Neighbor Information based Efficient Path Selection in Wireless Sensor Network

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***Abstract*— Wireless Sensor Networks is an active research area in today's computer science & Engineering and telecommunication field. In Mobile Adhoc Network, routing is a difficult task and it is an important research area of work due to its unpredictable network topology changes. It is a pure network layer scheme that can be built at the top off the shelf wireless networking equipment. Nodes in the network use a lightweight proactive source routing(AODV) protocol to determine a list of intermediate nodes that the data packets should follow end route to the destination. The main idea of the shortcut tree routing is to calculate remaining hops from an arbitrary source to the destination using the hierarchical addressing scheme in ZigBee, and each source or intermediate node forwards a packet to the neighbor node with the smallest remaining hops in its neighbor table. The shortcut tree routing is fully distributed and compatible with ZigBee standard in which it utilizes the addressing scheme and table without any changes of specification.**

Keywords- *Zigbee, tree routing, shortcut tree routing(STR)neighbor table, MANET,WSN,IEEE 802.15.*

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, ZigBe Alliance has extended the applications to the diverse areas such as smart home, building automation [1], health care [2], smart energy [3], telecommunication, and retail services. The ZigBee network layer [4], which is the core of the standard, provides dynamic network formation, addressing, routing, and network management functions. ZigBee supports up to network layer [4], 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 application. The reactive routing protocol in ZigBee is derived from AODV (AODV junior) [5], which is one of the representative routing protocols in mobile ad hoc networks (MANET). Similar with other MANET routing protocols [6], [7], [8], [9], [10], ZigBee reactive routing protocol provides the optimal routing path for the arbitrary source and destination pair through the on-demand route discovery.

II. RELATED WORK

MANET [11] 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 [6] and DSDV [7]. 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 [8], DSR [9], and TORA [10] 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 [12].

Moreover, they need to exchange control packets to maintain and discover the routing path, and the inter- ference of these control packets on the other transmissions enhances overall network performances such as packet delivery ratio, end-to-end latency, path stretch and so on. The mathematical analyses are also provided in this paper to prove that STR alleviates the traffic load concentrated on the tree links as well as provides an efficient routing path without loop.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 [13]. 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 [14] and RPL [15] 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 [16] 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 neighboring 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.

III. PROPOSED SYSYTEM

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 of our paper [17] suggests utilizing the 1-hop neighbor table to reduce the routing cost of ZTR. The proposed STR algorithm selects the neighbor 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 this paper, in additional to the inefficient routing path of ZTR [17], we have identified that ZTR suffers from performance degra- dation when all the packets are concentrated on the tree links. We demonstrate these prob ZTR is designed for resource constrained ZigBee devices to choose multihop routing path without any route discovery procedure, and it works based on hierarchical block addressing scheme described in (1) and (2). Fig. 1 shows an example of the ZigBee address assignment scheme and the address hierarchy when *Cm* (nwkMaxChildren), *Rm* (nwkMaxRouters), and *Lm* (nwk MaxDepth) are given with 3, 2, and 3 respectively. *Cm*, *Rm*, and *Lm* are defined as the maximum number of children a parent may have, the maximum number of routers a parent may have as children, and the maximum tree level of a network in ZigBee standard, respectively, The *Cskip*ð*d*Þ in (1) computes the size of address space assigned by each router node at tree level *d*, and the value of *Cskip*ð*d*Þ is the same as the amount of *Rm Cskip*ð*d* þ 1Þ þ ð*Cm-Rm*Þ þ 1 to cover the address spaces of its router capable children and end devices. Based on *Cskip*ð*d*Þ, the network address assignment scheme in (2) is defined for each kth router-capable child and nth end device given by the parent at tree level *d*. This block addressing scheme preallocates the available network address space at each tree level, and the address space is split in a recursive manner as the tree level increases. In other words, each parent node at tree level *d* assigns the *Cskip*ð*d*Þ size of address space to its router-capable child nodes, and its children distribute *Cskip*ð*d* þ 1Þ size of address space to their router capable children.

A. Shortcut Tree Routing

We propose the STR algorithm that solves these two problems of the ZTR by using 1-hop neighbor information. The STR algorithm basically follows ZTR, but chooses one of neighbor nodes as the next hop node when the remaining tree hops to the destination can be reduced. For example, in Fig. , STR computes the remaining tree hops from the next hop node to the destination for all the neighbor nodes, and selects the N4 as the next hop node to transmit a packet to the destination D. The main idea of STR is that we can compute the remaining tree hops from an arbitrary source to a destination using ZigBee address hierarchy and tree structure as discussed in previous section. In other words, the remaining tree hops can be calculated using tree levels of source node, destination, and their common ancestor node, because the packet from the source node goes up to the common ancestor, which contains an address of the destination, and goes down to the destination in ZTR. Tables 1 and 2 describe the detail algorithm of STR, and followings are the definitions used by STR. Let *level*ð*u*Þ be the tree level of node *u*, and *A*ð*u*Þ be {*A*ð*u; i*Þ j *A*ð*u; i*Þ is the network address of *u*'s ancestor at tree level *i*, *i level*ð*u*Þ}. The *LCA*ð*s; d*Þ [18] is defined as the lowest common ancestor between source node *s* and destination *d*. This inference procedure to find AðdevAddrÞ starts from the root node, which has the network address 0, until the network address of ancestor is identical to the given devAddr. For example, for the given network address of " and _ in Fig. 1, we can find the network addresses of the ancestors _, , for " and _, , _ for _.

ISSN No: - 2456 - 2165

Also, the addresses of the common ancestors between a source and a destination can be found by comparing the ancestor's addresses in each tree level. STR has the limitation that the routing path is not always optimal in an aspect of the end-to-end hop distance, because the next hop node is selected based on the local information like 1-hop neighbor table. For example, in Fig. 2c, the optimal path from S to D2 is S ! N5 ! D2, but, it requires 2-hop neighbor information in order for the source S to know that N5 is within 1-hop communication range of the D2. It is obvious that maintaining 2-hop neighbor information incurs high protocol overhead in the network with high node density [19], [20]; thus, we selected to provide a resource efficient routing protocol in a view point of memory consumption and routing overhead. Thus, we added AODV protocol to the performance evaluation for the quantitative comparison of the path efficiency, and STR shows only 10-20 percent.

The reactive routing protocol in ZigBee is derived from PLGPA, which is one of the representative routing protocols in mobile ad hoc networks (MANET). Similar with other MANET PLGPA 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.

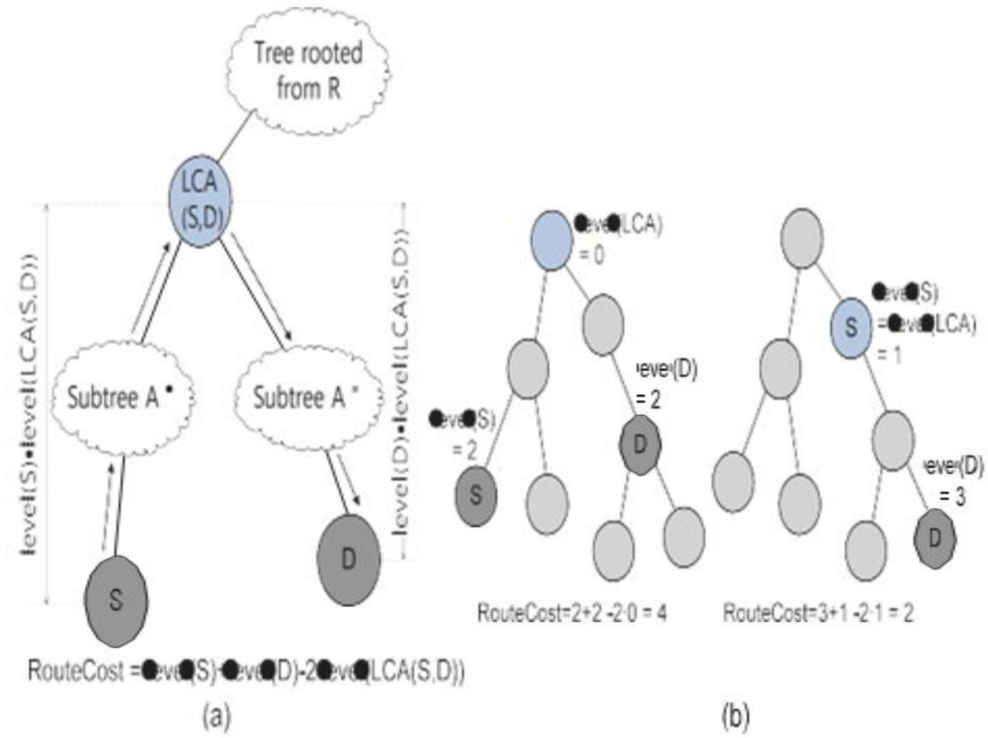

Fig.1.Calculation of ZigBee tree routing cost between as our destination.

B. Effect of the Network Density

As one of the fundamental analysis of the network protocol, we first evaluate the network performance on the network .On the other hand, both of STR and AODV are insensitive to the network density. It proves that STR and AODV provide the short routing path regardless of the network topology such as tree levels of the nodes. The average hop count of STR and AODV are about 3.2-4 hops and 2.9-3.2 hops, respectively. In contrast to ZTR, the of STR and AODV decreases for the higher , since both routing protocols find the more efficient routing path from the increasing number of candidate nodes. Note that STR has only about 0.5-1 larger hop count than AODV in spite of the limitation of the local minimum based routing selection. The end to end latency in Fig. shows similar trend with the hop count, since the end-to-end latency is mainly affected by the hop distance between a source and a destination.

The packet delivery ratio of ZTR significantly drops to27 percent as the number of nodes increases, as shown in main reasons are large hop count to the destination and the overlapped routing path. The packets are concentrated around the root of a tree, so and interferences occur around the root of a tree as the network. On the other hand, STR and AODV show high packet delivery ratio about 70 percent even in the 300 nodes, since the routing paths are short enough not to interfere each other and the are distributed through the neighbor nodes as well. The interesting point is that the packet delivery ratio of STR outperforms AODVfromthe200 nodes in spite of high average hop count. It is because the route discovery packets AODV, which is triggered before data packet transmission ,interfere with transmissions of other packets. In, since the route discovery packets use network, the degradation of the packet delivery ratio worse for the higher network density. On the contrary, as STR has no queuing delay and route establishing the routing path, it achieves the high delivery ratio regardless of network density.

A source or an intermediate node selects the next hop node having the smallest remaining tree hops to the destination regardless of whether it is a parent, one of children, or neighboring node. The routing path selection in STR is decided by individual node in a distributed manner, and STR is fully compatible with the ZigBee standard that applies the different routing strategies according to each node's status. Also, it requires neither any additional cost nor change of the ZigBee standard including the creation and maintenance mechanism of 1-hop neighbor information. Data routing means, data routing chooses best route to transfer the data between sources to destination. In existing system they used Path finding algorithm for routing purpose. EXOR is also another technique which is used in existing technique.

In existing system is have a handshake technique, called Selection Diversity Forwarding (SDF), to implement downstream forwarder selection in a multihop wireless network, where multiple paths are provided by the routing module. The sender will choose the route randomly to reach the destination using this SDF method. But this method is expensive.

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.

Perpetrators of DoS attacks typically target sites or services hosted on high-profile web servers such as banks, credit card payment gateways, and even root nameservers. This technique has now seen extensive use in certain games, used by server owners, or disgruntled competitors on games. Increasingly, DoS attacks have also been used as a form of resistance. DoS they say is a tool for registering dissent. Richard Stallman has stated that DoS is a form of 'Internet Street Protests' The term is generally used relating to computer networks, but is not limited to this field; for example, it is also used in reference to CPU resource management.

One common method of attack involves saturating the target machine with external communications requests, so much so that it cannot respond to legitimate traffic, or responds so slowly as to be rendered essentially unavailable. Such attacks usually lead to a server overload. In general terms, DoS attacks are implemented by either forcing the targeted computer(s) to reset, or consuming its resources so that it can no longer provide its intended service or obstructing the communication media between the intended users and the victim so that they can no longer communicate adequately.

- *Construct Network*

A Mobile Ad hoc Networks (CORMAN) is a lightweight proactive source routing protocol so that each node has complete knowledge of how to route data to all other nodes in the network at any time. When a flow of data packets are forwarded towards their destination, the route information carried by them can be adjusted by intermediate forwarders.

- *Proactive Source Routing*

Proactive source routing is to support opportunistic data forwarding in MANETs. In order to provide responsive data transfer capability in such networks, a proactive source routing protocol is highly preferred. Despite that the array of optimization techniques employed by OLSR, its overhead remains high in the presence of the constrained communication resources in MANETs. Thus, we set forth to design PSR, which can provide nodes with the cost of network structure information for source routing at a communication overhead similar to or even less than a proactive distance vector routing protocol. In PSR, nodes maintain and exchange BFSTs periodically.

- *Long live update*

As packets progress in the network, the nodes listed as forwarders can modify the forwarder list if any topology change has been observed in the network. This is referred to as large-scale live update in which it will have the information about the nodes whether they received the information or not.

- *Routing Information*

In this module have all nodes and route information should contain to find shortest path and find distance between neighbor nodes the send route information from that node .

ISSN No: - 2456 - 2165

- *Large-scale Retransmission*

Different nodes that are not listed as forwarders to retransmit data if this turns out to be helpful referred to as Large -scale retransmission. Which will re transmit the packets which are get loosed on the previous packet transmission.

IV. CONCLUSION

In this paper, 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 neighbor table, originally defined in the ZigBee standard. In STR, each node can find the optimal next hop node based on the remaining tree hops to the destination. The mathematical analyses prove that the 1-hop neighbor information in STR reduces the traffic load concentrated on the tree links as well as provides an efficient routing path. The network simulations show that STR provides the comparable routing performance to AODV as well as scalability respect to the network density and the network traffic volume by suppressing the additional route discovery process. Therefore, as discussed in Section 4 in the online supplemental material, we expect STR to be utilized in many ZigBee applications requiring both small memory capacity and high routing performances.

V. ACKNOWLEDGMENTS

This work was supported by Global Frontier Project (CISS-2013073718), International Research and Development Program (NRF- 2013064540), and Basic Science Research Program (grant no. 2011-0014204) through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology of Korea. D. Kim is the corresponding author of this paper.

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