ISSN:0975-9646

Application of Wireless Sensor Network at Home

Geeta Gupta[*], Mohit Rathore[**],Binoda Nand Prasad[***],Vikas Gupta[****]

[*] *VGAM Information Systems Private Limited*
SCF-38, 2nd Floor, Huda Market -2, Sector 19, Faridabad, Haryana INDIA 121002

[**]*Amity University, Sector 125, Noida, UP, INDIA 201313*
[***]*Guru Gobind Singh Indraprastha University, Sector 16C, Dwarka, Delhi, INDIA 110078*

[****] *VGAM Information Systems Private Limited*
SCF-38, 2nd Floor, Huda Market -2, Sector 19, Faridabad, Haryana INDIA 121002

Abstract: **Monitoring infants, elderly and the disabled people living alone has become a major health problem in our modern societies. For the home monitoring, we are interested in the study and the proposal of a solution allowing distributed sensor nodes to interact with each other in an optimal way adapted to the specific application constraints. We want to build a wireless sensor network that consists of several short range sensor nodes exchanging data between them according to a communication protocol at Medium Access Control (MAC) level. This protocol will reduce energy consumption, transmission time and also the loss of information. In this paper, we proposed a deterministic, adaptive and energy saving medium access method based on a mesh topology and the IEEE 802.15.4 physical layer. It ensures the reduced message delivery time with limited collision risk due to the spatial reuse of medium in the two hop neighbourhoods.**

Keywords: Sensor Network, Medium Access Control, Energy Saving, Mesh

I. INTRODUCTION

As the aging population is increasing and concept of nuclear family is getting popular many countries are facing an urgent requirement to provide appropriate home environment solutions for their citizens [1] [2]. Even elders love their immediate environment and they love their freedom. But in the case of any accident or sickness that autonomy can quickly turn into dependence. As a solution, some people use systems embedded on their body, like physiological sensors [3]-[5]. These devices have their own limitations. The patient is usually unable to use an alert system because either he is not wearing his equipment or if he suddenly feels unwell he is unable to perform the alert activation gesture.

The solution we consider is to instrument the environment of the person instead of person himself. By monitoring the main environmental characteristics of their living space it seems to be possible to get an independent and happy lifestyle pattern of the person [6]-[8]. For example, measuring room temperature, humidity level, noise levels, in many strategic areas at home can provide useful data to interpret a physical activity in time and space. Data processing will determine circadian activity and will contribute to detect unusual situations and emergency cases. But the major challenge is to propose a suitable sensor network that allows uninterrupted data transmission in a bounded time.

The objective of this paper is to suggest and modelize a complete heterogeneous wireless sensor network(WSN) allowing the measurement and the transmission of short-range data collected by the environmental sensors. The proposed network can be deployed in a house or even building and transmit alert messages caused by a malfunction of environmental factors via a continuous monitoring. So for a home monitoring application a limited scale up to 40 nodes seems to be sufficient. These nodes exchange data between them according to a communication protocol. The following performance criteria are necessary to an indoor monitoring application: 1) Different QoS capacities should be provided for message delivery because some time sensitive messages are zero tolerance for packet loss. 2) Power consumption is a major concern for the battery constrained sensor nodes. A long lifetime network is eagerly expected. 3) The network should be self-organizing, easily and quickly deployed and should be robust against link failure or link establishment. The failure of important nodes can lead to the entire network failure and harm the safety of people monitored by this network.

Our paper focuses on the concept of MAC layer to address the above constraints. A mesh WSN is more appropriate because it's more flexible and robust nature than a star or a tree topology. The avoidance of collisions between 2 hop neighbors is important goal because there is interference at distance of more than 2 hops [9]. The largest amount of energy is consumed by the nodes is due to the time spent in the receive state so time slot allocation is an important task to limit non efficient transceiver activities such as idle listening.

II. ADCF MAC PROTOCOL

In This section presents an original MAC protocol named as Adaptive and Distributed Collision Free (ADCF). The proposed protocol aims to improve flexibility ,which means the capacity of self-organization . ADCF should enable energy efficiency and guaranteed slots negotiation. Some assumptions must be highlighted:

1) The main contribution of ADCF concerns the router nodes.
2) To ensure full determinism during the build of the topology nodes addresses must be preliminary set during installation.

2.1 Overview of ADCF:

ADCF is based on the physical layer and classical superframe structure. ADCF proposes a distributed beacon scheduling mechanism in which a beacon only period spatially reuses the timeslots over 2-hop.The contribution of ADCF lies in the data slot allocation mechanism which makes GTS possible in a mesh topology.

Here, nodes can switch between two stages, one is initialization stage and the other is working stage. In initialization stage the nodes access medium by unslotted CA/CSMA mechanism. In working stage the time is divided into superframe and each superframe includes three parts

1) BOP
2) Active Period
3) Inactive Period.

This original mechanism is based on the Collision Free Data Slot. After active period inactive period allows all the nodes to go to sleep mode for energy saving.

2.2 CFBS Mechanism: The nodes which are far away more than 2 hops could reuse the same CFBS to enhance channel reutilization. Nodes determine their CFBSs by considering CFBSs used by their 2-hop neighbourhood with a certain priority.

To determine priority three parameters of the node are used.

1) ND (Neighbour Density) indicates the number of neighbours within 2 hops. The node with the higher ND is mostly in the center zone of a network and has a faster awareness to the topological changes.
2) Neighbour Energy indicates the residual energy level of a node.
3) Neighbour Address means the 16-bit address of the node. This address is unique for each node.

When a new node joins the network this will listen to the channel for a fixed period. After that the new node will send its own beacon by different mechanisms. The nodes according to their priorities will take the empty slots, not used by their 2 hop neighbours and store the slot number in their NT.

2.3 CFDS Mechanism: CFDS enables the traffics to be sent in some dedicated slots. This mechanism is very useful in our application. CFDS allocation is triggered by the upper layer. The schedule is calculated in order to get this direct collision free transmission (CFT). As there is no extra overhead for this CFDS negotiation source node can continue requesting until the valid CFDS are found by the destination node. So for destination node the objective is to find the available CFDS and respond to source node. The slot number must be decided by the destination of the traffic to avoid frame collision.

VI. CONCLUSION

This paper presented an original MAC protocol ADCF. This protocol was designed to build and to maintain a wireless sensor network providing energy saving solution for home monitoring application. The 2 hop CFBS and CFDS mechanisms were proposed and described.

In the future a prototype can be built which can evaluate the energy consumption of hardware. Another prospective is in the framework of cross-layer design to decrease routing overhead and further optimize network performances. Finally the elderly and the disabled can be invited to use the system in the smart home.

REFERENCES

[1] Boulanger Deroussent C. Preliminary Based Service Evaluation
[2] Chen S.-L. and Lee H.-Y Chen Wireless Body Sensor Network.
[3] IEEE Journal on Selected Areas in Communications
[4] Fnet T. (2006) Counting on an Aging Population. Computing in Science & Engineering [5] Noury N., Herve, T. Rialle, V., et al. (2000) Monitoring Behavior in Home Using a Smart Fall Sensor and Position Sensors.
[6] Proposition of a General Theoretical Framework. IEEE 6th International Conference (IDAACS 11), 540-545. http://dx.doi.org/10.1109/IDAACS.2011.6072825
[7] Mahfoudh, S. and Minet, P. (2009) Maximization of Energy Efficiency in Wireless Sensor Networks. Mobile Information Systems, Advances in Wireless Networks, 5, 33-52.
[8] IEEE 802.15.4 Standard (2006) Part 15.4: Wireless Medium Access Control(MAC) and Physical-Layer(PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs). IEEE Standard of Information Technology , IEEE-SA Standards Board.
[9] Jeong Gil and K., Tsiftes, N Pragmatic Low-Power Interoperability: TinyOS LPL vs ContikiMAC. 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON 2012), Seoul
[10] Yang O and Heinzelman, W.B. (2012) Modeling and Performance Analysis for Duty-Cycled MAC Protocols with Applications to S-MAC and X-MAC
[11] Koubaa, A., Cunha, A. and Alves, M. (2007) A Time Division Beacon Scheduling Mechanism of IEEE 802.15.4/ Zigbee Cluster-Tree Wireless Sensor Networks. 19th Euromicro Conference on Real-Time Systems (ECRTS 2007), Pisa, 4-6 July 2007, 125-135.