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Sensor Information

Replication in Mobile Ad-hoc

RSA for Security

Security & Management

Discovering Thoughts, Inventing Future

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Replication in Mobile Ad-hoc Network using Hopfield Network

By Tanu Chawla & Dr. Mukesh Kumar
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Abstract- Mobile Ad hoc Network (MANET) is a network comprises of mobile nodes connected without any centralized administration. Each node in the network has the ability to share a large number of objects with other nodes. The nodes are connected with other nodes to forward a message to other nodes until the search for node that desire meets. This paper represents a new replication method to recover the performance in distributed system. Objects are replicated on different nodes in the network to minimize the search for an object. It is observed that mobility of nodes predicted using SOM (Self Organizing Maps) technique provides less accuracy. This paper represents an algorithm that uses the network parameters as input condition to replicate objects into the nodes. The decision for each node will be taken by gathering the input conditions and feed to the Hopfield Neural Network. It is view that it will provide more accuracy and improve the performance.

Keywords: hop field network, mobile ad hoc networks, neural networks, replication, routing, routing protocols.

GJCST-E Classification : C.2.0

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Replication in Mobile Ad-hoc Network Using Hopfield Network

Tanu Chawla [α] & Dr. Mukesh Kumar [σ]

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I. Introduction

Due to increase in the demand of the computers in our daily life, it increases the demand of connectivity. Through connectivity of various nodes in the network, these nodes in the network can easily share their data or objects. Wired network have been used for a long time. Due to some restrictions of wired network, requirement for the wireless network has been increased for sending messages, emails and communicate with other. So Mobile Ad-hoc Network (MANET) have been developed which comprises of a large number of nodes. In mobile ad-hoc network, nodes can communicates with the other nodes without any need of central administration or base station [2]. MANET is commonly used for all purpose like offices for doing work and colleges for maintain details.

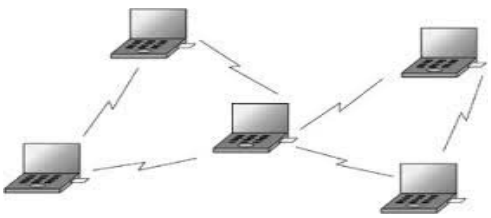

Figure 1 : Example of Mobile Ad hoc Network with having five nodes.

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So today demand for the ad-hoc network enhances. Mobile Ad-hoc Network is an autonomous system of mobile routers which are connected with the wireless links and easily communicate with each other. Each node has the ability to move freely in the network at any place. In Mobile ad-hoc network, each node communicates with its neighbours by forward a query message and establishes the communication between them [3].

This shows that every node acts as a host as well as a router [4]. Such a network may be used for the large number of nodes. So this network is a multi-hoped communication network. In this network, the routing protocols are used to transmit the data between the nodes in the network. MANET is used in many applications such as military services, healthcare [1]. Inside the wired network, when one node goes outside from the network, then it disturbs the whole network and the problem will not easily solved. So these days, people prefers to wireless network

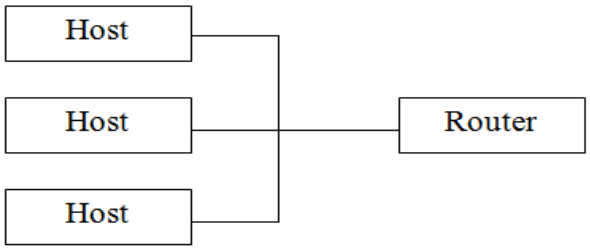


Figure 2 : Block Diagram of Mobile nodes that are act as a host as well as router.

Mobile ad-hoc network is a wireless network topology which is commonly used now-a-days. It consists of a large number of nodes that are linked with each other and share the objects between them. There are a large number of characteristics of MANET [2]. Some of these are summarized as below:

i. Nodes can perform the role of host as well as router.
ii. There is no need of centralized controller and infrastructure.
iii. MANET provides limited security.
iv. This network can be set up anywhere.
v. MANET is a dynamic network topology.
vi. Communication is done without the need of wires.

II. Overview On Data Replication

Data replication is a most useful technique is commonly used today. It is used for improving reliability,

scalability, fault-tolerance and accessibility of data services [6]. It is a technique stored on the multiple locations which reduce the search size. To be most useful, data replication should be invisible to the user. The main improvement of using replication is that if you change only single copy of the data that presents in one node then data available on other nodes changes automatically. This solves a large number of problems. So replication is commonly used.

Maintaining various copies of data is one of the most successful ways to stay away from database availability problems. After failure produced in one database, then you have the ability to use another local copy of the database or you can also competent of use the copy of the database that are present on other site. In networking, replication is well thought-out as a most important method to extend reliability [7].

III. Overview on Artificial Neural Network

Artificial Neural Network (ANN) is a computing system consists of a large number of processing elements which are used to take inputs and then processing takes place and then gives response to the inputs [8]. A large Neural Network consists of a large number of processing elements [9].

Neural network is made up of a number of layers. Layers are prepared by a number of interconnected nodes which include an activation function. Patterns are represented in the network as the input layer, which has links to one or more 'hidden layers' and input layer communicates with middle layer known as hidden layer. In the hidden layer, processing is done through a number of weighted connections. The hidden layer directly linked to an output layer which has the capability to gives response to all the inputs [10].

IV. Role of Replication in Manet

Replication is one of the most important techniques is most commonly used in MANET which allow the nodes to come apart the objects between them. The objective of this technique is to care for a number of object replicas in excess of the time before a node exits in decentralized and amorphous environment [11]. That is the reason that shows the need to replicate objects on the number of nodes that are linked to one another in the network, which is necessary [13].

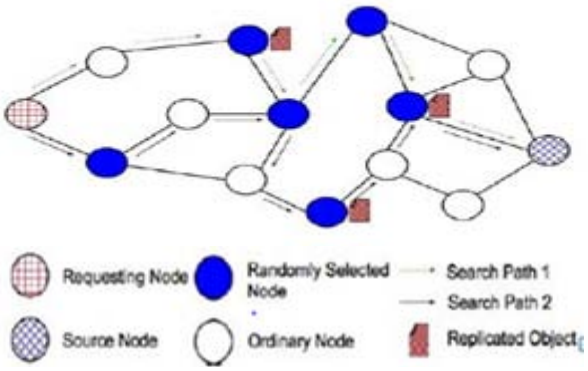


Figure 3 : Shows the replication of nodes in the network.

V. Related Work

We observe a large number of replication techniques that are most commonly used. Some of them are: reactive and proactive replication. Reactive replication is the generally used algorithm. **In reactive replication**, the requesting node has the copy of the object from the source node. After completion of the search, a copy of object is produced into the node where the query was generated. In this type of replication overhead is higher. But the main advantage of using this technique is that it minimizes the storage for replicas, so it provides better results. The only problem with this replication method is more overhead.

In proactive replication, the object is replicated from the node that is requested to the node that is provided only in the selected nodes. Sometimes it is copied along the complete path of the successful query from source node to requested node. It is called as the path replication. After the completion of the query, replication of object is takes place in the complete path from source node to node that are requested [13]. Beyond that a new third type of replication algorithm is developed known as "**random replication**". In random replication, beyond the enquiry is completed, the objects are copied randomly in selective nodes along the path from the requester to the requested node.

VI. Problem Overview

A network consists of a large number of nodes. Each node in the network has the ability to share their objects with other nodes [1]. By using one of the different kinds of search techniques, the location of the data is retrieved. A query for the certain object is initiated to perform the search among nodes. These nodes are linked with one another forward a request message from one node to another node until a search for a certain object is completed. The queries were processed on each node from source node to requested node. The message passes to the various nodes through connection between them until the node that is requested is determined. The nodes which are

used to forward a message from source node to request node is known as the path. The shorter path length has more performance than a longer path.

Replication method is the one of the method to get a good performance in a search on a distributed system [13]. This paper also calculates the predictability of the nodes. The main benefit of mobility prediction is to assign next access point before the mobile terminal leaves its current one which reduces the intrusion time in communication between terminal mobiles. Prediction is implemented using SOM (Self Organizing Maps) technique [13]. But that offers less accuracy. This paper implements new prediction technique which is Hopfield Neural Network technique used in MANET that will offer high accuracy and provide high performance.

VII. Proposed Algorithm

This algorithm is used to replicate the objects randomly on the nodes after the successful search to reduce our search and time and improve the performance of the system. This algorithm depends upon the theory of finding the conditions of the nodes that are moves out of network. According to this scheme, when a request for a certain object is created, and previously it is to be found then this algorithm is used to randomly replicate the objects along the path from source node to the node that is requested. The proposed algorithm uses the hops as an input condition to make the decision for replicate objects into the nodes. The decision made by gathering the input parameters of each node and feed this input parameters into the Hopfield Network technique.

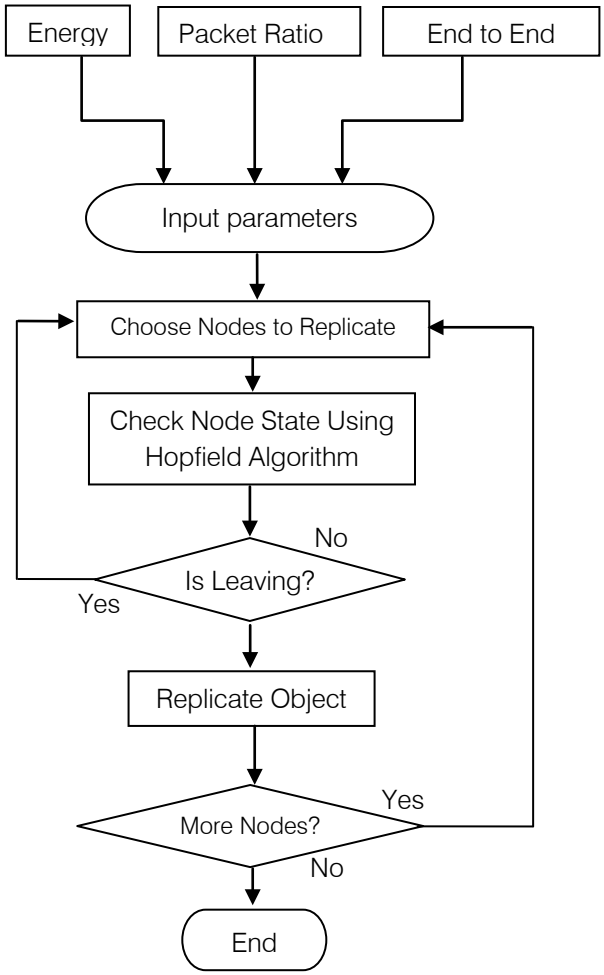
The various steps of the proposed algorithm are as follows:

1. Firstly, a set of input parameters such as packet ratio, energy and E2E delay are gathered as inputs.
2. Then the algorithm has to choose the nodes that are needed to replicate.
3. Then it checks the state of the node using Hopfield Network algorithm.
4. The output "0" is for nodes about to leave the network and "1" for those who have enough time to stay in the network.
5. Once a nodes category is specified, the copy of the requested object is placed for those nodes whose category is set to "1".
6. On the other hand, those nodes which contains the "0" category, the replication scheme ignores the replication of object on that node.
7. Then the category for the next node to be evaluated.
8. The method keeps on going until the requesting node in the random replication is reached.

VIII. Hopfield Network

Hopfield Network is a neural recurrent network which is used to classify input data into groups. The data is trained using the supervised learning. So it gives better performance than using SOM Algorithm.

Flow Chart of the proposed algorithm is



A set of input parameters are fed into Hopfield algorithm as input for each node to classify the input data into the groups. Only two categories of output are produced by Hopfield network for making decisions for the nodes. These are either "0" or "1". The number "0" indicates the nodes about to leave the network and "1" for those who are not going out from the network. When the search for all the data completed, then the random replication is used to replicate the objects randomly from the source node to requested node. It firstly checks the category of each node along the path by using the Hopfield algorithm. After the category for each node is explained, then replication scheme randomly copy the requested object for those nodes whose category is set to "1". On the other hand, the nodes which contain the "0" category, the replication scheme will not produce the replication of object for that node and check the category for the next node. The method keeps on going until the requesting node in the random replication is produced.

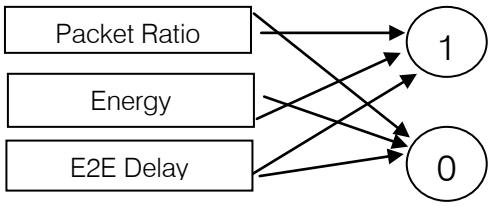


Figure 4 : Example of input parameters are given to the algorithm and produces only two outputs 0 and 1.

The inputs parameters for the nodes are distance energy and round trip time (RTT) and output contains only two values 0 or 1. This process is used for each node until the node that is requested is reached.

a) Distance

In the Mobile Ad-hoc Network, each node must be able to send a message to another node and able to establish the communication between them. Each node in the network sends the message to a node that it is linked is called initial node. The distance between two nodes is intended by using the simple equation which is expressed as:

$$D = \sqrt{[(x(i) - x(i+1))^2 + (y(i) - y(i+1))^2]}$$

Here D shows the distance between two nodes and i shows the initial node from which we want to calculate the distance and sqrt is a square root function which is used to calculate the square root of given value.

b) Round Trip Time (RTT)

The Round Trip Time is the return time measured by sending a packet from the local node to the isolated node. In this paper, this time is used to calculate the performance of the algorithm which is proposed. The Round Trip Time is evaluated by solving the simple equation which is expressed as:

$$RTT = (2*D)/C$$

Here RTT shows the Round Trip Time and D shows the distance between two nodes and C indicates the velocity of light and the velocity of light has the value $3*10^8$ m/s.

c) Energy

Each node in the network wants to communicate with the neighbouring nodes. Each node contains some energy. When the nodes communicate with neighbouring nodes, they consume some energy. Here energy factor is used to calculate the energy which is consumed when the nodes communicates with another nodes.

IX. Results

The performance evaluation of SOM and Hopfield Network was carried out using NS-2.34. For the experiments performed, a variable-size network of size 300 sq m was randomly generated with number of nodes typically in the range of 10-100. The power of the sensor radio transmitter was set so that any node within a 20 meter radius is within communication range and is called a neighbour of the sensor. Hopfield network provides better result than SOM Network.

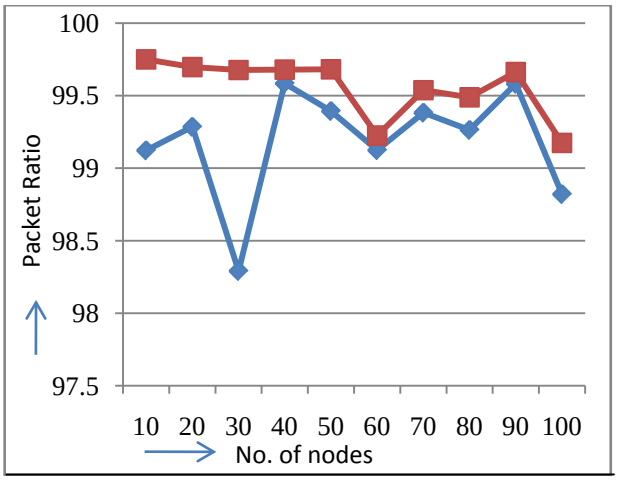


Figure 5 : Indicates the packet delivery ratio produced by SOM and Compare it with the packet ratio of new proposed Hopfield Algorithm.

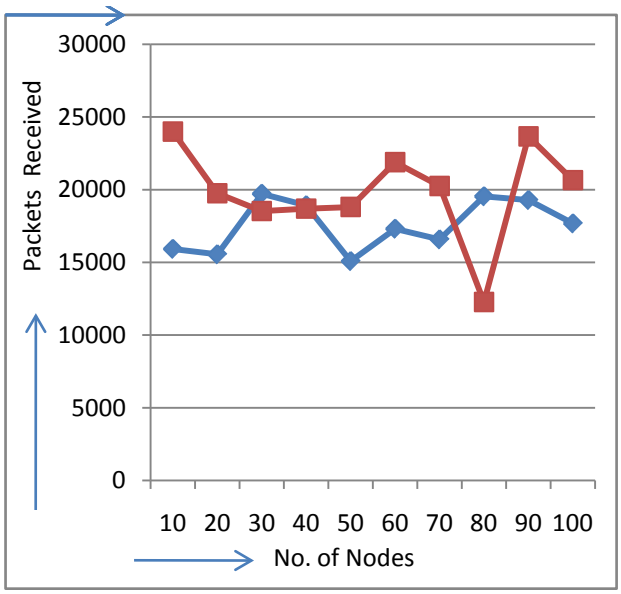


Figure 6 : Indicates the packets received by SOM and Compare it with the packets received by new proposed Hopfield Algorithm.

Table 1

For 100 Nodes in a Network	Packet Delivery Ratio	End to End Delay
Existing Algorithm	98.8202	474.827
Proposed Algorithm	99.1743	362.867

It shows the packet delivery ratio and E2E Delay generated by SOM Algorithm using 100 nodes and compares it with the packet delivery ratio and E2E Delay generated by Hopfield Algorithm.

Table 2

For 100 Nodes in a Network	Generated Packets	Received Packets
Existing Algorithm	17885	17674
Proposed Algorithm	20830	20658

It shows the Generated and Received Packets by SOM Algorithm using 100 nodes and compares it with the Generated and Received Packets by Hopfield Algorithm.

X. Conclusion and Future Work

This paper has proposed a scheme that is used for replicating objects on various nodes in a shapeless, self-configuring and self-motivated network, which randomly replicate the objects by determining the states of the node. If the status of the node is 1, which means that object is replicated for that node and status 0 indicates that object is not replicated for that node. For this, we proposed a new algorithm. The proposed algorithm tries to increase the accuracy and enhance the performance in MANET. As a result, data will be available at more nodes and it will be accessible vastly. Due to this, it will improve the performance of the network and provides more accuracy.

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Efficient use of Mobile Agents for Network Security & Management

By S. V. Patil, Dr. S. D. Khamitkar & S. N. Lokhande
SRTM University, India

Abstract- Mobile agents have special characteristics which can help intrusion detection in several ways. The use of mobile codes and mobile agent based computing paradigms has been proposed in several researches till date. In this paper we try to present a scope for the possible association of Mobile Agents in the field of network security and management.

Keywords: *mobile agent, network security, intrusion detection.*

GJCST-E Classification : *C.2.0*

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Keywords: mobile agent, network security, intrusion detection.

I. Introduction

Mobile Agents are composition of computer software and data which migrates from one computer to another. While doing this, they continue their itinerary up to the home computer. Autonomy and mobility are main features of mobile agents, specifically mobile agent is a process where mobile agent moves from one environment to another environment, with remains data intact. Mobile agent it self decides when and where to move. When a mobile agent decides to move then they save their own state and this state transport to another host. Mobile agents are specific about mobile code and they are choose the host and also active in respect of execution [1,4].

Mobile agents have special characteristics which can help intrusion detection in several ways. The use of mobile code and mobile agents computing paradigms have been proposed in several researches. The advantages include: overcoming network latency, reducing network load, executing asynchronously and autonomously, adapting dynamically, operating in heterogeneous environments, and having robust and fault-tolerant behavior. Moreover implementation of mobile agents in languages such as JAVA, provides mobile agents with system and platform independence and considerable security features [1,7].

As computer network is a collection of autonomous connected computers and other communication devices used for sharing resources or computers uses wired or wireless links as transmission media. Network security is an important task that must be seriously considered when designing a network. Network security is defined as the policies and procedures followed by a network administrator to protect the network devices from threats and simultaneously the unauthorized users must be prevented from accessing the network[2]. Maintaining Network security is a broad subject means securing our network from unauthorized entity or Mal ware. The unauthorized entity may modify the information or accessing the network through remote computer may harm the network. Following are some network security measures,

1. ***Availability :*** The term Availability means that a node should maintain its ability to provide all the designed services regardless of the security state of it.
2. ***Integrity :*** Integrity guarantees the identity of the messages when they are transmitted.
3. ***Confidentiality :*** Confidentiality means that certain information is only accessible to those who have been authorized to access it.
4. ***Authenticity :*** Authenticity is essentially assurance that participants in communication are genuine and not impersonators.
5. ***Non repudiation :*** Non repudiation ensures that the sender and the receiver of a message cannot disavow that they have ever sent or received such a message.
6. ***Authorization :*** Authorization is a process in which an entity is issued a credential, which specifies the privileges and permissions it has and cannot be falsified, by the certificate authority.

II. Literature Review and Findings

In this section we are reviewing some literature related with Mobile agent and Network management and security. Once the mobile agent has migrated, the connection between the client and server is disconnected, later when mobile agent finishes its job at the server, then it will reconnect to the client or host. This clearly saves the network bandwidth especially in the wireless environment where disconnection is frequent and bandwidth play a major role[3]. A Mobile agent (MA) is a composition of computer software and data which is able to migrate (move) from one computer to another autonomously and continue its execution on the destination computer. Taking the recent development i.e. going to this field, mobile agent based intrusion detection system is an efficient way to the intrusion detection in the distributed environment. [4] . Mobile agents perform a task by migrating and executing on several hosts connected to the network. For the sniffer

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detection, the network administrator sends some special types of mobile agents in the network and collects information from different nodes. After analyzing this information the network administrator can identify the computer system running in promiscuous mode. [5] In [1] evaluate the implications of applying mobile agent technology to the field of intrusion detection and present a distributed intrusion detection system (IDS) based on mobile agents that considers large-scale network environment in order to monitor multiple hosts connected via a network as well as the network itself. Once system will be operational it will be the first comprehensive real–life application using mobile agents that will not only provide security to network resources but also provide security and protection to the mobile agents system itself. The system efficiently solves several problems with the existing IDS/IPS solutions: it can detect new vulnerabilities, it can process and filter large volumes of logs, it reacts to intrusions in real–time, provides protection against unknown attacks, supports and improves IDS/IPS commercial products by different vendors, and handles software patches. The system not only improves the existing IDS/IPS solutions, but it also eliminates several of their core problems. In addition, it is self protected by full encryption, both mobile agents and their platforms, and therefore not vulnerable to attacks against its own components and resources. [6]

III. Discussions on Network Security & Management using Mobile Agents

There exist many contemporary approaches for network security categorized as Host based and Network based. However, they work for Intrusion detection and not for overall security management. As mentioned earlier, Mobile Agents can be useful in such places where we need network security as well as network management. We can use different mobile agents for securing the network from the threats as well as detect the threats. For example, network sniffing detector mobile agent used to find the network sniffer program in the network. Mobile agents can be used in above context as follows:

a) ***Network load Reducing*** *:* Due to the multiple interactions in network, it creates excess network traffic. A mobile agent through the package conversation they dispatches the packets on the destination host at that time locally interaction happens and it helps to reduce the network load.

b) ***Overcome Network Latency*** *:* In real time systems, with the help of mobile agents overcome the network latency, because mobile agents dispatches from central controller and acts locally.

c) ***Tolerant to Network Faults*** *:* Without active connection between clients and server mobile agents can operate.

d) ***Encapsulate Protocols*** *:* When data is being exchanged in network at that time every host has a code, for this code needs protocols e.g. incoming and outgoing. When these protocols needs security at that time protocol code becomes heavy and creates problems. Mobile agents move on the remote host and using specific channels creates new protocols.

e) ***Execute Asynchronously and Autonomously*** *:* It is possible to embedded different tasks in the mobile agents and may be dispatched on the hosts. When agents are dispatched they becomes independent from the process and due to this mobile agents become asynchronous and autonomous.

f) ***Adapt Dynamically*** *:* Mobile agents have their own sense about execution environment, because they reacts autonomously with the changes. They solve specific problem in the network by their own.

g) ***They are Naturally Heterogeneous*** *:* Network computing is itself heterogeneous in respect of hardware and software; therefore mobile agents are also heterogeneous in nature. [7]

In case of network management, the Mobile agents assist to the network administrator to manage the network security. For security management mobile agent's team launched in the network this team visits to all the computers in the network and different services security software analyzes and install. For this mobile agents uses following techniques

1. Connectivity and states of remote hosts are checked and reported.
2. Configuration of remote hosts are cheeked and recorded.
3. Security configuration management related tasks are applied.
4. Mapping of snort rules and identified vulnerabilities.

For completing the above four function mobile agents team automating launched, these teams interact with the all system and install security tools on the remote hosts and complete the desired network security management tasks.

Similarly we can detect intrusions also. Intrusion detection is implemented by an intrusion detection system and today there are many commercial intrusion detection systems available. In 1987 Dorothy E. Denning proposed intrusion detection as is an approach to counter the computer and networking attacks and misuses. In general, most of these commercial implementations are relative ineffective and insufficient, which gives rise to the need for research on more dynamic intrusion detection systems[8].Mobile agents plays very important role in the network security. Mobile agent searches the malicious activity in the network, for these work mobile agents provides following three groups.

1. Analysis of large volume of data in various logs generation of effective reports.
2. Detection of and reaction to host based intrusion attempts in real time.
3. Detection of and reaction in real time of distributed intrusion attempts.

For completing the above three functions the different mobile agent teams assembled and launched. The capacity of these teams to analyses the logs, these logs created from sensors e.g. Snort, Osiris and MS Windows firewall which are present on the host computers.[6] Mobile agent reaches on the remote hosts, analyses the logs and if any serious problem then reports to the security administrator. At the same time second team of mobile agent reaches on the remote host and continuously snorts, monitor and analyze, if this team finds any suspicious activity calls the new mobile agents and lastly the third team of mobile agents detects intrusion activity.

Above case can be extended for Distributed systems also. Today, computer system has evolved into a distributed computing machine, nothing is static now, not even the security threats and attacks. The security issues are of high concern today. In the world of open environment problem faced widely by the computer system and network is the network intrusion. [4] Intrusion detection system is the security mechanism that gathers and analyses the information to detect unwanted attempts of accessing and manipulating the user and system activities and report it to the management section.

As an example, MAIDS was developed by Lowa State University is a distributed IDS based on mobile agent technology. It build a model for an intrusion activity with software fault tree analysis (SFTA), and transform the SFTA model into intrusion detection by the use of Colored Petri net (CPN). Intrusion detection in MADIS is not only relied on direct linked neighbors of a particular host but also other hosts in the network. In this way the original host can obtain more information to achieve a more accurate decision. Mobile agent may enhance the performance of IDS and even offer IDS some new capabilities, however these benefits is not easy obtained. We could learn from these existing system that there are three main research areas in IDS with mobile agent technologies, MAIDS can gather information not only from neighbors of the compromised hosts but from more other hosts in the network that can lead to more accurate final decision.[9]

IV. Conclusion

Mobile agent provides an interestingly new way of network security & management. However, the security, infrastructure and standardizing issues still represent significant constraints. The main thing from our findings is that mobile agent has the potential in increasing the performance of network management. Due to its nature of being an innovative way from the programming environment, but some work is still required.

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PEGASIS-E: Power Efficient Gathering in Sensor Information System Extended

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Abstract- In this paper, an improved energy efficient PEGASIS based protocol (PEGASIS-E) has been proposed. PEGASIS-E uses average distance among the sensor nodes as the criteria for chaining, thereby providing better performance in terms of energy dissipation and amount of information sent to BS. The simulation results obtained show that PEGASIS-E gives an increase in the network lifetime as compared to PEGASIS.

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PEGASIS-E: Power Efficient Gathering in Sensor Information System Extended

Vibha Nehra [α] & Ajay K. Sharma [σ]

Abstract- In this paper, an improved energy efficient PEGASIS based protocol (PEGASIS-E) has been proposed. PEGASIS-E uses average distance among the sensor nodes as the criteria for chaining, thereby providing better performance in terms of energy dissipation and amount of information sent to BS. The simulation results obtained show that PEGASIS-E gives an increase in the network lifetime as compared to PEGASIS.

I. Introduction

Advances in wireless communication have made possible the development of wireless sensor networks consisting of devices called sensor nodes. Sensor nodes are low power, small size & cheap devices, capable of sensing, wireless communication and computation [1,2]. Applications of wireless sensor network include monitoring of harsh inhospitable, remote geographical locations like toxic urban industrial locations or a surveillance field. Other applications may include office automation, robot control, smart homes, interactive toys, identification and personalization [3].

A sensor network consists of hundreds & thousands of sensor nodes deployed in a geographical region. These nodes collectively form a high level description of event being sensed, which is further forwarded to a distant base station (BS), so that end user can access the available information. Energy awareness and computational feasibility are the key parameters that need to be addressed while designing protocols in resource constrained sensor networks. Variation in distance of nodes from BS and differences in internodal distances are primary antecedents causing unequal energy dissipation among the nodes. Thus, energy difference among the nodes increases with time resulting in deterioration of network performance [4]. PEGASIS (Power Efficient GAthering in Sensor Information System) is a chain based protocol [5] which has certain deficiencies like long chaining time in the process of greedy chain formation, inevitability of long links as well as abrupt death pattern of nodes in the network.

In recent years, researchers have proposed numerous improved algorithms based on PEGASIS such as PEG-ant [6], EEPB [7], IEEPB [8]. Among these EEPB adopts a threshold for chain formation to avoid the formation of long links LL, but this threshold is still uncertain and complex to determine, which induces LL, if not valued appropriately [7]. Likewise, IEEPB compares distance between the nodes twice, finds the shortest path to link two adjacent nodes & avoids the formation of LL between the neighbors [8]. The work in this paper introduces a PEGASIS based routing protocol called PEGASIS-E. PEGASIS-E computes average distance among the nodes and sets it as radio range for the farthest node from the BS. Then, it chains all the nodes in the radio range. Further, it compares the distance of all the chained nodes to find the nearest next end node to continue the chaining process. The simulation results show that PEGASIS-E outperforms PEGASIS.

The rest of the paper is organized as follows: section II explains the radio energy dissipation model, section III gives the network model and assumptions used followed by section IV which describes PEGASIS-E. Section V lists the performance metrics used for the simulation. Section VI describes the results obtained. Section VII concludes the paper.

II. Radio Energy Dissipation Model

In the radio energy model [9, 10], the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics as shown in Figure 1.

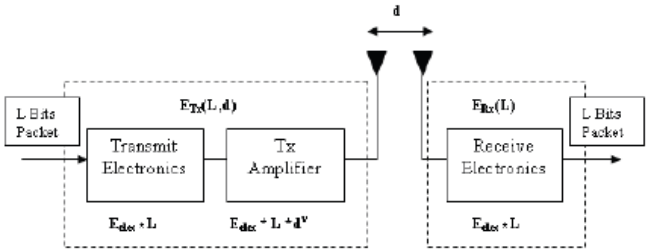

Figure 1 : Radio Energy Dissipation Model

Here both the free space (d^2 power loss) and the multipath fading (d^4 power loss) channel models are used, depending on the distance between the transmitter and receiver [9, 10]. Power control can be used to invert this loss by appropriately setting the power amplifier—if the distance is less than a threshold d_o, the free space model is used; otherwise, the multipath model is used. Thus, to transmit an L-bit message a distance, the radio expends

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$$E_{Tx}(L, d) = \begin{cases} L.E_{elect} + L.E_{fs}.d^2 & \text{if } d < d_o \\ L.E_{elect} + L.E_{amp}.d^4 & \text{if } d >= d_o \end{cases}$$

The electronics energy, E_{elec}, depends on factors such as the digital coding, modulation, filtering, and spreading of the signal, whereas the amplifier energy, $E_{fs}.d^2$ or $E_{amp}.d^4$, depends on the distance to the receiver and the acceptable bit-error rate [9, 10]. Value of threshold distance d_o is given by

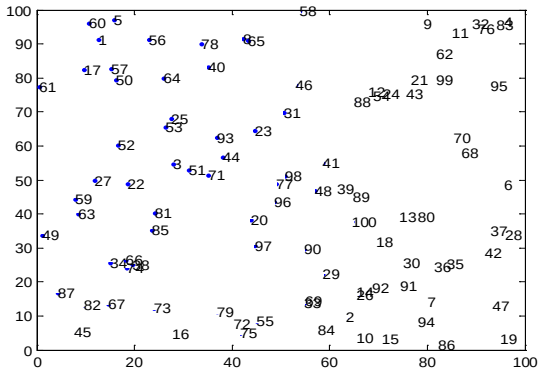
$$d_o = (E_{fs}/E_{mp})$$

And to receive this message, the radio expends energy equivalent to

$$E_{rx}(L) = L \times E_{elec}$$

III. Network Model

Our sensor network consists of 100 nodes in a 100 x 100 sensor field as shown in Figure 2



For Simplicity, we have taken following Assumptions [2, 8]:

- All nodes are static.
- All nodes have power control capabilities, and each node can change the power level and communicate with BS directly.
- BS is located far away from the sensor field and at a fixed location.
- For a given signal to noise ratio, symmetric radio channel, making the energy required to transmit from one point to another and in reverse direction identical.
- Nodes always have data to send.
- Every sensor node generates a fixed size packet and forwards it to next node in the chain.
- BS schedules transmission based on TDMA to avoid collision.

IV. PEGASIS-E

PEGASIS-E is a improved chain based routing algorithm which operates in rounds. It consists of 3 stages: (1) Chain construction phase, (2) leader selection phase, (3) data transmission phase.

a) Chain Construction Phase

The algorithm uses the following steps to form a chain:

a) Initialize the network parameters. Determine the number of nodes, initial energy, BS location information et al. Then, the chain construction starts.
b) BS broadcasts the whole network a *hello* message to obtain basic network information such as ID of nodes alive, distance of each node to BS, and distance among the nodes.
c) Set the node farthest from BS as *end node*, it joins the chain first and is labeled as node 1.
d) Calculate average distance between the alive nodes, D_{avg} and set it as the radio range for *end node*.
e) Join all the nodes to the chain which have not joined the network and lies in the radio range.
f) Compare distance of all nodes joined in the chain to calculate the minimum distance node.
g) Set the selected node as new *end node*.
h) Repeat steps e), f), g) till all the nodes have joined the chain.

The chain building scenario in PEGASIS-E for a network of 100 nodes randomly arranged is shown in figure 3.

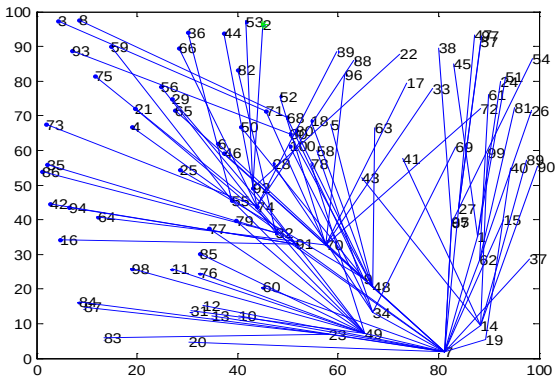


Figure 3 : The chain formed in PEGASIS-E

b) Leader Selection Phase

Leader selection in PEGASIS-E is same as that of PEGASIS [5]. Node which transmits the data from the chain is called a leader. Leader will be in some random position *j* on the chain. Nodes take turns transmitting to the BS, and will use node number *i* mod N (N represents the number of nodes) to transmit to the BS in round *i*. Therefore, the leader in each round of communication will be at a random position on the chain, for node deaths at random locations. This concept of random node deaths on the chain ensures robustness of the network towards failures.

c) Data Transmission Phase

Data transmission starts on successful construction of chain and leader node selection. Leader node initiates a token passing approach to start data

transmission from nodes which have just one link. Each node delivers its own sensed data to its neighbor node in the chain during their time slots assigned by TDMA mechanism. Then, the neighbor nodes fuse the received data with their own data & forwards further towards the leader. One round will end until BS receives data from the leader. In addition, it is assumed that chain is rebuilt when a node of the chain dies during simulation of experiment.

V. Performance Metrics

The number of Nodes Alive, number of Packets received at BS, Energy consumed per round & Total Residual Energy of the sensor network are the performance parameters that have been used to study and evaluate the performance of the proposed protocol.

- *Number of alive nodes :* This instantaneous measure reflects the total number of nodes and that of each type that has not yet expended all of their energy.
- *Data Packets received at base station :* It is total number of data packets or messages that are received by the base station. This is also a measure of amount of information sent to BS from the sensor field. This measure varies linearly for all protocols.
- *Energy consumed :* It measures the instantaneous amount of energy being consumed in the network per round. This is simply the energy difference from the beginning till the end of a round.
- *Network residual energy :* It measures the total remaining energy of the network. It is calculated at each transmission round of the protocol.

The metrics used allow us to conclude about the stability of the network which is the time interval from the start of network operation until the death of the last sensor node. The lifetime of the network defined as the number of rounds until the last node die is simply the operational period of the network that is the period for which the network continues to provide information to the BS.

VI. Results and Discussions

Table 1 : System parameters value

Parameter	Value
Network Size	100 X 100 meter^2
Sink	(50,300)
Number of Nodes	100
Initial Energy of Node	0.50 J
E_{elect}	50 nJ/bit
E_{fs}	10 pJ/bit/m^2
E_{mp}	0.0013 pJ/bit/m^4
E_{fusion}	5 nJ/bit/message
Data Packet	2000 bits

This paper uses MATLAB as simulator to evaluate the performance of PEGASIS-E. The system parameters used in the simulation are shown in the table 1 [1,5,9, 10].

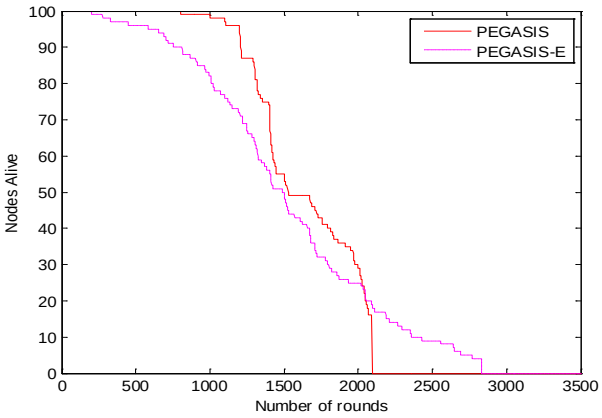


Figure 4 : Number of nodes a live

Figure 4 depicts the number of alive nodes in the network. It is observed that PEGASIS-E has a stable lifetime as compared to PEGASIS. The lifetime period of PEGASIS-E before the death of first node is less, but it continues to provide information about the sensor field for a longer period of time. PEGASIS shows abrupt death of nodes due to almost same energy dissipation in all nodes, as they consume same amount of energy in each round. While in PEGASIS-E, energy dissipation is different in every round. It is higher for end node.

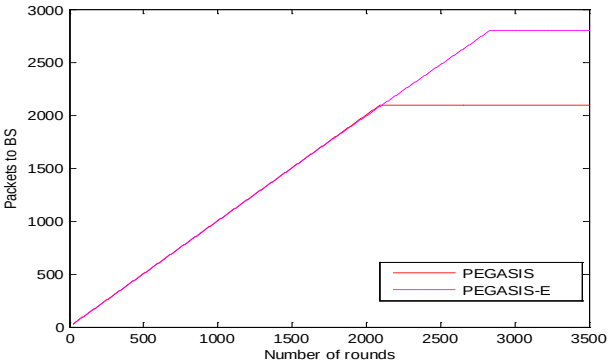


Figure 5 : Number of Packets to BS

Figure 5. indicates a clear gain of 34% in number of Packets sent to BS for PEGASIS-E as compared to PEGASIS. This is because death pattern of nodes in PEGASIS-E is such that a sub section of sensor field is not clearly cut-off after the death of certain nodes, leading to the availability of sensed data for a longer period of time.

Figure 6. shows energy consumption of PEGASIS-E. It is concluded that PEGASIS-E consumes less energy compared to PEGASIS because the number of nodes to be covered becomes less due to death of nodes with simulation time.

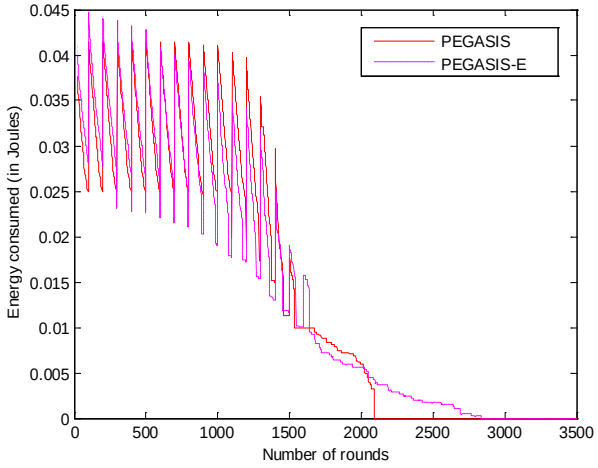


Figure 6 : Energy consumed over time.

Figure 7 depicts that PEGASIS-E has a balanced energy dissipation and more stable lifetime.

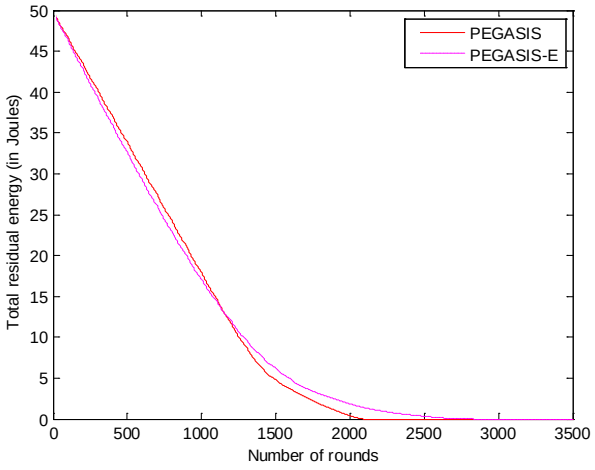


Figure 7 : Total residual energy

VII. Conclusion

This paper proposes an improved energy-efficient PEGASIS based protocol PEGASIS-E, which not only provides a set threshold, D_{avg} for chaining but also simplifies the complexity of chain construction. Moreover, the chaining speed of PEGASIS-E is faster than PEGASIS. The novel algorithm avoids the formation of LL and provides a stable and balanced lifetime to the network. The simulation results prove that PEGASIS-E outperforms PEGASIS by achieving higher energy-efficiency extending lifetime of network.

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A Study of Encryption Algorithms AES, DES and RSA for Security

By Dr. Prerna Mahajan & Abhishek Sachdeva
IITM, India

Abstract- In recent years network security has become an important issue. Encryption has come up as a solution, and plays an important role in information security system. Many techniques are needed to protect the shared data. The present work focus on cryptography to secure the data while transmitting in the network. Firstly the data which is to be transmitted from sender to receiver in the network must be encrypted using the encryption algorithm in cryptography. Secondly, by using decryption technique the receiver can view the original data. In this paper we implemented three encrypt techniques like AES, DES and RSA algorithms and compared their performance of encrypt techniques based on the analysis of its stimulated time at the time of encryption and decryption. Experiments results are given to analyses the effectiveness of each algorithm.

Keywords: DES, RSA, AES, encryption, decryption, private key encryption, public key encryption, cryptography.

GJCST-E Classification : E.3

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Dr. Prerna Mahajan [α] & Abhishek Sachdeva [σ]

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I. Introduction

Many encryption algorithms are widely available and used in information security. They can be categorized into Symmetric (private) and Asymmetric (public) keys encryption. In Symmetric keys encryption or secret key encryption, only one key is used to encrypt and decrypt data. In Asymmetric keys, two keys are used; private and public keys [1]. Public key is used for encryption and private key is used for decryption (e.g. RSA). Public key encryption is based on mathematical functions, computationally intensive. There are many examples of strong and weak keys of cryptography algorithms like DES, AES. DES uses one 64-bits key while AES uses various 128,192,256 bits keys [2].

Asymmetric key encryption or public key encryption is used to solve the problem of key distribution. In Asymmetric keys, two keys are used; private and public keys. Public key is used for encryption and private key is used for decryption (E.g. RSA and Digital Signatures). Because users tend to use two keys: public key, which is known to the public and private key which is known only to the user[2]. There is no need for distributing them prior to transmission. However, public key encryption is based on mathematical functions, computationally intensive and is not very efficient for small mobile devices [3]. Asymmetric encryption techniques are almost 1000 times slower than Symmetric techniques, because they require more computational processing power [4].

This study evaluates three different encryption algorithms namely; AES, DES and RSA. The performance measure of encryption schemes will be conducted in terms of encryption and decryption time such as text or document[5].

II. Encryption Algorithms

Encryption is a well known technology for protecting sensitive data. Use of the combination of Public and Private Key encryption to hide the sensitive data of users, and cipher text retrieval [6].

a) Data Encryption Standard (DES)

DES (Data Encryption Standard) algorithm purpose is to provide a standard method for protecting sensitive commercial and unclassified data. In this same key used for encryption and decryption process [7].
DES algorithm consists of the following steps

i. *Encryption*

1. DES accepts an input of 64-bit long plaintext and 56-bitkey (8 bits of parity) and produce output of 64 bit block.
2. The plaintext block has to shift the bits around.
3. The 8 parity bits are removed from the key by subjecting the key to its Key Permutation.
4. The plaintext and key will processed by following

i. The key is split into two 28 halves
ii. Each half of the key is shifted (rotated) by one or two bits, depending on the round.
iii. The halves are recombined and subject to a compression permutation to reduce the key from 56 bits to 48 bits. This compressed keys used to encrypt this round's plaintext block.
iv. The rotated key halves from step 2 are used in next round.
v. The data block is split into two 32-bit halves.
vi. One half is subject to an expansion permutation to increase its size to 48 bits.
vii. Output of step 6 is exclusive-OR'ed with the 48-itcompressed key from step 3.
viii. Output of step 7 is fed into an S-box, which substitutes key bits and reduces the 48-bit block back down to 32-bits.
ix. Output of step 8 is subject to a P-box to permute the bits.

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x. The output from the P-box is exclusive-OR'ed with other half of the data block. k. The two data halves are swapped and become the next round's input.

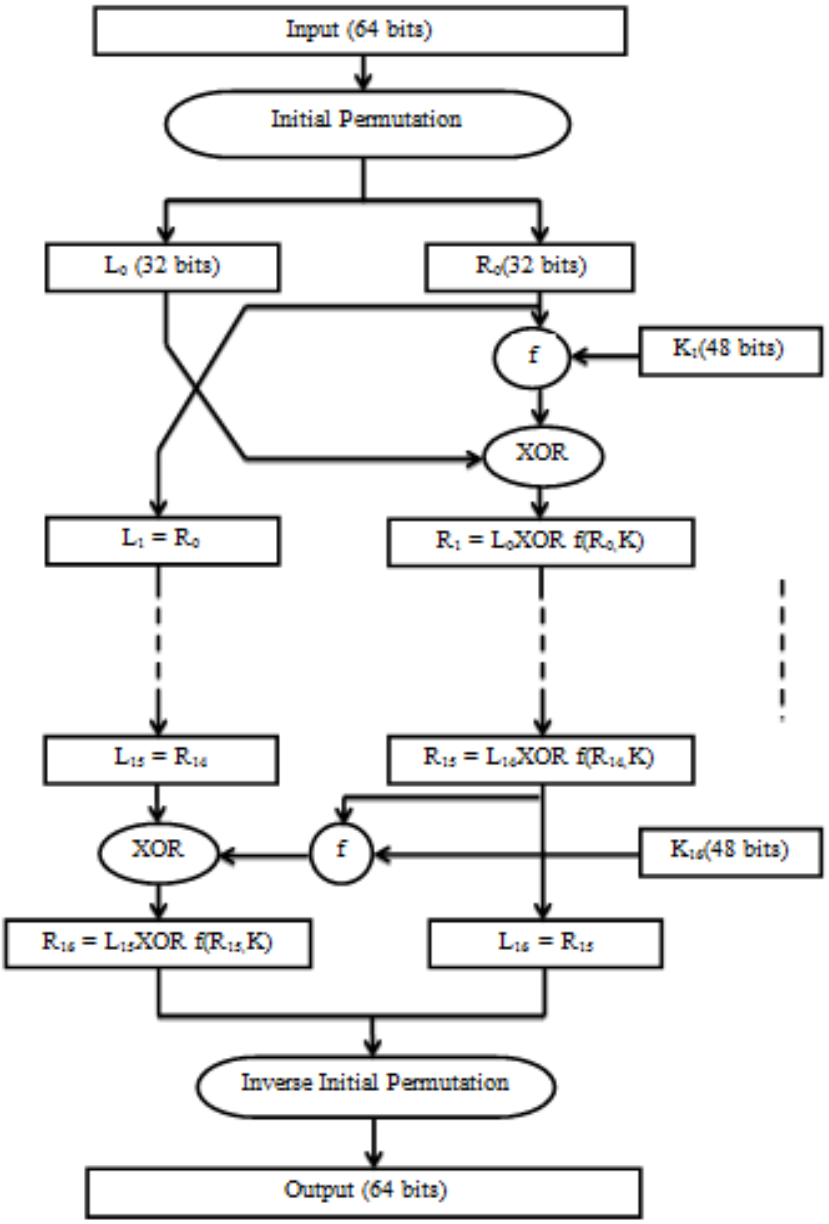

Figure 1 : Diagram of DES Algorithm

b) Advanced Encryption Standard (AES)

Advanced Encryption Standard (AES) algorithm not only for security but also for great speed. Both hardware and software implementation are faster still. New encryption standard recommended by NIST to replace DES. Encrypts data blocks of 128 bits in 10, 12 and 14 round depending on key size as shown in Figure - 2. It can be implemented on various platforms specially in small devices. It is carefully tested for many security applications.

i. ***Algorithm Steps :*** These steps used to encrypt 128-bit block

1. The set of round keys from the cipher key.
2. Initialize state array and add the initial round key to the starting state array.
3. Perform round = 1 to 9 : Execute Usual Round.
4. Execute Final Round.
5. Corresponding cipher text chunk output of Final Round Step

ii. *Usual Round :* Execute the following operations which are described above.

1. Sub Bytes
2. Shift Rows
3. Mix Columns
4. Add Round Key , using K(round)

iii. *Final Round:* Execute the following operations which are described above.

1. Sub Bytes
2. Shift Rows
3. Add Round Key, using K(10)

iv. *Encryption :* Each round consists of the following four steps:

i Sub Bytes : The first transformation, Sub Bytes, is used at the encryption site. To substitute a byte, we interpret the byte as two hexadecimal digits.

ii Shift Rows : In the encryption, the transformation is called Shift Rows.

iii Mix Columns : The Mix Columns transformation operates at the column level; it transforms each column of the state to a new column.

iv Add Round Key : Add Round Key proceeds one column at a time. Add Round Key adds a round key word with each state column matrix; the operation in Add Round Key is matrix addition.

The last step consists of XO Ring the output of the previous three steps with four words from the key schedule. And the last round for encryption does not involve the "Mix columns" step. [8]

v. *Decryption:* Decryption involves reversing all the steps taken in encryption using inverse functions like a) Inverse shift rows, b) Inverse substitute bytes, c) Add round key, and d) Inverse mix columns.

The third step consists of XO Ring the output of the previous two steps with four words from the key schedule. And the last round for decryption does not involve the "Inversemix columns" step.

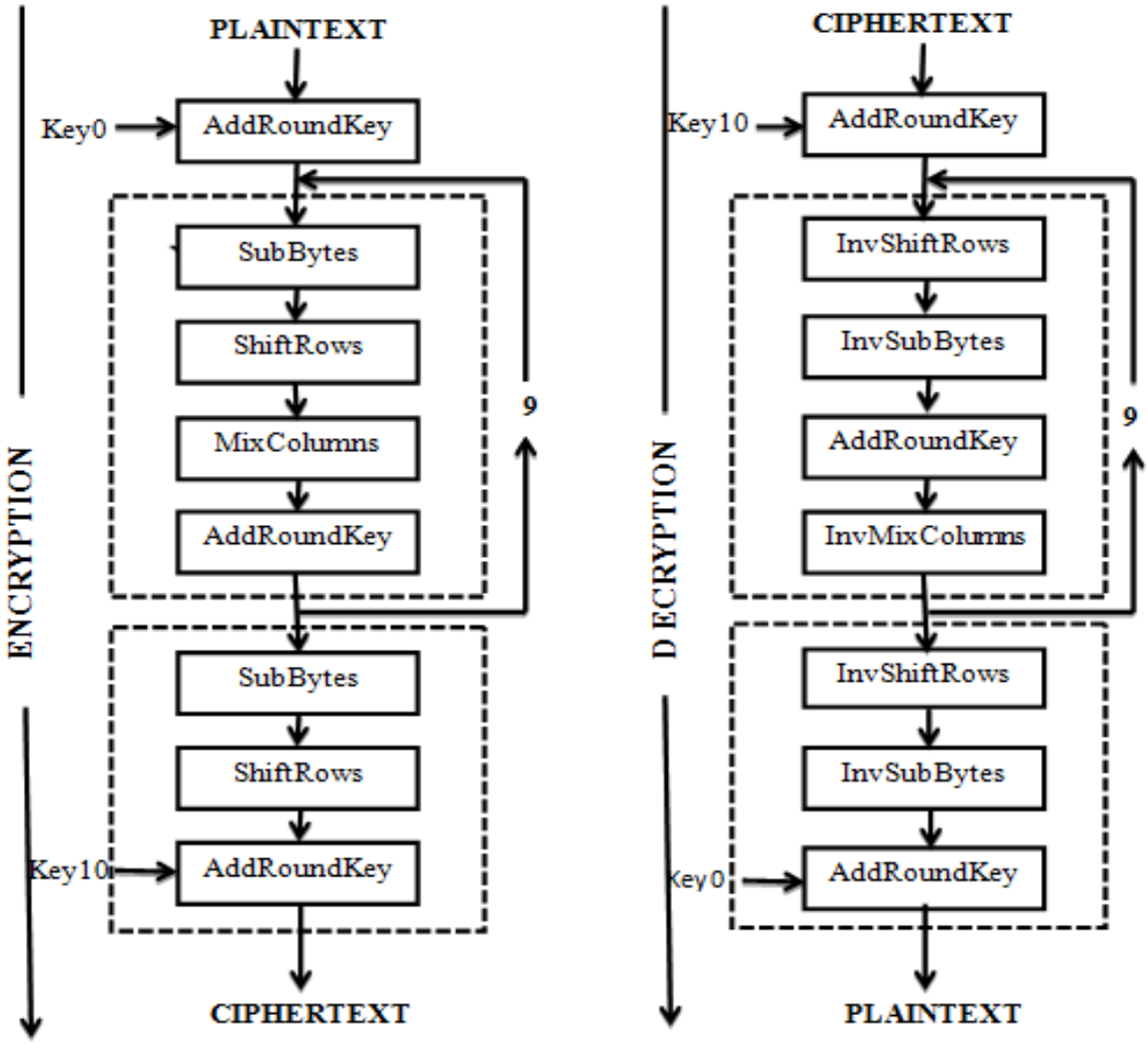

Figure 2 : AES Encryption and Decryption

c) Rivest-Shamir-Adleman (RSA)

RSA is widely used Public-Key algorithm. RSA firstly described in 1977. In our proposed work, we are using RSA algorithm to encrypt the data to provide security so that only the concerned user can access it.

RSA algorithm involves these steps:

1. Key Generation
2. Encryption
3. Decryption

i *Key Generation*

Before the data is encrypted, Key generation should be done. [9]

Steps:

Generate a public/private key pair :

1. Generate two large distinct primes p and q
2. Compute $n = pq$ and $\varphi = (p-1)(q-1)$
3. Select an e, $1 < e < \varphi$, relatively prime to φ.
4. Compute the unique integer d, $1 < d < \varphi$ where $ed \equiv_{\varphi} 1$.
5. Return public key (n, e) and private key d

ii *Encryption*

Encryption is the process of converting original plain text (data) into cipher text (data).

Encryption with key (n , e)

1. Represent the message as an integer $m \in \{0, \ldots, n-1\}$
2. Compute $c = m^e \bmod n$

iii *Decryption*

Decryption is the process of converting the cipher text (data) to the original plain text(data). [10]

Decryption with key d: compute $m = c^d \bmod n$

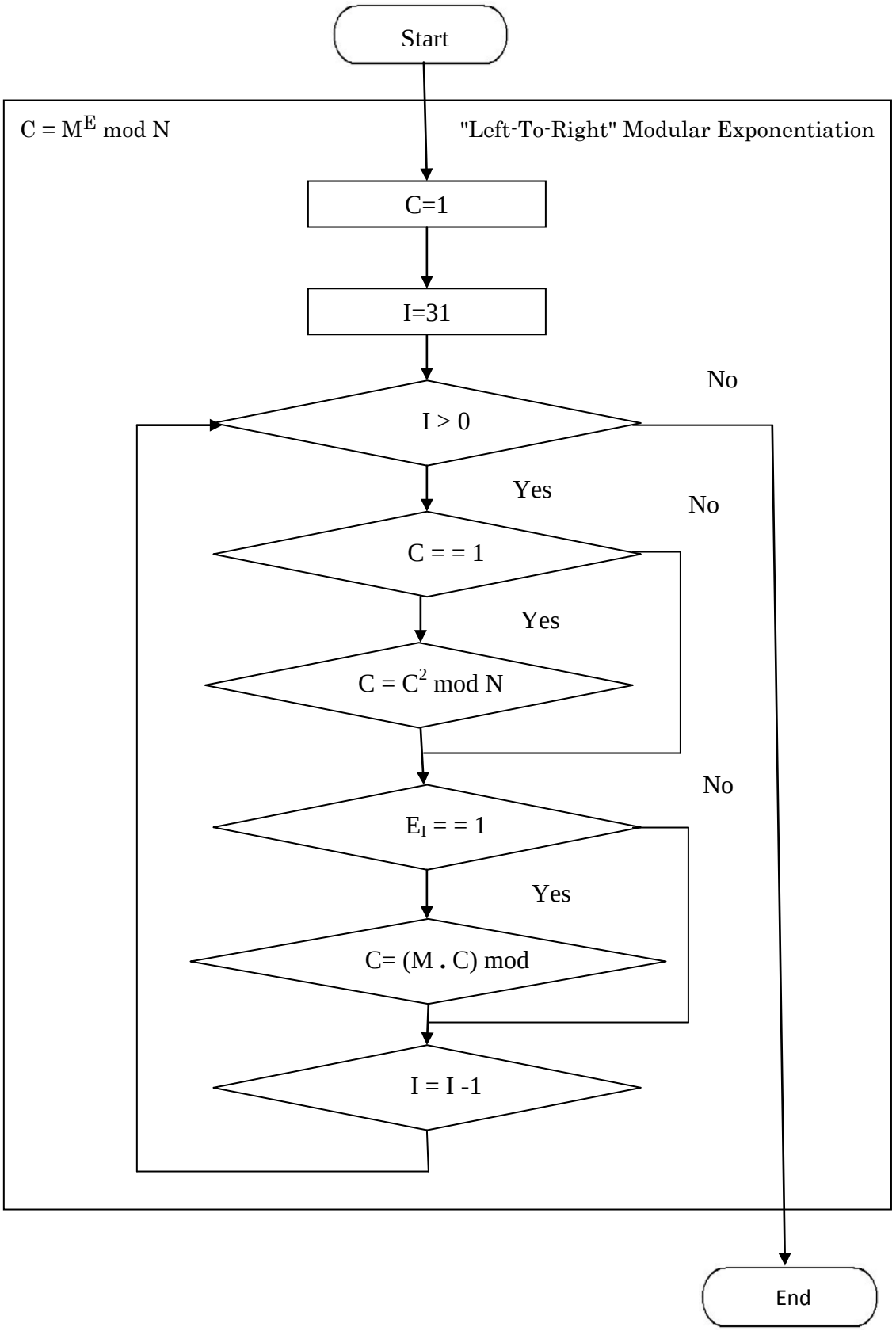

Figure 3 : RSA Encryption and Decryption Flowchart

III. Comparision

In the table below a comparative study between AES, DES and RSA is presented in to eighteen factors, which are Key Size, Block Size, Ciphering & Deciphering key, Scalability, Algorithm, Encryption, Decryption, Power Consumption, Security, Deposit of keys, Inherent Vulnerabilities, Key used, Rounds, Stimulation Speed, Trojan Horse, Hardware & Software Implementation and Ciphering & Deciphering Algorithm.

Table 1: Comparison between AES, DES and RSA

Factors	AES	DES	RSA
Developed	2000	1977	1978
Key Size	128, 192, 256 bits	56 bits	>1024 bits
Block Size	128 bits	64 bits	Minimum 512 bits
Ciphering & deciphering key	Same	Same	Different
Scalability	Not Scalable	It is scalable algorithm due to varying the key size and Block size.	Not Scalable
Algorithm	Symmetric Algorithm	Symmetric Algorithm	Asymmetric Algorithm
Encryption	Faster	Moderate	Slower
Decryption	Faster	Moderate	Slower
Power Consumption	Low	Low	High
Security	Excellent Secured	Not Secure Enough	Least Secure
Deposit of keys	Needed	Needed	Needed
Inherent Vulnerabilities	Brute Forced Attack	Brute Forced, Linear and differential cryptanalysis attack	Brute Forced and Oracle attack
Key Used	Same key used for Encrypt and Decrypt	Same key used for Encrypt and Decrypt	Different key used for Encrypt and Decrypt
Rounds	10/12/14	16	1
Stimulation Speed	Faster	Faster	Faster
Trojan Horse	Not proved	No	No
Hardware & Software Implementation	Faster	Better in hardware than in software	Not Efficient
Ciphering & Deciphering Algorithm	Different	Different	Same

IV. Experimental Design

The four text files of different sizes are used to conduct four experiments, where a comparison of three algorithms AES, DES and RSA is performed.

a) Evaluation Parameters

Performance of encryption algorithm is evaluated considering the following parameters.

A. Encryption Time
B. Decryption Time

The encryption time is considered the time that an encryption algorithm takes to produces a cipher text from a plain text. Encryption time is used to calculate the throughput of an encryption scheme, is calculated as the total plaintext in bytes encrypted divided by the encryption time. Comparisons analyses of the results of the selected different encryption scheme are performed. [11]

V. Experimental Results And Analysis

Experimental result for Encryption algorithm AES, DES and RSA are shown in table-2, which shows the comparison of three algorithm AES, DES and RSA using same text file for four experiment.

Table 2 : Comparisons of DES, AES and RSA of Encryption and Decryption Time

S.NO	*Algorithm*	*Packet Size (KB)*	*Encryption Time (Sec)*	*Decryption Time (Sec)*
1	AES	153	1.6	1
	DES		3.0	1.1
	RSA		7.3	4.9

2	AES	196	1.7	1.4
	DES		2.0	1.24
	RSA		8.5	5.9
3	AES	312	1.8	1.6
	DES		3.0	1.3
	RSA		7.8	5.1
4	AES	868	2.0	1.8
	DES		4.0	1.2
	RSA		8.2	5.1

By analyzing table-2, Time taken by RSA algorithm for both encryption and decryption process is much higher compare to the time taken by AES and DES algorithm.

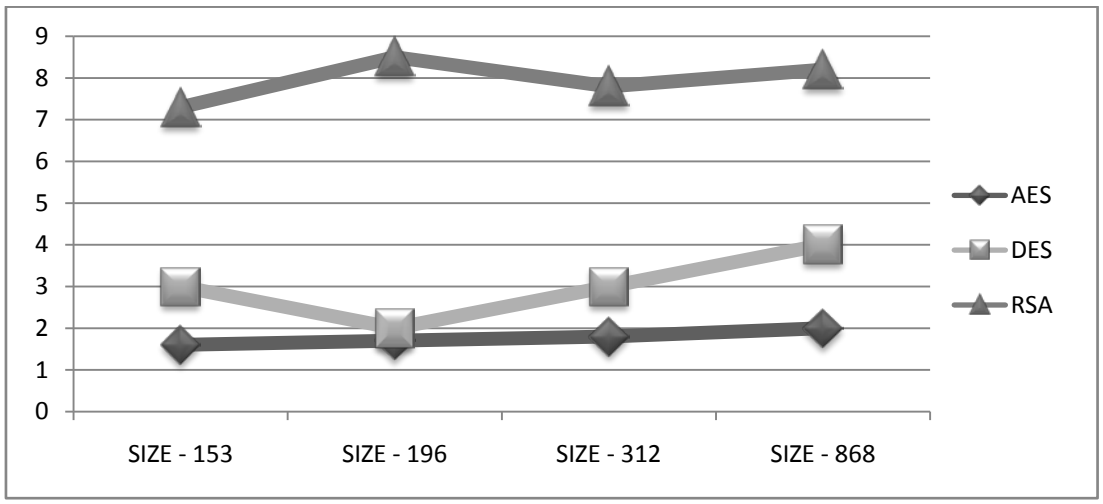

Figure 4 : Comparison of Encryption Time among AES, DES and RSA

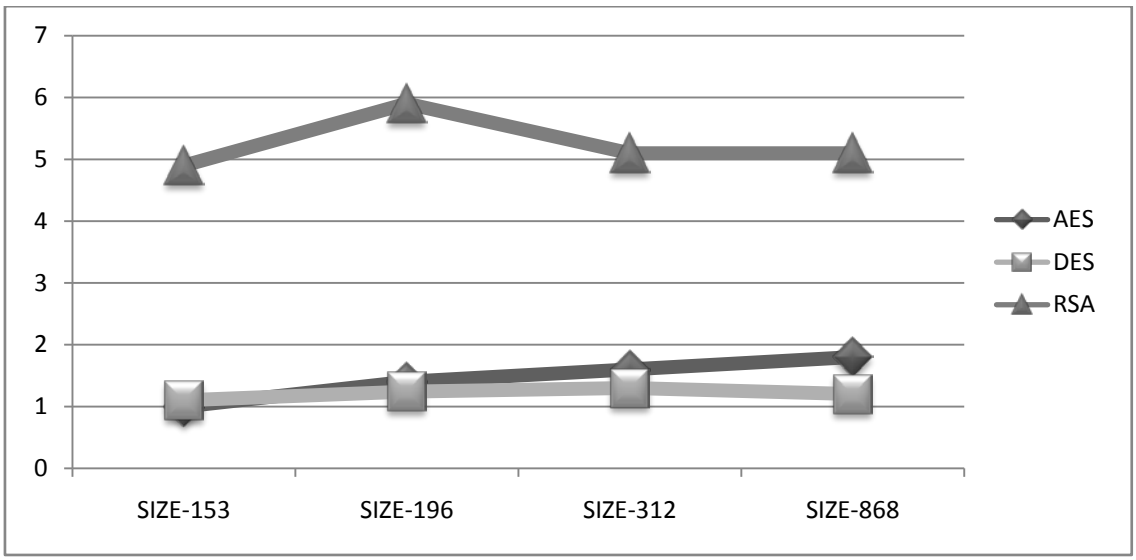

Figure 5 : Comparison of Decryption Time among AES, DES and RSA

By analyzing Fig-4 , Fig-5 which shows time taken for encryption and decryption on various size of file by three algorithms. RSA algorithm takes much longer time compare to time taken by AES and DES

algorithm. AES and DES algorithm show very minor difference in time taken for encryption and decryption process.

VI. Conclusion

Encryption algorithm plays very important role in communication security. Our research work surveyed the performance of existing encryption techniques like AES, DES and RSA algorithms.

Based on the text files used and the experimental result it was concluded that AES algorithm consumes least encryption and RSA consume longest encryption time.

We also observed that Decryption of AES algorithm is better than other algorithms.

From the simulation result, we evaluated that AES algorithm is much better than DES and RSA algorithm.

Our future work will focus on compared and analysed existing cryptographic algorithm like AES, DES and RSA. It will include experiments on image and audio data and focus will be to improve encryption time and decryption time.

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(h) Brief Acknowledgements.

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

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- One should avoid outdated words.

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References

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21. 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 to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

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25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

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

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After 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 to 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 in your research.

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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 criterion for grading the final paper by peer-reviewers.

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A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

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- Separating a table/chart or figure - impound each figure/table to a single page
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· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

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

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing 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 approach to the problem, relevant results, and significant conclusions or new questions.

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- Fundamental goal
- To the point depiction of the research
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- Significant conclusions or questions that track from the research(es)

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

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- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

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- Describe the method entirely
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- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

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

What to keep away from

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- 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 a 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. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise 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 in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to 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 part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a 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 implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly 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 with prospect, and let it drop at that.

- Make a decision if each premise is supported, 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 the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One 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 available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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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

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