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Clustering Based Efficient Data Aggregation Protocol for Wireless Sensor Networks

Rakesh Kumar
Department of Computer Science & Engineering, KC Institutes of Engineering & Technology

Abstract—Wireless Sensor Network is special types of Ad-hoc Network which contain very tiny nodes in size and their cost is also not very high. They are deployed in any geographical region in a random fashion. During the process of data sensing, data gathering and data transmission, the charge of the power unit associated with any node gets low, after certain time, i.e., each node has its life time. The life time of nodes directly affects the life time of the sensor network. As each node is very low in cost, it is unnecessary and difficult too, to recharge them once their energies are exhausted. Therefore, it is very important to conserve the power of the nodes so that the life time of the entire network can be conserved. Hence the requirement of a power efficient data gathering protocol is very important to serve the purpose in wireless sensor network. Clustering in according to different protocols is an important part of communication in WSN. Clustering is responsible for performing aggregation function over cluster-head still cause's significant energy wastage. In case of homogeneous sensor network cluster-head will soon die out and again re-clustering has to be done which again cause energy consumption. In our research we tends to propose a new strategy for ACH selection and a new algorithm for cluster head selection which is based on associate cluster for WSN.

Keywords—Wireless Sensor Node, Cluster, Cluster Head.

I. INTRODUCTION

A wireless sensor network is type of wireless network which is depends on a simple equation: Sensing + CPU + Radio = Thousands of possible applications. It is small and infrastructure less network. Basically wireless sensor network consist a number of sensor node, called tiny device and these are working together to detect a region to take data about the environment. Wireless sensor network has two types: structured and unstructured. if we talk about unstructured so is a collection of sensor nodes. And these deployed in adhoc manner into a region. Once deployed, the network is absent unattended perform monitoring and reporting functions. In other structured wireless sensor network, the all sensor nodes are deployed in pre designed manner. The benefit of structure wireless sensor network is that some nodes can be deployed with lower network maintenance and management cost. Fewer nodes can be deployed now since nodes are placed at specific locations to provide coverage while ad hoc deployment can have uncovered regions. Wireless sensor network aim is to provide efficient connection among the physical environmental condition and internet worlds. The sensor nodes of the wireless sensor network is allows random deployment in inaccessible terrains, this means protocol of the wireless sensor is self organized, another important feature of the wireless sensor network is cooperative effort of the sensor nodes. Sensor nodes are collecting data about environment, after collecting it they process it and then transmit to the base station. Base station provides a interface between user and internet. Basic characteristic of the wireless sensor network are limited energy, dynamic network topology, lower power, node failure and mobility of the nodes, short-range broadcast communication and multi-hop routing and large scale of deployment. After the initial deployment, sensor nodes are responsible for self-organizing an appropriate network infrastructure, through wireless communication between sensor nodes (as shown in Figure 1.1). The onboard sensors then start collecting data about the environment, using either continuous or event driven working modes. After collecting data, they process it and then send to base station. Base station behaves like an interface between users and network. Users can retrieve information of their own interest by from WSNs injecting queries and gathering results at base station. End users collect information from WSNs by connecting it to internet or satellite via base station (as shown in Figure 1.1). In the wireless sensor network architecture includes both a hardware platform and an operating system designed.

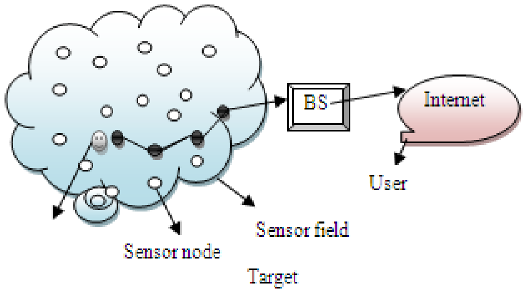

Figure1.1 Architecture of the Wireless Sensor network

TinyOS is a component based operating system designed to run in resource constrained wireless devices. It provides highly well-organized communication primitives and fine grained concurrency mechanisms to application and protocol developers. Basically TinyOS is the use of event based programming in conjunction with a highly efficient component model. TinyOS enables system-wide optimization by providing a tight coupling among hardware and software TinyOS has been designed to run on a generalized architecture where a single CPU is shared between application and protocol processing. All sensor nodes in the wireless sensor network are interact with each other or by intermediated sensor nodes .Wireless sensor network architecture includes both a hardware platform and an operating system designed specifically to address the needs of wireless sensor networks. TinyOS [2] is a component based operating system designed to run in resource constrained wireless devices. It provides highly efficient communication primitives and fine-grained concurrency mechanisms to application and protocol developers. A key concept in TinyOS is the use of event based programming. TinyOS enables system-wide optimization by providing a tight coupling between hardware and software, as well as flexible mechanisms for building application specific modules. TinyOS has been designed to run on a generalized architecture where a single CPU is shared between application and protocol processing.

II. WORKING OF WSN

Wireless sensor networks is collection of the small tiny device called sensor nodes. It may be small and large. That's why construct the wireless sensor network is based on sensor nodes. So entire working of sensor network is sensor nodes. These nodes are varying in size and totally depend on the size. Wireless sensor networking have such sensor nodes which are especially designed in such a typical way that they have a microcontroller which controls the monitoring, a radio transceiver for generating radio waves, different type of wireless communicating devices and also ready with an energy source like battery. The entire network worked simultaneously by using different dimensions of sensors and worked on the phenomenon of multi routing algorithm which is also termed as wireless ad hoc networking.

III. ARCHITECTURE FOR WSN

For better understanding of sensor network it is important to know about all the components of sensor node. Common sensor node architecture is shown in Figure 2. The architecture of a generic wireless sensor node consists of four subsystems [5]A computing subsystem consisting of a microprocessor, ALU and memory, a communication subsystem consisting of a short range radio for wireless communication, sensing subsystem that links the node to the physical world and consists of a group of sensors and actuators, and a power supply subsystem, which houses the battery and the (optional) DC-DC converter, and powers the rest of the node. Each subsystem plays a main role in the sensor node.

Radio: It enables wireless communication among sensor nodes and outside world. It consists of a short range radio which usually has a single channel, a low data rate and operates at unlicensed bands of near 2.4 GHz (global). For efficient energy consumption, it operates in four different modes: Transmit Receive, Idle and Standby modes. In case of most radios, it is observed that when radio operates in Idle mode it consumes energy almost equal to power consumed in Receive mode [6]. Thus, when it is not transmitting or receiving it is vital to completely shut down the radio rather than keep it in the idle mode to save precious energy. Another influencing factor is that, when radio changes its operating mode, radio electronics causes a significant amount of power dissipation in this transient activity. ***Microprocessor,*** it provides intelligence to the sensor node. The microprocessor controls the sensors, executes communication protocols and signal processing algorithms on the gathered sensor data [7]. To conserve energy, microprocessor works in four different modes: off, sleep, idle, and active. In sleep mode, the CPU and most internal peripherals are turned off, and can only be activated by an external event (interrupt). In idle mode, the CPU is still inactive, but other peripherals are active, for example, the internal clock or timer. In the active mode, multiple sub modes may be defined based on clock speeds and voltages. Within the active states, the CPU and all peripherals are active.

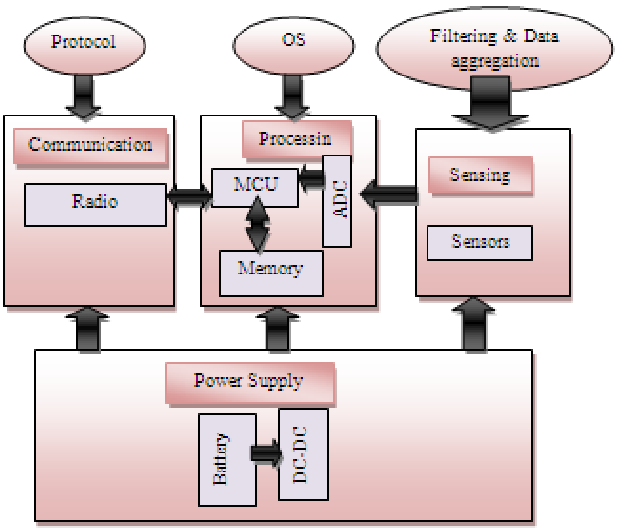

Figure 1.2 Sensor node architectures

Sensor It translates physical phenomena to electrical signals. There exists a variety of sensors that measure environmental parameters such as temperature, light intensity, temperature, magnetic fields, sound, image, etc. Due to the diversity of sensors, there is no standard power consumption figure. For a simple sensor we assume that only the states on and off are given, and that the energy consumption within both states can be measured by time. However, more powerful sensors operate in different states, comparable to the microprocessor. To reduce energy consumption low power components can be used at the cost of performance which is not required. ***Battery:*** The battery is an important component in sensor node. It supplies power to all component of sensor node. Therefore, sensor nodes lifetime totally depends on battery and network's lifetime depends on lifetime of sensor nodes. The amount of power drained from a battery should be checked. Since Sensor nodes are usually small, light and cheap and the size of the battery is limited. (Advancement in Battery technologies is much slower than semiconductor technologies. For example, the energy densities of Li-ion batteries only increased 50% from 1994 to 1999. While in the same period of time, the number of transistors of Intel processors doubles every 24 months.). Sensor nodes are deployed in unattended environment where battery replacement is not possible in network which consists of thousands of nodes. Hence, energy consumption is vital factor to prolong sensor nodes lifetime.

IV. FEATURES OF WSN

This section discusses some unique features of WSNs, which need to be taken into account when designing management architectures in WSNs.

A. Different types of nodes : In the wireless sensor network are three types of sensor nodes: the normal nodes are responsible for collecting information or sensor data. Sensor nodes have resource constraint. That's why sensor node has not storing capability for storing large amount of information or sensor data. It may take simply data processing if necessary; sink nodes responsible for receiving, storing, and processing (e.g. aggregation) data from normal nodes; and gateway nodes that connect sink nodes to external entities called observers. In addition, actuators can also be introduced to control or actuate on a monitored region in Wireless sensor networks.

B. Application-Specific: Wireless Sensor Networks are closely application-dependent. The constrained resources (e.g. processing, storage and transmission range) limit sensor nodes in WSNs to contain a wide variety of applications as the traditional network does. The designs of applications and management architectures in WSNs are also dependent on application semantics. As a result, application designers have to develop various complex and special program to execute node localization, data routing and data aggregation tailored to specific sensor applications. Thus, it is not likely that those programs can carry over directly from one application to another, since the application-specific requirements on WSNs are varied in terms of resource usage and communication patterns. Recent WSN research has focused increasingly on the solutions that can hold the diversity of various sensor applications by integrating the application knowledge with management architectures in WSNs.

C. Resource Constrains: Resource-constrains of sensor nodes is another unique feature of WSNs. Sensor nodes usually compose of four basic units as in Figure 1.2 a sensing unit, a processing unit, a transceiver unit, and a power unit. The power unit supports all the activities on a sensor node, including communication, local data processing, sensing, etc. The lifetime of a sensor node is mainly determined by the power supply since battery replacement is not an option in sensor networks, especially in dangerous environments as battlefields or environment monitoring. The longer the lifetime of a sensor, the morestable the WSN. In order to save power, redundant activities should be reduced if not eliminated.

D. Network Topology: Network Topology represents the actual topology map and the achieve ability of sensor nodes in the network. Note that the topology in WSNs may be dynamic due to the nodes changes. For example, nodes may fail (either from lack of energy or from physical destruction), and new nodes may join the network. Therefore, the network must be able to reconfigure itself periodically.

E. Fault Tolerance: Failures are prone to happen in WSNs, which normally include sensor nodes failure, and communication failures etc. Although the sensor application may have already measured this in their design, there is still a need for WSN to have the ability to reconfigure and recover itself without too much human being intervene, especially in inaccessible environment condition.

V. PROTOCOL STACK

The sensor network protocol stack is much like the traditional protocol stack, with the following layers: Physical, Data Link, Network, Transport, and Application as discussed by Elizabeth [8] and shown in Figure 1.3. The WSN must also be aware of the following management planes in order to function efficiently: Power, Mobility, and Task Management Planes. The Power Management Plane is responsible for minimizing power consumption and may turn off functionality to preserve energy.Mobility plane manages the movement of sensor nodes and maintains a data route to the sink.The task plane manages the sensing task assigned to sensor nodes so only those nodes which are necessary, are assigned sensing task and other node can focus their energy resource on routing and data aggregation.

Physical Layer: Physical Layer is responsible for frequency selection, carrier frequency generation, signal detection, modulation, and encryption. The main work of this layer is to minimization of energy Theminimum output power required to transmit over a distance d is proportional to d to a power of n, where n varies from 2 to 4 and is closer to four when the antennae are near the ground as is typical in WSNs. This is due to ground-reflected rays, which causes partial signal cancellation. This problem is overcome by multi-hop communication and high node density.

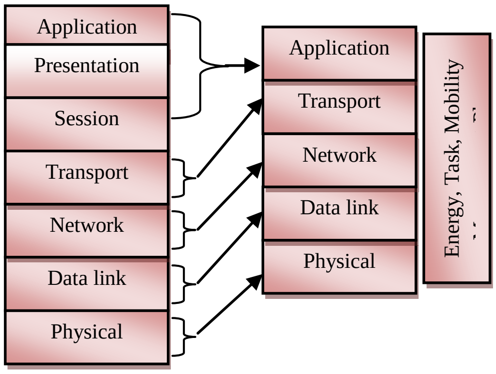

Figure 1.3 Protocol stack for Wireless Sensor Networks

Data Link Layer: The Data Link is responsible for the multiplexing of data streams, data frame detection, medium access and error control. A WSN must have a specific Medium Access Control (MAC) protocol to address the issues of power conservation and data-centric routing. The MAC protocol must meet two goals. The first is to create a network infrastructure, which includes establishing communication links among nodes, and providing the self-organizing capabilities to the network. The second goal is to efficiently share communication resources (frequency) among all the nodes. Traditional MAC protocols fail to meet these two goals because power conservation is only a secondary concern in their development. Also, WSNs are controlled centrally and a much larger number of nodes than traditional ad-hoc networks. Any MAC layer protocol for WSNs must overcome the problem of changing topology of the sensor network due to node failure and redeployment.

Network Layer: The network layer is to provide internetworking with external networks like other sensor networks, in one scenario, the sink nodes can be used as a gateway to other networks. The network layer in a WSN must be designed with the following considerations in mind: Power efficiency, WSNs are data-centric networks WSNs have attribute-based addressing and Sensor nodes are location aware. The Link layer handles how two nodes talk to each other, the network layer is responsible for deciding which node to talk to.

Transport Layer: The transport layer comes into play when the system needs to communicate with the outside world. Transmitting data from sink to outside user is a problem because WSNs do not use global identification and attribute based naming is used for sending the data. Very little research has been done at the transport layer.

Application Layer: At the application layer, a Sensor Management Protocol (SMP), SMP is used to make the hardware and software of lower layers transparent to the sensor network management applications. The programmers and system administrators interact with the sensor network using SMP. Again at application layer the lack of global ids and infrastructure less nature of sensor networks must be taken into account. SMP provides the rules for the following to enable interaction between applications and sensor networks: Data aggregation, attribute-based naming, and clustering ,Time synchronization, Moving sensor nodes, Exchange data related to the location finding algorithms, Authentication, key distribution, and security, Turning nodes on or off, Querying WSN configuration status, reconfiguring the WSN. Different considerations must be taken when developing protocols for WSNs. Traditional thinking where main focus is on quality of service must be reversed. In WSNs quality of service must be compromised to conserve energy and preserve network lifetime. The thought process must focus on the functionality of the entire network rather than what is best for each individual node. Concern must be taken at every level of the protocol stack to conserve energy, allow nodes to reconfigure the network, and modify their set of tasks according to the resources available.

VI. PROBLEM FORMULATION

Clustering is efficient scheme for data aggregation in the wireless sensor network. In which each sensor node sends data to the aggregator node means cluster head (CH) and then cluster head perform aggregation process on the received data and then send it to the base station (BS). Performing aggregation function over cluster-head still causes significant energy wastage. In case of homogeneous sensor network cluster-head will soon die out and again re-clustering has to be done which again cause energy consumption. The Problem is to propose an algorithm that can select an associate cluster head during cluster head selection process to reduce re-clustering. We will focus on efficient cluster head selection for data aggregation in wireless sensor network. In this we study Present proposed scheme and discusses the idea in the detail with working of the scheme in WSNs.

Main objectives of this thesis are:

Reviewing the various clustering based protocols in WSNs and finding out the challenges in devising efficient cluster head selection for WSN.

Proposing a new strategy for ACH selection and to propose a new algorithm for cluster head selection which is based on associate cluster for WSN.

Compare the performance of new devised algorithm with existing algorithm through simulation and by analysis.

VII. RESEARCH METHODOLOGY

To achieve the set objectives, we will do the research in following steps

Step 1: Brief introduction of WSNs, sensor node architecture will be considered and comparison with different protocols will be done.
Step 2: Proposal for finding some new strategy for ACH selection and to provide a new algorithm for cluster head selection which is based on associate cluster for WSN.
Step 3: Simulation could be done on opnet, matlab or omnet++.

VIII. CONCLUSION

The purpose of this Research is to provide some solution to better resource consumption in Smartphone. There is an ample scope of research in the stated area of Smartphone security. Present Analysis will reflect the effectiveness of the cloud services such as security as a service in Smartphone security. It will also explore the resources consumption like battery and cpu consumption for different vendors and for different versions of Smartphone's software (operating systems). Better results will be motivated through these analyses. Our research can be used in providing cloud services as security for different vendor's devices so that maximum resources can be saved without compromise to security in Smartphone devices.

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