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Comparative Analysis of Geographical Routing Protocol in Wireless Sensor Networks

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Abstract**—**The field of wireless sensor networks (WSN) engages a lot of associates in the research community as an interdisciplinary field of interest. This type of network is inexpensive, multifunctionally attributable to advances in micro-electromechanical systems and conjointly the explosion and expansion of wireless communications. A mobile ad hoc network is a wireless network without fastened infrastructure or federal management. Due to the infrastructure-less mode of operation, mobile ad-hoc networks are gaining quality. During this work, we have performed an efficient performance study of the two major routing protocols: Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) protocols. We have used an accurate simulation model supported NS2 for this purpose. Our simulation results showed that AODV mitigates the drawbacks of the DSDV and provides better performance as compared to DSDV.

Keywords**—**Routing protocols, mobility, Mobile Ad-hoc Networks, Ad-hoc On-demand Distance Vector, Dynamic Source Routing, Destination Sequence Distance Vector, Quality of Service.

I. Introduction

DUE to the current technological advances in wireless communications extremely integrated digital physics and small electromechanical systems, multifunctional sensing nodes have become attainable. These nodes can sense, communicate, and calculate diverse inputs from hardware as well as software [2]. WSN is a combination of sensor techniques, embedded techniques, distributed IP, and communication process. A WSN may be a network that is a product of hundreds or thousands of those sensor nodes that are closely deployed in an unattended setting with the proficiency of sensing, wireless communications, and estimations [3].

Wireless networks can be made of two types: infrastructure network and ad-hoc (infrastructure less) network. Infrastructure network is a kind of a network with fixed and wired gateways. A mobile host interacts with a bridge in the network within its communication radius [9]. The mobile unit has the potential to move geographically while it is communicating. When it exits out of range of one base station, it connects with new base station and starts communicating through it [4], [16]. This phenomenon is termed as handoff. On the other hand, mobile ad hoc network (MANET) is a group of wireless mobile nodes in which nodes team up by forwarding packets for every other to permit them to converse outside range of direct wireless transmission [17]. Ad hoc networks require no fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed.

It is very challenging to build efficient and scalable protocols in WSNs due to the limited resources and the high scale and dynamics [16]. There are geographic protocols which take the advantage of the location information of nodes, and they are very valuable for sensor networks. In addition to their fast response, the state required to be maintained is minimum, and their overhead is low. Sensor networks are applied in a wide range of areas, such as military applications, public safety, medical, surveillances, environmental monitoring, commercial applications, habitat and tracking [1]. In general, sensor networks are ubiquitous since they support opportunities for the interaction between humans and their physical world. In addition, sensor networks are expected to contribute significantly to pervasive computing and space exploration. Moreover, other applications for WSNs can be seen in environmental monitoring and control field, high-security smart homes, tracking, and identifications and personalization.

II. Mobile AD-HOC Networks

MANETS signify complicated spread systems comprising wireless mobile nodes that communicate with in the lack of any federal support. An ad-hoc network is an assortment of mobile nodes, that forms a brief network without the help of federal organization The nodes are liberated to move indiscriminately and organize themselves illogically. MANET nodes are composed with wireless transmitters and receivers using antennas which may be highly directional means point-to-point, Omni directional (broadcast) [4]. The MANET allows a more flexible communication model than traditional wire line networks. The reason is that the user is not limited to a fixed physical location. It is a new special network that does not have any fixed wired communication infrastructure.

III. Routing Protocols

Routing is generally the act of moving information from source to destination in a network. In routing, two basic activities are involved: determining optimal routing path and packet transfer through an internetwork. In WSNs, the network layer is mostly used to implement the routing of the incoming data [5]. A plethora of routing protocols has been projected for such kind of ad hoc networks. The main objective of protocols is to find a route for packet delivery and deliver the packet to the correct destination [6].

The routing protocols can be classified as:

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- Flat routing;
- Hierarchical routing and
- Geographic position associated routing.

Flat routing protocols can be broadly classified into two types as:

- Table Driven Protocols or Proactive Protocols and
- On-Demand Protocols or Reactive Protocols.

A. Flat Protocols: Flat routing protocols are further classified into two main categories: proactive and reactive protocols [7].

i) Proactive Protocols:

Proactive strategy tries to uphold consistent and efficient routing information for each pair of network nodes by propagating, proactively, route updates at fixed time intervals. As the routing information is habitually maintained in tables, these protocols are occasionally referred to as Table-Driven protocols. When a network topology modification occurs, respective updates must be propagated throughout the network to notify the change [18]. Some protocols that are considered as table-driven are: Destination sequenced Distance vector routing (DSDV), Wireless routing protocol (WRP), Fish eye State Routing protocol (FSR), Optimised Link State Routing protocol (OLSR), Cluster Gateway switch routing protocol (CGSR), Topology Dissemination Based on Reverse path forwarding (TBRPF).

ii) Reactive Protocols:

These protocols make only routes whenever needed. When the source node needs a route to a destination, it starts a route discovery process inside the network. This process is finished once a route is established, or all possible route variations have been inspected. Then, there is a route maintenance practice to save the suitable routes and to remove the unacceptable routes. Different types of On- Demand protocols are: AODV, DSR, temporally ordered routing algorithm (TORA), Associativity Based Routing (ABR) [8].

- Ad hoc On Demand Distance Vector Protocol (AODV)

AODV routing is a routing protocol for MANETs and other wireless ad-hoc networks. It is an on-demand and distance-vector routing protocol. The important principle of the protocol is that a route is recognized by AODV from a target solely on demand. AODV is able to do unicast and multicast routing. It carries these routes as long as they are fascinating via the senders. AODV uses different types of control messages to discover and maintain links. The first step is to discover the route. In route discovery, a node broadcasts a Route Request (RREQ) to all nodes in the network till either the destination is reached or another node is found with a valid route entry for the destination whose associated sequence number is at least as great as that contained in RREQ. Then, a Route Reply (RREP) is sent back to the source, and the discovered route is made available. In route preservation, once a node discloses that a route to a neighbor node is not applicable, it extracts the routing entry and dispatches a Route Error (RERR) message to the active neighbors that adopt the route. This process is continual at nodes that accept RERR messages [14].

Advantages:

- On-demand route establishment with small delay
- Link breakages in active routes can be efficiently handled
- Target series numbers are worn to discover the newest route to the target.
- Connection set up delay is less

- Dynamic Source Routing (DSR)

Like AODV, DSR establishes a route on-demand when a transmitting mobile node requests one. It is almost similar to the AODV protocol. It is a routing protocol for wireless mesh networks. However, it uses source routing instead of relying on the routing table at each intermediate device. It consists of two major components; Route Discovery and Route Maintenance [10].

In route discovery, if a node has to send data to a destination and if there is currently no known route(s), in that case the node tries to discover a route to the destination. Then, a node advertises a route request (RREQ) with a novel symbol along with the target address. The most critical issue is that if the node getting the RREQ packet has previously accepted the request, it drops the request packet [15].

Advantages:

- In case of DSR protocols, nodes can store multiple paths to destination, loop free routing, rapid recovery, compatible with networks containing unidirectional links.

Disadvantages [13]:

- Implementation of route discovery method is the foremost disadvantage of DSR.
- It cannot be used for massive networks, this is because when the traffic load increases congestion can occur and it does not have concrete methods for dominant congestion. Another factor is that once the network load increases, delay rate will increase as compared to different protocols.
- Destination Sequence Distance Vector (DSDV): DSDV routing protocol is associate improvement to distance vector routing for ad-hoc networks. During this protocol, a sequence range is employed to tag every route. A route with superior sequence range is better than a route with lesser sequence range. If two routes have identical sequence range, the route with less hops is additionally favorable. In case of route failure, the hop range is time associated with the sequence range [12].

IV. Problem Definition

Despite the advantages offered by the utilization of a WSN, their use is severely limited by the energy constraints posed by the sensors. The focus of most of the routing protocols in WSNs is at the attainment of power conservation since the energy expenditure of the sensor nodes which occurs during the wireless communication, the environment sensing and the data processing is unavoidable. Since most of the routing protocols developed for wired networks pursue the attainment of high Quality of Service (QoS), they are practically improper for application in WSNs. There can be various overheads in

ad-hoc networks which may include the issues such as: in wireless networks, nodes often change their location in the network. So, to avoid any confusion or conflict, some stale routes are generated in the routing table, hence leading to the routing overhead. The major problem with the ad-hoc networks is the interference of one transmission with other node, and the node might overhear the transmissions of other node leading to the corruption of the total transmission. Since the topology is not constant, the mobile node might move. In ad-hoc networks, the routing tables must reflect the changes in topology, and the routing algorithms have to be adapted. But, the issue is that the updating frequency might be very low.

Geographical routing has certain limitations, particularly with how to route around dead-ends and obstacles and how to function at very low node densities. Transmission range has to be increased to mitigate a void in route discovery. The case when the node dies or another new node joins the network has to be dealt with efficiently. The utilizing of scare source of energy and saving the bandwidth by low overhead are the concerns to be addressed. The existing geographical protocols need to be strengthened with respect to overhead, reliability, and efficiency.

Reactive Geographical Routing Protocol gives solution for routing with geographical information. This protocol tries to delay the preparatory beginnings as long as possible. Instead of keeping routing table maintenance, the routing occurs on demand only in reactive protocol.

The objective of the study is to provide improved parameters like packet loss rate, end to end delay.

V. Proposed Approach

The nodes are distributed randomly on a two dimensional network area. The nodes have no information about topology or their substantial locations and are static in nature. They are homogeneous in provision of early energy, communication and computational abilities. A set of nodes within the communication distance of a node is called its communication neighbourhood.

- Deployment of nodes

For any WSN to be established, nodes are deployed first. This can be done manually if the network is small. But for large networks, the sensor nodes are spread randomly by other means.

- Communication Model

A network is referred as connected if any active node can communicate with the sink node either in single hop or multiple hops. There is always a communication range defined, and two nodes can directly exchange messages if their Euclidean distance is less than or equal to the communication range (Rc).

- Topology of WSN

The layout design of WSN is called topology. This states how the nodes are connected to each other to share information. This also comes under certain models such as DOI (degree of irregularity), Logarithmic attenuation model, RIM model and Regular model. In present work, the regular model is applied. The parameters like communication range Rc, anchor communication range, model and DOI are required to determine the topology. We can vary the values for these parameters. In regular model, the radio range is a circle.

VI. Experimental Results

Throughput, packet delivery ratio, and end-to-end delay are the main issues in WSN. This paper focuses on these issues. The work uses the routing protocol, DSR, AODV, DSDV routing protocol to increase the lifetime of the network. The simulations have been performed using Network Simulator 2 version 2.31. It is scalable and open source used for the simulation behaviors of wired or wireless network functions and protocols. The simulation parameters are shown in Table I.

TABLE I
Simulation Parameter

Channel Type	Wireless Channel
Propogation model	Two ray ground
Antenna model	Omni-directional
Number of Sensor	24
Simulator	NS-2.35
MAC layer	IEEE802.11

Overhead, throughput, packet delivery ratio, and end-to-end delay are the main issues in WSN.

Whenever source has to find path to the destination, it will broadcast the messages to each and every node in the network which results in increase of overhead. Once the path is found, there is no increase in the overhead. When the dedicated path is formed between source node and destination node then time taken by source to send data to the destination is known as total delay.

In AODV protocol, packet loss only occurs till dedicated path is found. After the formation of dedicated path, packet loss reduces and throughput increases.

Fig. 1 shows the result of AODV applied to the nodes. Simulations have been carried for a sensor network of 24 nodes. This shows the scalability achieved by the simulator. The simulations show that the performance of simulator in terms of execution time remains the same for large number of nodes also.

VII. Conclusion and Future Scope

This paper provides the implementation of routing protocol for the Simulator developed at ns2. The comparisons of DSR, DSDV and AODV protocol in Sensor Simulator with ns2 validates the implementation details of various modules developed in the simulator. The various advantages and disadvantages are also presented. The simulator and the support provided make it very easy to develop and test protocols very fast, and we obtain results for large simulations at a reasonable amount of time.

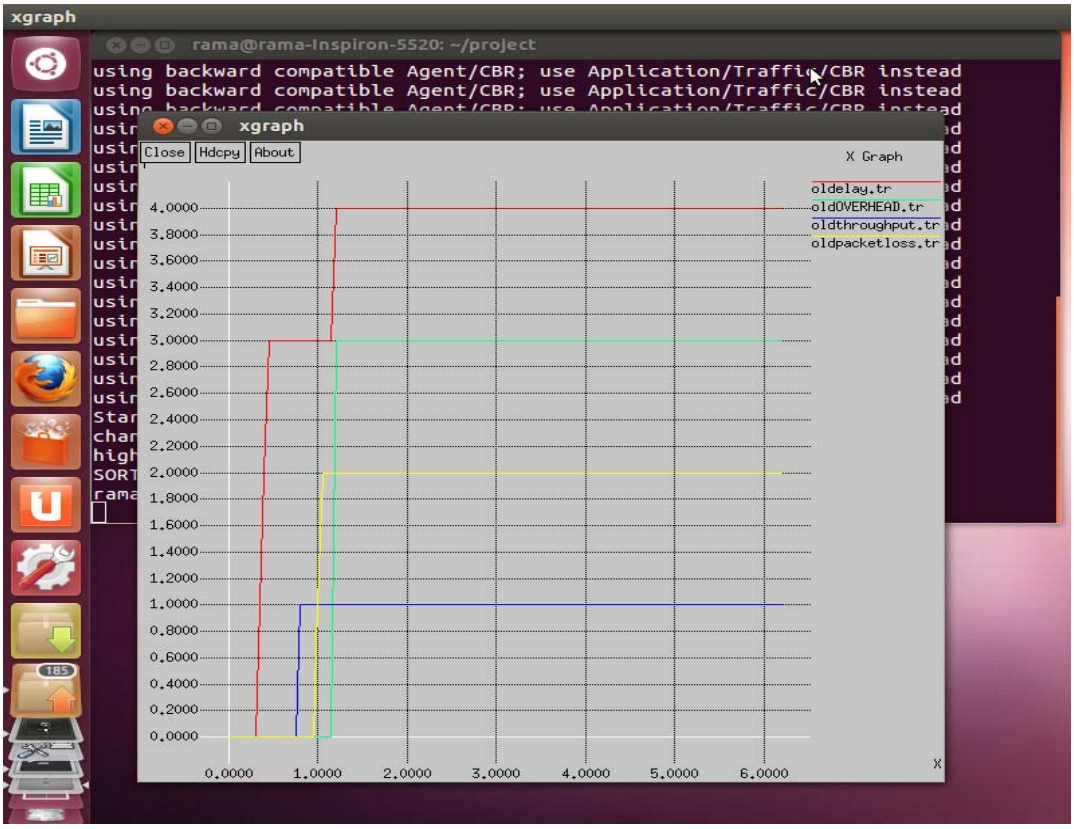

Fig. 1 Apply AODV routing protocol to the nodes

The future of ad-hoc networks is really appealing, giving the vision of anytime, anywhere and cheap communications. To make those imagined scenarios come true, huge amount of work is to be done in research and implementation. More of the trouble up to now has been done on making routing protocols to support effective and economical communication between nodes that are part of multicast cluster. At present, the general trend is towards mesh architecture and large scale. Improvement in bandwidth and capacity is required, which implies the need for higher frequency and better spatial spectral use.

The different dimensions in which the improvement can be done further are:

- The absolute locations can be further resolved using some new mapping techniques.
- The objective can be expanded considering communication complexity.

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