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Comparative Analysis of Reactive, Proactive Hybrid (MANET) Protocols & Security Issues

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Abstract – A computer Network is a methodology by which the two or more end users can connect in order to data sharing. To setup a network three main needs are – 1. Computers, 2. Connecting Media, 3. Protocol. In 1990's the ad-hoc network comes into light. A Mobile ad hoc network is a group of nodes that are capable of changing their location dynamically but still they can communicate, There is no need of centralized device in order to coordinate the other nodes. These nodes are able to able to perform routing also. The applications of MANET nowadays are used in many areas like Military, Disaster Management, Mining, Event Management, Sensor Network, Money making zone, Medical tune etc. The efficiency and flexibility of MANET in completely based on Protocols. Protocols are set of predefined rules, many routing protocols use in MANET. Mobile ad hoc network has several loop holes by which the attack in MANET is possible. There are many advantages of MANET but attacks are also possible. In this project we will throws light on scenario based comparative analysis of MANET Protocols and security issues.

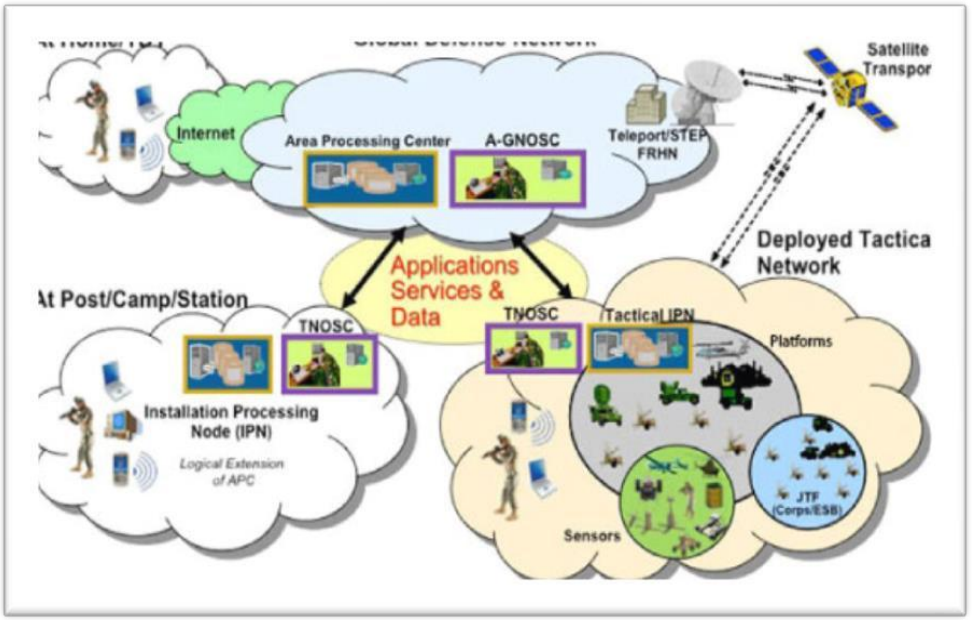

Figure 1

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INTRODUCTION

In last decade we have seen a rapid growth of in mobile ad hoc networking. The infrastructure less and the dynamic nature of these networks demands news set of networking strategies to be implemented in order to provide efficient end to end communication. This along with the diverse application of these networks in many different organization and institutes. This instant growth of communication takes the attention of researchers in this area.

Mobile ad hoc networks (MANET) consist of a collection of wireless mobile nodes which dynamically exchange data among without reliance on a fixed base station or a wired backbone network, which makes routing a crucial issue to the design of a MANET. MANET works with radio waves without need of any central coordinating devices. It's an autonomous network supporting dynamic topology. Active research work for MANET is carrying in mainly in the fields of Medium Access Control (MAC), routing, resources management, power control and

security issues. In this project, I provide an overview of all major routing protocols and also focus on comparison of all routing protocols and suggest which protocols may perform best in large networks.

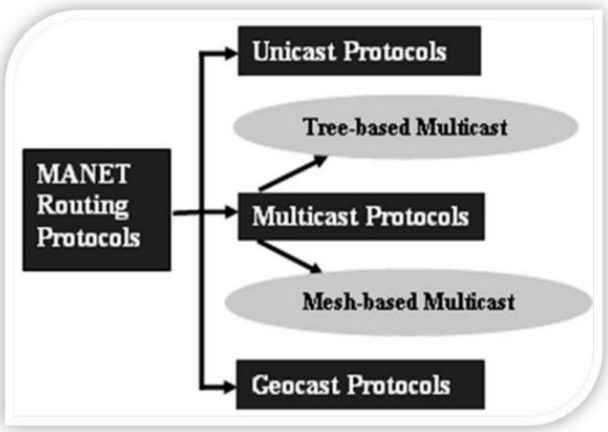

Figure 2

1.1 Brief Outline of MANET Protocols

The limited resources in MANET have made designing of an efficient and reliable routing strategy a very challenging problem. An intelligent routing strategy is required to efficiently use the limited resources while at the same time being adaptable to the changing network conditions such as: network size, traffic density and network partitioning. In parallel with this, the routing protocols may need to provide different level of QoS to different types of applications and users. Based on the method of delivery of data packets from the source to destination, classification of MANET routing protocols could be done as follows:

1. Uni path Routing Protocols – Routing Protocols are used to discover and maintain routes between the source and destination nodes.

a. On demand Protocols (Reactive Routing) –

i. DSR (Dynamic Source Routing Protocol)

ii. AODV (Ad-hoc On-Demand Distance Vector Routing)

b. Table based Protocols (Proactive Routing)

i. OLSR (Optimized Link State Routing Protocol)

c. Hybrid Routing

i. ZRP (Zone Routing Protocol)

2. Multi Path Routing Protocols – Routing Protocols consist of finding multiple routes between a source and destination nodes. The multipath routing could offer several benefits: Load Balancing, fault tolerance, higher aggregate bandwidth, lower end to end delay etc.

a. APR (Alternative Path Routing)

b. AODV-BR

c. Braided Multipath Routing

d. SMR (Split Multi path Routing)

e. MP-DSR(Multi Path Dynamic Source Routing)

f. GMR (Graph Based Multipath Routing)

g. DMSR (Dynamic Multipath source Routing)

h. DPSP (Disjoint Path selection Protocol)

i. CHAMP (Caching and Multipath Routing)

j. MSR (Multi Source Routing)

k. MQLBMSR (MANET Queue Length Based Multi-Source Routing)

l. HMPR (Hybrid Multipath Routing)

For Routing protocols following properties are expected, though all of these might not be possible to incorporate in single solution.

- A routing protocol for MANET should be distributed in manner in order to increase its reliability.
- A routing protocol must be designed considering unidirectional links because wireless medium may cause a wireless link to be opened in unidirectional only due to physical factors.
- The routing protocol should be power efficient.
- The routing protocol should consider its security.
- A routing protocol should be aware of Quality Service.

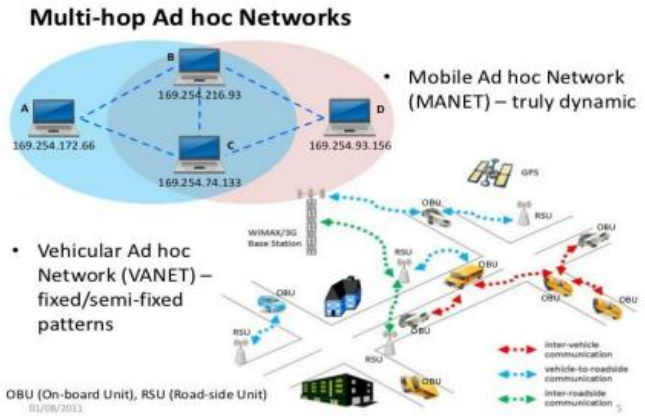

Figure 3

Unicast Routing protocols that consider sending information packets to a single destination from a single source. Multicast Routing Protocol is the delivery of information to a group of destinations simultaneously, using the most efficient strategy to deliver the messages over each link of the network only once, creating copies only when the links to the destination split. Its aging classified in two categories: Tree Based and Mesh Base. Mesh Based use several routes to reach a destination while the tree based protocols maintain only one path.

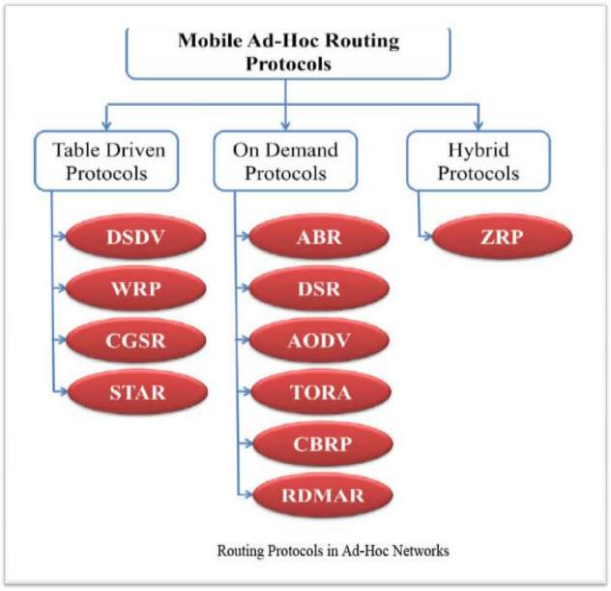

Figure 4

LITERATURE REVIEW

In This project we will mainly focus on comparative analysis of unicast protocols. Concentrate to find way to reduce routing overheads is by using conditional updates rather than periodic ones. Mobility and traffic pattern of the routing strategy for particular network is the key point which is concentrated in this project. For this we have analysis a lot published research papers.

The different authors written literature in the field of Mobile Ad Hoc Network has examined and reviewed for this synopsis to do work in project.

Wadhwa D. et al. [2014] compared different geographic routing protocol such as Location-aided routing, Greedy perimeter stateless routing, Energy-awer geographic routing on the basis of performance metrics such as system life time , the end to end delay, packet delivery ration and energy utilization by using simulation tool NS2. Author concluded that the geographic routing gives high packet delivery ratio, better energy utilization and better network lifetime as compared to other protocols when the topology changes dynamically and when the mobility is high (G€unes, *et. al.,* 2002).

Rajeshwar Sharma, Tarun Sharma, Aditi Kalia et al. [2016] Author get a summary of existing classes and advice which protocols may execute better respect to varying between network scenarios. An effort has been made to concentrate on the comparative study of active, proactive and hybride cols. Conclusion of study is that the choice of routing protocols should be done carefully according to the requirements of the specific application (Iwata, *et. al.,* 1999).

Kawal Jeet, Rajinder Singh Minhas, et al. [2011] A survey of active research work on routing protocols for MANET. A number of routing protocols for MANET, which are broadly categorized as proactive and reactive. Proactive routing protocols tend to provide lower latency than that of the on-demand protocols, because they try to maintain routes to all the nodes in the network all the time. But the drawback for such protocols is the excessive routing overhead transmitted, which is periodic in nature without much consideration for the network mobility or load. On the other hand, though reactive protocols discover routes only when they are needed, they may still generate a huge amount of traffic when the network changes frequently (Jiang, *et. al.,* 1999).

Muthana Najim Adulleh, Salman Yusuf, hothefa Shaker Jassim et al. [2015] the result was that neighbour discovery and the routing for neighbours with which nodes could communicate reliably enables the creation of reliable multi hop routes. Based on our experiences, we outline several recommendations for future work in MANET research. Author examined both a public domain implementation of the Ad Hoc On-Demand Distance Vector (AODV) routing protocol and implemented our own version of the Destination- Sequenced Distance Vector (DSDV) routing protocol (Kumar, Sengupta, 2009).

V.G. Muralishankar, DR E Geroge Dharma Prakash Raj et al. [2014] A Survery of active project work on routing protocols for MANET. Proactive Protocols tend to provide lower latency than that of the on-

demand protocols. Reactive protocols discover routes only when they are needed, they may still generate a huge amount of traffic when the network changes frequently (Muralishankar, Dr. E. Geroge, 2014).

Gurpinder Singh et al. [2012] Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations. Quantitative and qualitative metrics discussed on simulation analysis based on DSR, AODV, TORA. Author conclude that TORA create less load and throughput is high for AODV (Hass,Pearlman, 1999).

PROBLEM FORMULATION & OBJECTIVE

3.1 Problem Formulation

MANET have many disadvantages such as limited resources, limited security, Intrinsic mutual trust vulnerable to attacks, lack of authorizations facilities, volatile network topology makes it hard to detect malicious nodes, security protocols for wired networks cannot work for ad hoc networks, congestion in the network and poor utilization of the network etc. In MANET each node acts both as a host and even the topology of network may also change rapidly. Some of the challenges in MANET include –

a. Unicast Routing

b. Multicast Routing

c. Dynamic Network Topology d. Speed

e. Frequency of updates or network overhead

f. Scalability

g. Routing

h. Quality of Service

3.2 Objective

This project aims to provide a means of understanding the issues and protocols (DSR,AODV, TORA,OLSR) of MANET and investing behavior of DSR,AODV, TORA,OLSR,ZPR protocol using metrics throughput and network load. The behavior analysis has been done by using simulation tool OPNET 14.5 which is the main simulator. We will concentrate to evaluate performance of Protocols on the basis of qualitative and qualitative metrics and also on security issues of MANET.

3.3 Platform Used

NS-2(Network Simulator-2), Ns is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks.

3.4 Software Requirements

NS-2(Network Simulator-2), is the very well-known simulators. NS-2 is open source software; it has a comprehensive development environment to simulate network models. Simulation is performed on the protocols DSR, AODV will be used.

3.5 Hardware Requirements

1. Operating Systems: Windows /Linux

2. Memory: 256MB required

3. Disk space: 200MB required (additional 200MB required during installation)

4. A minimum 20MB of additional disk space is also recommended to store model files created during labs and tutorials.

5. Display: 1024x768 or higher resolution, 256 or more colors

6. X-Server for display, cygwin and a cygwin port of ns-2 and nam,

7. X-server version of gcc ported (Linux, Solaris, Unix, Trux, HPUX, Darvin, even Mac-OSX

RESEARCH METHODOLOGY

Step 1: Identify the Problem. Step 2: Review the Literature. Step 3: Clarify the Problem.

Step 4: Clearly Define Terms and Concepts. Step 5: Define the Population.

Step 6: Develop the Instrumentation Plan.

A mobile ad hoc network (MANET) is a wireless network that uses multi- hop peer to- peer routing instead of static network infrastructure to provide network connectivity. MANETs have applications in rapidly deployed and dynamic military and civilian systems. The network topology in a MANET usually changes with time. Therefore, there are new challenges for routing protocols in MANETs since traditional routing protocols may not be suitable for MANETs. For example, some assumptions used by these protocols are not valid in MANETs or some protocols cannot efficiently handle topology changes.

Researchers are designing new MANET routing protocols and comparing and improving existing MANET routing protocols before any routing protocols are standardized using simulations. However, the simulation from different research groups are not consistent with each other. This is because of a lack of consistency in MANET routing protocol models and application environments, including networking and user traffic

profiles. Therefore, the simulation scenarios are not equitable for all protocols and conclusions cannot be generalized. Furthermore, it is difficult for one to choose a proper routing protocol for a given MANET application. According to the aforementioned issues, my Ph.D. research focuses on MANET routing protocols.

Specifically, my contributions include the characterization of differ- ent routing protocols using a novel systematic relay node set (RNS) framework, design of a new routing protocol for MANETs, a study of node mobility, including a quantitative study of link lifetime in a MANET and an adaptive interval scheme based on a novel neighbour stability criterion, improvements of a widely-used network simulator and corresponding protocol implementations, design and development of a novel emulation test bed, evaluation of MANET routing protocols through simulations, verification of our routing protocol using emulation, and development of guidelines for one to choose proper MANET routing protocols for particular MANET applications. Our study shows that reactive protocols do not always have low control overhead, as people tend to think. The control overhead for reactive protocols is more sensitive to the traffic load, in terms of the number of traffic flows, and mobility, in terms of link connectivity change rates, than other protocols. Therefore, reactive protocols may only be suitable for MANETs with small number of traffic loads and small link connectivity change rates. We also demonstrated that it is feasible to maintain full network topology in a MANET with low control overhead. This dissertation summarizes all the aforementioned methodologies and corresponding applications we developed concerning MANET routing protocols.

The majority research in this field is based on simulation studies of the ad-hoc routing protocols of interest in arbitrary networks with certain traffic profiles. However, the simulation results from different research groups are not consistent. This is because of the lack of consistency in MANET routing protocol models and application environments including networking and user traffic profiles. Therefore, simulation scenarios used in past studies are not reasonable for all protocols and their conclusions cannot be generalized. Furthermore, this is complicated for one to choose an appropriate routing protocol for a given MANET application. However, there has been little research on this kind of framework.

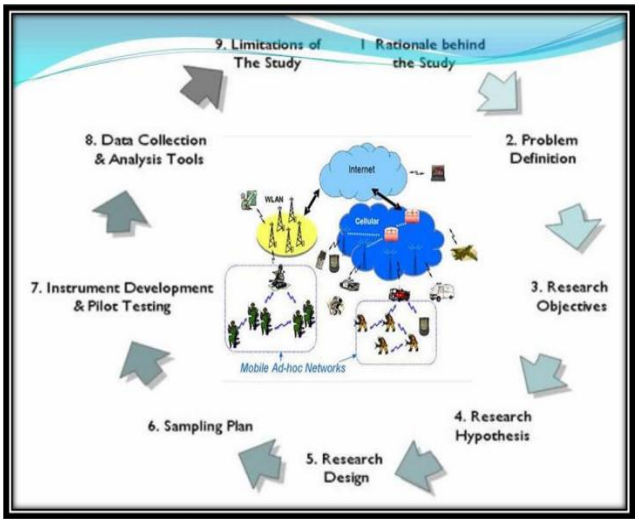

Figure 5

5. UNICAST PROTOCOLS – (TABLE DRIVEN & ON DEMAND)

A. Table-Driven Routing Protocol:

a. Proactive!!

b. Continuously evaluate the routes

c. Attempt to maintain consistent, up-to-date routing information

i. when a route is needed, one may be ready immediately

d. when the network topology changes

i. the protocol responds by propagating updates throughout the network **to** maintain a consistent view

e. Example DSDV

B. On-Demand Routing Protocol:

a. Reactive!!

b. on-demand style: create routes only when it is desired by the source node

i. Route discovery: invoke a route-determination procedure

ii. The procedure is terminated when

1. A route has been found

2. No route is found after all route permutations are examined

c. Longer delay: sometimes a route may not be ready for use immediately when data packets come

d. Example AODV

5.1 Dynamic source routing (DSR)

DSR protocol requires each packet to carry the full address (every hop in the route), from source to the destination. This means that the protocol will not be very effective in large networks, as the amount of overhead carried in the packet will continue to increase as the network diameter increases. Therefore in highly dynamic and large networks the overhead may consume most of the bandwidth. However, this protocol has a number of advantages over routing protocols such as AODV, LMR and TORA and in small to moderately size networks (perhaps up to a few hundred nodes), this protocol may perform better. An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery, and if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility. Since they routes stored in the route cache will be valid longer. Another advantage of DSR is that it does not require any periodic beaconing (or hello message exchanges), therefore nodes can enter sleep node to conserve their power. This also saves a considerable amount of bandwidth in the network.

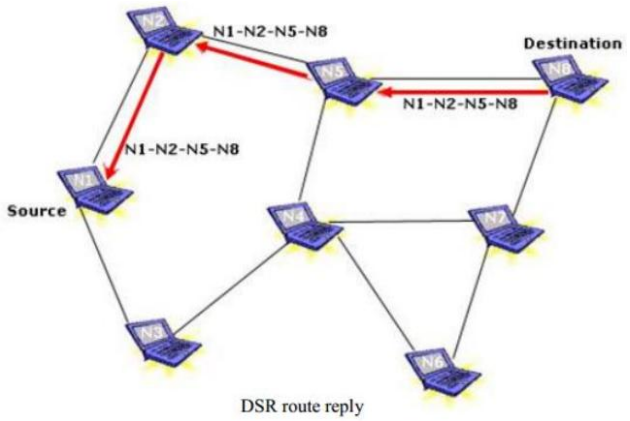

Figure 6

5.2 Temporally Ordered Routing Algorithm (TORA)

TORA is an adaptive routing protocol for highly dynamic mobile multi hop networks that are source initiated and based on link reversal algorithms. This protocol is able to rapidly build routes and reduce communication overhead via the localization response to topological alterations as much as they can. TORA uses the "direction of the next destination" to send data, instead of using the concept of the shortest path to determine routes. This means less processing and less bandwidth usage. The source node uses one or two paths to the destination through several intermediate neighboring nodes. The three main processes in the TORA protocol are route creation, route maintenance and route erasure. The route creation process uses query and UDP packets. For route creation, a height metric is used, where the height of the destination node is set to 0, while all of the others are set to NULL. The source node will then proceed to transmit a query packet containing the destination node's ID. Nodes that possess a non-NULL height will respond using a UDP packet that is made up of its height. The node receiving the UDP packet is set at a height that's higher, and is regarded as being "upstream" and vice versa. This results in the construction of a direct acyclic graph (DAG), from source to destination. The route formation process is realized by sending a request from the source, and receiving replies from its intended destination. During mobility, the DAG is broken, and route maintenance will then work to restore a DAG that is routed at the destination.

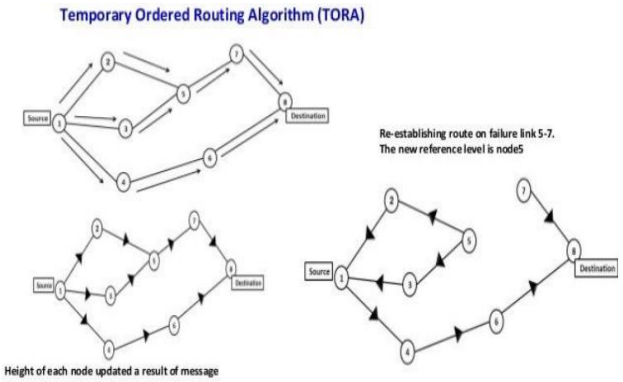

Figure 7

5.3 Ad-Hoc on Demand Distance Vector Routing Protocol (AODV)

Ad-hoc On-Demand Distance Vector Routing Protocol (AODV) is a unicast reactive routing protocol. Basically this implies that the routes are formed when they are needed. The AODV protocol contains four control packets; HELLO messages, route requests (RREQs), route replies (RREPs) and route error messages (RERRs). These control packets are used in the two protocol mechanisms which are route discovery and route maintenance. In the AODV protocol, all nodes maintain a routing table that stores information regarding active routes. The information stored are destination, next hop, number of hops, sequence number for the destination, active neighbours for a route and the expiration time for a route table entry. Route entry timeout are updated upon usage. To prevent looping in distance vector routing, a sequence number is sent with RREQs and RREPs, both of which are stored in the routing table. A larger sequence number is indicative of the fact that recent updated route information and the one with the highest sequence number will be utilized. If two routes possess the same sequence number, the one with the fewer number of hops (a shorter route) will be used. Route discovery mechanism begins when no

valid route is found within the routing table of the source node. Route requests (RREQs) are sent to the network to search for the route to the destination. Receiving nodes create reverse routing entries towards the source for the purpose of sending possible reply packets later. A route reply(RREP) is dispatched by either the destination or intermediate node that is a validated route towards the destination. Nodes that received RREPs also create reverse routing entries towards the nodes that sent the RREPs. Often, each of the nodes along an active route will transmit HELLO messages to the neighbouring nodes. If no HELLO message or data is received from a neighboring node after a period of time, the link is regarded as broken. If the destination of the route using this link is nearby the next hop from the neighbour, then a local repair process may be used to repair the route. If not, then a route error (RERR) message is sent to neighbouring nodes, which then broadcasts the RERR message towards other nodes that may have routes affected by the broken link. If the route is needed by the affected source, the route discovery process will then be repeated.

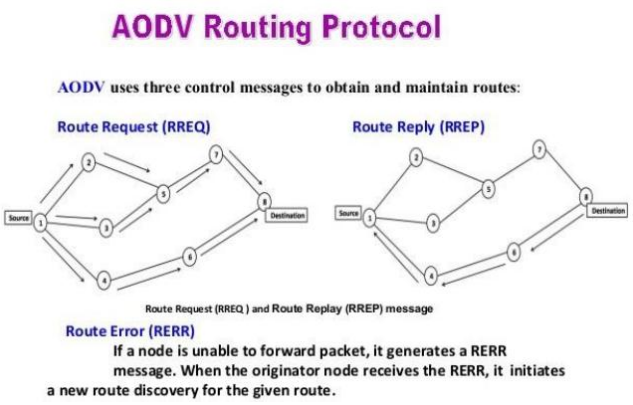

Figure 8

5.4 ZRP (Zone Routing Protocol):

ZRP protocol combines the advantage of both reactive and proactive routing protocol into protocols into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighbourhood, and using a reactive protocol for communication between these neighbourhoods, and using a reactive protocol for communication between these neighbourhoods. In a MANET, it can safely be assumed that the most communication takes place between nodes close to each other. The main concept is to use a proactive routing scheme within a limited zone in the r-hoop neighbourhood of each node, the reactive routing protocol scheme is to use for nodes beyond this zone. In ZRP two different zones routing protocols are used i.e. inter-zone routing protocol (IERP), intra- zone routing protocol (IARP). An Intra-zone routing protocol (IARP) is used in the zone where particular node employs proactive routing and limited by the zones radius hops. This protocol is used by a node to communicate with the interior nodes of its zone whereas Inter-zone routing protocol (IERP) is used by a node to communicate outside the zone.

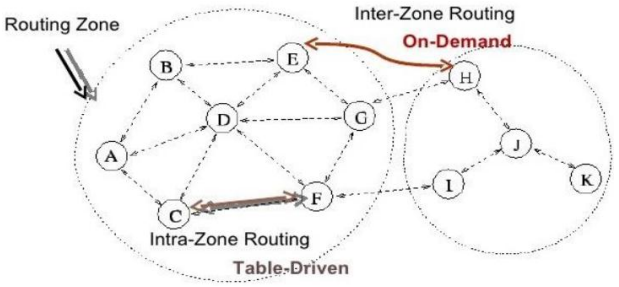

Figure 9

5.5 Optimized link state routing (OLSR)

OLSR is a point-to-point routing protocol based on the traditional link-state algorithm. In this strategy, each node maintains topology information about the network by periodically exchanging link-state messages. The novelty of OLSR is that it minimizes the size of each control message and the number of e broad casting nodes during each route update by employing multipoint replaying (MPR) strategy. To do this, during each topology update, each node in the network selects a set of neighbouring nodes to retransmit its packets. This set of nodes is called the multipoint relays of that node. Any node which is not in the set can read and process each packet but do not retransmit. To select the MPRs, each node periodically broadcasts a list of its one hop neighbours using hello messages. From the list of nodes in the hello messages, each node selects a subset of one hop neighbours, which covers all of its two hop neighbours. Since these nodes cover all the nodes, which are two hops away. Each node determines an optimal route (in terms of hops) to every known destination using its topology information (from the topology table and neighbouring table), and stores this information in a routing table. Therefore, routes to every destination are immediately available when data transmission begins.

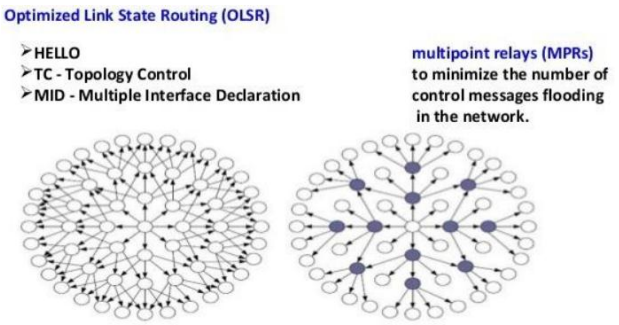

Figure 10

6. COMPARATIVE ANALYSIS OF PROTOCOLS

The performance of routing protocols depends on many factors such as traffic load and mobility of the nodes. However usually reactive protocols have a better performance in large ad hoc networks than proactive protocols but it further depends on the traffic and the topology. When the application needs a lower latency and the network does not have problems with overhead, a proactive protocol will have better performance. However, if the network suffers from high traffic flow, performing route discovery with a proactive protocol could be a bad idea because the overhead of route discovery have a negative effect.

Protocols	Advantages	Disadvantages
Proactive	Information is always available, Latency is reduced in the network	Overhead is high, Routing Information is flooded in the whole network
Reactive	Path available When needed, Overhead is Low and free from loops	Latency is increased in the Network
Hybrid	Suitable for Large Networks, Up to Date Information is available	Complexity Increased

Table 1 Protocol Advantage and disadvantages comparative

Parameters	Reactive	Proactive	Hybrid
Routing Philosophy	Flat	Flat/ Hierarchical	Hierarchical
Routing Scheme	On Demand	Table Driven	Combination of Both
Routing Overhead	Low	High	Medium
Latency	High due to flooding	Low due to routing Tables	Inside zone low and outside similar to reactive protocols
Scalability Level	Not suitable for large Networks	Low	Designed for Large Networks
Availability of Routing Information	Available when required	Always available stored in Tables	Combination of Both
Periodic Updates	Not Needed as Rout available on Demand	Yes Whenever the topology of the network Changes	Yes needed inside the zone
Storage Capacity	Lower generally depends upon the Number of routes	High Due to the routing Tables	Depends on the size of zone inside the zone sometimes high as proactive protocols
Mobility Support	Route Maintenance	Periodic Updates	Combination of Both

Table 2 Protocol Parameters Comparison

Routing Type	Routing Knowledge of Node A When it Communicate with Nodes B,F and J	Protocols
Proactive	A has route to B,C,D,E,F,G,H,I,J,K and L (All Nodes)	OLSR
Reactive	A has only route to B,F, and J	DSR,AODV
Hybrid	A has route to B,C,D,E,F,I and L proactively and Route to J Reactively	ZRP
Location Based	A Knows at least the location of its neighbours B,C,D and E and the location of F and J	DREAM, LAR

Table 3 Routing Type

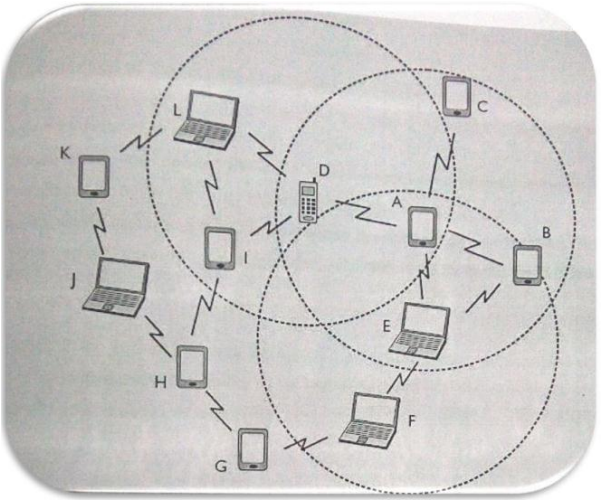

Figure 11 All Routing Type

7. RESULT AND DISCUSSION

Simulation Analysis of Protocols – We have taken two on demand (Reactive) routing protocols, namely Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). Throughput is defined as the ratio of the total data reaches a receiver from the sender. Throughput is expressed as bytes or bits per sec. A high throughput is good choice in every network.

Parameter	Value
Number of Nodes	10
Simulation Time	10 sec
Pause Time	5ms
Environment Size	800X800
Transmission range	250 m
Traffic Size	CBR (Constant Bit Rate)
Packet Size	512 Bytes
Packet Rate	5 Packets/ Sec
Maximum Speed	20 m/s
Queue Length	50
Simulator	NS 2.29
Mobility Model	Random Waypoint

Table 4 Implementation of AODV and DSR

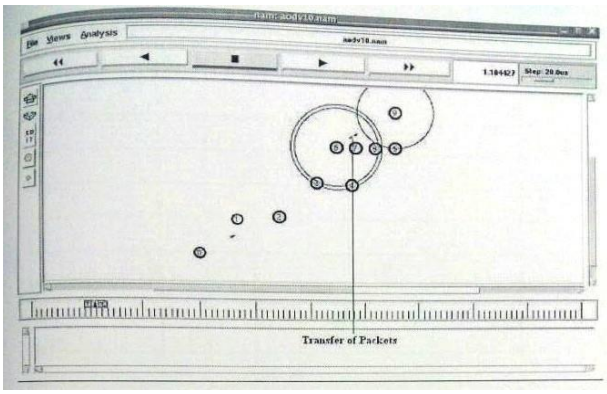

Figure 12 10 Nodes of AODV NAM- Network Animator

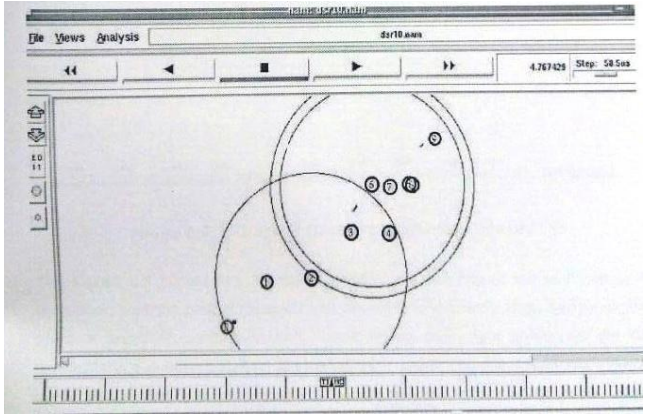

Figure 13 10 Nodes of DSR NAM- Network Animator

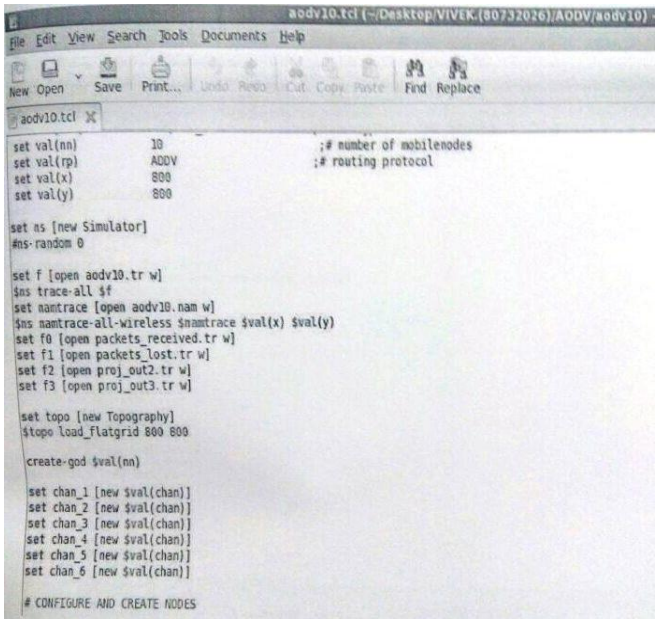

Figure 14 AODV TCL Script

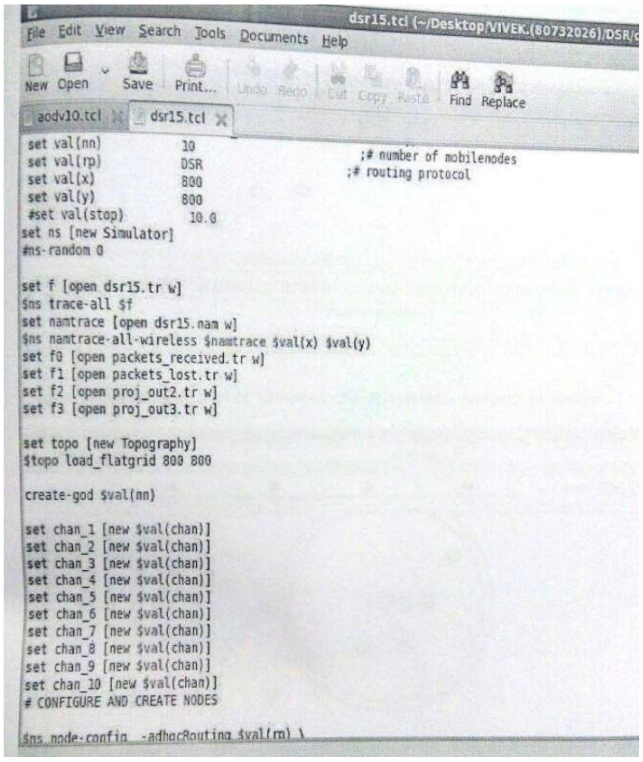

Figure 15 DSR TCL Script

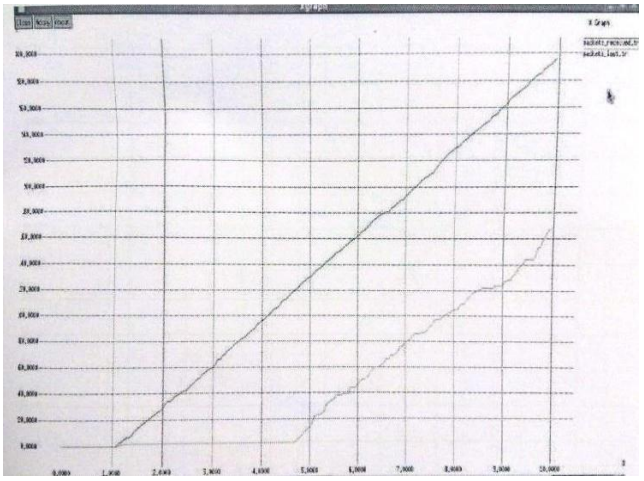

Figure 16 X Graph of 10 seconds simulation time of AODV

Figure shows the X Graph of AODV. By the Figure we can see that as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connections establish between the nodes the number of packets received increases but no packet loss is there, it means all generated packets are being received by the nodes. But the packet loss increases substantially on the simulation time increases. Finally the packets received are more than the packet loss.

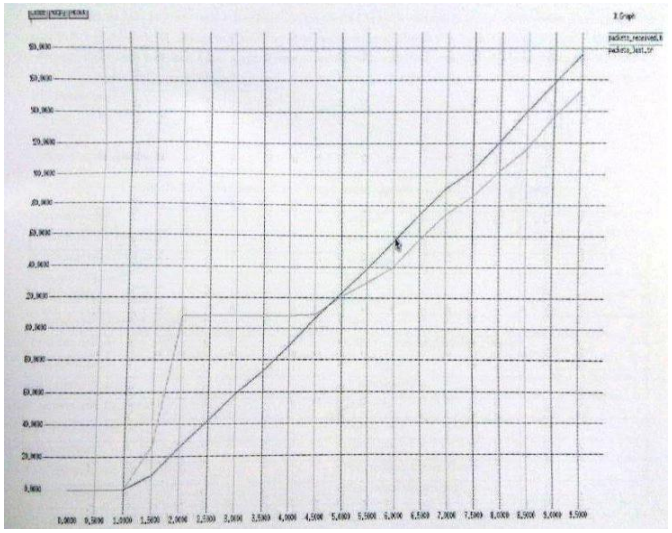

Figure 17 X Graph of 10 seconds simulation time of DSR

Figure shows the X Graph of DSR. By the Figure we can see that as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connection establish the number of packets lost increases very much as compare to packets received. It shows that mostly generated packets are being dropped by the nodes. But the packets loss decreases substantially on the simulation time increase and number of packets received increased substantially on the simulation time increases.

CONCLUSION

Importance of MANET cannot be denied as the world of computing is getting portable and compact. Unlike wired networks, MANET pose a number of challenges to security solutions due to their unpredictable topology, wireless shared medium, heterogeneous resources and stringent resource constraints etc. Security is not a single layer issue but a multilayered issue. It requires multi fence security solutions that provide complete security spanning over the entire protocol stack. In this minor project study reveals that protocols throughput varies on factors. Performance of Routing Protocols can be compare on aspects such as control overhead, packet delivery ratio, routing load, bandwidth cost for data, average end to end delay, load balancing, energy balancing and average energy consumption etc. In on demand routing protocols, the flooding based routing protocols such as DSR and AODV have scalability problems. In order to increase scalability, the route discovery and route maintenance must be controlled. This can be achieved by localizing the control message propagation to a defined region where the destination exists or where the link has been broken. In Nutshell, day by day as the applications of the ad hoc networks are increasing a continuous research and development is required in this field. There will always a scope of improvement in the working of the protocols and to make the protocols reliable for deployment, again and again intensive simulation based evaluation of the protocols will be required.

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