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A Novel Technique for Clock Synchronization to Increase Network Lifetime in WSN

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Abstract— Wireless Sensor network has no central controller. Energy consumption is the major issue of wireless sensor network. In this paper, we have discussed routing protocol which utilized more energy. The energy must be quantized for computational purposes. Giving greater probability to nodes with higher energy, to be selected as CH, helps in better distribution of energy and more reliable message transmission. In this paper, diffusion based technique is used to synchronized cluster head clock. By doing so, energy consumption has been reduced in terms of energy, packet loss and delay.

Keywords—: Cluster head, RFID, Diffusion, Time lay

I. Introduction

Wireless sensor networks comprises of many individual nodes which interconnect to form a system that operates as one. These sensor nodes play the main task of sensing the environmental conditions and maybe control them too. We need a collaboration of large number of such sensor nodes as it is not possible for a single node to cover large geographical areas. Sensor networks perform two main operations; they are data dissemination or spread of queries throughout the network and second is the data collection or gathering from individual sensor nodes and pass it on to sink [9]. The nodes use wireless communication, mostly wireless radio, to connect with each other and also with base station. The data collected is rarely processed by the nodes due to memory and battery limitations; hence it is passed on to remote device where it is analysed, processed upon or stored. The sensor nodes may differ in their physical size but the cost of these depends upon the complexity of each node.

1.1 Challenges for WSN: There are many issues of wsn. These are as follow:

1. Type of service: The service type as perceived by a conventional communication network mainly involves moving bits from one place to another. For a WSN moving of bits is not the actual purpose but just a means to an end. What is expected out of WSN is to provide meaningful information and/or actions about a given task [5].

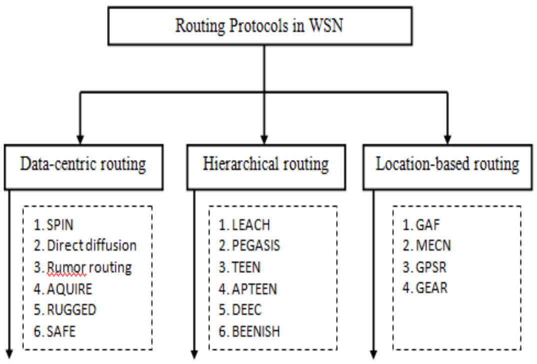
2. Quality of Service (QoS): QoS generally refers to the quality as perceived by the user/application while in the networking community. In other words QoS is accepted as a measure of the service quality that the network offers to the applications/users. QoS is characterised as a set of service requirements to be met when transporting a packet stream from the source to its destination. In this scenario, QoS refers to an assurance by the Internet to provide a set of measurable service attributes to the end-to-end users/applications in terms of delay, jitter, available bandwidth, and packet loss.

3. Fault tolerance: Due to any factor, which may be physical damage to the node or dead battery, a node may run out of service. This leads to a broken link. Overall functioning of the network should not be affected by this. One way to overcome such a glitch is by deploying redundant nodes [7].

4. Scalability: Number of nodes in action is mostly application dependent. Since such number varies from hundreds and thousands of nodes per WSN, the employed architectures and protocols must be able scale to these numbers [8].

5. Wide range of Densities: Number of nodes per unit area aka node density is a variable quantity per WSN or within a network. Application requirements set the node density. Even for a given application, node density can vary as the nodes may fail or move from their position. Also node density is not homogeneous through put the network, density can vary over time and space. Network should be flexible enough to adapt to these variations [10].

1.2 Routing Protocols: There are vast numbers of routing protocols available for WSNs [11]. Routing is the process of finding best path through which data can be sent from source to destination which is mainly base station [9]. When individual networks are connected together to create an Internetwork or large network, connecting devices routes the packets to final destinations and these connecting devices are known as routers or gateways. Various routing protocols can be broadly classified into three categories:



2. Review of Literature

Shah *et al.,* (2012) [1] introduced this routing protocol for homogeneous networks while keeping the merits of distributed clustering as well. Two nodes belonging to same application and nearest to each other are grouped into a pair. There is deployment of GPS (Global Positioning System) to collect location of all nodes. The paired nodes switch between "Awake" and "Sleep" mode in turns. Cluster heads are selected by distributed algorithm. In this way EESAA minimizes energy consumption while optimising stability of network much more than LEACH, SEP and DEEC.

In [2] is a consolidated paper regarding joint performance analysis of four cluster based hierarchical routing protocols; LEACH, TEEN, SEP and DEEC. Comparison is done by simulating these in MATLAB. Performance matrices taken are number of alive nodes, number of dead nodes and packets sent to BS. Sensor nodes can sustain their energy only for certain number of rounds. Making nodes to last for more number of rounds, increases network lifetime. Clustering process is explained in form of three states: Advertisement state, Setup state and Steady state. Finally after careful examination of the results obtained, author has concluded that DEEC outperforms among other protocols by providing feasible optimum solutions against constraints of modelled frame work.

In [3] designed Centralized Energy-Efficient Clustering (CEEC) routing protocol. This protocol has been implemented for three levels of heterogeneity. It tries to address the drawbacks of SEP, E-SEP and DEEC. In these protocols there is no provision for uniform geographical dissemination of high-energy nodes which are most likely to assume the role of Cluster-Heads. Also the distributed clustering algorithm introduces the additional computational overhead. In CEEC, base station is fixed with additional responsibility of selecting optimum number of cluster heads. The network topology is segmented into three local regions for three types of nodes present with base station on top. Normal nodes are present nearest to BS while super nodes are placed at the far end. Guaranteed number of CHs increases the throughput of CEEC.

In [4] suggests another way for energy efficiency through multipath routing scheme. Instead of routing all the data through a single low cost routing path, EERP (Energy-Efficient data Routing Protocol) distributes the traffic across various good paths selected on the bases of cost function and node energy. All nodes maintain Neighbours Information Table to look up for neighbour with minimum cost. Hence distribution of Network Load delays some particular nodes to run out of energy and produce partition in the network. This enhances network stability and lifetime.

In [5] proposed an energy efficient dynamic power management technique. Network as a whole expends energy in communication. Another way for power consumption is at each node level itself. Author we can reduce power consumed by each sensor node by shutting down some components of sensors according to our algorithm which enhances network life time and saves other resources. Energy consumption in wireless sensor networks is influenced by many factors.

1.3 RFID Protocol

RFID (Radio Frequency Identification) is a contactless automatic identification skill that is based on radio frequency. There are usually two types of RFID according to the power source: active RFID and passive RFID.

1.3.1 Active RFID: Active RFID system uses an internal power source (battery) inside the tag to constantly power the tag and its RF communication circuitry. It allows very low-level signals to be received by the tag. The tag can produce high-level signals back to the reader, driven from its inner power cause [12].

1.3.2 Passive RFID: Passive RFID relies on RF energy transferred from the reader to the tag to power the tag. Passive RFID either 1) reflects energy from the reader or 2) absorbs and provisionally stores a very little amount of energy from the reader's signal to produce its own fast response [12].

Active RFID is less advantageous than passive RFID in terms of its tag cost, size, and battery management, but more advantages in term of sensing nature, its nature, sensing rate ad sensing distance [13]. RFID is developed so that physical information can be stored and sensed for a long time to improve the quality of the system in the addition of basic functions.

Active RFID/WSN will be performing the availability of tag-to-tag communication. Active RFID is less useful than passive due to its cost, tags size, battery consumption. Active RFID saves the energy of tag operates on the tag ID period and data collection period [14]. The active RFID tag uses the radio module to deliver the stored physical information to the reader. RFID provides the point-to-multipoint (P2MP) Communication structure where the reader controls the tags. To minimize the energy consumption of the tag, the reader reins the energy that the radio module consumes by making the tag works in the active and sleep periods [7]. The reader transmits a collection command to multiple tags which are going to deliver the ID to the reader with contention. Data collection period, the reader collects the data on the tags that are sensed from the tag ID collection period using their IDs with the help of the point-to-point (P2P) method. The active period is divided into two periods first one is the tag identification period and other is the data collection period. The id period is called contention period [9]. A reader can be transmitting a command to multiple tag which also deliver ID to the reader via contention. In the data collection period, the reader collects the data on the tags that are sensed from the tag ID collection period using their IDs, via the point-to-point (P2P) method. Then the sleep command turns off the radio module of the tag from which the data have been collected. This is called the collection period (CP). The reader repeats this process proceeds until all the tags within its communication range are collected. Table1. Shows the technical difference between Active and Passive technologies as follows:

	Active RFID	Passive RFID
Tag Power Source	Internal to Tag	Energy transferred from the reader via RF
Availability of Tag Power	Continuous	Only within field of reader
Tag Battery	Yes	No
Available Signal Strength from Tag to Reader	High	Low
Required Signal Strength from Reader to Tag	Low	High

Table 1: Technical difference between Active RFID and Passive RFID

1.4 Network Time Protocol: Network Time Protocol (NTP) is a protocol based upon switching of packets and provides clock synchronization between computer systems. It is an internet protocol provides some interfaces as well. It is also known as Simple network time protocol. NTP is a protocol that is superimposed on top of TCP/IP that assures the time to the time and clock on the radio that is accurate [19]. Within milliseconds, this protocol is capable of synchronizing scattered clocks over long time periods.

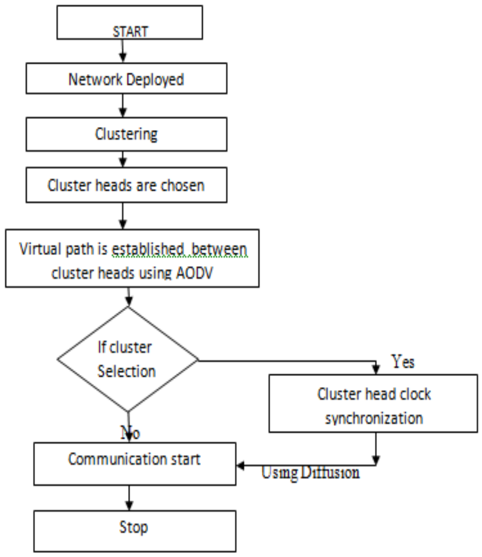
1.5 Global Positioning System: Nodes synchronized their clock according to the GPS which is act as a master clock. So GPS is a master clock and all other nodes are like slaves which set their clock according to the master clock. Mutual authentication is also present between all the nodes. A true relationship is maintained. First of all the nodes set their clock according to the master clock or GPS which sense about the location [20]. In this way, all the nodes are strongly synchronized when the data is transferred from source to destination through the intermediate node then these nodes send data immediately without any delay.

1.6 Clock Synchronization: Clock synchronization is a technique in which all the nodes in a network agree at the same time slot. In this process all the nodes or cluster head of the node set their time slot according to the master node. In data link layer, it works in an efficient manner if it is synchronized with the master clock. Clock synchronization has two techniques:
1. Time-lay synchronization
2. Diffusion based synchronization

In time-lay synchronization, all the nodes of the network set their clock according to the third party clock. In diffusion based technique, any two nodes set their clock accordingly when communication with each other.

4. Proposed Methodology

Firstly we deploy the sensor network with infinite sensor nodes. All the sensor nodes are grouped into clusters. According to the sensor nodes these clusters are formed. Each cluster has a cluster head. Cluster heads are chooses by election algorithm. A node in a cluster which has more resources and energy is selected for cluster head. Each cluster node sends clock time to the cluster head. After that cluster head calculate average clock time and set their clock according to average clock. Now cluster head sends its clock time to the other nodes of the cluster. Nodes set their clock according to the cluster head node. All the cluster heads works in the similar manners. Now to synchronize with the network, all the cluster head calculate their average time. According to the result, all the cluster head set their time.



Flowchart of proposed methodology

5. Experimental Results

The whole scenario is implemented on NS2.

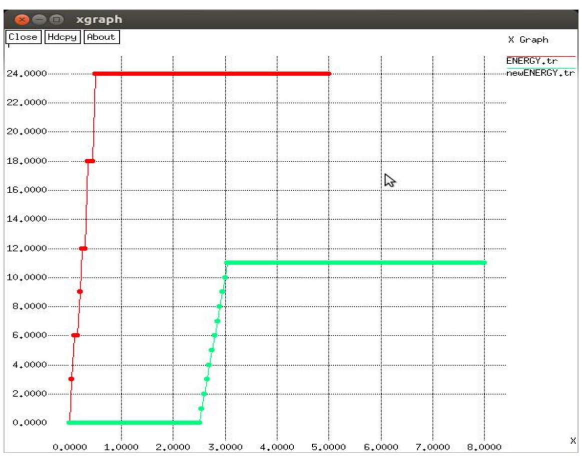


Fig.5.1 Energy Graph

In the figure 5.1, energy consumption of previous and new technique is shown. The red lines show the energy of previous technique. The green line shows the energy consumption in the new proposed technique. The clocks in the previous technique are not synchronized and fixed path are from source to destination. Due to these two reasons retransmission of the packet are required when packet loss is there in the network. In the new technique clocks are synchronized with master clock. The virtual is established between source and destination. The energy consumption is reduced as shown in red line. This graphs show that proposed technique is efficient than the existing technique.

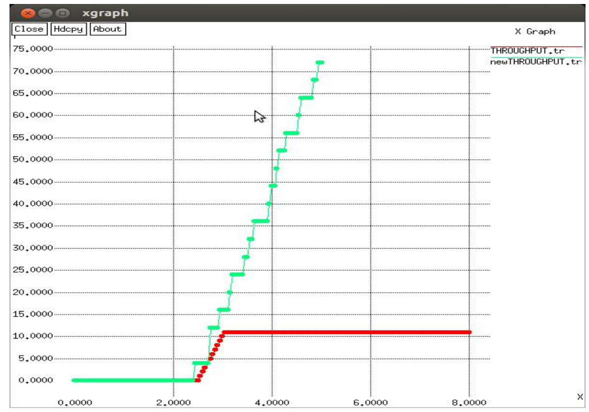


Fig.5.2 Throughput

The figure 5.2 illustrated the throughput of the new and previous technique. The green line shows the throughput of the network in previous technique. The throughput of the new technique is shown in red line. The efficiency of the network is enhanced with the clock synchronization. The throughput the network is enhanced through the use of new proposed technique because the packet loss in the network is reduced.

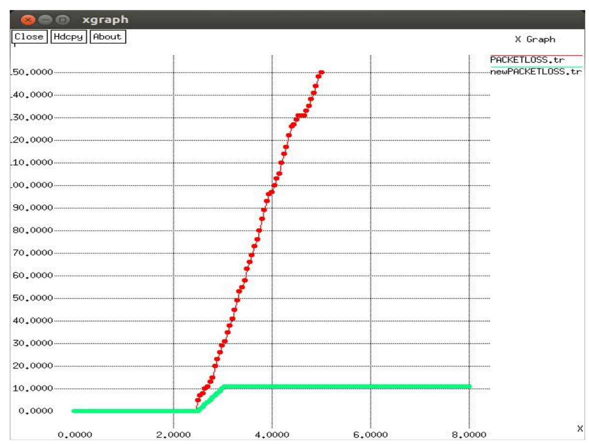


Fig.5.3 Packet Loss

The packet loss graphs are shown in the figure. The packet loss is more in the previous technique. In the previous technique clocks of the cluster heads are not timely synchronized. This is the reason that the packet loss is higher is more in the previous technique. The packet loss in the new technique is reduced , because the clocks of the cluster heads are synchronized with the diffusion technique.

6. Conclusion

All the sensor nodes are deployed in the fixed size area. Then the clustering of the sensor nodes is done. By using the bully algorithm the cluster head is selected means that node which has the highest energy that will be the cluster head. The virtual paths are selected between the cluster heads. The shortest path is selected by using the reactive AODV protocol. Here to avoid the collision the diffusion scheme used the clock is synchronized on each cluster head. RFID is used for the channel sensing to avoid the collisions. The proposed and existing techniques are implemented in NS2 and it is been analyzed that proposed technique performs well in terms of energy consumption, throughput, packet loss and packet overhead. In future work, various data link layer attacks are implemented on the proposed technique to test its performance under simulated environment.

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