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Mobile Data Collection in Wireless Sensor Networks Using Bounded Relay Hop

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Abstract

Energy consumption becomes a primary concern in a Wireless Sensor Network. Wireless sensor network (WSN) requires robust and energy efficient communication protocols to minimize the energy consumption as much as possible. We propose a polling-based mobile gathering approach and formulate it into an optimization problem, named bounded relay hop mobile data gathering (BRH-MDG). Specifically, a subset of sensors will be selected as polling points that buffer locally aggregated data and upload the data to the mobile collector when it arrives. We analyze the trade-off between energy saving and data gathering latency in mobile data gathering by exploring a balance between the relay hop count of local data aggregation and the moving tour length of the mobile collector.

Keywords: Bounded Relay Hop Method, Wireless Sensor Networks.

Introduction

Overview

A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes. On the other hand, the sink is typically rich in energy. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN.

The communications in the WSN has the many-to-one property in that data from a large number of sensor nodes tend to be concentrated into a few sinks. Since multi-hop routing is generally needed for distant sensor nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other nodes.

Sensor nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the sensor nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Energy conservation and harvesting increase lifetime of the network. Optimize the communication range and minimize the energy usage, we need to conserve the energy of sensor nodes .Sensor nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible. This address the lifetime of problem in WSN. Sensor nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the lifetime until the first battery expires is an important consideration. Designing energy aware algorithms will increase the lifetime of sensor nodes. In some applications the network size is larger required scalable architectures.

Energy conservation in wireless sensor networks has been the primary objective, but however, this constrain is not the only consideration for efficient working of wireless sensor networks. There are other objectives like scalable architecture, routing and latency. In most of the applications of wireless sensor networks are envisioned to handled critical scenarios where data retrieval time is critical, i.e., delivering information of each individual node as fast as possible to the base station becomes an important issue. It is important to guarantee that information can be successfully received to the base station the first time instead of being retransmitted.

In wireless sensor network data gathering and routing are challenging tasks due to their dynamic and unique properties. Many routing protocols are developed, but among those protocols cluster based routing protocols are energy efficient, scalable and prolong the network lifetime .In the event detection environment nodes are idle most of the time and active at the time when the event occur. Sensor nodes periodically send the gather information to the base station. Routing is an important issue in data gathering sensor network, while on the other hand sleep-wake synchronization is the key issues for event detection sensor networks. Recent years have witnessed the emergence of WSNs as a new information-gathering paradigm, in which a large number of sensors scatter over a surveillance field and extract data of interests by reading real-world phenomena from the physical environment.

- The energy consumption becomes a primary concern in a WSN, as it is crucial for the network to functionally operate for an expected period of time.
- To reduce the data packets are forwarded to the data sink via multi-hop relays among sensors.
- Due to the inherent nature of multi-hop routing, packets have to experience multiple relays before reaching the data sink.
- As a result of multi-hop, much energy is consumed on data forwarding along the path.
- Instead of minimizing energy consumption on the forwarding path does not necessarily prolong network lifetime as some popular sensors on the path may run out of energy faster than others, which may cause non-uniform energy consumption across the network.

Wireless Sensor Networks

A type of wireless networking which is comprised on number of numerous sensors and they are interlinked or connected with each other for performing the same function collectively or cooperatively for the sake of checking and balancing the environmental factors. This type of network is called as Wireless sensor network (WSN).

A wireless sensor network consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, enabling also to control the activity of the sensors. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting.

A sensor node might vary in size from that of a shoebox down to the size of a grain of dust. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth.

The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

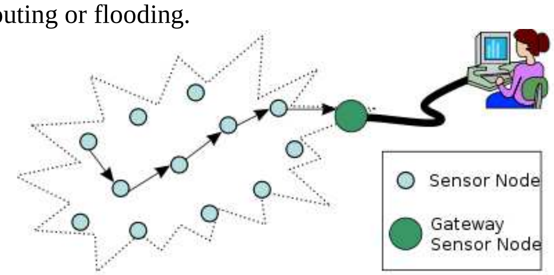


Fig 1.1: Multihop wireless sensor architecture

Energy is the scarcest resource of WSN nodes, and it determines the lifetime of WSNs. WSNs are meant to be deployed in large numbers in various environments, including remote and hostile regions, where ad-hoc communications are a key component. For this reason, algorithms and protocols need to address the following issues:

1. Lifetime maximization
2. Robustness and fault tolerance
3. Self-configuration

Lifetime maximization: Energy/Power Consumption of the sensing device should be minimized and sensor nodes should be energy efficient since their limited energy resource determines their lifetime. To conserve power the node should shut off the radio power supply when not in use.

Some of the important topics in WSN software research are:

- Operating systems
- Mobility
- Security

Characteristics of WSN

The main characteristics of a WSN include

- Sensor nodes are densely deployed.
- Sensor nodes are prone to failures.
- The topology of a sensor network changes very frequently.
- Sensor nodes are limited in power, computational capacities, and memory.
- Sensor nodes may not have global identification because of the large amount of overhead and the large number of sensors.
- Power consumption constrains for nodes using batteries or energy harvesting.
- Mobility of nodes.

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors or MEMS (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery. Other possible inclusions are energy harvesting modules, secondary ASICs, and possibly secondary communication devices (e.g. RS-232 or USB).

The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as they typically forward data from the WSN on to a server. Other special components in routing based networks are routers, designed to compute, calculate and distribute the routing tables. Power efficiency in WSNs is generally accomplished in three ways:

- Low-duty-cycle operation.
- Local/in-network processing to reduce data volume.
- Multihop networking reduces the requirement for long-range transmission since signal path loss is an inverse exponent with range or distance. Each node in the sensor network can act as a repeater, thereby reducing the link range coverage required and, in turn, the transmission power.

Components

Each node in the sensor network node consists of four components: a sensor which connects the network to physical world, computation part which consists of microcontroller or microprocessor in some application responsible for control of the sensors, a transceiver for communicating between nodes and base station, and power supply which is usually from batteries. Energy consumption is a requirement for all the components of the WSN node to work, and since a wireless sensor node is typically battery operated, it is therefore energy constrained.

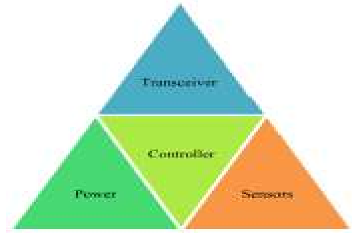


Fig1.2: Components of wireless sensor nodes

Performance Metrics of WSN

- **System lifetime**: This term can be defined in several ways: (a) the duration of time until some node depletes all its energy; or (b) the duration of time until the QoS of applications cannot be guaranteed; or (c) the duration of time until the network has been disjoined.
- **Energy efficiency:** Energy efficiency means the number of packets that can be transmitted successfully using a unit of energy. Packet collision at the MAC layer, routing overhead, packet loss, and packet retransmission reduce energy efficiency.
- **Reliability:** In WSNs, the event reliability is used as a measure to show how Reliable the sensed event can be reported to the sink. For applications that can tolerate packet loss, reliability can be defined as the ratio of successfully received packets over the total number of packets transmitted.
- **Coverage:** Full coverage by a sensor network means the entire space that can be monitored by the sensor nodes. If a sensor node becomes dysfunctional due to energy depletion, there is a certain amount of that space that can no longer be monitored. The coverage is defined as the ratio of the monitored space to the entire space.
- **Connectivity**: For multihop WSNs, it is possible that the network becomes Disjointed because some nodes become dysfunctional. The connectivity metric can be used to evaluate how well the network is connected and/or how many nodes have been isolated.
- **QoS metrics**: Some applications in WSNs have real-time properties. These applications may have QoS requirements such as delay, loss ratio, and bandwidth.

Network Architecture of WSN

A WSN is a network consisting of numerous sensor nodes with sensing, wireless communications and computing capabilities. These sensor nodes are scattered in an unattended environment (i.e. sensing field) to sense the physical world. The sensed data can be collected by a few sink nodes which have accesses to infrastructure networks like the Internet. Finally, an end user can remotely fetch the sensed data by accessing infrastructure networks. Fig1.4 shows the operation sketch map of WSNs. In Fig1.4, two kinds of network topologies are shown. The sensor nodes either form a flat network topology where sensor nodes also act as routers and transfer data to a sink through multi-hop routing, or a hierarchical network topology where more powerful fixed or mobile relays are used to collect and route the sensor data to a sink.

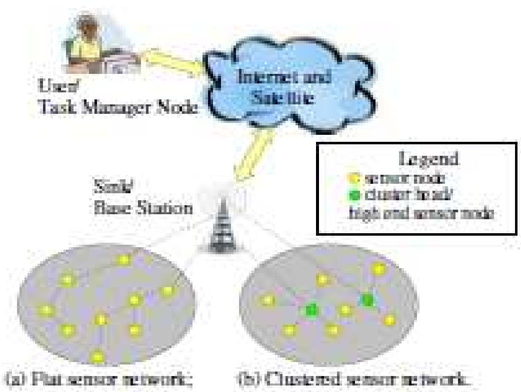


Fig1.4 Operations of WSN

WSN Protocol Stack

The architecture of protocol stack used by the sink and sensor nodes is shown in Fig1.5. This protocol stack integrates power and routing awareness (i.e., energy-aware routing), integrates data with networking protocols (i.e., data aggregation), communicates power efficiently through the wireless medium, and promotes cooperative efforts of sensor nodes (i.e., task management plane).

This protocol stack (Fig.1.5) is made up of physical layer, data link layer, network layer, transport layer, application layer, power management plane, mobility management plane, and task management plane.

The physical layer addresses the needs of a robust modulation, transmission and receiving techniques. The network layer takes care of routing the data supplied by the transport layer. The transport layer helps to maintain the flow of data if the wireless sensor network application requires it. Depending on the sensing tasks, different types of application Software can be set up and used on the application layer.

The power management plane manages how a sensor node uses its power and manages its power consumption among the three operations (sensing, computation, and wireless communications). For instance, to avoid getting duplicated messages, a sensor node may turn off it receiver after receiving a message from one of its neighbors. Also, a sensor node broadcasts to its neighbors that it is low in power and cannot take part in routing messages. The remaining power is reserved for sensing and detecting tasks.

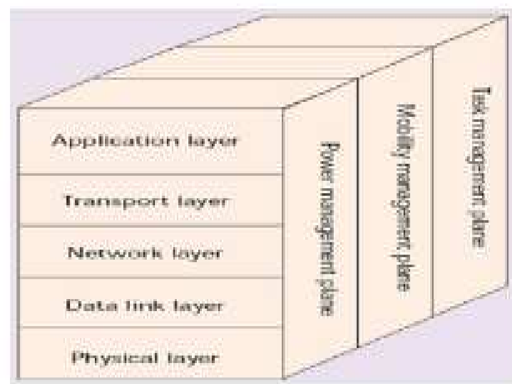


Fig1.5: The WSN protocol stack

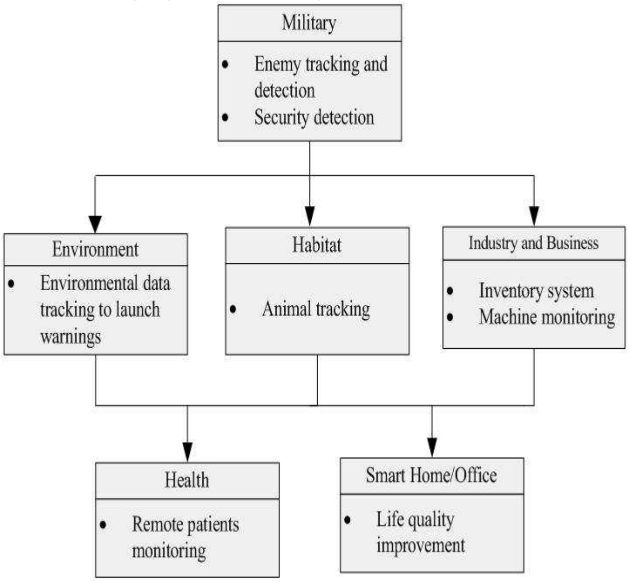
The mobility management plane detects and registers the movement/ mobility of sensor nodes as a network control primitive. Hence, a route back to the user is always kept, and sensor nodes can keep track of who their neighbors of other sensor nodes are. Therefore, the nodes can balance their power and task usage by knowing this situation. The task management plane (i.e., cooperative efforts of sensor nodes) balances and schedules the events sensing and detecting tasks from a specific area. Hence; not all of the sensor nodes in that specific area are required to carry out the sensing tasks at the same time. Depending on their power level, some nodes perform the sensing task more than others.

Applications of WSN

Area monitoring

Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors to detect enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.

When the sensors detect the event being monitored (heat, pressure), the event is reported to one of the base stations, which then takes appropriate action (e.g., send a message on the Internet or to a satellite). Similarly, wireless sensor networks can use a range of sensors to detect the presence of vehicles ranging from motorcycles to train cars.



Environmental/Earth monitoring

The term Environmental Sensor Networks, has evolved to cover many applications of WSNs to earth science research. This includes sensing volcanoes, oceans ,glaciers forests , etc. Some of the major areas are listed below.

Passive localization and tracking

The application of WSN to the passive localization and tracking of non-cooperative targets (i.e., people not wearing any tag) has been proposed by exploiting the pervasive and low-cost nature of such technology and the properties of the wireless links which are established in a meshed WSN infrastructure.

Smart home monitoring

Monitoring the activities performed in a smart home is achieved using wireless sensors embedded within everyday objects forming a WSN. State changes to objects based on human manipulation are captured by the wireless sensors network enabling activity-support services.

Data logging

Wireless sensor networks are also used for the collection of data for monitoring of environmental information, this can be as simple as the monitoring of the temperature in a fridge to the level of water in overflow tanks in nuclear power plants. The statistical information can then be used to show how systems have been working. The advantage of WSNs over conventional loggers is the "live" data feed that is possible.

Comparing Sensor Nodes to AD-HOC Wireless Networks

Wireless sensor networks share similarities (and differences) with ad-hoc wireless networks. The main similarity is the multi-hop communication method. The differences among the two types of networks are listed below:

- More nodes are deployed in a sensor network, up to hundred or thousand nodes, than in an ad-hoc network that usually involves far fewer nodes.
- Sensor nodes are more constrained in computational, energy and storage resources than ad-hoc.
- Sensor nodes can be deployed in environments without the need of human intervention and can remain unattended for a long time after deployment.
- Neighboring sensor nodes often sense the same events from their environment thus forwarding the same data to the base station resulting in redundant information.

Aggregation and in-network processing often requires trust relationships between sensor nodes that are not typically assumed in ad-hoc networks.

Literature Survey

"Rendezvous Design Algorithms for Wireless Sensor Networks with a Mobile Base Station"

The rendezvous-based solutions are presented for variable as well as fixed MS trajectories. The proposed technique assumes full aggregation. Apparently, this is not always possible and thus it is rather a strong assumption. The solution presented for fixed MS track seeks to determine a segment of the MS track shorter than a certain bound such that the total cost of the trees connecting source nodes with RNs is minimized. In both the cases of variable and fixed tracks, knowledge of network topology is necessary and the whole algorithm is performed centrally at the BS.

"Strategies for Data Dissemination to Mobile Sinks in Wireless Sensor Networks"

It uses data dissemination protocol to allow the dissemination of collected data towards a mobile sink. Because the static sink may limit the network lifetime as the one-hop neighbors of the sink are the bottleneck of the network. The design issues of mobile sinks are sink location and reporting method, mobility support. The large virtual infrastructure reduces the hot spot problem, on the other hand it increases the data look-up cost. The use of a small virtual infrastructure may reduce the energy cost of data dissemination and collection but it also may reduce the protocol redundancy, reliability, and robustness as it concentrates the traffic over a small structure, inducing congestion, and premature death of nodes.

"Joint Mobility and Routing for Lifetime Elongation in Wireless Sensor Networks".

Although many energy efficient/conserving routing protocols have been proposed for wireless sensor networks, the concentration of data traffic towards a small number of base stations remains a major threat to the network lifetime. The main reason is that the sensor nodes located near a base station have to relay data for a large part of the network and thus deplete their batteries very quickly. This paper suggests that the base station be mobile; in this way, the nodes located close to it change over time. Considering jointly mobility and routing algorithms in this case, and show that a better routing strategy uses a combination of round routes and short paths.

"Controllably Mobile Infrastructure for Low Energy Embedded Networks".

In this paper, a MS is used to collect data from groups of SNs. During a training period, all the WSN edge nodes located within the range of MS routes are appointed as RNs and build paths connecting them with the remainder of sensor nodes. Those paths are used by remote nodes to forward their sensory data to RNs; the latter buffer sensory data and deliver them to the MS when it reproaches in range. The movement of mobile robots is controllable which is impractical in realistic urban traffic conditions. Most importantly, no strategy is used to appoint suitable nodes as RNs while selected RNs are typically associated with uneven numbers of SNs.

System Analysis

Routing Protocols for WSN Networks

Routing protocols have a large scope of research work when implemented in a WSN, because the functioning of these protocols depends upon the type of network structure designed for the application or the network operations carried out using these protocols for a specific application model. Figure 1 shows the protocol classification or routing taxonomy for routing protocols which are further sub-divided into subcategories. A brief introduction of each category is given below.

Structure Based Routing Protocols

Routing protocols are divided into structure-based routing protocols, which are in turn classified as flat routing, hierarchical routing and location-based routing. The protocols which fall under these categories work with respect to the design constraints given for the network structure or area.

Flat Routing

This is a routing technique in which all the sensor nodes play the same roles, such as collecting data and communicating with the sink, i.e. all the data collected in the remote area can be same or duplicated as all the sensor nodes work in the same way.

Hierarchical Routing

In this routing technique all the routing sensors in the network are clustered and a cluster head collects and aggregates the data and checks for redundancy of the data that is collected before it is sent to the sink. This saves communication and processing work and also saves energy.

Location-based Routing

In location-based routing, all the sensor nodes are addressed by using their locations. Depending upon the strength of the incoming signals, it is possible to calculate the nearest neighboring node's distance. Due to obstacles in the network often the signal strength becomes weaker and nodes find it difficulty in finding the nearest neighbor nodes, SMECN performs well in such situations also by creating a sparse graph of the network nodes before transmitting to the next node. All the nodes in the network exchange this data in order to know about neighboring nodes. This is useful for communicating and transferring information. As energy is the major factor of concern in routing protocols, location-based schemes demand that nodes should change their state from active to sleep mode when there is no activity. The more nodes in sleep mode, the more energy is saved. There are many location-based schemes of which GAF (Geographic Adaptive Fidelity) and GEAR (Geographic and Energy aware Routing) are two examples.

Protocol Operation Based Routing Protocols

Routing protocols taxonomy has another basic and important classification, namely operation based routing protocols, which is in turn divided into multi-path based, query-based, negotiation-based, quality-of-service (QoS) based and coherent-based routing protocols. The protocols which come under this classification work according to the network-structure operation, or the way the structure needs the protocols to work depending upon the sudden changes it undergoes.

Multi path-based

These protocols are efficient in handling multiple paths. Nodes send the collected data on multiple paths rather than using a single path. The reliability and fault tolerance of the network increases as there is, as long as it is possible, an alternative path when the primary path fails.

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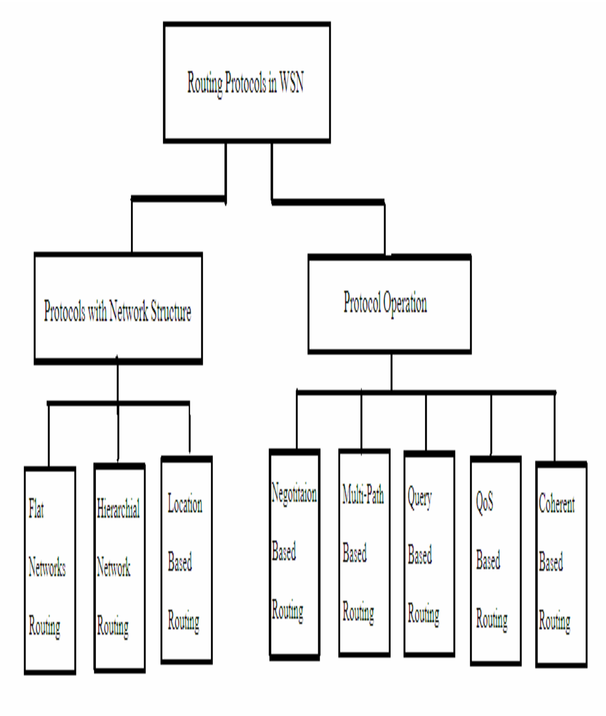


Query-based

Query-based routing propagates the use of queries issued by the base station. The base station sends queries requesting for certain information from the nodes in the network. A node, which is responsible for sensing and collecting data, reads these queries and if there is a match with the data requested in the query it starts sending the data to the requested node or the base station (here). This process is known as Directed Diffusion where the base station sends interest messages on to the network. These interest messages, which move in the network, create a path while passing through all the sensor nodes. Any sensor node, which has the data suitable to the interest message, sends collected data along with the interest message towards the base station. Thus, less energy is consumed and data aggregation is performed on a route.

Negotiation-based

These protocols use high-level descriptors coded in high level so as to eliminate the redundant data transmissions. Flooding is used to disseminate data, due to the fact that flooding data are overlapped and collisions occur during transmissions. Nodes receive duplicate copies of data during transmission. The same data content is sent or exchanged again and again between the same set of nodes, and a lot of energy is utilized during this process. Negotiation protocols like SPIN are used to suppress duplicate information and prevent redundant data from being sent to the next neighboring nodes or towards the base station by performing several negotiation messages on the real data that has to be transmitted.

Quality of Service (QoS)-based

In this type of routing protocol, both quality and energy have to be maintained within the network. Whenever a sink requests for data from the sensed nodes in the network, the transmission has to satisfy certain quality-of-service parameters, such as, for example, bounded latency (data has to be sent as soon as it is sensed without delaying any further) and bandwidth consumed. Sequential Assignment Routing (SAR) is one of the first routing protocols that use the notion of QoS in routing decisions. Routing decision in SAR depends on three factors: energy consumption within the network by the sink and the nodes, QoS of
each path in the network, and priority level of each packet sent .

Coherent-based

In a WSN, the sensor nodes collect data and send it to the nearest neighbors or the sink within the network. In this process, the processing of the collected data is the most important event. There are two types of data-processing techniques followed within the network structure: coherent and non-coherent data processing based routing. All the nodes within the network collect the data and process it before sending to the next nearest node for further processing. This technique is called non-coherent data process routing and the nodes that perform further processing on the data are called aggregators. In coherent routing, after minimum processing, the data is forwarded to the aggregators. This minimum processing includes functions like time stamping or duplicate suppression. This technique is energy efficient as all the processing is done by the nodes, which reduces the total time and energy consumption.

Additional Classifications

Protocols are further classified as proactive, reactive and hybrid, depending on the type of communication routes processed within the network for data transmission from the source to sink. In **Proactive routing protocols** all the paths are calculated before the sink makes an initiation to communicate with the nodes in the network, where as in **Reactive routing protocols**, the path values are calculated only when required. Whenever a sink wants to contact a particular node, the path values are calculated and the best path is selected for data transmission.

Hybrid routing protocols, as the name suggests, is a combination of both proactive and reactive protocols, which decides whether to calculate the path from the sink to the source, depending on the type of communication. Generally, it is suggested that tabledriven (proactive) routing protocols are better when we consider the nodes as static. The reason is that a lot of energy can be saved compared to reactive routing protocols that depend on the discovery of the best route path for data transmission. In proactive routing it is not necessary to search for the nearest neighbors for every next hop when data is transmitted.

Design of Bounded Relay HOP for Mobile Data Gathering

1 Cluster Head Selection

- The cluster heads may be special nodes with higher energy or normal node depending on the algorithm and application. Here base station is a cluster head performs computational functions such as data aggregation and data compression in order to reduce the number of transmission to the base station (or sink) thereby saving energy. Clustering based algorithms are believed to be the most efficient routing algorithm for the WSNs.

Clustering along with reduction in energy consumption improves bandwidth utilization by reducing collision. Work is currently underway on the energy efficiency in WSNs which will result from the selection of cluster heads.

Setting less hop count transmission

- Multi-hop routing, packets have to experience multiple relays before reaching the data sink.
- Minimizing energy consumption on the forwarding path does not necessarily prolong network lifetime as some popular sensors on the path.

A. So to avoid the problem in multi-hop routing we are setting the less hop count transmission.

Problem in static forward node

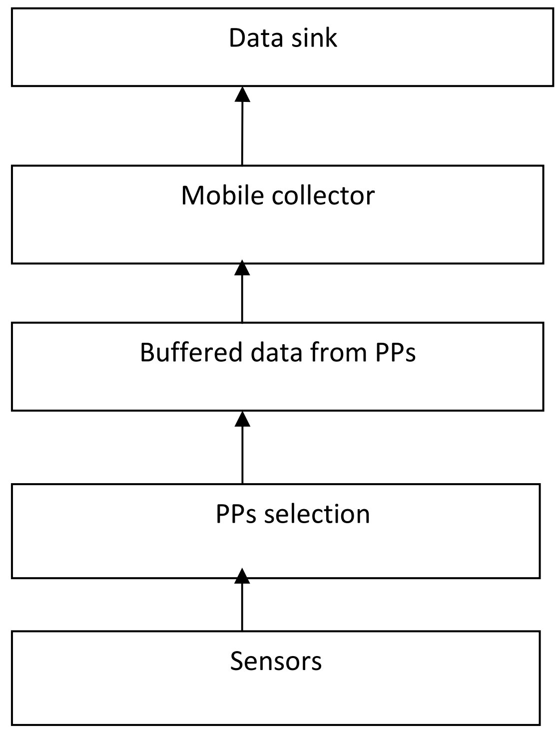
- When the node forwarding the data continuously, then that node will loss more energy. It may causes node failure.

Dynamic forward node

- If the forward node is dynamically changed with less hop count node then energy loss of node should be very less.

2 Information Processing & Polling Point Selection

- In Information Processing Phase, each and every sensor node involves in sensing the attribute and sending this information to the cluster-head of the respective cluster. Then the cluster-head performs the aggregation. This process will be repeated for specified regular intervals of time. A subset of sensors will be selected as the polling points , each aggregating the local data from its affiliated sensors within a certain number of relay hops. These PPs will temporarily cache the data and upload them to the mobile collector when it arrives.
- The PPs can simply be a subset of sensors in the network or some other special devices, such as storage nodes with larger memory and more battery power.



Flow Diagram – Data Collection from Sensor to Base Station

Data Dissemination Phase

- Since the mobile collector has the freedom to move to any location in the sensing field, it provides an opportunity to plan an optimal tour for it.
- Our basic idea is to find a set of special nodes referred to as PPs in the network and determine the tour of the mobile collector by visiting each PP in a specific sequence.

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- When the mobile collector arrives, it polls each PP to request data uploading. And then upload the data to MC. In Data Dissemination Phase the aggregated information from each cluster-head is passed to MC based on dissemination interval chosen.

Energy Efficient Routing

A PP uploads data packets to the mobile collector in a single hop. The mobile collector starts its tour from the static data sink, which is located either inside or outside the sensing field, collects data packets at the PPs and then returns the data to the data sink. Finally MC Handover the data to data sink, such as BS. By this we can increase the life time of the sensors and also we reduce the data gathering delay in WSN.

Algorithms

STEP-1: After starting the network, the wireless sensor nodes will be divided into several clusters in the WSN.

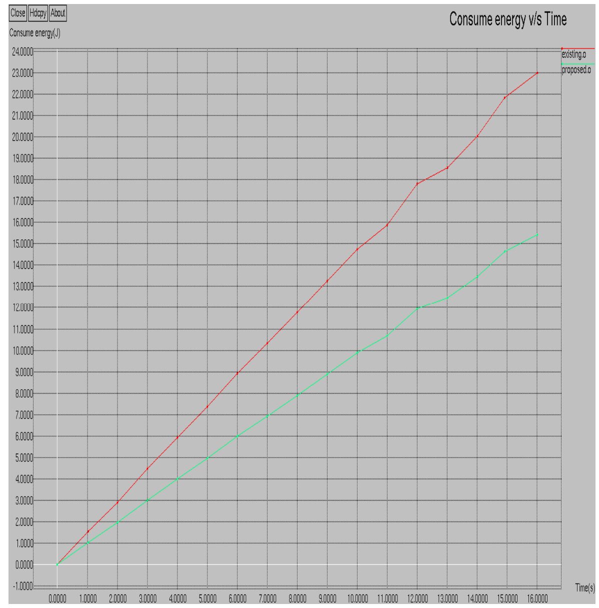
-STEP-2: One node will be chosen as the cluster head in each cluster area. This cluster head will use a negotiation system to send joining messages to the nodes near the cluster head.

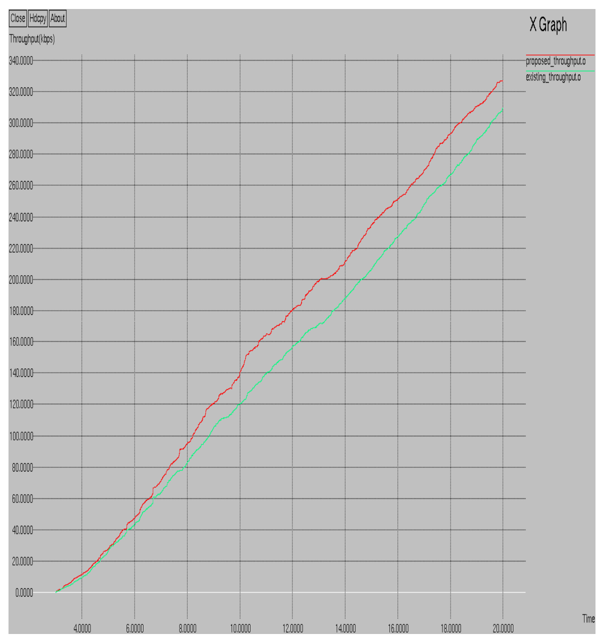
STEP -3: After that, the cluster-heads will send invitations to the wireless sensor nodes in each cluster asking them to join the cluster-heads to form the clusters. The second phase includes the \transferring data process" and the \distributing the role of cluster head process" including the following three steps. The AODV routing protocol is responsible for sending the data from the source to the destination nodes. The role of distribution is determined by regularly selecting a set of new cluster-heads based on the weight value.

STEP -4: When any wireless sensor node needs to send a message, it has to check its routing table and look for a path to the destination node. Therefore, if the route is available in the routing table, it will forward the message to the next node. Otherwise, the message will be saved in a queue, and the source node will send the RREQ packet to its neighbors to commence the discovery process.

STEP -5: During the forwarding of the message to the destination, the rate at which power is consumed by the cluster head will be calculated based on the energy model. If the energy consumption speed is high, then the procedure will choose another node to act as the cluster head based on the value.

STEP -6: Then, the procedure will remove the route from the routing table of the source, which will lead the source node to initiate the discovery process in phase 2 again and a new path to the destination node through the new cluster head.





Conclusion

In this paper we have shown the reduced data gathering delay from sensor node to base Station by Implementing the Polling points between the clusters & using bounded relay hop Mobile collector. Overall Energy consumed by each sensor nodes is comparatively low with maximum throughput of data. It is been achieved with moving tour length of mobile collector & total data aggregation in each cluster & base station.

Future Developments

The Future work on this Project includes the implementation of Mobile Data Collection in Wireless Sensor Network using Bounded Relay Hop, with the method described in the System Testing. Extensive Simulations will be carried to validate the efficiency of the Scheme & will be plotted on the graph. Also to be finding the efficiency of the algorithms outputs will be compared with existing solutions. The project will be implemented with the help of network implementation tools like

- Boston Network Simulator
- Packet Tracer
- Network Simulator – 2 (NS-2)

Network Simulator -2 (NS-2) helps to visualize the traffic flow from the user machine to the specific destination with the help of color coding the even the timer values are set as per the user requirement.

Thus results will demonstrate that proposed system will greatly shorten the data gathering tour length with bounded relay hops.

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