Mobility Based Tree Construction for ZigBee Wireless Networks

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Abstract— ZigBee is a specification for wireless personal area networks with low power, low cost, and a low data rate. It's defined by IEEE 802.15.4 standard. In ZigBee wireless network, tree topology is commonly practiced to form wireless sensor networks and perform data delivery applications. In an environment splendidly connected with ZigBee devices, major topological changes can occur due to device failures, mobility and other factor. The reconstruction method designed to reduce the effect of topology changes. In this paper, we explain reduces the frequency route tree construction in mobility patterns and increase the data delivery ratio, and reduce the packet loss caused by node mobility of route tree construction. Overhearing mechanism also includes for mobile nodes to improve the data delivery ratio. We develop an efficient algorithm for mobility based tree construction. The effectiveness framework network topologies constructed using ZigBee is verified by NS2 simulation against a real world circumstances.

Keywords- Mobility robustness, tree topologies, ZigBee wireless networks.

I. INTRODUCTION

Wireless sensor networks widely use IEEE 802.15.4 due to its low energy consumption, low cost and small size. This protocol is not initially designed for applications that require mobility. The mobility management in IEEE 802.15.4 is, as a consequence, not properly taken into account. With the increasing erudition of wireless communications and sensing technologies, various sensor-based applications, e.g., tour guiding, industrial automation and health care monitoring. The ZigBee standard, designed by the ZigBee Alliance [4], specifies the network and application layers for sensing data deliveries.

Many ZigBee applications require moving objects to be capable of with a sensor and dissemination [1]. Another category of applications use ZigBee routers as roadside units and end devices as in-vehicle units. With ZigBee technologies, various Intelligent Transportation System (ITS) applications in VANETs such as traffic control, system-aided navigation, location-based information pushing, and vehicular safety access control can be realized. Normally, routers that are connected to the backbone network are static and equipped with reliable power supplies, whereas mobile end devices rely on batteries. In many applications such as drivers who receive traffic information from ITSs, tourists who receive recreational information and workers who receive supervisory messages, the major function of mobile end devices is to receive data from the network coordinator rather than send data through the network. Even if both the end device and the router are mobile, a cluster tree performs better than a mesh structure does when the end device is receiving data. Therefore, this paper focuses on the ZigBee cluster tree as the main topology. Moreover, the ZigBee specification allows a small and simple protocol stack and, thus, has lower implementation cost compared with Bluetooth and Wi-Fi. The much lower power consumption of ZigBee, compared with Wi-Fi, also facilitates a long lifetime of mobile end devices, which greatly benefits the aforementioned applications.

In this paper, to improve the downlink delivery ratio, we develop mobility regularity and propose an approach to construct mobility-robust tree topologies in ZigBee wireless networks. Our goal is construct tree framework using ZigBee star network topology. Only focus on the ZigBee cluster tree topology is main topology. Moreover, the ZigBee specification allows a small and simple protocol stack [1] and, thus lower implementation cost compared with Bluetooth and Wi-Fi. The much lower utilization of ZigBee, compared with Wi-Fi, also facilities a long lifetime of mobile end devices. And we also designed low complexity algorithm for node deployment and tree construction framework in ZigBee networks. Tree construction is formulated as a graph optimization problem, and we construct effective tree topology using NS2 simulation.

The remainder of this paper is controlled as follows. In Section II describes the System model, and problem formulation. Section III proposed algorithm for mobility- robust tree topology and ZigBee node deployment. Simulation results and analysis are reported in section IV and Section V concludes this work.

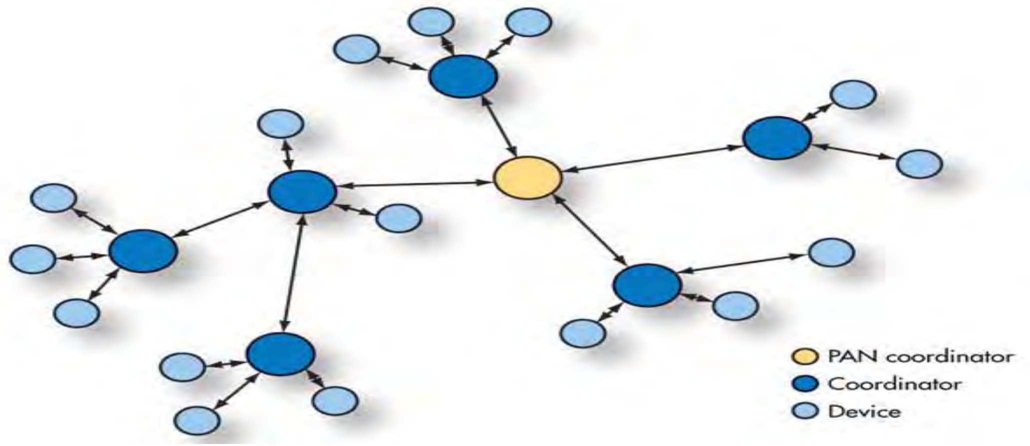

Fig.1. ZigBee cluster Tree

II. SYSTEM MODEL AND PROBLEM DEFINITION

A. System Model

First ZigBee is the product of the ZigBee alliance[7], an organization of manufactures dedicated to developing a network topology for small, ISM-band radios that could welcome even the simplest industrial and home end devices into wireless connectivity[3]. The ZigBee designed as low-cost, low-power, low-data rate wireless technology.

In ZigBee network three device types are distinct: the ZigBee coordinator, multiple routers, and multiple end devices. A ZigBee coordinator performs the initializing, maintaining, and controlling functions for the network. A router is responsible for routing data between the coordinator and end devices. Reduced function end devices, which can talk to routers ant the coordinator, but not each other. The ZigBee Network Layer (NWK) supports star, tree and mesh topologies. In a star topology, multiple end devices directly connected to the coordinator. In mesh and tree network topologies, the devices communicate with each other in a multihop fashion. Compare the three ZigBee network topologies, the cluster tree is most suitable for low-power WSN, because its responsible for IEEE 802.15.4 standard and supports the super frame structure [1]. Then the cluster tree topology supports a light weight routing protocol without maintaining a routing table.

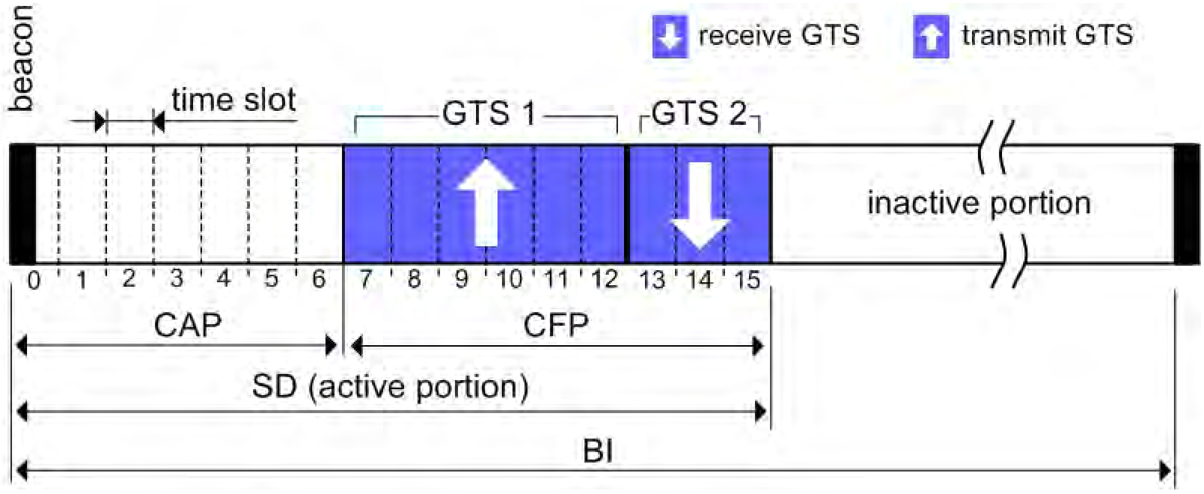

Figure 2.Super frame structure of IEEE 802.15.4.

Among the three topologies, the cluster tree is the most suitable for low power Wireless Sensor Networks, because it supports the super frame structure, which is responsible for power saving operations in IEEE 802.15.4. We consider the system model based on the ZigBee cluster tree network with a coordinator, routers, and mobile end devices. The coordinator acts as the tree root, whereas the routers serve as internal nodes in the tree for data forwarding, as in the conventional ZigBee cluster-tree network. The difference between the proposed scheme and the straight ZigBee network lies in the operations of the mobile end devices. The location of the mobile end device is recognized by the network and maintained by the coordinator, which identifies the last router that was used to forward the end devices uplink data packets. When a downlink packet is sent to a mobile end device, the coordinator delivers the packet to the last recorded location, i.e., the last router that received the uplink packet from the mobile end device. Upon the reception of the downlink packet, the router simply forwards it to the mobile end device and waits for an acknowledgement message from the end device. If the mobile end device has moved from the last known location, the data delivery fails, and the coordinator starts a search by broadcasting a message that asks for information about the mobile end device's current location. For the simplicity of presentation, we assume that every mobile end device has a similar amount of data traffic and there is no preference for delivering data through specific routers.

B. Problem Formulation

Our Deployment framework objective is to increase the downlink data delivery ratio in Zigbee cluster tree network. Mobility based deployment framework tree construction maybe formulated as a graph problem, in which vertex represents an immobile. For node deployment, we develop a virtual grid that covers the whole region. Each vertex that is the intersection of lines, on the grid is a candidate location for router node. The distance *d* calculates between adjacent grid points is determined based on the particular application. The node deployment performs following two subtasks: 1) router node deployment, 2) coordinator node selection. Our scheme selects the position based on the mobility profile, but the coordinator selection based on random measurement.

The zigbee network as represented as *G= V, E,* where *V* is a set of immobile nodes, and *E* is a set of transmission links in the zigbee network. After the router node deployment, the routing tree construction can be formulated as a graph problem, where a vertex represents an immobile node, and a directed edge represents a possible transmission link from an immobile node to another immobile node. The overall objective is minimizing the number of missed data deliveries caused by mobile end-device mobility, thereby minimizing the cost of propagation incurred by node searching.

III. SIMULATION AND RESULTS

In this section, we discuss the simulations that we conducted as consider the insights gained on mobility based tree construction for zigbee wireless networks. The proposed framework is used to deploy routers in a real-world indoor scenario with a custom-made mobility model and a real world outdoor scenario with real data set of human mobility trace so that connectivity can be satisfied.

A. Simulation Setup

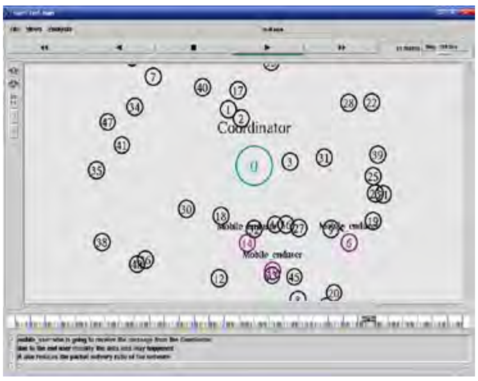

Fig 3.Mobile end user moving one location
To another location

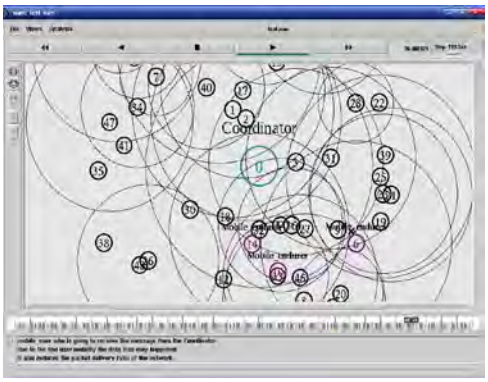

Fig 4.Routing operation

B. Result

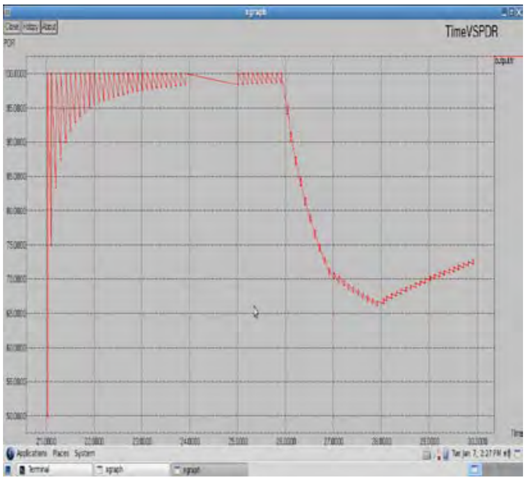

Fig.5. Mobility Regularity verses packet delivery Ratio

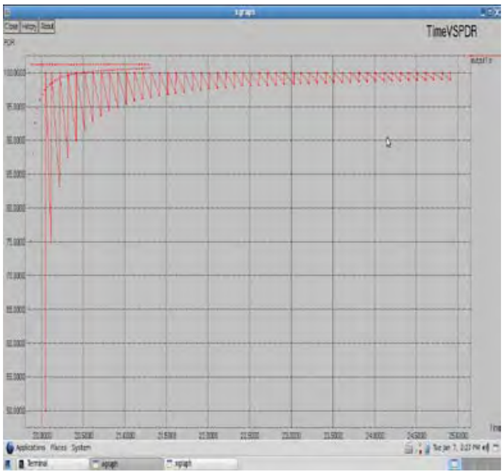

Fig.6. Mobility Regularity versus packet delivery delay

IV. CONCLUSION AND FUTURE WORK

A. Conclusion

In this paper, we introduce ZigBee routing tree topology deployment and construction framework incorporates the mobility information, and algorithms are developed to implement the framework. Compared to existing approaches, the proposed framework achieves higher data delivery ratios and longer path duration with much lower routing overhead in scenarios where the movements of mobile end devices are with regularity, proposed system ns-2 to conduct simulations in two real-world scenarios. The simulation results demonstrate the efficiency of the proposed approach.

B. Future work

The proposed system uses the cluster tree structure to transfer the packet in the networks and main objective of this future work is to minimize the overhead. The simulation evaluates the performance of the proposed tree structure. The proposed system produces the high downlink packet delivery ratio and it also reduces the overhead in the network, the tree structure also reduces the packet loss , it uses the mobility profile for fix the router in the network , so all the packets routed through the router reach the mobile end user even the mobile user move across the network. Compare the performance of the proposed system with the adhoc routing proposed system reduces the overhead in the network, Adhoc routing produces the many overhead in the network compare to the proposed system. The proposed system reduces the packet loss during the packet transfer in the network. The proposed system produces the high packet delivery ratio. Adhoc routing also produces the high packet delivery ratio, but it produces the high overheads in the network. Three parameters are used in the comparison. Delay, overhead, packet delivery ratio are compared in Performance evaluation.

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