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Zigbee Routing Opnet Simulation for a Wireless Sensors Network

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Abstract:
Wireless sensor network are nowadays considered as a viable solution for medical application. A zigbee network model is more suitable for battery capacity, bandwidth, and computing limitation for WSN. This paper will present an Opnet simulation of a zigbee network performance in order to compare routing results in 3 different topologies (Star, Mesh and Tree).

INTRODUCTION:

The miniaturization of the sensors, the increasingly low cost, the broad range of the types of sensors available as well as wireless support of communication [1], allow the networks sensors to develop in several applications. They also make it possible to extend the existing applications. The sensors network can appear very useful in many applications when it is a question of collecting and processing data coming from the environment. Among the fields where these networks can offer the best contributions, we quote: military, monitoring, environmental, medical, domestic, commercial, etc.

We could imagine that in the future, the monitoring of the human being vital functions would be possible thanks to micro sensors which could be swallowed or installed under the skin. Currently, of the micro-cameras which can be swallowed exist. They are able, without having recourse to the surgery to transmit images of the interior of a human body with a 24 hour endurance. Other ambitious biomedical applications are also presented, such as: monitoring of the level of glucose, the monitoring of the vital bodies or the detection of cancers. The use of the networks of sensors in the field of medicine could bring a permanent monitoring of the patients and a possibility of collecting physiological information of better quality, thus facilitating the diagnosis of some diseases [2].

ZIGBEE:

ZigBee is a LP-WPAN (Low Power-Wireless Personal Area Network): [3] it is a wireless network with short range and low power consumption. It is characterized by a range of a few hundred meters and a low flow (250kbit/s max)[2]. The standard was conceived to inter-connect embarked units like sensors.

It is based on the standard IEEE 802.15.4 for the physical and data link layers proposes its own other layers (network, etc)[2]. The difference between ZigBee and the majority of the other WPAN are the use of the medium; ZigBee is optimized for a weak use of the medium shared by all, for example 0,1% of time.

Typically, a transmitting receiving ZigBee module will occupy the medium during a few milliseconds in emission, will await possibly an answer or an aquitiment , then will be be in stand by for a long period before the next emission, which will take place at one predetermined moment.

This need introduces interesting problems of research, in particular on the level of the data link layer (Delay, storage and access to the medium) and network (routing respecting energy constraints). ZigBee envisages two types of entities network: the FFD (Full Function Device) [4] implement the totality of the specification and the RFD (Reduced Function Device) [5]are entities reduced in an objective of less power consumption and less memory use for the microcontrolor.

RFD are necessarily final nodes of the network because they does not implement a routing mechanism.

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Typically, an embarked sensor will be RFD and supplied with batteries, whereas a central processing unit of treatment, supplied with a source not forced by an energy containte (hand powered), is FFD with the function of routing.

IEEE 802.15.4, ZigBee can work on three frequency bands: 868MHz (Europe), 915MHz (North America) and 2,4GHz (World). The standard envisages two different physical layers (PHY), for the 868/915MHz (PHY868/915) and a second for 2,4GHz (PHY2450) implementing a spread spectrum modulation [6].

Zigbee protocole:

The ZigBee pile is composed of several layers of which the physical layer (PHY), MAC layer, layer network (NWK), underlayer support application (APS) and ZigBee Device Object (ZDO). In the following figure is the ZigBee pile with its layers.

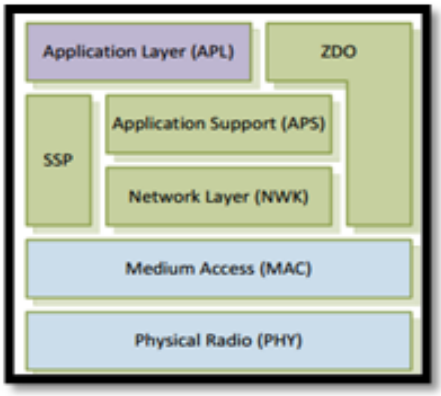

Fig. 1. Zigbee Protocol

- The physical layer (PHY), defines the physical operations of the ZigBee equipment by including the sensitivity of the reception, number of the channels, the power transmission , the modulation and the specifications of the transmission rate. The MAC layer manages the transactions of data RF between the neighbours nodes (point-to-point). This layer includes the services such as the management of retransmissions and payments without forgetting the techniques to avoid collisions CSMA-CA [3].
- The network layer (NWK) adds the capacities of routing which allow the RF data to cross several equipment (multiple hops) for router the data since the source towards the destination (peer to peer).
- This layer manages also the mechanisms of neighbors discovering , routes discovering and maintaining , mechanism to join or leave the network etc.
- Application support (APS) is an application layer which defines various objects of addressings including the profiles, the clusters and the end devices.
- ZigBee Device Object (ZDO) [2] is the applicative layer which provides the functionalities of discovering equipment and services, it includes also the advanced capacity for the management of the network. It defines also the role of the nodes in network for example coordinator or end device.
- Security Services Provider (SSP) manages MAC security only for the MAC frame , the security of the network for the NWK frames of order and safety for APS frame . The characteristics of this layer are the authentification, the encryption, the integrity of the message etc.

Topology:

The standard IEEE 802.15.4 envisages two topologies: star (star - all the nodes communicate with a central node called coordinator) or point-to-point (peer to peer - all the nodes with radio range can communicate together without hierarchy). The formed network is called PAN[2]. The network layer of ZigBee allows the creation of mesh topology thanks to an automatic routing: it is topology with a grid, or mesh topology [5].

Three topologies can be considered in the installation of a ZigBee network:

- Star topology
- Tree topology
- Mesh topology

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LITURATURE SURVEY:

Wireless Sensor Networks for Healthcare

Wireless healthcare monitoring sensor networks are multi-hop Zigbee-based systems which usually use broadcast or multicast to reliably deliver vital diagnostics information or event detection to the sink. However, such schemes typically lead to high network traffic and large path search delay. This paper presents an efficient, adaptive, distributed routing mechanism, called anycast Q-routing to route information to the nearest sink in multiple sink wireless sensor networks (WSNs). The proposed scheme requires only local information at each node, modest computational, storage, and learning overhead. Simulation results show that the anycast Q-routing scheme can discover paths using low communication overhead and short path search latency over existing AODV-based broadcast, multicast and anycast schemes used in WSNs for healthcare monitoring.

A Survey on the State of the Art and the 802.15.4 and ZigBee Standards

Multimedia applications in the wireless domain require not only contention-based communication, but also reservation based one. The IEEE 802.15.4 standard is widely used for Wireless Sensor Networks (WSNs), and is a standard for low rate, low power and low cost WPANs (Wireless Personal Area Networks). Moreover, it supports the allocation of Guaranteed Time Slot (GTS) to the devices in Contention free period (CFP). With time, many GTS scheduling and allocation algorithms have been proposed with the aim to make maximum the use of GTS. This paper provides a survey and comparison on the current state-of-the-art researches in this important area. We have firstly summarized all the important algorithms proposed till now and then classified and compared them based on various parameters including type, delay, bandwidth, cost, topology, traffic and energy efficiency.

Body Area Networks: A Survey

Body Area Networks are an effective solution for communication in ubiquitous health systems. BAN's can be applied into fields of military, defense, telecomm etc. Such networks are thus being researched to provide better routing techniques in and around the body. This paper discusses architecture of BAN along with the requirements and challenges. Various routing protocols available are discussed in section V. Various routing algorithms are discussed with their limitations and advantages.

A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation

Virtual reality and computer assisted physical rehabilitation applications require an unobtrusive and inexpensive real time monitoring systems. Existing systems are usually complex and expensive and based on infrared monitoring. In this paper we propose Avatar, a hybrid system consisting of off-the-shelf components and sensors. Absolute positioning of a few reference points is determined using infrared diode on subject's body and a set of Wii© Remotes as optical sensors.

Individual body segments are monitored by intelligent inertial sensor nodes iSense. A network of inertial nodes is controlled by a master node that serves as a gateway for communication with a capture device. Each sensor features a 3D accelerometer and a 2 axis gyroscope. Avatar system is used for control of avatars in Virtual Reality applications, but could be used in a variety of augmented reality, gaming, and computer assisted physical rehabilitation applications.

EXISTING SYSTEM:

- They also make it possible to extend the existing applications. The sensors network can appear very useful in many applications when it is a question of collecting and processing data coming from the environment.

- We could imagine that in the future, the monitoring of the human being vital functions would be possible thanks to microsensors which could be swallowed or installed under the skin.

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DISADVANTAGE:

- The disadvantage of star topology is that there are no alternate routes if the link between the coordinator and the end device fails.
- The other disadvantage of this topology is that all the packets must pass through the coordinator, this last can be saturated with a great number of packets and like result, we have a congested network.

PROPOSED SYSTEM:

- This need introduces interesting problems of research, in particular on the level of the data link layer Delay , storage and access to the medium and network routing respecting energy constraints.
- ZigBee envisages two types of entities network: the FFD Full Function Device implement the totality of the specification and the RFD Reduced Function Device are entities reduced in an objective of less power consumption and less memory use for the microcontroller.

ADVANTAGE

- The children can communicate only with their parents, while the parents can communicate with their children and their own parent.
- The disadvantage of this topology is that there is no alternate road if the bond necessary to reach the destination fails.

Module Description:

Zigbee

A transmitting receiving ZigBee module will occupy the medium during a few milliseconds in emission, will await possibly an answer or an aquitiment , then will be be in stand by for a long period before the next emission, which will take place at one predetermined moment. This need introduces interesting problems of research, in particular on the level of the data link layer (Delay , storage and access to the medium) and network (routing respecting energy constraints). ZigBee envisages two types of entities network: the FFD (Full Function Device) implement the totality of the specification and the RFD (Reduced Function Device) are entities reduced in an objective of less power consumption and less memory use for the microcontroller.

Rooting

ZigBee Device Object (ZDO) is the applicative layer which provides the functionalities of discovering equipment and services; it includes also the advanced capacity for the management of the network. It defines also the role of the nodes in network for example coordinator or end device. Security Services Provider (SSP) manages MAC security only for the MAC frame, the security of the network for the NWK frames of order and safety for APS frame . The characteristics of this layer are the authentification, the encryption, the integrity of the message etc.

Opnet

The router can be used as an end device in the tree of the network, but in this case the functionality of diffusion of message is not used. In tree topology, the coordinator and the routers can have children, therefore they can be parents. On the other hand, the end devices cannot be parents and cannot have children either. The children can communicate only with their parents, while the parents can communicate with their children and their own parent. The disadvantage of this topology is that there is no alternate road if the bond necessary to reach the destination fails.

Results:

- Number of hops (figure) is the average number of hops traveled by application traffic in the PAN. It's is the number of times a packet travels from the source throught the intermediate nodes to reach the destination.

- The number of hops for the star topology is equal 2 wish mean that the source and the random destination have another intermediate node wish relays the data (the coordinater).

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- The number of hops for the tree topology is equal 5 as we set the network depth to 4 , the mesh topology uses a routing table.

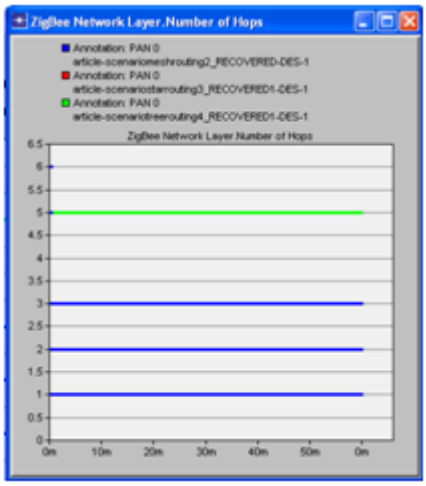

Fig. Number of hops simulation

- End to End delay (figure) is a measurement of the network delay on packet and is measured by the time interval between when a message is queued for transmission at the physical layer until the last bit is received at the receiving node.
- Our end to end delay results of the 3 topologies star and Mesh have close end to end delay in this simulation.
- The end to end delay of the tree is higher for more than 50%.

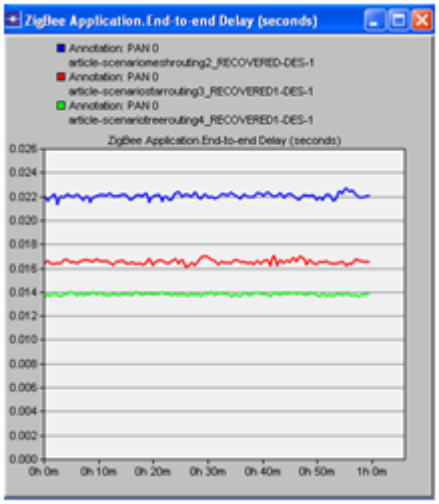

Fig. End to End delay simulation

CONCLUSION

From all the results , it can be conclude that the tree routing even if it present the lower and to end delay , it's less suitable for WSN due to number of hops results wish mean more energy consumption . Our future work will be more detailed study of energy efficiency and reliability. The major goal is developing a protocol that would be energy aware considering a medical application for WSN.

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