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Performance Evaluation of Routing Protocols in Large Size Disaster Scenario

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***Abstract:** Peoples in the disastrous areas under collapsed buildings or landslides need to be rescued in seventy-two hours. Ad hoc networks have been proved to be suitable for various disaster scenarios since no infrastructure needs to be deployed for communication. In this paper, various ad hoc routing protocols such as destination distance vector routing protocol, dynamic source routing protocol, ad hoc on demand routing protocol etc. are discussed and analyzed in such disaster scenario using disaster area mobility model on large size. Disaster area mobility model is more desirable in such scenario. Also these protocols are compared using various performance qualitative and quantitative metrics such as packet delivery ratio, delay, throughput, control overhead and energy etc.*

***Keywords :** MANET, DSDV, DSR, AODV, AOMDV, DM*

I. INTRODUCTION

Many people trapped in the disastrous areas may have a large chance to survive if they are rescued in 72 hours [1,2] (Golden 72 Hrs.). Communication is required at various levels among peoples for their rescue and relief operations. Due to the disasters, existing communication setup fails [3] and it is also difficult to set up a new infrastructure in short period of time. In order to simplify the communication process, ad hoc networks are very much useful in such scenarios. Such type of networks does not need infrastructure; instead communication among all entities takes place through radio waves.

Routing protocols in ad hoc networks are classified as proactive and reactive routing [4,5]. Proactive protocols are Destination Sequenced Distance vector (DSDV) [6,7], and Optimized Link State Routing Protocol.. Reactive protocols are Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV) and Ad Hoc On Demand Multipath Distance Vector (AOMDV)[7,9].

The table 1 thus summarizes the various routing protocols discussed before.

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Table 1: Routing protocol summary

Parameters	DSDV	AODV	AOMDV	DSR
Type of Routing	Proactive	On-demand	On-demand	On-demand
Route Updation	Periodic, Triggered to the neighbors	No	No	No
Loop Free	Yes	Yes	Yes	Yes
Routing Overhead	High	Less	High	Less
Caching Overhead	Medium	Low	High	High
Throughput	Low	High	High	Low

Movements of nodes inside ad hoc network are characterized by mobility models [10]. Random Waypoint mobility model is the most widely used in ad hoc networks. Manhattan mobility model also allows nodes to move determined paths like vehicles. In Disaster area model, various action areas such as incident location, transport location, casualty's treatment area and hospital zone exists. All peoples trapped in disasters area and involved in rescue operations belongs to any of the above areas.

II. TECHNOLOGY USED

In disaster area model (DM), the disaster scenarios are divided into different action areas [11] and the movements of nodes emulate the movements of ambulances taking injured people and other vehicles. Every person belongs to any of the above areas and represented by nodes. [12,13]. Separation of room method is used in this. Thus the disaster scenario is divided into different areas. There areas are: (1) incident site, (2) casualty's treatment area, (3) transport zone, and (4) hospital zone.

../bin/bm -f emer2 DisasterArea -n 250 -x 500 -y 500 -p 10 -a 1 -g 140 -r 3 -e 6 -q 3 -d 100 -i 1 -j 1 -b 20,190,20,174,56,190,56,174,38,174,56,182,1,40,30 -b 66,110,92,110,66,60,92,60,79,110,79,60,2,40,30 -b 20,190,20,174,56,150,56,174,38,174,56,182,1,40,30 -b 75,200,75,170,225,200,225,170,75,182,140,170,0,40,30 -b 160,15,160,55,200,15,200,55,270,0,130,0,160,25,200,25,4,50,30 -b 40,10,65,10,65,35,40,35,50,10,50,11,3,40,30 -o 230,200,230,140,270,200,270,140

../bin/bm NSFile -f emer2 –d

The various configuration parameters are set as follows:

0 incident location 1 patients waiting for treatment area, 3 for technical operational command, 4 for ambulance parking

For 1, 08 wanted groups and 04 transport groups

For 2, 07 wanted groups and

00 transport groups

For 1, 08 wanted groups and 05 transport groups
For 0, 12 wanted groups and 10 transport groups
For 4, 12 wanted groups and 10 transport groups
For 3, 3 wanted groups and 0 transport groups

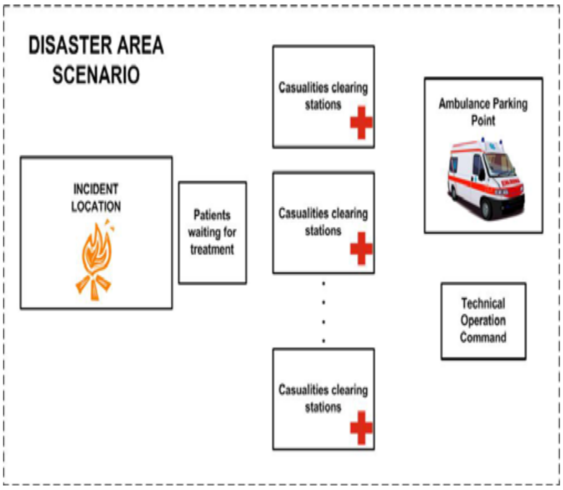

Fig 1: Disaster Area Scenario

It is assumed that in current disaster area, there could be more than 1 incident location and around 80 to 100 peoples are injured per incident location. Peoples will be carried out from incident place to treatment area and then finally admitted to hospital through transport zone as shown in fig. 2

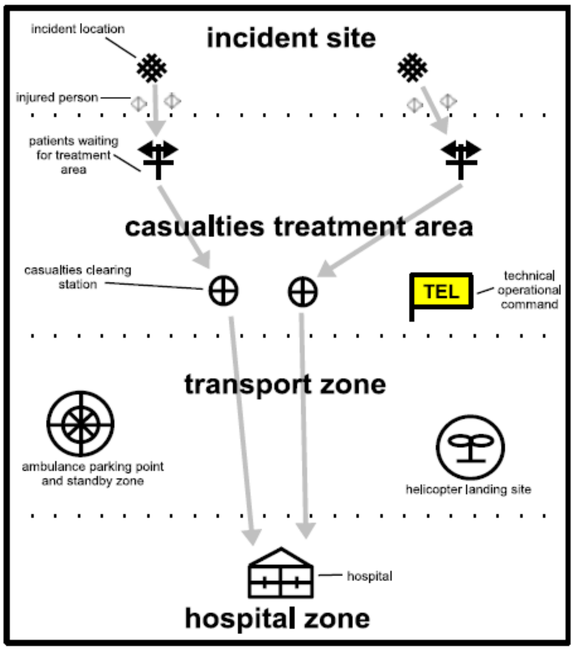

Fig 2: Disaster Area having multiple incident location

III. RELATED WORK AND PROPOSED MODEL

To simulate the desired work, network simulator 2.34 is used. NS2 is discrete event simulator, uses C++ and OTcl languages. The disaster area including all relief operations and medical assistance is 500 x 500 sq.m. Traffic is generated using cbrgen utility. Figure 2 and 3 shows the simulation of desired network in NS2. Various simulation network parameters listed below in table 2 are used in simulation.

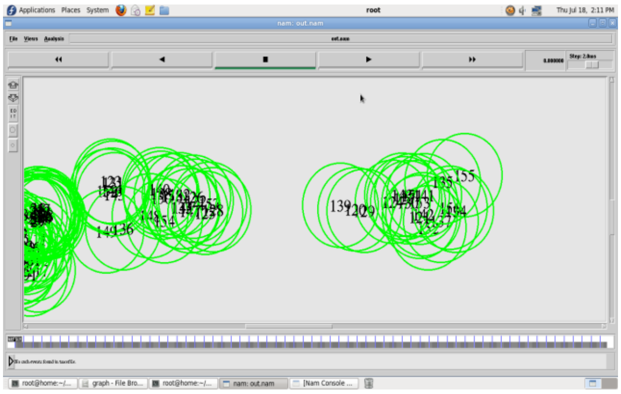

Fig 3: Simulation of Desired network in NS2

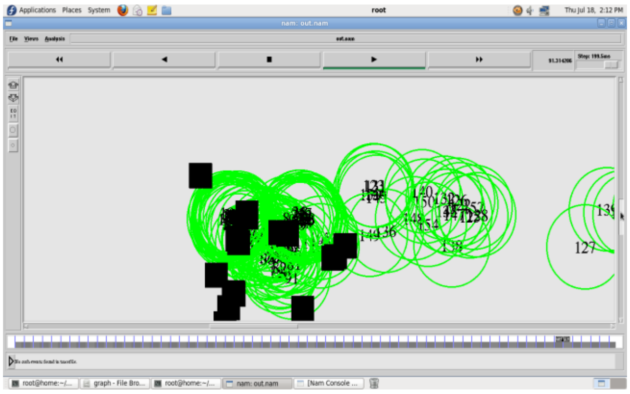

Fig 4: Tracing out.nam file generated after simulation

Table 2: Simulation parameters used for analysis

Parameter	**Value**
Interval	20ms to 100ms (10-50 packets/sec)
Packet size	512 bytes
Simulation time	100 Seconds
Number of nodes	251
Mobility model	Disaster Area Model (DM)
Topology size	500 m × 500 m
Initial energy	100 Joule per node
Traffic	CBR

AODV and DSR protocols provides highest packet delivery ratio. It is found that DSDV provides very low packet delivery ratio due to the frequent route failures and its proactive nature. Fig 5 shows a graph of the packet delivery ratio by varying interval. Table 3 specifies packet delivery ratio values for different intervals.

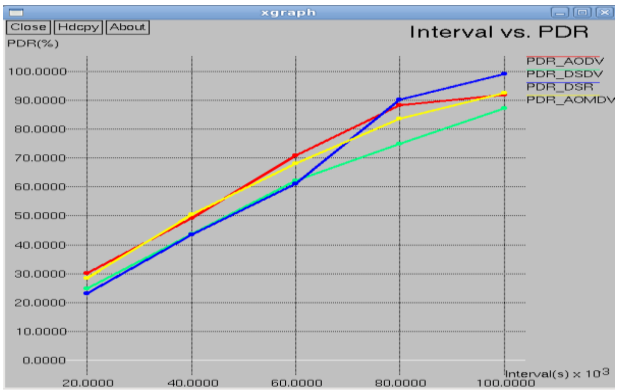

Fig 5: Interval vs. PDR

Table 3: Interval vs. PDR

Interval	0.02	0.04	0.06	0.08	0.10
AODV	30.12	49.33	70.80	88.35	91.84
AOMDV	28.58	50.45	68.21	83.56	92.49
DSDV	24.87	43.82	62.22	74.98	87.19
DSR	23.10	43.43	61.10	90.10	98.99

Lower delay is expected for better performance of a protocol. Fig 6 shows a graph of the delay by varying interval. Table 4 specifies delay values for different intervals.

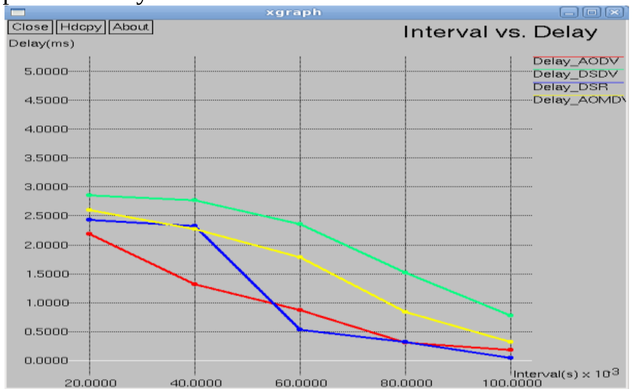

Fig 6: Interval vs. Delay

Table 4: Interval vs. Delay

Interval	0.02	0.04	0.06	0.08	0.10
AODV	2.19	1.31	0.87	0.31	0.18
AOMDV	2.60	2.27	1.78	0.83	0.31
DSDV	2.85	2.76	2.36	1.52	0.77
DSR	2.43	2.32	0.53	0.31	0.04

Control packets are required for proper synchronization of data packets but they consume bandwidth. Minimum control packets are desired such that more bandwidth will be available for data packets. AOMDV is multi-path routing protocol, which generates large overhead due to its dynamic nature. Fig 7 shows a graph of the control overheads by varying interval. Table 5 specifies packet delivery ratio values for different intervals.

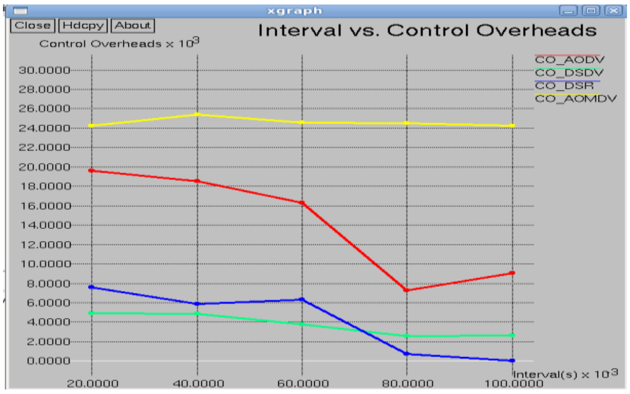

Fig 7: Interval vs. Control Overheads

Table 5: Interval vs. Control Overheads

Interval	0.02	0.04	0.06	0.08	0.10
AODV	19618	18537	16311	7285	9038
AOMDV	24249	25389	24539	24532	24250
DSDV	4946	4839	3794	2593	2606
DSR	7575	5846	9302	721	44

Throughput is the rate at which the data is traversing a link. As we go on increasing the interval, throughput starts decreasing. DSR provides the lowest throughput while AODV provides the highest throughput. Fig 8 shows a graph of throughput by varying interval. Table 6 specifies throughput values for different intervals.

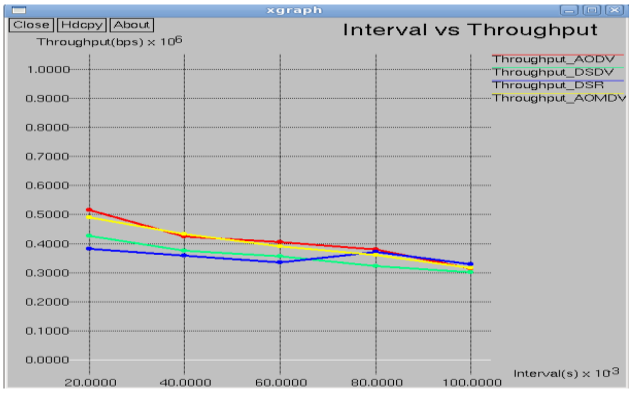

Fig 8: Interval vs. Throughput

Table 6: Interval vs. Throughput

Interval	0.02	0.04	0.06	0.08	0.10
AODV	0.51	0.42	0.40	0.38	0.31
AOMDV	0.49	0.43	0.39	0.36	0.31
DSDV	0.42	0.37	0.35	0.32	0.30
DSR	0.38	0.35	0.33	0.37	0.32

As nodes are having limited battery, hence minimum amount of energy must be utilized in transmission. This is the main concerns in MANET especially in disaster area scenario. Fig 9 shows a graph of the average energy consumption by varying interval. Table 7 specifies average energy consumption values for different intervals. For high traffic on a network, DSR provides good result.

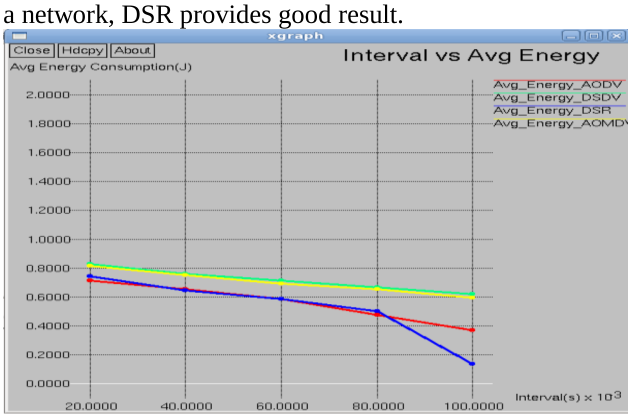

Fig 9: Interval vs. Avg. Energy

Table 7: Interval vs. Avg. Energy

Interval	0.02	0.04	0.06	0.08	0.10
AODV	0.71	0.65	0.58	0.47	0.37
AOMDV	0.81	0.75	0.69	0.65	0.59
DSDV	0.82	0.75	0.71	0.66	0.61
DSR	0.74	0.64	0.58	0.49	0.13

Experiment is also carried out by changing the size of packets. Various simulation network parameters listed below in table 8 are used in simulation.

Table 8: Simulation parameters used for analysis

Parameter	Value
Interval	20ms
Packet size	500 bytes to 2000 bytes
Simulation time	100 Seconds
Number of nodes	251
Mobility model	Disaster Area Model (DM)
Topology size	500 m × 500 m
Initial energy	100 Joule per node
Traffic	CBR

The size of packet varies from 500 bytes to 2000 bytes while interval between successive packets is 20ms which implies 50 packets/sec. As we increase the size of packets, more traffic is generated on a network and PDR drops. AODV protocol provides highest packet delivery ratio. It is found that DSDV provides very low packet delivery ratio due to the frequent route failures and its proactive nature. Though DSR is reactive, it will not sustain in high traffic network. Fig 10 shows a graph of the packet delivery ratio by changing the size of packet. Table 9 specifies packet delivery ratio values for different packet sizes.

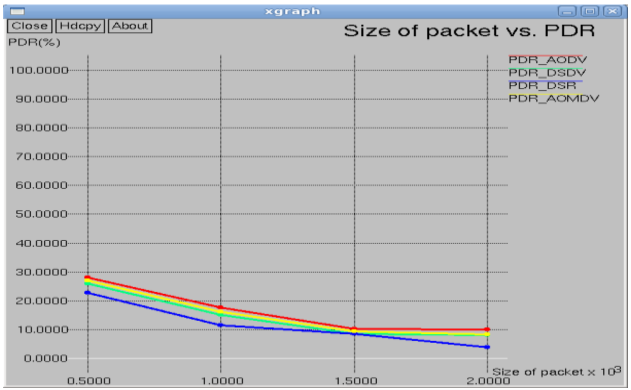

Fig 10: Size of packet vs. PDR

Table 9: Packet size vs. PDR

Size of Packet	500	1000	1500	2000
AODV	28.15	17.66	10.25	10.11
AOMDV	27.08	16.19	9.36	8.38
DSDV	26.02	15.15	8.51	8.14
DSR	22.84	11.55	8.62	3.96

Lower delay is expected for better performance of a protocol. Fig 11 shows a graph of the delay by varying the size of packet. Table 10 specifies delay values for different size of packets. It is found that DSR provides les delay as compared with other protocols.

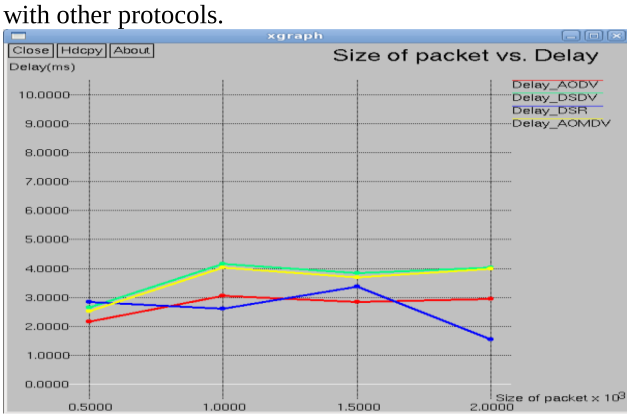

Fig 11: Size of packet vs. Delay

Table 10: Size of packet vs. Delay

Size of Packet	500	1000	1500	2000
AODV	2.17	3.06	2.85	2.94
AOMDV	2.53	4.03	3.69	3.99
DSDV	2.64	4.16	3.83	4.04
DSR	2.84	2.60	3.37	1.55

Control packets are required for proper synchronization of data packets but they consume bandwidth. AOMDV is multi-path routing protocol, which generates large overhead due to its dynamic nature. Also DSDV generates more control packets as compared with AODV and DSR. Fig 12 shows a graph of the control overheads by varying the size of packet. Table 11 specifies packet delivery ratio values for different size of packets.

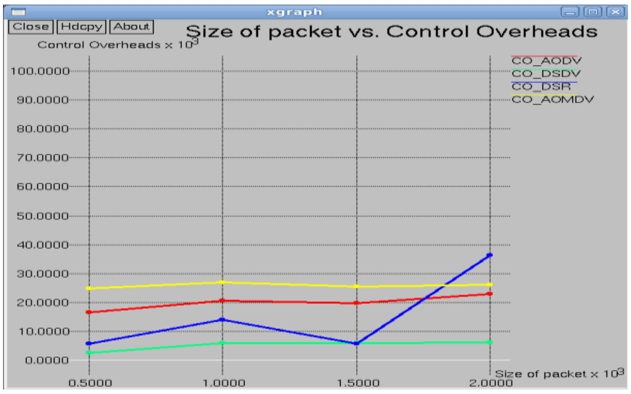

Fig 12: Size of Packet vs. Control Overheads

Table 11: Size of packet vs. Control Overheads

Size of Packet	500	1000	1500	2000
AODV	16.70	20.63	19.85	22.96
AOMDV	24.97	26.93	25.50	26.25
DSDV	2.59	6.07	5.95	6.19
DSR	5.83	14.14	5.72	36.34

Throughput is the rate at which the data is traversing a link. As we go on increasing the interval, throughput starts decreasing. DSR provides the lowest throughput while AODV provides the highest throughput. Fig 13 shows a graph of throughput by varying the size of packet. Table 12 specifies throughput values for different size of packets.

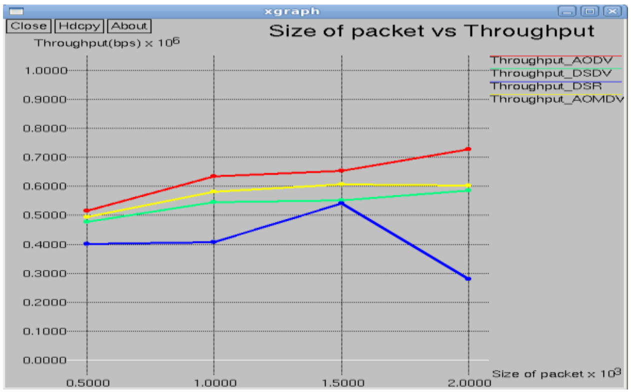

Fig 13: Size of packet vs. Throughput

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Table 12: Size of packet vs. Throughput

Size of Packet	500	1000	1500	2000
AODV	0.515	0.633	0.652	0.726
AOMDV	0.495	0.581	0.606	0.602
DSDV	0.477	0.544	0.551	0.585
DSR	0.401	0.407	0.541	0.279

Fig 14 shows a graph of the average energy consumption by varying size of packet. Table 13 specifies average energy consumption values for different packet size. It is found that average energy consumption is more in DSR as compared with other protocols.

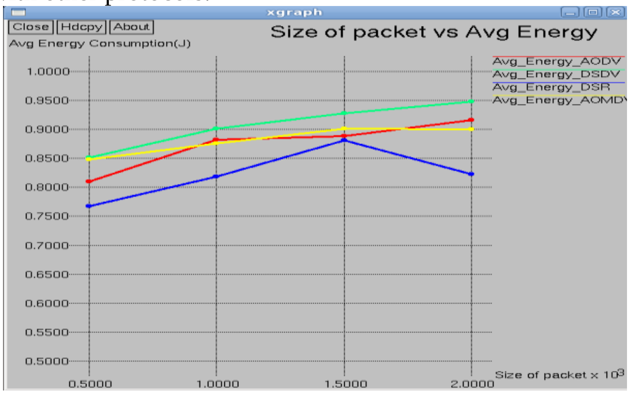

Fig 14: Size of packet vs. Avg. Energy

Table 13: size of packet vs. Avg. Energy

Size of Packet	500	1000	1500	2000
AODV	0.80	0.88	0.88	0.91
AOMDV	0.84	0.87	0.90	0.89
DSDV	0.85	0.90	0.92	0.94
DSR	0.76	0.81	0.88	0.82

IV. CONCLUSION

In this paper, performance analysis of various routing protocols such as DSDV, AODV, AOMDV and DSR is implemented. There are various mobility models out of which the disaster area mobility model is selected where the disaster scenario is divided into different areas such as incident site, casualty's treatment area, transport zone, and hospital zone. Various performance qualitative and quantitative metrics such as packet delivery ratio, delay, throughput, control overhead and energy are used to test the scenario. The results obtained from analysis shows, dynamic routing protocols such as AODV and DSR are selected to maintain minimum loss and high packet delivery ratio. Also for high traffic, AODV and DSR protocols are more suitable as they generate less control overhead due to their reactive nature. AODV and DSR protocols also provides high throughput. Average energy consumption is less in DSR protocols as compared with AODV. Thus DSR protocol minimizes the energy consumption and maximizes the network life time.

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