Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 3, March 2014, pg.72 – 78

RESEARCH ARTICLE

MOBILITY REACTIVE FRAMEWORK AND ADAPTING TRANSMISSION RATE FOR COMMUNICATION IN ZIGBEE WIRELESS NETWORKS

Prinslin.L, V.Janani

PG Scholar, Department of CSE, Adhiyamaan college of Engineering, TamilNadu, India
prinslin21@gmail.com

Assistant Professor, Department of CSE, Adhiyamaan college of Engineering, TamilNadu, India
vajjiram.janani@gmail.com

Abstract

ZigBee is based on the IEEE 802.15.4 standard and was designed to be used in wireless control and sensor networking. ZigBee provides self-organized, multi-hop and reliable networking facility with long battery lifetime. ZigBee standards have been developed to provide simple, low cost and battery efficient wireless devices. Mobility is part of ZigBee vision and it is difficult to provide to/from connections to mobile end-devices. Due to movement of end-devices, data delivery failures occur in ZigBee wireless network. So, to locate the misplace end devices, the Broadcasting method is used to lessen the effects of mobility. But it consumes large amount of resources in terms of bandwidth and power consumption. Recently ZigBee Node Deployment and Tree construction (ZNDTC) framework is proposed to reduce such resource consumption and provides efficient data transmission between coordinator and mobile end devices. Further adaptive transmission rate and bandwidth utilization technique is then introduced to improve network throughput. Adaptive transmission rate is used to improve the network throughput by increasing the transmission rate i.e. the rate of flow when there is no data loss in the flow. Thus transmission rate is managed based on network traffic.

Keywords*:* - ZigBee wireless network, IEEE 802.15.4, Mobility, Adaptive Transmission Rate

I. INTRODUCTION

ZigBee is a specification established for wireless personal area network (WPAN). ZigBee provides wireless networking between low power devices, aimed to reduce the energy consumption and delay. ZigBee technology is deployed in numerous applications such as home based healthcare, medical monitoring and consumer electronics. ZigBee communication technology is used in almost every appliance if not in all, because of being low-cost, low-power battery and wireless connectivity. By using a ZigBee technology it is possible for controlling and monitoring a whole factory unit sitting in one cabin. It centralizes all the units in one place and enables the remote monitoring. ZigBee network has the capability of self-forming, self-healing and can accommodate more than 65000 address spaces. Thus the network can be easily extended in terms of size and coverage area. Other wireless standards like Bluetooth and Wi-Fi address high data rate applications. The low cost and low power consumption allows the ZigBee technology to be widely distributed in wireless control and monitoring applications. Mobility is a part of the

ZigBee vision and is important for proper functioning of many ZigBee applications. It is crucial to provide ubiquitous connections to/from mobile device for various ZigBee applications. Device mobility is unavoidable in certain ZigBee applications. In the wireless environment, the signal strength sent by coordinator can be weakened as distance of nodes from it increases. Therefore it is difficult to perform stable and reliable wireless communication with wide range nodes. Therefore it is important to know how nodal mobility affects the ZigBee routing protocols and various applications. This paper describes about improving data delivery ratio and adapting transmission rate based on network traffic between communicating nodes in ZigBee wireless network.

II. ARCHITECTURE OVERVIEW

A. ZigBee Stack

ZigBee operates on top of IEEE 802.15.4 medium access and physical layers as shown in fig 1.The IEEE 802.15.4 standard provides a framework for application programming in the application layer. Based on PHY and MAC layers specified by the IEEE 802.15.4 standard [2], the ZigBee specification establishes a framework for the network and application layers. Network and Application layer can handle huge number of nodes. Physical layer accommodates high levels of integration to ensure simplicity and enable cheaper implementations. The MAC layer controls access to the radio channel by using the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism. MAC layer interfaces between physical and other upper layers in the ZigBee stack. The IEEE 802.15.4 MAC layer defines four frame structures: Data frame, ACK frame, MAC frame, Beacon frame.

- The data frame used for all transfers of data.
- Acknowledgment (ACK) frame is another important structure for IEEE 802.15.4 used for confirming successful frame reception.
- MAC command frame provides the mechanism for remote control and configuration of client nodes.
- Beacon frame used by a coordinator to transmit beacons.

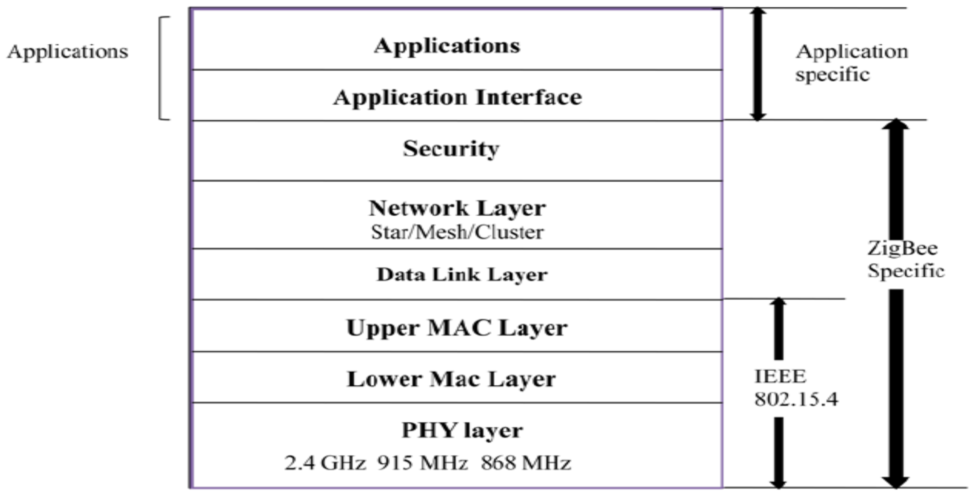

Fig 1: Overview of ZigBee stack

ZigBee uses three frequency bands for transmission as shown in fig 1. They are 868MHz band with a single channel, 915MHz band with 10 channels and 2.4GHz band with 16 channels. The responsibility of physical layer is to perform channel assessment. Above PHY and MAC layer ZigBee defines the application and security layer specifications enabling interoperability between products from different manufacturers. Table 1 describes the analysis between different IEEE 802 wireless protocol standards. ZigBee is the simplest protocol compared to other wireless standards and it is used in sensor network applications because of its memory and computational capacity.

Table 1: Analysis between different wireless standards

Name	ZigBee	Bluetooth	Wi-Fi
Standard	802.15.4	802.15.1	802.11
Power supply	Years	Days	Hours
Complicity	Simple	complicated	Very complicated
Transmission speed	250Kbps	1Mbps	1.54Mbps
Network nodes	65535	8	50
Application	Monitoring and control	Cable replacement	Web,e-mail,video
Success metrics	Reliability,power,cost	Cost, convenience	Speed , Flexibility

ZigBee has the ability to accommodate more than 6000 nodes in a network. Even though the transmission speed of ZigBee is less than other wireless standards it can be utilized for short range communications for about 30-50m based on environment. Transmission rate can also be increased based on traffic in the network.

B. ZigBee Communication Devices

ZigBee network comprises of three types of devices for communication.

1. ZigBee Coordinator (ZC): The Coordinator forms the root of the network tree and stores information about network.

2. ZigBee Router (ZR): A router act as an intermediate router, passing on information from other devices.

3. ZigBee End Device (ZED): contains enough functionality to talk to the coordinator or a router. It is less expensive to manufacture than ZC or ZR.

The diagrammatic representation of ZigBee network is shown in figure 2. Three types of devices are used for communication in ZigBee network. They are Coordinator, router and mobile end device. Data delivery failures occur during the downlink communication (i.e.) from Coordinator to mobile end device. These devices are used in proposed approach of node deployment and tree construction framework to improve packet delivery ratio during downlink communication.

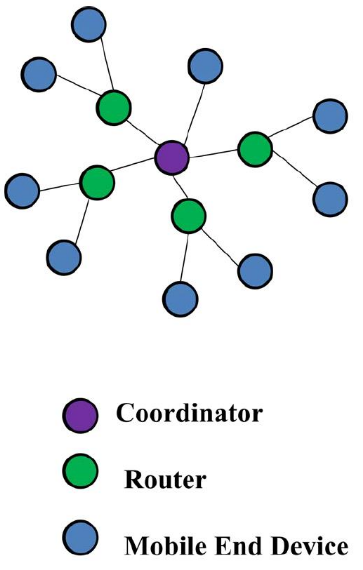

Fig 2: ZigBee Devices

III. MOBILITY IN ZIGBEE

Mobility is a critical component of various ZigBee applications. A network with highly mobile users raises challenging mobility issues. Device mobility is unavoidable in certain applications, such as the health monitoring application described in [3, 4] where a ZigBee enabled health monitoring sensor alerts the hospital through a home ZigBee wireless network, if health related emergency occurs. The effect could be disastrous if the ZigBee home network failed to send the alert message as planned. Therefore it is important to know how nodal mobility affects the ZigBee routing protocols and various applications. Adequate mobility support is necessary to lessen the effects of data delivery failures.

Two types of communication such as uplink and downlink communication are possible in ZigBee network. During uplink communication mobile end device send packet to coordinator and Downlink communication is between coordinator and mobile end device. Mobility affects downlink communication, based on the ZigBee specification, a device discovery procedure is triggered if the central server cannot locate a certain mobile end device. During the procedure, the central server simply floods the whole network with messages to locate the misplaced mobile end device. However, flooding the network is costly in terms of resources, and during the procedure, the network cannot accommodate multiple instances of rapid node mobility.

To improve data delivery ratio in this communication ZigBee uses approaches to provide efficient data delivery in ZigBee network. ZigBee provides mobility support in mesh and tree topology [5]. ZigBee provides mesh routing and tree routing scheme, which deploy different routing mechanisms to respond nodal mobility. ZigBee tree topology performs well when nodes are used as mobile and is suitable for low power consumption. ZigBee network layer defines how the network is formed and how the network address is assigned to each ZigBee node. ZigBee routers are routing capable, whereas ZigBee mobile end device are not. If ZigBee mobile end device moves out of range from Coordinator, router has the ability to route the path to that mobile end device. Thus ZigBee device plays a significant role in determining the routing performance in mobile scenarios.

IV. ZigBee Node Deployment and Tree Construction Framework (ZNDTC)

In ZigBee network if the mobile end devices are within the range of Coordinator data delivery is completed easily. Due to mobility, mobile end device moves out of range from Coordinator. ZigBee Node Deployment and Tree Construction framework [1] is proposed to reduce data delivery failures in ZigBee wireless network. To improve the downlink data delivery ratio, node deployment tree construction framework approach exploits the aforementioned information by the locations of routers and constructs a mobility robust tree topology in a ZigBee wireless network. This approach consists of three phases.

ZigBee Node Deployment (ZND) is the first phase of this approach. In this phase routers are deployed as static in appropriate locations of the network. This phase ensures that the map is fully covered by the router's communication range. Here, every router's communication range is at least partially overlapped with another deployed router's communication range.

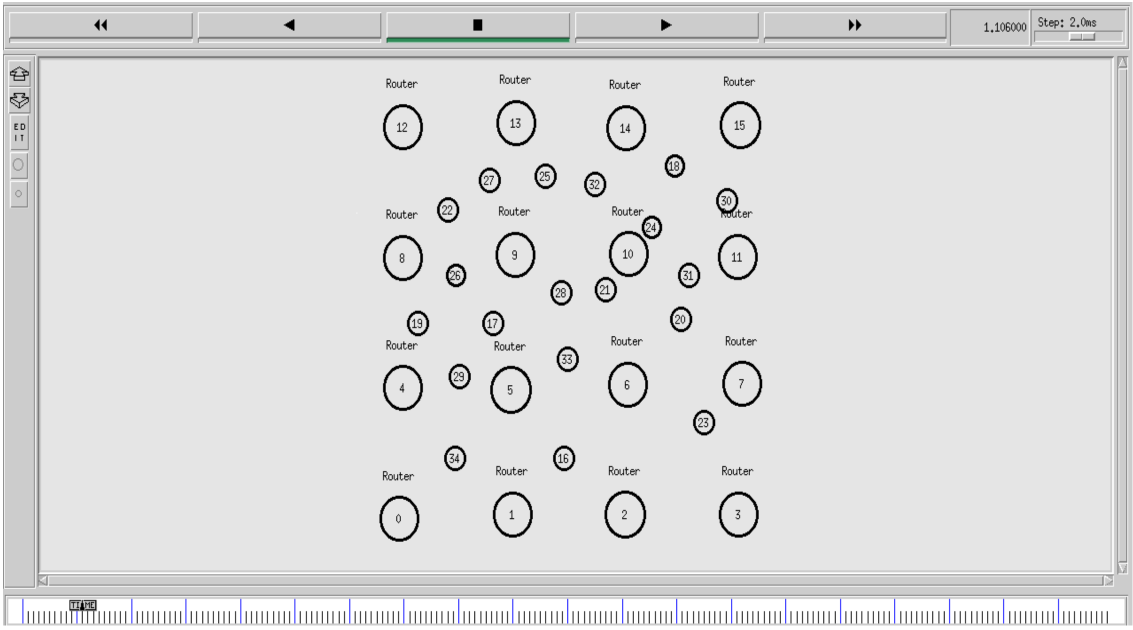

Fig 3: ZigBee Node Deployment

In deployment phase router nodes are deployed in the network and mobile devices are moved along each router's coverage area as shown in figure 5.

ZigBee Coordinator Decision (ZCD) is the second phase of this approach. Based on the deployment completed in the first phase, the ZCD phase selects one router in the region as the root (coordinator). Weight on each router node is divided into two types they are in-edge and out-edge weight. The weight on each edge represents the end-device movement counts from one router's coverage area to another router coverage area [1].

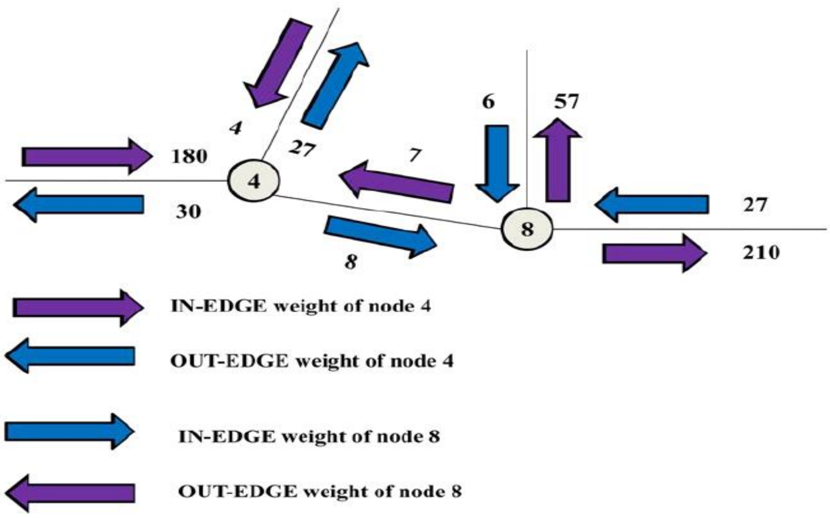

Fig 4: In-edge and Out-edge weights for routers 4 and 8.

For example figure 3 represents In-edge and Out-edge weight of routers 4 and 8. In-edge weight of routers 4 and 8 is calculated as

- In-edge weight of router node 4: (180+4+7=191)
- In-edge weight of router node 8: (8+6+27=41)

The sum of in-edge weight for router 4 is larger than that of router 8. ZCD chooses a router node with the maximum sum of in-edge weight as Coordinator. Thus in this example router 4 is chosen as Coordinator.

ZigBee Tree Construction (ZTC) is the third phase of this approach. In this phase mobility robust tree is constructed based on the following parameters. 1) R_m denotes the maximum number of child routers of a router or the Coordinator2) L_m the depth of the network. Results of these two phases are used along with network constraints R_m and L_m as the input to construct a single rooted tree T as the ZigBee routing tree.

Proposed model of node deployment and tree construction framework is shown in Figure 5. ZigBee network comprises three types of devices as nodes for communication. ZigBee communication devices are deployed in the network. Communication between Coordinator and mobile end device fails due to mobility. Conventional route reconstruction method is used to mitigate the effects of mobility in the network.

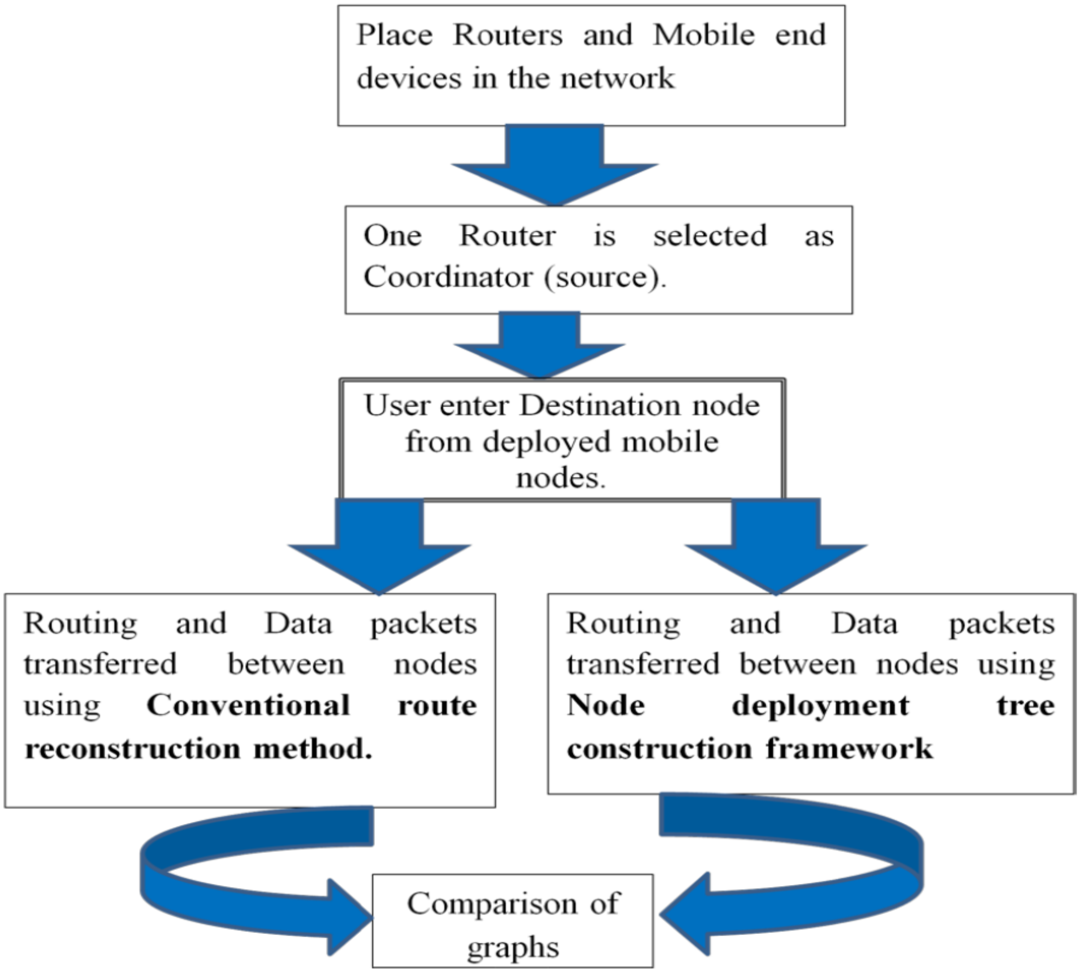

Fig 5: Proposed Model

But it consumes resources such as bandwidth. Thus mobility responsive node deployment tree construction framework is proposed to locate the displaced mobile device. Further Admission control concept [8] is used to increase transmission rate based on movement of nodes in the network. Comparison between these approaches is done using NS2 simulator. Comparison graph is shown in figure 6 where E_throughput.xg denotes conventional route reconstruction method, p_Throughput.xg denotes node deployment framework approach and Throughput.xg denotes Admission control approach. Throughput is improved when transmission rate is increased based on traffic flow in the network.

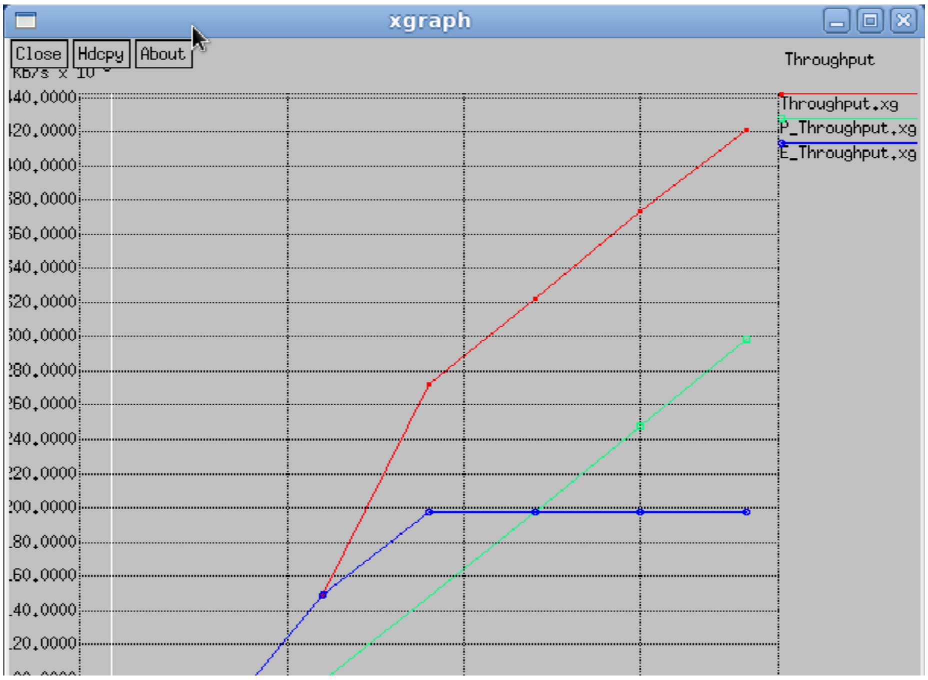

Fig 6: Comparison Graph

V. CONCLUSION

ZigBee node deployment and tree construction framework approach is proposed to optimize the locations of routers and construct a tree topology in a ZigBee wireless network. By using the historical movement of mobile nodes, tree is constructed so that most movements are highly probabilistic to move toward the root, i.e., the opposite direction to downlink transmissions. Thus data delivery ratio is increased efficiently during downlink communication i.e. between coordinator and mobile end device by using deployment framework, rather than using conventional route reconstruction method. Further admission control concept is then introduced to increase the transmission rate and to improve reliability and energy efficiency among nodes.

REFERENCES

[1] Yuan-yao shih,Wei-Ho chung,Pi-Cheng Hsiu, Ai-Chun Pang "A Mobility-Aware node Deployment and Tree Construction Framework for ZigBee Wireless Networks"IEEE transactions on vehicular technology,vol 62,no.6,july 2013

[2] ZigBee Alliance, ZigBee Specification. Version 1.0 ZigBee Document 053474r06, December 14th, 2004.

[3] R. Hafari, A. Encarnacao, A. Zahoory, F. D. and Hyduke Noshadi, and M. Sarrafzadeh. Wireless sensor networks for health monitoring. In ACM/IEEE International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services, 2005.

[4] I. Korhonen, J. Parkka, and M. V. Gils. Health monitoring in the home of the future. IEEE Engineering Medicine and Biology Magazine, 22(3):66 73, May-June2003.

[5] L. Chen, T. Sun, and N. Liang, "An evaluation study of mobility support in ZigBee networks," J. Signal Process. Syst., vol. 59, no. 1, pp. 111–122, Apr.2010.

[6] W. Chung, P. Hsiu, Y. Shih, A. Pang, Y. Huang, and K. Hung, "Mobility robust tree construction in ZigBee Wireless networks," in Proc. IEEE ICC, 2011, pp. 1–6.

[7] M. Pan and Y. Tseng, "A lightweight network repair scheme for data collection applications in ZigBee WSNS," IEEE Commun. Lett., vol. 13, no. 9, pp. 649–651, Sep. 2009.

[8] Lajos Hanzo II, Member, IEEE, and Rahim Tafazolli, Senior Member, "QoS-Aware Routing and Admission Control in Shadow-Fading Environments for Multirate Manets" IEEE Transactions On Mobile Computing, Vol. 10, No. 5, May 2011.

