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PROVIDING EFFICIENT ROUTE DISCOVERY USING REACTIVE ROUTING IN WIRELESS SENSOR NETWORKS

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Abstract: - Providing reliable and efficient route for communication under fading channel is one of the major challenges in WSN, especially in the industrial wireless sensor networks(IWSNs).In this work we present the Reliable Reactive Routing to increase the resilience to link dynamics for WSN/WSN. Reactive Routing protocols provide reliable and energy efficient packet delivery against the unreliable wireless by utilizing the local path diversity. In this work we are introducing based back off scheme during the route-discovery phase to find a robust guide path, which can provide more forwarding nodes. In this biased back off scheme we are using guide path, using this guide path data packets are moving towards the destination through node's cooperation without utilizing the local information.

Keywords: - Industrial wireless sensor network, opportunistic routing, reliable forwarding, unreliable wireless links.

I.INTRODUCTION

In wireless detector network routing may be a terribly difficult drawback owing to the inherent characteristics that differentiate such networks from alternative wireless networks. In recent years, several algorithms are planned for the routing issue in wireless detector networks

Wireless sensor networks are replacing the traditional wired industrial communication systems because IWSNs have several advantages over wired industrial like easy and fast installation and low-cost maintenance. IWSN have applications such as factory automation, industrial process monitoring and control, and plant monitoring. There are several traditional routing protocols such as AODV, AOMDV, and DSR.

Today's competitive industry marketplace, the companies face growing demands to improve process efficiencies, comply with environmental regulations, and meet corporate financial objectives. Given the increasing age of many industrial systems and the dynamic industrial manufacturing market, intelligent and low-cost industrial automation systems are required to improve the productivity and efficiency of such systems. The collaborative nature of industrial wireless sensor networks (IWSNs) brings several advantages over traditional wired industrial monitoring and control systems, including self-organization, rapid deployment, flexibility, and inherent intelligent-processing capability. In this regard, IWSN plays a vital role in creating a highly reliable and self-healing industrial system that rapidly responds to real-time events with appropriate action. In IWSNs transmission failure can result in missing or delaying of process or control data, and missing the process or control deadline is normally intolerable for industrial applications as it may cause chaos in industrial automation or possibly terminate the automation finally it results in economic losses. Varying wireless channel conditions and sensor node failure may cause network topology and connectivity changes over time, to forward a packet reliably at each hop this needs multiple retransmission it will results in undesirable delay as well as additional energy consumption.

Reactive routing protocols**,** are designed to reduce the bandwidth and storage cost consumed in table driven protocols. These protocols apply the on-demand procedures to dynamically build the route between a source and a destination. Routes are generally created and maintained by two different phases, namely: route discovery and route maintenance. Route discovery usually occurs on-demand by flooding an RREQ (RouteRequest) through the network, i.e., when a node has data to send, it broadcasts an RREQ. When a route is found, the destination returns an RREP (RouteReply), which contains the route information (either the hop-by-hop information or complete addresses from the source to the destination) traversed by the RREQ.

II.NETWORK MODEL AND ARCHITECTURE

A. Network Model

Here we are considering a dense multihop static WSN deployed in the sensing field. Assume that each node has more numbers of neighbors. When a node has packets to send to the destination, it provides the on demand route discover to find a route if there is not a recent route to a destination. We assume that the MAC layer provides the link quality estimation service.

Each node periodically sends HELLO messages to keep track of its neighborhood information. The HELLO message contains the IDs of node's one hop neighbors and the packet reception ration of the corresponding links. After the HELLO message has been exchange each node maintains the two_hop neighborhood information.

The motivation behind reactive routing is the idea of opportunistic routing is to utilize the path diversity for cooperative caching. Where as in each hop, neighboring nodes that hold the copies of a data packet serves as a caches, thus the downstream node could retrieve the packet from any of them. Here we are finding a virtual path to guide the packets to reach the destination. We are calling this virtual path as a guide path, where nodes are named as guide nodes. As shown in the fig.1, [S ,C,G,Dest]is a guide path, and nodes C and G are the guide nodes. The guide path points out the general direction towards the destination, and the routing decision is made a posteriori, i.e., the actual forwarders are chosen based on the packet reception results at each hop.

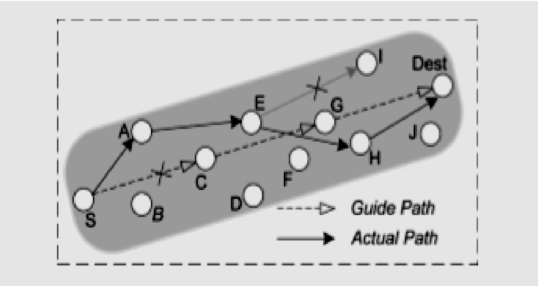

Fig. 1. Example of the guide path.

B. Architecture Overview

Fig. 2 illustrate an overview of the architecture of reactive routing, which is a middle ware design across the MAC and the network layers to increase the resilience to link dynamics for WSNs/IWSNs. The R3E enhancement layer consists of three main modules, the reliable route discovery module, the potential forwarder selection and prioritization module, and the forwarding decision module. The helper node and potential forwarder are interchangeable.

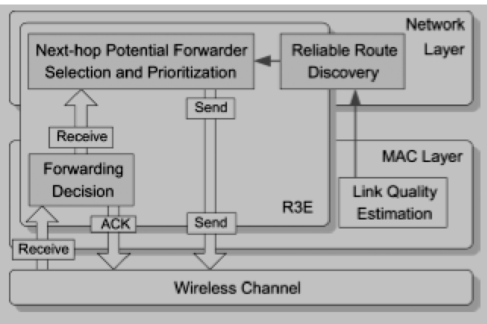

Fig. 2. Functional architecture overview of R3E.

The reliable route discovery module finds and maintains the route information for each node. During the route discovery phase, each node involved in the cooperative forwarding process stores the downstream neighborhood information, that is to say, when a node serves as a forwarder, it already knows the next-hop forwarding candidates along the discovered path. The other two modules are responsible for the runtime forwarding phase. When a node successfully receives a data packet, the forwarding decision module checks whether it is one of the intended receivers. If yes, this node will cache the incoming packet and start a backoff timer to return an ACK message, where the timer value is related with its ranking in the intended receiver list (called forwarding candidate list). If there is no other forwarder candidate with higher priority transmitting an ACK before its backoff timer expires, it will broadcast an ACK and deliver the packet to the upper layer, i.e., trigger a receiving event in the network layer. Then, the potential forwarder selection and prioritization module attaches the ordered forwarder list in the data packet header for the next hop. Finally, the outgoing packet will be submitted to the MAC layer and forwarded towards the destination.

We address the reliable routing problem in WSNs/IWSNs by applying the opportunistic routing paradigm to reactive routing protocols, and jointly optimizing the route discovery and cooperative forwarding. In order to show that R3E enables data packets to be greedily progressed toward the destination, we also report the evaluation results of the Geographic Opportunistic Routing (GOR). In our simulation, both R3E and GOR follow the same relay priority rule, i.e., minimizing the number of end-to-end data transmissions. We implement GOR as follows: all of the one-hop neighbours that are nearer from the destination than the current forwarding node and can hear from each other are selected as helper nodes, and the nodes closer to the destination are given higher relay priorities. Since the network is densely deployed, the routing recovery mechanism bypassing “holes” is not considered in the simulations.REPF: REPF (Reliable and Efficient Packet Forwarding) protocol is designed to improve the AODV routing performance by utilizing local path diversity. The route discovery phase finds an efficient primary path (composed of a set of primary forwarding nodes) in terms of the accumulated path ETX(expected transmission count), and alternative paths which have similar cost. However, REPF restricts the helper nodes to a very limited scope, i.e., only the nodes which can connect the two-hop away primary forwarding nodes are considered as helper nodes. As a result, it does not fully utilize the forwarding opportunities provided by available neighbouring nodes in evenly distributed networks.

C .Reliable Guide Path Discovery:

1. RouteRequest(RREQ) Propagation

If a node has data packets to send to a destination it finds the route discovery by sending RREQ message. When a node receives a non_duplicate RREQ, it stores the upstream node id and RREQ’s sequence number for reverse route learning. We are introducing a based backoff scheme at the current RREQ forwarding node, instead of rebroadcasting the RREQ immediately in existing reactive routing protocols. This operation is to intentionally amplify the differences o the RREQ’s traversing delays along different paths .This enables the RREQ to travel faster along the preferred path according to a certain defined matric.

Let Vi and V_j denote the last-hop node and current node of a RREQ, respectively. Let N(i) denote the set of V_i’s one-hop neighbours and CN(i,j) denote the common neighbour between V_i and V_j.We define a helper V_k between Vi and V_j as the common neighbour satisfying $P_{ik}>P_{ij}$ and $P_{kj}>P_{ij}$ where P_{ij} is the PRR between V_i and Vj. For cooperative routing, there exists an implicit constraint, that is, the nodes in the helper set should be able to hear from each other with a reasonably high probability. Let denote the set of helpers between and. In other words, is the common neighbor set between and on the premise that any two nodes in H(i,j) can overhear each other , and for all Vk belongs to H(i,j), $P_{ik}>P_{ij}$, $P_{ki}>P_{j}$j.

Let t_{ij} denote the backoff delay at the current forwarding node $V_{j,}$ which receives an RREQ from V_i. t_{ij} is calculated as defined

$$tij = \frac{HopCount}{\sum_k Pik\ \ Pkj} . \tau, Vk \in H(i,j) \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where τ is a time slot unit, the HopCount is the RREQ's hop distance from the source node thus far. The neighbours with more forwarding candidates, better link qualities, as well as shorter hop-count will have a shorter back off delay to rebroadcast the RREQ.

Fig. 3 illustrates the biased backoff scheme. Any node that forwards the RREQ will calculate the backoff delay by assuming itself as a guide node, and considering the last-hop node as its upstream guide node. For example, nodes A, B, and C receive an RREQ from the source S. When node C calculates its backoff delay, it considers itself as a guide node and S as the upstream guide node. From the local neighbor table, C knows that A and B are helper nodes. Then, it can calculate the value ofbackoffdelay.InFig.3,thelabel beside the helper node A means that and . At node C, the backoff delay is about according to (1). Compared with A and B, C has a shorter backoff delay, when C's backoff timer first expires, the RREQ is rebroadcasted. Consequently, node C has a higher priority to forward the RREQ. Similarly, node F forwards the RREQ before D and E. Thus, the RREQ that travels along the path arrives at the first. From (1), we can see that the higher priority is possibly given to the path with more potential helpers. Upon receiving an RREQ, a destination replies by sending an RREP message back to the source along the reverse route. In case of receiving the same RREQ multiple times, the destination shall only reply to the first received RREQ and neglect others. Algorithm 1 describes how a node handles a received RREQ.

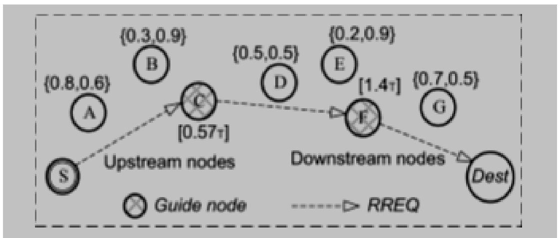

Fig. 3. Example illustrating the biased backoff scheme for RREQ propagation during the route discovery phase. The RREQ that travels along the path $[S \rightarrow C \rightarrow F]$ arrives at the $Dest$ first.

2. RouteReplay(RREP) Propagation

When a node receives an RREP, it checks if it is the selected next-hop (the upstream guide node) of the RREP. If that is the case, the node realizes that it is on the guide path to the source, thus it marks itself as a guide node. Then, the node records its upstream guide node ID for this RREP and forwards it. In this way, the RREP is propagated by each guide node until it reaches the source via the reverse route of the corresponding RREQ. Finally, this process find guide path from the source to the destination.

In our design, the RREP message has twofold functions. It not only implements the forward path setup, i.e., marking guide nodes along the reverse route, but also notifies the potential helpers to facilitate cooperative forwarding. Specifically, two sets of helpers and their relay priority assignments are included in the RREP.

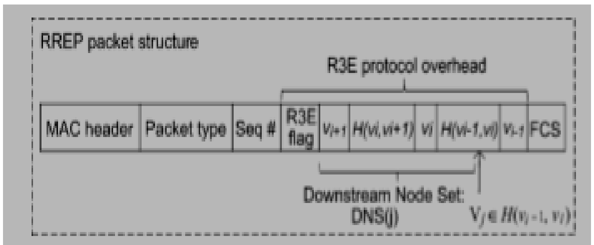

Fig. 4. RREP packet structure. Suppose guide node v_i sends out an RREP to the upstream guide node v_{i-1}, and node $v_j (v_j \in H(i-1, i))$ overhears this message.

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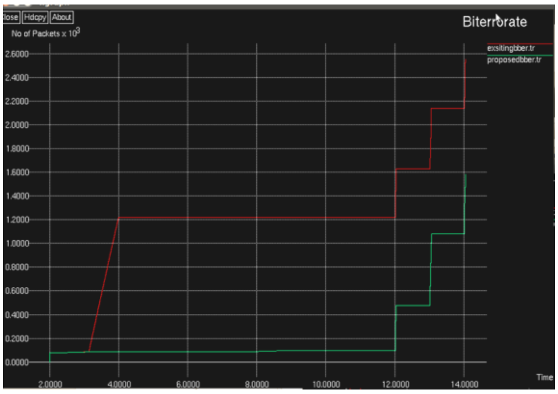
D.Four main evaluation metrics.

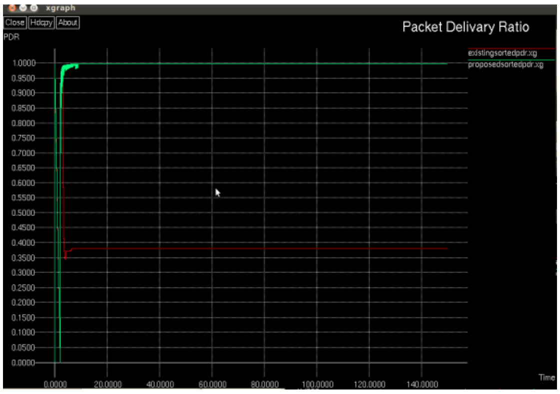
• **Packet delivery ratio:** the ratio of the number of packets received by the destination to the total number of packets sent by the source.
• **End-to-end delay:** the time taken for a packet to be transmitted from the source node to the destination node.
• **Data transmission cost:** it is measured as the total number of data transmissions for an end-to end delivery per packet.

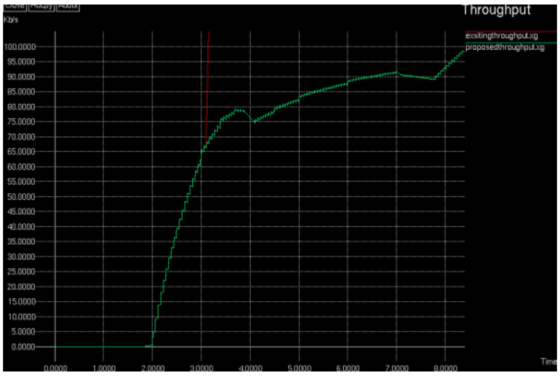
• **Control message cost:** it is defined as the total number of control message transmissions (such as RTS, CTS and ACK) for sending a single packet to the destination.

we address the reliable routing problem in WSNs/IWSNs by applying the opportunistic routing paradigm to reactive routing protocols, and jointly optimizing the route discovery and cooperative forwarding. In order to show that R3E enables data packets to be greedily progressed toward the destination, we also report the evaluation results of the Geographic Opportunistic Routing (GOR). In our simulation, both R3E and GOR follow the same relay priority rule, i.e., minimizing the number of end-to-end data transmissions. We implement GOR as follows: all of the one-hop neighbors that are nearer from the destination than the current forwarding node and can hear from each other are selected as helper nodes, and the nodes closer to the destination are given higher relay priorities. Since the network is densely deployed, the routing recovery mechanism bypassing "holes" is not considered in the simulations.REPF: REPF (Reliable and Efficient Packet Forwarding) protocol is designed to improve the AODV routing performance by utilizing local path diversity. The route discovery phase finds an efficient primary path (composed of a set of primary forwarding nodes) in terms of the accumulated path ETX (expected transmission count), and alternative paths which have similar cost. However, REPF restricts the helper nodes to a very limited scope, i.e., only the nodes which can connect the two-hop away primary forwarding nodes are considered as helper nodes. As a result, it does not fully utilize the forwarding opportunities provided by available neighbouring nodes in evenly distributed networks.

III. COMPARISON RESULTS







In the above graphs we are comparing the outputs of existing and proposed system red lines in the graphs indicating existing system and green lines are indicating proposed system. Hop count and delay time are calculated using the formula 1.

IV.CONCLUSION

In this work, we presented R3E, which can augment most exiting reactive routing protocols in WSNs/IWSNs to provide reliable and energy efficient packet delivery against the unreliable wireless links. We introduced a biased back off scheme in the route discovery phase to find a robust virtual path with low overhead. Without utilizing the location information, data packets can still be greedily progressed toward the destination along the virtual path. Therefore, R3E provides very close routing performance to the geographical opportunistic routing protocol.

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