Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 03, pp.5933-5936, March, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

TIME SYNCHRONIZATION PROTOCOL FOR WIRELESS PASSIVE SENSOR NETWORKS WITH COMMUNICATION COVERAGE

***Jaya Sankar, C. H. and Devaraju, Y.**

ECE Department, Dr.Samuel George Institute of Engineering and Technology, Markarpur, Ap, India

ARTICLE INFO

Article History:
Received 20th December, 2013
Received in revised form
18th January, 2014
Accepted 14th February, 2014
Published online 31st March, 2014

Key words:
Sensor networks, Wireless passive sensor networks, Modulated backscattering, Communication coverage.
Time Synchronization,
ITPSN protocol.

ABSTRACT

Wireless passive sensor networks (WPSN) designed to operate using MB do not have the lifetime constraints of conventional WSN. System lifetime of wireless sensor networks (WSN) is inversely proportional to the energy consumed by critically energy-constrained sensor nodes during RF transmission. In that regard, modulated backscattering (MB) is a promising design choice, in which sensor nodes send their data just by switching their antenna impedance and reflecting the incident signal coming from an RF source. The communication performance of WPSN is directly related to the RF coverage provided over the field the passive sensor nodes are deployed. This paper puts forward the ITPSN protocol, which makes the original single two nodes two-way messages exchange way into the third node monitor mode, greatly reduces the synchronous time, saves the time and energy for synchronization, adds the judgment of the node failure and treatment of node failure, and improves the robustness and expansibility. The simulation results show that ITPSN inherited TPSN's low energy consumption, low average errors and can effectively reduce the time and energy needed for synchronization, strengthening its robustness.

INTRODUCTION

Wireless sensor networks (WSN) are, in general, composed of low-cost, low-power sensor nodes which can only be equipped with a limited power source, i.e., a battery (Akyildiz and Sankara subramaniam 2002). Sensor nodes consume most of the stored power during RF transmission. At this point, modulated backscattering (MB) (Kossel *et al.*, 2000) is a promising communication technique leading to a new sensor network paradigm, Wireless Passive Sensor Networks (WPSN). WPSN are supplied with energy by external RF power sources. With MB approach, a passive sensor node transmits its data simply by modulating the incident signal from an RF source by switching its antenna impedance. Therefore, the transmitter is basically an antenna impedance switching circuitry, and WPSN is free of the lifetime constraint of conventional WSN. WSNs have been regarded as fundamental infrastructures for future ubiquitous communications due to a variety of potential applications: monitoring the health status of humans, animals, plants, and the environment; controlling industrial machines and home appliances; homeland security; detection of chemical and biological threats (Akyildiz and Sankarasubramaniam 2002). As in WSN, to meet application requirements, event characteristics must be reliably sensed and communicated via collective operation of sensor nodes to remote sink in WPSN.

****Corresponding author: Jaya Sankar, C H.** ECE Department, Dr.Samuel George Institute of Engineering and Technology, Markarpur, Ap, India.*

RF sources receive the signal reflected from sensor nodes, and they should send the gathered data to the sink without causing any interference in the network. Therefore, in order to maintain the communication connectivity and RF coverage without compromising the communication reliability due to possible interference, it is important to carefully design the WPSN deployment, especially the number of RF sources.

Time synchronization establishes the time relationship between two nodes, providing all the nodes with the local clock for Collaborative working. In the practical application, sensor nodes often need time information and incidental use of crystals to control local clock, the local clock is often disturbed to produce deviation by some external factors (temperature, pressure change and the electromagnetic wave, etc.), and for initial values of crystals are different, also it caused a deviation. Even if the nodes have been synchronous through the synchronization mechanism, the different environment also forms deviation slowly. Therefore, time synchronization mechanism need to be cyclically triggered to meet synchronous need. TPSN (Timing-sync Protocol for Sensor Networks) is one of the WSNs time synchronization protocols, through a two-way messages exchange to reach time synchronization (see Fig. 1). With the root node as the center, establishes a hierarchical structure of network topology, then synchronization with the clock of the root node, and eventually get the entire network synchronization. The whole process is divided into level discovery phase and synchronization phase (Kossel *et al.*, 2000; Kocer *et al.*, 2004).

SYSTEM DESIGN MODEL

WPSN MODEL

Wireless passive sensor network proposed in this study is based on MB. The source of energy is an RF power source which is assumed to have unlimited power. The source transmits RF power to run the passive nodes, and it transmits and receives information from WPSN nodes simultaneously. A typical WPSN node hardware is represented in Fig. 1. The WPSN node hardware differs from the conventional WSN hardware basically on the power unit and the transceiver.

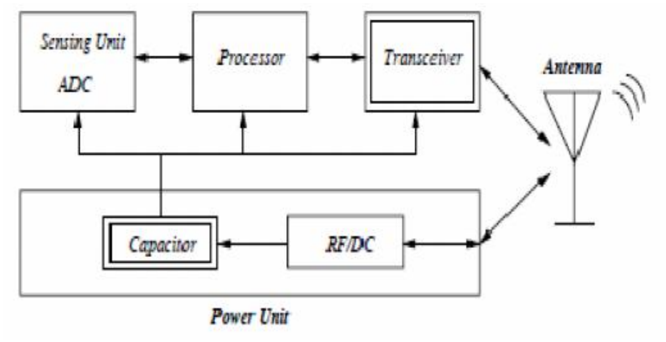


Fig. 1. Building blocks of a typical WPSN node

In a conventional WSN node, the power unit is a battery. In the WPSN node, however, the power generator, which is an RF to-DC converter (Kocer *et al.,* 2004), is an inherent part of the power unit and is the unique power source of the sensor node. Required power is obtained from the incident RF signal inducing a voltage on the receiver WPSN node. Then, as long as 100mV of voltage is induced on the receiving antenna (Kocer *et al.,* 2004), RF-to-DC converter yields DC power which is either used to wake up and operate the receiver, sensing and processing circuitries of sensor node, or kept in a charge capacitor to be used later. The transceiver of a conventional WSN node is typically a short range RF transceiver. Compared to the other units of the node, the power consumption of the transceiver is considerably high. For this reason, in WPSN, MB, a passive and less power consuming method is adopted as the main communication mean. Here, the incident signal from the RF source is reflected back by the WPSN node. The node modulates this reflected signal by changing the impedance of its antenna (Kossel *et al.,* 2000), thereby transmits the data gathered from its sensing unit and processed by its processing unit, back to the RF source. The transceiver for MB is much less power consuming and less complex, compared to conventional RF transceivers (Kossel *et al.,* 2000). Furthermore, the maximum communication range of MB is determined by the intensity of the incident signal, and the sensitivity of the corresponding receiver. Thus, long range communication with the WPSN node is theoretically achievable without increasing the power consumption of the node. In a WPSN deployment, let *Pr* and *Pt* be the received power on the passive sensor node and the transmitted power by the RF source, respectively. Then, the RF signal propagates according to Friis' transmission equation (Balanis 1997).

$$P_r = P_t G_t G_r \left(\frac{\lambda}{4\pi R_{rf}}\right)^2$$

where *Gt* and *Gr* are the antenna gains, *λ* is the wavelength, i.e., the ratio of the speed of light *c* to the frequency *f*, and *Rr f* is the distance between the RF source and WPSN node. Let the voltage induced on the antenna of WPSN node due to incident signal from RF source be *Vt*. Then, the relation between the received RF power *Pr* and the induced voltage level *Vt* is expressed as (Balanis 1997).

$$P_r = \frac{|V_t^2|}{8(\,R_r + R_t)}$$

where *Rr* and *Rl* are the impedances of the antenna of WPSN node and the RF source, respectively. According to (1) and (2) and for 4*W* effective isotropic radiated power (EIRP) output power of RF source, *Rr*=*Rl*=50Ω, *GtGr* = 8.5*dBi*; it is calculated that 100*mV* can be induced on the antenna of WPSN node from 6.75*m* at 2*GHz*, 13.49*m* at 1*GHz*, and 26.98*m* at 500*MHz*, respectively. These calculated range values clearly demonstrate that multiple RF sources are needed for the practical implementation of a WPSN deployed over a large event area. Therefore, the required number of RF sources, for a given network size and communication parameters, needs to be determined for sufficient RF coverage, and hence, effective communication in WPSN.

TPSN Synchronization

TPSN (Timing-sync Protocol for Sensor Networks) is one of the WSNs time synchronization protocols, through a two-way messages exchange to reach time synchronization (see Fig. 2). With the root node as the center, establishes a hierarchical structure of network topology, then synchronization with the clock of the root node, and eventually get the entire network synchronization. On receiving the time-sync packet, nodes wait for some random time to be synchronized to the higher level, and eventually every node is synchronized to the root node to realize the whole network synchronization.

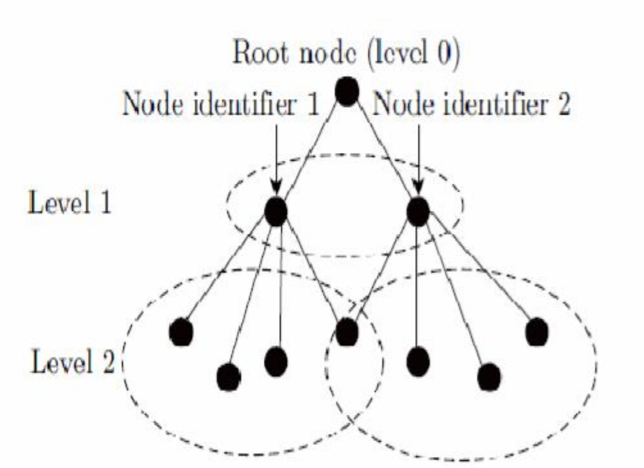


Fig. 2. TPSN topology building process

This randomization is to ensure they initiate the messages exchange until the nodes have been synchronized in the higher level. Therefore, based on the TPSN protocol, this paper proposes ITPSN (Improved Timing-sync Protocol for Sensor Networks) protocol, which makes the original single two nodes two-way messages exchange ways into the third node monitor mode, so that it can greatly reduce the synchronous time, saves time and energy for synchronization, and adds the judgment of the node failure method and treatment of node failure and adds to improve the robustness and expansibility.

ITPSN Synchronization

This paper presents ITPSN based on the combination of TPSN and RBS (Reference Broadcast Synchronization), and makes full use of the broadcast characteristic of RBS, takes the third party nodes to monitor, this makes two-way information exchange to be extended to the third node monitor, saving more time and energy (see Fig. 3). It has a certain measure to node failure and adds in the Synchronization, it is a more perfect Synchronization protocol.

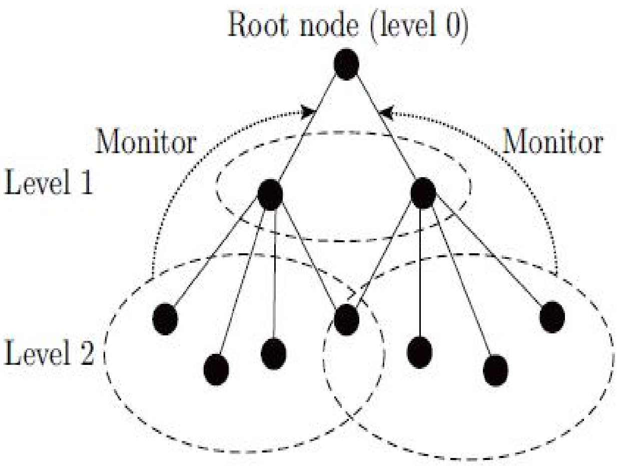
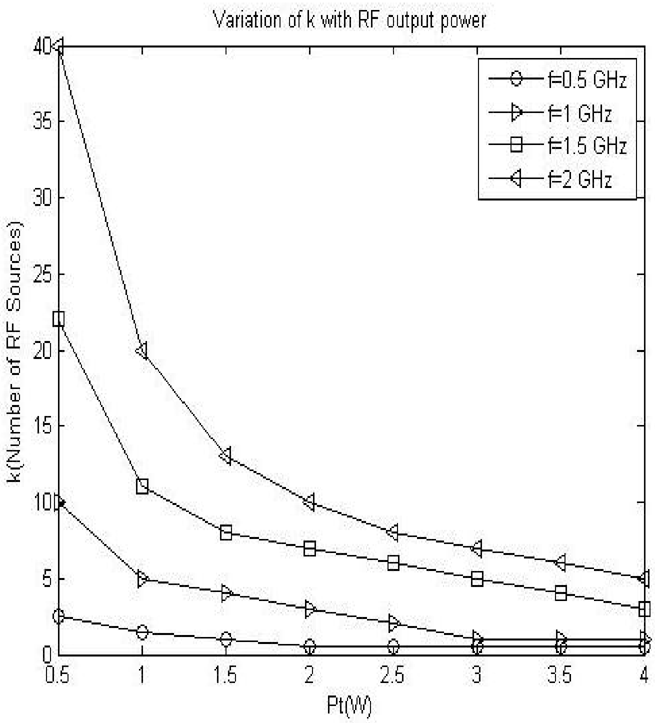


Fig. 3. ITPSN topology building process



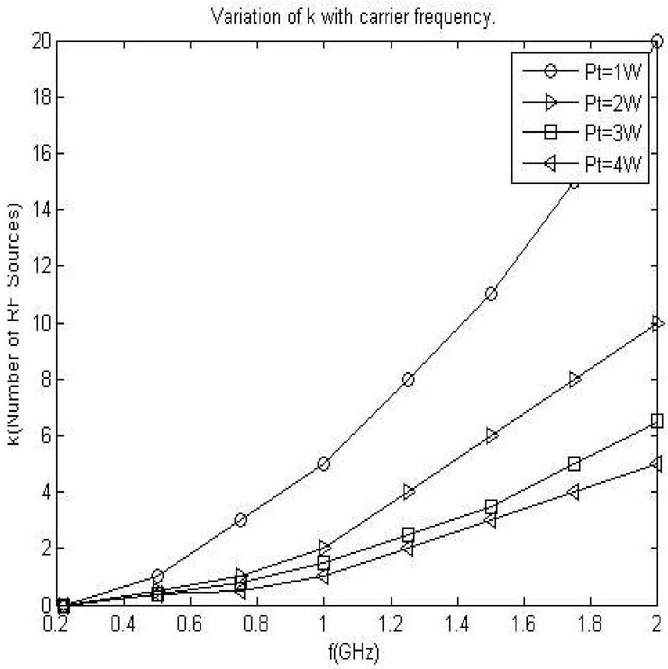


Fig. 4. Variation of *k* with (a) RF output power, (b) carrier frequency

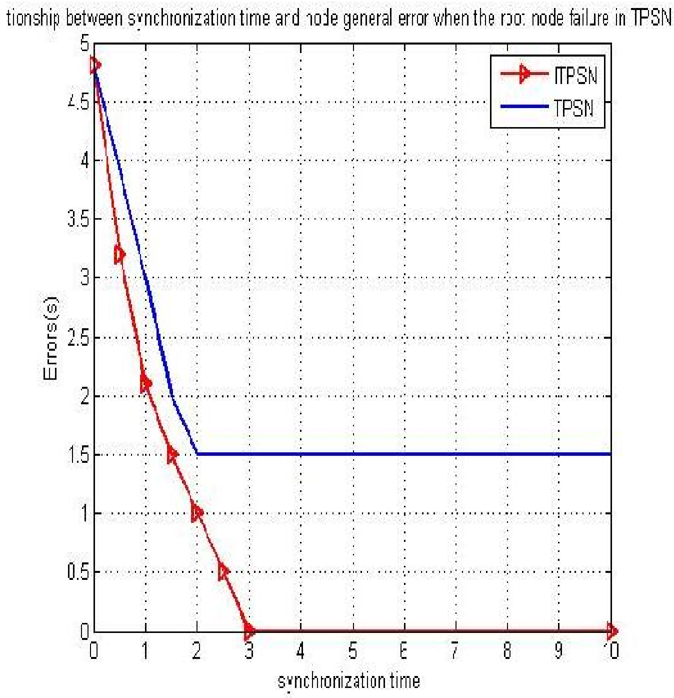


Fig. 5. After node failure, the relationship between time and node general error

SIMULATION RESULTS

The required number of RF sources, i.e., *k*, is investigated for varying event field Δ, RF frequency *f*, output power *Pt*. Note that in order to minimize the overall energy consumption in WPSN, the output power of RF sources needs to be minimized. In this case, for the minimum output power which is just sufficient to induce the necessary voltage, i.e., $V_{t\,min} = 100mV$, on the receiver of the WPSN nodes, Increasing the RF output power P_t means increasing the range R_{rf} as in (1). An event field can be covered by a smaller number of RF sources if the communication range of RF sources is increased. In Fig. 3(a), k decreases with increasing P_t, and hence, increasing R_{rf} range. The root node fails again to choose start root node mechanism; the energy of the highest node will be set as the root node, then layered again. This illustration shows the root node after failure TPSN and ITPSN synchronization time and node of the relationship figure general error.

CONCLUSION

In this letter, RF communication coverage in WPSN is analyzed. The required number of RF sources for effective modulated backscattering-based communication in WPSN is determined in terms of the dimension of the event field. This paper puts forward the improvement of the TPSN agreement ITPSN, not only inherits the TPSN low energy consumption, low average small errors, but also greatly improves the TPSN agreement scalability and synchronize ITPSN can effectively reduce energy consumption in the dense environment, laying the foundation for the future synchronization research and application in large-scale network.

REFERENCES

Akyildiz I. F., W. Su, Y. Sankarasubramaniam, and E. Cayirci, “A survey on sensor networks,” *IEEE Commun. Mag.*, vol. 40, no. 8, pp. 102-114, Aug. 2002.

Balanis C. A., *Antenna Theory: Analysis and Design*, 2nd ed. John Wiley and Sons Inc., 1997.

Ganeriwal S., R. Kumar, M. B. Srivastava, Timing-sync protocol for sensor networks, the First ACM Conference Embedded Networked Sensor System (SenSys), No. 11, 2003, 138-149.

Kocer F., P. M. Walsh, and M. P. Flynn, “Wireless, remotely powered telemetry in 0.25m CMOS,” in *Proc. IEEE Radio Frequency Integrated Circuits Symposium (RFIC)*, pp. 339-342, June 2004.

Kossel M., H. R. Benedickter, R. Peter, and W. B¨achtold, “Microwave backscatter modulation systems,” *2000 IEEE MTT-S Digest*, vol. 3, pp. 1427-1430, June 2000.

Saurabh Ganeriwal, Ram Kumar, Mani B. Srivastava, Timing-sync protocol for sensor networks, Proceedings of the First International Conference on Embedded Networked Sensor Systems, 2003, 138-149.

Yik-Chung Wu, Qasim Chaudhari, Erchin Serpedin, Clock synchronization of wireless sensor networks, IEEE Signal Processing Magazine, Vol. 28, 2011, 124-138.

****