Performance of Agro-Sensors: Assessment of Optimality in Routing Protocols of MANET in Wireless Sensor Networks

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***Abstract*— A Mobile Ad Hoc Network (MANET) is a group of wireless mobile nodes which dynamically form a network without any established infrastructure. The application is considered in an agro-based project and therefore, Routing protocols are mandatory to send and receive packets. In this paper, we have evaluated the most commonly used routing protocols in MANET and compared the performance of reactive routing protocols such as Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector (AODV) and proactive routing protocols such as Geographic Routing Protocol (GRP), and Destination-Sequenced Distance Vector (DSDV) routing protocol by using OPNET simulator 17.5. The OPNET simulator is optimal for core level network design and parameters of sensor nodes are detailed enough to design a sensor network as the MANET in this paper. Analysis of the performance of protocols are certainly depending on End to End delay (average), Network Load and the throughput. These parameters are the common primary issues behind routing and sensor nodes in the MANET will coordinate themselves following these issues staying in an environment of proactive or reactive routing. The result shows that AODV performs better than the other two.**

Keywords— Wireless sensor network; adhoc network; energy-efficiency; battery lifetime; DSR; GRP; AODV; DSDV; OPNET.

I. INTRODUCTION

Agriculture is a current issue as production rate is driving market demands and pricing in the whole world. Panchard identified needs with surveys and gathered information for sustainability of small farmer and land owners during water scarcity [1]. Environmental challenges were pointed out from different sources of under-developed countries and later on, applications of environmental monitoring was set and selected through wireless sensor networks (WSN) [1]. Shiravale and Bhagat also designed a WSN for agricultural field [2] creating some applications in point to point master-slave, short hop or multi hop arrangements. Routing is confirmed in IPv6 scheme with classification of objects and tracking along with sensing and actuation unit, processing unit, communication and other dependent units for the whole system [2]. Le and Tan also depicted a real time application for agricultural based WSN with which agricultural and environmental parameters can be monitored and controlled [3]. A multilevel sensor network for acquisition and processing of data in precision farming and ecological monitoring was designed by Romanov et al [4].

Here in our research an agriculture Project (Agro based project) is using 10 or 20 nodes (any of the quantity) of sensors which are being run through battery power. Sensors are put in a planned distant areas and thus almost all of them are equally distant. An adhoc network using sensors are formed in agriculture firm in a village in the district of Chittagong, Bangladesh. Sensors are plotted in a plane land for obtaining the measurement of the moisture and PH of soil. As nodes need to coordinate each other for being in a distributed environment to get a cumulative result, routing is the main concern here. For attaining an optimal result, routing should be either proactive or reactive. The distribution of data and coordination would get optimal if sensors can perform better in perspective of end to end delay, network load and throughput. This research is mainly focusing on lower density of nodes in MANET whereas higher density of nodes need other intentions with some other parameters. GRP and DSDV are proactive routing protocols; these protocols maintain routing information on every single node in network even before it needed. However, the routing mechanisms for these reactive protocols are quite different than proactive protocols.

The system architecture for wireless sensor networks is as shown below:

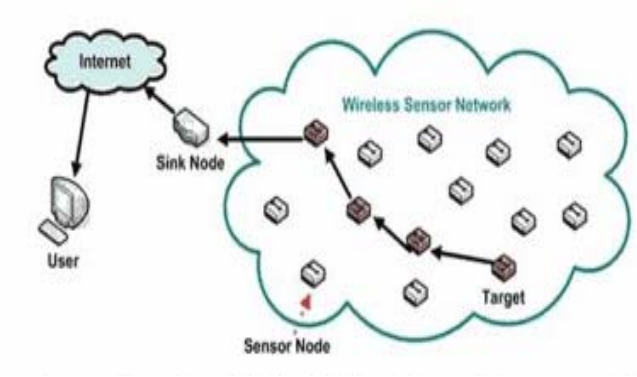

Fig. 1. Proposed network architecture

MANET in this architecture is the collection of wireless sensor nodes and all are coordinating each other. A sink node is responsible to act as the gateway to get reach to the cloud or the internet for all other nodes in the network.

II. BACKGROUND

Designing of network protocols need some factors to be considered especially in wireless environment of sensor networks. Routing decisions should follow some issues relating energy resources in the sensor network (MANET) as energy resources are scarce [5]. These resources are not common generally in other adhoc networks since communication channels are more available in events and sinks than individual source nodes and sinks. Communication in sensor networks is typically referred to as data center rather than address centric and data may be aggregated locally rather than having all raw data sent to the sinks [6]. A dynamic source routing is mandatory for any network working mobile nodes. Several dynamic source routing techniques have been clarified and researched in [7], [8] and this paper also evaluates and compares performances some dynamic source routing protocols to obtain a better performance in terms of end to end delay, network load and throughput.

III. RELATED WORK

Since 1970's, researches on mobile adhoc networks had been going on and number of protocols had been proposed over several networks.

As the MANET is formed without any central access point [9], protocols engaged in this network have to face several challenges due to changes in topologies (dynamically), lower transmission power and asymmetric links in the network. NS2 was used in paper [9] to study proactive and reactive routing in a stagnant quantity of nodes. Moreover, results in NS2 sometimes varies a little in core level network. When number of nodes changes within the same environment, that was not yet discovered and it is one of the major issues in this research study. In another research, performances of DSR and DSDV routing protocols have been compared using NS2 as well on end-to-end Delay, Packet delivery fraction, Throughput parameters [10]. Results showed that DSR was superior to DSDV [10].

In 2007, a brief research was done on AODV, DSR and OLSR [11] and proactive routing protocol was found to be optimal over reactive ones in a CBR traffic of MANETs. Some other researches had been done so far on minimum power routing, self-organizing protocols, minimization of transmission energy, and selection of routing cluster heads for collection of information and transmission to base stations.

An alternative approach is described in [12] by Heinzelman, Chandrakasan and Balakrishnan in Jan. 2000, whose LEACH protocol selects routing cluster-heads to collect local information and transmit it to a base station in a wireless sensor network. Like LEACH, Intanagonwiwat, Govinda and Estrin, Aug, 2000 in paper [6] directed diffusion mechanism takes advantage of aspects of sensor networks, particularly the possibility of aggregating and compressing data that are not present in general-purpose networks. An evaluation with a mathematical framework was done in [13] on performances of proactive and reactive routing protocols in MANETs. A parametric view of performances of protocols was highlighted where a routing logic is synthesized with performance of MAC. Analytical results on performances of proactive and reactive routing protocols were obtained from discrete-event Qualnet simulations under various network configurations and mobility conditions.

For load balancing measurement some clustering protocol was proposed with an architecture of intra cluster communication in comparison with protocols LEACH, TCAC and DSBCA [14]. The whole network was divided with some virtual circle with variable radiuses. Challenges of some average consensus algorithms used in WSN was highlighted in the paper of [15]. A Location aware sensor routing (LASeR) protocol was proposed for mobile WSN by Hayes and Ali [16]. With the Kringing Interpolation technique the challenge of location prediction is proposed with a prediction algorithm [17]. A model of heterogeneous WSN comprising of both BPSN and EHSN with a cost function oriented routing strategy was proposed integrating end to end path reliability, cost and energy consumption for a better QoS to run in a hybrid WSN in paper [18].

IV. SOFTWARE ENVIRONMENT

The Optimized Network Engineering Tool (OPNET 17.5) software is used for the research. OPNET simulator is used for solutions in network management and applications.

Fig. 2. Selecting MANET map of 10 nodes

Fig. 3. Selecting MANET map of 20 nodes

10 nodes are used in the first scenario where 20 nodes are used for the second. Size of the network is fixed on 500 x 500 meters. As the addressing scheme, IPv4 was preferred as IPv6 is still rare to be synchronized with current network structure and to be compatible with local computer network in the current research area. Parameters (delay, network loads and throughput) are assessed against AODV, DSR and GRP (three distinct protocols).

A. Simulation Parameters

TABLE I. SIMULATION PARAMETERS

Simulation Parameter	Value
Simulator	OPNET Modeler 17.5
Area	1000*1000(m)
Network Size	10 nodes, 20 nodes
Protocol	DSR, AODV, and GRP
Simulation Time	900 (sec)
Address Mode	IPV4

The chosen area is of 1000 x 1000 m. Two network sizes are considered (one is of 10 and the other is of 20 nodes). Three protocols **DSR, AODV, and GRP** are considered for routing here. As there is no parameters for DSDV protocol in this simulation environment only three have been used so far.

V. RESULT AND DISCUSSION

A. Performance of AODV, DSR, and GRP

TABLE II. TOTAL PACKET DROPPED

	Packet Dropped	
Protocols	**Node 10**	**Node 20**
AODV	2	3
DSR	constant	constant
GRP	150	199

There is a little difference between AODV and DSR. Data dropped in DSR is in 5 sec and in AODV, it is in 6 sec. Dropping of packets is higher in GRP (in 120 sec) compared to AODV and DSR (Fig. 5).

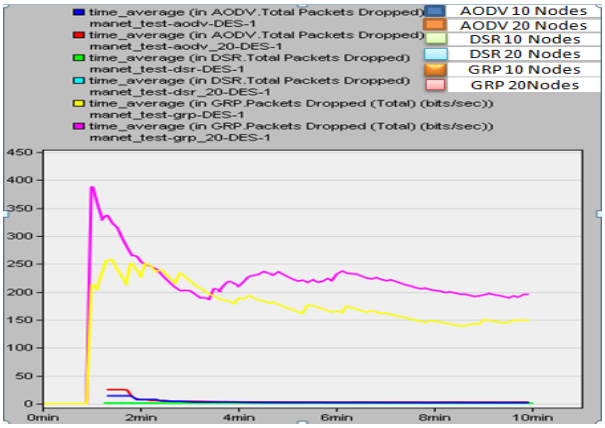

Fig. 4. Total Packet Dropped parameter for AODV, DSR& GRP

In (Fig. 5), from curves it is quite frequent that for 10 nodes, GRP is higher than AODV and DSR. Performance of DSR for 10 and 20 nodes are quite similar and optimal than that of AODV and GRP. GRP shows the highest curve in terms of packets dropped in this MANET.

The second parameter, End to End delay is measured and shown in (Fig. 6) and (Fig. 7). Result of simulation depict that end to end delay in GRP is lowest among these three protocols in 10 nodes.

TABLE III. OVERALL END-TO-END DELAY

	End-to-End Delay	
Protocols	***Node 10***	***Node 20***
AODV	0.00019	0.00044
DSR	0.00035	0.00059
GRP	0.00015	0.00043

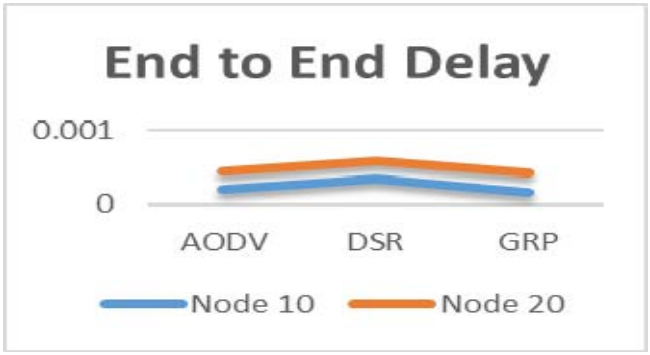

Fig. 5. End to end delay of nodes

The difference between AODV and GRP is very small when end to end delay in GRP is 0.00015 sec and in AODV is equal to 0.00019 sec. (Fig. 7) shows that delay in DSR is higher than that of AODV and GRP. DSR has initial Delay compared to others. Performances of node shows that End-to-End Delay for 10 and 20 nodes in DSR is maximum than AODV. Another parameter, the Network Load is measured and the result is shown in below Table IV:

TABLE IV. OVERALL NETWORK LOAD

	Network Load	
Protocols	*Node 10*	*Node 20*
AODV	3890.926	1209.348
DSR	1580.448	8040.236
GRP	1345.192	5184.101

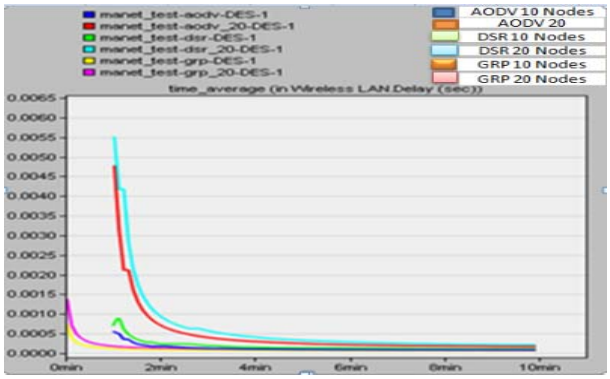

Fig. 6. Average Delay parameter for AODV, DSR& GRP

Several scenarios have been generated for AODV, DSR and GRP protocols. When number of nodes is 10, performance of AODV is the better than the other two. For AODV, the average peak value for Network load is 3890.926 bits/sec. For DSR, it is 1580.448 bits/sec and for GRP, it is 1345.192 bits/sec. At the other scenario, for 20 nodes (mobile), again AODV performs better than other two routing protocols.

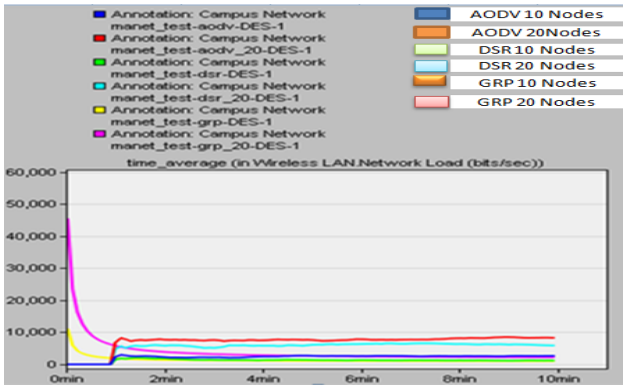

Fig. 7. Average Network Load parameter for AODV, DSR& GRP

(Fig. 8) shows that the network load in AODV network for both 10 and 20 nodes increases till the end of the simulation performance. AODV has maximum Network Load. Ordering of protocols according to network load can be specified as AODV>DSR>GRP according to the obtained result.

The last parameter, throughput is measured in perspective of transmission and receiving of data and the result is shown in the below Table V. The first scenario shows here that AODV attains optimal throughput than other two protocols in (Fig. 9) for both 10 and 20 nodes. DSR has the lowest throughput than that of others in 10 nodes where GRP has the lowest in 20 nodes environment.

TABLE V. OVERALL THROUGHPUT

	Throughput	
Protocols	*Node 10*	*Node 20*
AODV	25678	140198
DSR	15960	95988
GRP	20189	45124

Throughput rate of AODV reaches to the peak (25678 bits/sec) in time where DSR provides throughput rate more than 15960 bits/sec while it decreases at the middle. GRP provides a rate of 20189 bits/sec in (Fig. 9).

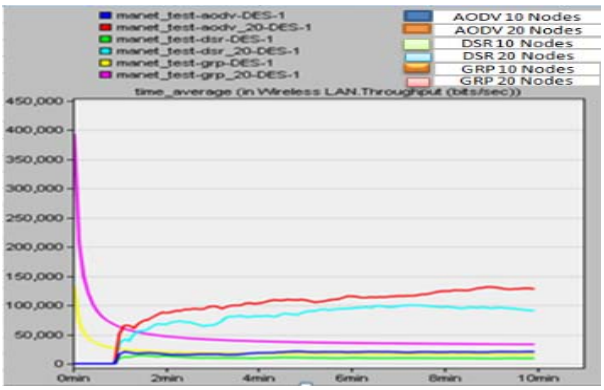

Fig. 8. Average Throughput parameter for AODV, DSR& GRP

TABLE VI. TOTAL EXPERIMENT RESULTS

Node	Matrix	AODV	DSR	GRP
10	Delay	0.00011	0.00025	0.00019
	Network Load	3890.926	1580.448	1345.194
	Throughput	25678	15500	20916
20	Delay	0.00044	0.00052	0.00043
	Network Load	1209.348	8040.236	5184.101
	Throughput	140198	95988	45124

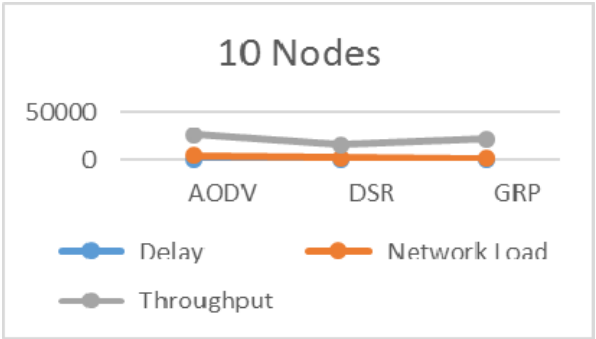

Fig. 9. Throughput, Delay and network load for 10 nodes

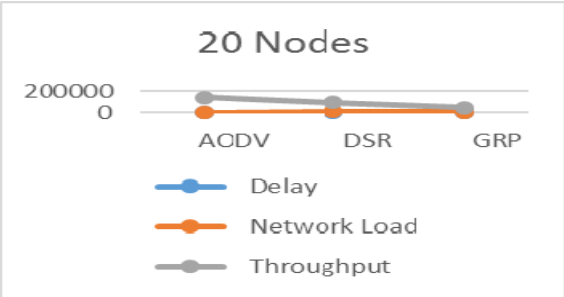

Fig. 10. Throughput, Delay and network load for 20 nodes

TABLE VII. COMPARISON AMONG MANET ROUTING PROTOCOLS

Routing Protocol	Reactive/Proactive	End-to-End Delay	Network Load	Throughput
AODV	REACTIVE	1	3	3
DSR	REACTIVE	3	2	1,2
GRP	PROACTIVE	2	1	2,1

The above scenario in the Table VII, GRP is not the optimal choice for a MANET considering three parameters (end to end delay, network load and throughput). AODV performs better than the other two and GRP performs worst. Therefore, reactive routing protocols dominates proactive ones considering these three parameters. Different number of nodes has a greater impact on consuming energies and performing in wireless adhoc networks (sensor networks).

VI. CONCLUSION

Comparison of three major routing protocols in a MANET of sensor network shows that in terms of end to end delay, network load and throughput AODV performs better than other two. In other sense, reactive routing protocols performs better than proactive routing protocols.

As, AODV routing protocol is suited for a large scale network and DSDV routing protocol suited for a small scale network, the AODV routing protocol is preferred more than the DSDV routing protocol.

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