code word x = [x0, x1, x2] are given by x0 = u0, x1 = u1 and x2 = u0 ⊞u1 [22].
where, ⊞ denotes the sum over GF (2)

## IV. Audio to Image Conversion Aided Encryption

In audio to image conversion aided chaos-based cryptosystem, Henon, a two-dimensional discrete chaotic map has been used to implement different equations of the Lorenz system as:

$$x_{i+1} = y_{i+1} - \alpha 1\, x_i \quad (39)$$
$$y_{i+1} = \beta 1\, x_i \ .$$

where, initial parameters are $\alpha 1$ , $\beta 1$ and the initial point is $(x_0, y_0)$. Each point $(x_n, y_n)$ is mapped to a new point $(x_{n+1}, y_{n+1})$ through the Henon map under consideration of $\alpha 1 = 1.4, \beta 1 = 0.3$ and $x_0 = y_0 = 0.1$.A segment of considered audio signal has 30,000 samples which on 8-bit A/D conversion provides $100 \times 100 \times 3$ integer values with each value ranging from 0-255. The plain color image is generated from the audio signal and it is $100 \times 100 \times 3$ pixel sized. Both the plain color image and the secret color images are the same in height and width. For processing of each red(R), green(G) and blue(B) components of created plane image, the minimum iterations of Henon map is $m^2 (= 100 \times 100)$.As first few iterations seem fairly close together, therefore, the total number of iterations is $m^2 + 100$ with discarding first 100 points to achieve higher randomness. The 2-D pixel distribution of each R,G,B components of plane image are resized into 10000 pixels. Another auxiliary color image of identical pixel size can be generated using the following relation:

$$\begin{aligned} pixXR_i &= abs(\lfloor x_{100+i} \times \gamma 1 \rfloor) \mod 256, \quad i=1,\ldots\ldots,m^2 \\ pixXG_i &= abs(\lfloor x_{100+i} \times \gamma 2 \rfloor) \mod 256, \quad i=1,\ldots\ldots,m^2 \\ pixXB_i &= abs(\lfloor x_{100+i} \times \gamma 3 \rfloor) \mod 256, \quad i=1,\ldots\ldots,m^2 \end{aligned} \tag{40}$$

where, $pixXR_i$, $pixXG_i$ and $pixXB_i$ are the pixel values and $\gamma 1=12345678, \gamma 2=23456789$ and $\gamma 3=34567891$ are the setting values of the R, G and B components of the auxiliary color image respectively.

On reshaping pixel values presented in Equation(34) from 1-D to 2D form, we can write,

$$\begin{aligned} secImgXR &= reshape\ (pixXR, m, m) \\ secImgXG &= reshape\ (pixXG, m, m) \\ secImgXB &= reshape\ (pixXB, m, m) \end{aligned} \tag{41}$$

If $pixR_i$, $pixG_i$ and $pixB_i$ with $i=1,\ldots\ldots,m^2$ are considered to be pixel values of the R, G and B components of the plane color image , we can write,

$$\begin{aligned} secImgR &= reshape\ (pixR, m, m) \\ secImgG &= reshape\ (pixG, m, m) \\ secImgB &= reshape\ (pixB, m, m) \end{aligned} \tag{42}$$

Finally, encrypted image is generated from a combination of selective components of Equation(35) and (36) by performing the bitwise XOR operation on the corresponding pixels as described by Equation(37)[23].

$$\begin{aligned} secImgRenc &= xor(secImgXR, secImgR)\ . \\ secImgGenc &= xor(secImgXG, secImgG)\ . \\ secImgBenc &= xor(secImgXB, secImgB)\ . \end{aligned} \tag{43}$$

## V. FBMC Signal Model and Description of Simulated System

We assume that our simulated5G compatible mmWave massive MIMO FBMC system depicted in Figure 2consists of 1024subcarriers with subcarrier spacing 1/T, where T is the interval between the two consecutive digitally modulated complex-valued symbols in time. Each complex-valued digitally modulated symbol is partitioned into its real-valued in phase and quadrature component symbol(sample). The real valued symbol at the frequency-time index (n; m) is denoted by $d_{n,m}$, where nis the frequency/sub channel index and m is the time index. The transmitted signals are organized in the form of FBMC bursts/ transmission frames with each of them is of N×M sized, where M is the number of real symbol slots per each FBMC burst. The mathematical formula describing the transmit signal in discrete form, s[k] for a FBMC burst can be written as:

$$\begin{aligned} s[k] &= \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} \hat{d}_{n,m}\, g_{n,m}[k] \\ &= \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} d_{n,m}\, g[k - m\frac{M_\Delta}{2}].\exp[j(n+m)\frac{\pi}{2}].\exp(j2\pi nN_\Delta(k - m\frac{M_\Delta}{2})] \\ &= \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} d_{n,m}\, g[k - m\frac{M_\Delta}{2}].\exp[j(n+m)\frac{\pi}{2}].\exp(j2\pi nN_\Delta k).\exp(-j2\pi nN_\Delta m\frac{M_\Delta}{2})] \\ &= \sum_{n=0}^{N-1}\sum_{m=0}^{M-1} d_{n,m}\, g[k - m\frac{M_\Delta}{2}].\exp[j(n+m)\frac{\pi}{2}].\exp(j2\pi nN_\Delta k) \end{aligned} \tag{44}$$

where, $M_\Delta$ is the time distance between the consecutive pulses (in samples), $N_\Delta$ is the frequency distance between the adjacent sample pulses(1/(total number of samples in N subcarriers),viz. $N_\Delta = \frac{1}{N}$ for discrete representationof the signal spectra), k=0,1,2…..NM-1, $g[k - m\frac{M_\Delta}{2}]$is the delayed impulse response of prototype filter, the phase value $\exp(-j2\pi nN_\Delta m\frac{M_\Delta}{2})]$ in s[k] is neglected customarily, the component $\exp[j(n+m)\frac{\pi}{2}]$ gives the value of ±1 for even values of (n+m) and ±j for odd values of (n+m).the component $\exp[j(n+m)\frac{\pi}{2}]$ alternates real and imaginary between adjacent subcarriers and symbols[24]. In Figure2, a segment of audio signal is considered to have been converted into

chaos based encrypted RGB color image with 100 pixels in width and 100 pixels in height. The pixel integer values of its respective three Red, Green and Blue components are converted into 8 bits binary form,

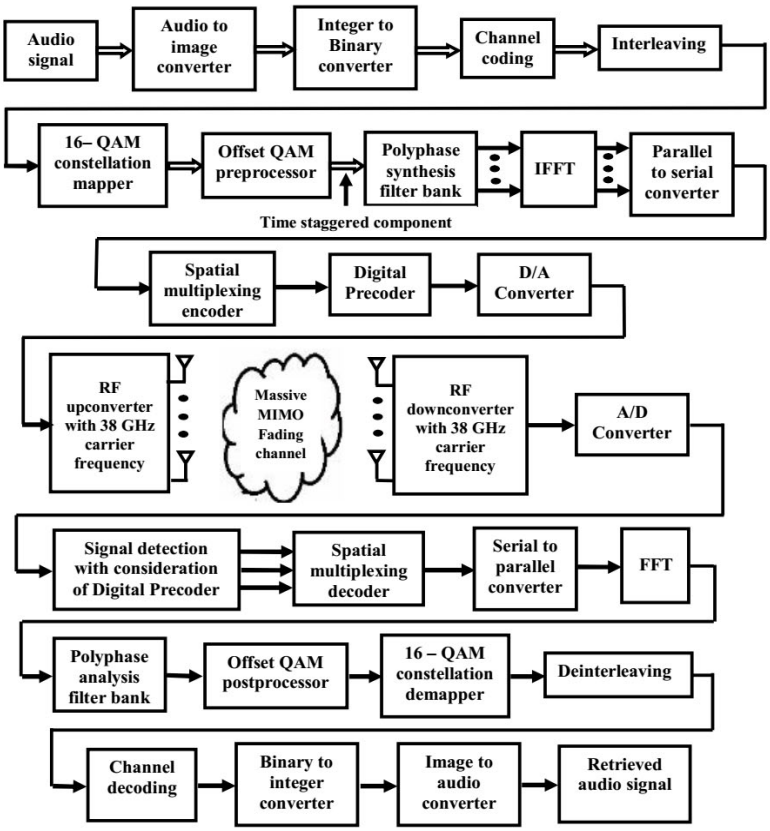



*Figure 2:* Block diagram of 5G compatible mm Wave massive MIMO FBMC wireless communication system

imaginary parts of each complex-valued symbol are separated to form two new symbols in Offset QAM(OQAM) preprocessing section. The time duration of each Offset QAM symbol is half of the time duration of QAM symbol. In one time index, a FBMC symbol consists of 1024 Offset QAM symbols operated independently on each of the 1024 subcarriers. A low pass prototype filter of coefficient length 4096 is considered with overlapping factor of 4 and it spans four FBMC symbols. The low pass prototype filter is decomposed into 1024 band pass polyphase filters assigned for each subcarrier with each sub and polyphase filter consisting of four real valued filter coefficients. Prior to multicarrier modulation in IFFT section, each FBMC symbol consisting of 1024 Offset QAM symbols are synthesized with polyphase synthesis filter bank. The filtered signals are parallel to serially converted and fed into spatial multiplexing encoder and eventually they are fed into digital precoder. Then the digitally precoded data streams are RF up converted with 38 GHz carrier frequency and transmitted from each of the transmitted antennas through massive MIMO fading channel. In receiving section, the transmitted signals are RF down converted and subsequently processed for signal detection based on considered previously designed digital precoder at the transmitter. The detected signal are subsequently processed in spatial multiplexing decoder, serial to parallel converter, multicarrier demodulation in FFT section and filtered in polyphase analysis filter bank. In Offset QAM post processing section, the in phase and quadrature components are combined and digitally demodulated/demapped, de interleaved, channel decoded, binary to integer converted, decrypted and eventually transmitted audio signal is retrieved.

## VI. Result and Discussion

In this section, simulation results using MATLAB R2017 are presented to illustrate the significant impact of various types of signal detection and channel coding techniques on performance evaluation of a single-user digitally precoded5G compatible mmWave massive MIMO FBMC system in terms of bit error rate (BER) on encrypted audio signal transmission. It has been assumed that the channel state information (CSI) of the geometrically estimated mmWave large MIMO 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 with considering the following parameters presented in the Table 2.

*Table 2:* Simulation Parameters

| Data Type | Audio Signal |
|---|---|
| No of samples | 30,000 |
| Sampling frequency of audio signal | 48KHz |
| Carrier frequency | 28GHz |
| Encryption technique | Audio to image( size: 100×100×3 pixels) |
| Path loss constant | 3 |
| Path loss, dB for carrier frequency wavelength λ and transmitter-receiver distance , d | $-20\log_{10}(\lambda/4\pi d)$ |
| No of iteration used in LDPC decoding | 10 |
| Antenna configuration | 32 x 256 Large MIMO Channel |
| Channel Coding | LDPC, Turbo and (3,2)SPC |
| LDPC Channel decoding | Log-domain sum product |
| Digital Modulation | 16-QAM |
| Signal Detection Scheme | LR based linear detection, LR based ZF-SIC, CLLL based LR and Q-Less QR |
| SNR | 0 to 10 dB |
| Channel | AWGN and Rayleigh |

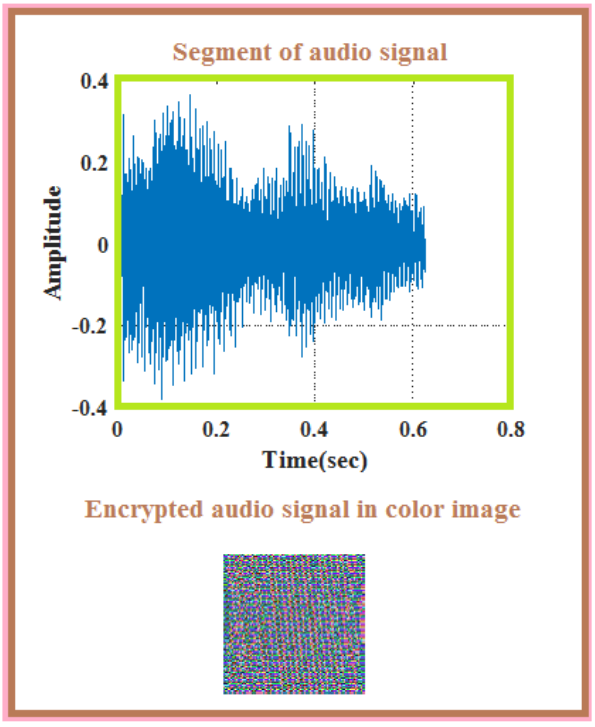



*Figure 3:* Conceptual graphical illustration showing the encryption of audio signal in non-understandable color image

Figure3 shows a segment of audio signal and the encryption of audio signal in non-understandable color image with 16-QAM digital modulation.

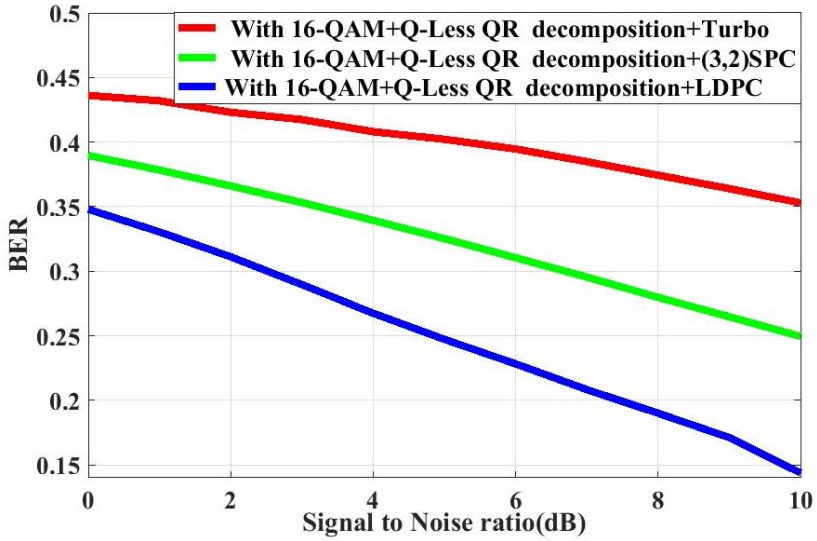



*Figure 4:* BER performance of secured5G compatible mmWave massive MIMO FBMC system with implementation of Q-Less QR signal detection, 16-QAM digital modulation and various channel coding schemes

The graphical illustrations presented in Figure 4 through Figure 7 manifest that the performance of the simulated system in terms of Bit error rate (BER) Vs. Signal to noise ratio(SNR) values at different scenario is clearly understandable and well defined. It is noticeable in Figure 4 that under consideration of implemented Q-Less QR signal detection technique, the estimated BER values are 0.4230, 0.366 and 0.3111 in case of Turbo, (3,2) SPC and LDPC channel coding schemes respectively for a typically assumed SNR value of 2 dB. In such specifically considered SNR value, system performance improvement of 1.330 dB and 0.706 dB are achieved in LDPC as compared to Turbo and (3,2) SPC channel coding techniques.

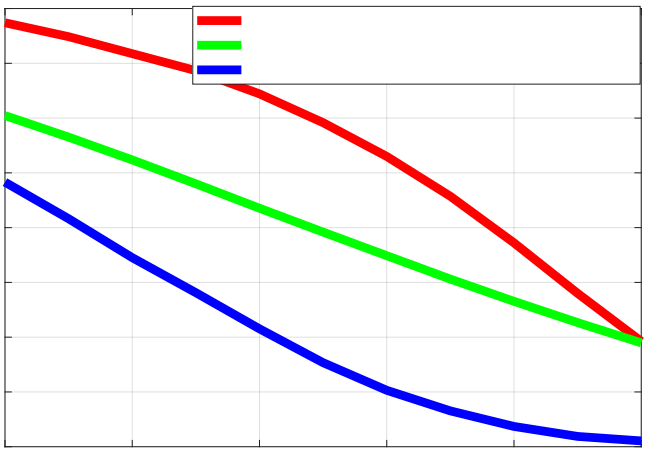


*Figure 5:* BER performance of secured 5G compatible mmWave massive MIMO FBMC system with implementation of CLLL aided Lattice Reduction signal detection, 16-QAM digital modulation and various channel coding schemes

Figure 5 show the impact of implementing CLLL aided Lattice Reduction signal detection technique on system performance. In such case, it is quite observable that at SNR value of 2dB,the estimated BERs are found to have values of 0.3588, 0.2618 and 0.1635 in case of Turbo, (3, 2) SPC and LDPC channel coding schemes respectively which are indicative of system performance improvement of 3.413 dB and 2.044 dB in LDPC as compared to Turbo and (3, 2) SPC channel coding techniques. At 20% BER, SNR gain of 6.7 dB and 3.9 dB are obtained in LDPC as compared to Turbo and (3, 2) SPC channel coding techniques.

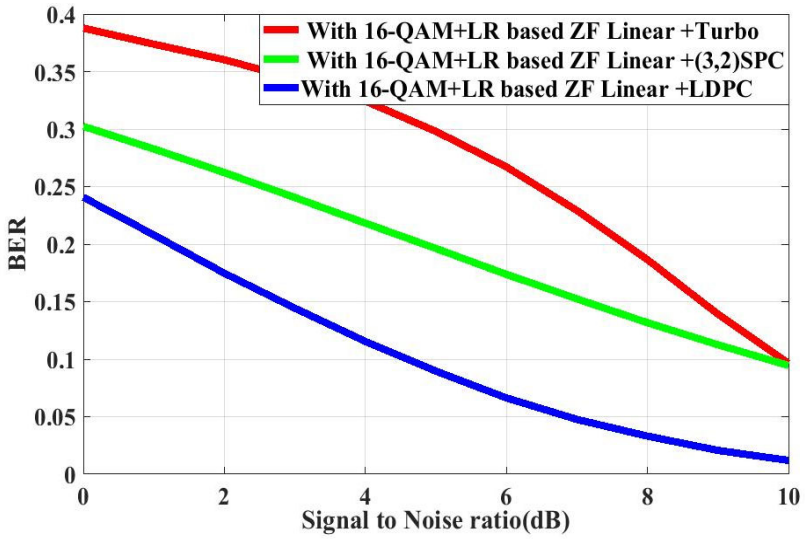



*Figure 6:* BER performance of secured 5G compatible mmWave massive MIMO FBMC system with implementation of LR based ZF linear signal detection, 16-QAM digital modulation and various channel coding schemes.

For identical consideration of SNR value(2dB) under scenario of LR based ZF linear signal detection, it is seen from Figure 6 that the estimated BER values are 0.3603, 0.2622 and 0.1747 in case of Turbo, (3,2) SPC and LDPC channel coding schemes respectively which ratify system performance improvement of 3.144 dB and 1.763 dB in LDPC as compared to Turbo and (3,2) SPC channel coding techniques. At 20% BER, SNR gain of 6.4 dB and 3.6 dB are obtained in LDPC as compared to Turbo and (3,2) SPC channel coding techniques.

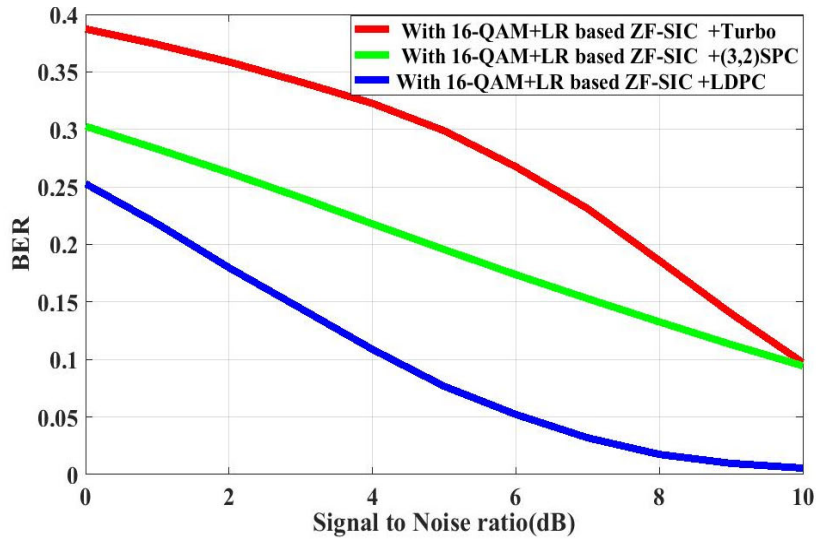



*Figure 7:* BER performance of secured 5G compatible mmWave massive MIMO FBMC system with implementation of LR based ZF-SIC signal detection, 16-QAM digital modulation and various channel coding schemes

Figure 7 represents characteristics features of the simulated system under implementation of LR based ZF-SIC signal detection technique. With previously considered SNR value, the estimated BER values are 0.3587, 0.2624 and 0.1798 in case of Turbo, (3,2) SPC and LDPC channel coding schemes respectively. In such situation, system performance improvement of 2.999 dB and 1.642 dB are achieved in LDPC as compared to Turbo and (3,2) SPC channel coding techniques. At 20% BER, SNR gain of 6.2 dB and 3.4 dB are obtained in LDPC as compared to Turbo and (3, 2) SPC channel coding techniques.

## VII. Conclusions

In this paper, the performance of single-user digitally precoded mmWave massive MIMO FBMC wireless communication system has been investigated on encrypted audio signal transmission under utilization of various modern channel coding and signal detection techniques. From the simulation results, it can be

concluded that the presently considered single-user digitally precoded mmWave massive MIMO FBMC wireless communication system shows satisfactory performance with lower order digital modulation under implementation of Lattice Reduction(LR) based ZF-SIC signal detection and LDPC Channel coding technique.

## Appendix

```
clear all;
close all;
H=(1/sqrt(2)).*[randn(16,16)+sqrt(-1)*randn(16,16)];%16×16 sized channel matrix
[Q,R] = qr(H);
delta= 0.75;
% T is unimodular matrix
T=diag(ones(1,16));%Initialization with consideration of 16×16 sized identity matrix
m = size(H, 2); %  m=16
rho = 2;
while rho <=m
for l = 1 :rho-1
mu = round((R(rho-l, rho)/R(rho-l, rho-l)));
if mu ~= 0
R(1:rho-l,rho)=R(1:rho-l,rho)-mu*R(1:rho-l,rho-l);
T(:, rho)= T(:,rho)-mu*T(:, rho-l);
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
first_term=delta*abs(R(rho-1,rho-1).^2);
second_term=abs(R(rho-1,rho).^2)+abs(R(rho,rho).^2);
if(first_term > second_term)
%Swap the (k-1) th and k th columns in R and T
bb=R(:,rho);
R(:,rho)=R(:,rho-1);
R(:,rho-1)=bb;
cc=T(:,rho);
T(:,rho)=T(:,rho-1);
T(:,rho-1)=cc;
alpha=(R(rho-1,rho-1))/normest(R(rho-1:rho,rho-1));
beta=(R(rho,rho-1))/normest(R(rho-1:rho,rho-1));
thetacut=[conj(alpha) beta ;-beta alpha];
R(rho-1:rho,rho-1:m) =thetacut*R(rho-1:rho,rho-1:m);
Q(:,rho-1: rho) = Q(:, rho-1:rho)*thetacut';
rho = max(rho-1,2);
else
rho=rho+1;
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Htilt=Q*R;% CLLL-reduced orthogonal matrix , Equation(22)
%T is the complex-valued  unimodular matrix
%Verification of Equation (24)
```

```
Htilt1=H*T;
%%%%%%%%%%%%%%%%%
Htilt(1:5,1:5)
Htilt1(1:5,1:5)
%%%%%%%%%%%%%%%%%%%%%%%%
```

## References Références Referencias


1. T. S. Rappaport, S. Sun, R. Mayzus, H. Zhao, Y. Azar, K. Wang, G. N. Wong, J. K. Schulz, M. K. Samimi, F. Gutierrez, 2013: Millimeter wave mobile communications for 5G cellular: It will work!, IEEE Access, vol. 1, pp. 335-349.
2. Wei Xiang, Kan Zheng and Xuemin (Sherman) Shen, 2017: 5G Mobile Communications, Springer International Publishing Company, Switzerland.
3. Fa-Long Luo and Charlie (Jianzhong) Zhang, 2016: Signal Processing for 5G Algorithms and Implementations, John Wiley & Sons, Ltd, United Kingdom.
4. François Rottenberg, Xavier Mestre, Dmitry Petrov, François Horlin and Jérôme Louveaux, 2017: Parallel Equalization Structure for MIMO FBMC-OQAM Systems under Strong Time and Frequency Selectivity, IEEE Transactions on Signal Processing, vol.65, no.17, pp. 4454 – 4467.
5. AlphanŞahin; İsmail Güvenç; Hüseyin Arslan, 2013: A comparative study of FBMC prototype filters in doubly dispersive channels, IEEE Globecom Workshop, pp. 197 – 203.
6. Malte Schellmann, Zhao Zhao, Hao Lin, Pierre Siohan, Nandana Rajatheva, Volker Luecken, and Aamir Ishaque, 2014: FBMC-based air interface for 5G mobile: Challenges and proposed solutions, 9th IEEE International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CROWNCOM), pp. 102 – 107.
7. Sohail Taheri, Mir Ghoraishi and Pei Xiao, 2015: Overhead reduced preamble-based channel estimation for MIMO-FBMC systems, IEEE International Wireless Communications and Mobile Computing Conference (IWCMC), pp. 1435 – 1439.
8. Jamal Bazzi, Katsutoshi Kusume, Petra Weitkemper, Keisuke Saito, Anass Benjebbour, Yoshihisa Kishiyama, 2015: Performance of multi-carrier waveforms in vehicle-to-vehicle communications, IEEE Vehicular Networking Conference (VNC), pp. 9 – 16
9. Petra Weitkemper, Johannes Koppenborg, Jamal Bazzi, Rupert Rheinschmitt, KatsutoshiKusume, DraganSamardzija, Rolf Fuchs and Anass Benjebbour, 2016: Hardware experiments on multi-carrier waveforms for 5G, IEEE Wireless Communications and Networking Conference (WCNC), pp. 270 – 275.
10. Saeed Afrasiabi-Gorgani and Gerhard Wunder, 2016: A Versatile PAPR Reduction Algorithm for 5G Waveforms with Guaranteed Performance, 20th IEEE International ITG Workshop on Smart Antennas (WSA 2016), pp.1-7
11. Aitor Lizeaga, Mikel Mendicute, Pedro Manuel Rodríguez and Iñaki Val, 2017: Evaluation of WCP-COQAM, GFDM-OQAM and FBMC-OQAM for industrial wireless communications with Cognitive Radio, IEEE International Workshop of Electronics, Control, Measurement, Signals and their Application to Mechatronics (ECMSM), pp.1-6.
12. Jing Wang, Zhenhua Yu, Kai Ying, Junwen Zhang, Feng Lu, Mu Xu, Lin Cheng, Xiaoli Ma and Gee-Kung Chang, 2017: Digital mobile fronthaul based on delta-sigma modulation for 32 LTE carrier aggregation and FBMC signals, IEEE/OSA Journal of Optical Communications and Networking, vol.9, no.2, pp: A233 - A244.
13. Ahmed Alkhateeb, Omar El Ayach, Geert Leus, and Robert W. Heath Jr, 2013: Hybrid Precoding for Millimeter Wave Cellular Systems with Partial Channel Knowledge, IEEE workshop on Information Theory and Applications (ITA), pp.1-5.
14. Weiheng Ni, Xiaodai Dong and Wu-Sheng Lu, 2015: Near-Optimal Hybrid Processing for Massive MIMO Systems via Matrix Decomposition, Cornell University Library pp.1-9, http://arxiv.org/abs/1504.03777
15. Shahid Mumtaz, Jonathan Rodriguez and Linglong Dai, 2017: mmWave Massive MIMO A Paradigm for 5G, Academic Press, an imprint of Elsevier Inc, United kingdom.
16. Lin Bai and Jinho Choi, 2012: Low Complexity MIMO Detection, Springer-Verlag New York, USA.
17. Ying Hung Gan, Cong Ling, and Wai Ho Mow, 2006: Complex Lattice Reduction Algorithm for Low-Complexity MIMO Detection, pp.1-9, https://arxiv.org/pdf/cs/0607078.pdf
18. Xiaoli Ma, and Wei Zhang, 2008: Performance Analysis for MIMO Systems with Lattice-Reduction Aided Linear Equalization, IEEE Transactions on Communications, vol. 56, no. 2.
19. Steven T. Karris, 2004: Numerical Analysis Using MATLAB and Spreadsheets, Second Edition, Orchard Publications, California, USA.
20. Mustafa Ergen, 2009: Mobile Broadband including WiMAX and LTE, Springer US, USA.

21. H. Futaki, and T. Ohtsuki, 2002: Low-Density Parity-Check (LDPC) Coded OFDM systems, IEEE International Conference on Communications, New York, USA.
22. Giorgio M. Vitetta, Desmond P. Taylor, Giulio Colavolpe, Fabrizio Pancaldi and Philippa A. Martin, 2013: Wireless Communications Algorithmic Techniques, John Wiley and Sons Ltd, United Kingdom.
23. Ali Soleymani, Md Jan Nordin, and Elankovan Sundararajan, 2014: A Chaotic Cryptosystem for Images Based on Henon and Arnold Cat Map, Hindawi Publishing Corporation, The Scientific World Journal, vol. 2014, Article ID 536930.
24. Hanna Bogucka, Adrian Kliks and Paŵe Kryszkiewicz, 2017: Advanced Multicarrier Technologies for Future Radio Communication 5G and Beyond, John Wiley & Sons, Inc, USA.

This page is intentionally left blank

Global Journal of Computer Science and Technology: E Network, Web & Security
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# Performance and Improvement of Various Antennas in Modern Wireless Communication System

By R. Sambasiva Nayak & Dr. R. P. Singh
*Sri Satya Sai University*

*Abstract-* Today, the importance of wireless communication is known around the world. To achieve better communication, many techniques and methods have been introduced. Among these techniques, intelligent / adaptive antennas are a hot topic in the field of research. Smart antennas consist of several antenna arrays and are able to optimize the radiation and reception of dynamically desired signals. In order to avoid or mitigate interference, smart antennas may also introduce zero values towards the receivers by adaptively updating the weights associated with each antenna element. Smart antennas can also improve reception quality and reduce missed calls. The various existing surveys are also discussed to identify the research deficit for the scope of future research.

*Keywords: wireless communication system, micro strip antenna, single-input, single-output, antenna diversity, multiple-input, multiple-output, multi-com with multiple antennas.*

*GJCST-E Classification:* C.2.1


*Strictly as per the compliance and regulations of:*

# Performance and Improvement of Various Antennas in Modern Wireless Communication System

R. Sambasiva Nayak [α] & Dr. R. P. Singh [σ]

*Abstract-* Today, the importance of wireless communication is known around the world. To achieve better communication, many techniques and methods have been introduced. Among these techniques, intelligent / adaptive antennas are a hot topic in the field of research. Smart antennas consist of several antenna arrays and are able to optimize the radiation and reception of dynamically desired signals. In order to avoid or mitigate interference, smart antennas may also introduce zero values towards the receivers by adaptively updating the weights associated with each antenna element. Smart antennas can also improve reception quality and reduce missed calls. The various existing surveys are also discussed to identify the research deficit for the scope of future research.

*Keywords: wireless communication system, micro strip antenna, single-input, single-output, antenna diversity, multiple-input, multiple-output, multi-com with multiple antennas.*

## I. Introduction

In the era of modern wireless communication systems, antennas capable of operating at broad frequency band range are increasingly demanded. Various antenna design which enable antennas with low profile, light weight, enhanced dual or wideband frequency capabilities have been developed and presented in the literature. However, such antennas mostly need a large size of ground plane or a via hole connection for feeding the signal which increases manufacturing difficulty and cost. Antennas are useful mode of communication in different fields; antennas are used to communicate in form of audio, video, graphically. As their importance in communication antennas are develop time to time according to the need. Antennas are design for different application of different materials, structures for better communication. They are design for radio, television, satellite, broadcasting, and cellular system etc., communications. It also considered essential in discovering the properties of the system where antennas are used. Different systems have different kinds of antennas employed to them. In some systems directional properties of the antennas are designed around by operational characteristics of the system, whereas the antennas are simply used to transmit electromagnetic energy in omnidirectional in some other systems or in some systems it could be used for point to point communication where increase gain and lessened wave impedance are require.

*Author α: Research Scholar, Department of Electronics & Communication Engineering, Sri Satya Sai University of Technology and Medical Science, Sehore, Bhopal, Madhya Pradesh, India.*
*e-mail: Sambanayak@gmail.Com*
*Author σ: Vice- Chancellor, Sri Satya Sai University of Technology & Medical Science, Sehore, Bhopal, Madhya Pradesh, India.*
*e-mail: Prof.rpsingh@gmail.Com*

## II. Performance and Improvement of Various Antennas

Much of the success or failure of a wireless product depends on the performance of the antenna. Too often, the antenna tends to be an afterthought and is added on towards the end of the design phase. A monopole antenna is a class of radio antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a ground plane. The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feedline is attached to the lower end of the monopole, and the other side is attached to the ground plane, which is often the Earth. This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna.

In terms of antenna performance, fractal shaped geometries are believed to result in multi-band characteristics and reduction of antenna size. Although the utility of different fractal geometries varies in these aspects, nevertheless they are primary motives for fractal antenna design. For example, monopole and dipole antennas using fractal Sierpinski gaskets have been widely reported and their multiband characteristics have been associated with the self-similarity of the geometry. However this qualitative explanation may not always be realized, especially with other fractal geometries. A quantitative link between multiband characteristics of the antenna and a mathematically expressible feature of the fractal geometry is needed for design optimization. To explore this, a Koch curve is chosen as a candidate geometry, primarily because its similarity dimension can be varied from 1 to 2 by changing a geometrical parameter (indentation angle).

Extensive numerical simulations presented here indicate that this variation has a direct impact on the primary resonant frequency of the antenna, its input resistance at this frequency, and the ratio of the first two resonant frequencies. In other words, these antenna features can now be quantitatively linked to the fractal dimension of the geometry. This finding can lead to increased flexibility in designing antennas using these geometries.

## III. Micro Strip Antenna

Rectangular micro strip antenna is designed with a centre frequency of 2.4 GHz and using FR4 glass epoxy substrate of dielectric constant 4.4. A rectangular slot defective ground structure is then inserted into the ground plane and the simulation is carried out by varying the length of the slot with a fixed width of 2mm.The simulation is carried out using HFSS. HFSS is a finite element method solver for electromagnetic structures. The performance of both the rectangular microstrip antenna and the rectangular microstrip patch antenna with defective ground structures are investigated. Depending on the relative permittivity, operating frequency, the width and length of the patch are determined. The substrate used is FR4 with a relative permittivity of 4.4 and the height of the substrate is 1.6 mm .The desired length and width can be found out by using following equations obtained from the transmission model analysis.

Sensitivity to board size is an important factor when choosing an antenna. For example, a monopole antenna is an antenna working with an ideal, relatively large ground which is considered part of the antenna. This makes the monopole antenna sensitive to ground size and shape, meaning that the ground can greatly affect the antenna's performance. Inverted-F antennas, also called PIFA antennas, have an arrangement that makes them less sensitive to ground. Lastly there are dipole or sleeve antennas. These antennas have a positive current on one side and negative current on the other, thus establishing their own ground reference. Of the three antenna types listed here, the dipole is least sensitive to ground. All antennas require some amount of space for placement. When deciding on antenna placement, the surrounding materials must be considered, particularly conductive materials, as they affect the performance of the antenna. Antenna selection also depends on the system in which the antenna will be used. Here is a list of systems and their ideal antenna numbers and placement:

*Single-Input, Single-Output (SISO):* This system uses only one antenna. SISO systems are usually quite sensitive to location. Performance is easily affected by the multipath effect. In a SISO system, some locations generate what is called a constructive effect and other locations generate a destructive effect. For example, a car's FM radio is usually a single antenna system. As the car moves along the road, you may receive a clear signal one location and static noise in another. SISO systems with a single antenna are the easiest to design and are inexpensive.

*SISO with antenna diversity:* In this configuration, the system has two antennas. A SISO system with a single antenna can only receive a signal at one point in space with no redundancy. However, a SISO system with antenna diversity support has two antennas, either one of which can be used at any point in time. This allows the system to switch antennas if the performance of one antenna is lacking. The system always switches to the best antenna to overcome the multipath problem. If your system supports antenna diversity, it is better to use two antennas. The rule of thumb is to place the antennas at least a quarter of a wavelength apart. As a rough estimate, a quarter of a wavelength is three centimeters in the 2.4 GHz band and 1.5 centimeters in the 5 GHz band.

*Multiple-input, multiple-output (MIMO):* These systems use multiple antennas to receive and transmit concurrently. For example, if you are using a 2X2 MIMO system, you need two antennas; this configuration is called a two data stream system. MIMO systems must have adequate isolation between each antenna. Typically, approximately 25dBm isolation gives you better signal quality and thus better throughput. How can you achieve higher isolation? The first and easiest method is to increase the distance between the antennas. Move the antennas as far away from each other as possible. Longer antenna distance provides better antenna isolation. The second method is to adjust the antenna polarization. For example, if you have two dipole antennas, you can adjust them so that they form a 90-degree angle, one in in the horizontal polarization and the other in the vertical polarization. This way, even at very short ranges, you can still achieve 25dBm isolation.

*Multi-com with multiple antennas:* Multi-com systems use two different standards, such as Wi-Fi and Bluetooth, in one product. Multi-com systems require multiple antennas. Wi-Fi and Bluetooth operate at the same frequencies so adequate isolation between the antennas helps avoid interference and makes for better multi-com coexistence. For example, Wi-Fi products can handle a maximum of -20 dBm input signal and a maximum transmit power (TX) of approximately +20 dBm. Normally, Bluetooth can receive a maximum input signal of -10 dBm and TX power is typically limited to approximately 4 dBm. Therefore, you need approximately 25~30 dBm isolation between Wi-Fi antennas and Bluetooth antennas. This provides increased performance when Wi-Fi and Bluetooth operate concurrently.

## IV. Conclusion and Further Study

A wideband antenna that covers all Wi-Fi and WiMAX frequency bands has been designed and implemented on FR4 substrate successfully. The widebnad antenna characteristic covers the frequency of 2.3 – 6 GHz. Wideband characteristic is produced by modifying a basic circular patch with square ground plane by truncating the patch and by adjusting the square ground plane to widen the bandwidth at the higher frequency band. The antena gain shows an almost linearly increase with the frequency from 0 dB at 2.3GHz to around 4.5 dB at 6 GHz. Antenna radiation pattern is bidirectional. Antenna measurement shows a good agrement with simulation results. Our further study is to investigate a more challenging antenna design using a multiband approach. Multiband antenna can provide a filtering capability at RF level, so as to improve interference to other system.

## References Références Referencias


1. R. K. Raj, M. Joseph, C. K. Aanandan, K. Vasudevan, and P. Mohanan, "A new compact microstrip-fed dual-band coplanar antenna for WLAN applications," IEEE Trans. Antennas Propag., 2006.54(12). p. 3755-3762.
2. J. W. Wu, H. M. Hsiao, J. H. Lu, and S. H. Chang, "Dual broadband design of rectangular slot antenna for 2.4 and 5 GHz wireless," IEE Electron. Lett, 2004.Vol. 40, no. 23, Nov.
3. K.-L. Wong, Compact and Broadband Microstrip Antennas, New York: John Wiley and Sons, 2002.
4. Chen, When-Shan., Chang, Yu-Chen.. Novel Design of a Printed Monopole Antenna for WLAN/WiMAX Applications, Microwave Journal, 2007. Vol. 50, no. 10, pp.62-70.
5. Chen, When-Shan., Ku, Kuang-Yuan., A Microstrip-fed Monopole Antenna for WLAN USB Applications, Microwave Journal, 2008. Vol. 51, no. 3, 104p.
6. Chen, When-Shan., Kao, Bao-Hung., (2007): A Triple-band Polygonal Slot Antenna for WiMAX Applications, Microwave Journal, Vol. 50, no. 1, pp. 134-138.
7. Kumar, G., Ray, K.P.,: Broadband Microstrip Antenna, Artech House Inc, ch. 1, ch. 2. 2003.
8. Vengatesan K., and S. Selvarajan: Improved T-Cluster based scheme for combination gene scale expression data. International Conference on Radar, Communication and Computing (ICRCC), pp. 131-136. IEEE (2012).
9. Kalaivanan M., and K. Vengatesan.: Recommendation system based on statistical analysis of ranking from user. International Conference on Information Communication and Embedded Systems (ICICES), pp.479-484, IEEE, (2013).
10. Simons, Rainee N., Coplanar Waveguide Circuits, Components, and Systems, John Wiley & Sons, Inc., New York, 1 – 5, 15 – 21. 2001.
11. Wadell, Brian C., Transmission Line Design Handbook, Artech House, Norwood, 1 – 5, 73 – 75. 1991.
12. J. Yoon, G. T. Jeong, and K. S. Kwak, "Fabrication and measurement of triangular-slot antenna for triple-band (2.4/5.2/5.8 GHz) antenna with rectangular tuning stub," Microwave and Opt. Technol. Lett., 2007. Vol. 49, no. 8.
13. M. D. Plessis, and J. Cloete, "Tuning stubs for microstrip patch antennas," IEEE Antennas Propag. Mag, 1994.Vol. 36, pp. 52-56.
14. K. Vengatesan, S. Selvarajan: The performance Analysis of Microarray Data using Occurrence Clustering. International Journal of Mathematical Science and Engineering, Vol.3 (2), pp 69-75 (2014).
15. Vengatesan K., Mahajan S.B., Sanjeevikumar P., Mangrule R., Kala V., Pragadeeswaran (2018) Performance Analysis of Gene Expression Data Using Mann–Whitney U Test. In: Konkani A., Bera R., Paul S. (eds) Advances in Systems, Control and Automation. Lecture Notes in Electrical Engineering, vol 442. Springer, Singapore.
16. D. Liu and B. Gaucher, "A branched inverted-F antenna for dual band WLAN applications," Proceedings of the IEEE Antennas and Propagation Society International Symposium, Monterey, CA. 2004.3. p. 2623-2626.

This page is intentionally left blank

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# BER Performance Analysis of MIMO-Wimax Wireless Communication System for the Transportation of Multimedia Data

By Owk. Srinivasulu & Dr. P. Rajesh Kumar

*Abstract-* There is a recent trend in communication because it's changed to a great extent in current days and necessity of all human being. As there is need of internet and recent multimedia data for every user, there is a high demand for wide-band and high data rate robust communication systems. As there is a requirement of huge data rate users preferred to use a famous novel technique of multiple inputs and multiple output (MIMO) system for the more feasible solution of gain in data rate in wireless communication through fading channels. The MIMO has been used especially for increasing the bit error rate (BER) performance analysis of WiMAX based wireless systems. Different modulation and fading channels are analyzed by the Alamouti STBC. The two fading channels used are Rician and AWGN channels. Different space-time block coding (STBC) schemes including Alamouti's STBC for two transmit antennas. At first, STBC techniques are developed in MATLAB after that analyzed for bit error-rate performance using different modulation schemes. Finally, there is a use of many variants implemented to get improved performance of the system, however, in this implementation, we focused the study on Alamouti's based space-time block code (STBC) encoder to obtain both space diversity and maximum combining ratio-based equalizer to combat the effects of the Rician fading channel.

*Keywords:* *OFDM, WiMAX, maximum combining ratio, alamouti's STBC, MIMO, rician channel, QPSK, BER.*

*GJCST-E Classification:* *C.2.1, H.5.1*


*Strictly as per the compliance and regulations of:*

# BER Performance Analysis of MIMO-Wimax Wireless Communication System for the Transportation of Multimedia Data

Owk. Srinivasulu[α] & Dr. P. Rajesh Kumar [σ]

*Abstract-* There is a recent trend in communication because it's changed to a great extent in current days and necessity of all human being. As there is need of internet and recent multimedia data for every user, there is a high demand for wide-band and high data rate robust communication systems. As there is a requirement of huge data rate users preferred to use a famous novel technique of multiple inputs and multiple output (MIMO) system for the more feasible solution of gain in data rate in wireless communication through fading channels. The MIMO has been used especially for increasing the bit error rate (BER) performance analysis of WiMAX based wireless systems. Different modulation and fading channels are analyzed by the Alamouti STBC. The two fading channels used are Rician and AWGN channels. Different space-time block coding (STBC) schemes including Alamouti's STBC for two transmit antennas. At first, STBC techniques are developed in MATLAB after that analyzed for bit error-rate performance using different modulation schemes. Finally, there is a use of many variants implemented to get improved performance of the system, however, in this implementation, we focused the study on Alamouti's based space-time block code (STBC) encoder to obtain both space diversity and maximum combining ratio-based equalizer to combat the effects of the Rician fading channel. Different modulation schemes are used to get the high data rates of Wi-MAX is QPSK; We calculated BER performance of proposed work for different SNRS and represent the results for different cases of multimedia data.

*Keywords: OFDM, WiMAX, maximum combining ratio, alamouti's STBC, MIMO, rician channel, QPSK, BER.*

## I. Introduction

In recent broadcasting, the term communications refer to all the sending, receiving as well as processing of information by electronic means. Demands for capability in wireless Communications, driven using a Cellular cell, Internet, and Multimedia offerings have been rapidly growing to very high- level international standards. On the alternative hand, the available radio spectrum is constrained, and the Communication ability wishes. Advances in different coding such as inclusive of Turbo codes, Low-density parity test codes and space-time block codes made it simpler as well as more feasible to approach the Shannon ability limit in a machine with a single antenna hyperlink. Significant further advances in spectral performance are available by increasing the antennas both at transmitter and receiver is known as MIMO technology.

There is consideration of one of the numerous types of the smart antenna-based era. In reality, the recent MIMO concepts are useful and embrace many other scenarios inclusive of digital subscriber line (DSL) structures as well as single-antenna frequency-selective channels. MIMO system era has attracted a lot of interest in wi-fi communications because it gives considerable increases in data throughput as well as hyperlink variety without extra bandwidth requirement or transmits energy requirement. It is performed based on higher spectral performance and hyperlink trustworthiness. Due to necessities in MIMO, it is an important consideration that present-day wi-fi conversation standard along with all the techniques, IEEE 802.11n (Wi-fi), 4G, 3GPP LTE and Wi-MAX, HSPA+.

The objective of this paper is to increase the wireless communication system performance by using the Alamouti's encoder and Maximum ratio combining equalizer techniques through AWGN and Rayleigh fading channels.

MIMO has additionally incited wireless local area networks (WLANs) because the IEEE 802.11n standard exploits the practice of MIMO structures to collect throughputs as high as 600Mbps.This proposed paper offers a short history on MIMO schemes consisting of the gadget classical, overall the performance evaluation and analysis with typical fading channel fashions. The attention is then specified to space-time block codes (STBC) and Alamouti's encoder.

## II. MIMO System Model

When speaking for a wireless fading channel, transmitted data may be afflicted by attenuation as well as fading due to the reason of multipath within the given fading channel, consequently making it difficult for the receiver to determine these effects. Diversity techniques take advantage of the multipath propagation traits to improve receiver sensitivity to a great extent. MIMO structures are utilized for antenna diversity to achieve

*Author α: Research scholar, AUCE (A), Visakhapatnam, Associate professor, Mallaredy Institute of Engineering & Technology Maisammaguda, Dhullapally, Telangana State-Hyd.*
*e-mail: srinivasulu.owk@gmail.com*
*Author σ: Professor & BOS Chairman, Department of ECE, AUCE (A), visakapatnam-03. e-mail: rajeshauce@gmail.com*

the stated improvement and subsequently lowest fading.

Compared with the conventional systems a MIMO system is advantageous concerning ability and variety gain. Channel capacity theorem according to Shannon's law is given by

$$C = B\log2\ (1+ SNR)$$

From the Channel capacity theorem according to Shannon's law as the bandwidth increases channel capacity reaches to the maximum limit. The most blessings of MIMO networks finished traditional SISO channels are the array gain, the variety benefit, and the multiplexing gain.

*a) The MIMO Channel Model*

MIMO network comprises of $N_T$ transmit antennas and $N_R$ receive antennas for a signal model is given as

$$Y=Hx+n$$

Where, X, Y, H and n are vectors of the transmitted signal, received signal, channel matrix and noise added in the channel respectively.

Signals with multiple transmissions in time discrete index is given as

$$Y(t)=Hx(t)+n(t)$$

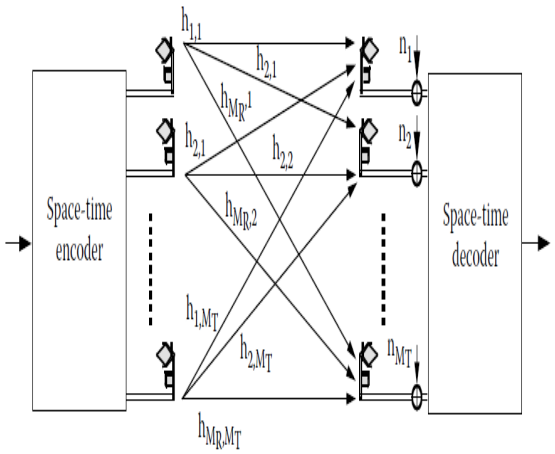



*Figure 2.1:* A MIMO system Model

The transmitted symbols are mentioned by xi, with the subscript index1 taking integers with non-zero values up to MT. Based on this notation, the channel transfer feature transmits antenna to the receive antenna is denoted by hj,i. To have a MIMO system should get better results to a SISO device, the sum of the transmitted powers of all antennas MT need to be equal to the transmitted strength of a SISO gadget denoted P. Hence, the transmitted energy from each antenna is P/MT.

It is feasible as well as robust technique to generate a MIMO channel with a correlation matrix denoted by H. The channel correlation matrix is commonly measured within the subject, and it considered all the parameters related to the environment setup together with antenna element parameters, spacing among antennas for given conditions, and surrounding reflectors with all its possibilities. The Paper is to assess the performance of different STBC schemes. The channel version is chosen such that the correlation is not produced with the overall performance. Additionally, the normalization of the channel coefficient must be such that at each acquire antenna j the sum of channel gains of all transmit antennas to acquires antenna j is equal to the wide variety of transmit antennas, i.e., MT. The Additive White Gaussian Noise (AWGN) fading channels are introduced to each obtain antenna and are special by way of NJ, with nj being an index taking values from 1 to MR. The AWGN fading channel components are assumed identically and independently dispensed and not depend on any other parameters.

The MIMO system can be given with the help of following formulae,

$$\left.\begin{aligned} r_1 &= \sum_{i=1}^{M_T} h_{1,i}\cdot x_i + n_1 \\ r_2 &= \sum_{i=1}^{M_T} h_{2,i}\cdot x_i + n_2 \\ &\cdots \\ r_{M_R} &= \sum_{i=1}^{M_T} h_{M_R,i}\cdot x_i + n_{M_R} \end{aligned}\right\} \Rightarrow R = H\cdot X + N$$

$$\Rightarrow \begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ r_{M_R} \end{bmatrix} = \begin{bmatrix} h_{1,1} & h_{1,2} & \cdots & h_{1,M_T} \\ h_{2,1} & h_{2,2} & \cdots & h_{2,M_T} \\ \vdots & \vdots & \ddots & \vdots \\ h_{M_R,1} & h_{M_R,2} & \cdots & h_{M_R,M_T} \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{M_T} \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_{M_R} \end{bmatrix}.$$

In the given equations, *R* is a column vector of size $M_R$x1 is composed with the received signals $r_j$, *X* is total column vectors of size $M_T$x1 composed of the transmitted all constellation points denoted by *xi*, *N* is a column vector of size *MR*x1 added with the noise components $n_j$ , and *H* is channel coefficient of size $M_R$x$M_T$ matrix with size *j*ith component being the channel coefficient $h_{j,i..}$

## III. Degradation Effects of Fading

The major problem of correlation between indicators can occur due to the spacing between antennas. To prevent that they are generally spaced as a minimum λ/2, where λ is the wavelength of the carrier frequency. The 2d purpose correlation can occur due to lack of multipath additives. MIMO systems can handle rich scattering in multipath fading channels. The

multipath impact we can remove by using each get hold of the antenna being in a specific channel.

*a) Fading Effects*

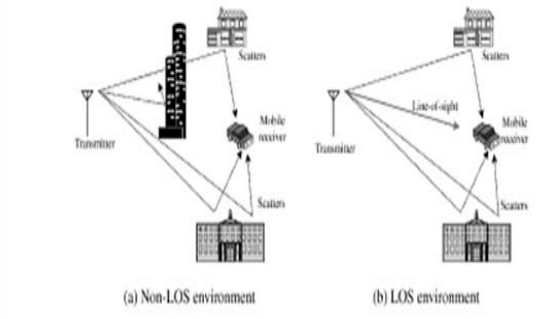



*Figure 3.1:* Non-LOS and LOS propagation environments

Fading is set the problems due to which there is lack of signal in telecommunications. Fading effects from the superposition of transmitted signals which have skilled variations in attenuation put off and phase shift at the same time as touring from the supply to the receiver.

*b) Multipath Fading*

In wireless communications, multipath is the propagation phenomenon that consequences on radio indicators reaching the receiving antenna by two or extra paths. Causes of multipath consist of atmospheric ducting, ionosphere mirrored image and refraction and reflection from the terrestrial object which includes mountains, buildings or automobiles. Figure display some of the possible methods in which multipath indicators can arise.

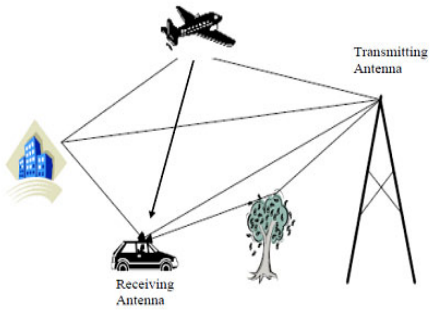



*Figure 3.2:* Multipath Signals

Fading, or equivalently small-scale fading, is because of interference between two or more versions of the transmitted signal which arrive on the receiver at barely special instances. These signals, called multipath waves, integrate at the receiver antenna and the corresponding matched filter out and provide blended signal. This ensuing signal can vary widely in amplitude and segment. The presence of reflecting gadgets and scatterers creates some converting surroundings. Multipath propagation will increase the time required for the baseband portion of the sign to attain the receiver. The resulting dissipation of the signal electricity in amplitude, section, and time. We have categorized fading channels based on their multipath time put off into flat and frequency selective and based totally on Doppler spread into gradual and rapid. These two phenomena are unbiased of every other and result in the following four types of fading channels. Flat slow fading or frequency, flat, fast fading, frequency selective slow fading, and frequency selective fast fading.

## IV. Diversity Schemes

Dissimilar to the Gaussian channel, the noisy channel display experiences sudden decreases in the power. As we talked about some time recently, this is because of the dangerous expansion of multipath motions in the engendering media. It can likewise be because of impedance from different clients. The measure of progress in the got power can be now and then more than 20 to 30 db. The energy of the warm clamor is not changing that much at the collector. In this manner, SNR at the recipient can experience profound blurs and be released drastically. For the most part, there is a base got SNR for which the beneficiary can dependably identify and disentangle the conveyed standard. On the off chance that they got SNR is lower than such a limit, a dependable recovery of the transmitted flag is outlandish. This is typically called a "blackout." The likelihood of blackout can be computed considering the factual model that models the channel or given the real estimations of the channel. It is the likelihood of having a gotten control lower than the given edge.

The primary thought behind "diversity" is to give distinctive imitations of the transmitted signal to the receiver. If these diverse reproductions blur autonomously, it is less likely to have all duplicates of the transmitted signal in a profound blur all the while. In this manner, the recipient can dependably disentangle the communicated flag utilizing these got signals. To characterize assorted variety quantitatively; we use the connection between the got SNR, inevitable by $\gamma$, and the likelihood of mistake, meant by G.
A tractable definition of the diversity, or diversity gain, is

$$G_d = -\lim_{\gamma \to \infty} \frac{\log P_e}{\log \gamma}$$

Where $P_e$ is given error probability at given SNR of $\gamma$.

*a) Alamouti's Scheme*

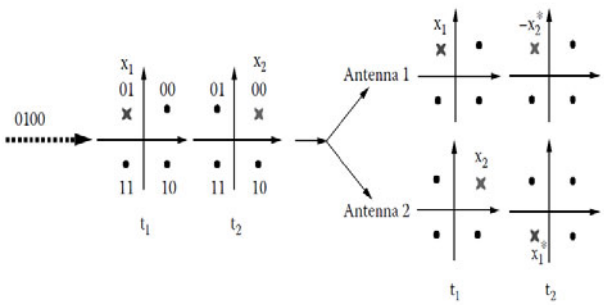
Verifiably, the transmit signal variety procedure proposed by Alamouti was the main technique used for STBC. Henceforth, the data information bits are first adjusted means they are used to divide original data

and mapped into their comparing group of stars focus. In this way, let us indicate by and the two-balanced data for transmission that enter the space-time encoder. Often, in frameworks with just a single transmit reception apparatus, these two-data selected are transmitted at two back to back time occasions. In the Alamouti transmission technique the data used are transmitted by the first and the second reception apparatus component, individually. For the second-time case, the negative of the conjugate of the second data, i.e., the data is sent to the primary radio antenna while the conjugate of the primary heavenly body point, i.e., x1, is transmitted from the second receiving antenna. The encoding operation is depicted in Table 4.1. The transmission rate is equivalent to the transmission rate of a SISO framework. Space– time encoding mapping of Alamouti's two-branches transmits attired variety procedure can be spoken to the coding grid as given below:

$$X_1 = \begin{matrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{matrix}$$

In the coding matrix X1, the subscript index gives the transmit fee compared to a SISO gadget. For Alamouti's scheme, the transmission we used 2 transmitting and two receiving antennae. The rows of the coding matrix constitute the transmit antennas while it columns correspond to single time instances.

*Table 4.1:* Alamouti's Scheme




In alternative way, the channel coefficients used are given from the first antenna to the $j^{th}$receiver antenna $h_{j,1}$ and those from the second antenna to the $j^{th}$receiver antenna $h_{j,2}$ must satisfy the following equations:

$$h_{j,1} = h_{j,1}(t) = h_{j,1}(t+T) = h_{j,1}(t_1) = h_{j,1}(t_2)$$

$$h_{j,2} = h_{j,2}(t) = h_{j,2}(t+T) = h_{j,2}(t_1) = h_{j,2}(t_2)$$

Finally, the received signals obtained at receiver antenna $j$ during the two-time instances are $r_{j,1}$and $r_{j,2}$. The received signals satisfy following equations,

$$r_j{}^1 = h_{j,1}.x_1 + h_{j,2}.x_2 + n_j{}^1$$

$$r_j{}^2 = h_{j,2}.x_2{}^* + h_{j,2}.x_1{}^* + n_j{}^2$$

In the above Equation, the Additive White Gaussian Noise (AWGN) fading channel components are added at each receiver antenna element j while during the transmission time instances serially *t*1 and *t*2, are denoted *nj*1 and *nj*2, respectively.

*b) Maximal Ratio Combining*

Maximum ratio combining is one of the well-known linear combining methods. In a well-known linear combining process, many sign inputs are in my opinion weighted and delivered together to get an output signal. The weighting elements may be preferred in frequent approaches. The output sign is a linear aggregate of a weighted replica of all the obtained alerts. The received signal is given below,

$$r = \sum_{i=0}^{n_R} \alpha_i . r_i$$

Where, r is the obtained signal at acquiring antenna i, and αi is the weighting factor for receiver antenna 1. In most ratio combining, the weighting issue of every get hold of the antenna is selected to be in percentage with its very own signal voltage to noise power ratio. Let Ai and φi be the amplitude and segment of the acquired signal, respectively. If every obtain antenna has the equal average noise electricity, the weighting vector can be represented as,

$$\alpha_i = A_i e^{-j\varphi_i}$$

This method is referred to as superior combining due to the fact it can maximize the output SNR. This scheme requires the information of channel fading amplitude and sign phases. So, it could be used at the side of coherent detection, but it isn't realistic for non-coherent detection.

## V. Simulation Results

In this implementation, MATLAB is used to check the overall channel performance using different modulation technique primarily based on BPSK modulation scheme. By making use of Alamouti's STBC and Maximum ratio combining approach, it's miles feasible to make channel reaction from Rayleigh fading channel to AWGN channel. However, from the subsequent figures, it is visible that the performance doesn't appear to improve in the case of no range and it considerably recovers using applying the diversity techniques like 2x2 Alamouti and 2x4 Alamouti case. Also, we can see from the graphs that the BER performance of the gadget increases for multimedia statistics and because the information rate increases, we need additional diversity as an example for the case of 4x4 Alamouti methods and it works extensively quality with low records price programs. The two varieties of

statistics which it's miles examined for are the actual time audio and photo statistics.

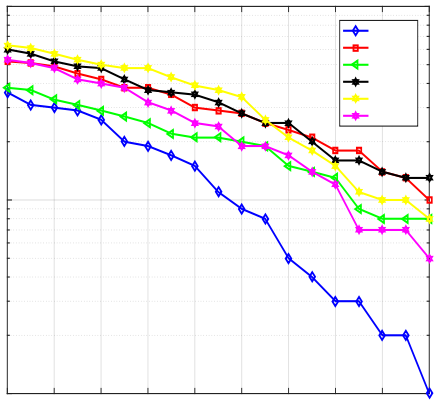


*Fig.5.1:* BER analysis for different modulations in Alamoutis STBC with ZF equalizer (Rician channel)

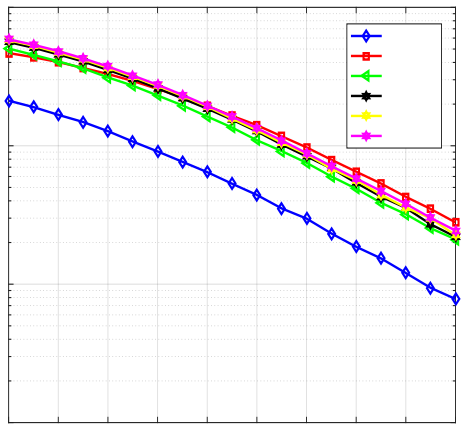


*Fig.5.2:* BER analysis for different modulations in Alamoutis STBC with ZF equalizer (AWGN channel)

Below there is an analysis of Alamouti STBC for Rayleigh channel using BPSK modulation. By BER performance analysis we get the better results for proposed work with Alamouti STBC with 2 T-X antennae and 2 R-X antennae than the existing techniques like without diversity.

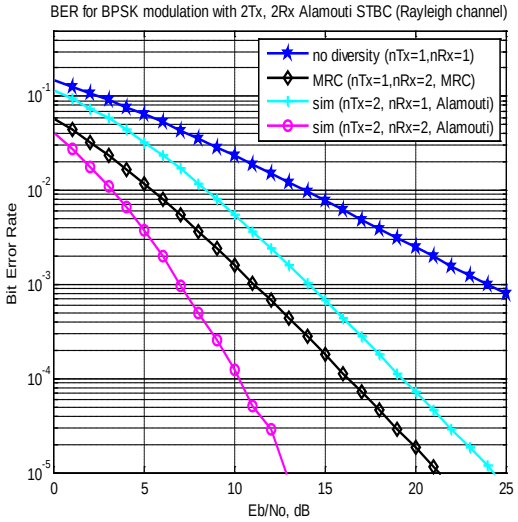



*Fig.5.3:* BER for BPSK modulation with Alamouti STBC (Rayleigh channel)

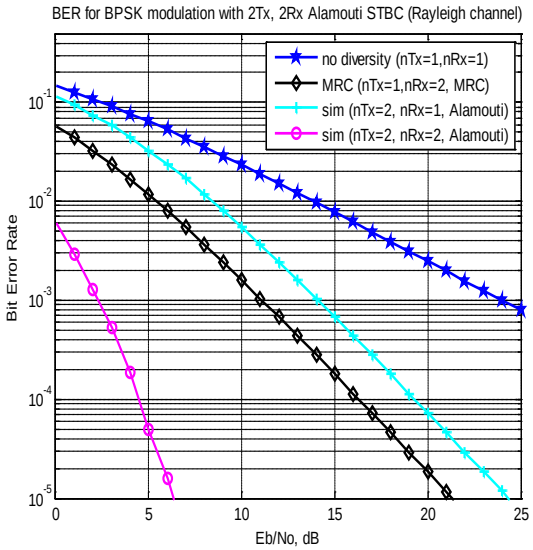



*Fig.5.4:* BER for BPSK modulation with Alamouti STBC (Rayleigh channel)

## VI. Conclusion

With implementation execution using MATLAB software, we can go for analysis of wireless fading channel environment, as the nature of fading increases to the certain extent and the data rate is also increased to the great extent, one of the ways to get good BER performance of the system is increasing the spatial diversity. We analyzed the working of Almouti STBC under the different modulations and under different fading channel. From this analysis, we get to know that as modulation index is increases, there is increased in BER that means degraded the performance of a system. With the help of increasing the number transmitter or receiver, we can achieve better performance of the proposed implementation. The future work can be

extended to real-time signals like the high-resolution images, video streams, and live videos or live broadcasting signals like the DVB-2 to check the efficiency of the diversity-based systems to crisscross its robustness and improvement for multimedia applications. Finally, with the subjective and objective quality assessment of the data, we can prove that the implemented system is having improved performance.

## References Références Referencias


1. "Space-Time Coding", England, B. Vucetic and J. Yuan, Wiley, 2003.
2. Fundamentals of Wireless Communication, D. Tse and P. Viswanath, Cambridge University Press, USA, 2005.
3. "Space-time block codes from orthogonal designs", V. Tarokh, H. Jafarkhami, and A.R. Calderbank, IEEE Transactions on Information Theory, Vol. 45, No. 5, pp. 1456-1467, July 1999.
4. "Layered space-time architecture for wireless communication in a fading environment when using multi element antennas", G. J. Foschini, Bells lab technical journal, Vol. 1, No. 2, pp. 41-59, Autumn 1996.
5. "Multichannel Signal processing for data communications in the presence of crosstalk", M. L. Honig, K. Steiglitz and B. Gopinath, IEEE Transactions on communication, Vol. 38, No. 4, pp. 551-558, April 1990.
6. "Redundant filterbank precoders and equalizers Part I: Unification and optimal designs", A. Scaglione, G. B. Giannakis, S. Barbarossa, IEEE Transcation on Signal Processing, Vol. 47, No. 7, pp. 1988-2006, July 1999.
7. "Space-time block codes for wireless communications: Performance results", V. Tarokh, H. Jafarkhami, and A.R. Calderbank, IEEE Journal on Selected Areas in Communications, Vol. 17, No. 3, pp. 451-460, March 1999.
8. "Space-time codes for high data rate wireless communication: Mismatch analysis", A.F. Naguib, V. Tarokh, N. Seshadri, and A.R. Calderbank, Proceedings of IEEE International Conf. on Communications, pp. 309-313, June 1997.
9. MIMO System Technology for Wireless Communications, G. T soulos. CRC press, 2006.
10. Digital Communications: Fundamentals and Applications, B. Sklar, Second Edition, Pearson Education, India, 2003.
11. Intuitive Guide to principles of communications www.complextoreal.com.
12. Wireless communications, A. Goldsmith Cambridge university Press, 2005.
13. A Wireless Communications, .Molisch, Wiley-IEEE Press, 2005.
14. "From theory to Practice: an overview of MIMO Space –time Coded wireless Systems "D.Gesbert, M.Shafi, D.shiu, P.Smith, and A.Naguib, IEEE Journal on selected areas in communications, Vol.21, no.3, pp.281-302, 2003.
15. "A Simple Transmit Diversity for wireless communications" S.M. A lamouti, IEEE J.Sel.Areas Commun., 1998, 16, 1451-1458.

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

# An Agent-based Grouping Strategy for Federated Grid Computing

By Aminul Haque & Md. Tanvir Rahman
*Daffodil International University*

*Abstract-* Characterizing users based on their requirements and forming groups among providers accordingly to deliver them the stronger quality of service is a challenge for federated grid community. Federated grid computing allows providers to behave cooperatively to ensure required utility by users. Grouping grid providers under such an environment thus enhance the possibility of more jobs executed whereas a single provider or organization might not be able to do the same. In this paper, we propose an agent-based iterative Contract Net Protocol which supports in building federated grid via negotiating distributed providers. The main focus of this paper is to minimize the number of iterations using a grouping mechanism. Minimizing the number of iterations would produce less communication overhead which results in the minimum queue waiting time for users to publish their jobs. Simulation results further ensure the feasibility of our approach in terms of profit and resource utilization compared to that of the traditional non-grouped market.

*Keywords:* *grid computing, agent technology, economic model, group formation.*

*GJCST-E Classification:* *C.1.4, C.1.m*


*Strictly as per the compliance and regulations of:*

# An Agent-based Grouping Strategy for Federated Grid Computing

Aminul Haque [α] & Md. Tanvir Rahman [σ]

*Abstract-* Characterizing users based on their requirements and forming groups among providers accordingly to deliver them the stronger quality of service is a challenge for federated grid community. Federated grid computing allows providers to behave cooperatively to ensure required utility by users. Grouping grid providers under such an environment thus enhance the possibility of more jobs executed whereas a single provider or organization might not be able to do the same. In this paper, we propose an agent-based iterative Contract Net Protocol which supports in building federated grid via negotiating distributed providers. The main focus of this paper is to minimize the number of iterations using a grouping mechanism. Minimizing the number of iterations would produce less communication overhead which results in the minimum queue waiting time for users to publish their jobs. Simulation results further ensure the feasibility of our approach in terms of profit and resource utilization compared to that of the traditional non-grouped market.

*Keywords: grid computing, agent technology, economic model, group formation.*

## I. Introduction

Grid computing is a special kind of network that connects distributed computer resources (such as clusters, supercomputers, and datasets) to provide stronger computation power as well as data warehouse over the Internet in order to solve computationally intensive problems (such as drug design, investigate material properties and weather forecasting). These resources are typically owned by different owners and driven by different rules and policies. Economic models such as Contract Net Protocol (CNP) [1], Double Auction [2], and Commodity market [3] are found suitable in harnessing these distributed resources over different ownership. Recently federated grid has emerged as a new approach that supports coordination of resources through grouping mechanism in order to optimize users quality of service (QoS) (i.e. resource availability, reliability, performance etc.) [4], [5]. However, autonomous coordination of distributed resources is essential to achieve perceived utility by users. However, extreme heterogeneity, dynamic nature, and different ownership of these resources impose challenges to do that.

Agent technology in computer science is well known due to their autonomous actions in making decisions and capability of interacting (such as cooperate, coordinate and negotiate) with other agents like other social beings. Due to the development and application of agent technologies, a surge of interest has been focused on agent-oriented methodologies and modeling techniques. The reason for including agents in grid computing is that grid computing and agent systems have similar objectives. Both aim to achieve *"large-scale open distributed systems, capable to effectively and dynamically deploy and redeploy resources as required, to solve computationally complex problems"* [6]. Similarly, agents representing different grid providers can interact with each other and form groups or teams in order to meet their respective goals (e.g. meeting users QoS, earning profit etc.). However, differentiating among QoS (i.e. typically represented by user's preference values on QoS), and forming groups accordingly to meet their demands are open issues in this field.

In this paper, we study how to characterize different users in terms of their varied utility demands and budget constraints. Perceive different utility is important in order to deliver stronger QoS. In addition, we study how to map appropriate groups with received users to enhance system efficiency (e.g. better profit and resource utilization). We propose an agent-based iterated CNP (*i*CNP) where agents representing users and providers are autonomous to interacting each other and both appear with their respective requests and offers. *i*CNP allows multi-round iterative bidding. In general, under such an economic model, a manager (user) issues/publish the initial call for proposal *(cfp)*/ resource demand. The contractors (providers) then evaluate the proposal and propose their bids. The manager then accepts one or more of the bids or may iterate the process by issuing a revised *cfp*. However, escaping from one round and then waiting for the next round to resubmit the request may cause a long queue waiting time in a large-scale framework which is typically comprised of thousands of users and providers such as grid. Hence, in this paper, we further focus on how to treat a user in a better way from the first round by incorporating grouping mechanism and thus to minimize the number of iterations. Minimize the number of iterations prevents users from the uncertainty to best treat their values and reduces communication delay dramatically since negotiation with users as well as

*Author α σ: Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh.*
*e-mails: aminul.cse@daffodilvarsity.edu.bd, sajal.it.ju@gmail.com*

among providers requires huge communication process. We group providers based on their resource availability so that they can treat the corresponding users the best it is possible by them.

## II. Related Work

Chao et al. [4] proposed for grouping grid nodes in terms of nodes' own desires to optimize resource allocation problem. They grouped-up according to compatible users and providers based on catallaxy-based market though how they defined different criteria to do this is not clear. In addition, they conducted the simulation with 100 agents (50 users and 50 providers) but what impact it would have if they conducted the simulation with varying the number of users and providers is not taken into account. We conduct our simulation with thousands of users and a varying number of users and providers.

CNP has been used in a cluster environment to optimize utility for users [1]. They have compared the performance of CNP and traditional Round Robin Protocol (RRP) in terms of different job arrival rates and show the advancement of CNP over RRP in terms of utility and computational cost. They have conducted their simulation by incorporating two scenarios; firstly, the scenario that accommodates all the mono-thematic applications (similar kind of applications) and secondly, which accommodates heterogeneous tasks. However, in our work, we focus on *i*CNP and characterize users in terms of their preferences, such that they can be efficiently evaluated.

Goswami adopts [7] CNP to deal with resource heterogeneity and proposes two resource selection policies. One is K-time optimization policy, in which users are sorted in ascending order in terms of their proposed deadlines of finishing their jobs. Another one is, K-cost optimization policy, in which users are sorted in terms of their budgets, they are willing to pay. The value of K refers to whether to switch from K-time to K-cost or not and vice versa. The drawback of this system is, though the failed users have the chance to re-announce/revise their *cfp,* they still resubmit their *cfp* without changing anything (e.g. increase budget or reduce QoS). Hence, the probability of accepting revised *cfp* would be decreasing and produce high communication overhead. We change *cfp* over iterations which maximize to successful SLA establishment in each round.

An agent-based Content Distributed Grid (CDG) is proposed to form VOs [5]. The concept of CDG is borrowed from Content Distributed Network (CDN) in where all the servers are co-operative to each other and belong to the same organization. The CDG is different to the point that all the resources under grid computing are competitive and belong to different owners. Hence, they propose an economic approach to motivate grid providers such that they can be cooperative in contributing their resources in order to maximize utility for users. The failed users can re-negotiate with providers based on their revised *cfp* and this can happen over a certain number of iterations. However, under which condition how many iterations it may have to allow users re-negotiate is not discussed. If the number of iterations is very low, some users might lose their chance to re-negotiate or if it is very high, it might produce high communication delay. We allow the auction to be continued until there are at least one potential user and one potential provider in the market which guarantees all the users making deal with providers. In addition, our grouping strategy helped to minimize iterations while ensuring best treat the users.

Ranjan et al. [8] proposed CNP-based negotiation for meta-scheduling resources in federated grids. Their proposed SLA-based approach is designed to satisfy users by maintaining their job deadlines as well as allows providers to control over their resources. Users in their system are allowed to iterate the negotiation process if they fail in a particular round. However, how users revise their *cfps* is not discussed. Hence, accepting revised *cfp* becomes harder, since the providers keep the resource cost constant throughout an experiment. There could be another way of revising *cfp*, that is, minimizing resource requirements rather than maximizing budget but it may not be applicable to a group of users who define a resource as their optimization. Our group-based optimization strategy minimized the occurring of revising *cfp* and thus decreased the chance of generating such unexpected scenarios.

An enhanced ant colony algorithm combining the technique of Ant Colony System and Mix Ant System for job scheduling for grid computing is proposed in [9]. The proposed algorithm also contains the concept of agent for the purpose of updating the grid resource table.

Laizhi Wei et al. [10] proposed an improved ant algorithm for Grid task scheduling strategy with a new sort of pheromone and node distribution selection rule. The proposed algorithm can measure the performance of resources and tag on it. By dealing with the unsuccessful situations of task scheduling, unnecessary overhead of the system is reduced that results in shortening the total time requirement of a complete task. Sonal Yadav et al. [11] proposed a cost based job grouping and scheduling algorithm that will be beneficial to both user and resource broker. Before allocating resources the algorithms groups the users job which results improved communication to computation ratio and utilization of available resources.

The authors of [12] have proposed a grouping based job scheduling algorithm that uses priority queue and hybrid algorithm to maximize the resource utilization

and minimize processing time of the jobs. By considering static restrictions and dynamic parameters of jobs and machines the algorithm selects the best suitable machine for user's job.

## III. System Model

We model our framework (Figure 1) with three types of agents, which are user-agent, provider-agent and traffic-agent. Each type of agents is programmed in a way so that it can try its maximum to reach an agreement (Service Level Agreement) while interacting with other agents. We use *i*CNP as the interaction protocol. Since it is iterative, agents in our model can optimize their goals through renegotiation. Details on *i*CNP are described in the following section. The three types of agents in our system try to reach the following individual goal:

*Type 1 (User-agents):* Try to optimize the preferred values (e.g. storage, budget) as defined by the corresponding users,

*Type 2 (Provider-agent):*Aims to receive more users so that they can maximize their profit,

*Type 3 (Traffic-agent):* Is designed to receive and evaluate users' request and finally switch to the appropriate groups.

Therefore, it is clear that each type of agents has its own task to accomplish. However, in this work, we only consider users requests (jobs) as tasks. Such a task-oriented domain can be defined as,

P = Provider, *cfp* = call for proposal, OP = Optimization
SLA not established and send back to revise *cfp*
Migration due to unavailable resources
Accessing Virtual Organization (VO)

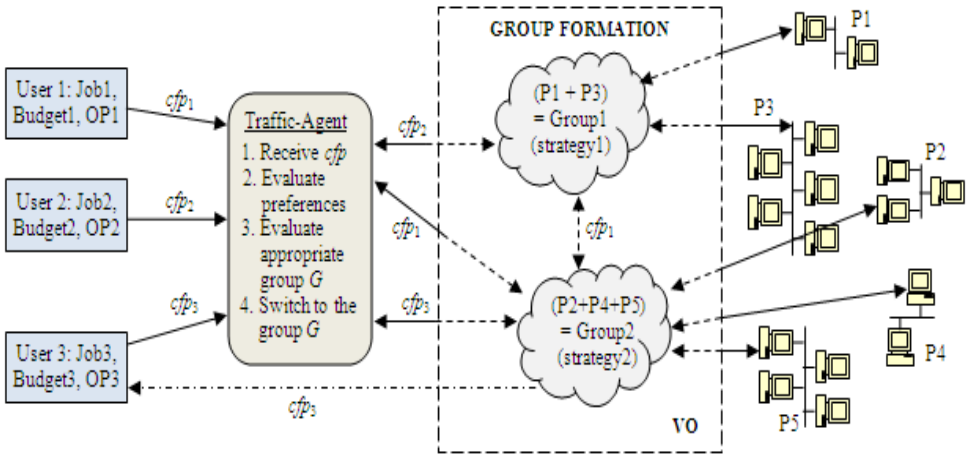



*Fig. 1:* An overview of our proposed group-based federated grid

<T, A, C>

Where *T* refers to the set of all tasks. Here the number of tasks (subsets) is equal to the number of users.

$A=(\{A_1,\ldots,A_u\}, \{A_1,\ldots,A_p\}, A_t)$ is the set of participating agents. Au, Ap, and At refer the user-agent, provider-agent and traffic agent. Again, $A_u \subset A$, $A_p \subset A$, and *t* are always 1.

*C* refers to the cost of executing a particular task.

Now, we describe different types of agents in terms of their activity.

*a) User-Agent*

In our model, a user-agent is represented by $A_u$ where $|u| > 0$ and can be any arbitrary number. Each $A_u$ is set by a few resource requirements, budget, deadline, and preferred optimization. This is called "call for proposal (*cfp*)" and given by,

$$cfp_u = \{R, B, D, Pref\}$$

However, in this work, we set an $A_u$ only with resource requirements (storage and processors) *R*, budget *B* and preferred value *Pref*. The preferred value can be either in resources or budget. The role of an $A_u$ is to try optimizing its *Pref* while considering other associated constraints. Hence, an $A_u$ can easily be characterized based on its $cfp_u$. User-characterization is mandatory to deliver stronger service. In our work, we consider four different ways to differentiate users.

Firstly, the users set processing as their preferences. In addition, respective budgets are relaxed, that is, willingly to pay whatever price providers impose on *cfp.* An $A_u$ can perceive its preference value automatically based on resource requirements. Hence, a $cfp_u$ can be re-written as,

$$cfp_u = \{CPUs \geq predefined\ CPUs\ and\ storage < predefined\ storage,\ B(relaxed),\ D,\ CPU\}$$

Secondly, the users set storage as their preferences. In this case, the budgets are relaxed as well. Similarly, an Au can perceive its optimization entity by using the following $cfp_u$,

$$cfp_u = \{CPUs < predefined\ CPUs\ and\ storage \geq predefined\ storage,\ B(relaxed),\ D,\ storage\}$$

Thirdly, the users come with cost optimization. This is recognized by the following $cfp_u$,

$$cfp_u = \{CPUs < predefined\ CPUs\ and\ storage < predefined\ storage,\ B,\ D,\ cost\}$$

Finally, the users set combined optimization as their preferences, which means, they want more resources with lower costs. This type of $cfp_u$ can be defined as,

$$cfp_u = \{CPUs \geq predefined\ CPUs\ and\ storage \geq predefined\ storage,\ B,\ D,\ combined\}$$

Characterizing users in terms of their *cfp* would help grid providers to treat them better than might otherwise be expected. However, this characterization can be extended in a few more ways (such as both of resources optimization with relaxed budget). We have left either ways for our future work. We use different ranges for different resource requirements in order to dynamically set thousands of users. The average values of the ranges are considered as predefined resources. Please note that if an Au fails in a particular iteration, it revises its $cfp_u$ for the following iteration by increasing its budget until the budget reaches its maximum value. The next step of an Au is interacting with traffic-agent.

*b) Traffic-Agent*

A traffic-agent is represented by $A_t$. Only one $A_t$ is designed to deal with all $A_u$. At first, it receives $cfp_u$ from an $A_u$. Then it evaluates the $cfp_u$ and detects the preference value. After that, it evaluates appropriate group in order to better serve the user. Details on grouping are described in Section 2.3. Finally, it switches the $A_u$ to the appropriate group which is designed to treat the user best. Hence, it is crucial for an $A_t$ to determine appropriate groups of users otherwise it may cause some extra iterations which ultimately increases communication overhead.

*c) Provider-Agent*

A provider-agent is represented by $A_p$. Where, $|p| > 0$ and can be any arbitrary number. An $A_p$ is designed with resource availability and prices for the unit amount of resource consumption. Details on pricing are explained in the Economic model section. In this paper, we focus on the provider side. Therefore, we concentrate on provider strategy rather than user strategy. Although providers in grid computing are known to be self-interested, they can save costs by coordinating their activities among themselves. In a multi-agent paradigm, such a grouping activity is known as characteristic function game *(CFG)*. In such games, the value of each group G is given by a characteristic function $v_G$. Hence, providers can be grouped in several possible ways based on $v_G$. This is called group structure *(GS)*. So, for any group, we can say $G \in GS$.

We assume that providers are aware of the demand curve (a market trend on resource demand) and all available cases users can be characterized on. Based on this, all the providers under our federated grid automatically form into four different groups based on their resource availability. Groups are presented here in terms of their set of characteristic functions:

$$v_G{=}1{:}\ \{processors \geq predefined\ processors\ and\ disk\text{-}space < predefined\ disk\text{-}space\}$$
$$v_G{=}2{:}\ \{processors < predefined\ processors\ and\ disk\text{-}space \geq predefined\ disk\text{-}space\}$$
$$v_G{=}3{:}\ \{processors < predefined\ processors\ and\ disk\text{-}space < predefined\ disk\text{-}space\}$$
$$v_G{=}4{:}\ \{processors \geq predefined\ processors\ and\ disk\text{-}space \geq predefined\ disk\text{-}space\}$$

Here, each *G* is formed to better treat its corresponding $cfp_u$. For example, *G1* (group1) is designed with that provider who are able to supply more processing power and thus to deliver stronger quality to type1 $cfp_u$. However, grouping in our model occurs prior to serving a particular $cfp_u$ rather than after receiving the $cfp_u$. The reason for this is to prevent users from waiting while forming groups over distributed domains. In addition, this would increase the probability of receiving more users by a particular *G*.

For each *G*, there is a group correspondent (typically the first provider), who initiates dealing with a $cfp_u$ and negotiates with other providers within that *G* if requires. However, *G* formation in any *CFG* needs to satisfy the following facts;

*Group structure generation:* Formation of groups by the agents such that agents within each group coordinate their activities, but agents do not coordinate between groups. Typically, this generation occurs super-additively, which is, any *G* of agents is best off by

merging into one. This can be explained in terms of the utility function,

$$UtilityA1 \cup A2 \geq UtilityA1 + UtilityA2$$

For all disjoint agents $A1, A2 \subseteq A$. The utility function of an agent $A$ for a deal $\delta$ in order to accomplish a task $T$ can be defined as,

$$\text{UtilityA}(\delta) = \text{C}(\text{TA}) - \text{costA}(\delta)$$

Where $C\ (TA)$ refers to the cost originally assigned to the agent $A$ to accomplish the task $T$ and $costA\ (\delta)$ is the cost spends to process the deal. The agents presented here are all $A_p$ and the utility function is restricted to $G$ generation.

However, in many cases, $G$ formation may not be super-additive since there are some costs (such as communication cost, security cost) to $G$ formation process itself. Therefore, under costly computation, component grouping within a single provider or organization may be better off by not forming a composite grouping with different providers. However, in case of grid computing, most cases, a single provider is not able to meet large-scale resource requirements. Again, due to large-scale resources trading, associated costs would be less in most cases.

*Optimization of the group:* Here, a particular *G's* objective is to maximize monetary value, that is, to maximize the utility value in combination. This can be achieved by increasing the money received from users or decreasing the cost of using resources.

*Payoff division:* It divides the generated solution among the provider-agents of a particular *G*. The division should be in a fair and stable way so that the agents are motivated to stay with the *G* rather than move out of it. In our model, the solution of a particular *G* is divided into the providers according to the number of resources they have shared.

i. *Group migration*

Though each $cfp_u$ is supposed to receive in its respective *G* which is appropriate to treat that $cfp_u$, the corresponding $A_u$ can still be migrated to another *G*, if the designed *G* becomes unable to deliver the resource demands. Under a federated grid, this migration policy would increase the system efficiency, since it tries its maximum to treat a user well. However, there are some restrictions to migrate a $cfp_u$ from one *G* to another. As aforementioned, we are focusing on provider side; hence, we have used some strategies over migration so that the system can produce a better payoff.

Please note that all strategies of migrating a $cfp_u$ from one *G* to another is subject to unavailable resources with the *G* it is migrating from.

*Strategy 1:* From providers' point of view, *G1* and *G2* users receive priority than others, since these users come with a relaxed budget. Hence, *G1* and *G2* users are allowed migrate to *G3* and *G4* at any iteration while *i*CNP.

*Strategy 2: G3* and *G4* users are allowed migrate to *G1* and *G2* at all iterations except the first since the budgets of *G3* and *G4* users are not relaxed and thus get less priority by providers. This is done such that in the first iteration providers can receive more users with relaxed budget and thus to maximize profit.

However, our model supports to define a migration policy by a particular group *G* in either way about when to migrate and migrate to which.

## IV. Implementation

We established a simulation environment and implemented the proposed model using a cross-platform multi-agent programmable modeling environment known as Netlogo [13], [14]. We choose Netlogo because:

- Netlogo is a FIFA (Foundation for Intelligent Physical Agent) conformant platform [15].
- It has extensive built-in models to deal with multi-agents.
- It can work as a 'simulated parallel' environment [13].
- It is platform (Mac, Windows, and Linux) independent [14].

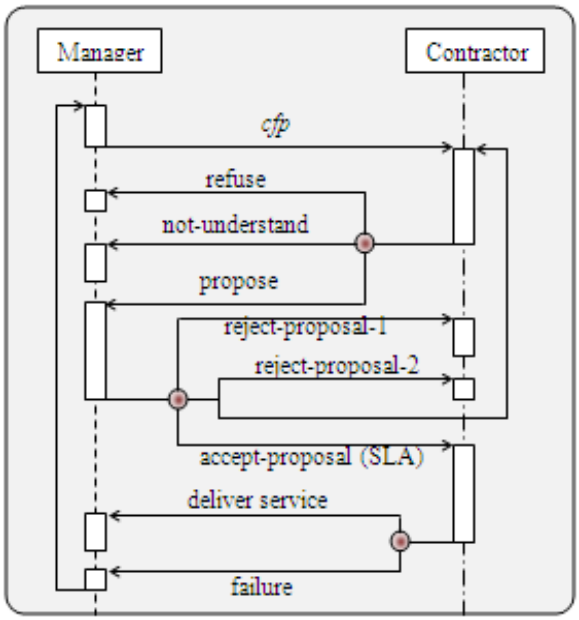



*Fig. 2:* FIFA Iterated Contract Net Protocol

*a) Economic model*

We implemented FIFA conformant *i*CNP (Iterated Contract Net Protocol) which is an extension of the basic CNP, but it differs by allowing multi-round iterative bidding [16]. *i*CNP supports optimizing a particular user's request by negotiating distributed providers. In such a model (Figure 2) a user is called a manager who issues an initial *cfp*. Providers are known as contractors, who then response with their bids and the manager may then accept one or more of the bids, rejecting the others, or may iterate the process by issuing a revised *cfp*. However, the number of iterations can be based on a time period or potential users (who can still maximize their budgets) and providers (who can still serve at least one standard user). We consider that the iteration continues until there are a potential user and a potential group. Though using our approach seems to increase number of iterations and thus communication overhead, the approach is more consistent in grid perspective and using our grouping strategy, number of iterations could be decreased. In our case, a group G receives a *cfp* via the traffic-agent *($A_t$)* with the guarantee that the group *G* receives the correct *cfp*. However, evaluating a particular *cfp* would be different, if a particular group *G* receives the *cfp* from another group *G* (migration) rather than the traffic-agent *($A_t$)*.

*b) Bidding policy*

In our system, each user comes with a band of budgets, which are minimum budget and maximum budget the user is willing to pay. Typically, an $A_u$ (user-agent) corresponding to a user starts bidding from its minimum budget to the maximum budget over iterations if it can establish the SLA. The bidding in our mechanism follows linear increment. Though we are not focusing on user-strategy, we would like to change user-bid over iterations rather than linearly in future. If an $A_u$ is unable to establish its SLA even after reaching its maximum budget, it will be considered as a failed job. Resources requested by an $A_u$ are priced by $A_p$ (provider-agent) using the unit price of each particular resource. These unit prices do not change over iterations. However, in future, we would like to change the prices based on supply and demand. The cost *C* of a task, *T* requested by a particular $A_u$ can be formalized as follows:

$$C(T_{A_u}) = \sum_{m=1}^{n} Req_m \times P_m(A_p) \quad (1)$$

Where *m* refers to the resource type requested by $A_u$. Typically, this can be storage, CPU, and memory. However, we conduct our simulation only with storage and CPU.

*n* is the total number of resource types, $Req_m$ means required resource amount of type *m*

$P_m$ is the unit price (e.g. price/GB storage) for type *m*. This is a function of a particular provider $A_p$

**Algorithm 1: Dealing Users with Group-based Iterated Contract Net Protocol**

```
1.1  PROCEDURE: ITERATED_CONTRACT_NET_PROTOCOL
1.2  begin
1.3      set job-settled false
1.4      set continue-iteration true
1.5      set number-of-iterations 1
1.6      begin
1.7          SUB-PROCEDURE: RECEIVE_cfpus
1.8          evaluate cfpus by At
1.9          call appropriate groups Gs
1.10     end
1.11     begin
1.12         SUB-PROCEDURE: INTERACT_GROUP
1.13         while (continue-iteration = true)
1.14             [ foreach cfp-list
1.15               begin
1.16                   SUB-PROCEDURE: EVALUATE_ cfp_BY_G
1.17                   if (job-settled = true)
1.18                       [Remove the cfp from cfp-list]
1.19                   end
1.20                   else Don't remove the cfp from cfp-list
1.21                       call the corresponding Au for revising cfp
1.22                   end
1.23               end
1.24               increment of number-of-iterations by 1
1.25               begin
1.26                   SUB-PROCEDURE: EVALUATE_POTENTIAL_GROUP
1.27                   if (length of potential-group = 0 or length of cfp-list = 0)
1.28                       [set continue-iteration false]
1.29                   end
1.30               end
1.31             ]
1.32     end
1.33 end
```

c) *Optimize user-defined preferences in the group-based federated grid*

In our implementation, we distinguished user-defined preferences in two ways. One is resource optimization which includes optimization for storage and CPU and another one is budget optimization. As we are using group-based strategy, it is easier to optimize a particular resource type, since typically a group only receives *cfp* with those preferences which the group is specialized for. For example, if a user's preference is storage, he goes under group 2, since the group is comprised of those providers who have more storage power. Therefore, the optimization of a particular resource is done via negotiating different providers within a particular group. Hence, a task may have to be shared by several providers. A large-scale task can be shared as the following steps:

- *Task decomposition:* involves decomposing large task into subtasks. The task decomposition is typically done by the dispatcher.
- *Task allocation:* refers to assigning the subtasks into different providers.
- *Task accomplishment:* is the completion of the subtasks by the respectively dedicated providers, which could further include decomposition and subtasks assignment.
- *Result synthesis:* includes passing the results from different providers to the corresponding provider (usually who initiates the negotiation). The corresponding provider then composes the results and passes it to the user.

## V. Simulation Results and Evaluation

We conduct our simulations according to the resource configuration presented in Table 1. Column 1 of Table 1 represents different parameters that a user and a provider use to set their agents. In our simulation environment, one can accommodate a large number of users as well as providers. To set this large number of users and providers with different requests and offers, we use ranges of values so that each participant can select a value from its respective range. All users' requests are set using the Column 2 ranges and all providers' offers are set using the Column 3 ranges automatically. Since, the provider agents do not change their resource prices over iterations; we use only a single range to define a resource unit price. The first range [1-5] is used to refer to the price for 1 GB storage and the second range [10-20] is used to refer to the price for the processor of 1 MIPS (Million Instructions Per Second) capacity. The deadline parameter might not be consistent in case of simulation and so we are not using time parameter to pricing resource cost (e.g.

$3/MIPS/hour). In addition, we assume concurrent arrival of different requests and offers.

*Table 1:* Resource configuration

| User/provider-level parameter | User-level-range | Provider-level-range |
|---|---|---|
| **Storage/diskspace (GB)** | 200-600 | 6000-10000 |
| **Number of CPUs (MIPS per CPU)** | 10-30 | 800-850 |
| **Minimum Budget/demand ($)** | 500-1000 | 1-5 (/GB), 10-20 (/MIPS) |
| **Maximum Budge($)** | 4000-5000 | Not Considered |

*a) Evaluation criteria*

In the Netlogo framework, three different results can be obtained based on the interaction of $A_u$ (user-agent) and $A_p$ (provider-agent). The first result describes the job rejection rate for an $A_p$. Job rejection occurs due to scenarios such as disagreement of resource prices or unavailability of resources. This rate is calculated using two parameters - the total number of rejected jobs ($J_{rejected}$) and the total number of requested jobs ($J_{requested}$). The job rejection rate is assumed to range from 0 to 1. The job rejection rate, $R_{rate}$, is given by:

$$R_{rate} == \frac{J_{rejected}}{J_{requested}} \quad (2)$$

We conduct our experiment with 5000 users and 250 providers and results are compared between group-based *i*CNP and traditional *i*CNP. The traditional approach is, using *i*CNP without applying our group-based strategies. At first, we compare these two approaches in terms of job rejection rate. Job rejected rate is plotted in terms of a number of interactions between users and providers (requests).

Figure 3 demonstrates the job rejection rate patterns between the two approaches. The horizontal axis describes the number of interactions between users and providers and the vertical axis shows the rate. The number of interactions is more than the total number of the user, since the protocol is iterative, which allows failed users re-interact to providers.

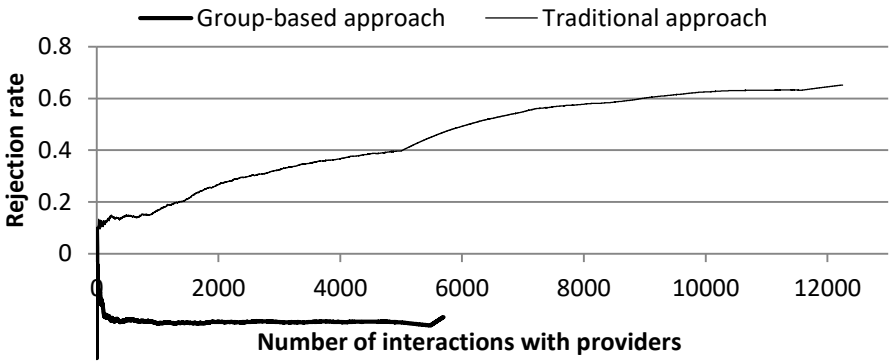



*Fig. 3:* Job rejection rate comparison

However, in terms of a number of interactions, our group-based approach outperforms than the traditional one, since a high number of interactions would require high communication process, which degrades system performance and keep failed users waiting for the following rounds. Our group-based optimization strategy helps to minimize the number of interactions by switching to appropriate groups based on users' optimizations. Even though the traditional approach uses optimization policy, because of not using characterizing jobs and grouping strategy, any provider can receive any job, which minimizes the probability to meet a job requirement by a single provider. The parallel trend of a particular rejection rate with the horizontal axis refers to accepting jobs and keeps the rejection rate constant. For the group-based approach, initially, the rejection rate fluctuates to 0.5. This happens due to rejecting a few jobs in the beginning. Then it abruptly goes down due to starting accepting jobs and almost keeps constant. At the end, some jobs are rejected. This might occur due to unavailable resources or the users reach their maximum budgets without getting their SLAs established. The second result demonstrates the total revenue earned by a provider or a group. It sums only the prices of the accepted jobs. Hence, the total revenue, Erev, is:

$$E_{rev} = \sum_{l=1}^{j} M_l \quad (3)$$

Where *l* denotes the executed job number, *j* denotes a total number of executed jobs and $M_l$ defines agreed price (between a user and a provider) for the $l^{th}$ executed job. For revenue as well group-based approach performs better than the traditional (Figure 4). The variation in a number of interactions can be explained in a similar way as aforementioned. For revenue, it is an upward trend except while rejecting jobs. During rejection the trend keeps constant. For group-based approach, the trend is almost straight, which means jobs are accepted smoothly without many iterations. On the other hand, the trend for traditional approach starts off increasing (accepting jobs) smoothly, then after 5000 interactions (i.e. first round finished by dealing with 5000 users), it stops moving up (rejecting jobs) and gradually going up through a couple of iterations. In the end, for both cases system receives no revenue. The third output illustrates how the resources on provider side are utilized. In this paper, we consider the utilization of storage and CPU. The percentage of utilization, $U_m$ for a resource of type *m* by a provider $A_p$ can be calculated by using the following formula:

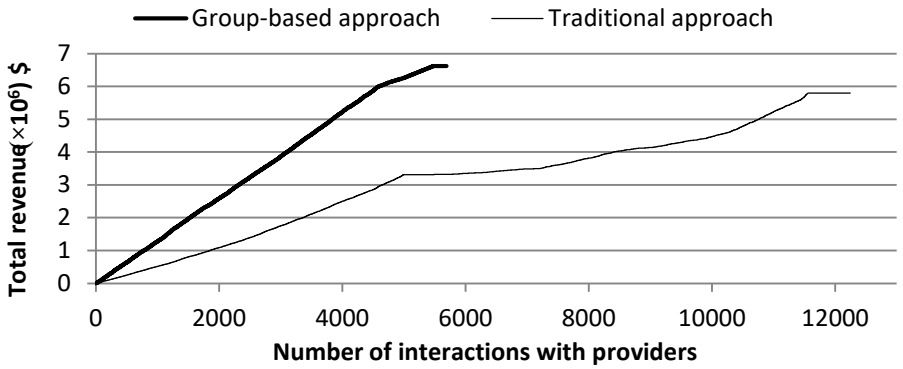



*Fig. 4:* Total revenue comparison

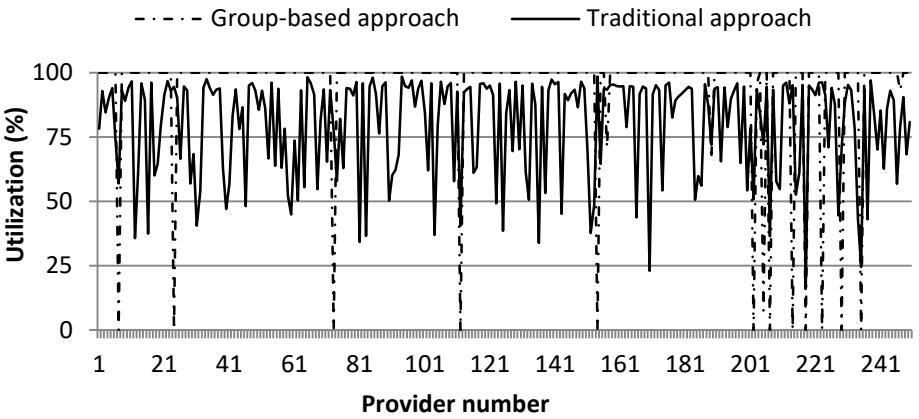



*Fig. 5:* Resource (disk space) utilization comparison

$$U_m(Ap) = [\frac{initial\ resource_m - available\ resource_m}{initial\ resource_m}](Ap) * 100 \quad (3)$$

For resource utilization, we obtain similar patterns for both disk space and processors. Hence, we explain the utilization for disk space only (Figure 5). The simulation pattern illustrates the utilization pattern for 250 providers (along x-axis). Unlikely in the group-based approach, traditional approach does not share resources between providers. Hence, a chance to utilize more resources by a single provider decreases. For example, if a provider is unable to fulfill a user's requirements, the provider has to reject the job, since the provider does not support sharing resources with other providers. On the other hand, in our group-based approach, even if a provider is unable to fulfill a user's requirements, the provider still can communicate with

other providers within the group and share resources. Hence, the chance of accepting jobs and thus utilization resources increases. For group-based approach, most of the providers achieve maximum utilization (100%) and a few of them are unable to utilize any resources. Typically, these providers are dedicated to optimize budget constraint by users and propose highest resource cost. Hence, it becomes hard to optimize budget by these providers and could not able to utilize any resources. However, the traditional grid providers could contribute their resources in a group-based federated grid, since the chance of utilizing maximum resources is higher in the group-based system than the traditional one. For the traditional approach, the trend is scatted across the figure, which implies the adoption of no optimization strategy.

*Example 1:* Resource Optimization. Figure 6 shows the throughput of provider-provider negotiation within group-4 to optimize storage. Due to unavailable resources, user 247 is migrated from group-2 to group-4. 40% of the user's storage demand is met by provider-6 and rest 60% is shared by provider-8. Provider-4 is the group-4 correspondent here.

*Example 2:* Budget Optimization. Figure 7 presents the budget optimization process within group-3. Though provider-4 and provider-6, both accept user 204's *cfp,* user 204 awarded provider-6, since provider-6's asking bid was less than that of provider-4. Please note that provider-6 is appeared in both groups, this is because of taking the two shots from different simulations. In practically, one provider cannot exist within different groups.

```
Optimization: Storage
USER 247 GOES UNDER GROUP 2
MIGRATED TO GROUP 4
RESOURCE SHARING HISTORY:
ResourceType  ProviderNo   (%)Shared
Storage           6            40
Storage           8            60
User 247 dealt with provider 4
```

*Fig. 6:* Resource (storage) optimization

```
Optimization: Cost
USER 204 GOES UNDER GROUP 3
Provider 2 : Not interested with user 204
Provider 4 : Interested with user 204
Provider 6 : Interested with user 204
SLA ESTABLISHED!
User 204 awarded provider 6
```

*Fig. 7:* Budget optimization

The illustrations presented in this paper with the resource configuration in a way such that *"supply is equal to demand"*. However, we conduct simulations with such other scenarios, which are *"supply is greater than demand"* and *"supply is less than demand"*.

*Table 2:* Scenario based comparison between group-based federated grid (GFD) and traditional grid (TG)

| Scenario | Number of users | Number of providers | Task generation time (sec) | | Offer generation time (sec) | | Number of rejected jobs | | Number of iterations | | Net simulation time (sec) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | GFG | TG | GFG | TG | GFG | TG | GFG | TG | GFG | TG |
| Supply = Demand | 5000 | 250 | 4.95 | 8.59 | 1.625 | 1.516 | 213 | 737 | 3 | 7 | 132.76 | 2072.10 |
| Supply > Demand | 4000 | 250 | 4.96 | 5.57 | 5.266 | 2 | 0 | 0 | 3 | 9 | 113.18 | 1984.23 |
| Supply < Demand | 5000 | 200 | 4.65 | 4.17 | 2.547 | 1.453 | 1043 | 1449 | 2 | 5 | 68.23 | 706.72 |

For all three cases, we use the resource configuration according to Table 1. Table 2 demonstrates that our group-based approach outperforms in most cases than the traditional approach. The group-based approach consumes less simulation time, produce less number of iterations, and even rejects fewer jobs in all three scenarios except when supply is greater than demand. Due to more supply compared to demand, the chance of accepting jobs by traditional provider increases.

## VI. Conclusions and Future Work

The vision of grid computing is to collaborating computer resources that are distributed. However, due to the dynamic nature and heterogeneity of these resources, seamless collaboration is hindered. Agents are well known for collaborating distributed resources due to their autonomous and proactive nature in building decisions without human intervention. In this paper, we proposed an agent-based Iterated Contract-net-protocol to deal with users' QoS and providers satisfactions. We characterize users in terms of their preferences and switch them to the groups accordingly. A grouping strategy has been proposed for the federated grid, where grouping formed in terms of providers' availability and users' preferences. Our strategy enabled users to receive a stronger QoS without letting them waiting much. The less number of iterations and thus the less time consumption while negotiating between users and providers provided the justification of our approach. The adoption of such a group-based approach would produce less communication delay while dealing with thousands of users as well as providers. In addition, this would minimize execution uncertainty while ensuring better payoff and resource utilization by providers.

In future, we would like to conduct our experiments in real grid scenarios such as Globus, Nimrod in order to test the real-time adaptability and feasibility of our work. Future work would also extend the characteristic functions to distinguish between users in order to maximize the number of delivering required QoSs. We further would like to experience the agent behavior in terms of dealing with distributed environment and adapting accordingly.

## References Références Referencias


1. C. Massimiliano, G. Stefano, "Resource allocation in grid computing: an economic model", J. WSEAS Trans. Comp., vol. 3 pp.19-27, 2008.
2. H. Izakian, A. Abraham, B.T. Ladani, "An auction method for resource allocation in computational grids", Future Generation Computer Systems, vol. 26, pp.228-235, 2009.
3. W.-C. Ni, L.-C. Liu, C. Wu, "Services selection based on commodity-market in grid workflow", Journal of Computer Applications, vol.27, pp.2973-2975, 2007.
4. C. Isaac, S. Ramon, A. Oscar, J. Liviu, F.R. Omer, "Optimizing decentralized grid markets through group selection", Int. J. Web Grid Serv., vol. 4, pp. 357-366, 2009.
5. A. Di Stefano, C. Santoro, "An economic model for resource management in a Grid-based content distribution network", Future Generation Computer Systems, vol. 24, pp. 202-212, 2008.
6. A. Foster, C. Kesselman, "The grid blueprint for a future computing infrastructure", Morgan Kaufmann, 1999.
7. G. Kunal, G. Arobinda, "Resource Selection in Grids Using Contract Net", in Proceedings of the 16th Euromicro Conference on Parallel, Distributed and Network-Based Processing (PDP 2008), IEEE Computer Society, 2008.
8. R. Rajiv, H. Aaron, B. Rajkumar, "Sla-based cooperative super scheduling algorithms for computational grids", J. ACM Transaction of Autonomous and Adaptive System, 2008.
9. K. R. Ku-Mahamud and H. J. A. Nasir, "Ant Colony Algorithm for Job Scheduling in Grid Computing," 2010 Fourth Asia International Conference on Mathematical/Analytical Modelling and Computer Simulation, Kota Kinabalu, Malaysia, 2010, pp. 40-45. doi: 10.1109/AMS.2010.21
10. Laizhi Wei, Xiaobin Zhang, Yun Li, Yujie Li, " An Improved Ant Algorithm for Grid Task Scheduling Strategy", in International Conference on Applied Physics and Industrial Engineering, vol. 24, pp. 1974-1981, 2012.
11. Sonal Yadav, Amit Agarwal and Ravi Rastogi, "Cost-based Job grouping and Scheduling Algorithm for Grid Computing Environments", International Journal of Computer Applications vol. 91, no.15, pp. 21-27, April 2014.
12. Pinky Rosemarry, Ravinder Singh, Payal Singhal and Dilip Sisodia, "Grouping Based Job Scheduling Algorithm Using Priority Queue and Hybrid Algorithm in Grid Computing", International Journal of Grid Computing & Applications (IJGCA), vol.3, no.4, December 2012.
13. Y. Sallez, T. Berger, C. Tahon, Simulating intelligent routing in flexible manufacturing systems using NetLogo, in: IEEE International Conference on Industrial Technology, pp. 1072-1077, 2004.
14. R.-C. Damaceanu, An agent-based computational study of wealth distribution in function of resource growth interval using NetLogo, Applied Mathematics, and Computation, vol. 201, pp. 371-377, 2008.
15. J.N. Michael, T.C. Nicholson, R.V. Jerry, Experiences creating three implementations of the repast agent modeling toolkit, ACM Trans. Model. Comput. Simul., vol. 16, pp. 1-25, 2006.
16. FIPA Iterated Contract Net Interaction Protocol Specification, in: Foundation for Intelligent Physical Agents, 2000 http://www.fipa.org/specs/fipa00030/

# Global Journals Guidelines Handbook 2018

www.GlobalJournals.org

## FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (FARSC)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSC" title to individuals. The 'FARSC' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

- The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

FARSC accrediting is an honor. It authenticates your research activities. After recognition as FARSC, you can add 'FARSC' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

*The following benefits can be availed by you only for next three years from the date of certification:*

FARSC designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSC title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.


The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.


The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.
Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.


The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

## MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

*The following benefitscan be availed by you only for next three years from the date of certification.*


MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.


We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSC member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.


Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

# Auxiliary Memberships

## Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

*The Institute will be entitled to following benefits:*

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.


The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.


After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

**The following entitlements are applicable to individual Fellows:**


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**

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

**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.

## The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

*Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection*.

*Segment draft and final research paper:* You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

*Written material:* You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

## Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

**Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).**

| Topics | Grades | | |
|---|---|---|---|
| | **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<br><br>Above 200 words | No specific data with ambiguous information<br><br>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

save our planet

# Global Journal of Computer Science and Technology

Visit us on the Web at www.GlobalJournals.org | www.ComputerResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9754350