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Assignment Report

On

Computer Networks

20MCA13

NS2

Submitted in Partial Fulfillment of the Requirement

for the I Semester MCA

MASTER OF COMPUTER APPLICATIONS

By

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DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

CERTIFICATE

This is to certify that the assignment entitled "NS2" submitted in partial fulfillment Computer Networks (20MCA13) of I Semester MCA is a result of the bonafide work carried out by PANNAGA SHASTRI S_RVCE21MCA077 , during the Academic year 2021-22.

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INTRODUCTION TO COMPUTER NETWORK

Computer network is a group of computers connected with each other through wires, optical fibres or optical links so that various devices can interact with each other through a network.

COMPONENTS OF COMPUTER NETWORKS:

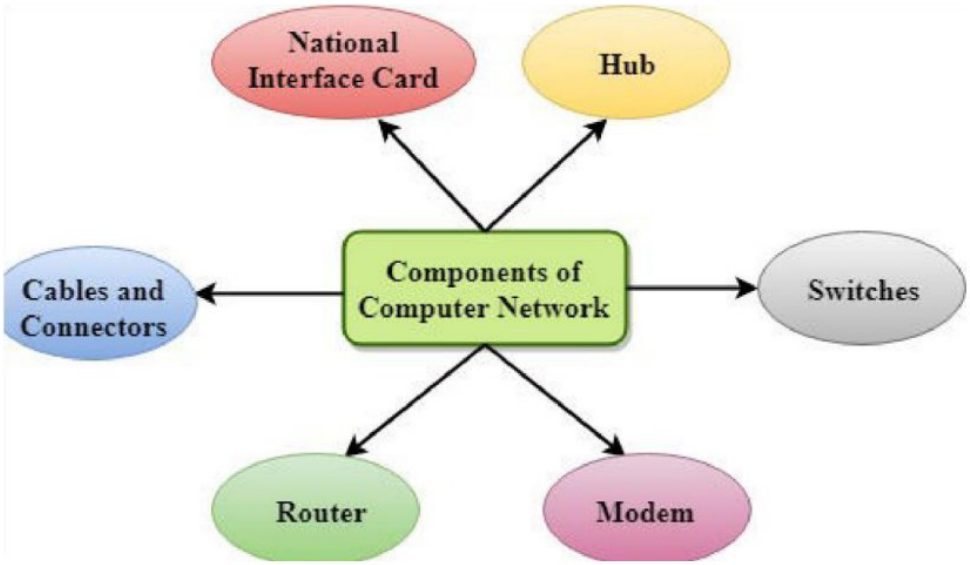


Figure 1:Components of computer networks [4]

USES OF COMPUTER NETWORK

- **Resource sharing:** Resource sharing is the sharing of resources such as programs, printers, and data among the users on the network without the requirement of the physical location of the resource and user.

- **Server-Client model:** Computer networking is used in the server-client model. A server is a central computer used to store the information and maintained by the system administrator. Clients are the machines used to access the information stored in the server remotely.

- **Communication medium:** Computer network behaves as a communication medium among the users. For example, a company contains more than one computer has an email system which the employees use for daily communication.

- **E-commerce:** Computer network is also important in businesses. We can do the business over the internet. For example, amazon.com is doing their business over the internet, i.e., they are doing their business over the internet.

FEATURES OF COMPUTER NETWORKS:

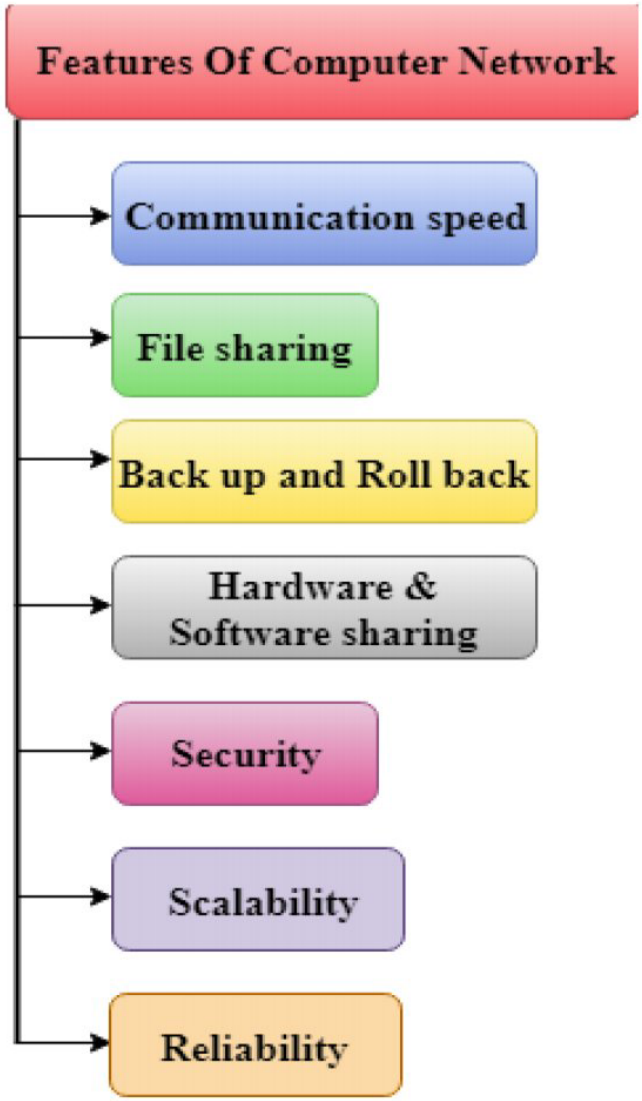


Figure 2: Features of computer networks [5]

COMPUTER NETWORK ARCHITECTURE:

Computer network architecture is defined as the physical and logical design of the software, hardware, protocols, and media of the transmission of data. Simply we can say that how computers are organized and how tasks are allocated to the computer.

The two types of network architectures are used:

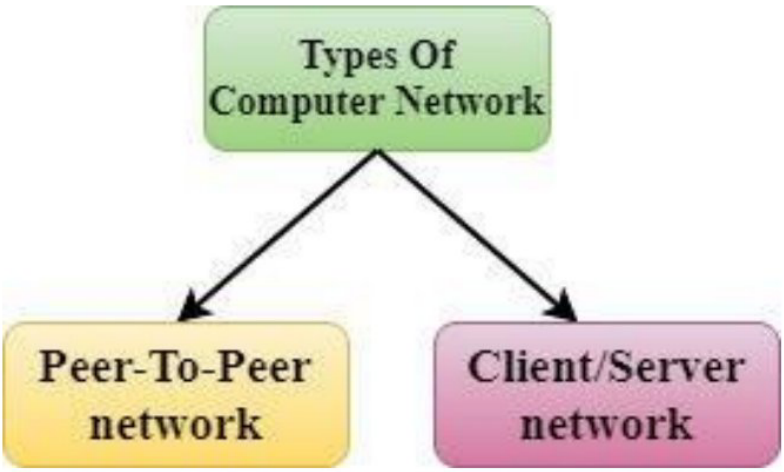


Figure 3: Types of network architectures [5]

- **Peer-To-Peer network**
- **Client/Server network**

COMPUTER NETWORK TYPES:

A computer network can be categorized by their size. A computer network is mainly of four types:

- LAN (Local Area Network)
- PAN (Personal Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)

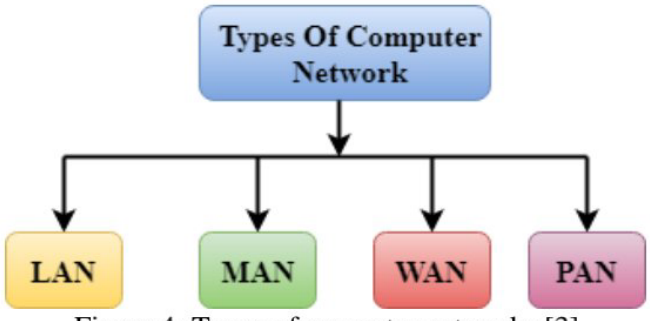


Figure 4: Types of computer networks [3]

LAN (LOCAL AREA NETWORK):

- local area network is a group of computers connected to each other in a small area such as building, office.
- lan is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
- It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables.
- The data is transferred faster in the local area network.
- local area network provides higher security.

Figure 5: local area network [4]

PAN(PERSONALAREA NETWORK):

- Personal area network is a network arranged within an individual person, typically within a range of 10 meters.
- Personal area network is used to connect the computer devices of personal use, known as personal area network.
- Thomas zimmerman was the first research scientist to bring the idea of the personal area network.
- Personal area network covers an area of 30 feet.
- Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.

Figure 6: Personal area network [5]

MAN (Metropolitan Area Network):

- A metropolitan area network is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.
- Government agencies use MAN to connect to the citizens and private industries.
- In MAN, various LANs are connected to each other through a telephone exchange line.
- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.
- It has a higher range than Local Area Network (LAN).

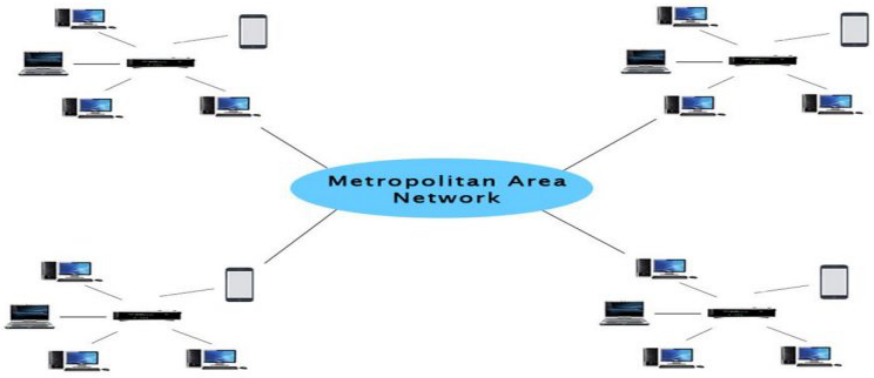


Figure 7: Metropolitan area network [4]

WAN(Wide Area Network):

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.
- A Wide Area Network is quite bigger network than the LAN.
- A Wide Area Network is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links.
- The internet is one of the biggest WAN in the world.
- A Wide Area Network is widely used in the field of Business, government, and education.

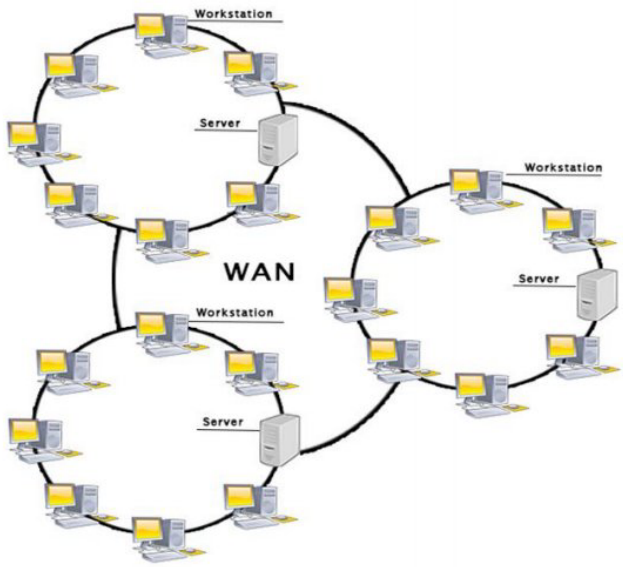


Figure 8: Wide area network [4]

TOOL USAGE

Simulation is the process of learning by doing. Whenever there is something new in the world, we try to analyze it first by examining it and in the process get to learn a lot of things. This entire course is called Simulation.

Correlating to this process, in order to understand all the complexities one needs to model the entire role-play in form of computer simulation, the need is to build artificial objects and assign them roles dynamically.

Computer simulation is designing a theoretical physical system on a digital computer with emphasis on model designing, execution, and analysis. After the creation of the mathematical model, the most important step is to create a computer program for updating the state and event variables through time (by time slicing or event scheduling). If this simulation is carried out successively in parallel computers, it is called Parallel or Distributed simulation.

Network simulation (NS) is one of the types of simulation, which is used to simulate the networks such as in MANETs, VANETs, etc. It provides simulation for routing and multicast protocols for both wired and wireless networks. NS is licensed for use under version 2 of the GNU (General Public License) and is popularly known as NS2. It is an object-oriented, discrete event-driven simulator written in C++ and Otcl/Tcl.

NS-2 can be used to implement network protocols such as TCP and UPD, traffic source behavior such as FTP, Telnet, Web, CBR, and VBR, router queues management mechanism such as Drop Tail, RED, and CBQ, routing algorithms, and many more. In ns2, C++ is used for detailed protocol implementation and Otcl is used for the setup. The compiled C++ objects are made available to the Otcl interpreter and in this way, the ready-made C++ objects can be controlled from the OTcl level**.**

INSTALLATION OF TOOL

Pre-requisites:

To view your network simulation traces made using ns-2, you'll need Nam: Network Animator.

Nam is a Tcl/TK based animation tool for viewing network simulation traces and real world packet traces. It supports topology layout, packet level animation, and various data inspection tools.

Install it by running the following command in your terminal:

```
sudo apt-get install -y nam
```

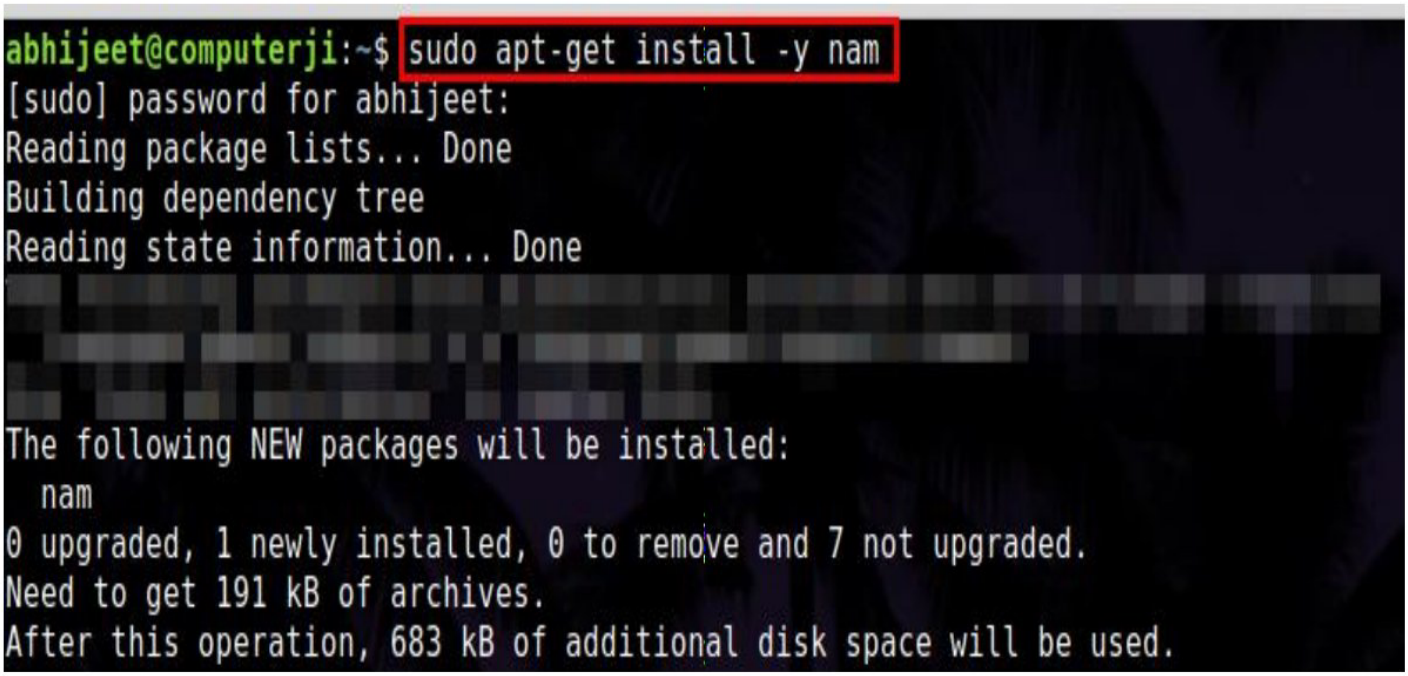


Figure 9: Installing nam

Installing NS-2

Run the following command in your terminal to install ns-2

$sudo apt-get install -y ns2

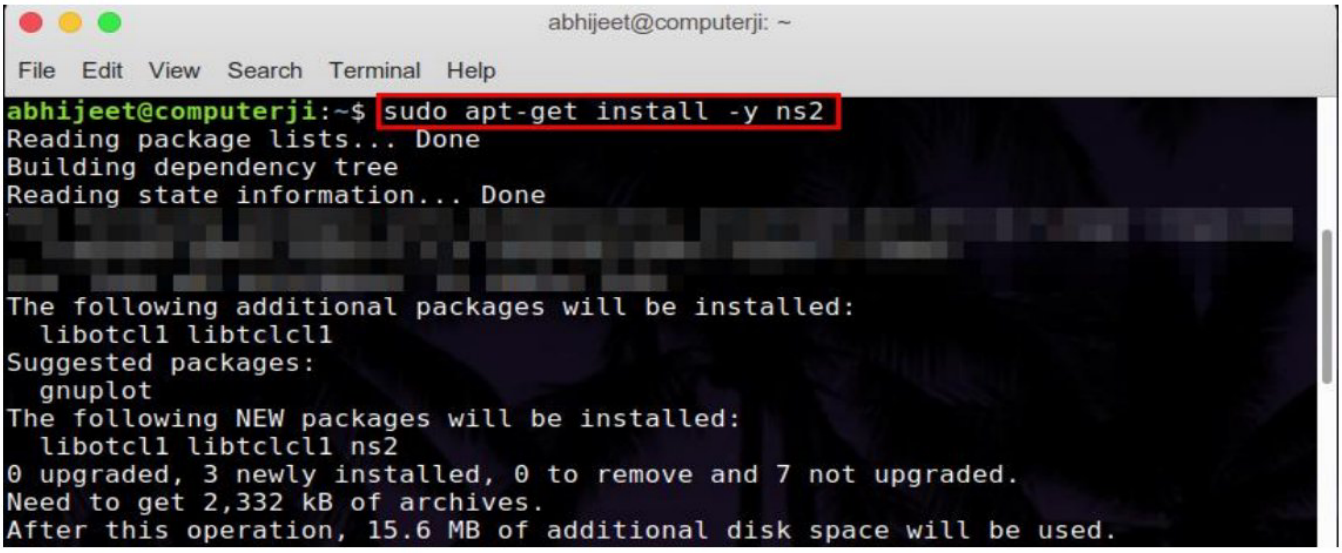


Figure 10: Installing ns2

Installing NSG2:

Step 1:

nsg2 requires java jar and other files to run . So install it using below command

$sudo apt install default-jdk

Figure 11: Installation of jdk

Step 2:

Download nsg2 from this link- https://sites.google.com/site/pengjungwu/nsg

Step 3:

1. Open the terminal and move to directory where your download file is present

   $cd Download/

2. Give permission to your file to execute

   $chmod +x NSG2.1.jar

Step 4:

Run the file with jar using the following command.

$ java -jar NSG2.1.jar

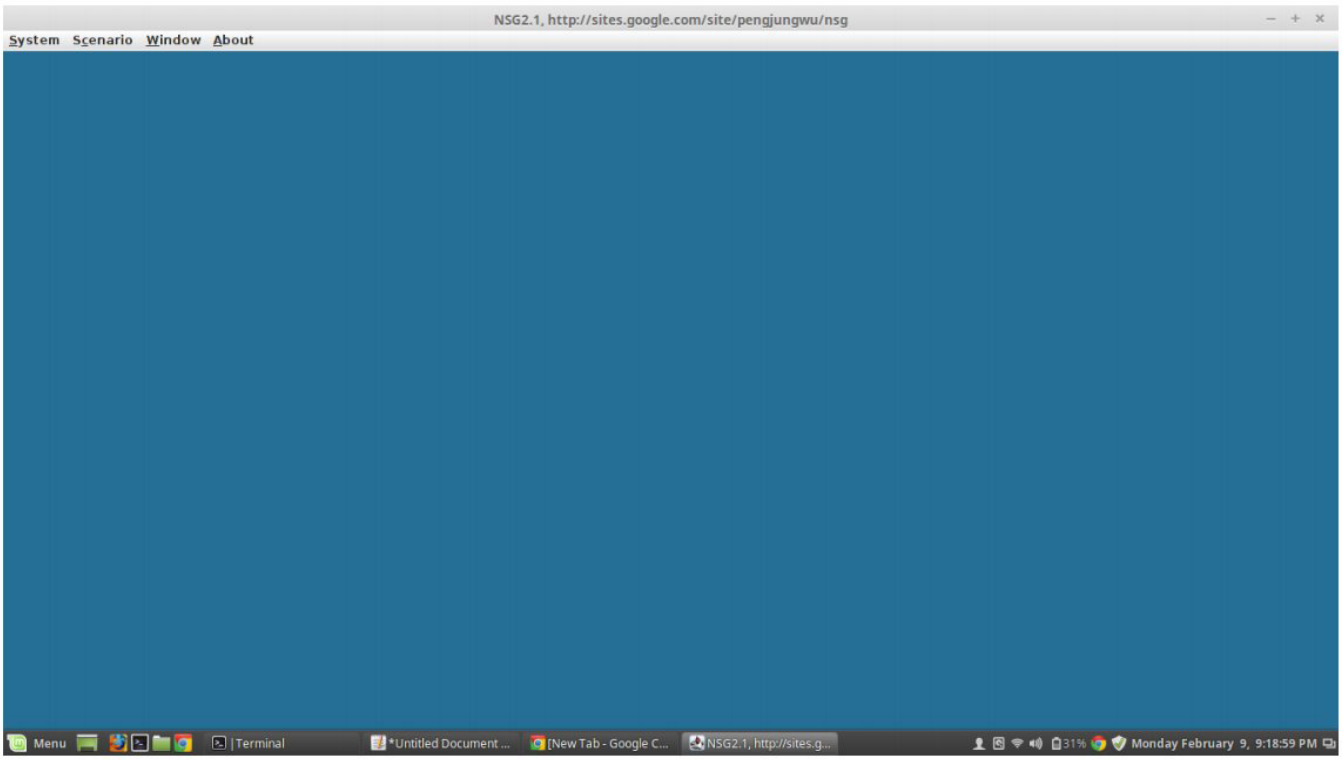


Figure 12 : nsg2

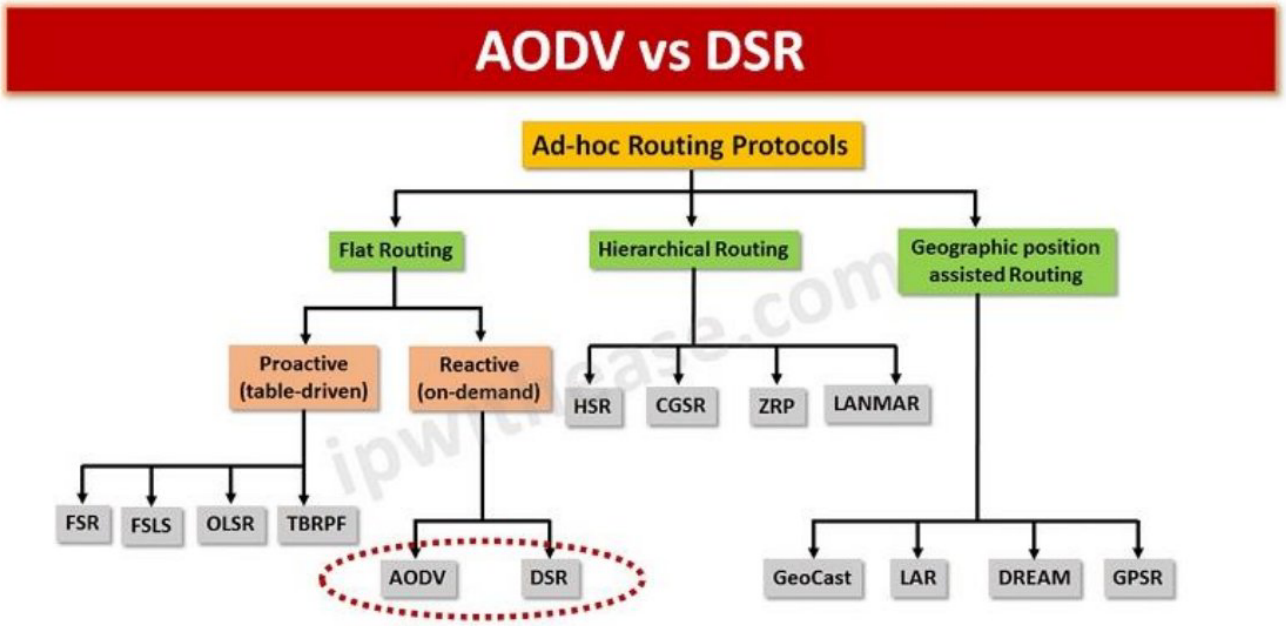


Fig 13: AODV vs DSR [3]

Features of NS-2:

- It is a discrete event simulator for networking research.
- It provides substantial support to simulate bunch of protocols like TCP, FTP, UDP, https and DSR.
- It simulates wired and wireless network.
- It is primarily Unix based.
- Uses TCL as its scripting language.
- Otcl: Object oriented support
- Tclcl: C++ and otcl linkage
- Discrete event scheduler

PROTOCOL

AODV and DSR PROTOCOL:

AODV: Adhoc On-demand Distance Vector

Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks (MANETs) and other wireless ad hoc networks.

It is a reactive protocol. Until a node needs a connection the network will be silent at which the node broadcasts its request for connection.
Each node store the next-hop information corresponding to each flow for data packet transmission and hence providing temporary routes to the needy node.
Then the needy node uses the route that has least hop count for further exchange of data. When a link fails, a routing error is passed back to the transmitting node and processrepeats.
In AODV, each request for a route has a sequence number which is used by nodes in order to avoid repeat request of route that is already done.
Types of messages used for route discovery and route maintenance.

1. RREQ (Route Request)
2. RREP (Route Reply)
3. RERR (Route Error)
4. HELLO

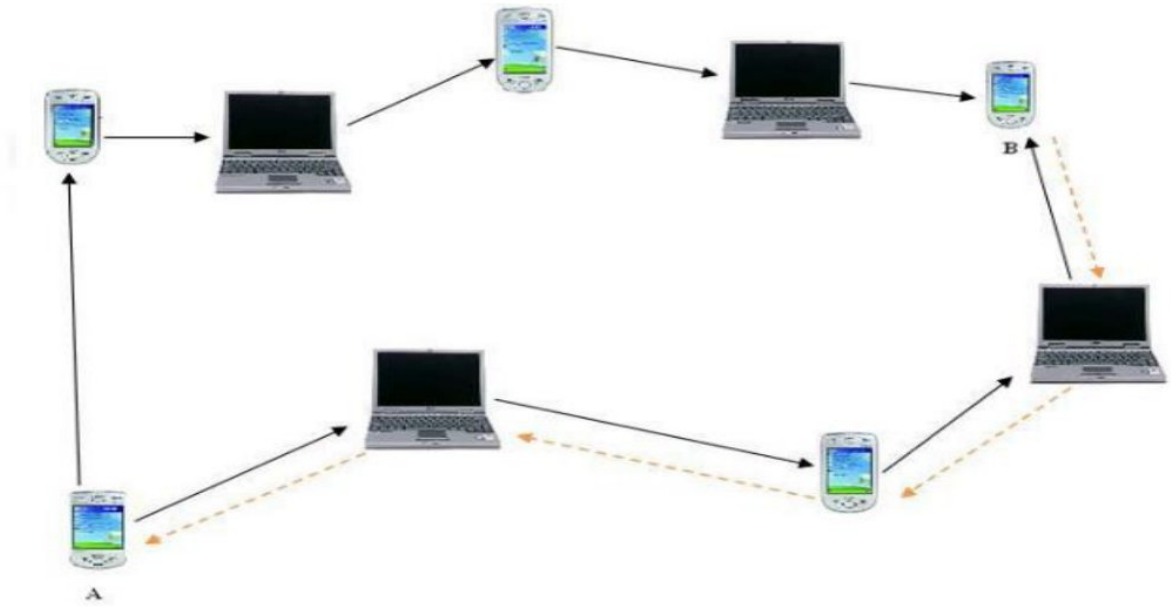


Figure 14.1: RREQ and RREP messages in MANET using AODV [3]

DSR : Dynamic Source Routing

Dynamic Source Routing (DSR) is a reactive routing protocol that uses source routing instead of depending on routing table. It restricts the bandwidth used by control packets since it is on-demand without HELLO commands that are used in AODV. In route discovery the source will check first in route cache and if its not there it initiates a route discovery. Else if that is an unexpired route, it uses that route. Source floods RREQ. It receives RREP if RREQ reaches destination or it reaches node that has unexpired route to destination. RREQ is forwarded to neighbouring nodes if an intermediate node does not have unexpired route and TTL is also not expired. Whenever a link is broken RERR is generated leading source to delete contaminated nodes and source may start a new RREQ.

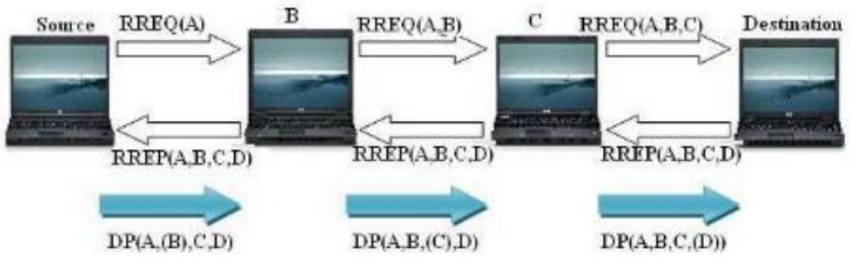


Figure 14.2: Route discovery procedure in MANET using DSR [4]

The route maintenance uses two kind of messages i.e. route error (RERR) and acknowledgement (ACK). The messages successfully received by the destination nodes send an acknowledgement ACK to the sender. Such as the packets transmitted successfully to the next neighbors nodes gets acknowledgement. If there is some problem in the communication network a route error message denoted by RERR is transmitted to the sender, that there is some problem in the transmission. In other words the source didn't get the ACK packet due to some problem.

So the source gets the RERR packet in order to re initiate a new route discovery. By receiving the RERR message the nodes remove the route entries. In figure 3-4 four nodes are shown i.e. A, B, C and D. The node A sends a message to destination node D. When the node C forward the RREQ message to the node D and it does not receive the ACK message from node D. The node C recognizes that there is some problem in the transmission. So the node C sends a RRER message to the source node A. Which in return search for a new route to the destination node D.

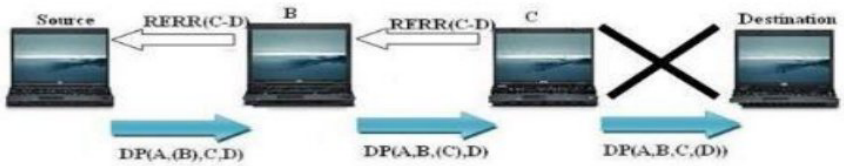


Figure 14.3: Route maintenance procedure in MANET using DSR [4]

Simulation Parameter:

Simulation Parameters	Value
Simulator	NS-2.35
Protocols	AODV,DSR
Traffic Source	TCP
MobilityModel	Model Random Way Point
Application Agent	FTP
Number Of Nodes	40,60,80
Simulation Area(in meter)	500 X 500

Table 1: Performance Parameters

Performance Parameters:

Throughput:

Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy.
A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation **2**;

$$\text{Throughput} = \frac{number\ of\ \ delivered\ packet * Packet\ size * 8}{Total\ duration\ of\ simulation} \text{ - - - - } \mathbf{2}$$

Delay:

The packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network. This time is expressed in sec. Hence all the delays in the network are called packet end-to-end delay, like buffer queues and transmission time. Sometimes this delay can be called as

latency; it has the same meaning as delay. The FTP is tolerant to a certain level of delays. We have several kinds of delays which are processing delay:

- processing delay (PD)
- queuing delay (QD)
- transmission delay (TD)
- propagation delay (PD

$$d_{end-end} = N[d_{trans} + d_{prop} + d_{proc}] \text{..... (i)}$$

$d_{end-end}$ = End to end delay

d_{trans} = Transmission delay

d_{prop} = Propagation delay

d_{proc} = Processing delay

Suppose if there are n number of nodes, then the total delay can be calculated by taking the average of all the packets, source destination pairs and network configuration.

PROTOCOL DEMONSTRATION

Step 1:

Layout of nodes:

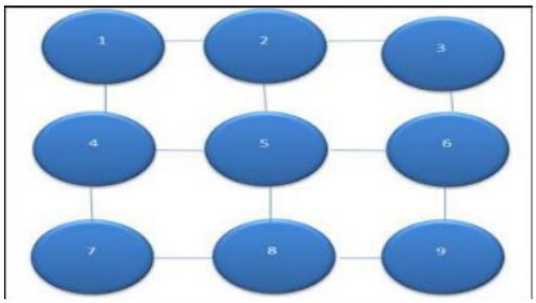


Fig 15.1: Structure of nodes [2]

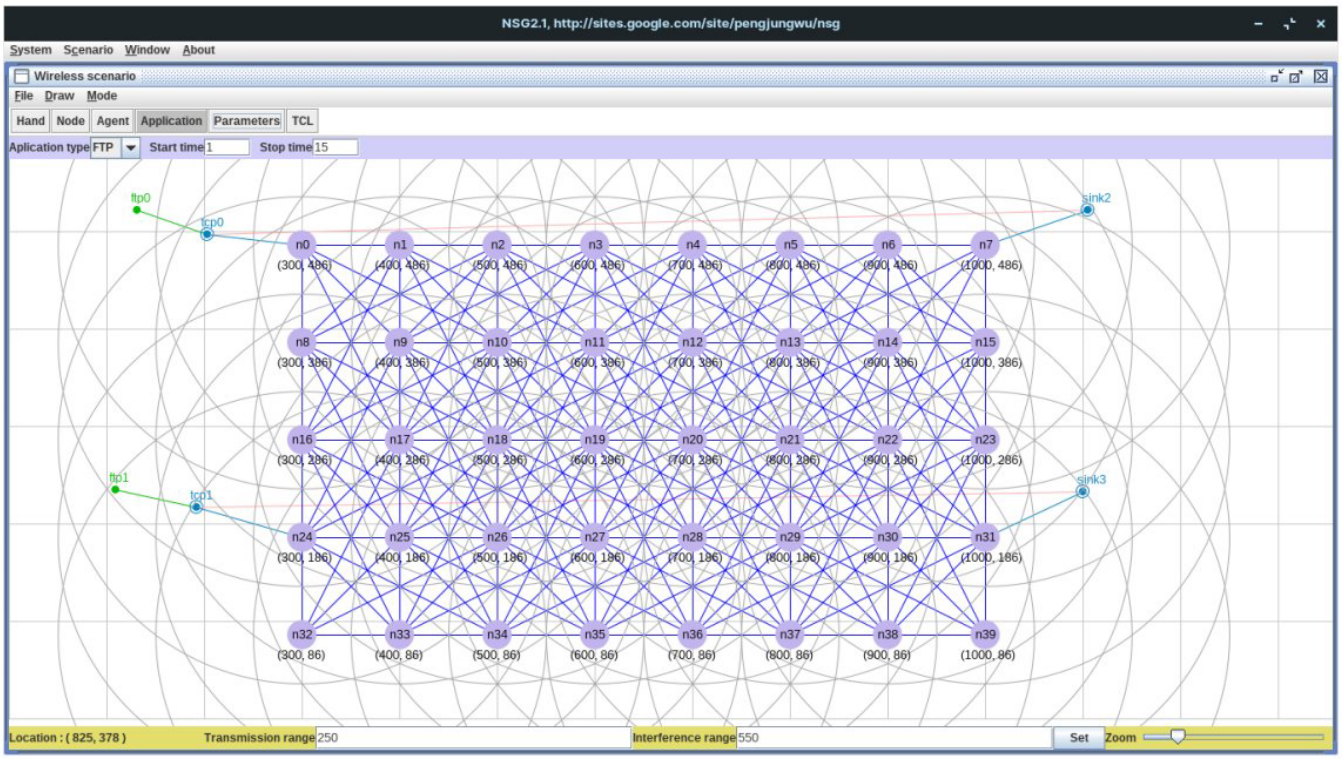


Figure 15.2: Creating scenario using nsg2 for 40 nodes [1]

Create a scenario using nsg2 using 20 nodes and TCP

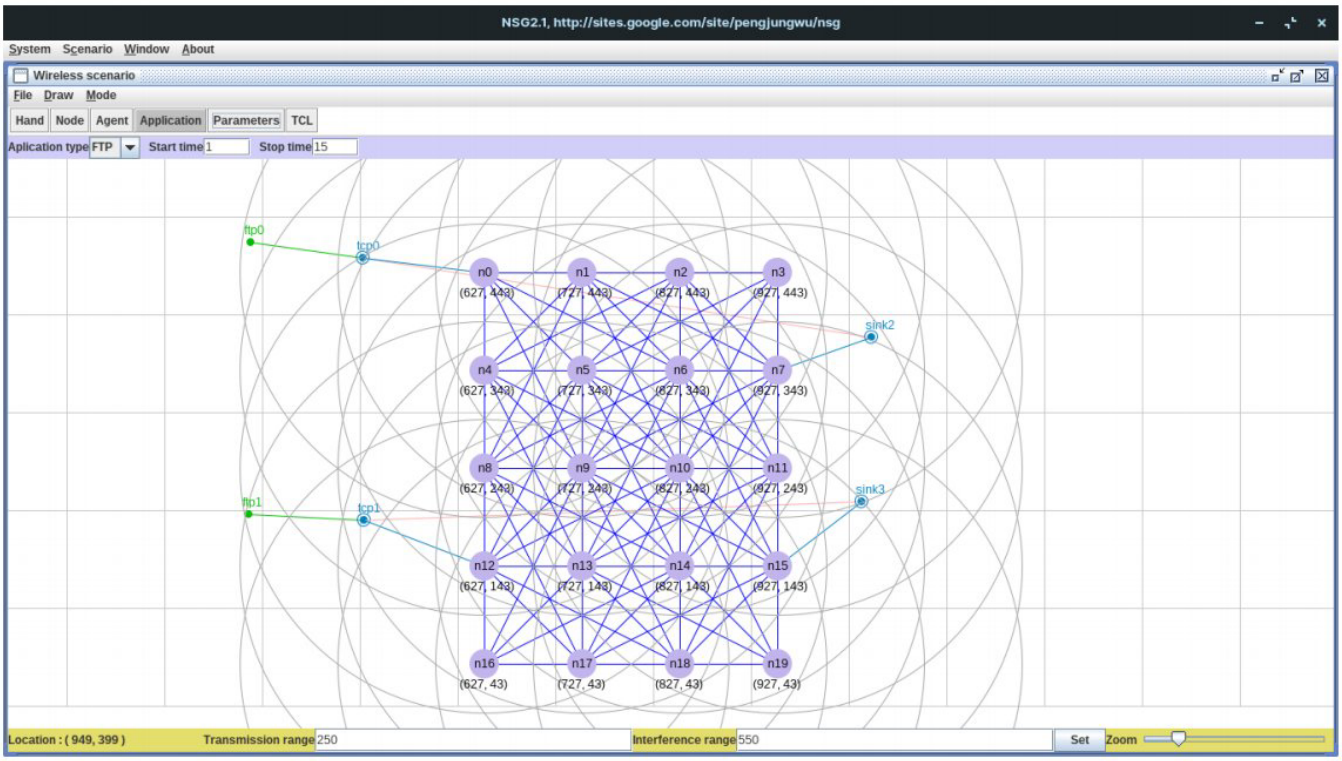


Figure 15.3: Creating scenario using nsg2 for 20 nodes [1]

Create a scenario using nsg2 using 80 nodes and TCP

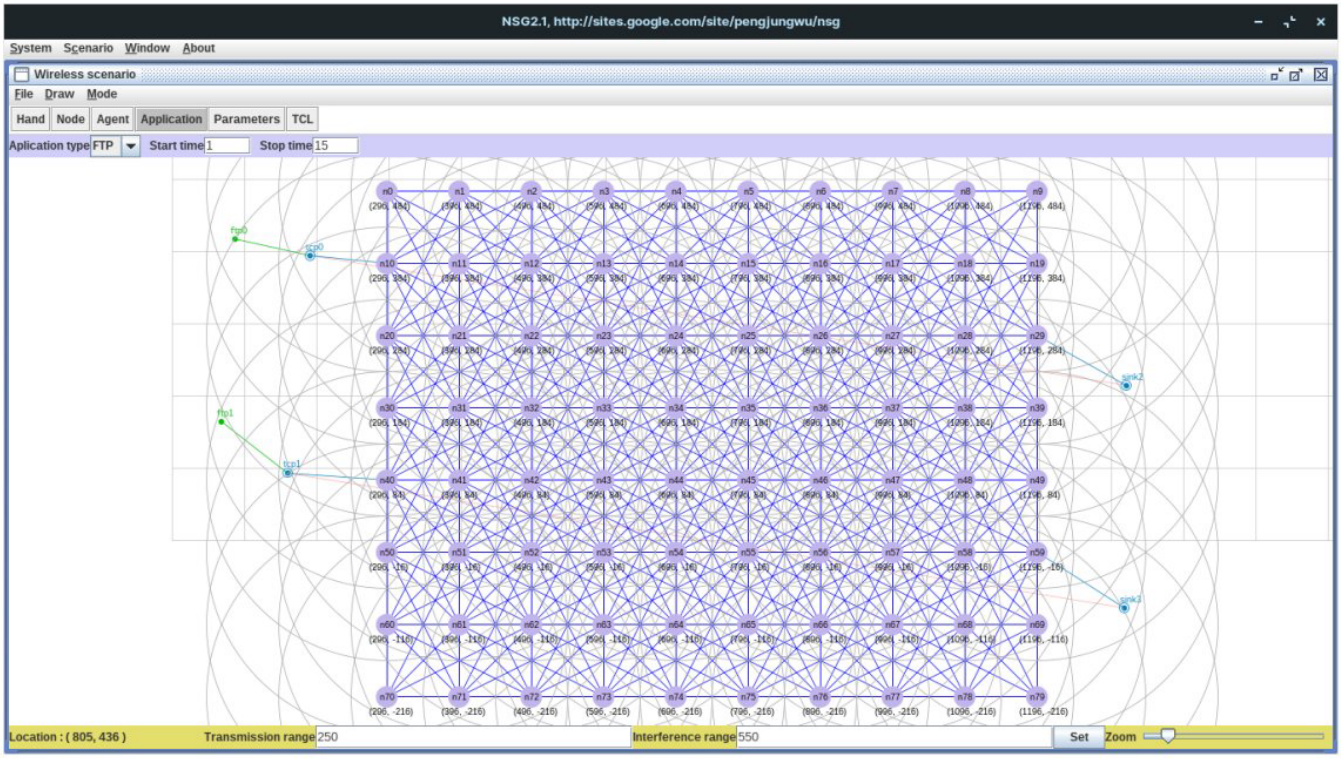


Figure 15.4: Creating scenario using nsg2 for 20 nodes [1]

Step 2:

Save the file using extension .tcl (con.tcl)

Step 3:

Open terminal and use the following command.

$nam com.tcl

// this command will open the tcl file in the ns2.

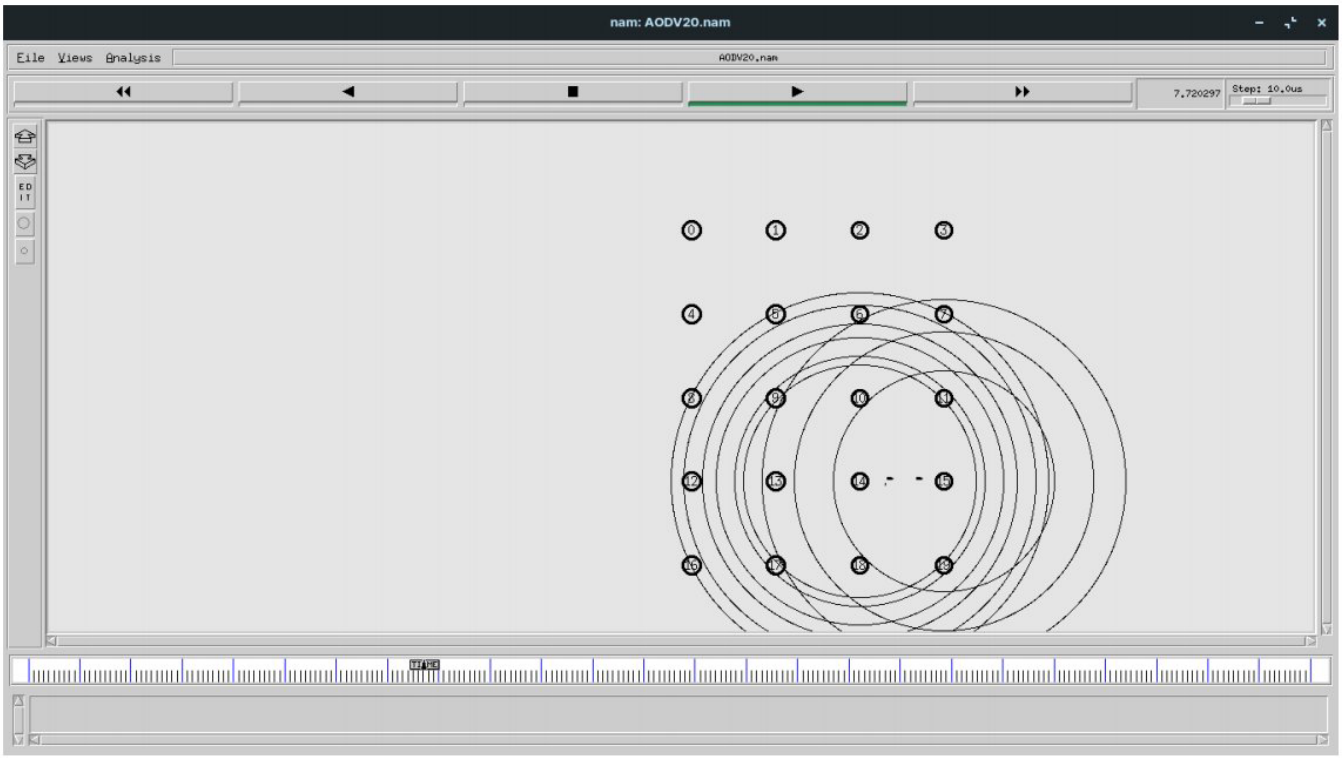


Figure 15.5: Demonstration of 20 nodes in ns2 [1]

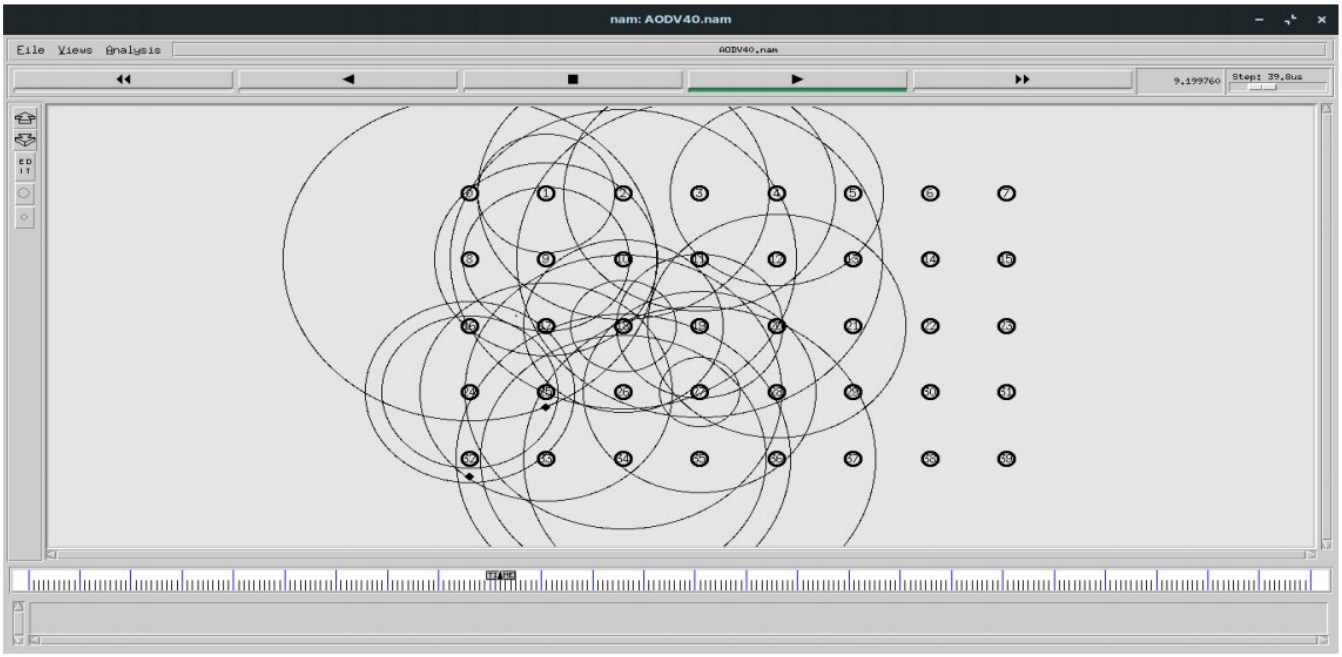


Figure 15.6: Demonstration of 40 nodes in ns2 [1]

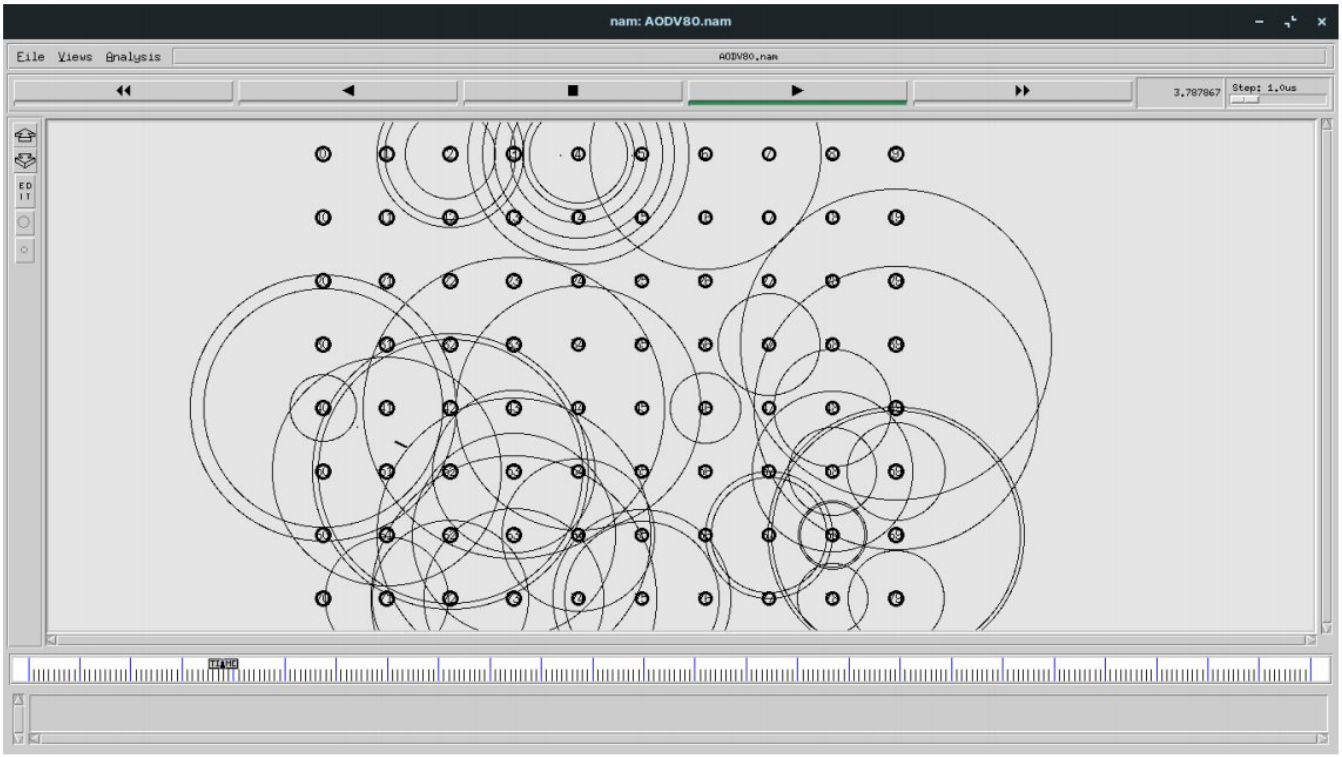


Figure 15.7: Demonstration of 80 nodes in ns2 [1]

Step 4:

Click on start the ns2 will start demonstrating transferring of packets and congestion will occur in some nodes and packets will be dropped.

Step 5:

To calculate End-to-End delay for 20 nodes to both AODV and DSR there is script gawk

Command: gawk -f e2edelay.awk AODV20.tr

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f e2edelay.awk AODV20.tr

Average End-to-End Delay    = 476.691 ms

[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16:End-to-End for 20 nodes [1]

For nodes 40:

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f e2edelay.awk AODV
40.tr

Average End-to-End Delay    = 265.706 ms

[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16.1: for 40 nodes [1]

For Node 80

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f e2edelay.awk AODV80.tr

Average End-to-End Delay    = 183.723 ms

[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16.2: for 40 nodes [1]

Step 5 Repeat:

To calculate Throughput delay for 20 nodes to both AODV and DSR there is script gawk

Command: gawk -f genthroughput.awk filename.tr

For 20 nodes:

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f genthroughput.awk  AODV20.tr
Average Throughput[kbps] = 383.40              StartTime=1.06 StopTime=15.19
[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16.3: for 20 nodes [1]

For 40 nodes:

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f genthroughput.awk  AODV40.tr
Average Throughput[kbps] = 131.83              StartTime=3.12 StopTime=15.05
[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16.4: for 40 nodes [1]

For 80 nodes:

```
[~/Downloads/college works/CN/endToEnd/Demonstration]$ gawk -f genthroughput.awk  AODV80.tr
Average Throughput[kbps] = 94.18               StartTime=1.17 StopTime=15.27
[~/Downloads/college works/CN/endToEnd/Demonstration]$
```

Figure 16.1: for 80 nodes[1]

Same procedure for All DSR and also to calculate End-to-End and Throuput is same command.

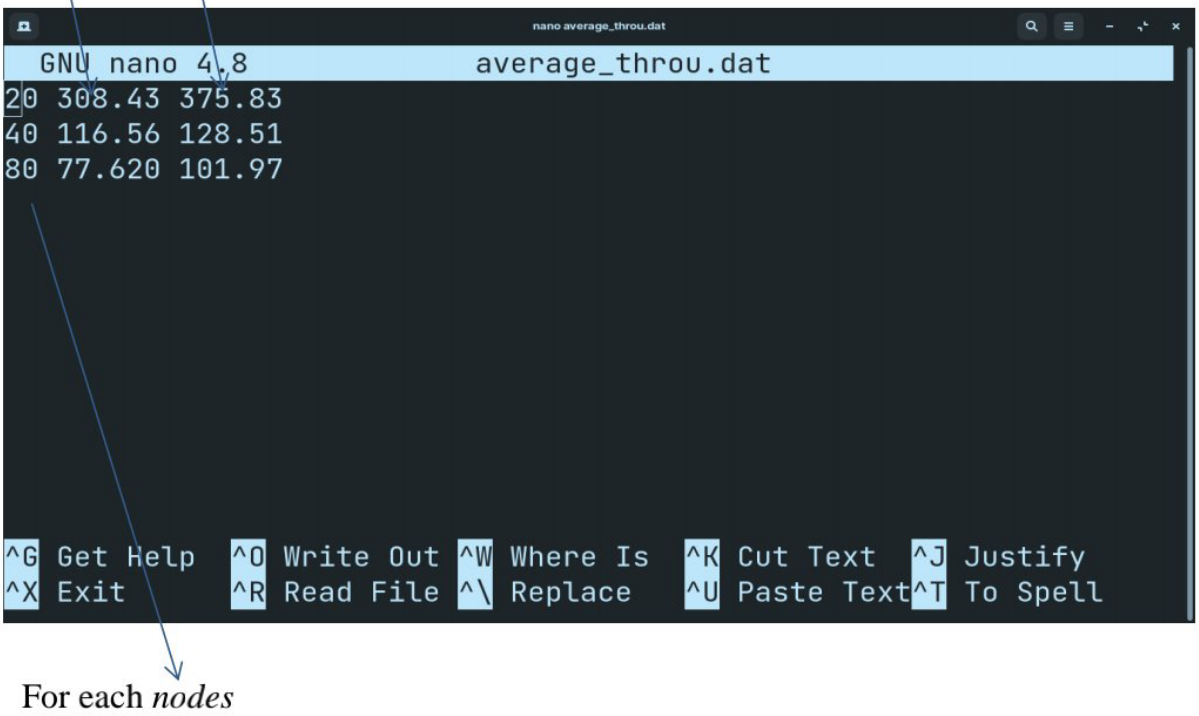
Step 6:

Take all values of average Throughput and EndtoEnd delay store in a file extension called .dat

Example: End-to-End.dat

For Throughput Graph :

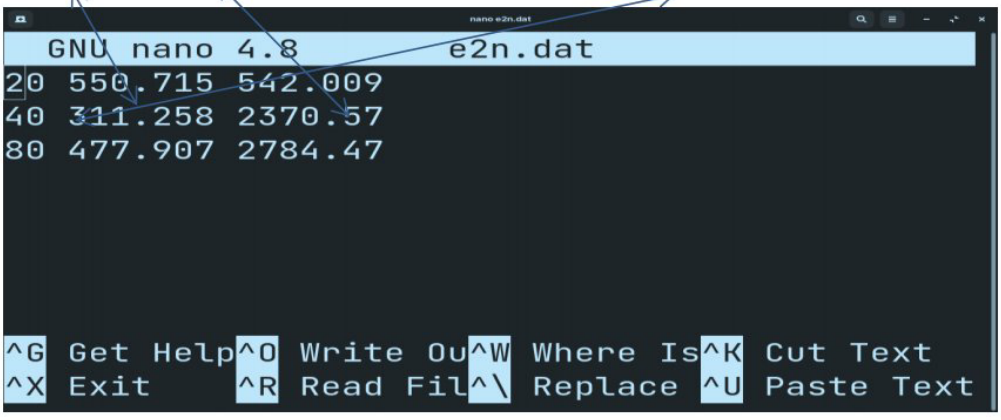
AODV and *DSR* Throupghut values



For each *nodes*

For End-to-End values:

AODV and *DSR* End-to-End values for each *nodes*



Step 7:

Plottin Graph:

The Throughput and scenario can be shown using the graph using the following command.

$gnuplot

gnuplot > plot “file.plt”

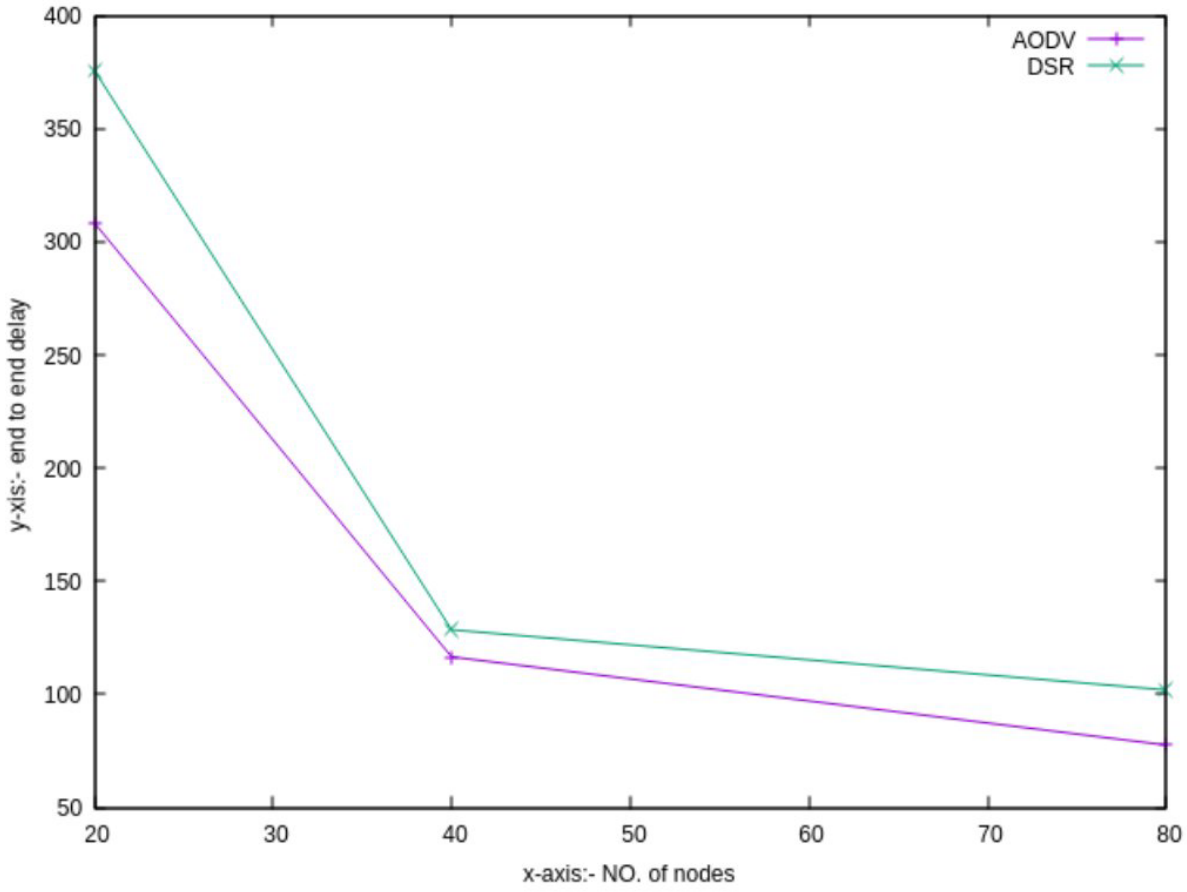


Figure 17: Graph of average Throughput [1]

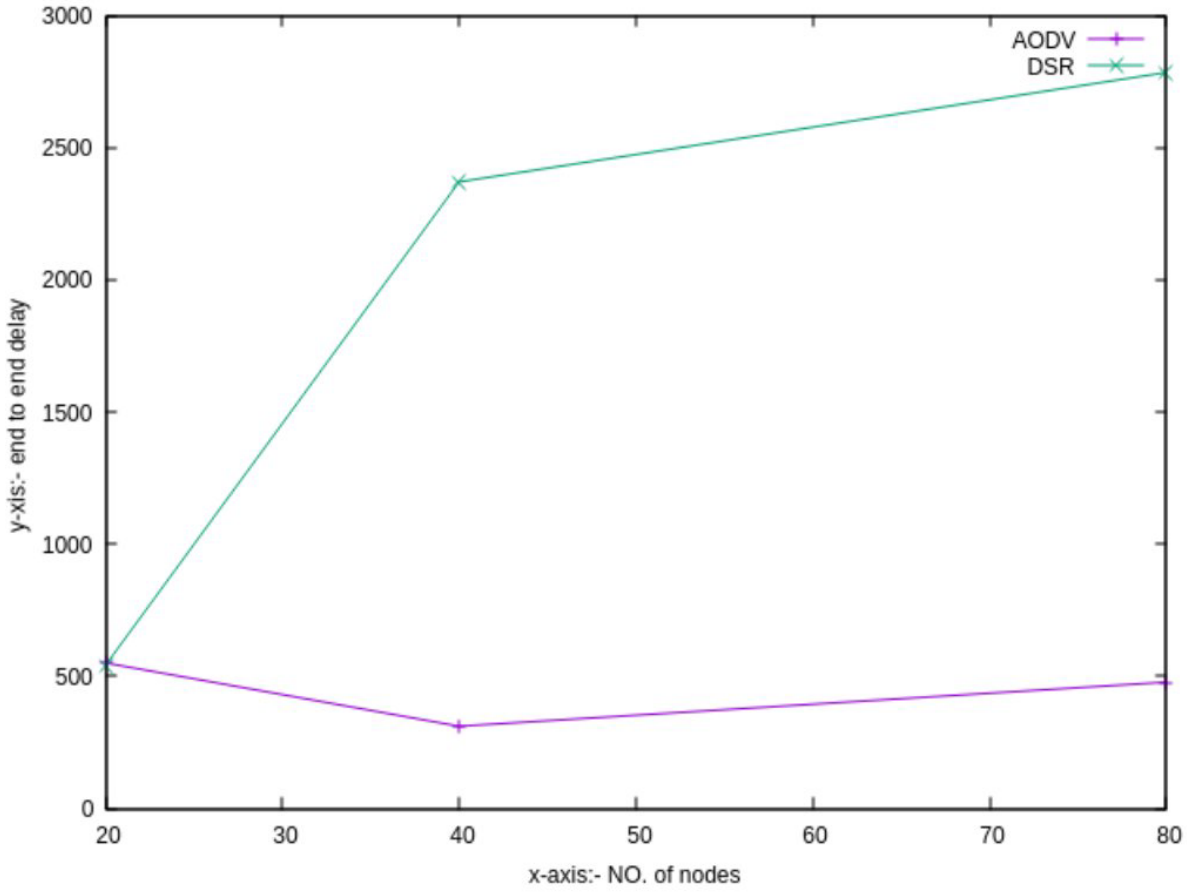


Figure 18: Graph of average End-to-End delay [1]

CONCLUSION

It is observed that when the network has little or no mobility DSDV clearly outperforms the other two protocols irrespective of the error rate in the network. Similary DSR performs the worst in case of increasing error rates because of loss of its heavy control packets.
AODV performs better than its reactive counterpart DSR because of AODV incurrs lesser control packet data loss compared to DSR.

Nodes	Parameters	AODV	DSR
20	Delay	308.43	542.009
	Throughput	308.43	355.83
40	Delay	116.56	2370.57
	Throughput	116.53	128.51
80	Delay	477.62	2784.47
	Throughput	77.620	101.97

Table 2: Output Performance Parameters

In this paper, from the simulation result we can interpret that DSDV and AODV perform better as compared to DSR in terms of end-to-end Delay. Delay of AODV is slightly greater than DSDV. We have examined PDF for DSDV, AODV and DSR and from our simulation we conclude that PDF of AODV is high for varying number of connections and number of nodes. While the PDF of DSR is good for low traffic and its performance degrades as the traffic load and number of connections grows. Performance of DSDV is very poor in terms of PDF. By analyzing the DPR of the three routing protocols, it can be concluded that AODV performs more efficiently than DSR and DSDV, as it is dropping least no of packets. DSR's performance is also good with less connections and traffic load but its efficiency degrades as

traffic load and number of connections increases. Finally, it can be concluded on the basis of our simulation study that AODV is the best performer among the three Routing protocols.

- DSR have triple numbers of control messages than AODV
- AODV has difficult when the nodes are moving fast
- AODV has the shortest end-to-end delay
- DSR has higher routing overhead than AODV
- AODV outperforms DSR in more stressful situation (eg: more load, higher mobility)
- Poor delay and throughput of DSR due to lack of any mechanism to expire stale routes or determine the freshness of routes

AODV generates more RREQ pkts. So, it is better to incorporate some ideas of DSR such as cache routing information into the specification of AODV. And , for DSR, it is better to have some expiration time for the routing cache entries.

This performance evaluation mechanism developed by this project is really effective for scalable performance test in NS-2

Performance metrices	Varying Maxspeed	Varying Pause time
Avg End to End Delay	DSR is high	DSR is high
Packet Delivery Ratio	DSR is high	DSR is high
Throughput	AODV is high	Both are approximately same
Routing Load	AODV is high	AODV is high
Routing Frequency	DSR is high	DSR is high
Jitter	DSR is high	DSR is high

Table 2.1: Output Performance Parameters [5]

REFERENCES

1. YouTube -https://youtu.be/C5Uf93PttKA [1]
2. Wikipedia-https://en.wikipedia.org/wiki/Dynamic_Source_Routing [2]
3. Wikipedia-https://en.wikipedia.org/wiki/Ad_hoc_On-Demand_Distance_Vector_Routing [3]
4. OPNET Modeler 14.5 Documentation [4]
5. Webopedia-https://www.webopedia.com/definitions/static-routing/ [5]
6. Opnet Technologies, Inc. "Opnet Simulator," Internet: www.opnet.com ,date last viewed:2009-12-21 [6]