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Highlights

- Analysis of DSDV, AODV
- Multicasting Overlay Protocol
- Wireless Sensor Network
- Fixed and Mobility Network

Discovering Thoughts, Inventing Future

VOLUME 14 ISSUE 6 VERSION 1.0

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Infrastructure Requirements and Outsourcing

By Richard Scroggins
Capella University, United States

Introduction- Out-of-band Management, or Lights-out Management, is an important tool to manage devices like servers, core routers, and switches. This is facilitated by a secondary card in the device that has an IP address assigned to it and it typically accessible over the network via a web browser even if the device it powered down, assuming of course that the power plug is connected to an electrified outlet. This functionality is very important for a WAN environment. Without this ability to control these devices remotely, the company would either have to employ a resource in the local offices or spend a large amount of time and money on technician travel. This is therefore a cost saving measure as well as a management tool and strategy. In initially pitching and gaining approval for projects, cost savings is often the larger selling point for management. In addition to and as an add-on to the Lights Out management, I also like monitoring the systems though SNMP, using a tool like What's Up. The Lights Out system is very valuable, but you also need a system that informs you when systems go down, and when they are responding to ping again after a restart. Network performance is very much related to network monitoring, however, monitoring is a task that we perform in service to performance, among other things.

GJCST-E Classification : D.2

INFRASTRUCTUREREQUIREMENTSANDOUTSOURCING

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Infrastructure Requirements and Outsourcing

Richard Scroggins

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"Increasingly, organizations are jumping onto the information technology (IT) outsourcing bandwagon in an effort to create value. However, evidence indicating the positive economic consequences of such initiatives has been limited. This study attempts to fill this void by synthesizing the process-oriented research in IT business value literature and the resource-based theory to develop an integrative research framework for assessing the value proposition of IT outsourcing." (Wang, Gweba, Wang, & Zhu, 2008) I have been through an IT outsourcing project, and I can say from my experience that the business value created through IT outsourcing is typically exaggerated. Not even taking into consideration the negative stigma and the damage to the reputation of the company or organization, but in house assets are more valuable and it takes multiple outside resources to make up for one in house resource. Communication by itself is a major issue with outsourcing, and the lack of communication ability might stand in the ways of resolving issues. Everyone has a story of dealing with a tech support person from India who is so hard to understand that many give up. So this supports the idea that some things are better left in house. Wang, Gweba, Wang, & Zhu (2008) make this point by separating who does better with outsourcing and to some degree what functions are more outsourceable, " With a process-oriented lens, the framework suggests that the effects of IT outsourcing are best documented at the process level and hence, it is imperative that one takes into consideration the impact of IT outsourcing on performance at both the process level as well as the firm level. Grounded in the resource-based view, the framework also accounts for the complementary role of firms' core IT capability as a critical condition for the value creation of IT outsourcing. Consistent with the process-oriented prediction, the findings suggest that the positive effects of IT outsourcing appear mostly at the process level, but not at the firm level. Moreover, it is found that the level of business value created by IT outsourcing is contingent on firms' core IT capability. Firms with superior core IT capability are found to enjoy an advantage in leveraging their outsourcing initiatives to enhance firm value" (p. 01).

My current company does outsource some specific functions, but only to local resources that have good communication skills. We also have the "core IT capability" that Wang, Gweba, Wang, & Zhu (2008) mention. For instance, we have an IT resource on retainer in one of our remote offices that has a limited need for onsite support. This location is too far away to service like we do our corporate location. We are able to handle most things remotely, but this office performs critical functions for the company so we need to be able to provide same day service. We do not outsource our core functions, nor do we give any external resource sole access to any of our systems. For us, outsourcing is a function of augmenting, not replacing. I have observed many companies use the model of

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outsourcing as a replacement and this can be dangerous. I was recently working with a third party who had outsourced there phone system to a consultant. When the relationship was severed to the consultant, the company lost all access, passwords, configurations, etc. to their phone system. This was very short sighted on their part. I know that this was done on the direction of the management who thought that they were saving a few bucks, but look at the eventual cost.

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Application Layer Multicasting Overlay Protocol- NARADA Protocol

By G. Sankara Rao, E. Jagadeeswararao & N. Sai Prathyusha
Jawaharlal Nehru Technological University, India

Abstract- The conventional wisdom has been that Network Layer Internet protocol(IP) is the natural protocol layer for implementing multicast related functionality but it is still plagued with concerns pertaining to scalability, network management, deployment and support for higher layer functionality such as error, flow and congestion control. In this context, an alternative architecture is, Application layer multicast (End Systems Multicasting), where at Application layer, implements all multicast related functionality including membership management and packet replication. This shifting of multicast support from routers to end systems has the potential to address the most problems associated with IP multicast. In Application-layer multicast, applications arrange themselves as a logical overlay network and transfer data within the overlay network (between end hosts). In this context, we study these performance concerns in the context of the NARADA protocol (an application layer multicasting protocol). In Narada, end systems self-organize into an overlay structure using a fully distributed protocol. We present details of NARADA and evaluate it using NS-2 simulations.

Keywords: multicast, end system multicast, graph, network, random numbers, routers, links, bandwidth, latency, minimum cost spanning tree, unicast , datagram, ip- multicast, narada, performance, dvmrp.

GJCST-E Classification : C.2.2

APPLICATIONLAYERMULTICASTINGOVERLAYPROTOCOLNARADAPROTOCOL

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Application Layer Multicasting Overlay Protocol – NARADA Protocol

G. Sankara Rao [α], E. Jagadeeswararao [σ] & N.Sai Prathyusha [ρ]

Abstract – The conventional wisdom has been that Network Layer Internet protocol(IP) is the natural protocol layer for implementing multicast related functionality but it is still plagued with concerns pertaining to scalability, network management, deployment and support for higher layer functionality such as error, flow and congestion control. In this context, an alternative architecture is, Application layer multicast (End Systems Multicasting), where at Application layer, implements all multicast related functionality including membership management and packet replication. This shifting of multicast support from routers to end systems has the potential to address the most problems associated with IP multicast. In Application-layer multicast, applications arrange themselves as a logical overlay network and transfer data within the overlay network (between end hosts). In this context, we study these performance concerns in the context of the NARADA protocol (an application layer multicasting protocol). In Narada, end systems self-organize into an overlay structure using a fully distributed protocol. We present details of NARADA and evaluate it using NS-2 simulations. Our results indicate that the performance penalties are low both from the application and the network perspectives. We believe the potential benefits of transferring multicast functionality from routers to end systems, significantly outweigh the performance penalty incurred.

Keywords: multicast, end system multicast, graph, network, random numbers, routers, links, bandwidth, latency, minimum cost spanning tree, unicast , datagram, ip- multicast, narada, performance, dvmrp.

I. Introduction

Recently, more and more group communication applications (e.g., video-conferencing, online-gaming, and long-distance education) have emerged with the increasing popularity of the Internet. To support such multi-user applications, multicast is considered as a very efficient mechanism since it uses some delivery structures (e.g., trees or meshes) to forward data from senders to receivers, aiming to reduce duplicate packets, whereas a separate delivery path is built for each sender-receiver pair when simple unicast scheme is adopted.

Initially, multicast is implemented at the IP layer,in which a tree delivery structure is usually employed, with data packets only replicated at branching nodes. In IP multicast, the multicast tree nodes are network routers. However, due to many technical and marketing reasons, such as the lack of a scalable inter-domain multicast routing protocol, the requirement of global deployment ofmulticast-capable IP routers and the lack of appropriate pricing models, etc., IP multicast is still far from being widely deployed.

To resolve the deployment issues of IP multicast, application layer multicast has been proposed as an alternative solution to realize multicast in the Internet.

This paper is organized as follows: Existing System and its Disadvantages, Advantages of the proposed system, Narada features, Narada Design, Our implementation of Narada.

II. Existing System

IP multicast (Fig.1) is a bandwidth-conserving technology that reduces traffic by simultaneously delivering a single stream of information to potentially thousands of corporate recipients and homes. IP Multicast delivers application source traffic to multiple receivers without burdening the source or the receivers while using a minimum of network bandwidth.

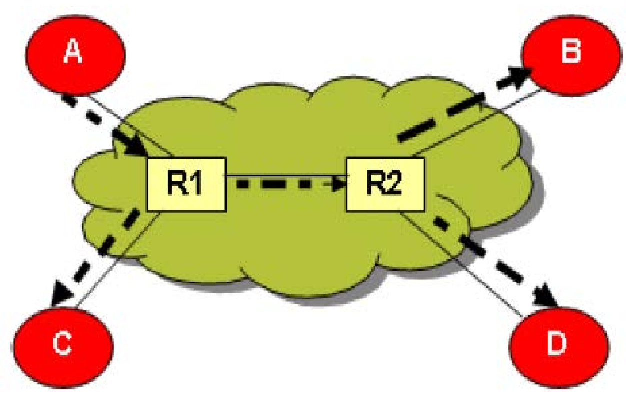

Figure 1 : IP Multicasting

Advantage of IP Multicast is that

No duplicate packets are sent across any physical link and hence there is efficient bandwidth utilization.

a) *Disadvantages of IP Multicast*

- The first problem is that IP Multicast requires every router to maintain the group state information. This violates the initially envisioned "stateless" principle

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and it is also introduces a lot of complexity and has scalability constraints.

- The second problem is that IP Multicast tries to conform to the traditional separation of network and transport layers. This worked well in the unicast context but other features like reliability, congestion control, flow control and security are difficult to implement.
- The third and final problem is that it requires changes at the infrastructure level and hence it is not easy to deploy.

III. Proposed System

An alternative to this proposed system is the Application Layer Multicast (Fig.2) in which all the functionality of multicast is pushed to the end systems or end hosts. Application layer multicasting can implement many complex features of multicast functionality basically constructs an overlay structure among all hosts in the network and then sends messages to the either end hosts in the overlay structure, implementing all other features of multicast is easier at application layer rather tat network layer.

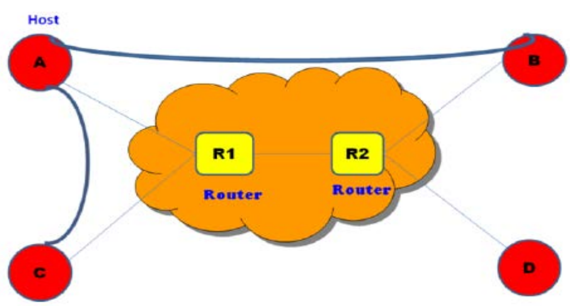

Figure 2 : Application Layer Multicasting

a) Advantages of Application Layer Multicast

- The overlay structure is built on existing physical links. so we may have multiple overlays over a single physical link hence there will be redundant traffic across the links.
- No more routers need to maintain the per group state information. And the end systems or end hosts take up this responsibility. Since these end systems are part of very few groups it becomes easy to scale the systems.
- Supporting higher layer features such as error, flow, and congestion control can be significantly simplified by leveraging well understood unicast solutions for these problems, and by exploiting application specific intelligence.

IV. Narada Features

Narada is the protocol to implement End System Multicasting. It has many features like:

a) Self organizing

The construction of the end system overlay in fully distributed fashion and is adaptive to dynamic changes in group membership.

b) Overlay efficiency

The tree constructed is efficient both from application and network perspective and the number of redundant packets transmission is kept minimal. However the definition of efficiency differs for every application.

c) Self Improving

The end systems gather network information in a scalable fashion. So the overlay structure improves as more information becomes available.

d) Adaptive to network dynamics

The overlay created adapts to long term variations in internet path characteristics and it is resilient to the inaccuracies in the measurement of these quantities.

V. Narada Protocol Design

a) Tree and Mesh Creation

Narada creates a mesh, a highly connected graph between all the nodes (end systems) in the group. It then creates a minimum cost spanning tree among all the end hosts using the mesh. A mesh based approach is used for multi source applications. Also a single shared tree is susceptible to a central point of failure. They are not optimized for a single source. It is important to create a good mesh for creating good trees. A good mesh has the following properties: *Firstly*, quality of a path between any two members is comparable to the unicast path between the two members. *Secondly*, each member is connected to a limited number of neighbors in the mesh. Narada runs a variant of standard distance vector routing algorithms and it creates reverse shortest path spanning trees for each source.

b) Group Management

Narada keeps the mesh connected, to incorporate new members into the mesh and to repair possible partitions that may be caused by members leaving the group or by member failure. The burden of group maintenance is shared jointly by all members. To achieve a high degree of robutness, our approach is to have every member maintain as list of all other members in the group. Since Narada is targeted towards medium sized groups, maintaining the complete group membership list is not a major overhead. Every member's list needs to be updated when a new member joins or an existing member leaves. The challenge is to disseminate changes in group membership efficiently, especially in the absence of a multicast service provided by the lower layer. We tackle this by exploiting the mesh to propagate such information.

c) Member Join

The joining member randomly selects a few group members from the list available to it. And sends the messages requesting to be added as neighbor, it repeats the process until it gets a response from some member, when it has successfully joined the group. Having joined, the member then starts exchanging refresh messages with its neighbors.

d) Member Leave and Failure

When a member leaves a group, it notifies its neighbors, and this information is propagated to the rest of the group members along the mesh. We also need to consider the difficult case of abrupt failure. In such a case, failure should be detected locally and propagated to the rest of the group. In this project, we assume a fail-stop failure model, which means that once a member dies, it remains in that state, and the fact that the member is dead is detectable by other members.

e) Mesh Performance

The constructed mesh can be quite sub -optimal, because

1. Initial neighbor selection by a member joining the group is random given limited availability of topology information at bootstrap.
2. Partition repair might aggressively add edges that are essential for the moment but not useful in the long run.
3. Group membership may change due to dynamic join and leave.
4. Underlying network conditions, routing and load may vary.

Narada allows for incremental improvement of mesh quality by adding and dropping of overlay links.

VI. Data Delivery

On the top of the mesh, Narada runs the distance vector protocol. Each member maintains a routing cost to the destination and also the path that leads to that node. A member M that receives a packet from source S through a neighbor N forwards the packet only if N is the next hop on the shortest path from *M* to *S*. Further, M forwards the packet to all its neighbors who use M as the next hop to reaches (fig. 7).

VII. Narada Implemenation & Results

a) Mesh Creation

We use the network entities given by JNS (Java Network Simulator) to create a mesh (Fig. 3). We create entities like nodes, links, routers etc. We'll assign weights to the links manually or can be done using a random number generator. The nodes have names 1, 2 …etc. the number of edges in the network for a number of nodes is also generated by random numbers. We try to have a highly connected graph. All those nodes which are not connected have a weight of a constant high valued number.

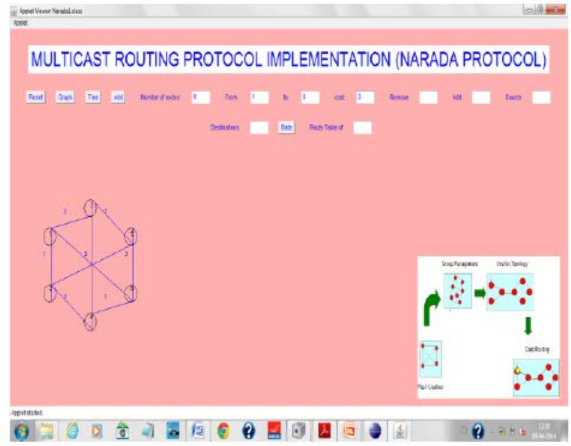

Figure 3 : Mesh Creation

b) Group Creation

In Narada every member of the group contains a list of all members in the group to which it is connected. So a Group Member object has a Node object and an array of nodes and costs to reach them in it. If a member is not connected to a node it has the constant value representing an unreachable node in it. A group is defined as a list of Group Member objects.

c) Member Join

When a new node wants to join a group, it brings along with it some information about its distance to any existing group member with it. The group join algorithm works as follows (fig.4).

In the first step, the list of the joining node is updated. All those elements to which it's not connected are added with unreachable weight to its list. Then it is added to the lists of all existing group members with corresponding weights. Finally it is added to the list of members of a group. When data routing has to be done a new spanning tree will be created with this node.

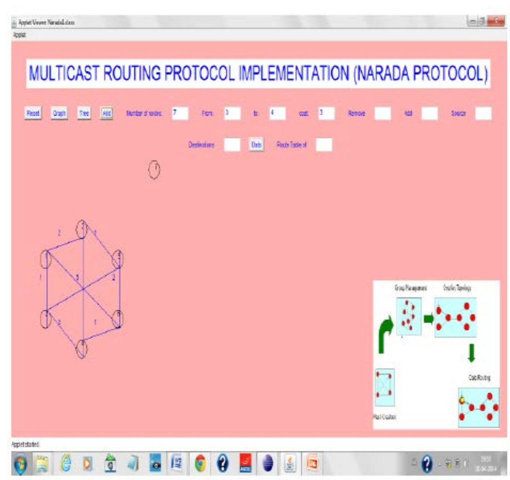

Figure 4 : Member joining the group

d) Member Leave

When a member leaves the group gracefully it informs other group members that it is leaving. Accordingly when he leaves his list is deleted and his record is deleted from the its of all other existing group members(fig.5).When data routing has to be done a new spanning tree will be created without this node.

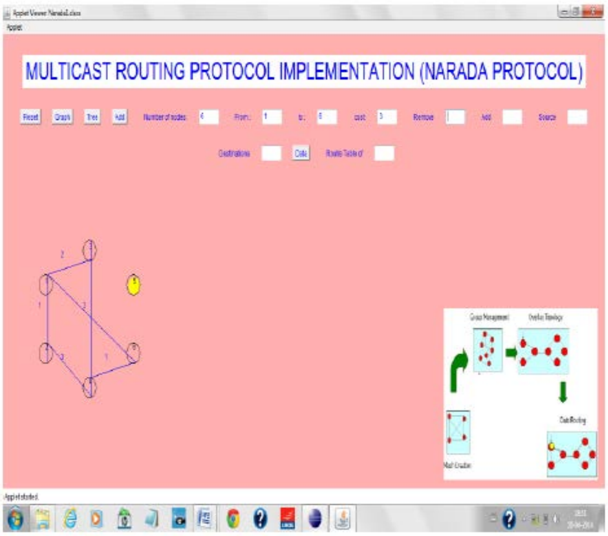

Figure 5 : Member leaving the group

e) Tree Creation

The entire structure of network consisting of all nodes and weighted edges is given to the spanning tree algorithm. We then use the Kruskal's algorithm to construct the minimum cost spanning tree (fig.6) among these nodes. We also calculate the start and end times for each message of the spanning tree and also the hop number in the tree.

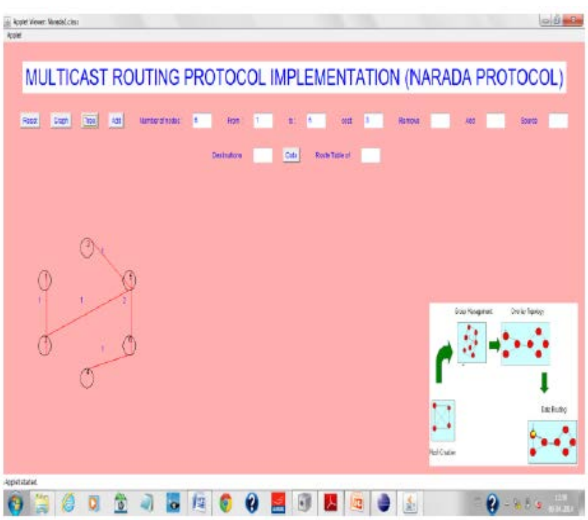

Figure 6 : Spanning Tree Construction

f) Data Delivery

The user enters a source and we consider the last node as the destination. We then extract a path from the spanning tree from the source to the destination. We then give the edges in the path to the simulator which sends the messages along those paths at the specified start times (fig.7).

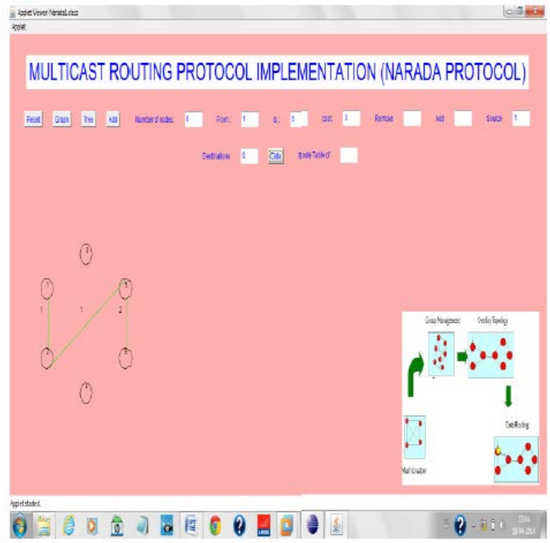

Figure 7 : Data Delivery

g) Routing Table

This DVMRP (Distance vector multicast Routing protocol)-like routing algorithm is iterative, asynchronous and parallel, and the multicast tree is generated based on the cooperative work of each node.(fig.8)

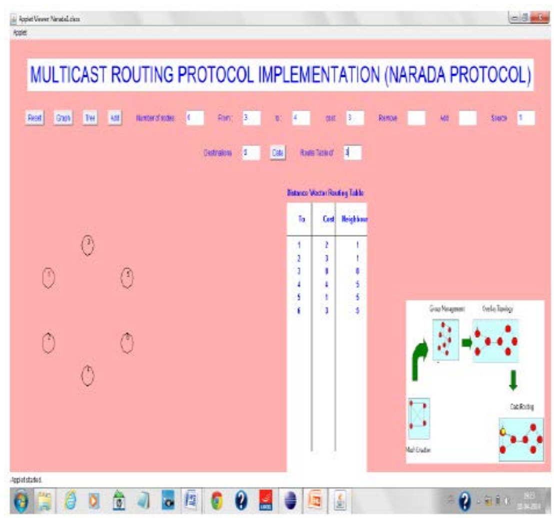

Figure 8 : Routing Table

NARADA uses DVMRP Algorithm as given below

h) DVMRP Algorithm

Initialization.

For all adjacent nodes V

$D^x(*,v)$ =infinity/* the * operator means "for all rows"*/

$D^x(v,v)=c(x,v)$

For all destinations, y

Send min $_wD^x(y, w)$ to each neighbor

Loop

Wait (until I see a link cost change to neighbor V
Or until I receive update from neighbor V)
If(c(x, V) changes by d)
For all destinations y: $D^x(y, V) = D^x(y,V) + d$
Else if
(Update received from V with respect to destination Y)
For the single destination
y:$D^x(Y,V)=c(X,V)+$ newval
If we have a new min ${}_wD^x(Y, w)$ for any destination Y
Send new value of min ${}_wD^x(Y, w)$ to all neighbors
Forever

i) NS2 SIMULATOR & NAM

Ns-2 is a discrete event simulator targeted at networking research. Ns-2 provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. Ns-2 is written in c++ and an Object oriented version of Tcl called OTcl.

Nam is a Tcl/TK based animation tool for viewing network simulation traces and real world packet traces. It is mainly intended as a companion animator to the ns simulator.

NS-2 is a discrete event simulator and supports various flavors of TCP, many different models of unicast and multicast routing, along with different multicast protocols. It supports mobile networking including local and satellite networks. It also supports applications like web caching. And NS-2 uses NAM, an animation tool, developed in Tcl/Tk, to visualize the simulation packet traces which are created by running ns scripts. Thus ns-2 and nam could be used together to easily demonstrate different networking issues in a classroom environment.fig.9 shows the topology creation with ns-2 simulator.

Now, we make use of these to show the flow of packets (data delivery) over the network from one member to another member (fig.10)

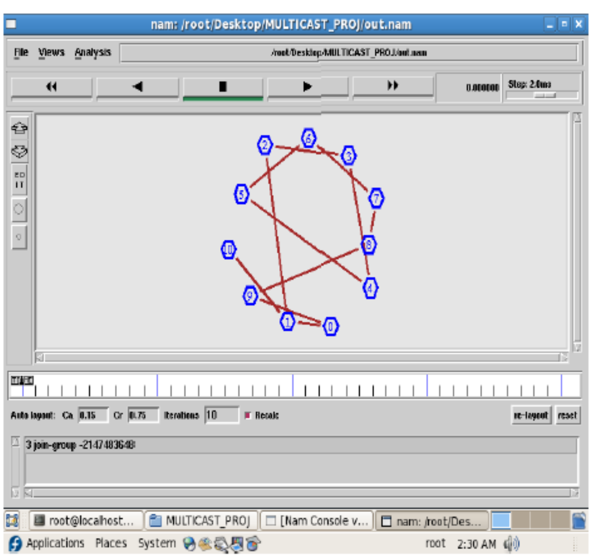

Figure 9 : Network Topology

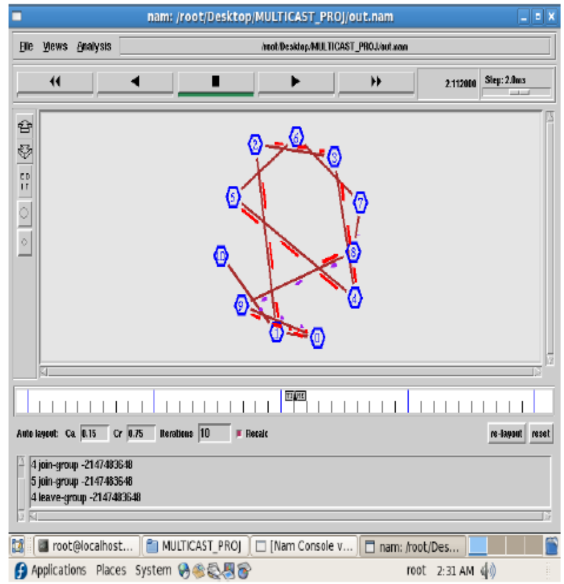

Figure 10 : Delivery of Multicasting packets

VIII. Results Analysis

We have considered two Parameters to measure the mesh (network) performance. One is the Throughput. And the other is the Latency(Delay). Throughput is nothing but, number of packets sent per unit time successfully. Latency refers to the time taken for a packet to reach the destination after their transmission. We conducted several Experiments to observe the mesh performance. Fig.11 shows the results generated for throughput with respective time. NARADA achieves better throughput as compared others for medium sized group member's mesh. Fig.12 shows the delay vs group size, but for small size groups delay is neglible while using narada protocol.

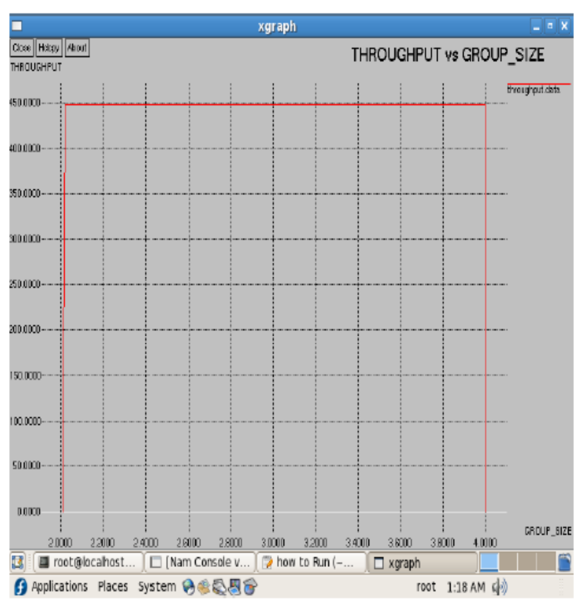

Figure 11 : Resultant Graph of Throughput vs Time

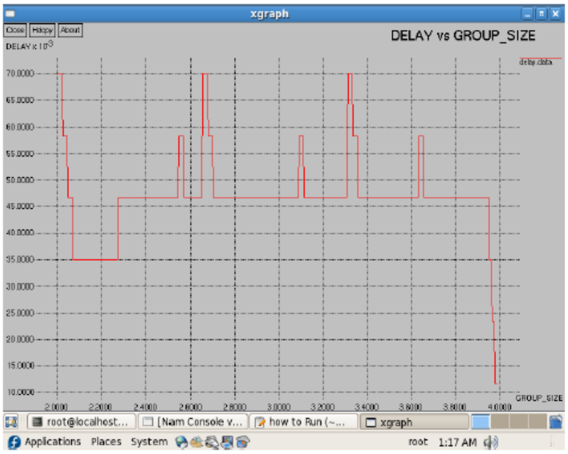

Figure 12 : Resultant Graph for Delay vs GroupSize

a) Application Layer Multicasting Applications

End system Multicasting is used *in Group Communication (i.e* Multiparty Conferencing session, Audio Conferencing, Video Conferencing). And these are also used in small to medium group size. And multiple sources

IX. Conclusion

End systems overlay is feasible. End Systems (Application Layer) Multicasting Addresses the problems associated with IP multicasting. Application layer Multicasting is easy to maintain. NARADA is Better for small sized groups from the results we drawn.

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Performance Analysis of DSDV, AODV AND AOMDV Routing Protocols based on Fixed and Mobility Network Model in Wireless Sensor Network

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Abstract- Wireless sensor networks (WSN) is capable of autonomously forming a network without human interaction. Each node in a WSN acts as a router, forwarding data packets to other nodes. Without routing protocols, these routers cannot work together in phase. A central challenge in the design of WSN is the development of routing protocols that can efficiently find routes in a network. The question is which criteria should be considered when selecting a routing protocol, for instance, energy consumption (battery life), bandwidth, or security? We selected energy consumption as this is the most important criterion in WSN. To find out the best routing protocol, we analyzed three routing protocols namely AODV (Ad-hoc On Demand Distance Vector), AOMDV (Ad-hoc On Demand Multiple Distance Vector), and DSDV (Destination Sequence Distance Vector). Overall performance of these protocols was analyzed by comparing end-to-end delay, throughput, normalized routing load, and energy consumption of the network.

Keywords: AODV, AOMDV, DSDV, end-to-end delay, throughput, normalized routing load, energy consumption, wireless sensor networks.

GJCST-E Classification : C.2.2

PERFORMANCEANALYSISOFDSDV,AODVANDAOMDVROUTINGPROTOCOLSBASEDONFIXEDANDMOBILITYNETWORKMODELINWIRELESSSENSORNETWORK

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Abstract - Wireless sensor networks (WSN) is capable of autonomously forming a network without human interaction. Each node in a WSN acts as a router, forwarding data packets to other nodes. Without routing protocols, these routers cannot work together in phase. A central challenge in the design of WSN is the development of routing protocols that can efficiently find routes in a network. The question is which criteria should be considered when selecting a routing protocol, for instance, energy consumption (battery life), bandwidth, or security? We selected energy consumption as this is the most important criterion in WSN. To find out the best routing protocol, we analyzed three routing protocols namely AODV (Ad-hoc On Demand Distance Vector), AOMDV (Ad-hoc On Demand Multiple Distance Vector), and DSDV (Destination Sequence Distance Vector). Overall performance of these protocols was analyzed by comparing end-to-end delay, throughput, normalized routing load, and energy consumption of the network. This was accomplished by using the Network Simulator, NS-2.34 over IEEE 802.11. The analysis shows that AOMDV is the best routing protocol in terms of energy consumption.

Keywords : AODV, AOMDV, DSDV, end-to-end delay, throughput, normalized routing load, energy consumption, wireless sensor networks.

I. Introduction

A wireless Sensor Network (WSN) is a spatially distributed autonomous system which is a collection of many power-conscious sensor nodes, having wireless channel to communicate with each other [21]. Wireless networks are characterized by infrastructure-less, random and quickly changing network topology. This makes the traditional routing algorithms fail to perform correctly since they are not strong enough to accommodate such a changing environment [7].Efficient routing protocols can provide significant benefits in terms of both performance and reliability. Since latency, reliability and energy consumption are inter-related with each other, the proper selection of the routing protocol to achieve maximum effi-ciency is a challenging task [2]. Due to this fact, a detailed analysis becomes necessary and useful at this stage.

The application of wireless sensors in our real life such as controlling temperature and acceleration sensor is shown below.

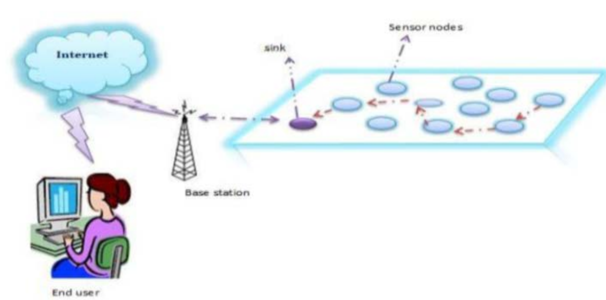

Figure 1 : Accessing WSNs through Internet

Well-organized routing in a sensor network requires that routing protocol must minimize network energy dissipation and maximize network lifetime [21]. Performance comparison of routing protocols has been done in various research papers like D. D. Chaudhary, Pranav Pawar and Dr. L. M. Waghmare [2] studied and compared performance evaluation of Wireless Sensor Network with different Routing Protocols, Adel. S. Elashheb [3] evaluated the performance of AODV and DSDV Routing Protocol in wireless sensor network environment but our simulation results are based on different simulation environment (fixed and mobility) and simulation parameters. Simulation result shows that the performance of AOMDV routing protocol is better than AODV and DSDV in terms of throughput, energy consumption, normalized routing load and end-to-end delay.

II. Related Work

Charles E. Perkins, Elizabeth M. Royer, Samir R. Das and Mahesh K. Marina compared the performance of DSR and AODV, two prominent on-demand routing

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protocols for ad hoc networks[1]. The general observation from the simulation these is that for application-oriented metrics such as delay and throughput, DSR outperforms AODV in less "stressfulll" situations (i.e. smaller number of nodes and lower load and/or mobility). AODV, however, outperforms DSR in more stressful situations, widening performance gaps with increasing stress (e.g., more load, higher mobility). DSR, however, consistently generates less routing load than AODV.

Adel. S. Elashheb [4] evaluated the performance of AODV and DSDV Routing Protocol in wireless sensor network environment. In this paper two protocols AODV and DSDV had been simulated using NS-2 package and compared in terms of packet delivery fraction, end to end delay and throughput in different environment; varying period of pause time and the number of expired nodes. Simulation results show that AODV routing protocol had better performance in terms of packet delivery fraction and throughput but, AODV suffers from delay.

III. Description of The Routing Protocols

a) DSDV

DSDV is a proactive routing protocol and is based on the idea of the Bellman-Ford Routing Algorithm with certain improvements [2]. In DSDV, each node maintains a routing table, which lists all available destinations, next hop to each destination and a sequence number generated by the destination node to provide loop freshness [11] [12] [20]. The sequence numbers are generally even if a link is present; else, an odd number is used. Using such routing table stored in each node, the packets are transmitted throughout the network [20]. The routing table is updated at each node either with advertisement periodically or when significant new information is available to maintain the consistency of the routing table with the dynamically changing topology of the network [20]. If there is a failure of a route to the next node, the node immediately updates the sequence number and broadcasts the information to its neighbors. After receiving routing information the node checks its routing table. If it does not find such entry into its routing table then it updates the routing table with routing information it has found. If the node finds that it has already entry into its routing table then it compares the routing table entry with the sequence number of the received information with and updates the information. When a node receives a new route update packet; it compares it to the information available in the routing table and the routing table is updated based on the following criteria [13] [19]

- If the destination sequence number of receiving packets is greater, then the routing table information is replaced with the information in the new route update packet.
- When the destination sequence numbers are the same, the routing table is updated by selecting the route with better metric.

Thus, DSDV is not suitable for highly dynamic networks.

Figure 2 shown below represents the implementation of DSDV protocol. Table 3.1 illustrates the routing information stored in node 6 of Figure 2. The Destination column represents the destination nodes throughout network. Next hop field column represents the neighbor node which can forward data to the destination node. Metric column represents the number of hops the destination is away from node. Sequence number column represents the destination sequence number [9].

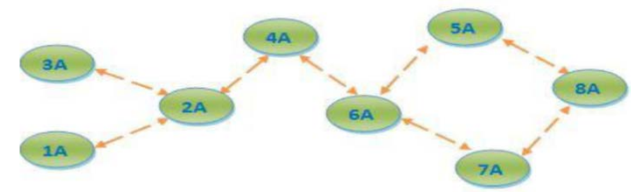

Figure 2 : Implementation of DSDV Protocol [9]

Table 3.1 : Routing Table of Node 6

Destination	Next Hop	Metric	Sequence Number
1A	4A	3	S213_1
2A	4A	2	S899_2
3A	4A	3	S343_3
4A	4A	1	S441_4
5A	5A	1	S155_5
6A	6A	0	S067_6
7A	7A	1	S717_7
8A	5A/7A	2	S582_8

b) AODV

AODV is a development on the DSDV algorithm because it decreases the number of broadcasts by creating paths on-demand. AODV discovers routes as and when necessary. For inactive communication, it is not necessary to establish routes to destination. Whenever desired routes are not getting within the expected time, time to live (TTL) of AODV get expired. The nodes of every valid route employ routing tables to store routing information. The route table stores: <destination addr, next-hop addr, hop count, routing flags, destination sequence number, network interface, life_time> [15]. Sequence numbers are used to provide up-to-date routing information for route freshness criteria and for loop prevention. Life-time is updated every time the route is used. Whenever a node wishes to send a packet to some destination, it checks its routing table to determine if it has a current route to the destination. If it has found current route, then it forwards the packet to the next node, otherwise it initiates a route discovery process [15].

AODV uses different control messages for the discovery and maintenance of routes. They are Route Request Message (RREQ), Route Reply Message (RREP), Route Error Message (RERR), HELLO Messages [7] [14]. By creating a Route Request (RREQ) message, AODV initiates Route discovery process to reach from source to destination. Every time when the source node sends a new RREQ, broadcast ID gets incremented. After receiving of request message, each node checks the request ID and source address pair. The new RREQ is rejected if there is already RREQ packet having the same pair of parameters. If a node has no route entry for the destination, it rebroadcasts the RREQ with incremented hop count parameter. RREP contains the route information about the destination which is mentioned in RREQ and it is transmitted to the sender of the RREQ If there is a link failure of a valid route, a RERR message is generated by the node upstream of a link breakage to inform other nodes about the link failure. In AODV, Hello messages are broadcasted in order to know neighborhood nodes and to notify the neighbors about the activation of the link. Absence of hello message is defined as an indication of link failure [7] [14].

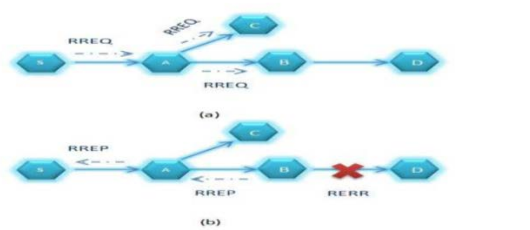

Figure 3 : AODV Route discovery process

Figure 3 shows the route discovery process of AODV. If node S needs a route to node D, then node S sends route request to A. Similarly node A broadcast route request to its neighbors. If node D receives RREQ, it makes a reverse route entry for S and sending RREP message. If link failure occurs between B and D, it sends RERR message.

c) AOMDV

The motivation for designing AOMDV is to compute multiple loop free and link disjoint paths in highly dynamic ad hoc networks where the link breakage occurs repeatedly [17]. It is the extension of AODV routing protocol [2] [10] [16]. AOMDV maintains a routing table for each node containing a list of the next-hops and its associated hop counts. Every next hop has similar sequence number for maintaining of a route. To send route advertisements, each node maintains the advertised hop count of the destination. If any node's hop count is less than the advertised hop count, then loop freshness is guaranteed for that node by receiving alternate paths to destination. In the case of a route failure, AOMDV uses alternate routes [2]. In AODV routing protocol, a route discovery procedure is needed for each link failure. Performing such procedure causes more overhead and latency also [17]. In the case of AOMDV, new route discovery process is required only when all the routes fail [10] [16]. In AOMDV, a source initiates a route discovery process if it needs a communication route to a destination. The source broadcasts a route request (RREQ) along a unique sequence number so that duplicate requests can be discarded. After receiving the request, an intermediate node record previous hop. If it has a valid and fresh route entry to the destination in its routing table, then it sends a reply (RREP) back to the source. If it has no valid and fresh route entry, it rebroadcast the RREQ. The nodes on reverse route towards source update their routing information by establishing multiple reverse paths. Duplicate RREP on reverse path is only forwarded if it contains either a larger destination sequence number or a shorter route found [10] [16].

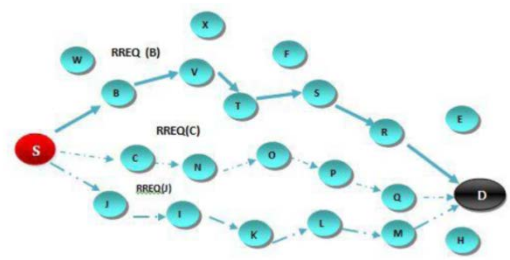

Figure 4 : Route Discovery Procedures in AOMDV

Table 3. 2 : Routing Table for Node S

Destination	Next hop	Number of hops	Destination Sequence Number
D	B	5	S1
D	C	5	S2
D	J	5	S3

Figure 4 shows the route discovery process of AOMDV and in table 3.4, it is shown that each entry in the routing table consists of all available destinations, next hop towards each destination (i.e. B, C and J), number of hops required to reach destination and a destination sequence number.

IV. Simulation Model

To configure both of the network models, we used the following simulation parameters which we have discussed in table 4.1.

Table 4.1 : Simulation Parameters

Parameters	Details
Simulator	NS-2.34
Node Placement	Random, Fixed
No. of Nodes	12,16,20,24,28,32,36
No. of sink (destination)	One(Node 0)
No. of sources	35 (Node 1 to 35)
Area of simulation	2500 m *1000m
Packets generated by each source	1000
Total packets generated in N/W	36*1000=36000
Size of each packet	1000 bytes
Model	Energy Model
Initial energy	1000J
Transmission Range	250m
Radio model	Two Ray Ground
Protocols	AODV,DSDV,AOMDV
Max speed	28m/s
Traffic type	FTP
MAC	Mac/802_11
Bandwidth	11mb
Simulation time(in sec)	1000 sec
Antenna Type	Omni directional
Link Layer Type	LL
Interface queue type	Queue/Drop tail
Channel type	Channel/Wireless channel
Network interface type	Phy/WirelesssPhy

V. Performance Results

a) Performance Metrics

i. *Average end-to-end delay*

Average end-to-end delay is the average time from the transmission of a data packet at a source node until packet delivery to a destination which includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation delay for propagation and transfer times and carrier sense delay for carrier sensors [7] [18].

ii. *Average Throughput*

Throughput is the total number of packets that have been successfully delivered from source node to destination node and it can be improved with increasing node density [7] [18].

iii. *Normalized Routing Load*

It is the number of routing packets transmitted per data packet delivered at the destination [18].

iv. *Energy Consumption*

$$\frac{\Sigma \text{Percentage Energy Consumed by all nodes}}{\text{Number of all nodes}} \quad [18]$$

v. *Remaining Energy*

Remaining Energy is defined as Initial Energy – Energy Used [18]

b) Result and Analysis

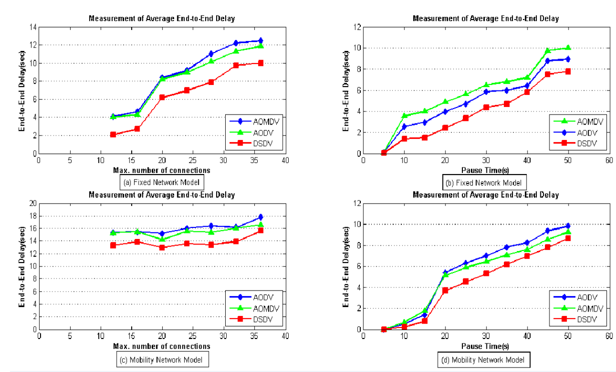

Figure 6 : Measurement of average end-to-end delay varying maximum number of connections and pause time (sec.)

Figure 6 (a, c) illustrates a comparison among AODV, DSDV, and AOMDV in terms of end-to-end delay based on fixed and mobility scenario by varying maximum number of connections (number of nodes) respectively. Figure 6 (a) shows that the average end-to-end delay of DSDV stays much lower than AODV and AOMDV. The average end-to-end delay increases with the increased number of connections. The numbers of connections were varied as 12,16,20,24,28,32,36 nodes. After increasing number of connections more than 16, end-to-end delay increase much higher because of queuing and retransmission delay. In heavy traffics load as the maximum number of connections increase, the number of packets delivery also increase. That's why queue is getting full. DSDV routing protocol tries to drop the packets if it is not possible to deliver them. This cause less delay and most dropping packets are retransmitted over again that causes retransmission delay. On the other hand, AODV and AOMDV both routing protocol allow packets to stay in the send buffer for 30 seconds for route discovery and once the route is discovered, data packets are forwarded on that route to be delivered at the destination. In this graph, result shows that AOMDV performs significant more delay than AODV after 24 connections. Due to multi paths in AOMDV there can be many stale routes which may contribute to more delay than AODV. As the number of connections increases, the end-to-end delay also increases in a fixed scenario.

To analyze the effects of mobility, figure 6 (c) shows that end-to-end delay of AODV is comparatively higher than AOMDV and DSDV at high density. When queue is getting free from 16-20 numbers of connections, the delay of DSDV is decreased because it consumes less time to deliver packets. AOMDV loses fewer packets than AODV (1-2% less) at high density in mobility cases. From 30-32 numbers of connections, the delay is almost similar in AODV and AOMDV because of less queuing delay. When a links failure is occurred in mobility scenario, the route discovery process of AODV causes very long delays for large scale networks due to the amount of control packets transmitted. These delays result in deliver packets waiting in the queues being dropped .The average end-to-end delay is 3% higher than fixed scenario because of high mobility environment, topology change rapidly.

Figure 6 (b, d) respectively shows the average end-to-end delay versus pause time by taking the each time delay which we considered as simulation time for AODV, AOMDV, DSDV routing protocol. Figure 6 (b) shows that DSDV performs less delay than AODV and AOMDV with 36 connections and with pause time varying from 0-60 second's when simulation is started. As the simulation time increases, the average end-to-end delay increases because of number of packets generates by each source increases. If there is no alternate path or unable to deliver packets from source to destination, both AODV and AOMDV allow packets to stay in buffer for 30 sec. This causes the data packets waiting to be routed. The packets are dropped if the time the packets have been in buffer exceeds the limit (30s). In the case of a link failure at a node, AOMDV can find an alternate route whereas AODV is caused to be ineffective at that point. Being a proactive routing protocol the packet drop of DSDV is maximum than the other two protocol when its fails to find a route. So delay of DSDV is less than AODV and AOMDV.

Figure 6 (d) shows the effects of mobility, each node chooses a random destination and moves there at a high speed on expiry of its pause time. The observation is that the AOMDV routing protocol outperforms AODV when the pause times varies from 10 to 20 sec .But AODV outperforms AOMDV when the pause time is high that is varying from 26 to 50 sec.

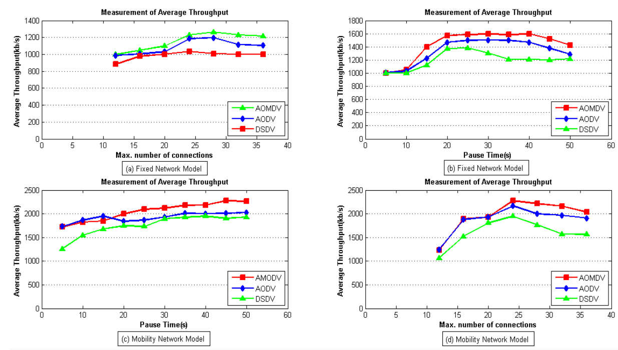

Figure 7 : Measurement of average throughput varying maximum number of connections and pause time (sec.)

Figure 7(a, d) illustrates a comparison among AODV, DSDV, and AOMDV in terms of average throughput based on fixed and mobility scenario by varying maximum number of connections (number of nodes). The numbers of connections were varied as 12,16,20,24,28,32,36 nodes respectively. It can be observed from the figure 7 (a) that the average throughput of AODV and AOMDV routing protocol increases at low density in between the number of connections from 12 to 28 and AOMDV outperforms AODV. This is because whenever the packets are dropped, most of the missing packets are retransmitted again over multiple reliable routes from source or intermediate node to destination. At high density like from 32 numbers of connections, the average throughput decreases because of packet lost. Packets loss is minimum in both AOMDV and AODV than DSDV.DSDV provides much packets drop at high density from 28 number of connections. That's why its throughput is comparatively less than AODV and AOMDV.

Figure 7(d) shows that mobility affects the throughput of AODV, AOMDV and DSDV differently. For randomly changing topology, at low density from 12 to 20 numbers of connections, the throughput of AODV and AOMDV is almost similar. But at high density from 28 connections, the possibility of link failures increases. This causes the average throughput decreases of AODV, AOMDV, and DSDV routing protocol. AOMDV is able to select multiple paths to achieve more loads balancing in a high mobility to delivery packets than AODV and DSDV respectively.

As seen in figure 7 (b), the average throughput value of AOMDV and AODV increases and maintains its value with the pause time increases from 5 to 30 sec because of the proper receiving of packets and less packet drop. The average throughput decreases with the pause time varying from 35 sec because the amount

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of dropping packets increases at the time of interface queue, buffer is getting full. The average throughput increases comparatively in DSDV varying pause time 5 to 25 sec. Throughput decreases as it needs to broadcast periodic updates. DSDV throughput is comparatively less than AOMDV and AODV respectively.

Figure 7(c) shows that the mobility affects the throughput of AODV, AOMDV and DSDV differently varying the pause time. AODV outperforms AOMDV when pause time increases from 5 to 15 sec. The reason behind this is when mobility is low, the occurrence of link failure is less and packets drop is less than AOMDV. As the pause time increase from 16 sec AOMDV outperforms AODV. This is because if the node mobility is high, then occurrence of link failure increases and as we said before in AOMDV as if one path fails or congested, an alternate path is utilized to deliver packets and it maximizes the throughput than AODV. With respect to varied pause time as from 5 to 20 sec, throughput increases because of less periodic updates of routing table. DSDV shows more variation of throughput if the node mobility is high. Thus its throughput decreases quicker as pause time increases from 25 sec and throughput increases again when pause time is 30 sec. AOMDV provides more data packets delivery than AODV and DSDV respectively.

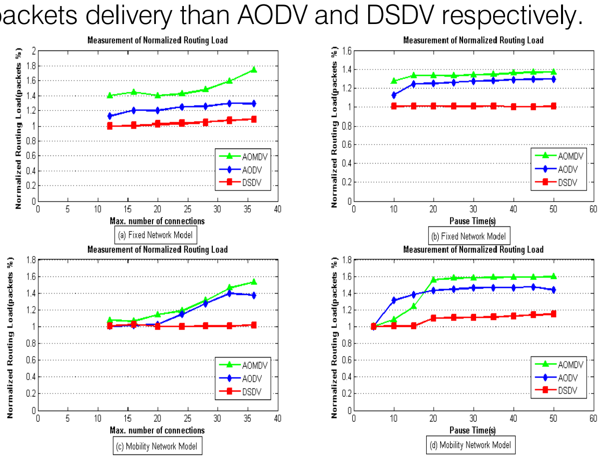

Figure 8 : Measurement of normalized routing load varying maximum number of connections and pause time (sec.)

Figure 8 (a, c) illustrates a comparison among AODV, DSDV, and AOMDV in terms of normalized routing load based on fixed and mobility scenario by varying maximum number of connections (number of nodes). The numbers of connections were varied as 12,16,20,24,28,32,36 nodes respectively. In figure 8 (a), it is observed that AOMDV has more normalized routing load as compared to the DSDV and AODV .For both AOMDV and AODV, the NRL increases as number of connections increases except number of connections 20, 30 respectively. This is because for fixed scenario with smaller number of connections, a link failure is very rare and there is less control packets to route discovery such as hello message, RREQ, RREP, and RERR. DSDV has the least NRL which remain stable than AOMDV and AODV in case of low and high numbers of connections density by varying 12,16,20,24,28,32,36. DSDV does not adapt to increase so much because the difference of routing update interval at every 15 seconds in the network is not very noticeable. AOMDV is a multipath routing protocol and if the current route breaks it searches for alternate paths by flooding the network with RREQ packets. AODV being a unipath routing protocol, the packet delivery along that route stops in the case of link breakage. So NRL of AODV is less than AOMDV.

Figure 8(c) shows the performance of NRL as a function of mobility. DSDV gives the lowest NRL, except at initially the NRL is slightly increased than AODV and AOMDV, when numbers of connections are in between 12 to 16 numbers of connections. This means DSDV sends periodic updates which increase routing load in the mobility network. In case of mobility by varying high density from 17 numbers of connections, more link failures occur than fixed scenario .To detect and handle the pressure of routing load with large number of connection, AOMDV sends HELLO packets periodically which gives higher routing packet overload than AODV.

Figure 8 (b, d) illustrates a comparison among AODV, DSDV, and AOMDV in terms of NRL based on fixed and mobility scenario by variations of pause time from 5 to 60 sec which we consider for simulation time. In figure 8 (b), AOMDV outperforms AODV and DSDV. It is clear from the figure that the NRL of AOMDV and AODV increases linearly with varying pause time 5 to 60 sec and this is because for a static network, max. Speed is of 0 m/s. That's why in the case of less link failure, DSDV's NRL is quite stable with an increasing number of pause time from 15 sec even though its delivery get increasingly worse. The effects of mobility are particularly visible in figure 8 (d). AOMDV outperforms AODV except pause time at 5 to 15 sec. Because in this case, the routing packets travel through more hops to reach the destination that increase the frequency rate of route discovery which is less than AOMDV. For DSDV the NRL remains almost unaffected by variations in pause time from 10 to 20 sec and with the increases of pause time from 20 sec, the routing load increases.

AOMDV being a multipath routing protocol and it searches for alternate paths if the current route breaks by flooding the network with RREQ packets. Hence AOMDV has more normalized routing load than AODV in both fixed and mobility scenario due to AODV being a unipath routing protocol.

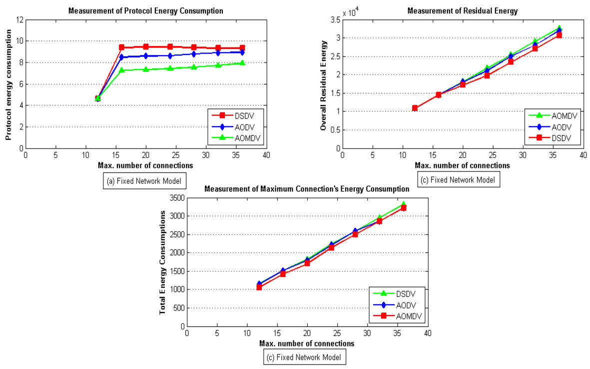

Figure 9.1 : Measurement of protocol energy consumption, residual energy and energy consumption of maximum number of connections (fixed network model)

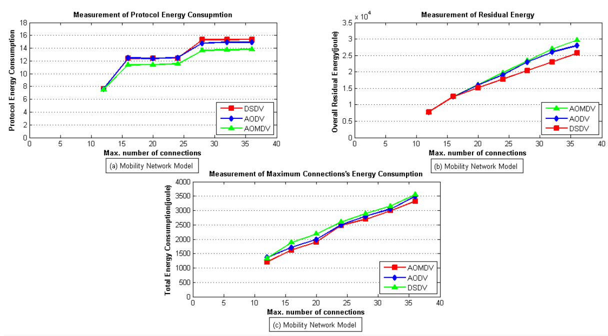

Figure 9.2 : Measurement of protocol energy consumption, residual energy and energy consumption of maximum number of connections (mobility network model)

Figure 9.1 (a, b, c) and Figure 9.2 (a, b, c) shows protocol energy, remaining energy and the maximum number of connections energy consumption respectively. Figure 9.1 (a) and 9.2 (a) shows that DSDV protocol consumes more energy compared to AOMDV and AODV. It is clear from the figure 9.2(a) that in mobility scenario, all the protocol consumes more energy than fixed scenario. The life time (battery) of the node for AOMDV is higher than other protocol. To utilize the same path for route discovery process of DSDV, the node life time expires (battery power) which consumes more bandwidth and energy than reactive protocols like AOMDV and AODV. In the case of a link failure, AOMDV has the ability to make longer battery and node's life time because of the proper utilization in choosing a path. Figure 9.1 (b) and 9.2(b) shows the overall residual energy of each route in the route discovery process. The overall residual energy of AOMDV and AODV in both cases higher than DSDV because of proper utilization stale routes and choosing alternate paths when it's needed. DSDV routing protocol is updated its all routing protocols if its need to be changed. For this reason residuals energy is less than AODV and AOMDV. Figure 9.1 (c) and 9.2(c) depicts that the maximum number of connection energy consumption. The number of sources of DSDV consumes more energy because its routing table updated at every 15 seconds in the network. For mobility cases in DSDV lots of link failure occurs and mostly drop packets are needed to retransmit on a same path which expires a sensor node battery life time than on-demand routing protocols (AODV and AOMDV). Both on-demand protocols have the ability to choose alternative path if link failure occur.

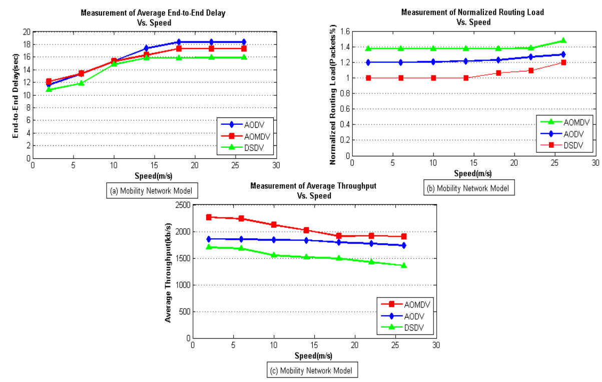

Figure 10 : Measurements of Speed vs. Average Throughput, Speed vs. Normalized Routing Load and Speed vs. Average End-to-End Delay

Figure 10 (a, b, c) show the comparison among AODV, DSDV, and AOMDV in terms of speed vs. end-to-end delay, normalized routing load and throughput respectively by varying speed such as 2,6,10,14,18,22, 26 m/s (average speed 4 m/s). Figure 10 (a) shows average end-to-end delay vs. speed. End-to-End delay increases as speed increases. AODV outperforms AOMDV and DSDV respectively except as the speed of nodes is varied from 2 to 10 m/s. In case of a link failure at a node, AOMDV can find an alternate route whereas AODV is caused to be ineffective at that point. DSDV shows less delay because it immediately drops the packets when there is a link failure. The results show that in "low mobility" situation, AODV protocol gives approximately same end-to-end delay as that of AOMDV protocol but in "high mobility" situation, AODV outperforms AOMDV protocol. Figure 10 (b) shows Normalized routing load vs. speed. AOMDV has the highest normalized routing load than AODV and DSDV. As we seen from the figure, the NRL value for AOMDV and DSDV increases very less (the difference is unnoticeable) till 2 to 14 m/s. If any route fails in AOMDV, AOMDV tries to find alternate multiple routes which tend to incur greater routing packets. While a node moves at a high speed, a source node generate more RREQs to find an alternate route. For DSDV protocol as node speed increases, the topology changes occur quickly, and thus DSDV has fewer chances to make available routes at once.

Figure 10 (c) shows the effect of average throughput, throughput decreases as speed increases. If speed of each mobile nodes increases, the source to destination distance increases which makes less packets delivery and causes more packets drop. This is because it has gone out of packets transmission ranges since finding the route requires more and more routing traffic as speed increases. AOMDV outperforms AODV and DSDV. As AOMDV and AODV both are on demand routing protocols, they have the ability to deal with high mobility speed for delivering good numbers of packets.

VI. Conclusion and Future Work

This paper evaluated the performance of the well-known routing protocols in wireless sensor network on the basis of fixed and mobility network model in terms of average throughput, average end- to-end delay, normalized routing load, energy consumption, protocols residual energy, total energy consumption of each nodes, speed vs. throughput, speed Vs. end-to-end delay, speed vs. normalized routing load with different simulation period and maximum number of connections. Being a proactive routing protocol, DSDV immediately drops the packets in the case of a link failure. Therefore, it has less delay than AOMDV and AODV in both fixed and mobility scenario. In mobility network scenario, the average end-to-end delay is 3% higher than fixed scenario because of high mobility environment and frequent topology changes. DSDV is not suitable for larger networks. In terms of average throughput and normalized routing load, both reactive protocols (AODV, AOMDV) performs better than DSDV. This is because AODV and AOMDV both chooses the alternate path if link failure occurs. Therefore, packet loss ratio of AODV and AOMDV protocols is lower than DSDV. The number of received packets for fixed scenario is 87-90% whereas the number of received packets for mobility scenario is 70-75%. In mobility scenario, received packets ratio is always less than fixed scenario due to the repeated update of the position of the sensor nodes and frequent link failures. AOMDV and AODV have higher normalized routing load than DSDV, because of maintaining stale routes and alternate paths. In both fixed and mobility scenario, AOMDV is energy efficient routing protocol than AODV and DSDV respectively. AOMDV has much residual energy along with the hop count. To utilize the same path for route discovery process of DSDV, the node life time expires (battery power) which consumes more bandwidth and energy than reactive protocols like AOMDV and AODV. In the case of a link failure, AOMDV has the ability to make longer battery and node's lifetime because of the proper utilization in choosing a path. So our performance analysis among DSDV, AODV and AOMDV routing protocol depicts that the applications where throughput, residual energy are important and delay can be tolerated; then the AOMDV routing protocol can be the best solution. We also observed that in a high speed movement of nodes, AOMDV can be the best choice. Though AOMDV routing protocol performs better in our simulation environment considering energy consumption and throughput, still it has some limitations like more delay, more routing load in the network. The future work would be to improve AOMDV routing algorithm so that these limitations can be removed.

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Managing DDoS Attacks on Virtual Machines by Segregated Policy Management

By E. S. Phalguna Krishna, E. Sandhya & M. Ganesh Karthik
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Abstract- Security is considered as most crucial aspect in cloud computing. It has attracted lots of research in the recent years. On the other hand, attackers are exploring and exploiting the vulnerabilities in cloud. The heart of the Cloud computing lies in Virtualization technology. Attackers are taking the advantage of vulnerabilities in Virtual Machines and they can able to compromise virtual machines thereby launching DDOS attacks. Services such as Saas,IaaS which are meant to support end users may get affected and attackers may launch attacks either directly or by using zombies. Generally, Data Centres own security policies for dealing with security issues. Suppose incase of DDoS attacks, only the policies which deals with it ,can only been applied. However, in datacenters, all the security policies are commonly been applied on the applications irrespective of their category or security threats that it face. The existing approach consumes lots of time and wastage of resources. In this paper, we have developed an approach to segregate the applications as per the type or threats (by adapting detection mechanisms) being faced . Based on the zone in which it is lying , only the relevant security policies will only be applied. This approach is optimized where we can efficiently reduce the latency associated with applying security policies.

GJCST-E Classification : C.2.1

MANAGINGDDOSATTACKSONVIRTUALMACHINESBYSEGREGATEDPOLICYMANAGEMENT

Strictly as per the compliance and regulations of:

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E. S. Phalguna Krishna [α], E. Sandhya [σ] & M. Ganesh Karthik [ρ]

Abstract- Security is considered as most crucial aspect in cloud computing. It has attracted lots of research in the recent years. On the other hand, attackers are exploring and exploiting the vulnerabilities in cloud. The heart of the Cloud computing lies in Virtualization technology. Attackers are taking the advantage of vulnerabilities in Virtual Machines and they can able to compromise virtual machines thereby launching DDOS attacks. Services such as Saas,IaaS which are meant to support end users may get affected and attackers may launch attacks either directly or by using zombies. Generally, Data Centres own security policies for dealing with security issues. Suppose incase of DDoS attacks, only the policies which deals with it ,can only been applied. However, in datacenters, all the security policies are commonly been applied on the applications irrespective of their category or security threats that it face. The existing approach consumes lots of time and wastage of resources. In this paper, we have developed an approach to segregate the applications as per the type or threats (by adapting detection mechanisms) being faced . Based on the zone in which it is lying , only the relevant security policies will only be applied. This approach is optimized where we can efficiently reduce the latency associated with applying security policies.

I. Introduction

Virtualization is considered as back bone for cloud computing ,With which users can access multiple instances of apps, resources etc.Virtualization technology will allow one computer to do the job of multiple computers.This environment let one computer host multiple operating systems at the same time.It transforms hardware into software.It is emulation of a fully functional virtual computer that can run its own applications and operating system and also Creates virtual elements of the CPU, RAM, and hard disk. Hardware-independence of operating system and applications. Hence, using virtualization it is possible to run operating systems and multiply applications on the same SERVER at the same time, thereby it raises the utilization and flexibility of hardware.

Some of the virtualization technologies include VMWare, Hyper V,Virtual Iron etc.,

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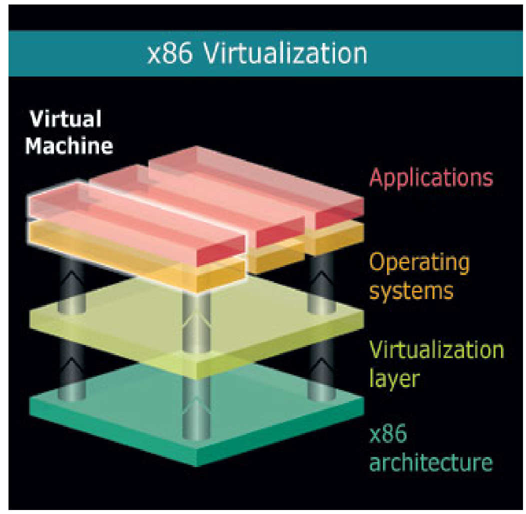


Figure 1 : Virtualization

a) Virtual Machines

These are the things that can manage OS and application as a Single unit by encapsulating them into Virtual Machines. A Virtual machine (VM) is an efficient, isolated duplicate of a real machine.
Virtual machines can be provisioned to any system.

i. *Duplicate*

The behaviour of the VM should be identical to the real machine. There is no differentiation with respect to the execution of the program at the low level.

ii. *Isolated*

Multiple Virtual Instances corresponding to different VMs execute without interfering with each other.

iii. *Efficient*

VM should operate at the speed of the under-lying hardware.

All the resources of the physical computer are shared to create the virtual machines.By virtualization, it creates an emulation that user is actually using owned resources.But at the implementation level,these resources are shared between multiple number of users at any given point in time.Further,Disks are partitioned into virtual disks and a normal user time sharing terminal serves as Virtual machine operators console.

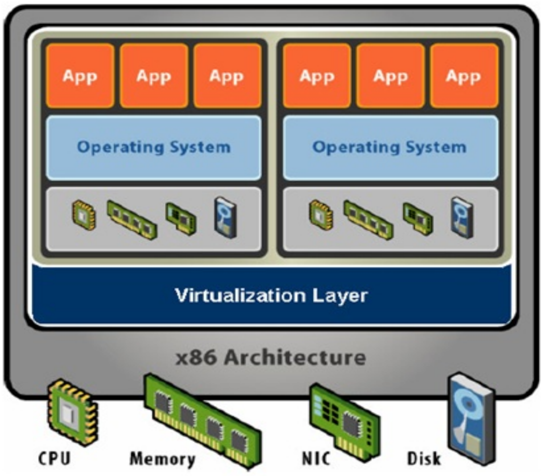


Figure 2 : Virtual Machine & Its Layers

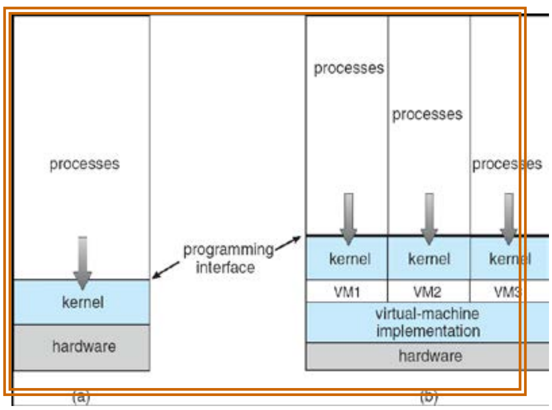


Figure 3 : VIRTUAL MACHINE

a) Types of Virtual Machines: Type 1 / Type 2

i. *Type 1*

They are also Called Hypervisors or virtual machine monitor or VMM.Hypervisors of this type is dependent of bare metal (bare machine) and always interacts with the machine. They Sit just above the HW and virtualizes the complete hardware. It runs at the physical hardware and is the real operating system. Normal unmodified operating systems, like Linux or Windows runs atop of the hypervisor. The server which is hosting Type 1 Hypervisor requires some form of persistent storage for storing the files of concern. In ESX server, the kernel uses device drives to actually get interfaced with bare metal.

- Example: Xen, VMware ESX server

b) Type 2 hypervisor

It is considered as most common type of hypervisor and depends on the underlying OS.Such hypervisors requires to be directly installed on bare metal.It runs within an OS, and rely on OS services to manage HW. A normal unmodified host operating system like Linux or Windows runs on the physical hardware.

A type 2 hypervisor like VMware Workstation runs on the host operating system.Once after installing host operating system, we can now deploy hypervisor and it doesn't modify it. Examples include QEMU, VMware Workstation etc.

II. Threats on VMs

Like any other technology, Virtual Machines are prone to different categories of threats.Some attacks against virtual machine, or VM, environments are variations of common threats such as denial of service etc. Others are still largely theoretical but likely approaching as buzz and means increase, these are the critical weaknesses.

a) VM Sprawl

VMs are easy to deploy, and many organizations view them as hardware-like tools that don't merit formal policies. This has led to VM sprawl, which is the unplanned proliferation of VMs.

Attackers can take advantage of poorly monitored resources. More deployments also mean more failure points, so sprawl can cause problems even if no malice is involved.

b) Hyperjacking

Hyperjacking takes control of the hypervisor to gain access to the VMs and their data. It is typically launched against type 2 hypervisors that run over a host OS although type 1 attacks are theoretically possible but practically difficult.

In reality, hyperjackings are rare due to the difficulty of directly accessing hypervisors. However, Hyperjacking is considered a real-world threat, and administrators should take the offensive and plan for it.

c) VM escape

A guest OS escapes from its VM encapsulation to interact directly with the hypervisor.By doing so, the attacker can gain access to all VMs and, if guest privileges are high enough, the host machine can also be targeted as well. Although few, if any instances are known, experts consider VM escape to be the most serious threat to VM security.

d) Denial of Service

Considered most common threat.These attacks exploit many hypervisor platforms and range from flooding a network with traffic to sophisticated leveraging of a host's own resources. The availability of botnets continues to make it easier for attackers to carry out campaigns against specific servers and applications with the goal of derailing the target's online services.

e) Incorrect VM Isolation

To remain secure and correctly share resources, VMs must be isolated from each other. Improper control over VM deployments can lead to isolation breaches in which VMs communicate.

Attackers can exploit this virtual drawbridge to gain access to multiple guests and possibly the host. The attacker can take the loop holes in the interfaces and can attack.

f) Unsecured VM migration

This occurs when a VM is migrated to a new host, and security policies and configuration are not updated to reflect the change. Potentially, the host and other guests could become more vulnerable. Attackers have an advantage in that administrators are likely unaware of having introduced weaknesses and will not be on alert.

g) Host and guest vulnerabilities

Host and guest interactions can magnify system vulnerabilities at several points. Their operating systems, particularly Windows, are likely to have multiple weaknesses. Like other systems, they are subject to vulnerabilities in email, Web browsing, and network protocols. However, virtual linkages and the co-hosting of different data sets make a serious attack on a virtual environment particularly damaging.

h) Dynamic environment

Tracking and updating what you have can be a challenge as people create, suspend and move virtual machines. If you don't update your golden image from which virtual machines are deployed, you can end up needing to find and patch many virtual machines.

i. *Mitigating Risk*

Inorder to overcome the existing problem with respect to the security, one can take Several steps to minimize risk.

- Characterization:The first task is to accurately characterize all deployed virtualization and any active security measures beyond built-in hypervisor controls on VMs.
- Standards: Security controls should be compared against industry standards to determine gaps. Coverage should include anti-virus, intrusion detection, and active vulnerability scanning.

Additionally, consider these action steps:

ii. *VM traffic monitoring*

Efficient monitoring of VM backbone network traffic is critical. Conventional methods will not detect VM traffic because it is controlled by internal soft switches. However, hypervisors have effective moni-toring tools that should be enabled and tested.Also , by maintaining traffic logs ,one can have vigilance over the network traffic.

iii. *Administrative control*

Procedures such as authentication, author-ization, Identity management etc must be done as a regular process by the concerned admins.Sometimes, Secure access can become compro-mised due to VM sprawl and other issues.

iv. *Customer security*

Outside of the VM, make sure protection is in place for Customer interactive interfaces such as web-sites.

v. *VM segregation*

In addition to normal isolation, strengthen VM security through functional segregation.

For example, consider creating separate security zones for desktops and servers. The goal is to minimize intersection points to the extent feasible.

III. Virualization Vulnerabilities

Virtualization has eased many aspects of IT management but has also complicated the task of cyber security. The nature of virtualization introduces a new threat matrix.

a) Single Server

- VMs run on a single server which poses serious security problems.
- Virtual monitor should be root secure meaning that no privilege within the virtualized guest environment permits interference with the host system been found in all virtualization software which can be exploited by malicious, local users to bypass certain security restrictions or gain privileges.
- For example, the vulnerability of Microsoft Virtual PC and Microsoft Virtual Server could allow a guest operating system user to run code on the host or another guest OS.
- Vulnerability in Virtual PC and Virtual Server could allow elevation of privilege.

A perfection of properties like isolation is yet to be completely achieved.

b) Ease of reconfiguration

Ability to flexibily reconfigure restart and also movement of VM's to other servers. Because of this easeness, an optimal environment to propagate vulnerabilities and unknown configuration errors has been created.

c) Dormant machines

In public-cloud environments, VM is available to any application even though it is offline.

- For example, a Web server that can access the physical server on which it resides.
- So a remote user on one VM can access another dormant VM if both reside on the same physical server.
- As Dormant machines can't perform malware scans, they are highly susceptible to malware attacks.

- Exploitation of this vulnerability is not only restricted to the VMs on a particular hypervisor but also affect other physical devices in the cloud.

For example: A Dormant machine might have been backed up or archived to another server or storage device.

d) Patch management

Generally users does the patch management in cloud computing and attackers could easily misuse this opportunity to attack VMs.

e) Cross-VM information leakage

It is the ability of a malicious instance to utilize side channels to learn information about co-resident instances.

IV. Modules

a) Packet Feeder

Packet arrives from multiple streams and they are feeded into the packet feeder module which acts as entry point for this approach. The responsibility of the packet feeder is to collect packets from various incoming streams and feed them to the module "FLOW DISCRIMINATOR".

b) Flow Differentiator

It differentiates as per the type of packets based on its properties (multimedia, text, voice, images etc).

c) Decision Maker

This Module applies "Outlier Analysis" technique to discriminate and differentiate different types of flows or vulnerablilities. For example: Normal traffic, Flash Crowd traffic, DDOS traffic etc. Our approach using Outliers requires lesser amount of computations and considered to be effective in discriminating the attacks.

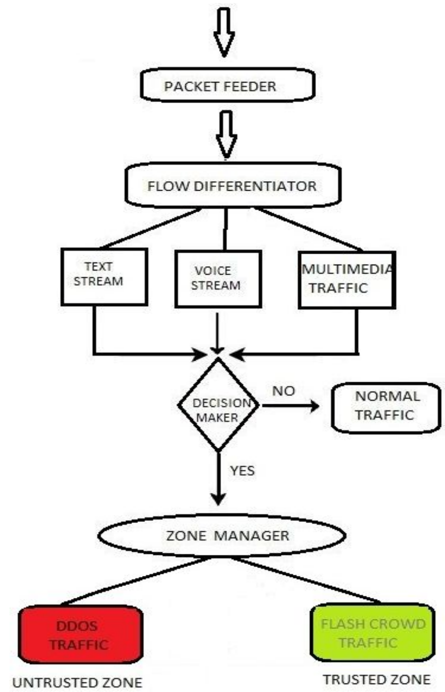
d) Zone Manager

Based upon the nature of VMs, it is prescribed to adopt necessarily relevant policies.

i. *Advantages*

- Optimizes the application of rule sets on different categories of applications.
- This approach significantly reduces the time taken by the data center admin by applying only essential set of security policies.

ii. *Block diagram*



V. Methodology

Users from various locations sends the service requests in the stream of packets to the Virtual servers/ Virtual machines, which internally utilizing virtualization technology. The packets arrived are feeded into the "*Packet Feeder*" module which acts as entry point for this approach. The responsibility of the packet feeder is to collect packets from various incoming streams and feed them to the module "*Flow Discriminator*".

The flow discriminator which takes various streams of packets as input differentiates what type of packet stream it is based on its properties like file extension, contents in the packet etc and categorizes them accordingly such as multimedia, voice, text, images etc. The discrimation is done mainly to adopt the relevant decision strategies and appropriate security policies. All categorized packet streams are given as input next module named "*Decision Maker*".

Decision Maker is the most important module which applies Outlier Analysis technique to discriminate and differentiate different types of vulnerablilities in the flow. For example : Normal traffic, Flash Crowd traffic, DDOS traffic. An advantage of using Outliers in this approach just not only requires lesser amount of computations but also considered to be effective in terms of discriminating the attacks.

Finally the identified malicious traffic from normal traffic is sent to the "*Zone Manager*" which in turn discriminates the DDOS traffic from FLASH CROWD traffic. Based upon the nature of VMs it is prescribed to adopt necessarily untypical policies to safeguard users trust.

This paper consists of three cases: Normal Traffic, DDoS, Flash Crowd. Based on the case, we apply the relevant necessary security policies. This is in converce with the previous approach, where in which the admins of the data centre used to adopt common security policies for discrete set of applications. The previous approach not only consumes time but also leads to consuming more number of processor cycles.

VI. Analogy

Normally datacenter own discrete categories of applications. Inorder to provide the security, each and every data center maintains set of security policies.It specifies what it means to be secure for a system, organization or other entity. But the scenario is like data center admins or tools apply complete set of security policies irrespective of the concept thereby consuming lots of processor cycles and raises latency.

In this paper, we have used an approach to segregate the applications as per the type or threats (by adapting detection mechanisms) being faced and we segregate them into zones. Based on the zone in which it is lying, only the relevant security will only be applied. This approach is optimized where we can efficiently reduce the latency associated with applying security policies.

Consider a scenario in which a data center hosts different set of software applications on their infrastructure. Let S be the main rule set, there exists Subsets S_i, S_j, S_k. For example A, B, C, D applications belong to a particular type of application (multimedia) or facing particular threat (DDoS). Let P, Q, R & X, Y be different categories. Then suppose, A, B, C, D, are the applications that are facing DDo S attack as a threat at this instance, Then it may be relevant to apply for example Si set of rules on those machines which are affected by it, Instead of applying S. Where Si, Sj, Sk ⊆ S. We assumed applications A,B,C,D as web apps and they are prone to DDoS attacks and Si as the subset of rule set that consists of the security policies and mitigation strategies to be applied for DDo S. Similary $S_j \in$ (P,Q,R,S) and $S_k \in$ (X,Y).

VII. Applcations

- The approach can be adopted to the data centres consisting diversified applications.
- The approach is applicable to the data centers which considers security as a service.

VIII. Security Policies

A security policy is a comprehensive document that defines a companies' methods for prevention, detection, reaction, classification, accountability of data security practices and enforcement methods.It generally follows industry best practices as defined by ISO 17799, 27001-02, PCI, ITIL, SAS-70, HIPPA , SOX or a mix of them. It is the key document in effective security practices. Following are some of the policies of data centers:

- Develop a checklist for standard operating procedures to follow in the event of an attack, including internal firewall teams, intrusion detection teams and network teams. Identify who should be contacted during an attack, what processes should be followed by each and what information is needed.
- ISPs and hosting providers might provide mitigation services. Be aware of the service-level agreement provisions.
- Identify and prioritize critical services that should be maintained during an attack so as to keep resources turned off or blocked as needed to limit the effects of the attack.
- Ensure that critical systems have sufficient capacity to withstand an attack.
- Determine whether the denial of service attack is attempting to consume:
  a. Network bandwidth resources, or
  b. Server resources.
- Separate or compartmentalize critical services, including public and private services; intranet, extranet, and Internet services and create single-purpose servers for services such as HTTP, FTP, and DNS.
- Keep network diagrams, IT infrastructure details and asset inventories current and available to help understand the environment.
- Have a baseline of the daily volume, type, and performance of network traffic to help identify the type, target and vector of attack.
- Identify existing bottlenecks and remediation actions needed.
- Harden the configuration settings of the network, operating systems and applications by disabling unnecessary services and applications.
- Implement a bogon (bogus IP address) block list at the network boundary to drop bogus IP traffic.
- Employ service screening on edge routers: very useful to decrease the load on stateful security devices such as firewalls.

a) *Mitigation Strategies of DDOS attacks in data centres*

Data centres cannot rely on their ISP alone to provide a complete DDoS solution that includes application layer protection.

To protect against application-layer DoS, several mitigation strategies can be considered:

i. Traffic subjected to rate limits, prioritization, and load balancing.
ii. Fast-expiring session aging

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iii. Two-factor authentication to validate user roles, especially at admin levels.
iv. Advanced next generation firewalls (NGFWs), such as Fortinet's FortiGate products, offer DDoS and IPS services.
v. Dedicated DDoS Attack Mitigation Appliances: These are dedicated hardware-based devices that are deployed in a data centre used to detect and stop basic (layer 3 and 4) and advanced (layer 7) DDoS attacks.
vi. Deployed at the primary entry point for all web-based traffic, they can both block bulk volumetric attacks and monitor all traffic coming in and leaving the network to detect suspicious patterns of layer 7 threats.

b) Top three mitigation solutions

To make services more robust against a DDoS attack, the following combination of strategies are proposed, they are:

i. *Increase the barrier to entry by using a Pricing-Based Scheme*

Price of entry varies with the load level. This will throttle the machines used in the attack, thereby forcing the attacker to employ (or subvert) a larger number of machines.

ii. *Differentiated model*

Allocating a priority mechanism to desirable clients is key which Provides prioritized access to classes of users though a DDoS attack will raise the price so high that lower priority classes get locked out, higher priority clients can still access the service.

iii. *Dynamic and Differential pricing mechanism*

This will be applied to penalize clients who are responsible for a load on the server and it typically requires flow monitoring and isolation capabilities.

c) Flash Crowd Mitigation Strategies

1. Adaptive Admission Control Based on Application-Level Observations.
2. Flash Crowd Detection within the realms of an Internet Service Provider (ISP).
3. Dynamic CDN against Flash Crowds.
4. Managing Flash Crowds on the Internet
5. Handling Flash Crowds from your Garage
6. KadCache: Employing Kad to Mitigate Flash Crowds and Application Layer DDoS Attacks Against Web Servers.

IX. Conclusion

The flow differentiator is responsible to identify and discriminate attack ,normal flows.Further, we apply zone managers,which will move VM's & its applications to respective zones .Only the relevant security policies will only be applied on the VM's which are running those applications that are affected with security vulnerabilities. Our approach is considered to be effective in optimizing the security policies. Further, this approach is considered to be effective and consumes less resources and time.

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Effect of Channel Equalization Schemes in Performance Evaluation of a Secured Convolutional Encoded DWT based MIMO MCCDMA System

By Rifat Ara Shams, M. Hasnat Kabir & Mohammed Mustaqim Rahman
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Abstract- In this research work, performance of different channel equalization techniques and various M-ary modulation schemes (MPSK, MQAM and DPSK) for DWT based MIMO Multi-Carrier Code Division Multiple Access (MC-CDMA) wireless communication system has been analyzed through simulation. We propose this system using convolutional coding scheme over AWGN and Rayleigh fading channel with implementation of Walsh Hadamard code as orthogonal spreading code. In this paper, we derive a generalized analytical framework to evaluate the Bit Error rate (BER) with respect to Signal-to Noise Ratio (SNR) and also use Electronic Codebook (ECB) mode as cryptographic algorithm to encrypt the actual data for security issues.

Keywords: DWT, MIMO, MC-CDMA, MMSE, ZF, SVD,Q-less QR, ECB.

GJCST-E Classification : C.2.1

EFFECT OFCHANNEL EQUALIZATION SCHEMESINPERFORMANCE EVALUATION OFASECUREDCONVOLUTIONAL ENCODED DWTBASED MIMO MCCDMASYSTEM

Strictly as per the compliance and regulations of:

Effect of Channel Equalization Schemes in Performance Evaluation of a Secured Convolutional Encoded DWT based MIMO MC-CDMA System

Rifat Ara Shams [α], M. Hasnat Kabir [σ] & Mohammed Mustaqim Rahman [ρ]

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I. Introduction

In the era of technologies the demand for wireless systems are rapidly increasing. To gain user satisfaction, multiple access technologies, high data transfer rates and flexible bandwidth allocation must be ensured by using the significant inventions of science and tech worlds [1]. Nevertheless high quality communication with low implementation cost is the centre of attraction of the users [2]. To fulfill user's requirements and to support a wide range of multimedia services, the 3rd generation or beyond wireless communication systems prefer Multi Carrier- Code Division Multiple Access (MC-CDMA) because of its high performance over multipath fading environment and increased capacity for a specified bandwidth [2,3]. MC-CDMA combines Code Division Multiple Access (CDMA) and Orthogonal Frequency Division Multiplexing (OFDM) to support multiple users at the same time as well as to ensure perfect utilization of frequency domain [1,4]. Moreover to curtail the dreadful presence of Inter Symbol Interferences (ISI) and to improve the Signal-to-Noise Ratio (SNR) performance, Discrete Wavelet Transform (DWT) based MC-CDMA is preferred over Discrete Fourier Transform (DFT) based MC-CDMA because of its ability to minimize the analytical complexity and to avoid the influence of delayed waves [2,5].

In our previous work presented in [2], the performance of Wavelet based MC-CDMA systems using Forward Error Correction (FEC) with interleaving in different modulation schemes on fading environment has been investigated. In this paper we propose this very system with Multiple-Input Multiple-Output (MIMO) where different channel equalization and different digital modulation techniques are used over AWGN and Rayleigh fading channel with implementation of convolutional coding scheme as error control coding and a cryptographic algorithm, Electronic Code Book (ECB) mode for secured transmission of data.

We preferred MIMO over other technologies because of its ability to increase the data rate that is to provide multiple forms of the same signal at the receiver without consuming much time [6]. Besides, the use of channel equalization schemes has enriched our proposal because it protects the data from Inter-Symbol-Interference (ISI) by adding redundant bits and exploiting the original transmitted data structure [7]. In our proposed DWT based MIMO MC-CDMA system, the Bit Error Rate (BER) performance of Minimum Mean Square Error (MMSE), Zero Forcing (ZF), Singular Value Decomposition (SVD) and Q-less QR decomposition based channel equalization techniques are compared. It may sound incredible, but with the colossal advancement of science and technology, network security faces a lot of threats. To overcome this problem, we have encrypted the original text message while transmitting using ECB algorithm where each plaintext is divided into several blocks that are encrypted using the same key and at the receiver end, the corresponding ciphertext is decrypted also using that key to retrieve the original message from its indecipherable form [8].

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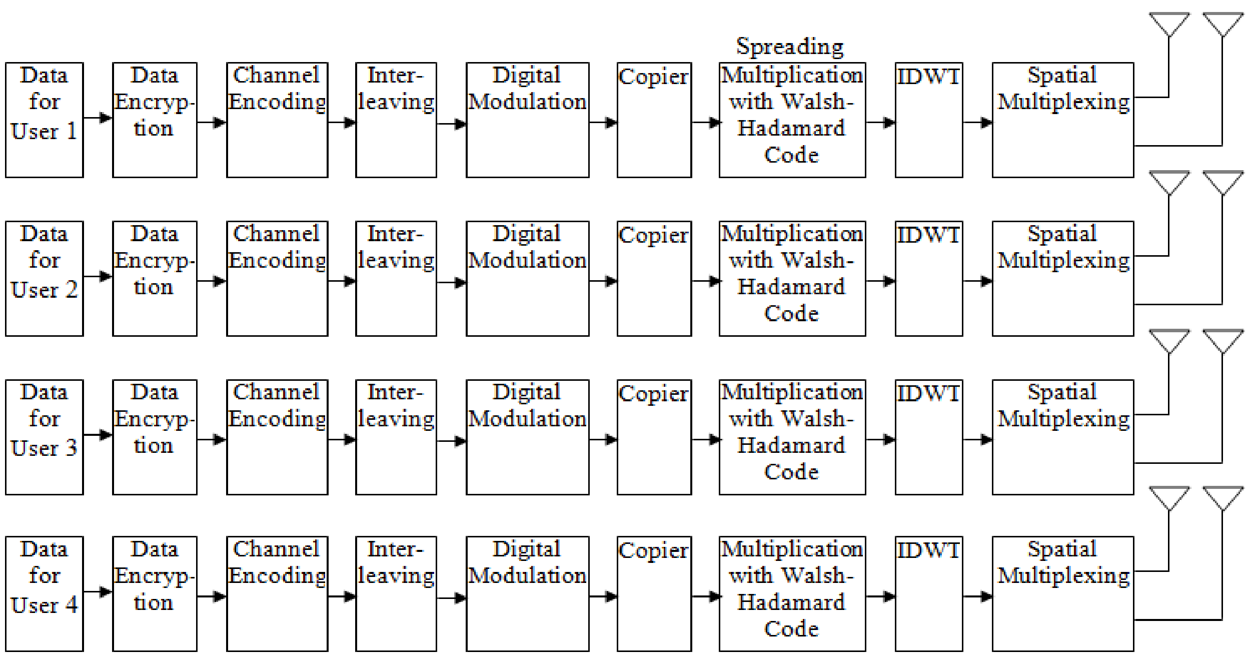
Our attempt is to propose an efficient MC-CDMA scheme that provides the most copacetic result taking the benefits of ubiquitous presence of different channel equalization and digital modulation schemes.

II. System Model

A simulated multi-user 2 × 2 spatially multiplexed and wavelet based MC-CDMA wireless communication system that utilizes spatial diversity coding scheme has been proposed as depicted in Figure 1. In such a communication system, the text message for different users is processed for encryption with ECB cryptographic algorithm so that unauthorized access of data can be prevented. The encrypted data are converted into binary bits and then channel encoded using ½-rated convolutionally encoding schemes and interleaved for minimization of burst errors. The interleaved and channel encoded bits are digitally modulated using BPSK, DPSK, QAM and QPSK. After that, the number of digitally modulated symbols is increased eight times in copying section (as the processing gain of the Walsh Hadamard codes is eight) and subsequently multiplied with Walsh Hadamard codes. The Walsh–Hadamard and channel encoded interleaved digitally modulated symbols are passed through inverse wavelet transformation and eventually fed into Space time block encoder for processing with implemented philosophy of Alamouti's G2 Space Time Block Coding scheme. The space time block encoded signals are then transmitted from each of the two transmitting antennas. In receiving section, the transmitted signals are detected using different channel equalization schemes (MMSE, ZF, SVD and Q-less QR decomposition). The detected two signals are passed through Space time block decoder and subsequently sent to forward wavelet transformation section. Its output is multiplied with assigned Walsh–Hadamard codes for despreading purposes. The despreaded digitally modulated symbols are then decopied, digitally demodulated, deinterleaved and channel decoded scrupulously. Finally the channel decoded binary bit stream is processed for performing decryption operation using the same key as encryption for retrieving the original transmitted text properly.



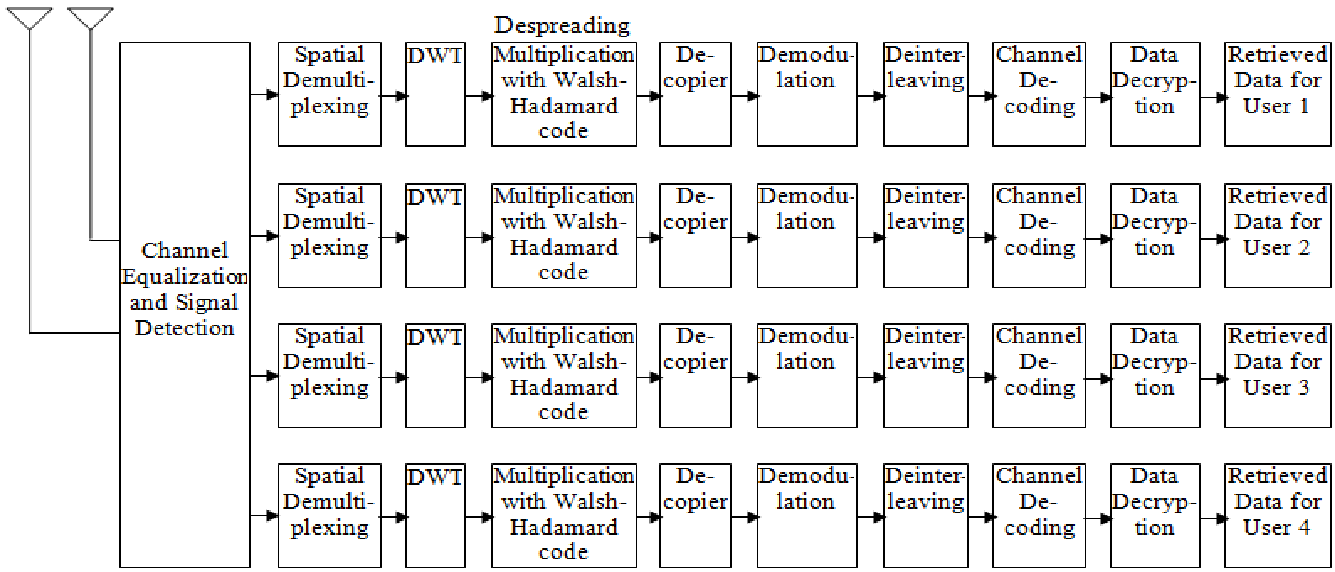


Figure 1 : Block diagram of a wavelet based MIMO MC-CDMA wireless communication system

III. Simulation Parameters

Here, we have used MATLAB 7.5 for simulation of DWT based MIMO MC-CDMA system where different graphical waveforms for different channel equalization schemes and different digital modulation techniques as well as some data for Bit Error Rate (BER) as a function of Signal-to-Noise-Ratio (SNR) per bit have been found. The proposed model for the wavelet based MIMO MC-CDMA transmitter and receiver in Figure 1 is simulated with considering the following parameters shown below in the Table 1.

Table 1 : Summary of simulation model parameters

Parameters	Types
User	4
Input Data	Text
Signal processing scheme	Wavelet
Processing gain	8
Modulation	BPSK,DBPSK,QPSK and 4QAM
SNR	0-10 dB
Spreading code	Walsh-Hadamard Code
Channel coding scheme	Convolutional
Signal detector (Equalizer)	MMSE, ZF, SVD and Q-less QR Decomposition
Channel	AWGN and Rayleigh fading
Cryptographic algorithm	Electronic Codebook (ECB)
Antenna Configuration	2 x 2

IV. Simulation Results and Discussion

In our dissertation, the performance of different channel equalization (MMSE, ZF, SVD AND Q-less QR decomposition) and digital modulation techniques (BPSK, QPSK, 4QAM and DBPSK) is compared in the perspective of bit error rate of MIMO MC-CDMA system based on DWT as a result of simulation, where convolutional coding technique and a cryptographic algorithm (Electronic Codebook Mode) are implemented for security purposes over AWGN and Rayleigh fading channel for wide range of SNR from 0 dB to 10 dB. From all the figures, it is seen that the bit error rate is decreasing with the increase of SNR as expected [2].

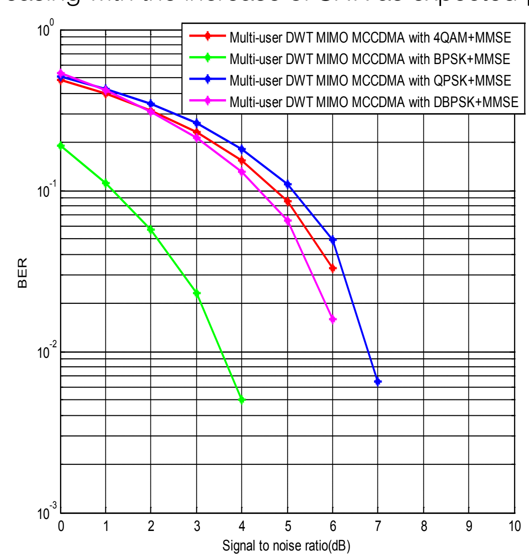


Figure 2 : Effect of different digital modulations under MMSE channel equalization technique in DWT based MIMO MC-CDMA system with implementation of convolutional coding scheme

In Figure 2, the performance of different digital modulation schemes (BPSK, QPSK, 4QAM and DBPSK) is compared in MIMO MC-CDMA system using MMSE channel equalization scheme. From the figure, it is noticeable that the system outperforms in BPSK digital modulation as compared to others (QPSK, 4QAM and DBPSK). For example, the BER values are 0.0229 and 0.2615 in case of BPSK and QPSK digital modulations respectively in a typically assumed SNR value of 3 dB as shown in Table 2, that is, the system performance achieves a gain of 10.58 dB. It is also observable from Figure 4 that at 10% BER value, the system performance with BPSK is superior to QPSK by 4 dB SNR value.

Table 2 : BER performance of the DWT based MIMO MC-CDMA system with implementation of MMSE channel equalization, convolutional coding and various digital modulation schemes

SNR (dB)	BER with MMSE Channel Equalization			
	4QAM	BPSK	QPSK	DBPSK
0	0.4893	0.1899	0.5098	0.5350
1	0.4024	0.1112	0.4301	0.4169
2	0.3151	0.0569	0.3459	0.3091
3	0.2310	0.0229	0.2615	0.2133
4	0.1535	0.0050	0.1810	0.1313
5	0.0863	0	0.1088	0.0649
6	0.0327	0	0.0492	0.0159
7	0	0	0.0065	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0

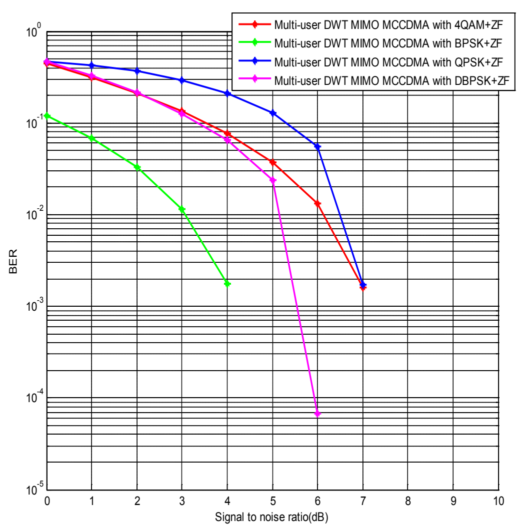


Figure 3 : Effect of different digital modulations under ZF channel equalization technique in DWT based MIMO MC-CDMA system with implementation of convolutional coding scheme

In Figure 3, it is remarkable that at higher SNR value area (5 dB – 7 dB), the estimated BER values at different digital modulations (BPSK, QPSK, 4QAM, DBPSK) ranges from minimum 0.0000 to maximum 0.0017 with implementation of Zero Forcing (ZF) channel equalization scheme (Table 3). Here, BPSK also gives the best performance among others as shown in the figure. The system shows almost identical performance in low SNR value area with 4QAM and DBPSK digital modulations. After SNR value of 5 dB, the BER value falls dramatically for DBPSK digital modulation whereas the BER of others decreases almost linearly with the increase of SNR.

Table 3 : BER performance of the DWT based MIMO MC-CDMA system with implementation of ZF channel equalization, convolutional coding and various digital modulation schemes.

SNR (dB)	BER with ZF Channel Equalization			
	4QAM	BPSK	QPSK	DBPSK
0	0.4412	0.1208	0.4668	0.4695
1	0.3131	0.0680	0.4296	0.3261
2	0.2115	0.0326	0.3686	0.2130
3	0.1336	0.0116	0.2924	0.1270
4	0.0765	0.0017	0.2092	0.0650
5	0.0373	0	0.1275	0.0237
6	0.0133	0	0.0555	0.0001
7	0.0016	0	0.0017	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0

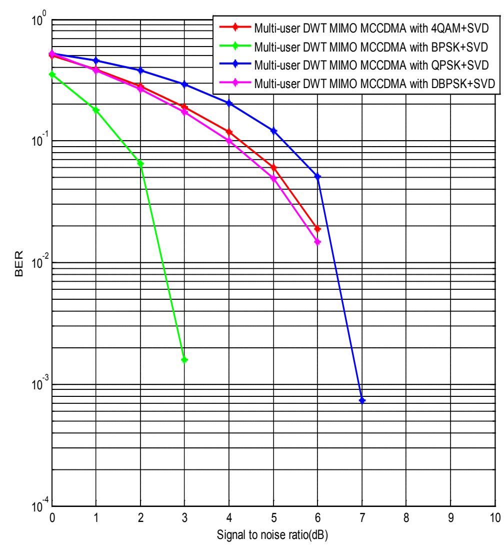


Figure 4 : Effect of different digital modulations under SVD channel equalization technique in DWT based MIMO MC-CDMA system with implementation of convolutional coding scheme

From critical examination on Figure 4, it can be unanimously mentioned that the system under investigation shows the best performance in BPSK digital modulation as compared to others (QPSK, 4QAM and DBPSK) with implementation of Singular Value Decomposition (SVD) channel equalization technique. This is because the BER value for BPSK is the lowest than others. For example, if we consider only BPSK and QPSK digital modulations, it can be shown from Table 4 that, for a typically assumed SNR value of 3 dB, the BER values are 0.0016 and 0.2920 for BPSK and QPSK digital modulations respectively viz., the system performance achieves a gain of 22.61 dB. It is also shown from the figure that, the BER values of BPSK and QPSK decrease rapidly within 2dB-3dB and 6dB - 7dB respectively whereas the decreasing rate is linear for both before these SNR values. The system shows almost identical performance in low SNR value area with 4QAM and DBPSK digital modulations.

Table 4 : BER performance of the DWT based MIMO MC-CDMA system with implementation of SVD channel equalization, convolutional coding and various digital modulation schemes

SNR (dB)	BER with SVD Channel Equalization			
	4QAM	BPSK	QPSK	DBPSK
0	0.5083	0.3544	0.5237	0.5221
1	0.3872	0.1787	0.4586	0.3805
2	0.2816	0.0650	0.3792	0.2644
3	0.1919	0.0016	0.2920	0.1718
4	0.1181	0	0.2038	0.1007
5	0.0604	0	0.1214	0.0490
6	0.0190	0	0.0515	0.0150
7	0	0	0.0007	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0

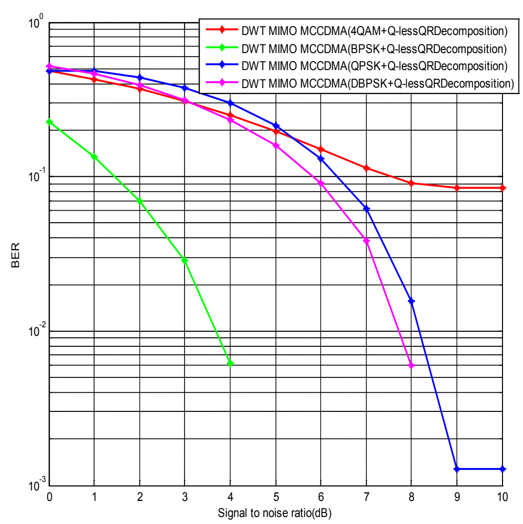


Figure 5 : Effect of different digital modulations under Q-less QR decomposition based channel equalization technique in DWT based MIMO MC-CDMA system with implementation of convolutional coding scheme

From Figure 5, it can easily be noticed that, the system using Q-less QR decomposition based channel equalization scheme provides the best performance with BPSK as before whereas it gives the worst performance with 4QAM in the perspective of the decreasing rate of BER. It is remarkable that, at higher SNR value area (4 dB –10 dB), the estimated BER values at different digital modulations ranges from minimum 0.0062 to maximum 0.0850 as shown in Table 5. As an example, it can be shown that, at 10% BER value, the system performance with BPSK is superior to 4QAM by 6.3 dB SNR value.

Table 5 : BER performance of the DWT based MIMO MC-CDMA system with implementation of Q-less QR decomposition based channel equalization, convolutional coding and various digital modulation schemes

SNR (dB)	BER with Q-Less QR decomposition based Channel Equalization			
	4QAM	BPSK	QPSK	DBPSK
0	0.4841	0.2265	0.4866	0.5214
1	0.4297	0.1340	0.4814	0.4634
2	0.3708	0.0696	0.4420	0.3926
3	0.3105	0.0286	0.3778	0.3145
4	0.2517	0.0062	0.2982	0.2346
5	0.1974	0	0.2128	0.1584
6	0.1506	0	0.1309	0.0912
7	0.1142	0	0.0621	0.0386
8	0.0914	0	0.0157	0.0060
9	0.0850	0	0.0013	0
10	0.0850	0	0.0013	0

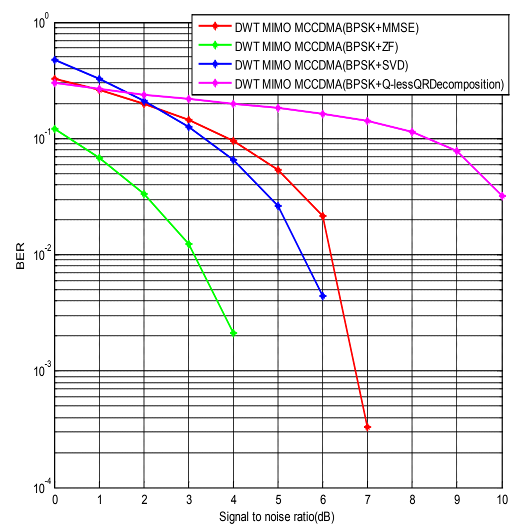


Figure 6 : Effect of different channel equalization techniques in DWT based MIMO MC-CDMA system with implementation of convolutional coding and BPSK digital modulation schemes

In Figure 6, the performance of different channel equalization schemes (MMSE, ZF, SVD, Q-less QR decomposition) in DWT based MIMO MC-CDMA system has been investigated with BPSK digital modulation incorporating with convolutional coding technique. A remarkable system performance has been observed from this figure with implementation of ZF channel equalization scheme. The system shows the worst performance in Q-less QR decomposition based channel equalization scheme as compared to others. For example, considering SNR value of 4 dB, the BER values are 0.0021 and 0.2009 in case of ZF and Q-less QR decomposition based channel equalization schemes respectively (Table 6), that is, the system performance achieves a gain of 19.81 dB. From the figure, an interesting property can be noticed that, a dramatical decreasing of BER has been occurred for MMSE channel equalization scheme after 6 dB SNR value.

Table 6 : BER performance of the DWT based MIMO MC-CDMA system with implementation of convolutional coding, BPSK digital modulation and various channel equalization schemes

SNR (dB)	BER with BPSK Digital Modulation			
	MMSE	ZF	SVD	Q-less QR Decomposition
0	0.3253	0.1202	0.4714	0.2998
1	0.2612	0.0685	0.3252	0.2664
2	0.2005	0.0335	0.2114	0.2402
3	0.1447	0.0124	0.1263	0.2191
4	0.0952	0.0021	0.0659	0.2009
5	0.0537	0	0.0266	0.1835
6	0.0215	0	0.0045	0.1648
7	0.0003	0	0	0.1424
8	0	0	0	0.1143
9	0	0	0	0.0784
10	0	0	0	0.0324

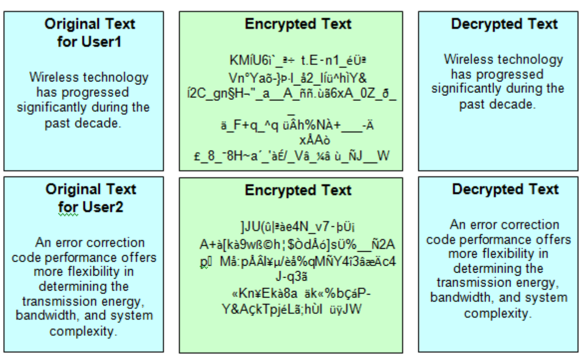


Figure 7 : Transmitted original messages, encrypted and decrypted messages using Electronic Codebook (ECB) mode of operation

In Figure 7, the transmitted, encrypted and decrypted messages for different users at SNR value of 10 dB have been presented. It is observed from the figure that, in all cases the encrypted text message is totally unintelligible, that is, it does not have any similarity to that of the original text message whereas this message can be retrieved with the decrypted one. Hence, it can be concluded that, this system ensures secured communication because it is possible to protect the transmitted data from eavesdropping of third party using this cryptographic algorithm.

V. Conclusion

In this thesis work, the performance of a 2 × 2 multi antenna supported 4G compatible DWT based MC-CDMA wireless communication system adopting convolutional coding and various channel equalization schemes with different digital modulations has been studied. In the context of system performance, it can be concluded that with BPSK digital modulation under implementation of ZF channel equalization scheme, the system provides the most satisfactory result. Furthermore, by using ECB cryptographic algorithm, confidentiality of data, which is one of the burning issues nowadays, can be ensured. Hence, by adopting this system, secured transmission of data with lower BER performance is possible.

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LWE Encryption using LZW Compression

By M. N. M. Prasad, Mohammed Ali Hussain & C.V. Sastry

KLEF University, India

Abstract- ENCRYPTION of data has become essential, for sending confidential information from one system to another system, especially in banking sector. NTRU labs have done pioneering work using a ring of truncated polynomials which was based on the impossibility (with proper choice of parameters) of finding the polynomial with knowledge of its inverse in modular arithmetic. Recently, Learning With Errors (LWE) has been studied extensively and its hardness can be linked to the near impossibility of finding the Shortest Vector on integer lattices. In this paper we have shown that a preprocessing of input before applying the LWE algorithm greatly reduces the time of encryption and decryption.

Keywords: number theory research unit (NTRU), LWE, SVP, LZW, ring of truncated polynomials, modular arithmetic.

GJCST-E Classification : *I.4.2*

LWEENCRYPTIONUSING LZW COMPRESSION

Strictly as per the compliance and regulations of:

LWE Encryption using LZW Compression

M.N.M. Prasad [α], Mohammed Ali Hussain [σ] & C.V. Sastry [ρ]

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Keywords: number theory research unit (NTRU), LWE, SVP, LZW, ring of truncated polynomials, modular arithmetic.

I. Introduction

Secure transmission of data has become the key for successful completion of all transactions. NTRU Labs have created a bench-mark in secure transmission of data using a ring of truncated polynomials [1, 2, 3, 4]. Many attempts have been made to break the crypto-systems based in NTRU technique; but no successful attempt has ever been reported. However polynomial inversions are difficult to perform in modulo-arithmetic. Moreover, polynomials are to be repeatedly chosen until they could be properly inverted.

In the last three to four years, Learning With Errors (LWE) has emerged as a versatile alternative to the NTRU cryptosystems. All cryptographic constructions based on LWE [5, 6, 7] are as secure as the assumption that SVP (Smallest Vector Problem)[8,9] is hard on integer lattices.

The LWE problem can be stated as follows:

Recover s, given $A.s \cong b$ where $s \in Z_q^n$, $b \in Z_q^n$ and A is m × n matrix with m > n and Z_q^n is set of integer vectors of size n and modulo q. In other words, we are given a set of m equations in n unknowns and the right hand side slightly perturbed with the error vector chosen from normal distribution χ with low standard deviation. More precisely we say that an solves LWE[10] if we can recover s, given that the errors are distributed according to the error distribution χ and the elements of A are chosen uniformly at random from Z_q^n [10].

The number of equations or the number of rows in the matrix is irrelevant since additional equations can be formed that are as good as new, by adding the given equations.

One way to obtain a solution to the LWE problem is to repeatedly form new equations until we get the first row of the matrix A as (1, 0, 0, 0, ..., 0) which gives a solution to the first component of s. We can repetitively apply the same procedure for the other components of s. However the probability of obtaining such a solution is almost nil, of the order of q^{-n}, and the set of equations needed are $2^{O(n \log n)}$ and with a similar running time.

The algorithm can be stated as follows:

Private Key: s, chosen uniformly at random from Z_q^n.

Public Key: m samples of (A_i, b_i).

Encryption: for each bit of the message, we chose at random a set T from the 2^m subsets of the m equations. The encryption is $(\sum_{i\in T} A_i, \sum_{i\in T} b_i)$, if the bit is zero and the encryption is $(\sum_{i\in T} A_i, \left\lfloor \frac{q}{2} \right\rfloor + \sum_{i\in T} b_i)$ if the bit is 1.

Decryption: The decryption of the pair (a, b) is 0 if b – <a, s> is closer to 0 than to $\left\lfloor \frac{q}{2} \right\rfloor$, 1 otherwise.

However, transmitting a text with bitwise encryption will be cumber-some and time-taking. We use a slightly modified version of the algorithm to encrypt 'l' bits simultaneously. We choose A, S uniformly at random from $Z_q^{m\times n}$ and $Z_q^{n\times l}$ respectively and S is the private key. We generate the error matrix $E \in Z_q^{m\times l}$ by choosing each entry according to normal distribution$\boldsymbol{\chi}\alpha$, where α is a measure of standard deviation which is usually chosen as $\sqrt{\alpha q}$ and α is small. The public key is (A, B) where B= A.S + E.

Farther simplification is made by choosing the elements of A in the form of a circulant matrix. In other words we have chosen A as [11]

$$\begin{bmatrix} a_1 & a_2 & a_3 & a_4 & . & . & . & . & a_n \\ a_2 & a_3 & a_4 & a_5 & & . & . & . & -a_1 \\ a_3 & a_4 & a_5 & a_6 & . & . & . & -a_1 & -a_2 \\ . & & & & . & . & . & . & \\ . & & & & . & . & . & . & \end{bmatrix}$$

Let v be a vector belonging to message space Z_t^l. Choose a vector $a \in \{\mathbf{-1,0,1}\}^{\boldsymbol{m}}$ uniformly at random. The cipher text u corresponding to the

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message v is $(u = A^T a, C = B^T a + f(v))$ where f is an invertible mapping from the message space Z_t^l to Z_q^l and in this paper we have chosen the mapping as a multiplication of each co-ordinate by q/t and rounding to the nearest integer.

The original message can be recovered from the cipher text (u, C) using the private key S as $f^{-1}(C - S^T u)$ which can be seen as follows:

$$\begin{aligned} f^{-1}(C - S^T u) &= f^{-1}(B^T a + f(v) - S^T A^T a) \\ &= f^{-1}((AS+E)^T r + f(v) - S^T A^T a) \\ &= f^{-1}(E^T a + f(v)) \\ &= f^{-1}(E^T a) + v \end{aligned}$$

If a decryption error is to occur, say in the first letter, the first co-ordinate of $E^T a$ must be greater than $q/(2t)$ in absolute value the probability of which is shown to be negligible [11].

However, some pre-processing of data greatly helps to reduce the time for encryption and decryption as well as time for transmission. We choose to compress the data before encryption using LZW (Lemple-Ziv-Welch)[12,13,14] technique and encrypt the reduced text. The LZW method of compression is based on dictionary structure. It creates a dictionary of its own for each character or a string of the input text. It is known to be a lossless compression and the percentage of reduction in the text is approximately 40% [15].

Another frequently used compression algorithm is the well known Huffman Technique [16,17,18] which constructs a binary tree based on the frequency of the occurrence of the letters and the corresponding code is generated. We have also used Huffman algorithm on the same text and compared the two compression technique used with LWE.

II. Illustration of the Proposed Algorithm

The parameters of the proposed algorithm are chosen as q =2003, t =2, n =136, l =136, alpha = 0.0065 and m =2008 [11]

Original text message

str: wild animals, rocks, forest, beaches, and in general those things that have not been substantially altered by human intervention, or which persist despite human intervention.

The Compressed message using LZW is cmes=

$$\begin{bmatrix} 87 & 105 & 108 & 100 & . & . & . & 352 & 110 & 46 \end{bmatrix}$$

Where the integers indicate the indices to the patterns generated by the compression algorithm.

Then we convert the message vector as obtained above into a binary

v=

$$\begin{bmatrix} 0 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & . & . & . & 0 & 0 \end{bmatrix}$$

$$f(v) = round(v \times \tfrac{q}{t}) =$$

$$\begin{bmatrix} 0 & 0 & 1002 & 0 & 1002 & 0 & 1002 & 1002 & 1002 & 0 & 0 & 1002 & 1002 & 0 & 1002 & 0 & 0 & 1002 & . & . & . & 0 & 0 \end{bmatrix}$$

$A \in Z_q^{m \times n}$ is chosen as

$$\begin{bmatrix} 1591 & 757 & 1974 & . & . & . & 1216 & 1991 \\ 757 & 1974 & 892 & . & . & . & 1991 & -1591 \\ 1974 & 892 & 1760 & . & . & . & -1591 & -757 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 1137 & 1368 & 375 & . & . & . & -887 & -1301 \\ 1368 & 375 & 449 & . & . & . & -1301 & -1137 \\ 375 & 449 & 154 & . & . & . & -1137 & -1368 \end{bmatrix}$$

$S \in Z_q^{n \times l}$ is as follows

$$\begin{bmatrix} 1759 & 2 & 154 & . & . & . & 1044 & 1218 \\ 764 & 1434 & 996 & . & . & . & 1703 & 945 \\ 475 & 1846 & 462 & . & . & . & 956 & 1644 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 136 & 591 & 1728 & . & . & . & 1489 & 708 \\ 782 & 945 & 84 & . & . & . & 121 & 1215 \\ 1271 & 916 & 1500 & . & . & . & 1439 & 76 \end{bmatrix}$$

$E \in Z_q^{n \times l}$ is as follows

$$\begin{bmatrix} -3 & 0 & -1 & . & . & . & 2 & 3 \\ -2 & 0 & 0 & . & . & . & 0 & 0 \\ -3 & -1 & -2 & . & . & . & -3 & 0 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ -7 & 4 & -1 & . & . & . & 8 & 1 \\ -2 & -2 & 0 & . & . & . & 2 & -6 \\ -4 & 1 & 4 & . & . & . & -1 & 2 \end{bmatrix}$$

$$B = A \times S + E (mod\ q) =$$

$$\begin{bmatrix} 1637 & 130 & 771 & . & . & . & 671 & 453 \\ 908 & 123 & 438 & . & . & . & 1399 & 264 \\ 527 & 963 & 184 & . & . & . & 1573 & 61 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 720 & 312 & 299 & . & . & . & 1955 & 130 \\ 403 & 389 & 357 & . & . & . & 1428 & 1659 \\ 277 & 1467 & 1094 & . & . & . & 1056 & 39 \end{bmatrix}$$

Let $\boldsymbol{a} = \{-\mathbf{1}, \mathbf{0}, \mathbf{1}\}^{\boldsymbol{m}}$ where the elements are chosen randomly.

$$\begin{bmatrix} -1 & 0 & -1 & -1 & . & . & . & 0 & 1 & 1 & 1 \end{bmatrix}$$

$$\boldsymbol{C} = \boldsymbol{B}^{\boldsymbol{T}} \times \boldsymbol{a} + \boldsymbol{f}(\boldsymbol{v})(\boldsymbol{mod}\ \boldsymbol{q}) =$$

$$\begin{bmatrix} 98 & 1396 & 408 & 1049 & . & . & . & 291 & 1356 & 193 \end{bmatrix}$$

$$\boldsymbol{u} = \boldsymbol{A}^{\boldsymbol{T}} \times \boldsymbol{a}\ (\boldsymbol{mod}\ \boldsymbol{q}) =$$

$$\begin{bmatrix} 314 & 1840 & 1588 & 148 & . & . & . & 988 & 1447 & 1125 \end{bmatrix}$$

$$\boldsymbol{D} = \boldsymbol{C} - \boldsymbol{S}^{\boldsymbol{T}} \times \boldsymbol{u}\ (\boldsymbol{mod}\ \boldsymbol{q}) =$$

$$\begin{bmatrix} 1952 & 1992 & 13 & 58 & . & . & . & 15 & 1998 & 143 \end{bmatrix}$$

D/(q/t) =

$$\begin{bmatrix} 0 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 \\ & 1 & 0 & 1 & 0 & 0 & 1 & . & . & . & 0 & 0 \end{bmatrix}$$

Convert binary to decimal

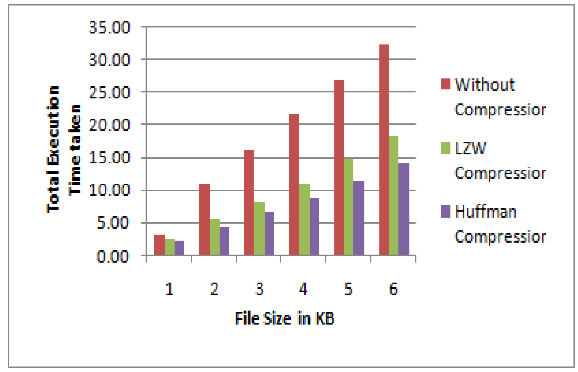
$$\begin{bmatrix} 87 & 105 & 108 & 100 & . & . & . & 87 & 105 & 108 & 100 \end{bmatrix}$$

When the compression process is reversed we get the original message:

III. Experimental Results

The following table gives the total execution time taken for a direct encryption and decryption, encryption and decryption after a LZW compression and encryption and decryption after a Huffman compression:

File Size in KB	Total Execution time without Compression	Total Execution time with LZW	Total Execution time with Huffman
1	3.13	2.4289	2.10777
2	10.84	5.3588	4.28654
3	16.26	8.1736	6.56431
4	21.63	10.9583	8.90506
5	27.00	14.7273	11.39183
6	32.43	18.2190	13.98658



IV. Conclusions

In this paper we have used ring-LWE to encrypt an input text. The text to be transmitted has been initially compressed using LZW Technique and the compressed text is encrypted using LWE. We have also used Huffman coding algorithm for compression for comparison purpose. It has been observed that compressing the input text greatly reduces the total time of transmission and Huffman coding works out to be better.

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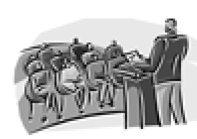

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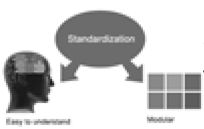

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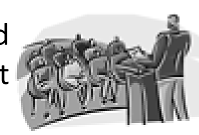

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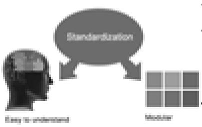

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- Significant conclusions or questions that track from the research(es)

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What to keep away from

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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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