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Performance Evaluation of Various Routing Protocols in Wireless Sensor Networks

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ABSTRACT
The ad-hoc network is self organized infrastructureless network. In wireless network, comparison of the routing protocols for different network topologies plays very important role for evaluation of its performance. There are many different ad-hoc routing protocol such as Ad-hoc On demand Distance Vector(AODV), Dynamic Source Distance Vector Routing (DSR) , Destination Sequenced Distance Vector (DSDV) and Ad-hoc on demand Multipath Distance Vector (AOMDV)protocol. In this paper present a survey on different ad-hoc routing protocols & also give suggestion to evaluates the performance analysis of these four protocol under different performance metrics such as throughput, packet delivery ratio, Normalised routing load, Energy consumption and end-to-end delay.
Keywords **-** Ad-hoc network, Routing Protocol, AODV, AOMDV, DSR, DSDV, NS-2

I. Introduction

A Wireless Sensor Network is a network of many sensor nodes, having wireless channel to communicate with each other. Without any centralized control and predefined communication link, it can transfer signals to the exterior world[2].All nodes are capable to act as source or sink node at the same time. These nodes have a limited processing power because of their tiny physical size, which limits the capacity of processor and size of battery. When collectively works together, they have an ability to collect information of the physical environment. They have transceiver to communicate with the virtual world and the physical world. Routing topology to be used for the network depends on the transmission power available at its nodes on the nodes location, which may vary time to time. The main problem in ad-hoc networking is the efficient transmission of data packets to the mobile nodes. Hence, proper routing in ad-hoc networks is the challenge to the designers.

There are so many routing protocols are available, but in this paper, four protocols DSDV,DSR, AODV and AOMDV are compared and analyzed by using NS-2 .

II. Classification of Routing Protocols

Routing protocols are broadly classified into three categories on the basis of the time on which routes are discovered and updated evaluation of its performance.

2.1 Proactive Routing Protocol (Table Driven)
2.2 Reactive Routing Protocol (On-Demand)
2.3 Hybrid Routing Protocol

2.1 Proactive Routing Protocol

The Proactive routing protocols are sometimes referred to as table-driven protocols since the routing information is maintained in routing tables[6].Proactive protocol have the advantage that routes are available the whenever they are needed. Proactive routing protocol includes Destination-Sequenced Distance-Vector (DSDV) protocol, Wireless Routing Protocol(WRP), Optimized Link State Routing Protocol (OLSR) etc.[3][7][8].

2.2 Reactive protocol

If any node in the network wants to send packet to another node then the protocol searches for the route in on-demand and establish the connection in order to transmit and receive the packet[2].It means that the routes are only discovered whenever they are actually needed[9]. Hence, route discovery becomes on-demand. Introduction of route acquisition latency is the drawback to reactive approaches. Reactive routing protocol includes Dynamic Source Routing (DSR) protocol, Ad hoc On-demand Distance Vector (AODV) protocol, Ad hoc On-demand Multiple Distance Vector (AOMDV) protocol etc.[4]

2.3 Hybrid Routing Protocol

Hybrid routing protocol have advantages of proactive and reactive routing protocol. This is combination of both and overcomes on the disadvantages of these protocols. Hybrid routing

protocols includes zone routing protocol (ZRP) and temporally-ordered routing algorithm (TORA)[2][9].

III. Routing Protocols for WSN

3.1 AODV (Ad-hoc On demand Distance Vector)

Ad–hoc on demand distance vector routing (AODV) is designed for ad hoc network. The Ad-hoc On Demand Distance Vector (AODV) classified under reactive protocols[10]. The route discovery and route maintenance are the two operation performed in AODV protocol. In Ad-hoc routing network when there is a need of route is to some destination then protocol starts route discovery[8]. Then the source node sends route request message (RREQ) to its neighbors by broadcasting. The nodes that do not have any information about the destination node in the network they will send the message to all its neighbours and so on. And if any neighbor node has the information about the destination node, the node sends route reply message (RREP) to the source[7] . On the basis of this process a path is recorded in the intermediate nodes. This path identifies by the route and is called the reverse path. Since each node forwards route request message to all of its neighbors, more than one copy of the original route request message can arrive at a node. A unique id is assigned, when a duplicate route request message is created[6]. When a node received a route request message it will check this unique id and the address of the source and discarded the message . Node that has information about the path to the destination sends route reply message to the neighbour from which it has received route request message. This neighbour does the same. Then the route reply message travels back using reverse path of the route. When a route reply message reaches to the source the route is ready and the source can start sending data packets[4][2].

3.2 *DSR (Dynamic Source Routing)*

Dynamic Source Routing, DSR, is classified under a reactive routing protocol which uses source routing. The Dynamic Source Routing protocol (DSR) [11] is a simple and efficient routing protocol. DSR uses source routing technique rather than the hop- by-hop routing. In this routing protocol each packet is routed carrying in its header which contain the complete address of the destination route of the node through which it is passes [3]. The main advantage of DSR protocol is that the intermediate nodes do not need to maintain up- to-date routing information in order to route the packet in the network they forward so that the packet contain all routing decision[6].DSR protocol consist of the two main routing mechanisms: Route Discovery and Route Maintenance which work together. It allows the nodes to discover and maintain routes to destinations in the ad hoc network. Route discovery is used whenever a source node has a desires route to a destination node. First, the source node looks up its route cache to determine that if the route already contains a route to the destination [5][6]. If the source finds a valid route to the destination, it uses this route to send its data packets. If the node does not have a valid route to the destination, it initiates the route discovery process by broadcasting a route request message [1][8]. The route request message contains the address of the source and the destination, and a unique identification number. Route maintenance is used to handle route breaks[5]. When a node encounters a fatal transmission problem at its data link layer, it removes the route from its route cache and generates a route error message. The route error message is sent to each node that has sent a packet routed over the broken link. When a node receives a route error message, it removes the hop in error from its route cache [6][5].

3.3 *AOMDV (Ad-hoc on Demand Multipath Distance Vector)*

Ad-hoc On Demand Multipath Distance Vector Routing Algorithm (AOMDV) .The main advantage in AOMDV is that it has a multipath during route discovery. This protocol is designed for highly dynamic ad hoc network where the route break and link failure occurs very frequently. In AOMDV only disjoint nodes are considered in all the paths, thereby achieving path disjointness. For route discovery route request packets are propagated throughout the network thereby establishing multiple paths at destination node and at the intermediate nodes. Multiple loop-Free paths are achieved by using the advertised hop count method performed at each node. This advertised hop count is to be maintained at each node in the routing table entry. The routing table at each node also contains a list of next hop as well as the corresponding hop counts. Every node maintains an advertised hop count for the destination. Advertised hop count can be defined as the maximum multipath for the current node. Route advertisements of the destination are sent using this hop count. An alternate path to the destination is accepted by a node if the hop count is less than the advertised hop count for the destination.[10][7][2].

3.4 DSDV (Destination Sequenced Distance Vector)

DSDV is a proactive routing protocol in which table driven technique is used[2].DSDV provides hop-by-hop distance vector routing protocol in which each node maintain routing information in the form of table[10][[4].In Destination-Sequenced Distance Vector routing protocol (DSDV), routing data packets are exchanged between neighbouring mobile nodes. Updated data message is triggered in case routing information from one of the nearby node. This data get change in the

routing table data[9]. Packets for which route to destination is unknown that data packets are catched and its routing queries are sent in that duration. The packets are allowed to receive route-replies are received from the destination. The maximum buffer size of memory is available for collecting those packets, waiting for routing information. If the packets are received beyond that size then, that packets may be and it is mostly even number if a link is present otherwise it is an odd number. Further, it is necessary for the transmitter to transmit the next update with this sequence number [5]. Routing protocol DSDV is explored by C. Perkins and P. Bhagwat in 1994. It is based on the Bellman-Ford algorithm and it is a table-driven protocol. This algorithm is suitable to solve the routing loop problems in the networks consist of a small number of nodes. Since DSDV has limitations to use for dynamic network, its improved versions are available [10][6][8].

IV. Performance Metric

There are various performance metric on basis of which performance of these protocol can be evaluated. Some of them are defined below

4.1 *Packet Delivery Fraction (PDF*): The ratio between the number of data packets received and the number of packets sent.

4.2 *Throughput*: Throughput is total packets successfully delivered to individual destination over total time divided by total time.

4.3 *End-to-End Delay:* It is the ratio of time difference between every CBR packet sent and received to the total time difference over the total number of CBR packets received.

4.4 *Normalized Routing load*: The Normalized routing loads measures by the total number of routing packets sent divided by the number of data packets delivered successfully.

4.5 Energy Consumption: It is defined as the ratio between sum of energy consumed by each node to the total no. of data packet deliverd.

V. Conclusion

One of the main challenges in the design of routing protocols for WSNs is energy efficient due to the scarce energy resources of sensors. The energy consumption of the sensors is dominated by data transmission and reception. Therefore, routing protocols designed for WSNs should be as energy efficient as possible to thus extending the network lifetime. Wireless sensor network is highly emerging area for industrial control and monitoring applications. In some typical application like, disaster management or environmental control, the delay in data transmission is not acceptable In this paper, we have surveyed a sample of routing protocols by taking into account several classification**.** Using Network simulator tool we will evaluate the performance of AODV, AOMDV, DSR, DSDV and comparing this protocol using various parameters.

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