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Comparative Analysis of Energy Consumption in Mobile Ad Hoc Networks (MANETs)

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Abstract: *MANETs (Mobile Ad hoc Networks) is self-organizing and self-configuration and self-controlled network without the need of any base station. The topology changes and the limited battery resources are the challenges of MANETs. It is important to know the energy efficiency of routing protocols to limit the power consumption, prolong the battery life and to improve the robustness of the system. This paper focuses on the comparative analysis of energy consumption of reactive routing protocols like AODV and DSR with how successful data delivery in MANET. The performance evaluation is performed by using NS-2.*

Keyword: *AODV; DSR; Mobile Ad Hoc Networks (MANETs); NS-2;*

1. INTRODUCTION

The advanced in wireless communication technology becomes increasingly popular in nowadays. There are two major differences in wireless network infrastructure: *infrastructure networks* and *ad hoc networks*. The infrastructure network is fixed with wired backbone. The mobile nodes communicate directly with access points (base station node). The ad hoc network is a network without any base stations "infrastructure-less" or multi-hop. It can support anytime and anywhere computing. Ad hoc networks are a new feature of wireless communication for mobile nodes. In MANET [2], each node acts as a router or a host and the topology of the network may also change rapidly. This type of network has no fixed infrastructure.

A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Such a network may operate in a standalone fashion or may be connected to the larger Internet. Energy conservation is also an important issue in MANET because mobile nodes are often battery-powered and cannot function without enough power level. As devices are being designed to be smaller (cell phones, PDAs, digital cameras), communication, energy cost becomes a more significant portion of the total power consumed. The emergency rescue, military actions, and scientific field missions, energy conservation in MANET are important and energy conservation should be considered carefully when designing or evaluating ad hoc routing protocols.

The features of MANETs are:

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(1) Distributed operation: There is no centralized control network to send and receive packets. Mobile nodes can do self-control and management of routes to reach destinations.

(2) Multi-hop routing: Packets are transmitted to the destination in both routing algorithms, single-hop and multi-hop. Multi-hop is more complex than single-hop not only in structure but also in the configuration. Unlike a simple wireless network, MANET needs to hop multipath to reach the destination.

(3) Light-weight terminals: MANET nodes are mobile devices with less CPU processing capability, small memory size, and low battery power. Such devices need optimized algorithms and mechanisms that implement computing and communicating functions.

The challenges in MANETs are:

(1) Packet loss: MANET gets higher packet loss due to ever-changing network, due to the presence of hidden terminals and the presence of interference. Frequent paths break occurs because of node mobility.

(2) Battery constraints: One of the major constraints in MANET [11] is exhausted battery power consumption. Devices in MANET need to maintain mobility, size, and weight of devices to save battery power.

(3) Route changes: Network topology in MANET is ever-changing due to movement of nodes. Paths break in every time. This situation leads to change routes.

(4) Potentially frequent network partitions: Randomly movement of nodes in MANET [3] in mobile ad hoc network lead to partitions of the network. Intermediate nodes are the major nodes to the partitioning of MANET.

(5) Limited wireless transmission range: Radio band is limited in the wireless network and data rates it can transfer is much lesser than a wired network.

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The features and challenges motivate the comparative analysis of energy consumption in MANETs.

The rest of this paper is organized as follows. Section 2 describes the comparative studies of reactive protocols: DSR (Dynamic Source Routing) and AODV (Ad-hoc On-Demand Distance Vector). Section 3 set up the experiment with the simulation process. Section 4 discusses the performance evaluation and result in the analysis. Section 5 concludes the attempt of evaluation on comparative analysis of energy consumption in MANETs.

2. REACTIVE ROUTING PROTOCOLS

This section reviews the route discovery and route maintenance of reactive routing protocols (AODV, DSR).

2.1 AODV

AODV [12] provides route discovery when need to send packets or in MANET. It is called on-demand routing. If the source node doesn't have routing information in its table when the source needs to send destination, the route discovery process is started to find the routes from source to destination.

2.1.1 Route Discovery

The route discovery process is performed on nodes, which may be source node, an intermediate node, and destination node. Source Node initiates RREQ route request messages. RREQ contains source node IP address and current sequence number of Source, Destination IP address, last known sequence number of destination and broadcast ID. It sets a timer to wait for the reply. Intermediate nodes check the unique identifier (Source IP address & broadcast ID) of the RREQ. If it has already seen from it, discards the packet. If not, set up a reverse route for the source node, associated with a lifetime and broadcast the RREQ to its neighbors. The node responds to the RREQ (not necessary destination node) must have an unexpired entry for the destination and reply a RREP back to the source, using the node from which it received the RREQ as the next hop.

2.1.2 Route Maintenance

Suppose some routes are not used, they are expired their lifetimes and need to remove these routes. But if routes are needed to be used, the lifetime period of time is needed to be updated so those routes are not expired. When a source node wants to send data to some destination, first it searches the routing table. If it finds the route that can reach the destination, it will use those routes. Otherwise, it must start with a route discovery to find a route. It is also needed to send the Route Error (RERR) message that used to notify the other nodes about some failures in other nodes or links.

2.2 DSR

Dynamic Source Routing (DSR)[6]is a reactive routing protocol. It has an equality of treating routing algorithm in all nodes on the network as it as a flat structure. In DSR routing, the source node needs to append the complete routing path to each data packet header before transmitting to other nodes. Additionally, each node uses a caching technique to maintain the route information that they have traversed before. Routing construction in DSR also has two major phases; the route discovery and the route maintenance.

2.2.1 Route Discovery

When a source node wants to send a data, it broadcasts the RREQ packet to its neighbor nodes. When an intermediate node on the route to the destination receives the RREQ packet, it appends its address to the route record in RREQ and re-broadcast the RREQ. When the destination node receives the first RREQ packet, it starts a timer and collects RREQ packets from its neighbors until quantum q time expires. The destination node finds the two (primary +backup) best routes from the collected paths within the quantum q time. The destination node D sends a RREP packet to the source node S by reversing (RREQ) packets which include the two routes (Primary +Backup) for further communication.

2.2.2 Route Maintenance

In the Route maintenance, DSR provides three successive steps: link-layer acknowledgment, passive acknowledgment, and network layer acknowledgment. When a route is broken and one node detects the failure, it sends a Route Error packet to the original sender.

2.3. Differences between AODV and DSR

The differences in AODV and DSR in terms of routing messages:

- AODV sends Periodic routing message.
- DSR no need to send periodic routing message, thus reduces bandwidth overhead and conserved battery power.

In terms of routing table:

- In AODV, the routing table is maintained thus it does not require sending the whole route with the message during the route discovery process.
- In DSR, the whole route is carried with the message as an overhead during the route discovery process.

3. EXPERIMENTAL SETUP

The experimental setup and parameters are shown in Table I consist of 25, 50, 75,100 nodes which were randomly deployed in different areas. The run time

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for the study environment is 100 s.

TABLE I SIMULATION PARAMETERS

Parameter	Value
Protocols	AODV,DSR
Traffic Source	Constant Bit Rate (CBR)
Simulation time	100 s
Packet size	512 bytes
Area	500x500m^2,500x1000m^2, 1000x500m^2,700x700m,^{2} 1000x1000m^2
Number of nodes	25,50,75,100 nodes
Pause time	0,2,4,6,8,10,20,30,40,50,60, 70,80,90,100 s
Maximum speed	1,2,4,6,8,10,20,30,40,50,60, 70,80,90,100 m/s
Mobility model	Radom way point model
Radio propagation mode	Two ray ground
Initial Energy	7.0J
Transmit Power	0.6W
Receive Power	0.3W

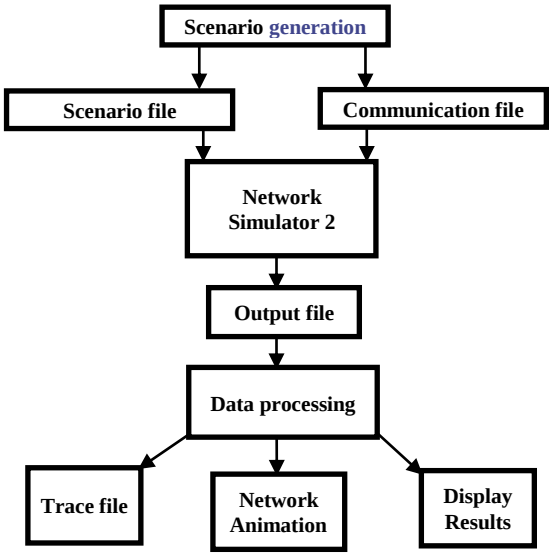

Figure 3.1 Flow of simulation process

We set the propagation model of the wireless sensor network as the two-ray ground reflection model and set the transmission range of nodes as 100 m. The MAC protocol is set in IEEE 802.11 and the bandwidth of the channel is set to 1 Mbps.

The initial energy of all of the nodes is 7 J. The transmit power is 0.6 W and the receiving power is 0.3. During the simulation, the used traffic model is UDP/CBR traffic streams between the source and destination. The size of the data packet is set to 512 bytes with various speeds.

Simulation is one of the important features to evaluate the protocol performance. A typical simulation is done with ns and the flow of the simulation process is shown in Figure 3.1. It consists of generating the following input to NS-2:

- A node pattern generation that describes the topology scenario in an environment.
- A communication pattern that describes the traffic in the network.

These patterns are then used for the simulation and as a result of this, a trace file is generated as output. Before the simulation, the parameters that are going to be traced during the simulation must be selected. The trace file can then be scanned and analyzed for the various parameters that we want to measure.

4. PERFORMANCE EVALUATION AND RESULT ANALYSIS

The comparative analysis of energy consumption of AODV and DSR is evaluated with the NS-2 simulator [15]. NS-2 is a discrete event-driven network simulator which supports various mobile ad hoc routing algorithms. The performance metrics used for comparative analysis of energy consumption in AOD and DSR are:

Total Remaining Energy (TRE): It is taken as the sum of the remaining energy levels of all the nodes in the network at the end of the simulation.

$$TRE = \sum_{n=0}^{n-1} Remain\ Energy \qquad (1)$$

Total Consumed Energy (TCE): It is taken as the sum of the consumed energy of all the nodes in the network at the end of the simulation.

$$TCE = (NodeNum \times IniEnergy) - \sum_{n=0}^{n-1} Remaining\ Energy \qquad (2)$$

trace files from in Figure 3.1. It accepts trace file as inputs and stores them into the local database in a more suitable form. Results are shown in the following diagrams.

Figures 4.1 and 4.2 show the energy consumption and the remaining energy with varying nodes for AODV and DSR. Both protocols AODV and DSR energy consumption increases in the increasing number of nodes. In dense node number, the energy consumption of AODV energy decreases.

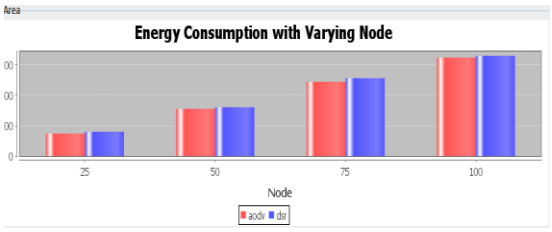

Figure 4.1 Energy consumption with varying nodes

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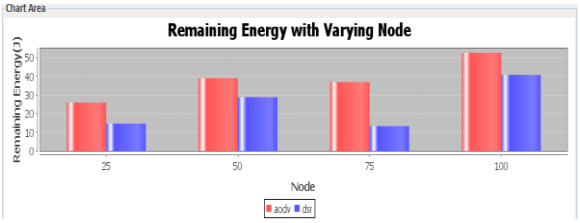

Figure 4.2 Remaining energy with varying nodes

The energy consumption in Figure 4.1 and 4.2 show AODV consumes more energy than DSR because of routing tables. But in increasing node numbers, DSR consumes more energy than AODV. DSR has many hop counts to get a destination in dense node number. DSR has greater energy consumption in the dense network because it sends routing packets than AODV and stale route.

Figures 4.3 and 4.4 show the performance graphs for AODV and DSR varying packet sending rate. In lower node numbers, the DSR protocol has nearly the same energy consumption as AODV. But in a larger node number AODV has lesser energy consumption than DSR in both lower and higher packet sending rate. And in the higher packet sending rate, energy performance is nearly the same values because of nodes can only send packets that they are available to send whatever packet sending rate is increasing.

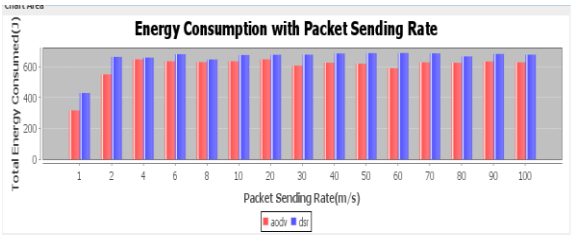

Figure 4.3 Energy consumption with packet sending rate for 100 nodes

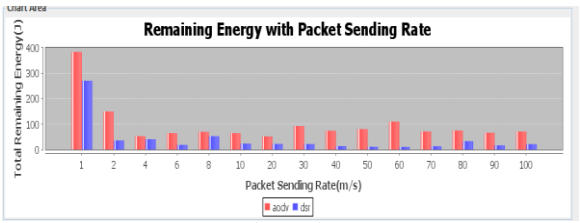

Figure 4.4 Remaining energy with packet sending rate for 100 nodes

Figure 4.5 shows the performance graphs for AODV and DSR varying topology size. In topology, size changing, DSR outperforms than AODV in smaller topology size. But in a dense and large network, AODV has better energy consumption performance. Because of source routing in DSR. DSR cannot handle the large and dense network.

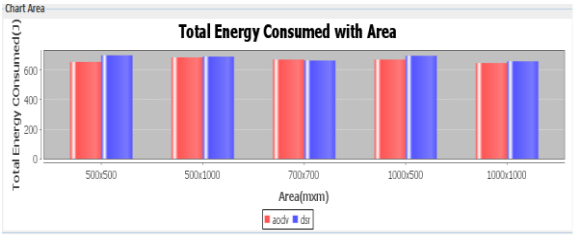

Figure 4.5 Total energy consumed with various area (different node densities)

5. CONCLUSION

This paper is an attempt to the comparative analysis of reactive routing protocols namely AODV and DSR. Performance evaluation is performed on the NS-2 simulator. The result is analyzed by Trace File Analyzer. The comparison was based on Total Remaining Energy and Total Coumed Energy. The results show AODV outform in a wide range of simulation conditions for MANET but DSR can only give good energy consumption in the low dense node, mobility, high packet sending rate.

REFERENCES

[1] Adaramola Ojo Jayeola,Olasina Jamiu Rotimi (2018), **"**Determination of Most Efficient Routing Protocol in Vehicular Ad-hoc Network (VANET) for Highway Scenario Using the Simulation Approach**"** *International Journal of Advances in Computer and Electronics Engineering*, Volume 3, Issue 12, pp. 7–13

[2] Buttyan, L., and Hubaux, J. P.(2003) "Stimulating cooperation in self-organizing mobile ad hoc networks", *Mobile Networks and Applications*: Special Issue on Mobile Ad Hoc Networks**8**(5), 2003.

[3] Hsu Hnin Aye, Aung Htein Maw(2014) "Mobility aware Performance Study of Routing Protocols in Ad-Hoc Network", University of Computer Studies, Yangon,Myanmar, pp.25-40

[4] http://www.enggedu.com/ns2/Setting Energy Model for Mobile Nodes.html

[5] http://www.isi.edu/nsnam/ns/tutorial/

[6] Johnson, D. B., & Maltz, D. A. (1996)"Dynamic source routing in ad hoc wireless networks" In *Mobile computing* (pp. 153-181). Springer, Boston, MA

[7] Kevin Fallkfall@ee.lbl.gov, Editor and Kannan Varadhan(2000), "The *ns* Manual(formerly *ns* Notes and Documentation)1", The VINT Project A Collaboration between researchers at UC Berkeley, LBL, USC/ISI, and Xerox PARC,47,pp.19 -231

[8] L M Feeney and M Nilsson,(2001) "Investigating the Energy Consumption of a Wireless Network Interface in an Ad Hoc Network Environment" *Twentieth Annual Joint Conference of the IEEE Computer and Communications Society,*vol.3, pp. 1548-1557

[9] LAURA MARIE FEENEY,(2001)"An Energy Consumption Model for Performance Analysis of Routing Protocols for Mobile Ad Hoc Networks", *Mobile Network and Applications, Vol 6, Issue 3.pp 239-249*

[10] Mariya Zheleva, Arghyadip Paul, David L. Johnson and Elizabeth Beldin(2013), "Local Cellular Network Services in Remote Areas", *Proceeding of the 11th annual international conference on Mobile systems, applications, and services*. ACM, pp. 417-430

ISSN: 2456 - 3935
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Volume 4, Issue 8, August 2019, pp. 1–5

[11] Nisar Hundewale, Sunsook Jung, Alex Zelikovsky,(2007) "Energy Efficient Node Caching and Load Balancing Enhancement of Reactive Ad Hoc Routing Protocols", *Journal of Universal Computer Science, Vol* 13.*Issue* 1,pp.110-132
[12] Perkins, C. E., & Royer, E. M. (1999). "Ad-hoc on-demand distance vector routing" In *Proceedings WMCSA'99. Second IEEE Workshop on Mobile Computing Systems and Applications* (pp. 90-100). IEEE.
[13] Perkins, C. E., Malinen, J. T., Wakikawa, R., Nilsson, A., and Tuominen, A. J. "Internet Connectivity for Mobile Ad Hoc Networks", *Wireless Communications and Mobile Computing*, **2**(5), pp. 465–482.
[14] S. Narayanaswamy, V. Kawadia, R. S. Sreenivas, and P. R. Kumar,(2002) "Power control in ad hoc networks: Theory, architecture, algorithm and implementation of the COMPOW protocol," in *European WirelessConference*, p. 156-162
[15] http:// www. isi. edu/ nsnam/ ns/ ns-documentation.html

Authors Biography

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