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ENERGY EFFECTIVE MECHANISM FOR DATA COLLECTION IN SENSOR NETWORK USING ADAPTIVE GEAR

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***Abstract*— The routing protocols are playing a major role in the design and proper utilization of wireless sensor networks .Adaptive Geographical and Energy Aware Routing is a novel solution to the challenges of energy constraint of nodes while routing in mobile wireless sensor networks where energy is the main constraint. Location aware sensor routing (Laser) protocol uses blind forwarding to transmit packets, which means that the decision to forward a packet is made by the receiving node, rather than the transmitting node .The decision to forward a message is made based on the received packets gradient metric. Therefore, energy efficiency is an important design consideration for these networks. Motivated by the fact that sensor network queries may often be geographical, in this paper we evaluate an energy efficient routing algorithm that selects a relay node to route the packets to the sink with high residual energy and then routes the packet to the sink. The decision to forward a packet is made by the receiving node, rather than the transmitting node. Hence, when a node receives a packet it stores it in a queue until its next opportunity to transmit. Then the node will decide if any of the packets in the queue should be forwarded. The decision to forward a message is made based on the received packets gradient metric. The proposed Geographic and Energy Aware Routing algorithm uses energy aware neighbor selection to route a packet towards the target region and LASeR protocol uses location awareness to maintain an up-to-date gradient metric in highly mobile environments. Protocols are evaluated on packet delivery ratio, end-to-end delay, overhead, and throughput and energy consumption.**

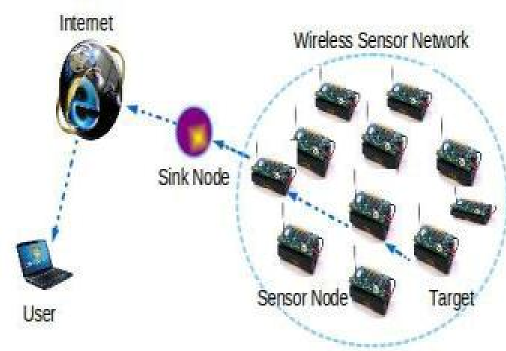
Keywords*— *Wireless sensor networks, Geographic routing, location aware Routing

I. INTRODUCTION

Wireless Sensor Network (WSN) has emerged as one of the most promising technologies of this decade. Advances in wireless communication technology are enabling the deployment of networks of small sensors. These sensor networks have applications in military monitoring, health, industrial control, weather monitoring, commodity tracking, home control, etc.

A WSN is basically composed of a base station and several sensor nodes distributed over a certain geographical area. Sensor nodes monitor the environment in which they are deployed to collect information such as temperature, humidity, pressure, vibration, sound and so on. Each node in a WSN reports the information it gathered to the base station directly or through multihop wireless communication link. A wireless sensor node consists of four main components: a sensing unit to monitor the environment, a processing unit to process information, a radio transceiver unit for wireless communication and a power supply unit.[1] A critical constraint on sensors networks is that sensor nodes employ batteries. A second constraint is that sensors will be deployed unattended and in large numbers, so that it will be difficult to change or recharge batteries in the sensors. Therefore, all systems, processes and communication protocols for sensors and sensor networks must minimize power consumption

The wireless sensor node, being a microelectronic device, can only be equipped with a limited power source (< 0.5Ah, 1.2 V). In some application scenarios, replenishment of power resources might be impossible. Sensor node lifetime, therefore, shows a strong dependence on battery lifetime. In a multihop ad hoc sensor network, each node plays the dual role of data originator and data router. The malfunctioning of a few nodes can cause significant topological changes and might require rerouting of packets and reorganization of the network. Hence, power conservation and power management take on additional importance. It is for these reasons that researchers are currently focusing on the design of power-aware protocols and algorithms for sensor networks. Since wireless sensor networks (WSNs) consist of hundreds and thousands of unattended, resource-constraint and low energy sensor nodes designing energy efficient routing protocols is significantly important. Typically, sensor nodes are energy constrained, since rely on batteries as energy source. Due to energy constraints, the life time of a WSN is also limited. The critical issue in developing WSN applications is the limited amount of energy usually available in the nodes. An application can take years to drain the battery of the sensor node or consume it in a matter of weeks. Energy poses a big challenge for network designers in hostile environments, for example, a battlefield, where it is impossible to access the sensors and recharge their batteries. Furthermore, when the energy of a sensor reaches a certain threshold, the sensor will become faulty and will not be able to function properly, which will have a major impact on the network performance. Thus, routing protocols designed for sensors should be as energy efficient as possible to extend their lifetime, and hence prolong the network lifetime while guaranteeing good performance overall. In WSNs, the information regarding the amount of residual energy found distributed in the network is called an energy map [6]. An insight about this available amount of energy in each part of the network can be used to take corrective measures such as redeploying additional nodes before some part of the network gets disconnected due to energy depletion. Routing protocols can also use the information provided by an energy map to reroute traffic through nodes with higher residual energy, so that nodes with less residual energy can preserve their energy for future use. By evaluating the power consumption, it is possible to estimate the application's lifetime, be aware of application's power consumption bottleneck, to adopt strategies to increase the network lifetime, to anticipate the time to replace the sensor node (to maintain always-on network) and so on.



II. LITERATURE SURVEY

The topic of wireless sensor networks (WSNs) has recently gained a lot of research interest due to the availability of low cost, low power transmitters, making it cost effective to create small networks of sensors [1]. These sensors are typically radio enabled nodes with simple transducers connected to a microcontroller. Of primary importance in all WSN applications is the routing protocol, which defines how data is passed from the sensors to the sink. The majority of WSN applications do not require the routing protocol to take into account the movement of nodes because the nodes are static or just very slow moving. Introducing mobility to the nodes can cause frequent changes in topology. This dynamic topology in mobile wireless sensor networks (MWSNs) causes problems for routing protocols, since there is no fixed path from source to sink. Mobile ad-hoc networks (MANETs) also share this problem; however their requirements differ to those of a MWSN. As such, the problem of routing in a MWSN will necessitate an alternative solution to those protocols designed for static WSNs or MANETs.

In general MWSN routing protocols take influence from two main research areas; WSNs and MANETs. WSNs are commonly considered to be static and so cannot handle the mobility of nodes, whereas MANETs are designed to cope with mobile nodes. Contrastingly to MANETs, most sensor networks only require data to flow in one direction; from source to sink. In addition to this, the hardware and power constraints on these small sensor nodes, means that protocols must have low computational complexity and low energy consumption. Energy is a major concern with battery powered mobility platforms since high energy consumption can dramatically reduce the lifetime of the network.

MANET protocols are often defined as proactive or reactive. The proactive protocols,

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such as optimized link state routing (OLSR) [2], attempt to ensure that each node has an active path to every other node. This usually requires the flooding of topology data, which can cause huge amounts of congestion in large networks. Contrastingly, reactive protocols, such as ad-hoc on-demand distance vector (AODV) [3], only discovers routes when they are needed. This can often reduce the overhead of control packets, making reactive protocols a more common choice for mobile networks. This can be seen by the number of reactive protocols that have been adapted from MANETs to MWSNs. For example, AODV with preemptive self-repair is an adaptations of AODV designed for MWSNs, which, attempts to predict link breaks and find replacements. Opportunistic routing seen in geographically opportunistic routing, which splits up the network into sections. Using location information, each node then tries to forward the packet to a node in a section that is closer to the sink. It opportunistically attempts to transmit to the furthest section within its transmission radius, before trying increasingly closer sections. Alternatively, WSN routing protocols are categorized by their structure, as either flat or hierarchical. The hierarchical protocols, such as low-energy adaptive clustering hierarchy (LEACH) [5], split the network up into clusters. Low energy adaptive clustering Protocol (LEACH) works well for homogeneous networks, where every node has the same initial energy. This protocol works in rounds and each round is divided into cluster formation and steady phases. In the cluster formation phase, a cluster is formed and p.n sensor nodes are selected as cluster heads (CH) for the proper utilization of energy, where n is the number of sensor nodes and p is the desired percentage of CH. Otherwise, if only one node is selected as CH it will fail because of the shortage of energy. If a random number (between 0 and 1) chosen by a node A is less than a threshold value, A is selected as a CH in the current round. The steady state is divided into many frames where CH assigns time slots to each non-CH node using TDMA scheme .At the end of each round, the CH collects and aggregates data and sends to the BS. In LEACH, a new cluster formation is initiated in every round, which is not energy efficient. Moreover, occasionally all CHs exist in a close area (since CH rotates in a cluster) and require more energy for non-CH nodes to communicate CHs. LEACH also does not support mobility of sensors. Sensor nodes then forward data to a cluster head, which then forwards it to the sink. This approach has been shown to reduce energy consumption in static sensor networks. However, the requirement of nodes to first elect and then associate themselves with a cluster head can cause significant overhead, especially if nodes are frequently moving between different clusters.

LASeR [6] uses a method of blind forwarding as opposed to selecting a single next-hop node. In blind forwarding, a transmitting node broadcasts its packet to all of its neighbors; the neighbors then use the received gradient to determine whether they should forward the packet. The main issue with using blind forwarding in mobile networks is maintaining an up-to-date gradient. Since, in LASeR, this is done using location information, the need to flood the network is negated making it an ideal solution for MWSNs.

The use of location awareness also produces the issue of the dead-end problem [7], in which a node is locally maximal and as such has no neighbors that are closer to the sink, which prevents the progress of any data received by this node. This is addressed in GPSR with the use of the right-hand rule. The partial-partition avoiding geographic routing [8] algorithm was proposed as an alternative solution to the dead-end problem in GPSR. In comparison, LASeRs use of blind forwarding causes a single packet to take multiple paths through the network, which mostly alleviates the dead-end problem. As such the contribution of this work is in a novel routing protocol designed for MWSNs, which utilizes available location information to route packets towards the sink. The protocol also takes advantage of the blind forwarding technique to create a unique protocol, which requires very little control overhead, making it suitable for highly dynamic networks.

Most previous geographic routing protocols use greedy algorithms to forward the packet to the destination. They differ in how they handle communication holes [9].Scalable Location Update-based Routing Protocol (SLURP) constantly maintains approximate location information of nodes in the network, and finds accurate routes to specific nodes on demand. It uses approximate geographic routing to route a packet to the region that contains the destination, and once the packet is inside that region, it uses source routing to reach the destination. It relies on route request to circumvent holes. The route request/ reply overhead and constant snooping mode in SLURP make it unsuitable for sensor net applications. Geographic and Energy Aware Routing (GEAR) protocol uses energy aware and geographically informed neighbor selection to route a packet towards the target region [10].

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This strategy attempts to balance energy consumption and thereby increase network lifetime. Within a region, it uses a recursive geographic forwarding technique to disseminate the packet.

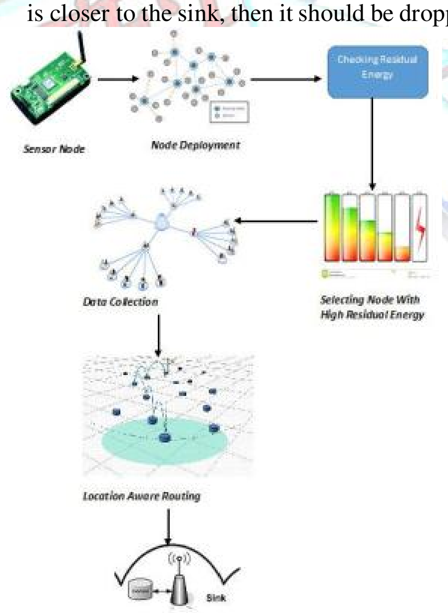
A. PROBLEM STATEMENT

Sensing, processing and data communication are the main activities of a sensor node, which causes energy depletion. Data communication accounts for consuming most of the energy stored in the battery, but the energy consumed in sensing and processing cannot be neglected as well. Most previous geographic routing protocols use greedy algorithms to forward the packet to the destination. They differ in how they handle communication holes. Typically, sensor nodes are energy constrained, since they rely on batteries as energy source. Due to energy constraints, the life time of a WSN is also limited. Because of the nature of the applications in which WSNs are used, it is usually very difficult to reach every node and replace their batteries [3]. Therefore, to minimize the energy consumption in each node and prolong the life time of the network, several methods have been proposed such as power efficient components, energy aware protocols etc. In WSNs, the information regarding the amount of residual energy found distributed in the network is called an energy map. Routing protocols can also use the information provided by an energy map to reroute traffic through nodes with higher residual energy, so that nodes with less residual energy can preserve their energy for future use. Location aware sensor routing (LASeR) protocol makes use of location information in routing [2]. LASeR uses blind forwarding to propagate data through the network, which inherently creates route diversity. Hence, if one of the routes was to fail, there would be another available to deliver the packet. LASeR uses blind forwarding to transmit packets, which means that the decision to forward a packet is made by the receiving node, rather than the transmitting node. Energy efficiency is an important design consideration for these networks. [4] proposed a secure hash message authentication code. A secure hash message authentication code to avoid certificate revocation list checking is proposed for vehicular ad hoc networks (VANETs). The group signature scheme is widely used in VANETs for secure communication, the existing systems based on group signature scheme provides verification delay in certificate revocation list checking. In order to overcome this delay this paper uses a Hash message authentication code (HMAC).

II. ANALYSIS OF FRAMEWORK

Adaptive GEAR uses energy aware neighbor selection heuristics to route a packet towards the target region. The sensors are aware of their residual energy as well as the locations and residual energy of each of their neighbors. The source node selects the relay node with high residual energy and routes the packet via that node. If any of the node dies, LASeR uses blind forwarding to transmit packets, which means that the decision to forward a packet is made by the receiving node, rather than the transmitting node. Hence, when a node receives a packet it stores it in a queue until its next opportunity to transmit. Then the node will decide if any of the packets in the queue should be forwarded. The decision to forward a message is made based on the received packets gradient metric. In this way, there are three possible actions to take based on a received packets' location information:

- If the location information indicates that the packet has come from a node that is further away from the sink, then it should be forwarded.
- If the packet has come from a node that is the same distance away from the sink, then it should be forwarded, with the priority bit clear
- If the packet has come from a node that is closer to the sink, then it should be dropped.



A. Algorithm

communicated with each other by using the IV.

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```
onHearing(Packet P) begin
      updateSenderInfo(p); if
(isDataPacket(p))
      if(!isForwarderToMe(p))
             DropPAcket(p);
Else
       Calculate Q
       a=FindNeighborWithMAx(Q)
       AttachLocalInformation(p);
       ForwardPAcket(p,a,q(max));
End if End if
```

EXPECTED OUTCOME

The performance is analyzed by using the Network simulator (NS2). The NS2 is an open source programming language written in C++ and OTCL (Object Oriented Tool Command Language). NS2 is a discrete event time driven simulator that is used to mainly model the network protocols. The nodes are distributed in the simulation environment. The parameters used for the simulation of the scheme are tabulated in Table-1.

The simulation of the proposed scheme has 60 nodes deployed in the simulation area 1000×600. The nodes are communication protocol User Datagram Protocol (UDP).All the nodes receive the signal from all direction by using the Omni directional antenna. During simulation time the events are traced by using the trace files. The performance of the network is evaluated by executing the trace files. The events are recorded into trace files while executing record procedure. In this procedure, we trace the events like packet received, Packets lost, Last packet received time etc. These trace values are write into the trace files. This procedure is recursively called for every 0.05 ms. so, trace values recorded for every 0.05 ms.The performance of the proposed scheme is evaluated by the parameters packet delivery rate, packet loss rate, average delay, throughput and residual energy.

Table-1. Simulation parameters.

PARAME	VALUE
Channel	Wireless
Simulatio	50 ms
Number	60
MAC	802.11
Antenna	Omni
Simulatio	1000×60
Transmiss	250m

A. Packet delivery rate

Packet Delivery Rate (PDR) is the ratio of number of packets delivered to all receivers to the number of data packets sent by the source node. The PDR is calculated by Equation (1)

$$PDR=\frac{\text{Total Packets Received}}{\text{Total Packets Sent}} \qquad (1)$$

B. Packet loss rate

The Packet Loss Rate (PLR) is the ratio of the number of packets dropped to the number of data packets sent. The PLR is calculated by Equation (2).

$$PLR=\frac{\text{Total Packets Dropped}}{\text{Total Packets Sent}} \qquad (2)$$

C. Average delay

The average delay is defined as the time difference between the current packets received and the previous packet received. It is measured by Equation (3).

$$\text{Average } \frac{\text{Packet Received time-Packet Senttime}}{\text{Total Packets Dropped}} \qquad (3)$$

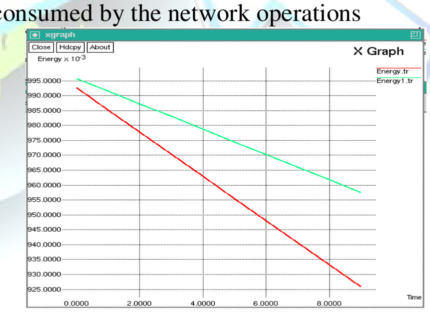
D. Throughput

Throughput is the average of successful packets delivered to the destination. The average throughput is calculated using Equation (4).

$$\textit{Throughput } \frac{\text{Packet Received time(n)*Packet Size}}{1000} \qquad (4)$$

E. Residual energy

The amount of energy remaining in a node at the current instance of time is called as residual energy. A measure of the residual energy gives the rate at which energy is consumed by the network operations



CONCLUSION

Motivated by future sensor network applications, we studied the problem of forwarding a packet to nodes in a geographic region of an ad-hoc wireless sensor network. The proposed Geographic and Energy Aware Routing (GEAR) protocol uses energy aware and geographically informed neighbor selection to route a packet towards the target region.

This strategy attempts to balance energy consumption and thereby increase network

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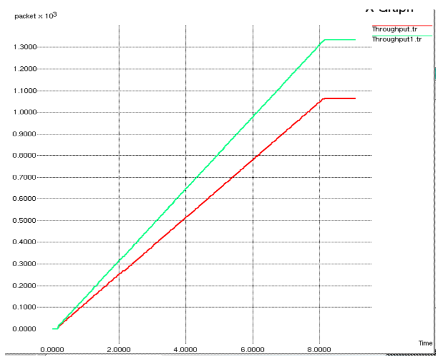
lifetime. The simulation results show that for an uneven traffic distributions, GEAR delivers 80% to 90% more packets than GPSR. For uniform traffic pairs, GEAR delivers 25 - 35% more packets than GPSR. Moreover, in both cases, GEAR performs better in terms of connectivity after initial partition. We are currently implementing a prototype of the GEAR protocol in a moderate size testbed. We plan to investigate how the details of a real implementation affect the protocol performance.



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