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Efficiency Enhancement In WSN By Using RTS/CTS Based Relative Time Synchronization

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Abstract
Wireless Sensor Network is a radio frequency based communication network which can be used for operation over multiple data source points simultaneously. Recent developments in the field of wireless communication have enabled the diminishing size and enhancing capabilities of sensor nodes. The authenticity and usability of network data is largely dependent upon the time synchronization within the network. In order to achieve time synchronization, GPS-based Absolute Time Synchronization is used. But this technique leads to rapid energy drain the system. To overcome this drawback, RTS/CTS based Relative Time Synchronization is used. In the present work, both these techniques have been implemented in the Network Simulator 2 (ns2) and the results have been analyzed for efficiency & energy.

Keywords: *WSN, Time Synchronization, GPS-based Time Synchronization, RTS/CTS based Time Synchronization*

1. Introduction

A Wireless Sensor Network (WSN) is formed by a group of wireless sensors which coordinate with each other to sense and collect similarly classified data from their respective localities. The nodes can either be homogeneous or heterogeneous; depending upon their work environment, nature of work, etc.[1] Since these nodes are wireless and independent in nature, they typically depend on their own battery for their energy requirements. In other words, wireless sensor nodes have limited lifetime. This lifetime is generally shrinks further due to successive data transmission overheads resulting due to frequent packet losses. A WSN which has all its member nodes synchronized to a common clock does not suffer from such problems. That is, clock synchronization is an important pre-requisite for maintain an efficient sensor network. [2]

For achieving clock synchronization among various nodes, numerous algorithms and strategies have been proposed; namely *Reference Broadcast Synchronization (RBS)*[3], *Network-wide Time Synchronization (NTS)*[4], *Time Diffusion Protocol (TDP)*[5], *Probabilistic Clock Synchronization Servicein Wireless Sensor Networks*[6], etc. In the present work two such techniques for obtaining clock synchronization in Wireless Sensor Networks; namely GPS based Time Synchronization protocol [7] and RTS/CTS based Time Synchronization protocol have been implemented on the ns2 simulator and the results have been analysed for energy consumption and longevity of the network.

In both the protocols under consideration, the network is divided into multiple clusters and each cluster selects its own cluster head. All the cluster heads are further connected with a common network Sink where the entire data is collected and processed to get meaningful information [8]. In case a cluster head reaches critically low level of energy or completely dies out, then the elections is carried out again to designate the new cluster head.

2. GPS based Time Synchronization Technique

In this technique, clock synchronization in the network is achieved by using an additional node called the ‘Master Node’ which is connected with the GPS. All cluster heads communicate with the Master Node and adjust their clocks with the time feed from the Master Node. Subsequently, the cluster heads use the same time feed to adjust the member nodes also. In this way, the entire network is synchronized with the real-time GPS based absolute time. [7]

2.1 Simulation in NS2

The Network Simulator 2 (NS2) has been used to implement the simulated version of the protocol. Network Simulator is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks.

NS2 is an object oriented simulator, written in C++, with an OTCL interpreter as a frontend. It is used for simulating a variety of network scenarios or topographies with varying features and parameters.

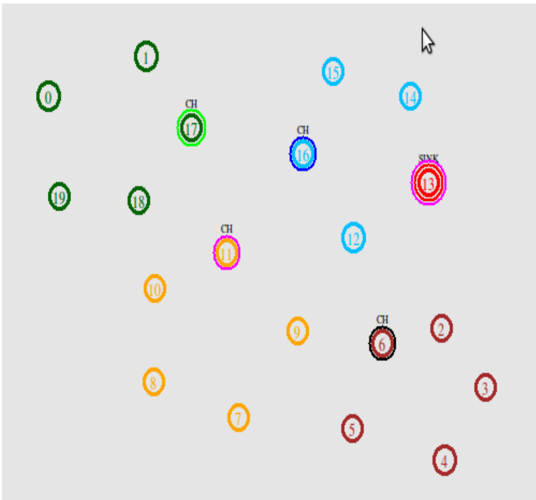

Fig. 1 – Cluster Formation & Cluster Head Selection

After the deployment of the network nodes, they are divided and organized into various clusters based on their energy status and neighbourhood parameters. After cluster formation, election is carried out in each cluster for selecting the member with maximum remaining battery life as the cluster head. All further communication with the Sink is carried out through these cluster heads.

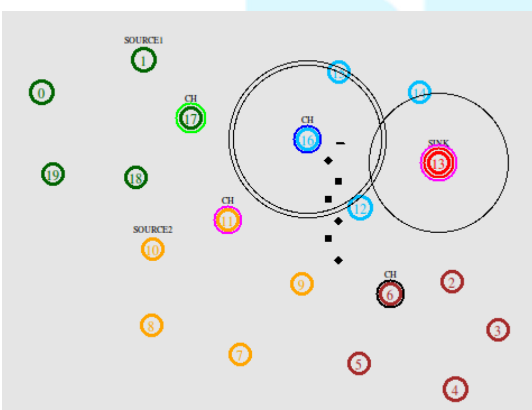

Fig. 2 – Packet Loss due to clock mismatch

During the communication or data transfer, the clock timings on various nodes is very crucial. Due to absence of a common clock in the network, all the nodes maintain their separate individual clocks. The time mismatch among the nodes or clusters leads to frequent packet collisions and data losses.

In order to prevent such losses, a GPS connected 'Master Node' is introduced in the network. This node provides a real-time absolute time feed to all the nodes in tthe network, irrespective of their heirarchical status. As a result, the entire network gets synchronized with the absolute GPS time, and thus, eliminating the problem of data loss.

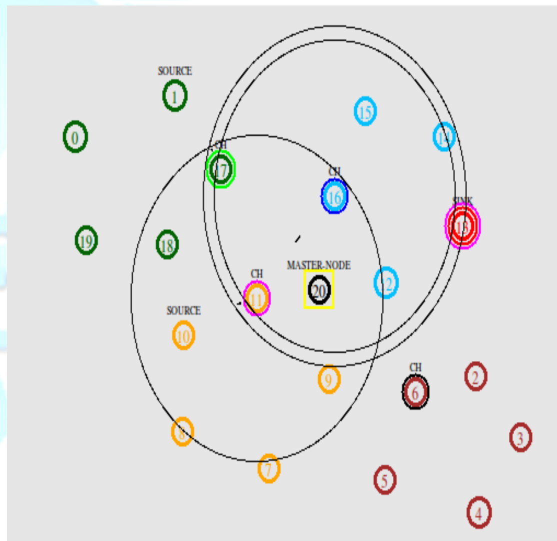

Fig. 3 – GPS based Absolute Time Synchronization

3. RTS/CTS based Time Synchronization Technique

In the RTS/CTS based technique, no Master node is used. Instead, the time feed of the Network Sink is used to relatively synchronize the whole network. Firstly, the Sink sends a Request To Send (RTS) message to all the cluster heads. Then the cluster heads send the Clear To Send (CTS) signal and receive the NONCE time feed (Number to be used only Once) from the Sink. All the cluster heads adjust their clocks according to the time feed from the Sink. Now, each cluster head pings its time feed to all its cluster members who ping back after adjusting their respective clocks. In this manner, the entire network is synchronized by a two-phased strategy.

3.1 Simulation in NS2

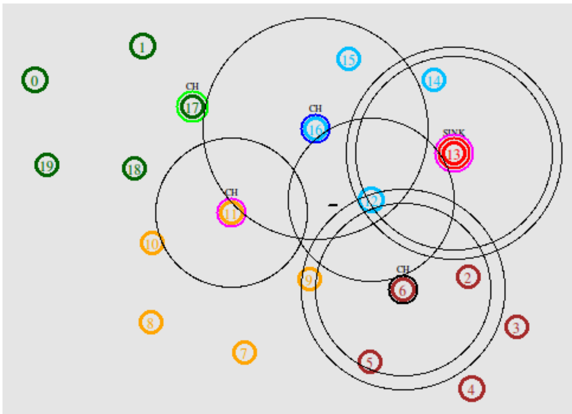

Fig. 4 – Phase One: Cluster Head Synchronization

In Phase One, the nodes in the first level of hierarchy, i.e., the Cluster Head nodes are synchronized with the time feed provided by the Sink node. After clock adjustment, the Cluster Heads acknowledge their synchronization by sending a message to the Sink regarding this.

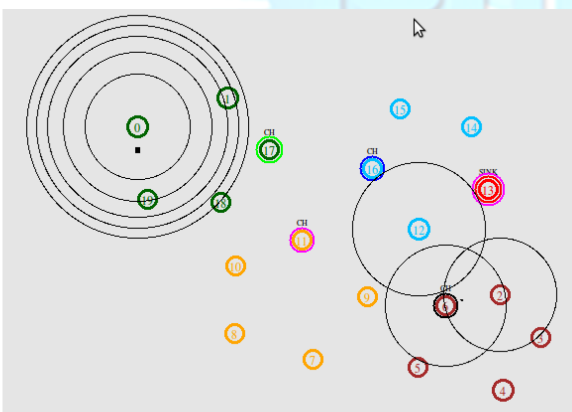

Fig. 5 – Phase Two: Intra-cluster Synchronization

4. Comparison and Analysis

The results provided by the NS2 simulation [9] of both the strategies have been used to compare the energy efficiency of the two. It has been found that although the absolute time synchronization has various inherent advantages but this approach leads to massive and sudden drain in the network energy due to the use of GPS technology (shown in red). On the other hand, the RTS/CTS based strategy (shown in green) shows a two-step energy usage which is still less than the former technique.

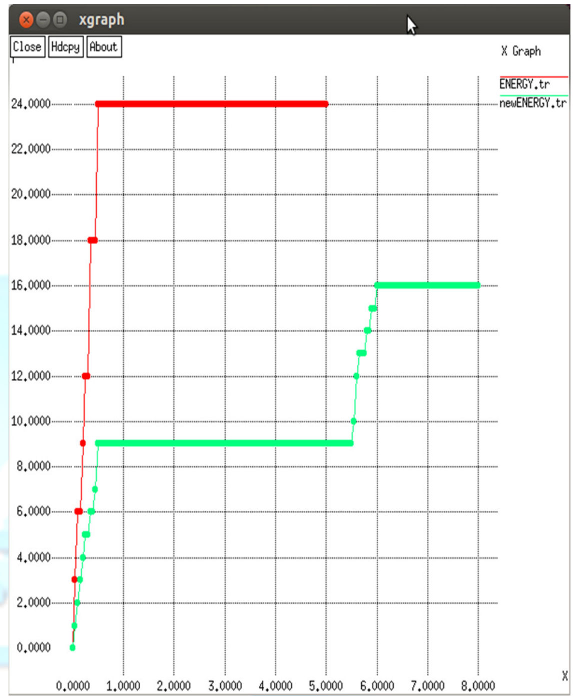

Fig. 6 – Energy Graph

Here, the X-axis represents time per second and the Y-axis shows the energy in joule. The lower energy utility of the RTS/CTS based technique provides the following advantages to the network:

a. It increases the lifetime of the cluster heads involved in the transmission.
b. The increase in the lifetime of cluster heads eliminates the need for holding frequent elections in the clusters.[10]
c. The decrease in the rate of change of cluster heads reduces the overall packet loss in the network.[11]
d. The increase in the lifetime of the whole network raises the usability, efficiency, authenticity and sustainability of the network.

5. Conclusion

Clock Synchronization and energy/battery life consideration are the two important and interlinked areas of concern in Wireless Sensor Networks. In the present work, two Clock Synchronization strategies namely; GPS-based Time Synchronization and RTS/CTS-based Time Synchronization have been comparatively analyzed. The simulation (in NS2) results show substantial improvement in the network performance by using the RTS/CTS based technique when compared with the GPS-based technique. The use of Relative Time Synchronization substantially increases the longevity, throughput and efficiency of the network.

References

[1] Distributed Surveillance Sensor Network. ONR SPAWAR Systems Center, San Diego. Available at http://www.spawar.navy.mil/robots/undersea/dssn/dssn.htmli

[2] B. Liskov, "Practical Uses of Synchronized Clocks in Distributed Systems", *Proc. Tenth Annual ACM Symposium on Principles of Distributed Computing,* pp. 1–9, Aug. 1991

[3] J. Elson, L. Girod, and D. Estrin, "Fine Grained Network Time Synchronization using Reference Broadcasts", *Proc. FifthSymposium on Operating Systems Design andImplementation (OSDI 2002),* Vol 36, pp.147–163, 2002.
Sensor Networks: A Survey", *University of Illinois*, pp. 1-49, 2005.

[9] Yinfei Pan, "Design Routing Protocol Performance Comparison in NS2: AODV comparing to DSR", Department of Computer Science, SUNY Binghamton Vestal Parkway East, Vestal, NY 13850

[4] S. Ganeriwal, R. Kumar, S. Adlakha, and M. Srivastava, "Network-wide Time Synchronization in Sensor Networks", *Technical Report, Networked and Embedded Systems Lab,* Elec. Eng. Dept., UCLA, 2003.

[5] W. Su, I. Akyildiz, "Time-Diffusion Synchronization Protocols for Sensor Networks", *IEEE/ACM Transactions on Networking*, 2005.

[6] S. Pal Chaudhuri, A. Saha, and D. B. Johnson, "Probabilistic Clock Synchronization Service in Sensor Networks", Technical Report TR 03-418, Department of Computer Science, Rice University, 2003.

[7] Michael Meier, Philipp Sommer and Roger Wattenhofer, " Precise Time Synchronization for Wireless Sensor Networks using the Global Positioning System**",** Distributed Computing Group, Computer Engineering and Networks Laboratory (TIK), ETH Zurich

[8] Bharath Sundararaman, Ugo Buy, and Ajay D. Kshemkalyani, "Clock Synchronization for Wireless

[10] Tal Anker, D.Bickson, BrachaHod and Danny Dolev, "Efficient Clustering for Improving Network Performance in Wireless Sensor Networks", *The Hebrew University of Jerusalem, Israel*

[11] J.Ahmeset. at., "RFID-WSN Integrated Architecture for Energy and Delay-Aware Routing", *SpringerBriefs in applied Sciences and Technology*, 978-981-287-414-6_1