Comparison of Different Performance Measures of Routing Protocols in WSN

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***Abstract*— The emerging trend of wireless sensor networks provides the need for small and low-cost sensor nodes in a wide range of applications. Communication in WSN, are limited within the transmission range, storage and processing capabilities. Data are transmitted with specified delay and energy resources to the sink. Routing protocols are used for maintaining the routes in the network and also ensures the hop communication. The current routing protocols in WSN increase the delay and reduce the energy. In this paper, different routing algorithms are discussed and the performances are measured with node energy and average delay. Experimental results are obtained from NS-2 simulator. Analyses with performance metrics are discussed.**

Keyword- Wireless sensor networks (WSN), routing, delay, QoS,AODV,DSDV,DSR.

I. INTRODUCTION

The rapid development and growth in wireless sensor network have resulted in wide range of applications such as environmental monitoring, health-care, military areas, event detection and tracking. The network comprises of many sensor nodes which are tiny, energy constrained, and battery powered devices. Each node is built in with the main capabilities like sensing, processing and communication.WSN may be deployed randomly or deterministically according to the application. Nodes are randomly deployed in hazardous areas and deployment in a non-hazardous area is generally deterministic. Sensor networks routing is different from the traditional routing schemes due to their undetermined topology structure. For example, during transmission a single path routing is followed .If one link fails, all the data in that route will be dropped which leads to entire communication to halt. To overcome this problem multipath routing can be used in sensor network .In multipath routing if a link fails alternate path will be taken.

Routing algorithms with minimum energy consumption and shortest path to transfer data with less delay is desired. Energy and delay are determining factor for performance of wireless sensor networks. QoS is the effective factor in WSN which is required by all applications. QoS defines the service quality measure of the network and application users which depends on service attributes in terms of network throughput, delay, packet loss and packet delivery ratio. Here we are dealing about the network QoS, it describes how the data is delivered to the sink node with its corresponding requirements.

In this paper, an effort is made to evaluate the performance of two reactive and one proactive routing protocol AODV (Ad-Hoc On-Demand Distance Vector Routing), DSR (Dynamic Source Routing) and DSDV (Destination Sequenced Distance Vector Routing) protocols.

II. RELATED WORK

In [1], author compares the reactive protocols like AODV and DSR with unstable delay, packet delivery ratio through varying routing load. The results are validated with pause time and delay, PDR (Packet Delivery Ratio) for 20 and 30 sources of sensor nodes, with AWK scripts the performance metrics are simulated. In [2], the On-demand routing protocols are examined. The performance metrics uses altering network size and load.CBR (Constant Bit Rate) data traffic type model is applied. The three routing protocol OLSR (Optimized Link State Routing), AODV, DSDV are compared in [11], with Random waypoint mobility model. The measures are formalized with changing pause time, network area and no. of nodes. OLSR exploits with periodic transfer of packets and topology control messages, but it is exchanged only through Multipoint Relays (MPR).Multimedia streaming traffic is channelled with TFRC (TCP Friendly Rate Control) over AODV and DSDV in [10].Random-way point mobility model is used for the simulation to evaluate throughput, jitter and delay. TFRC is widely used in the TCP flows by the inelastic coverings. Metrics are subjected with respect to background traffic and without background traffic. Multicast routing protocols are examined in [15], like OPHMR (Optimized Polymorphic Hybrid Multicast Routing) is a hybrid protocol, CAMP (Core Assisted Mesh Protocol) is proactive protocol, and ODMRP (On-Demand Multicast Routing Protocol) is reactive procedure. It is implemented with Glomosim simulator for the metric average throughput average packet delivery and

average power consumption. In [14], also multicast routing is reviewed. QoS is the important parameter for sensor network it has specific protocols peculiarly to increase the quality of the network which are surveyed in [16]. The issue in operation of QoS arguments on several protocols like AODV, DSDV and DSR are analysed. In [12], DSR protocol on various multi-hop networks with parameters like salvaging, delay, throughput and jitter are analysed. It is exploited under low mobility and low routing overhead condition, it out performs well. Impacts of node density with different routing protocols are described in [9], and studied with quantitative and qualitative criteria with node density, connectivity and bandwidth. In [3], the energy conservation metric for ERAODV ,RAODV (Reverse Ad-Hoc On-Demand Distance Vector),AODV and DSDV protocols are evaluated, by means of a variety of parameters such as network routing load, packet delivery function, sent packets and received packets under reliable TCP connections. Improved protocol analysed in [4], with bandwidth, overhead, delay, energy and packet dropping in NS-2 in TCP traffic type. LEACH (Low Energy Adaptive Clustering Hierarchy), TORA (Temporally Ordered Routing Algorithm) and AODV are compared in [7], the broadcast message transferred through the route, is reduced by the up to date route information. In [5], experimental results are shown with AODV and DSDV. They used varying traffic sources from 10 to 50. AODV, DSDV and DSR performances is measured by various authors in [6][8].On-demand multicasting protocols FSR (Fisheye State Routing protocol), AODV and ODMRP (On Demand Multicast Routing Protocol) performances are evaluated in [13].Reactive, proactive and hybrid protocols are studied in [17]. The overview of AODV, DSR and TORA is given by the OPNET simulator evaluating the route discovery time, no. of hops per route, traffic load and throughput.

III. DESCRIPTION OF ROUTING PROTOCOLS

A. AODV (Ad-Hoc On-Demand Distance Vector Routing)

AODV is an approach of on-demand for detecting path. The path is set up as soon as the source node is prepared for the transmission of data packets. Routing table is maintained to store the next-hop address; sequence numbers. The source node forwards the RREQ to the sink node via the intermediate nodes. The routing information is preserved in the routing tables at each entry [3].Time To Live (TTL) is issued during the flooding [5]. It will be raised with each process, until the threshold limit is reached. RREP is generated by the sink node after accepting the RREQ packet, the connection is established and route is stored in the routing table with the ID and sequence number. During error RRER packet is sent to the failure or fault node.

B. DSDV (Destination Sequenced Distance Vector Routing)

DSDV solves the routing loop problem in which path selection is established with Bellman-Ford Algorithm. Entries in the routing table contain a sequence number for the data exchange. If a node receives information it checks the sequence no. is already present in the table, the route metric is checked. The three main attributes in the protocol is to avoid loops, solve count to infinity problem and to reduce routing overhead [6]. Rebroadcasting of source route details with same sequence no. is reduced. Only Bidirectional links are considered.

C. DSR (Dynamic Source Routing)

DSR uses the source routing technique, the sender has knowledge of entire route to the sink .Route discovery is used, in case of new route identification dynamically and stored in route cache. The RREQ is flooded over the network, it is only received by the sink node, all other nodes re route the packets. Node replies with the RREP to the source, and then the path is built. It makes use of source routing and route caching [6].

IV. METHOD

A. Overview

The work flow diagram of proposed work is shown in Fig.1.

- The nodes are deployed randomly and initialized with energy, both transmit and receive power are declared.
- Source node selects the path and forwards the data to the sink node.
- Source node selects the alternate route if the queue is full or link failure.
- The performance metrics are calculated.

B. Algorithm

src is source node

dest is destination node

N(e) Node energy

t_x transmit power

r_x receive power

dist(src) is the minimum distance *src* from *dest*

dist(dest) is the destination distance from *src*

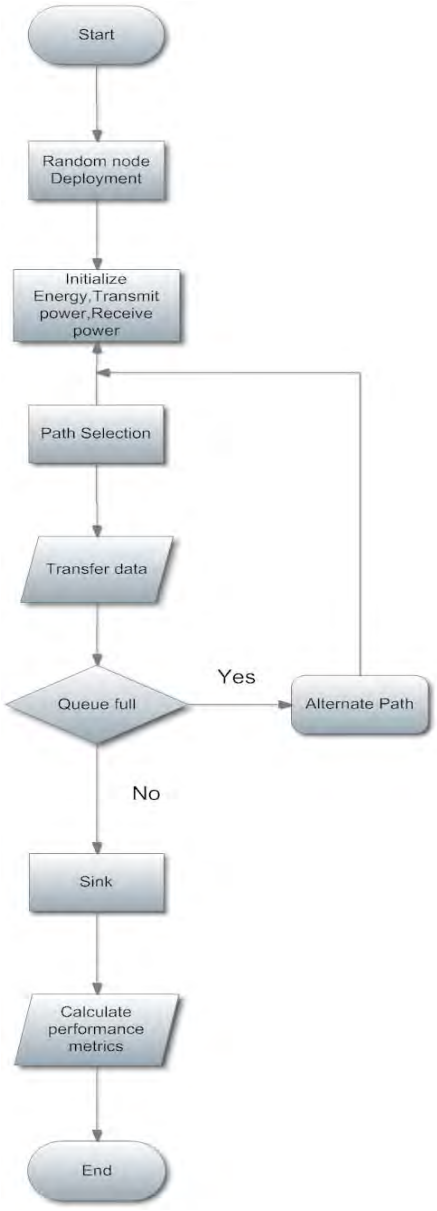

Fig. 1. Work Flow diagram

- Set up phase:

  Nodes are deployed, initialized with energy.

- Configuration phase:

  Nodes initial energy is set during packet transmission, the transmit power is reduced from node energy.

  $N(e)=N(e)-t_x$

  For data routing 3 algorithm are used in switch case

  Case 1: AODV ( ) the RREQ is forwarded to the destination from source and new route is updated in the table.

  Case 2: DSDV ( ) similar to the Bellman-Ford algorithm,calculates the distance with the weight of the , if it is low updated to the table, repeated until all the paths are traversed.

  Case 3: DSR ( ) it uses 2 parts route discovery with RREQ and RREP, to discover a new route, update in the table. Route maintenance ( ), the route are cached until it is changed or any failure.

During receive packets ,the receive power is reduced from node energy

$N(e)=N(e)-r_x$

- Determination phase:

  Calculating the values for delay and overhead.

C. Pseudo code

i) Initialization

deploy the nodes randomly

ii) Configuring energy level of nodes

repeat until *N(E)*=Null

Send packet from *src* to *dest*

$N(e)=N(e)-t_x$

Case of protocol

1. Aodv( ): **Send** RREQ,add new route in routing table
   Receive RREP,add new route in routing table
   Update table
2. Dsdv(): calculate the distance
   dis(dest)=dis(src)+weight
   Update table
3. Dsr( ): Route discovery ( )
   Send RREQ,add new route in routing table
   Receive RREP,add new route in routing table
   Update table
   Route maintenance ( )

Receive packets from *dest* to *src*

$N(e)=N(e)-r_x$

iii) Determine the delay and overhead

V. EXPERIMENTAL RESULTS

This study is performed simulation to evaluate various performance metrics with network simulator (NS-2).The table I shows the simulation parameters and its corresponding values. Descriptions of the simulation setup and performance metrics are given. The table shows the values of AODV, DSDV, DSR protocols for varying no. of nodes with energy, delay and overhead.

Table I
Simulation Parameters

Simulation parameters	**Values**
Area	1000x700
Simulation time	100ms
Node deployment	Random
Queue Type	DropTail
Antenna	Omni directional
Initial energy	100 J
Transmit power	0.6 W
Receive power	1.2 W
Traffic type	TCP NewReno/FTP

TABLE I
Simulation factors

Nodes	AODV			DSDV			DSR		
	Energy	Delay	Overhead	Energy	Delay	Overhead	Energy	Delay	Overhead
5	41.008	20.44	15	480.31	20.46	35	39.220	20.48	8
10	76.462	20.40	26	87.025	20.50	61	87.348	20.42	10
20	153.57	20.41	56	173.55	20.51	116	183.79	20.44	17
50	384.12	20.39	146	464.54	20.52	270	473.63	20.41	50
70	535.86	20.42	206	637.88	20.52	401	667.07	20.44	118

A. Performance metrics

Table II shows the performance matrix of protocols with change number of nodes.

Total consumed energy: The total energy used by all nodes in the network.

$$T_e = \sum C_e$$

T_e is total consumed energy, C_e is overall energy by all nodes

End-to end delay: The total sum of transferred packet from source to sink node.

End-to-end delay = ($\sum$ recv pkt – sent pkt / $\sum$ recv pkt)*100

recv pkt is no. of received packets, sent pkt is no. of sent packets

Overhead: It is the ratio between the RTR packets to the total received packet.

Overhead = $\sum$ RTR pkt / $\sum$ recv pkt

VI. Analysis

Factor of analysis focus on total consumed energy, end to end delay, Overhead/ Routing Load. We are also examining the effect in performance of these QoS parameters during various numbers of nodes, when mobility speed of nodes changes.

Fig. 2 shows energy levels of the protocols where AODV consumes less energy compared with others.DSR utilises more energy for data transfer.

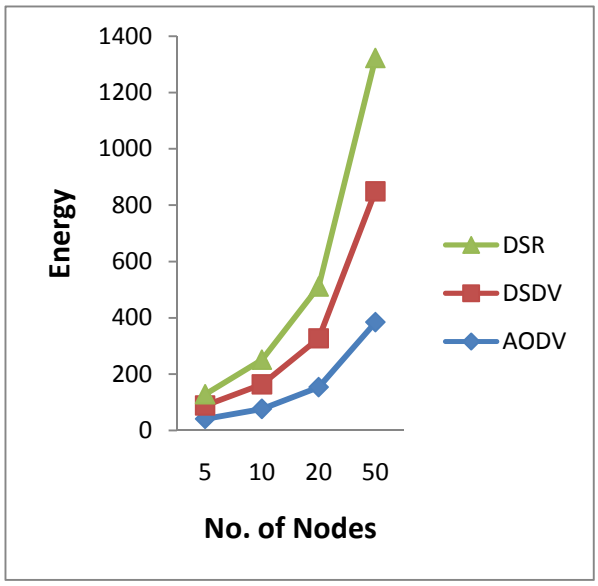

Fig. 2. No. of nodes Vs Energy

Fig. 3 depicts the delay graph for AODV, DSDV and DSR. DSDV protocol delay increases with no of nodes. AODV performs well compared to the other 2 protocols with less delay.

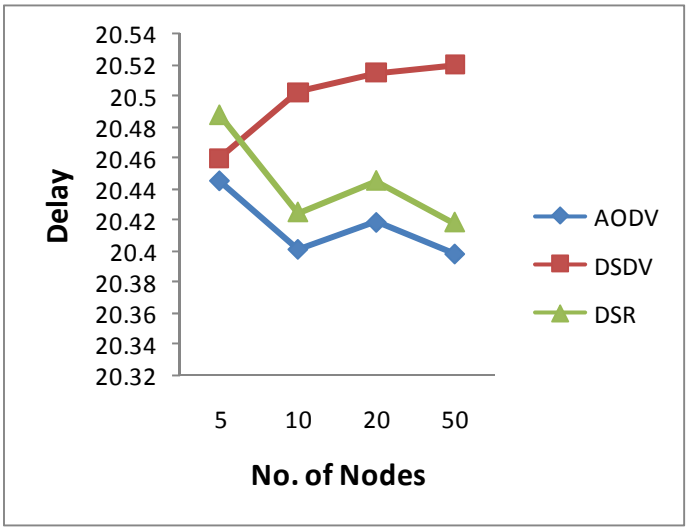

Fig. 3. No. of nodes Vs Delay

Fig. 4 shows the comparison of overall performance metrics of AODV, DSDV and DSR protocols in spite of energy AODV works well but DSR has less overhead. But for routing purposes AODV is well suited than DSR.

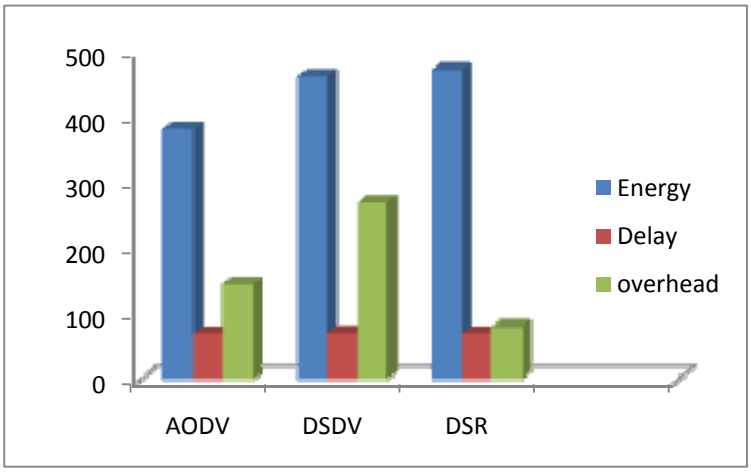

Fig. 4. Performance metrics

Compared with all other routing protocols clustering protocol can be used in sensor network to reduce delay, energy. In the Fig. 5 k-hop clustering protocol is evaluated with AODV when the nodes are 70. Performance measures are effectively used in clustering than AODV.

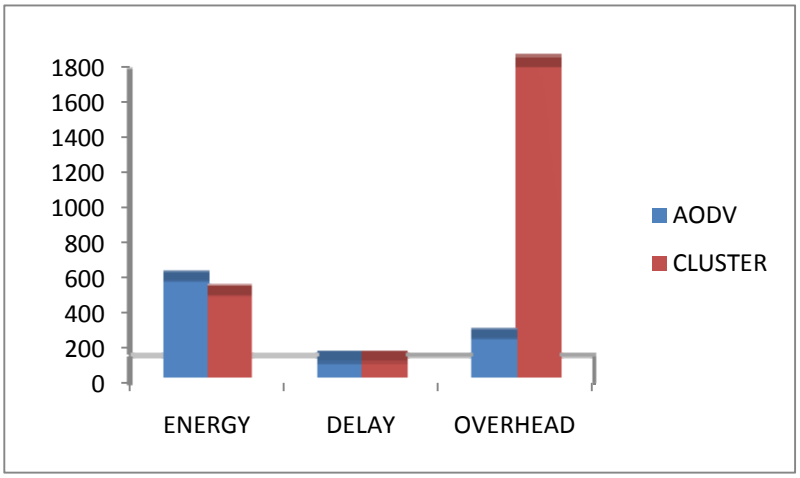

Fig. 5. AODV Vs K-hop cluster

VII. CONCLUSION

From all the above graphs and tables, we analysed the performance measures of routing protocols AODV,DSDV,DSR.AODV performs well than the other protocols, consumption of energy is reduced.DSR generates low network overhead than AODV. In figure 5 AODV is compared with k-hop clustering protocol, results depicts that clustering performs substantially well than AODV. In future the performance analysis will be examined with clustering and Hidden Markov Model (HMM).

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