Implementation, Analysis and performance evaluation of ideal routing protocols under WSN Scenario

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ABSTRACT

Wireless sensor networks have attained increasing attention from both the research industry and academia. Wireless Sensor Networks consist of small wireless nodes which are capable of sensing, computation and wireless communication capabilities. The efficient exertion of energy source is a benchmark to protract the life-time of wireless sensor network. So, the routing protocols design for Wireless sensor networks is a imperative objection. In consideration of routing protocols should be in complex, energy proficient, and powerful to proceed with a very large number of nodes. So we introduce PEGASIS protocol, this PEGASIS is a chain-based data gathering protocol in that sensors using greedy algorithm. In this paper PEGASIS routing protocol compare with existing protocol and simulated using Network simulator-2 (NS-2) and analyzed performance in terms of packet delivery ratio, throughput and normalized routing load.

Keywords: Wireless Sensor Network, Network Simulator-2.35, packet delivery ratio, throughput, End-to-End Delay, PEGASIS.

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INTRODUCTION

Wireless sensor networks (WSNs) generated an increasing interest from industrial and research perspectives. A WSN can be generally described as a network of nodes that cooperatively sense and may control the environment enabling interaction between persons, computers and the surrounding environment. WSNs comprise of relatively inexpensive sensor nodes capable of aggregating, transforming, accumulating and transverse information from one node to another. These nodes are capable to separately form a network over which sensor readings can be originated. Since the sensor nodes have some judgment, data can be processed as it out flows wound up whole network. [1]

Wireless Sensor Networks (WSNs) subsist of mostly four components: radio, processor, sensors and battery. A WSN is formed by densely deployed micro sensor nodes that have proficiency of finite sensing and computation scopes, communication work and power. A huge number of sensor devices are scattered over an area of interest for gathering information [2].Nodes can convey with each other for sending or gathering information either directly or through intermediate nodes and thus form a network. So node in a sensor network acts as a router in whole network. each sensor node convey information directly with a center called Base Station (BS) in direct communication routing protocol and sends accumulated information. The base station (BS) is fixed and positioned far away from the sensor nodes. The topography of the wireless sensor network shifts very frequently. Nodes may not have universal testimony. Since in case of direct communication, the span among the sensor nodes and base station is large, they dissipate energy quickly. In another advent, data is routed via intermediate nodes to the base station and thus saves node energy. [3]

Classification of Routing protocols in wireless sensor network [4]

The classification of routing protocols in WSN might differ depending on the application are

- Operation based Routing Protocol.
- Network Structure based Routing Protocol.

This classification of routing protocol is shown in Figure

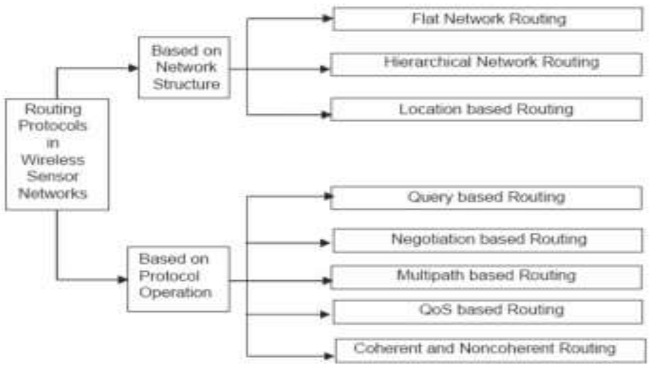

Figure-1 Classification of Routing Protocols in WSN

Operation based Routing Protocols

Depending on the operation we can divide routing protocols in

- Negotiation Based Routing

  These protocols use high- level data descriptors in order to eliminate redundant data transmissions through negotiation. The necessary decisions are based on available resources and local interactions. Examples are: Sensor Protocols for Information via Negotiation (SPIN), SPAN, Virtual Grid Architecture routing (VGA) and Sequential Assignment Routing (SAR) protocol.

- Multipath Based Routing

  Multipath is used rather than single path in order to enhance the network performance. These protocols offer fault tolerance by having at least one alternate path (from source to sink) and thus, increasing energy consumption and traffic generation. These paths are kept alive by sending periodic messages. Directed Diffusion is a good for robust multipath routing and delivery.

Query Based Routing

In these protocols, the destination nodes propagate a query for data (sensing task or interest) from a node through the network. The node containing this data sends it back to the node that has initiated the query. Examples are: Directed Diffusion, Sensor Protocols for Information via Negotiation (SPIN), Rumor Routing, Gradient-Based Routing (GBR).

- QOS Based Routing

  In these protocols, the network has to balance between energy consumption and data quality. The network has to satisfy certain QoS metrics (delay, energy, bandwidth, etc.) when delivering data to the BS. Examples are: Sequential Assignment Routing (SAR) and SPEED are QoS based routing protocols.

- Coherent Based Routing

  In these protocols, the entity of local data processing on the nodes distinguish between coherent (minimum processing) and non-coherent (full processing) routing protocols.

Network Structure based Routing Protocol

Depending on the network structure we can divide routing protocols in

- Flat Based Routing

  According to the flat based routing, if any node needs to transmit data, it searches a valid route to the BS first and then transmits data. Nodes throughout the base station may ditch their energy rapidly. Its scalability is average. Examples are Sensor Protocols for Information via Negotiation (SPIN), Directed Diffusion, Rumor Routing, Gradient-Based Routing (GBR), Minimum Cost Forwarding Algorithm (MCFA), Active Query forwarding in sensor networks (ACQUIRE).

- Hierarchical (Cluster-based) Routing

  Hierarchical Routing is the well-known technique with special advantages analogous to scalability and valuable transmission. PEGASIS, TEEN and APTEEN use hierarchical Routing technique. In hierarchical architecture, higher energy nodes can be used to process and send information, while low-energy nodes can be used to perform the sensing in the proximity of the target. Hierarchical routing is an efficient way to lower energy consumption within a cluster, performing data aggregation and fusion in order to decrease the number of transmitted messages to the sink node. Examples are: Low Energy Adaptive Clustering Hierarchy (LEACH), Threshold sensitive Energy Efficient sensor Network (TEEN), Adaptive Threshold sensitive Energy Efficient sensor Network Protocol (APTEEN), Power Efficient Gathering in Sensor Information Systems (PEGASIS), Hybrid Energy Efficient Distributed Protocol (HEED), Stable Election Protocol (SEP).

- Location Based Routing

  In these Protocols like MECN sensor nodes are addressed by means of their locations. The distance among neighboring nodes can be estimated on the basis of incoming signal power. Neighboring nodes can exchange information between neighbors through their Relative coordinates.[20] Examples are: Geographic Adaptive Fidelity (GAF), Geographic and Energy Aware Routing (GEAR), SPAN, Greedy Other Adaptive Face Routing (GOAFR).

ROUTING PROTOCOL OF WSN

The routing protocol also specifies how routers report changes and share information with the other routers in the network that they can reach. A routing protocol allows the network to dynamically adjust to changing conditions, otherwise all routing decisions have to be predetermined and remain static. Routing is the procedure of directing packets from a resource node to a destination node on a different network. Getting packets to their next hop requires a router to perform two basic activities: path determination and packet switching. If all the hosts that want to communicate are within programme range of one another, no routing protocol or routing decisions would be necessary. Several routing protocols have been proposed for mobile ad-hoc networks. Sensor nodes are tightly constrained in terms of energy, processing, and storage capacities. Thus, they require careful resource management i.e. routing.

There are two types of routing process in WSN:

- Static routing.
- Dynamic routing.

Dynamic routing executes the same task as static routing distinct from it is more energetic. Static routing allows routing tables in specific routers to be set up in a static manner, so routes of packets in network are set.[4]

AODV: The Ad hoc On Demand Distance Vector (AODV) is a routing protocol designed for ad-hoc mobile networks. AODV is capable of both uncast and multicast routing. It is an on demand algorithm, means that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are used by the sources. Additionally, AODV designs tree topography which connects multicast group members. The trees are composed of the group members and the nodes required attaching the members. [5]

DSDV: DSDV is an enhancement to distance vector routing for ad-hoc networks. A sequence number is used to tag each route. A route with higher sequence number is more favourable than a route with lower sequence number. However, if two routes have the same sequence number, the route with fewer hops is more favourable. In case of route failure, its hop number is set to infinity and its sequence number is increased to an odd number where even numbers are reserved only to connected paths.[6]

AOMDV: It is an extension to AODV and also provides two main services i.e. route discovery and maintenance. Unlike AODV, every RREP is being considered by the source node and thus multiple paths discovered in one route discovery. Being the hop-by-hop routing protocol, the intermediate node maintains multiple path entries in their respective routing table. As an optimization measure, by default the difference between primary and an alternate path is equal to 1 hop. The route entry table at each node also consist of a series of next hop forward with the analogous hop counts. Every node maintains an advertised hop count for the destination. Advertised hop count defined as the “Maximal hop count for entire paths”. Route broadcasts of the destination are sent using this hop count [7]. 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.

PEGASIS: In wireless sensor network, Data handling is accomplished by data dissemination and data gathering. A routing protocol is a protocol that determines how routers (Sensor nodes) convey with each other, propagating information that permits them to preferred routes between any two nodes on the network [8]. The prime route being done by applied routing algorithms. Each router has awareness only of the networks attached to it directly. A routing protocol proportion this information first between existing neighbors, and then throughout the network. This way, routers achieve knowledge of the topography of the network. In data-gathering application, all data from all nodes need to be collected and transmitted to the base station (BS) by a leader node, where the end-user can approach the data.

A simple approach to accomplishing this data gathering assignment is for entire nodes to transmit its data directly to the BS [9]. The goal of algorithm which implement data gathering is maximize the numbers of rounds of communication before the nodes die and the networks becomes ruined. This means minimum energy should be consumed and the transmission should occur with minimum delays, which are incompatible requirement. Hence, the energy x delay metrics used to compare algorithms, since this it measures speedy and energy-decisive data gathering[10].

SIMULATION AND RESULT

SIMULATION TOOLS

Simulation is distinct as the process of designing a model of a real system and conducting experiments with this model for the function of understanding the behavior of the system and/or evaluating various strategies for the operation of the system. The C++ classes of ns-2 network components or protocols are implemented in the subdirectory “ns-2”, and the TCL library in the subdirectory of “tcl”. NS2 is simply an event driven simulation tool that has proved useful in studying the dynamic nature of communication networks. NS-2 provides the substantial support to simulate bunch of protocols like TCP, UDP, FTP and HTTP. Ns-2 is discrete event simulator i.e. timing of events is maintained in a scheduler NS is Object-oriented Tcl (OTcl) script interpreter that has a simulation event scheduler and network component object libraries, and network setup (plumbing) module libraries. Our programming is done is OTcl script language if we want to run network simulator. An OTcl script should be written to setup and run a simulation network, which initiates an event scheduler, sets up the network topology using the network objects and the measuring functions in the library, and tells traffic sources when to start and stop transmitting packets through the event scheduler [6]. In this manner the basic translation of the script is achieved and the simulation can execute. Tracing during the simulation can capture the simulation results in two different ways. If the purpose of tracing is the visualization of the script, then there is an option of tracing for the network animator (name). However, if the purpose is to perform analysis of the behavior described by the script, then a different command captures the appropriate measures in a file and also provides the option of generating a comparison graph.

SIMULATION PARAMETER

In order to evaluate the performance of wireless network routing protocols, the following parameters were considered.

1. Packet Delivery Fraction (PDF): Packet Delivery Fraction is the ratio of the number of data packets successfully delivered to the destination nodes and number of data packets produced by source nodes.

2. End-to-End Delay: The term End-to-End delay refers to the time taken by a packet to be transmitted across a network from source node to destination node which includes retransmission delays at the MAC, transfer and propagation times and all possible delays at route discovery and route maintenance. The queuing time can be caused by the network congestion or unavailability of valid routes.

3. Normalized Routing Load (NRL): It is the number of route control packets per data packet delivered a destination end. It is important to measure the scalability of routing protocol; the adaption to low bandwidth environment and its efficiency in relation to sensor node battery power. Sending more routing packets may increase the probability of packet collision. As a result end-to-end delay may increase and decrease the PDR as well.

RESEARCH WORK

There are many research papers on routing protocols in wireless sensor network and all are used for evaluating performance of different parameters in different scenario. Researchers specify the difference between routing protocols and its performance for different parameters and which one is best for the case of Wireless Sensor Network. In comparison of AODV, AOMDV, DSDV and Pegasis. The Average end-to-end delay and throughput in DSR are very high. While in comparison of DSDV and AODV routing protocols, AODV performed better than DSDV in terms of bandwidth as AODV do not contain routing tables so it has less overhead and consume less bandwidth while DSDV consumes more bandwidth. In this paper we selected to investigated pegasis protocol for different performance parameters for different areas like small (1500m x 1500m.). Analysis were done using ns-2 simulator on these three cases of terrain areas in order to derive an estimation of the performance parameters.

SIMULATION SETUP

In this work 10node, 15node and 20node taken and the simulation is done using Network simulator-2.35 to analyze the performance of the static network.

Network specification:-

Parameters	**Values**

Simulator	NS-2.35
Mobility Model	Random Way Point
Antenna type	Omni directional
Area of Map	1500*1500
PHY/MAC	IEEE 802.15.4
Routing Protocol	AODV,DSDV,AOMDV, PEGASIS
Network Traffic	TCP
Simulation Time	100sec
Antenna type	Omni directional

Table no.1 Network Specification of Parameters

RESULT AND ANALYSIS

Packet delivery ratio: In order to calculate the Packet Delivery Ratio (PDR) in velocity and density scenarios, the number of packets received by the destination will be divided by the number of packets originated. The attained value specifies the packet loss rate which confines the maximum throughput of the network. The better PDR implies the more accurate and suitable routing protocol.

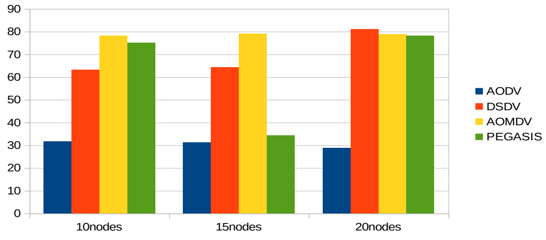

Figure 2:- Packet Delivery Ratio for various node density

Average End-to-End Delay: The time taken by the data packets to be delivered from source to destination is known as Average End-to-End Delay. Therefore, the time at which the first data packet is received by destination deducted from the time at which the first packet transmitted by the source.

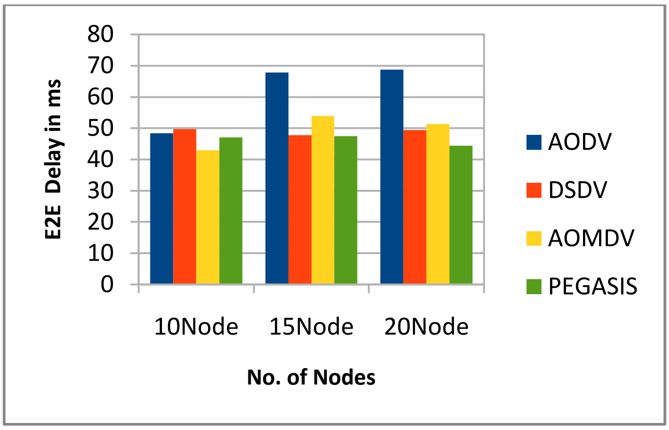

Figure 3:- Average End to End Delay for various node density

Normalized Routing Load: Normalized routing load (NRL) is defined as the number of routing packets transmitted per data packet arrived at the destination.

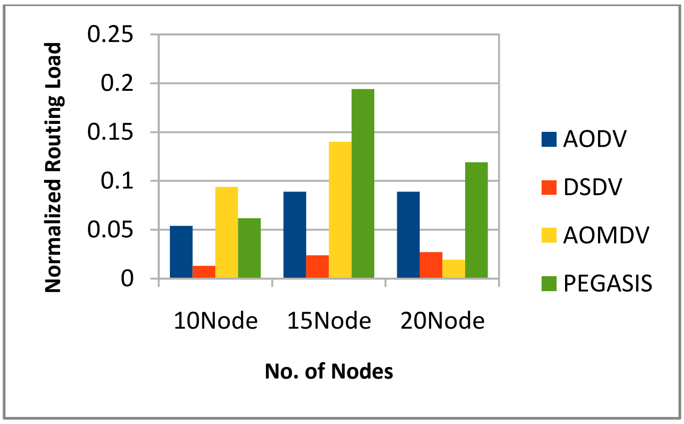

Figure3:- Normalized routing overhead for various node density

CONCLUSION

WSN architecture has been implemented with different protocols and scenario and it concluded that from the result PEGASIS have high PDR with less End to End delay as compare to other routing protocol but it has high Routing overhead due to the high packet delivery ratio.

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