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Performance Analysis of Routing Protocols (DSR, AODV & DSDV) in MANET Environment using NS-2

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ABSTRACT

Mobile Ad-hoc Network (MANET) became very popular with the recent advancement in wireless communication technologies. It is self-configurable, infrastructure less number of mobile wireless devices. A node can join or leave the network without the need of authorization. This is the reason why MANET faces challenges including message routing, data security, energy efficiency, stability and reliability of transmission. Over the past decade, researchers have developed many routing protocols that offer acceptable performance under various different scenarios. Some of the most popular routing protocols are Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector (AODV), Temporally Ordered Routing Algorithm (TORA), Zone Routing Protocol (ZRP) and Destination-Sequenced Distance Vector (DSDV). In this research some of famous routing protocols are implemented and evaluated. Their performance is evaluated on the bases of parameters including throughput, routing overhead (ROH), end-to-end delay, packet-delivery-ratio (PDR) and energy consumption. In this research, we have investigated DSR, AODV and DSDV in different mobility models in MANET. All these protocols are simulated in NS-2 and performance is observed. The DSR protocol performs well when both the mobility models i.e. random. Direction and reference point group model are used. Furthermore, AODV protocol also shows better performance than DSDV in case of random direction mobility model. We proposed BWA-DSDV which performs better than other two selected protocols in Random direction only. On a conclusive note, we observed that the performance of the studied protocols varies from one mobility model to another.

Keywords: MANET, DSR, AODV, DSDV, NS-2

1. Ad hoc network

Ad hoc network [2][3] because it does not follow any structure or model. Wireless ad hoc networks also called decentralized networks because it has no central device to control network. The network is ad hoc network because it cannot use the preexisting infrastructure and no administrative control. In this network the host can enter or leave the network any time without any permission. In this type of network there is no central device such as router or switch which control the network. In network each device act as host or as router because it forwards data to next device in network. In this network all devices have equal status and free to create link with other ad hoc networks where link is available. The devices in this type of network are free in moving and also provide the services of host and router forwards the packet to destination.

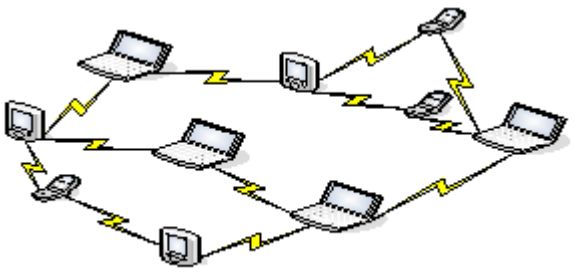

Figure1: Ad hoc network

1.1 Advantages of MANET

The advantages of MANET are following.

- Easy to design and deployment.
- No preexisting infrastructure.
- Low cast.
- Setup anywhere

1.2 Disadvantages of MANET

The disadvantages of MANET are following;

- Energy constraints.
- No central administration.
- No network topology.
- Easy for attacks.
- No authentication facility.
- No security.

2. Queues in MANET

2.1 What is Queue

General Queue is just like buffer in which data is stored in order for processing. Computer queue is object or people waiting for processing. Computer science queue works as service provider and stores data objects to be processed. Queue is most important thing in computer processing and performance. In NS-2 different routing queues are used according to the requirements. Some of them discussed following here are FQ, RED, DRR and Drop-Tail Queues.

Volume 5, Issue 6
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2.2 Drop-Tail Queue

The simplest queue mechanism is known as Drop-Tail Queue [1] and other name of drop tail is passive queue management (PQM). In this mechanism each data unit treat separately and when queue is full packet draped start of news incoming packets, and have no scheme for calculating its probability values. Drop Tail queue is like the FIFO, it means the first packet processed first. In drop tail management scheme all packets have same priority.

Weakness:

- Reduce throughput
- Increase congestion window

2.3 Random Early Detection (RED)

Random Early Detection [1] is another management technique which was used earlier in 1990 by Sally Floyd and Van Jacobson in different projects. This management technique also known as congestion avoidance management technique. Drop tail is passive queue technique but Random Early Detection is active queue technique. It does not drop packet when queue is full, it drop packets depending upon data or information. Random Early Detection controls the losses of packets and reduces delay in queue. Aim of Random early detection is to get high throughput for high performance. In drop tail queue packet is dropped when queue is full but in random early detection packet is dropped before queue is full.

Pros:

- High throughput
- Low delay

Cons:

- Drop all packets which have small percentage.
- Drop all packets which have high dropping probabilities.

2.4 Deficit Round Robin (DRR)

Deficit Round Robin also known as Weight Round Robin (WDRR) and deals with all size of packets. In this queue management scheme, queue is dividing into different size of quantum and sends a packet which is best fit in available quantum. For assigning queue to be used for flow and reducing collision it uses hash function.

Pros:

- Well design idea for getting better performance.
- Cost effect manner.
- Provide farm work for implementing Fair Queue.
- Better throughput.

Cons:

- Poor latency.
- Cannot be used for real time traffic.

3 Routing Protocols

3.1 Overview:

Routing is the process of communication between nodes in which data is transferred from host or place to other host in network and for this purpose routing protocols is used. The protocol does two types of functions one is selection of best route from the available routes and second to find the correct destination.

Routing is the process of transmission of information form source to destination in reliable and correct form. The routing uses different protocols and follows three steps.

- Maximum paths
- Select the path
- Moving information

1) First the protocols find maximum links between source and destination.
2) The selection of path is very important, select the path which provide more reliable transmission.
3) After the selection of path the transmission of information form source to destination.

The moving of data from source to destination number of hops can be counted, and the hops create slow transmission. If the hops are large so the data well reached slowly to the destination as compared to other path which has limited hops, the path which less hops provides reliable and quick transmission.

3.2 Conversational protocols:

For transmission of data, routing protocols are needed then why not conversation routing protocols is used. The conversational protocol is link state and distance vector. The people of networking are familiar with them and they are well test protocols and mostly used for wired network communication, but the main problem is that they are designed for static topology and require more bandwidth and energy. These protocols can be used in low mobility ad hoc networks and cannot be used in high mobility ad hoc networks. As the conversational protocols require more bandwidth and power, that's why conversational, protocols cannot be used in mobile ad hoc network.

Volume 5, Issue 6
December 2016

ITEE Journal
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3.3 Expected or Desirable properties:

The following are desirable properties of routing protocols discussed in [2] [3].

3.3.1 Loop free

The routing protocols should provide loop free route and thus the performance of network is increased using the loop free route.

3.3.2 Demand based operation:

This feature includes that protocol react at the time of demand, it means that it uses the network resources at time when needed, thus it reduces the network overhead and no wastage of network resources.

3.3.3 Unidirectional link:

The routing protocol should create unidirectional link because it improves the performance of network. Radio environment not supports bi-directional link.

3.3.4 Security:

Security is needed to secure communication thus the protocol should be secure from different type of attack and threads.

3.3.5 Power consumption:

Nodes of mobile ad hoc network are laptops PDA and mobile phone which has limited battery power thus routing protocol utilize that battery power in proper way and protocol support sleep mode.

3.3.6 Multiple routes:

Routing protocol support multiple routes when one route down it uses other route from the stored routes it reduce the reaction time when topology changed.

3.3.7 Quality of Services QoS:

Routing protocol should support Quality of Services and know the throughput, delay from source node to destination node.

3.3.8 Localized reaction to topology change:

This property mean when one part of network is changed then little changes in routing polices in other part of network and it reduces the routing over head.

4. Routing protocols Classification:

The mobile ad hoc network can used routing protocols which are following.

- Proactive protocols/table driven:
- Reactive protocols/source initiated:
- Hybrid protocols:

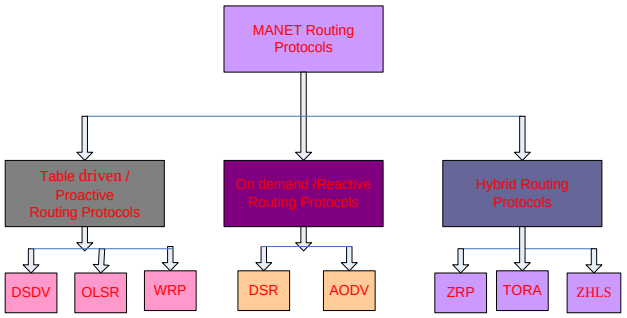

Figure2: Classification of MANET routing protocols

4.1 Destination-Sequenced Distance-Vector:

DSDV [4] is proactive protocol in MANET network. DSDV was developed by P. Bhagwat and C. Perkins in 1994. DSDV protocol used the Bellman-Ford algorithm for providing loop free routes. Destination-Sequenced Distance-Vector is adopting from the wired network protocol which is Routing Information Protocol (RIP) to ad hoc network routing. The main advantage of DSDV it guarantee loop free and for this it used sequence number. The DSDV update message has three fields address of destination Sequence Number and Count of Hop. In DSDV protocol two type of routing table updates are used.

Full table/dump

In full routing table, the whole routing table update means full routing table are transferred.

Incremental/ partial

Partial routing update contains the update information.

Each Node used two mechanisms to send DSDV update.

Periodic Updates

The periodic update can be sent after the default update interval which is default: 15s. The periodic update is broadcasted to all devices or the whole network.

Trigger Updates

The triggers update is a small update in periodic update. The trigger update is used when node receive DSDV change routing table.

Volume 5, Issue 6
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In DSDV each node maintain routing table with the following information

Destination IP	Destination Sequence No	Next Hop	Cost	Install Time

Advantage

- DSDV is suitable for small network
- Loop free path to destination

Disadvantage

- Battery power is require for regularly update
- Not suitable for high dynamic network
- Used bandwidth when network is ideal

4.2 Dynamic Source Routing (DSR)

The DSR [4] are source routing protocols and it create route dynamically thought out network with require destination. The designers of DSR are D.B Johnson, Maltz, and Broch. DSR does not used periodic updates and compute route when necessary and maintain it. The DSR is used in multi hop mobile ad hoc networks. The DSR can perform two things one is route discovery and second route maintenance in a network. This protocol has node cache and stores the path which is recently used. When a node wants to transfer data, other node 1st check entry in cache, if the record exists, used it for the transmission and attach own source address. If there is no entry exits in cache the sender sends a broadcast packet for route request to all neighbors for route to receiver. The source will wait until the path is discovered and during the ideal time source perform some other tasks. As the request reached to other nodes in network, it checks its own cache, if the asked destination is exits or not. The process is repeated until the required route or destination is discovered and the packets forwarded back to sender on the discovered route. The discovered route is saved in cache for future use. The second phase is route maintenance. The route maintenance is occurred when route error packet is generating at any node.

Advantages

- Create route on demand
- Efficiently to reduce the control overhead
- Low through put
- Easily guaranteed loop-free routing

Disadvantages

- Connection setup delay is high
- Performance decrease rapidly with increasing mobility
- Routing overhead is high

4.3 Ad hoc on demand distance vector (AODV)

Ad hoc on demand distance vector [5] is also known as vector routing for mobile ad hoc networks, so it create and maintain route on demand, it means when they need. These protocols create routes between nodes only desire sources nodes and maintain that route until they are needed by sources. The AODV is proposed by C. E. Perkins and E. M. Royer. AODV protocol can support both type of routing which is unicast and multicast. AODV combine source and vector routing features. The protocol is self-starting and scale large numbers of nodes. The AODV use some of basic features from DSR which are route creation and maintenance, sequence number and hop routing from DSDV.

Route can build using these packets route request, route replay and query cycle. The route request packet is used when source want a route to a destination which is not already exits. The RREQ packet is broadcasted across the network; the packet contains the source, destination IP addresses and some other related information. As node receives RREQ packet, if the destination address matched, it sends replay back and if IP does not matched, it increments the broadcast ID and initiate RREQ again. Timeliness of packet can be determined from sequence number. The process is repeated until required destination has been found. As the RREQ packet reached to correct destination node, a replay packet generates, which is route replay packet (RREP) to reverse of the path. The route replay packet is Unicast from destination to source, when source received the RREP packet start communication on best route from the available routes. RERR is generated when the route is broken and sends form destination to source.

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AODV routing table management:

AODV table contains basic information which is following.

- Destination IP.
- Sequence number.
- Number of hops or hop count.
- Life time.
- List of active neighbor.
- Next hop.
- Request buffer.

AODV properties:

ADOV reduce no of number messages.
Sequence number prevents loops.
AODV create one route to each destination.

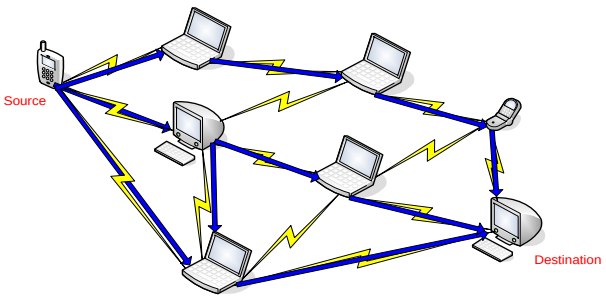

Figure3: RREQ packet propagation

Volume 5, Issue 6
December 2016

ITEE Journal
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AODV RREQ packet contains these things show in table:

RREQ Packet

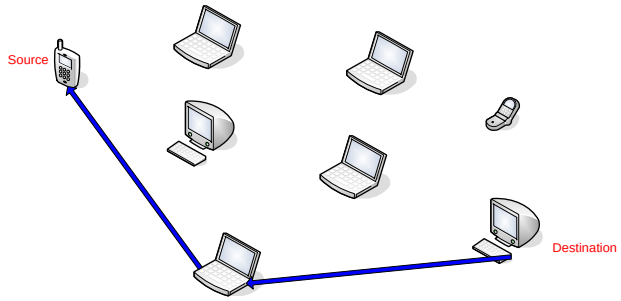

Figure4: RREP packet propagation

5. Related work

The work in [6] was the comparison of different routing protocols such as OLSR, AODV and ZRP with different performance metrics such as E2E delay, PDR, through put and packet jitter. In paper, the simulation result shows that the performance of ZRP is better than other protocols for high mobility and high network traffic, but in low mobility and low traffic OLSR has same performance as ZPR. The limitation of paper is that the simulation tool and parameters are not mentioned. The work in [4] discussed the challenges of MANETs and the advantages of routing protocols to simulate it using ns2 with 5 mobile nodes. In paper, reactive protocols and proactive protocols were evaluated and the result show that AODV gives better performance in all situations. As mobility and speed increases, the AODV give maximum throughput and average delay decrease. Simulation tool used in paper is NS2. The limitation of paper is that simulations are checked only on 5 nodes and not mentioned the load of network and other network parameters. The Anuj K.Gupta [7] analyzed different protocols using model of mobility and divided models into two type one is traces and other is synthetic. The performance of protocols depends upon on the mobility model because the mobility model describes node behaviors. The limitation of paper is that no mobility models choose which give better result in all situations, but only two mobility models are proposed which is random waypoint mobility and group mobility model. Sachin Kumar Gupta and R.K.Saket [8] discussed the protocols and simulate only two from them which is AODV and DSDV. The simulation tool is NS-2 and mobility model is random positions, and result show DSDV is not suitable for real time applications and under high mobility. In this paper only TCP and UDP packet have been analyzed. In this paper packet delivery ratio of AODV is 70% to 90% while the ratio of DSDV is 50% to 75%. Main limitation of paper is numbers of nodes, means the simulation are checked on only 16 nodes and not changed. Other weakness of paper is that the performance parameters are limited and the other weakness of the paper is numbers of protocols are limited. Salman Naseer, et, al [9] discussed routing protocols which is OLSR, AODV and TORA and evaluated the performance of it using OPNET for video conferencing or multimedia traffic. The simulations result shows the OLSR is good in term of high load, high throughput and small delay for video conferencing. For real time applications the proactive protocols are proposed with moderate size of network or moderate numbers of nodes. The weakness of paper is that the simulation model is not mentioned and other is simulation tool which not give good result for real time network as compared to NS-2 and the performance parameters in paper are limited and other disadvantage of paper is this the simulation is checked only on video streaming.

6. Methodology

Methodology is one of the important elements in the success of project, without proper management and planning no project can be complete at time. For the success of project/thesis and to acquired correct results and objectives, we clearly define methodology in our project because methodology helps to provide proper management and control

6.1 Platform

For implementation of routing protocols I have choose the ubuntu operating system and NS-2 simulator which details given below.

6.2 Ubuntu

Ubuntu is Linux based operating system which is freely available. Ubuntu is complete package and support different type of work and can be used in Varity purposes. I used Ubuntu as platform for our thesis.

6.3 Network Simulator (NS-2)

Network simulator is event driven and object oriented simulator tool written in Otcl and C++. NS-2 is used in wired and wireless network researches. Why NS-2 is written in C++ and Otcl because for protocols implementation it is used C++ and Otcl is used for configuration purposed.

Uses of NS-2

- Evaluate the performance of network (wired/ wireless) routing protocols
- Used for large scale network experiments.
- Simulation of IP addresses

Volume 5, Issue 6
December 2016

ITEE Journal
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6.4 Simulation Parameters and other Requirements

The Random Direction (RD) and reference point group models (RPGM) are used with different node speed from 0.5 to 5.0 m/s, 100 seconds is simulation time, CBR is source of traffic with UDP transport protocol. Remaining parameters are show in below table.

Table Simulation parameters

Simulation Parameters	
Window & Simulator	Ubuntu NS-2(Version 2.34)
Transmission range	500m x 500 m
Channel type	Channel/Wireless channel
Antenna	Omni directional
MAC Type	IEEE 802.11
Link Layer Type	LL
Node speed	0.5m/s to 5.0 m/s
Performance matrices	ROH, PDR ,Energy consumption, Throughput and end to end delay
Simulation Time	10 sec
Packet rate	8 packet/sec
Traffic Type	CBR
Data payload	512 bytes/ packet
Interface Queue Type	Drop Tail/ RED
Node Pause Time	0
Mobility Model	Random Direction, Reference Point Group Model
Interface Queue Length	50
Routing Protocols	DSR, AODV AND DSDV
No. of Nodes	10,20,30,40,50,80,100

Parameters shows in above table are variable and constant. These parameters are varying during simulation for resting and verifying results

7. Simulation-I Random Direction Mobility

7.1 PDF/ PDR (Packet Delivery Function /Ratio)

According to the figure it is shown that DSR gives good PDR from other two protocols because it is reactive protocols and select best route. DSDV give poor PDR because it is proactive in nature consume bandwidth by building routing table, has no procedure for best route selection.

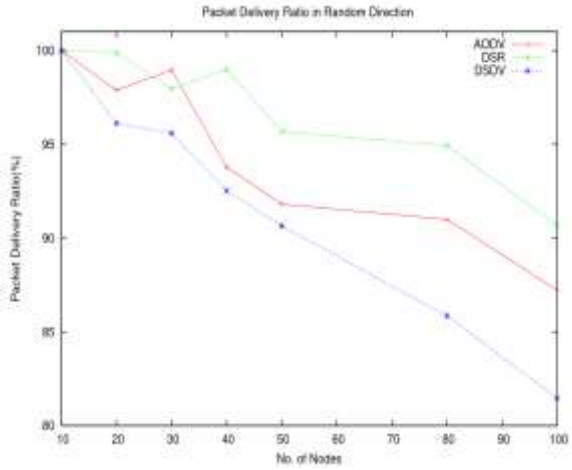

Figure 5:1 Packet Delivery Function /Ratio of DSR, AODV and DSDV in Random direction

7.2 Throughput

According to this figure 32 it shows that the DSR give good throughput than other protocols. DSR select best route with small number of hops and have minimum routing over head because it is reactive in nature and does not build routing table as in DSDV. DSDV also give good throughput as compare to AODV

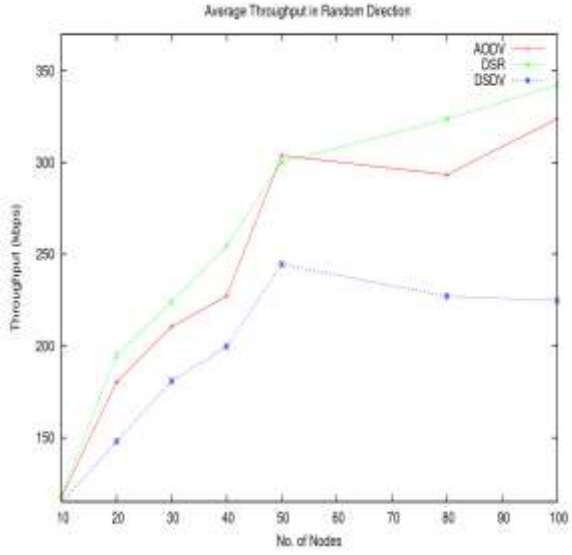

Figure 6: Throghput of DSR, AODV and DSDV in Random direction

7.3 Average End to End delay (E2E)

According to below figure it is shows that the end to end delays of DSR is low as compared with other two selected

Volume 5, Issue 6
December 2016

ITEE Journal
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protocols. DSDV give poor end to end delay than AODV.

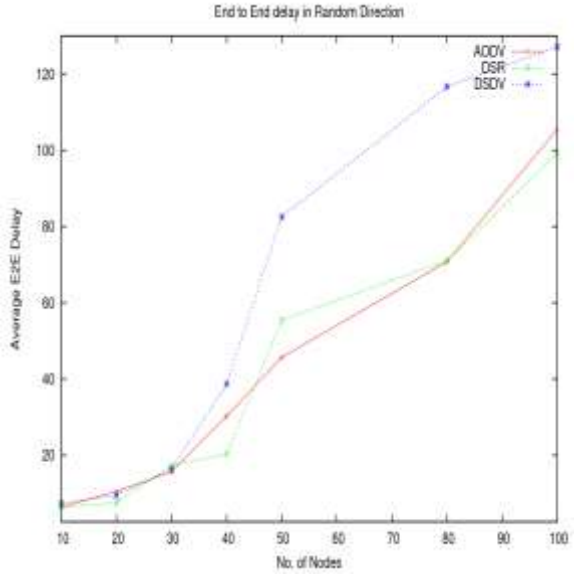

Figure7: Average E2E delay of DSR, AODV and DSDV in Random direction

7.4 Routing over Head (RoH)

According to figure it shows that the routing over head of DSR is very low than other two protocols. AODV also give low routing over than DSDV but not good than DSR.

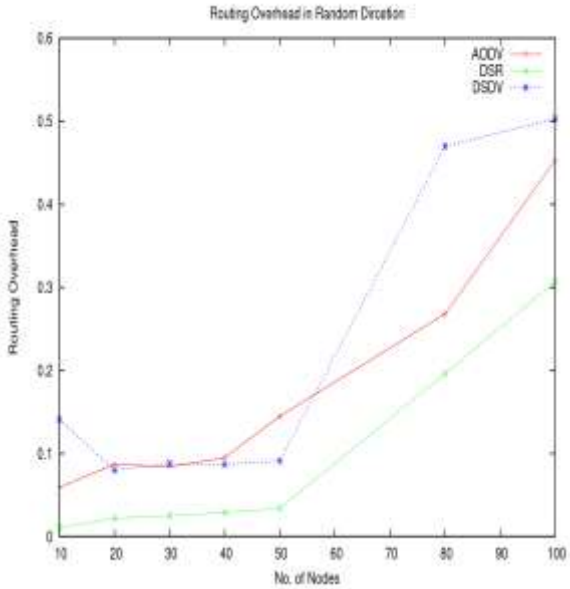

Figure8: Routing Over Head of DSR, AODV and DSDV in Random direction

7.5 Energy Consumption (EC)

According to figure energy consumption of DSR is very low than other two protocols. Energy consumption of DSDV is little increase but after some time goes down decrease.

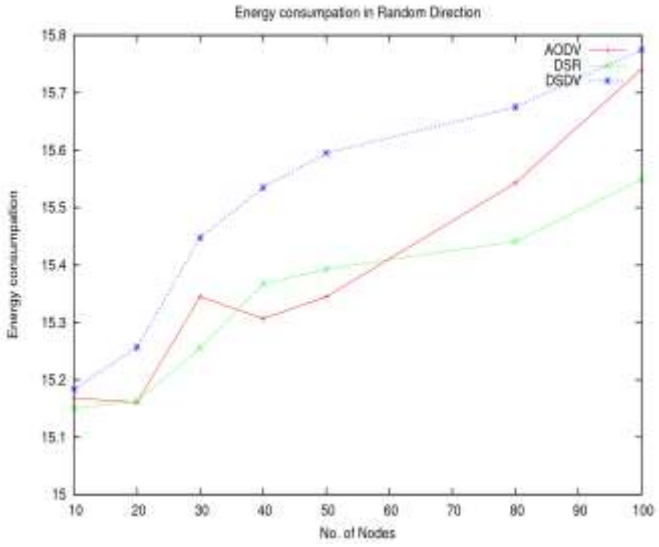

Figure9: Energy Consumption of DSR, AODV and DSDV in Random direction

8. Simulation-II Reference Point Group Model (RPGM)

8.1 PDF/ PDR (Packet Delivery Function /Ratio)

According to the figure it is shown that DSR gives good PDR from other two protocols because it is reactive protocols and select best route. DSDV give poor PDR because it is proactive in nature consume bandwidth by building routing table, has no procedure for best route selection

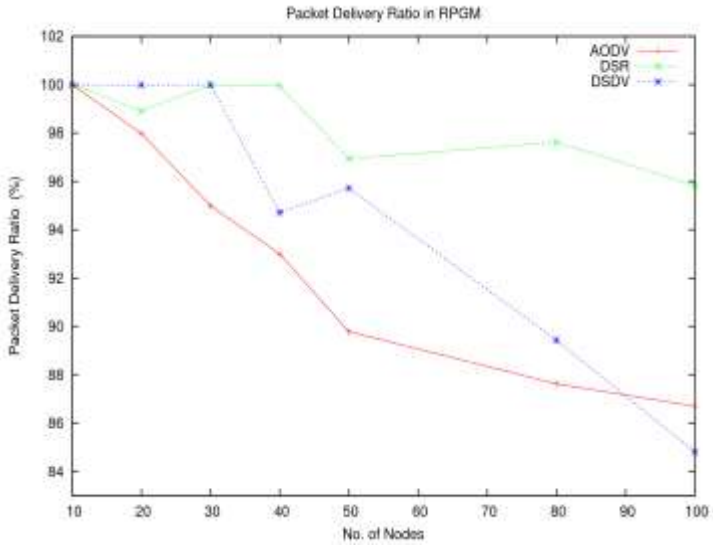

Figure10: Packet Delivery Ratio of DSR, AODV and DSDV in (RPGM)

Volume 5, Issue 6
December 2016

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

8.2 Throughput

According to figure it is examine that the throughput of DSR is very well than other two protocols. DSDV and AODV give middle level throughput.

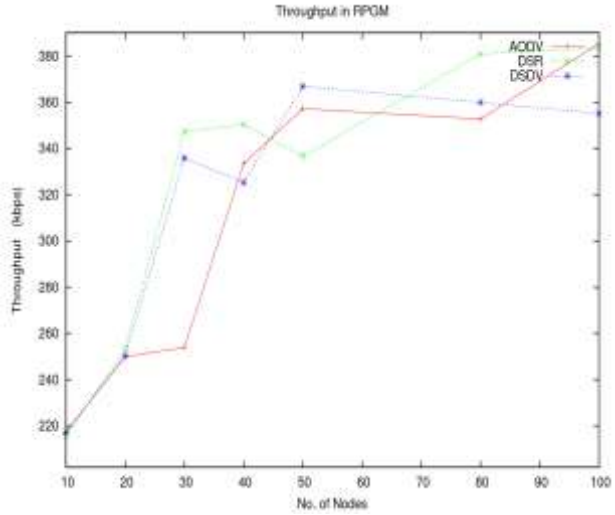

Figure11: Throughput of DSR, AODV and DSDV in (RPGM)

8.3Average End to End Delay(E2E)

According to below figure 33 it is shows that the end to end delays of DSR is low as compared with other two selected protocols because it used minimum hops route. DSDV give poor end to end delay than AODV because it is proactive in nature and has no procedure for selection minimum hops route

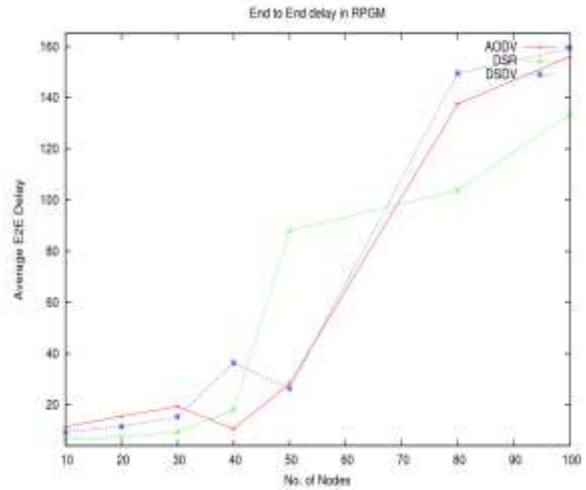

Figure12: Average End to End Delay of DSR, AODV and DSDV in (RPGM)

8.4 Routing over Head (RoH)

According to figure it shows that the routing over head of DSR is very low than other two protocols. In DSR source and intermediate node store alternate routes in his route cache and does not perform extra operation as in DSDV. AODV also give low routing over than DSDV but not good than DSR. DSR does not perform any extra calculation as DSDV done. DSDV continuously send network updates that why it have high routing over head for high density network.

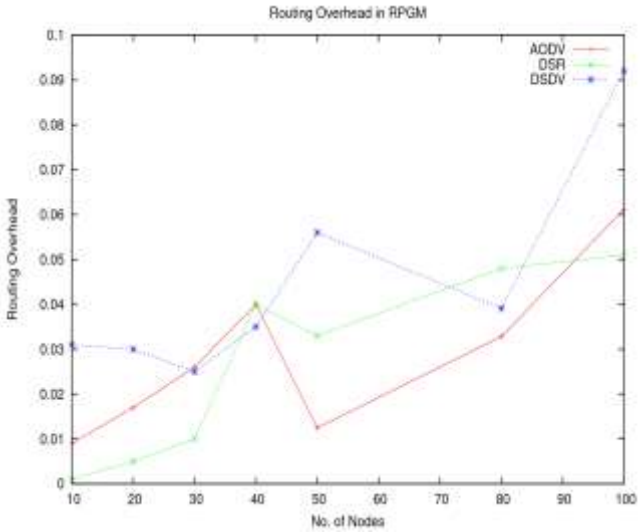

Figure13: Routing Over Head of DSR, AODV and DSDV in (RPGM)

8.5 Energy Consumption (EC)

According to figure the energy consumption of DSR is very low than DSDV and AODV. AODV also give low energy consumption than DSDV.

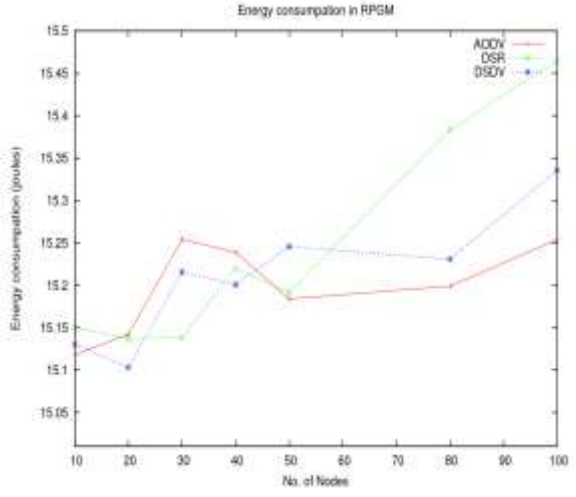

Figure14:Energy Consumption of DSR, AODV and DSDV in (RPGM)

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9. Conclusion

In my research I simulate different routing protocols which are DSR, AODV and DSDV. I compare and investigate the performance of it in three different mobility models. Simulation result shows that performance of DSR is well when mobility models are random direction and reference point group model. AODV protocol also shows better performance than DSDV in case of random direction mobility model.

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