International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 18 (2015) pp 39179-39183
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Energy efficient distributed flooding time synchronization Protocol for Heterogeneous WSN's.

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Abstract
Wireless sensor networks had attracted interest of researchers in the decade due to number of challenges and applications. It is a type of ad hoc network that consist of hundred of nodes and can be deployed and work without human intervention. These nodes are micro sensors which are less in their price and therefore have different constraints. Nodes work together using wireless networking in different areas such as accurately monitoring the environmental conditions and then aggregate the data to form useful information. There are number of other applications of Wireless sensor networks. The nodes require working together for distributed tasks and accurate, reliable time is one of the needs for some of its applications. The protocols used for the clock synchronization for wired network are not suitable for wireless sensor networks due to severe energy constraints. The protocols in wired network need to send messages to server again and again to get synchronized, which is not possible in Wireless sensor networks. The reliable and energy efficient clock synchronization have different challenges, which are intensively working out by the researchers in this field. In this paper work, we propose that clock synchronization provide overhead and these overheads can be eliminated up to some extent. Physical clock synchronization is not possible and we advocate the concept of virtual clocks, which are used for the purpose of synchronization. The wireless sensor networks are single hop and multi hop in nature. We use a method "Waiting Flood" which is a hybrid protocol.

Keywords: clock synchronization, adaptive, pragmatic, hierarchy, disaster, Time Stamp, hybrid, waiting flood.

Introduction

New advancements towards reducing the size and cost, low power consumption design have led to research in tiny, wireless, low power sensors. The vision of many researchers is to create environment that consist of sensors which are deployed in large scale and each such sensor is have radio transmission capability which can send data in short range of wireless communication. These sensors can be used to detect conditions such as sound, temperature or movement of objects. There are other applications for sensor networks such as climate study, disaster prevention, maintenance of machines, groundwater containment monitoring and military. The main phenomenon of wireless sensor network is to deploy small wireless sensors closer to their target instead of using high powered, long range sensors. This placement use distributed concept of communication and working[2]. It also improves signal to noise ratio, which is critical for sensing phenomena that are transmitted with high path loss. It is also

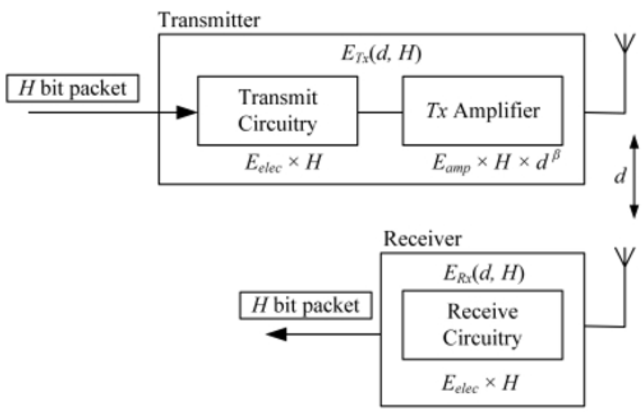


Figure 1 WSN Architecture

impractical to deploy large number of wired sensors as they require co-deployed infrastructure. It is very labor intensive and time consuming to deploy a human power to monitor the events where the frequencies of events are very low. Adhoc deployment of wireless sensor network may succeed in the applications where tradition solutions have failed[3]. They are capable of actuation affecting the rather than only observing the target. The design of such systems put various challenges to the researchers working in this area[1]. The sensor networks are different from the traditional distributed systems in many ways. The most important characteristic of sensor networks that differentiate them from other is the need of energy efficiency. The sensors are not deployed manually one by one at the target but usually air throne at the desired or target area. This makes the battery replacement impossible. So the sensors must be designed in such a way that they conserve energy and provide a long network life and observations. Wireless sensor node compose of many components such as Transmit circuitry, Amplifier connected to antenna for a sender node wish to transmit H bits of packets, similarly receiver node have receiving antenna and receive circuitry architecture as shown in figure 1 as WSN architecture[7], m bits Packets need to be transmitted over a distance of d from sender node to receiver node where m bits of packets are result of query requested form the sink node after any interval of time, Designs allow users to query the network such as "notify me when a large region experiences a temperature below 5 degrees" or "report the location where the following animal call is heard" If a node can correlate an incoming audio stream to the desired pattern locally, and report only the time and location of a match, the system will be many orders of magnitude more efficient than one that transmits the complete time-series of sampled audio. The use of local processing, hierarchical collaboration, and domain knowledge to convert data into increasingly distilled and high-level representations or, data reduction is key to the energy efficiency of the system. To enhance the battery backup various harvesting source can are be inculcate for the batter performance of the network and can increase the network prolong life time[10]. Energy Source from the surrounding can improve the energy graph, which is the main current research proliferation and can uphold in the development of the WSNs as shown in figure 2, where energy harvesting possible from solar components, thermal energy harvesting.

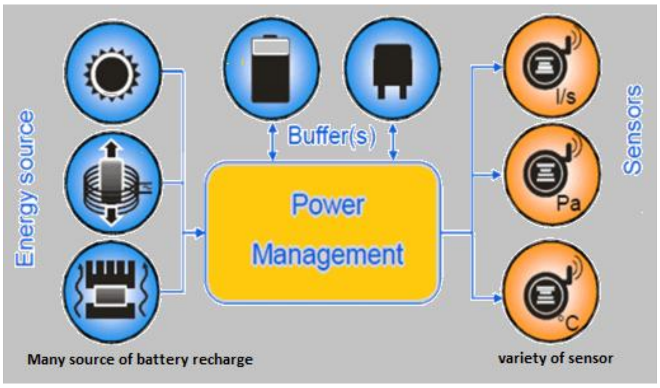


Figure 2 Harvesting Energy Architecture of WSN

In general, a perfect system will reduce as much data as possible as early as possible, rather than incur the energy expense of transmitting raw sensor values further along the path to the user. Another fundamental property of sensor networks is the dynamics. Over time, nodes can fail they may run out of energy, overheat in the sun, be carried away by wind, crash due to software bugs, be eaten by a wild bear or due to logging of water on the surface many more.

Even in fixed positions, nodes' communication ranges (and, thus, topologies) can change dramatically due to the vagaries of RF propagation, a result of its strong environmental dependence. These changes are difficult to predict in advance many traditional large-scale networks such as the Internet work in the face of changing configurations and brittle software partly because the number of people maintaining the network has grown along with the size of the network itself. In contrast, there may be a single human responsible for thousands of nodes in a dense sensor network. Any design in which each device requires individual attention is infeasible. This leads to another important requirement sensor networks must be self-configuring, and adaptive to changes in their environment.

I. Ease of Use

A. Application

Tracking and Monitoring are the two different domains of application for wireless sensor networks. Tracking applications are generally focused on the tracking of vehicles, animals, humans and objects. Monitoring applications are focused on areas as power monitoring, location monitoring, environmental monitoring, health monitoring and many more. We like to mention here few applications that have been deployed and tested in the real environment. Health monitoring applications using wireless sensor network can improve the existing health care and patient monitoring. Five prototype designs have been developed for applications such as infant monitoring, alerting the deaf, blood pressure monitoring and tracking, and fire-fighter vital sign monitoring. The prototypes used two types of motes: T-mote sky devices and SHIMMER (Intel Digital Health Group's Sensing Health with Intelligence, Modularity, Mobility, and Experimental Re-usability). Because many infant die from sudden infant death syndrome (SIDS) each year, Sleep Safe is designed for monitoring an infant while they sleep. It detects the sleeping position of an infant and alerts the parent when the infant is lying on its stomach. Sleep Safe consists of two sensor motes.

One SHIMMER mote is attached to an infant's clothing while a T-mote is connected to base station computer. The SHIMMER node has a three-axis accelerometer for sensing the infant's position relative to gravity. The SHIMMER node periodically sends packets to the base station for processing. Based on the size of the sensing window and the threshold set by the user, the data is processed to determine if the infant is on their back. PinPtr is an experimental counter-sniper system developed to detect and locate shooters. The system utilizes a dense deployment of sensors to detect and measure the time of arrival of muzzle blasts and shock waves from a shot. Sensors route their measurements to a base station (e.g., a laptop or PDA) to compute the shooter's location. Sensors in the PinPtr system are second-generation Mica2 motes connected to a multi-purpose acoustic sensor board. Each multi-purpose acoustic sensor board is designed with three acoustic channels and a Xilinx Spartan II FPGA. Mica2 motes run on a TinyOS operating system platform that handles task scheduling, radio communication, time, I/O processing, etc. Middleware services developed on TinyOS that are exploited in this application include time synchronization, message routing with data aggregation, and localization.

B. Time synchronization in wireless sensor network

Motivation is one of the main requirements for research and it depends on need. In this section we focus on the factors and need that motivate us to work in the area. Clock synchronization is important for coordinating actions across a distributed set of actuators. A very important aspect of distributed system design is multisensory integration i.e combination of information gained from multiple sensors. For example, consider a sensor network whose goal is to detect a stationary phenomenon Q might be a region of the water table that has been polluted, within a field of chemical sensors. Each individual sensor might be very simple, capable only of measuring chemical concentration and thereby detecting whether or not it is within Q. By integrating knowledge across all the sensors, combined with knowledge about the sensors' positions, the complete network can describe more than just a set of locations covered by Q: it can also compute Q's size.

ENERGY-EFFICIENT SCHEDULING

Low-power, short-range radios of the variety typically used for wireless sensor networks expend virtually as much energy passively listening to the channel as they do during transmission. As a result, MAC (Medium Access) protocols are often designed around this assumption, aiming to keep the radio off for as long as possible. TDMA is a common starting point because of the natural mechanism it provides for adjusting the radio's duty cycle, trading energy expenditure for other factors such as channel utilization and message latency. Precious energy can be conserved by turning the radio off, waking up only briefly to exchange short messages before going back to sleep.

The energy savings is often directly correlated with the precision of time synchronization. Consider two wireless sensor nodes that have agreed to rendezvous on the radio channel once every 60 seconds to exchange a short message say, 8 bits representing the current temperature. Using a 19.2kbit/sec radio, 8 bits can be transmitted in about 0.5ms. However, in practice, the radio must be awakened early to account for time synchronization error, as depicted in figure 3 below. The amount of time the radio is expending energy listening to the channel. The factor is even larger for faster radios with a 56kb /sec radio, a 1ms guard band is more than 7 times longer than the time needed to transmit 8 bits.

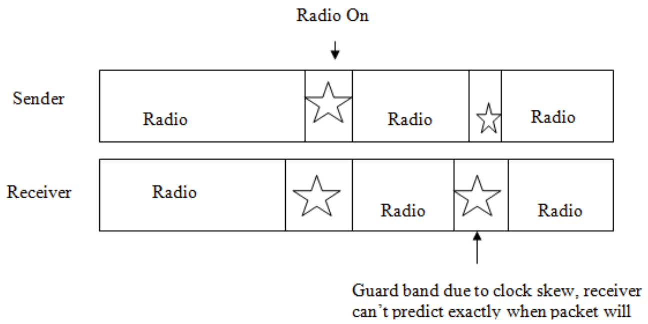


Figure 3 The effect of time synchronization on the efficiency of a TDMA radio schedule.

In addition, even assuming perfect synchronization at the start of a sleep period, a typical quartz oscillator on such a sensor will drift on the order of 1 part in 105 or 0.6ms after 60 seconds. Of course, sending synchronization packets during the sleep period defeats the purpose of sleeping, so we must consider frequency estimation as part of the time synchronization problem. This example demonstrates not only the importance of time synchronization in a sensor network, but also one of its difficulties: any resource expended for synchronization reduces the resources available to perform the network's fundamental task. Traditional TDMA systems (e.g., cellular telephone networks) often do not have this constraint, and are engineered only to maximize channel utilization. Good time synchronization is important in those systems because it reduces the size of the guard time, but it is also easier because of the high data rate: each frame received also implicitly gives information about the sender's clock. This information can be used to frequently re-synchronize a node with its peers.

In this paper we will discuss the excursus need of synchronization problem in sensor network to coordinate their operation and to achieve a complex sensing task, synchronization is need in our thesis as to accomplish many aspect of data collection from source to sink seeking for the caliber deliver of packets between the nodes without any delay or lack any timescale.

Table 1 parameter of proposed protocol

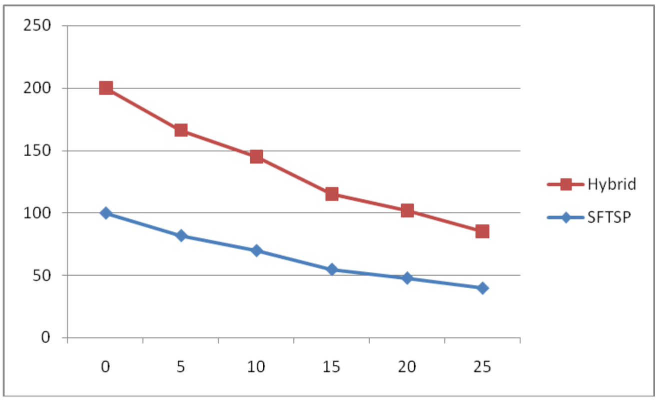
Parameter	Value
Deployed energy of sensor	1000 milli joule
Energy in receiving	0.1 Milli joule
Energy in transmitting	0.4 Milli joule
Maximum simulation time	500 units
Range of Sensor	100 units

The model used for simulation of the proposed protocol is as under:

- ➢ The sensor nodes that are deployed are fixed and distributed upon a predefined area.
- ➢ Cluster head are already placed in the network.
- ➢ Sink node is also deployed in the network.
- ➢ The time for resynchronization is user defined.
- ➢ Parameter for resynchronization must be given before start of the simulation.
- ➢ Due to limitation of deployed are the number of nodes varies from 25-40
- ➢ The sensor node can transmit up to 100 units along its radius.
- ➢ The transmission area is considered as circle in nature.
- ➢ A sensor is registered with only cluster head at a time.

II. RESULT

Simulation is one of the most powerful methods for designing, analyzing and comparing the system. It is a very cost effective method for exploring the system before making a huge cost investment to develop the real system. Simulation deals with realty and therefore most of the work in Wireless Sensor Network are done using simulators. The number of messages that are propagated in the network in the proposed method reduces as we increase the number Whereas the use of hybrid method only use Reference broadcast at the leaf nodes and hence reduces the messages. The reduction of messages in hybrid method finally concludes to less energy consumption at the nodes. The figure 4 clearly demonstrate the above said facts. A large number of nodes, when work together wirelessly to achieve a similar target is known as wireless sensor network. Sensor is small battery operated device which communicate with each other by the mean of sending and receiving messages. The role of a sensor can be broadly divided as sensing and routing. They sense the phenomenon and route the information collected to other nearby sensor, depending upon the architecture and protocol used in the network.



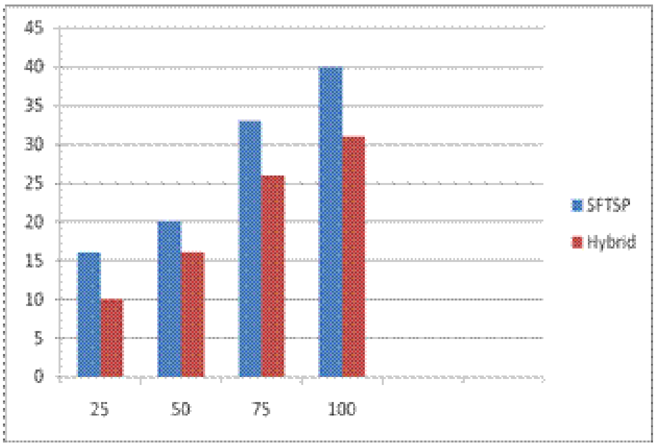


Figure 4 Energy consumption and nodes in network

All the operations are battery consuming and saving battery is one of the main concerned of the researchers. Time synchronization is one of the needs of sensor network to work properly and efficiently. Time synchronization requires communication and again this communication will be battery consuming. There is large overhead due to message exchanging requirement of time synchronization in wireless sensor network and this overhead can be reduce or avoided in some specific situations. The proposed "Hybrid protocol" assumes the scenario where the number of events is very less. In this scenario keeping sensor synchronized by exchanging a lot of messages will reduce the network life time drastically. Existing algorithm Slow Flooding is used to flood the synchronization message in the network and no further resynchronization is proposed. In case there is any event detection at the sensor node, the node will synchronized with its neighbor node using the existing protocol Reference Broadcast synchronization. On detection the event at the cluster head and further at sink node, the Slow Flooding message is again resynchronized to keep the clock time synchronized in the network. The proposed algorithm provide low overhead of message transmission and hence save energy at each sensor node. This will also increase the network life time. Simulated the proposed Hybrid method and comparing it with the individual protocols on same parameter shows that the Hybrid method provides low overhead as compared to other methods.

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Conclusion

The idea proposed here can be fully or partially implemented in any protocol to improve the performance of that protocol. A new protocol can be designed using the concepts proposed here to implement in other application where time synchronization is a need and the events are very low. In this implementation the cluster head based approach is assumed in the network. The lesser the number of cluster head the less is the overhead of the protocol is, this is another open research problem for the researchers. Comparison to already existing many other protocols for time synchronization can be done.

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