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Evaluation of AODV using performance metrics

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Abstract
The clients exchange information with each other forming an impermanent network, without any centralized system called Ad-hoc networks. In this growing world, mobile devices are very important for human beings. Without mobile, no one can fulfill their daily routines. For this scenario, we have studied mobile ad-hoc networks (MANETs). The communication between mobile nodes is infrastructure-less. Many Routing Protocols are there for communication between these wireless nodes. Performance metrics have been designed for comparison in Ad-hoc wireless networks. This paper includes comparison between two protocols AODV and AODVE (AODV with energy), in which average delay, packet delivery ratio, and throughput have been measured. It describes beneficial information regarding AODV Routing Protocols by adding some energy parameters and will also be very helpful in upcoming research.

Keywords: MANET, AODV, AODVE, NS2

1. Introduction
MANETs are Mobile Ad-hoc networks, in which a number of mobile nodes are connected via some communication medium using wireless links. To develop all these routing protocols, Mobile Ad hoc Networks face great challenges. In Mobile Ad-hoc networks, all the nodes are free to move anywhere in the network and as a result, constant changes occur in topology. Between each node, there may be very less range during transmission time. Many routing protocols have been designed for achieving the efficient routing in MANETs. In MANETs, energy consumption is a big and common issue, since mobile devices have limited battery capacity. There are mainly two types of Ad-hoc routing protocols viz. Table-driven routing protocols and on–demand routing protocols. The Table-driven routing protocols maintain a up-to-date routing information at each node, whereas in On-demand routing, the paths are created on the demand of starting nodes [1]. The previous analysis represents how to save energy or better lifetime in nodes using some energy saving methods [2]. For the study of MANETs, there exist a number of research groups, which help to remove all the hassle regarding MANETs. In OSI model, three layers have been added to solve the limited battery capacity aspect [5]. In some situations, when networks are divided into more than two parts, some nodes use more battery than others and a problem occurs that node cannot be included further in network [8]. Routing is the basic functionality of a network, which aims at finding an optimal route to a specified destination [9].

In wireless communication, mobile ad-hoc network handles all network devices. MANETs use dynamic network topology because constant change in network is detected. The important part is that no infrastructure is needed in MANETs. All the nodes are free to make the connections. In MANETs, frequent routing updates happen. MANETs are flexible networks, and dynamic topology concept is used in MANETs [4].

The application areas of MANETs include Defence development, Disaster relief operations, Sensor Networks and Mine site operations [4].

2. Study of AODV Protocol
Mainly for wireless and mobile networks, AODV (Ad-hoc on demand distance vector) protocols were designed. It was developed in July 2003 in Nokia Research Center, University of California. Various implementations of AODV are MAD-HOC, Kernel-AODV, AODV-UIUC, and AODV-UCSB. In AODV, broadcast on every node is not necessary in the network. AODV establishes the path only when necessary. All these routing protocols use routing tables to contain path related information. There are two types of routing tables, one for unicast path and other for multicast path. AODV behaves as distance vector routing algorithm and is included in the category of a reactive routing protocol. When connection is established, life time of every node is also updated [3].

Working of AODV
In the working phase of AODV, mainly two aspects Route Discovery stage and Route Maintenance stage are important.

Route Discovery Stage
Route Discovery process initiates with the Route Request packet (RREQ). When any node wants to send packet to other node then it checks in its routing table that it is a current route for the destination node. And if is so, then it forwards the packet to the next node, else it initiates route discovery process again [6].

Route maintenance stage
Broadcasting of active nodes is done periodically by hello message. As there is no hello message from neighbor, up streams node notifies source with a Route Reply Error packet

(RRER) and entire node is invalidated. Initialization is done by source to a new route discovery stage. And then it will flood the RREQ packet [7].

3. Qualitative Analysis of AODV and AODVE routing protocols

In Qualitative analysis, firstly in AODV three performance metrics have been calculated i.e. Average Delay, Throughput, packet Delivery Ratio and then some energy parameters are added to calculate AODVE. At last, both AODV and AODVE have been evaluated with the same performance metrics.

AODV

In AODV, for all the cases comparative analysis is performed. And for the experimental purposes 5, 10, 20, 40 and 50 nodes have been created. All these scenarios are generated using TCL scripts. All these are simulated using NS2.34 and run using random scenario model. For making the scene more realistic, speed is taken as 2 and pause time is 100 for all the cases. For 5 nodes, number of connections are 2. For 10 nodes, this connection varies from 3 to 5. The case changes for 20 nodes, where connections established are 7-11. For 40 and 50 nodes, 11-13 and 13-15 connections have been established, respectively.

A. Average Delay

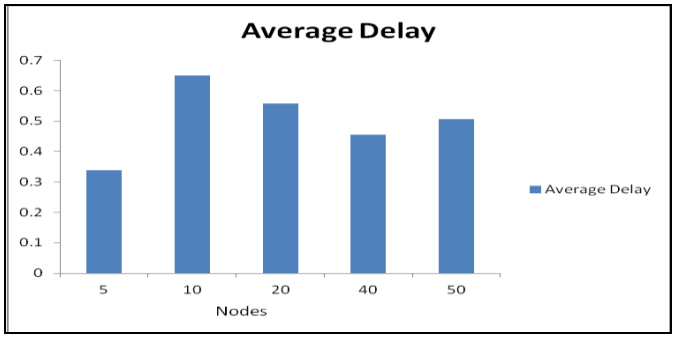

Fig 1: Average delay of AODV

In Fig 1, x-axis shows all the nodes and y-axis shows average delay in packet transfer for various scenarios. In this case, normal AODV is run and average delay is calculated. Average Delay specifies the delay of a network and defines how much time it will take for a bit of data to travel from source to the destination. In sparse medium of 5 nodes, delay is less and at node 10, average delay increases and after that node there is increase and decrease also according to their parameters. So at every node, average delay is calculated. In case if node density is increasing, the calculation part is less after route establishment, so delay reduces.

B. Throughput

In Fig2, x-axis represents the nodes and y-axis shows throughput. In networking, throughput is the amount of data which is transferred successfully from one location to another within in a given time period, and measured in bits per second and in megabits per second or gigabits per second. As the Fig shows, throughput is different in every case. Throughput should be high in the network to improve the efficiency.

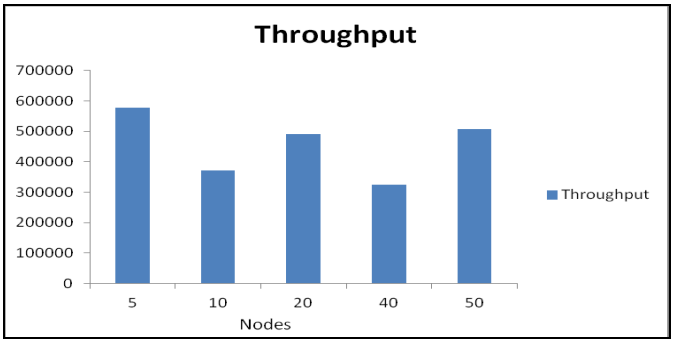

Fig 2: Throughput of AODV

C. Packet Delivery Ratio

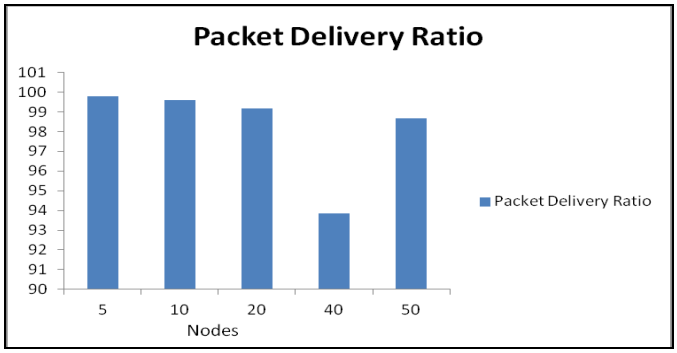

Fig 3: Packet Delivery Ratio of AODV

Packet Delivery Ratio is described as the ratio of data packets which are received by the destination to the packets generated by the source. The Fig 3 shows that at node 5, packet delivery ratio is increased and at node 10 and 20, PDR is same and at node 40, PDR is very low, again at node 50, PDR is increased.

AODVE

In AODVE (Ad-hoc on demand distance vector with energy). Extra E with AODV shows energy which means if lifetime of nodes is increased efficiency also increases. In AODVE for all the cases, comparative analysis is performed. And for the experimental purposes 5, 10, 20, 40 and 50 nodes have been created. All these scenarios are generated using TCL scripts. All these are simulated using NS2.34 and run using random scenario model. For making the scene more realistic, speed of 2 and pause time of 100 have been used for all the cases. For 5 nodes, number of connections are 2. For 10 nodes, this connection varies from 3 to 5. The case changes for 20 nodes, where connections established are 7-11. For 40 and 50 nodes, 11-13 and 13-15 connections have been established respectively. Only the difference is that AODVE contain energy parameterized script.

D. Average Delay

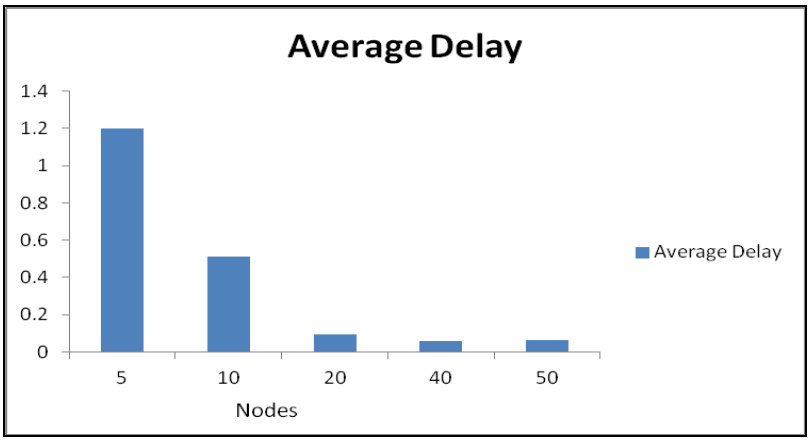

Fig 4: Average Delay of AODVE

In this case, AODVE is run and average delay is calculated. In this, TCL file contains energy parameter. And there is a clear difference in Average Delay of AODV and AODVE. In this Fig at node 5 average delays is very high but at node 50 average delay is very less. To reduce the average delay is the main motive of AODVE.

E. Throughput

In this Fig, x-axis represents the nodes and y-axis represents the throughput. As the Fig clearly depicted that at node 5, throughput is very less and gradually it is increasing at node 10 and at node 50, throughput is maximum. To maximize the throughput is the main aim of using these energy parameters.

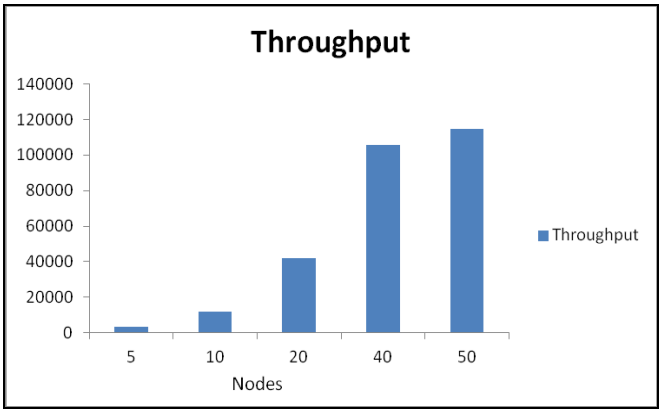

Fig 5: Throughput of AODVE

F. Packet Delivery Ratio

Packet Delivery Ratio is described as the ratio of data packets which are received by the destinations to those packets that are generated by the source. PDR should be high according to networking aspect by which successful transmission of data packets is achieved. And the possibility to lose the packets is very less in AODVE. As a result, efficiency is improved as there is no loss of data. By using this approach, cost is also reduced because there is no need to data retransmission. And in the Fig, at node 5 PDR is very small but after that PDR is increasing continuously i.e. good for successful data transmission.

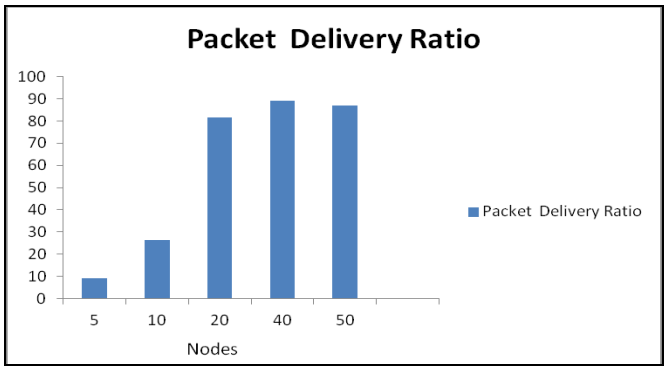

Fig 6: Packet Delivery Ratio of AODVE

AODV and AODVE

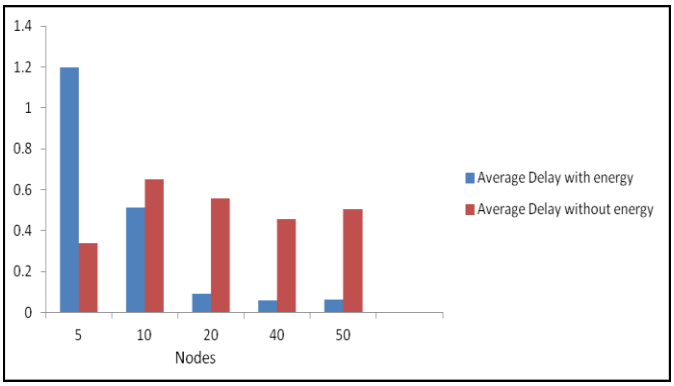

Fig 7: Average Delay of AODV and AODVE

In the Fig 7, x-axis shows the nodes and y-axis shows the average delay with energy and average delay without energy. This Fig represents the combination of both AODV and AODVE. This is clear from the Fig that using AODV delay is very high at each node, but after using the AODVE average delay is very less.

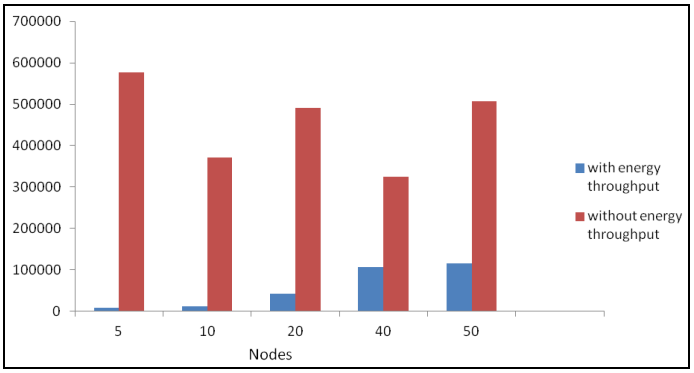

Fig 8: Throughput of AODV and AODVE

In Fig 8, throughput of AODV and AODVE has been compared. This Fig clearly represents that in normal AODV throughput is varying at each node but in AODVE throughout is increasing at each node.

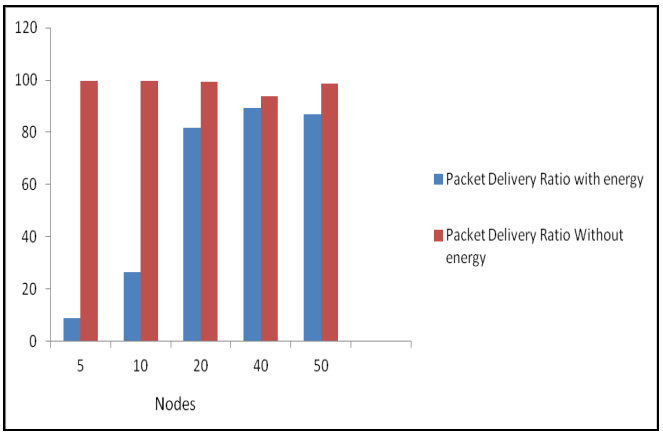

Fig 9: Packet Delivery Ratio of AODV and AODVE

In Fig 9, PDR of AODV and AODVE has been compared. In this Fig, when normal AODV is used, PDR is high at each node, but in AODVE at node 5 and node 10, PDR is less than other nodes. But after these nodes PDR is very high in AODVE case. It is beneficial to improve the performance of PDR in both the cases to achieve optimization.

Network Simulator (NS2)

All the work has been performed with the help of network simulator. For the simulating environment, TCL scripts files, NAM files and TR files are executed and results are compared with other one. Node5 to Node50 are calculated with corresponding Average Delay, Throughput and Packet Delivery Ratio. From the results it's clear to understand that as node increases there is variation in results. Results have been depicted in Fig form which shows clear and easy way to understand the problems. Mostly simulation scripts are created in TCL (Tool Command Language). In this experiment, results have been analyzed by the awk and output in the trace file. Network simulation has been done using NS2.34.

4. Conclusion

In this paper, the routing protocols AODV and AODVE have been evaluated for the performance metrics Average Delay, Throughput and Packet Delivery Ratio up to 50 nodes. It has been observed from the results that AODVE works better than AODV. In AODVE, performance is increased since Throughput and PDR is better and average delay decreases. The overall efficiency increases in case of AODVE. Hence it can be said that AODVE is better than conventional AODV protocol.

5. References

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