A Review on Tree Routing in Zigbee Wireless Network

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Abstract: As ZigBee is a standard for wireless personal network. Tree Routing is simple routing where the node communication is restricted to parent-child links only. There is no routing discovery in tree routing as well as routing overhead. But one demerit of tree routing is that end to end delay is increased during packet transmission which resulting more energy usage or energy consumption and that results in failure of sensor nodes. After that when deeply study of extended tree routing or improved tree routing in that neighbor table are implemented but finding the best neighbor node or apt node is not implemented. In this paper we have compare all the relevant technologies available for tree routing in Zegbee Wireless network, also tried to point out the limitations in the existing systems and also proposed the system which can overcome the limitations of the existing system, We propose the systemwhich finds or chooses the best node or data transmission and then after energy model helps in conservation of energy as well as routing cost balance. It reduces the network cost also and increases the lifetime of the sensor node. Simulations have been run using NS2.

Keywords*:-ZigBee, Extended Tree Routing*

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I. INTRODUCTION

ZigBee is a worldwide standard of wireless personal area network targeted to low-power, cost-effective, reliable, and scalable products and applications. Different from the other personal area network standards such as Bluetooth, UWB, and Wireless USB, ZigBee provides the low power wireless mesh networking and supports up to thousands of devices in a network. Based on these characteristics, ZigBee Alliance has extended the applications to the diverse areas such as smart home, building automation, health care, smart energy, telecommunication, and retail services. The ZigBee network layer, which is the core of the standard, provides dynamic network formation, addressing, routing, and network management functions. ZigBee supports up to 64,000 devices in a network with the multi- hop tree and mesh topologies as well as star topology. Every node is assigned a unique 16 bit short address dynamically using either distributed addressing or stochastic addressing scheme. The routing protocols of ZigBee are diverse so that a system or users can choose the optimal routing strategy according to the applications.

The reactive routing protocol in ZigBee is derived from AODVjr (AODV junior), which is one of the representative routing protocols in MANET (Mobile Ad-hoc Networks). Similar with other MANET routing protocols, ZigBee reactive routing protocol provides the optimal routing path for the arbitrary source and destination pair through the on-demand route discovery. It requires the route discovery process for each communication pair, so the route discovery overhead and the memory consumption proportionally increases with the number of traffic sessions. Moreover, route discovery packets are flooded to the overall network, which interfere with transmission of other packets even in the spatially uncorrelated area with the route discovery.

On the other hand, ZigBee tree routing (ZTR) prevents the route discovery overhead in both memory and bandwidth using the distributed block addressing scheme. In ZTR, since each node is assigned a hierarchical address, a source or an intermediate node only decides whether to forward a packet to the parent or one of the children by comparing its address with the destination address. The most benefit of ZTR is that any source node can transmit a packet to an arbitrary destination in a network without any route discovery overheads. Due to this efficiency, ZTR is considered as a promising protocol for resource constrained devices in diverse applications such as smart grid project and Internet of Things (IoT). However, in ZTR, packets are forwarded along the tree topology to the destination even if the destination is located nearby. Thus, ZTR cannot provide the optimal routing path, while it does not require any route discovery overhead.

II. LITRATURE REVIEW

Tree routing is a simplified routing protocol for low-rate wireless sensor networks, battery operated devices whose scarcest resources are energy and memory. The hierarchical route search method in tree routing precludes the need of route discovery and, thus, helps reduce the initial latency, control overhead and memory consumption as a direct result of the elimination of the routing table. Nevertheless, in data-gathering systems that are based on spanning trees rooted at a sink node, tree routing can degenerate network performance as a result of non optimal route selection, congestion and uneven distribution of traffic. [1] The nodes in lower levels must handle the major part of network traffic, and this makes them vulnerable to early battery exhaustion. ZigBee routing addresses this problem by adding a simplified version of ad hoc on demand vector routing to the cluster tree and making trade-offs between them according to application requirements and network conditions.

Shortcut tree routing is a new proposal for ZigBee networks, which breaks the conventional tree routes in favor of shorter and lower-cost routes. The neighbor table that is originally defined in the ZigBee standard is used to find the optimal next hop node that has the smallest remaining hop count to the destination. [2] The shortcut tree routing algorithm is efficient in terms of both routing performance and time complexity: it reduces significantly the required routing costs and it can be solved within polynomial time even when the number of neighbors is not limited. The performance evaluation of this method shows promise in a hop count reduction of routes, but other important metrics like routing overhead, end-to-end delay, data delivery ratio and load balancing are not evaluated.

The possibly most important requirement for a routing scheme for wireless sensor networks is energy efficiency. A previous study showed that the minimum spanning tree-based routing provides good performance in terms of lifetime when the data are gathered using aggregation. In the authors propose a novel data-gathering algorithm called energy aware multi-tree routing (EAMTR) for low-rate wireless sensor networks. Aiming at the alleviation of the hotspot problem, this protocol achieves energy balancing and the extension of the network lifetime, and enhances reliability via route redundancy for high-density sink-type networks. In this scheme, multiple trees are formed in the initialization phase and according to network traffic, each node selects the least congested route to the root node.MANET [1] routing protocols can be classified into proactive and reactive routing protocols. The proactive routing protocol periodically updates the topology information, so it always has an up-to-date optimal routing path. The representative examples of proactive routing protocols are OLSR [3] and DSDV. In contrast, the reactive routing protocol invokes the route discovery procedure only when an application requests transmission of data. Thus, it does not generate the control packet overhead if there is no data packet to transmit, while it causes long delay to find a routing path. AODV [5], DSR , and TORA are examples of the reactive routing protocol. Regardless of whether it is proactive routing or reactive routing, these MANET routing protocols provide the optimal routing path for the given source and destination pair. However, the required routing table size of these protocols is too big to store all the routing paths in the resource-limited devices [6]. Moreover, they need to exchange control packets to maintain and discover the routing path, and the interference of these control packets on the other transmissions of the packets may be severe in the low rate and narrow bandwidth channels. Here, before explaining the other routing protocols, we categorize communication traffic patterns into any-to-any, many-to-one, and one-to-many traffic pattern [7]. In the any-to-any traffic pattern, all the nodes can be a source or a destination of the packets. The many-to-one traffic pattern designates one destination and this destination collects the information from all the other devices in a network.

Conversely, the one-to-many traffic pattern is used for the designated one source node to transmit the packets to the other devices. CTP [7] and RPL are the representative wireless personal area network protocols mainly supporting many-to-one and one-to-many traffic pattern.

Collection tree protocol (CTP) in TinyOS [8] is the representative tree routing protocol. In CTP, the base station as a root of the tree builds a collection tree and every sensor node selects its parent node. The routing metric of CTP is the expected transmissions count (ETX), and a root has an ETX of 0. Each node calculates its ETX by sum of the ETX of its parent and ETX of its link to its parent. The CTP maintains the ETX of its neighbouring device and selects the node with the lowest ETX as the parent. When a sensor node has data to send, it simply sends a data packet to its parent. This forwarding process is repeated until the base station receives. RPL (IPv6 Routing Protocol for Low Power and Lossy Networks) is the IETF standard protocol based on CTP. RPL constructs a destination oriented directed acyclic graph (DODAG) to optimize the many-to-one traffic pattern. Every device in the DODAG establishes the optimal routing path to the destination using a single route request from the destination, which may be the gateway of a network. The DODAG significantly reduces the route discovery overhead and routing table size, because it requires only one time of route discovery from the destination comparing with

MANET routing protocols requiring all the individual sources to invoke route discovery to the same destination. The main advantage of these protocols is that they significantly reduce the route discovery overhead by concentrating on the many-to-one and one-to-many traffic.

Even though they can support the any-to-any traffic pattern, a routing path is inefficient by traversing along the tree topology and they also suffer from detour path and traffic concentration problems like ZigBee tree routing. For the ZigBee standard, there have been researches on improving the path efficiency of the ZigBee tree routing. The preliminary version [9] suggests utilizing the 1-hop neighbour table to reduce the routing cost of ZTR. The proposed STR algorithm selects the neighbour node if it can reduce the routing cost to the destination. It showed that the proposed algorithm saves more percent of hop count compared with ZTR without any route discovery overhead. However, it is limited on evaluating the saved hop count comparing with ZTR. In this paper, in additional to the inefficient routing path of ZTR [10], we have identified that ZTR suffers from performance degradation when all the packets are concentrated on the tree links. We demonstrate these problems of the ZTR by the network simulation, and prove that STR significantly.

III. SCOPE FOR RESEARCH

ZigBee tree routing (ZTR) prevents the route discovery overhead in both memory and bandwidth using the distributed block addressing scheme. In ZTR, since each node is assigned a hierarchical address, a source or an intermediate node only decides whether to forward a packet to the parent or one of the children by comparing its address with the destination address. Even though they can support the any-to-any traffic pattern, a routing path is inefficient by traversing along the tree topology and they also suffer from detour path and traffic concentration problems like ZigBee tree routing. For the ZigBee standard, there have been researches on improving the path efficiency of the ZigBee tree routing.

IV. PROBLEM DEFINITION

The tree routing protocol uses only parent and child relationship for routing, ignoring neighbor nodes. As a result, packets may be routed through several hops towards the destination even if this is within sender's 1-hop transmission range. The packet from the source node goes up to the root node following the parent node, and goes back to the destination. In this way, 4 hops are required to reach the destination. However, if the source node sends the packet directly to the destination, it needs only 1 hop routing cost. In many cases, the routing overhead of tree routing algorithm cannot be avoided if only parent-child relationships are considered in the routing. In order to overcome such problem, each node should consider its neighbour nodes as next hop nodes.

V. OBJECTIVES OF PROPOSED SYSTEM

In the tree routing protocol, when packets transmitted from Source S to Destination D it follow tree topology for forwarding the packets to Destination D. It is simple to understand as well as easy to implement and use limited resources. In this routing, when node sense data from environment and want to send it to Destination D, it first checks if the Destination address is in address space of its descendants. If this is the case when Source simply transmit the data packet downwards to its descendants. Otherwise it transmits the packet upwards to its root node or parent node. When both parent and descendants are receive this packet they will select the hop node according to the destination address following the same manner. In this routing strategy we consider only parent child relationship not neighbor node.

The Main Drawback of tree routing is that it uses only the parent and relationship for routing, ignoring neighbor nodes. As a result, Data packet may be routed through several hops towards the destination even Destination node is nearby Sender node. So it would lead to end to end delay increase during data packet transmission, especially in the large networks, which results transmission imbalance and energy consumption.

After that Taehong Kim and Youn-Soo Kim proposed Shortcut Tree algorithm and Extended Tree algorithm by using neighbor table which can reduce the routing hop. But how to select the neighbor nodes is not introduced. If there are unapt (not suitable) neighbor nodes, memory and complexity will be added. Nodes exhaustion is fast due to energy usage by the nodes.

For the ZigBee standard, there have been researches on improving the path efficiency of the ZigBee tree routing. The preliminary version of our paper suggests utilizing the 1-hop neighbour table to reduce the routing cost of ZTR. The proposed STR algorithm selects the neighbour node if it can reduce the routing cost to the destination. It showed that the proposed algorithm saves more than 30 percent of hop count compared with ZTR without any route discovery overhead. However, it is limited on evaluating the saved hop count comparing with ZTR. In additional to the inefficient routing path of ZTR, we have identified that ZTR suffers from performance degradation when all the packets are concentrated on the tree links. We demonstrate these problems of the ZTR by the network simulation, and prove that STR significantlyenhances overall network performances such as packet delivery ratio, end-to-end latency, path stretch and so on. The mathematical analyses are also provided to prove that STR alleviates the traffic load concentrated on the tree links as well as provides an efficient routing path without loop.

VI. RESEARCH TO BE CARRIED OUT

The Improved Tree Strategy basically follows ZigBee tree routing algorithm, but chooses neighbor nodes as next hope nodes if the routing cost to the destination can be reduced. The neighbor table that we use in improved algorithm is defined in the ZigBee Specification, so we don't need to make an effort to search neighbor list.

In order to choose the next hope node that can reduce the routing cost, the remaining hope count from next hop node to the destination is computed for all the neighbor nodes including parent and children nodes. In the above the remaining hops to the destination for each neighbor can be computed assuming that the route from the neighbor to the destination goes along the tree. In this the route cost can be minimized if the sender transmits the data directly to the destination.

Case 1: Destination is parent of source: The source node checks if its parent node is the destination node. If yes, then it will transmit the packets to the parent and stop.

Case 2: Destination is source's descendent: The source node checks if the destination address is one of its descendants. If yes then it will transmit the packets to its descendant. Then checks if the descendent is the destination. If yes, it means destination is found therefore stop. Otherwise, the descendent will search for the destination in its own descendents until the destination found.

Case 3: Destination is its neighbor: The source nodes checks if the destination address is one of its neighbors. If yes, then it will transmit the packets to the neighbors and stop.

Case4: Destination is its neighbor's descendent or parent: The source node checks if the destination address is one of its neighbor's descendents. If yes, it will transmit the packets to the neighbor. Then the neighbor will find the destination among its descendents.

VII. CONCLUSION

We have identified the detour path problem and traffic concentration problem of the ZTR. These are the fundamental problems of the general tree routing protocols, which cause the overall network performance degradation. To overcome these problems, we propose STR that uses the neighbour table, originally defined in the ZigBee standard. As we all know, there are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays. Here we have new strategy it finds or choose the best node or data transmission and then after energy model helps in conservation of energy as well as routing cost balance. It reduces the network cost also.

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