PERFORMANCE IMPROVEMENT IN WIRELESS SENSOR NETWORK BASED TECHNOLOGIES

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ABSTRACT

Wireless Sensor Network (WSN) is type of network which consists of collection of tiny device called sensors nodes. Sensor node has a resource constraint (i.e. battery power, storage and communication capability). In this paper, the review of Wireless Sensor Network based technologies such as WIMAX and ZIGBEE by using PHY layer and MAC layer parameter like energy consumption, battery remaining, number of nodes, throughput, average delay, packet loss percentage and jitter.

Keywords: MAC, PHY, Wimax, WSN, Zigbee

I. INTRODUCTION

A wireless sensor network is a large scale network which consists of tens of thousands of nodes having low memory, low processing power and limited communication capacity. These nodes collect, process and co-operatively pass this collected information to a central location. A wireless sensor network (WSN) consists of sensing devices, processing and communication ability that can provide quantifying and detecting facility to users and gives reaction to particular events and phenomena in sensing field. A sensing device is that which provides information from sensing physical characteristics such as temperature, pressure and sound etc and transmits that data to the base station through radio on time basis or demand basis. A base station is a powerful device having more memory, high processing power and high communication capacity. A sensor network may consist of number of sensor nodes, working in synchronized and coherent manner to fulfill a common task depending on application.[1], [2].

1.1 Zigbee

The term Zigbee is derived from the bees zigzag dance, that enables them to share information, and it is a low cost and low power consumption Wireless Personal Area Network (WPAN) standard, which can be used in many different wireless sensor network applications such as home/building automation, consumer electronics, industrial controls, medical sensor applications, etc. In other words, applications of IEEE 802.15.4 devices are: i) industrial control, ii) environmental and health monitoring, iii) home automation, entertainment and toys, iv) security, location and asset tracking, v) emergency and disaster response.

ZigBee is the name of a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard. The technology is intended to be simpler and cheaper than other WPANs such as Bluetooth. ZigBee protocols are intended for use in embedded applications requiring low data rates and low power consumption. Though WPAN implies a reach of only a few meters, 30 feet in the case

of ZigBee, so designed as to enable intrapersonal communication within the network, connection to a network of higher level and ultimately an uplink to the Web.[8]

The Zigbee Standard has evolved standardized sets of solutions, called ‘layers'. [9] These layers facilitate the features that make Zigbee very attractive such as : low cost, easy implementation, reliable data transfer, short-range operations, very low power consumption and adequate security features. These layers and their respective operation are given below:

I. Network and Application Support layer*:* The network layer has been designed to allow the network to spatially grow without requiring high power transmitters. The network layer also can handle large amounts of nodes with relatively low latencies. The Application support sub-layer's responsibilities include maintenance of tables that enable matching between two devices and communication among them, and also discovery, the aspect that identifies other devices that operate in the operating space of any device.
II. Physical layer: The IEEE 802.15.4 physical layer accommodates high levels of integration by using direct sequence to permit simplicity in the analog circuitry and enable cheaper implementations.
III. Media access control layer: The IEEE 802.15.4 media access control layer permits use of several topologies without introducing complexity and is meant to work with large numbers of devices.[8]

1.2 Wimax

The IEEE 802.16, the Air Interface for Fixed Broadband Wireless Access Systems, also known as the IEEE Wireless MAN air interface, is a suite of standards for fixed, portable and mobile BWA in MAN. These standards are issued by IEEE 802.16 work group that originally covered the wireless local loop (WLL) technologies in the 10.66 GHz radio spectrum, which were then extended through amendment projects to include both licensed and unlicensed spectra from 2 to 11 GHz.

The IEEE 802.16 standard is versatile enough to accommodate time division multiplexing (TDM) or frequency division duplexing (FDD) deployments and also allows for both full and half-duplex terminals. WiMAX uses microwave radio technology to connect computers to the Internet. WiMAX works like cell phone technology in that reasonable proximity to a base station is required to establish a data link to the Internet. Users within 3 to 5 miles of the base station will be able to establish a link using non line- of-sight (NLOS) technology with data rates as high as 75Mbps. Users up to 30 miles away from the base station with an antenna mounted for line-of-sight (LOS) to the base station will be able to connect at data rates approaching 280Mbps [11].

1.2.1. Applications of WIMAX

WIMAX allows people to go from their homes to their cars, and then travel to their offices or anywhere in the world, all seamlessly. [10] WIMAX can serve the business, residential and mobile segments. The applications in these areas are listed below:

i. Residential users

•Basic voice services, low cost domestic & international calls

•Basic (dialup speed) to advanced (over 1Mbps) data connections

•Bundled voice and data services

ii. Business users

• Basic data connectivity for small businesses
• Advanced data services to medium and large businesses
• Feature-rich, low cost voice services (VoIP)

iii. Mobile users (mobile WIMAX only)

• Data connectivity for mobile workforce
• Data connectivity for international visitors

II. LITERATURE SURVEY

IEEE 802.15.4 was developed to work in all-wireless environment supporting either peer-to-peer or star network topology. The performance based on commonly known metrics such as throughput, packet delivery ratio, and average delay. The 802.15.4 standard defines physical (PHY) and medium access control (MAC) layer protocols for supporting relatively simple sensor devices that consume minimal power and operate in an area of 10m or less. The point of service (POS) may be extended beyond 10m but this requires additional energy to operate.

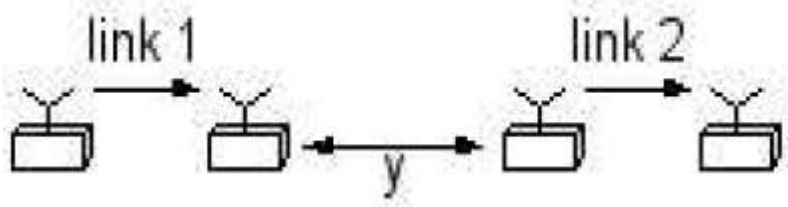

Fig 1: Topology Setting for Investigating the Impact of Packet Collision[3]

In the figure.1, for the inter-node distance y three possibilities can arise which are as follows:
(1) contention free and collision free region,
(2) collision and contention free region, and
(3) contention and collision region.

The region is meant to investigate the effect of collisions due to `hidden node'which is a source of performance degradation in high rate traffic scenario. Two traffic loads of 50 kbps are established on link 1 and link 2. There is high throughput utilization for low application traffics, i.e. 10 and 20 kbps in the case of End-To-End Throughput vs Optimum traffic load. However in case of End-to-End Packet Delivery Ratio vs optimum traffic loads, the traffic load increases the performance slumps, delivering less than 50% for traffics beyond 70 kbps. The effect of varying number of hops and traffic loads on throughput gives the maximum throughput recorded for interference free (and error free) traffic which is about 40 kbps.[3]. Another problem faced in Wireless sensor networks is that power and/or energy is often limited. Various parameters of physical layer are tuned depending on applications. The equation is:

$$Eb = \frac{1}{(1-pb)^{L+a}}[SNRr\gamma(ud^2 - 1) + \beta]\frac{L+a}{RL} \quad (1)$$

Where, Eb = Average energy consumption per bit

$\mu = \sqrt{\frac{4\pi}{\lambda Gt.Gr}}$.(1+n)

γ = PN. FN

PN = noise power

SNRr = signal-noise power ratio at the receiver

FN = noise figure

L = size of payload

a = size of header

GT/ R = transmit/receive antenna gain

R = Data rate

d=transmitting distance

β = Po,TX . Po,RX

Po, TX =transmit overhead power, is the power consumed by all the transmit chain circuitry except for the amplifier

Po,RX = receive overhead power, is the power consumed by all the receive chain circuitry

The foremost characteristics of IEEE 802.15.4 are minor power, minor bit rate and short range and ZIGBEE is better suited and has long battery life. A model for physical layer and is proposed [4] that automatically optimizes transmission power, throughput and latency and proposed that increased battery lifetime depends upon bit rate, payload size and distance. After that a system using Wimax gateway that is proposed [5] for wireless sensor networks to communicate and share information conveniently as WIMAX has good coverage and capacity it can easily access sensor nodes that are scattered or remotely deployed. Sensor networks may work on different protocols like ZIGBEE, Bluetooth so it calls for different gateways to access network. With WIMAX gateway sensor nodes can exchange information with ease. The connectivity and delay of system shows that the nodes are well connected with acceptable delay. WIMAX and UMTS networks are compared in [6], using three algorithms with the main focus on mobility and Quality Of Service (QOS). The QOS parameters tested are off rate, delays, jitter and Packet Loss Ratio. Result shows that performance of WIMAX is superior to UMTS. The speed of UMTS is estimated to be 90-100 km/h and WIMAX is up 130-150 km/h. WIMAX can enable both mobile and broadband services. Further, a dynamic uplink weight scheduling approach has been proposed for WIMAX networks [7] and the performance of the proposed algorithm is compared with Weighted Round Robin (WRR) algorithm and Modified Deficit Round Robin (MDRR) algorithm is presented by using OPNET simulator which shows that the proposed algorithm outperforms in terms of parameter such as throughput, delay, jitter and load as functions of the number of subscriber stations. The Variably Weighted Round Robin (VWRR) algorithm and WRRs can be used with channel-aware algorithms. An overview of application, range, frequency range, data rate, topology and attributes of Wi-Fi, Zigbee and Wimax are discussed [8].

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