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An Enhancement of Reliable Reactive Protocol for Secure Packet Transmission

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***Abstract*— In a wireless sensor network the main problem is signal loss. The sensor nodes have a limited storage, transmission range and their energy resources, Reactive Routing protocols for wireless sensor networks are responsible for maintaining the routes in the network and have to ensure reliable multi-hop communication under these conditions. Reliability of routing protocols by incorporating fault tolerance scheme is significantly important to identify the failure of data link and sensor nodes and recover the transmission path. The main idea is to maintain a bakeoff scheme during the route discovery phase to find a robust guide path, also consider the guide nodes. In case of any failure occurs, that time to take intermediate node to discover the new path also the destination also search the best path to send back the acknowledgment. By using this technique packets are greedily progressed towards the destination without knowing the location information. So this method will enhance the packet delivery ratio.**

***Keywords:* WSN, back off, guide path, sensor node, Reactive routing protocol.**

I. INTRODUCTION

A sensor is a scientific device that measures a physical quantity and converts it into a signal which would be read by human observer or by an electronic instrument. For ex, a mercury-in-glass thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. Sensor node is node in wireless network that performs functions such as processing, gathering sensory information and communicating with other nodes in the network. The collection of large number of sensor nodes densely deployed in particular area to detect some physical environmental conditions such as temperature, sound, pressure, etc, is termed as Wireless Sensor Network (WSN). It passes their data through the network to a main location cooperatively. A typical architecture of WSN includes randomly deployed sensor nodes near to which Base Station (BS) sink is placed. Sink is connected to internet through any other wired or wireless network.

Sink gives instructions to sensor nodes and gathers sensed data from them. As per the application requirement, sensor nodes sense the desirable physical phenomenon and locally do the data aggregation to avoid communication of redundant data. It sends aggregated data to sink using hop-by hop communication. Resource constraints include limited battery power, low Sensing power, limited processing power, limited memory and storage space, low communication range and low bandwidth. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and most important is in agricultural field to monitor soil humidity, temperature, pressure etc. Each sensor network node has typically several parts such as has power source, transceiver, microcontroller, memory and analog to digital converter (ADC) etc. The existing routing protocol for sensor networking can be divided into proactive routing protocol, reactive routing protocol and hybrid routing protocol. Each routing protocol has its merits and shortcomings. The lifetime will end when the working routing protocol can no longer support the whole wireless sensor network.

Proactive protocols continuously learn the topology of the network by sharing topological information among the network nodes. Thus, when route is required for a destination, such route information is given immediately. If the network topology changes too frequently, the cost of maintaining the network could be very high. If the network activity is low, the information about actual topology could not be used. The reactive routing protocols are based on query-reply dialog. Reactive protocols establish route(s) to the destination only when the need arises. They need not periodic transmission of topological information of the network. Hybrid protocol takes advantages of both proactive and reactive protocols. Reactive routing protocols are designed to reduce the bandwidth and storage cost consumed in table driven protocols.

Since the varying wireless channel conditions and sensor node failures may cause network topology and connectivity changes over time, to forward a packet reliably at each hop, it may need multiple retransmissions. This result in undesirable delay as well as additional energy consumption. Opportunistic routing (OR) [11]–[16] has been proposed as an effective cross-layering technique to combat fading channels, thus improving the robustness and energy efficiency in wireless networks. The idea of opportunistic routing is to take advantage of the broadcast nature of wireless communication, involving multiple neighbors of the sender into local forwarding. Since the wireless medium is shared, each node can overhear data Packets sent by its neighbors. In the network layer, a set of forwarding candidates are specified in the data packet and these nodes will follow the assigned priorities to relay the packet. Essentially, only one node is chosen as the actual forwarder at the MAC layer in an *a posteriori* manner. Reactive routing protocols [3], [4], [17] 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.

There are 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.

In this paper the main objective is to maintain a biased back off scheme during the route-discovery phase to find a robust guide path, which can provide more cooperative forwarding opportunities. It means that it will act like caching that is each hop will stores the data packet, so if any node failure that time another higher priority node will taken care that packet and send it to the destination quickly. Also the destination will replay back to the source.

II. Related Work

We initial expose relevant analysis work associated with signal strength based mostly routing.

Then, we are going to specific however our approach combines each the signal strength and energy metrics, to search out reliable path for communication and extend the network life. Most of the routing algorithms planned for painter is predicated on reactive routing strategy, during which route is established only if there is a necessity to transmit a packet. In these protocols route recovery and maintenance procedures area unit initiated solely when a route break. This procedure consumes further information measure and power at process nodes and additionally will increase the delay. It's necessary to search out routes that last longer, to scale back the route breakage and consumption of resources. In [8], Link stability is outlined as a live off however stable the link is and the way long the communication can endure. Signal Strength is one among the parameter wont to estimate the steadiness of links. In [9], the route discovery is predicated on signal strength and site stability of nodes. In SSA, a mobile node determines the typical signal strength at that the packets area unit changed between nodes and site stability is employed to settle on longer-lived route. Sulabh Agarwal and Pal Singh propose RABR [10], during which the route choice is finished supported the intelligent residual life assessment of the candidate routes. This major challenge with this protocol is, to settle on the optimum threshold values. In [11], the authors calculable the link stability supported the signal strength. If the received signal strength is larger than a definite threshold, the link is taken into account to be stable. In [12], Min-Gu and Sunggu lee planned a route choice supported Differentiated signal strength [DSS]. DSS indicates whether or not the nodes obtaining nearer or getting farther apart. If the signal strength is obtaining stronger, the link is taken into account to be stable. If the signal strength is obtaining weaker just in case of node moving away is taken into account to be unstable link. In [13], N.Sharma and S.Nandi propose RSQR, during which the link stability and route stability area unit computed mistreatment received signal strength. Supported the brink values the links area unit classified as stable or unstable link. Link stability and link uncertainty values area unit used for stable route choice among all the possible routes. Gun Woo and Lee propose EBL [14], during which the authors offer importance to all link stability and therefore the residual Battery capability. The EBL not solely improve the energy potency however additionally scale back network partition. Floriano and Guerriero propose LAER [15], during which they take into account joint metric of link stability and energy drain rate into route discovery, which ends in reduced management overhead and balanced traffic load.

The expected route life is principally expected with the parameters node battery energy and link stability. It's preferred to pick out stable links i.e. links having longer expected life, rather than choosing weak links that break presently and introduce routing overhead [16]. In [17], Guerriero propose PERRA, and reactive routing protocol, that accounts each link stability and power potency. Intermediate nodes in PERRA propagates route request, given that it meet the energy demand specific by the supply node. Thus, the trail established may be a stable path that incurs residual energy, path stability and calculable energy for information transmission. It additionally maintain alternate path, which might be used before link break happens to scale back the trail breakage. Management overhead is greatly reduced because of affected flooding and maintenance of alternate path. Flooding is natural for wireless detector networks; however it consumes an excessive amount of energy on relaying unnecessary information. Several variant of flooding have designed as routing protocols for detector networks. For instance, Gradient Broadcast (GRAB) [18] sets up price field by flooding. Well-known Directed Diffusion [19] uses restricted flooding an acknowledgement theme to line up route. Geographical and Energy Aware Routing (GEAR) [20] bounds flooding to satiny low region. Rumor protocol is Associate an integration of Gossip and GRAB. It combines question flooding and event flooding. Cluster based schemes [8] that kind detector nodes to clusters or a series are introduced to assemble information.

In cluster-based schemes, each detector node should be able to adapting its radio power that increase manufacture prices of every detector node. Besides, the information delivering delay is long bonded. Considering the load balance of detector nodes and therefore the restricted memory areas, dynamic multi-path routing schemes [9, 10] was planned for detector networks. In multi-path routing theme [9, 10], detector nodes have multiple methods to forward their information.

III. Scenario And Definitions

Reactive routing protocols are use on-demand procedures to dynamically build the path from source to destination. Routes are generally created and maintained by two different phases, namely: path discovery and path maintenance. Path discovery usually occurs on-demand by flooding an RREQ (Route Request) through the network that is when a node has data to send, it broadcasts an RREQ.

When a route is found, the destination returns an RREP (Route Reply), which contains the route information (either the hop-by-hop information or complete addresses from the source to the destination) traversed by the RREQ.

Some draws back are as follows

- Undesirable delay as well as additional energy consumption.
- Wireless channel conditions and sensor node failures may cause network topology and connectivity changes over time.
- In WSNs, transmission failures can result in missing or delaying of process
- Does not provide reliable and energy-efficient packet delivery against the unreliable wireless links by utilizing the local path diversity.
- High delivery latency.

Does not improve the packet delivery ratio, while maintaining high energy efficiency.Here we propose a Reliable Reactive Routing protocol is to increase the resilience to link dynamics for WSNs. These protocols inherit the advantages of opportunistic routing, thus achieving shorter end-to-end delivery delay, higher energy efficiency, and reliability. By using this reactive protocol we can achieve a best solution for the existing problems, the major contributions of this papers are as follows. Provide the solutions to reliable route discovery and efficient cooperative forwarding problems. To achieve effective cooperative forwarding method. Compatible with most existing reactive routing protocols in WSNs. The Reactive routing protocols used to provide reliable and energy-efficient packet delivery against the unreliable wireless links by utilizing the local path diversity and also reduce the bandwidth and storage cost consumed in table driven protocols. Improves the packet delivery ratio, while maintaining high energy efficiency and low delivery latency. By using Opportunistic routing, it achieving shorter end-to-end delivery delay, and reliability.

A. Network Model

We consider a dense multihop static WSN deployed in the sensing field. Since opportunistic routing is normally effective for wireless networks with higher node densities (e.g., more than ten neighbors per node) [18], we assume that each node has plenty of neighbors. When a node has packets to send to the destination, it launches the on-demand route discovery to find a route if there is not a recent route to a destination.

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We assume that the MAC layer provides the link quality estimation service. There has been a lot of existing work on how to measure wireless link quality in an efficient and accurate manner. We can use a representative link estimation method, such as those in [19] and [20]. In [21], through a set of real experiments, the authors reported that the size of the packets has a direct relationship with the packet reception ratio (PRR) in Wireless networks.

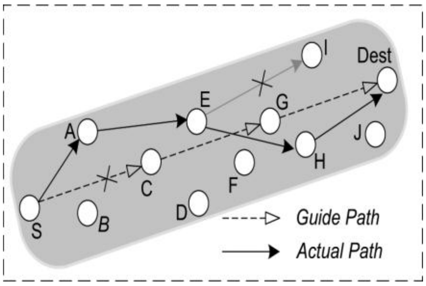

Fig. 1. Example of the guide path.

Short control messages, such as RREQ and RREP, have higher PRRs than data packets. Each node periodically sends HELLO messages to keep track of its neighborhood information. The HELLO message contains the IDs (addresses) of a node's one-hop neighbors and the PRRs of the corresponding links. After the HELLO message exchange, essentially, each node maintains the two-hop neighborhood information.

B. Motivation

Before providing the detailed design, we first illustrate the motivation behind up/down stream design. The idea of opportunistic routing is to utilize the path diversity for cooperative caching that is, in each hop, neighboring nodes that hold the copies of a data packet serve as caches, thus the downstream node could retrieve the packet from any of them [22]. The rationale is that, the path with higher spatial diversity (more potential helper nodes) may possibly provide more reliable and efficient packet delivery against the unreliable links. With this observation, we aim to find such a reliable virtual path to guide the packets to be progressed toward the destination. We call this virtual path a *guide path*, in which the nodes are named as *guide nodes*. As shown in Fig. 1, is a guide path, and nodes C and G are the guide nodes. The guide path points out the general direction toward 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.

IV. MAIN DESIGN

Here, we first present the reactive routing protocol functional architecture overview, followed by a detailed description of design, which is compatible with most existing reactive routing protocols in WSNs

A. Architecture Overview

Fig. 2 illustrates an overview of the functional architecture of Up/down stream, this is a middle-ware design across the MAC and the network layers to increase the resilience to link dynamics for WSNs. The up/down stream 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 in this work. 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

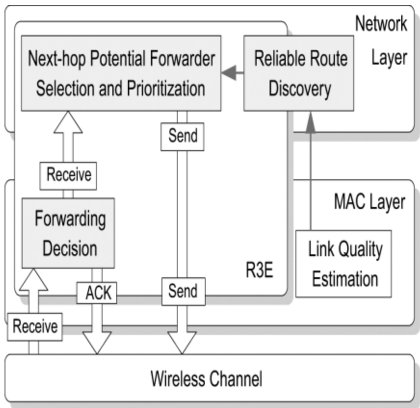

Fig. 2. Functional architecture overview of up/down stream of reactive protocol

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 back off 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 back off 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.

B. Reliable Guide Path Discovery

Route Request (RREQ) Propagation: If a node has data packets to send to a destination, it initiates a route discovery by flooding an 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. Instead of rebroadcasting the RREQ immediately in existing reactive routing protocols, we introduce a biased back off scheme at the current RREQ forwarding node. The aim of this operation is to intentionally amplify the differences of RREQ's traversing delays along different paths.

Load Balancing is to calculate the fair load of all sensor nodes; Data Transmission is the working phase that is the sensor network creates its task; Routing Maintenance is to adjust the fair load of the sensor node whose energy has reduced a specified value. In general, the wireless sensor networks can be converted into a graph $G = (V, E)$ in that each node is set V locates for a sensor node (including the *Sink* node), an edge is in E if sensor nodes u and v can converse each other straight forwardly. We guess all the nodes in the networks are homogenous except the *Sink* node that is the initial battery energy and the transmission power of all the sensor nodes are similar, while there is not battery restriction for the Sink node. According to the hop distance from a node to the sink node the routing models the sensor network into levels. A node is in level, if it is hops apart from the sink node which is a *level 0* node. All nodes that can talk directly with at least one level L node but cannot converse directly with any level L-1 node are described as Level L+1 node. As a result, level nodes have path length of L hops reverse to the sink node. The layered network can be constructed as follows:

Through broadcasting the packet and comparing h with h_u step by step, the layered network can be constructed. At last, each node is aware of its minimum hop count to sink node, and knows its parent nodes, sibling nodes and son nodes.The layered network can be constructed as follows:

Algorithm 1: The layered network construction

1. Procedure construct network layer.
   Let hop count h_v - α and
   Node u, v, packet (p) also sink set h_s= 0
2. Broadcast h_s -> neighbors
3. Check ->; msg ( ) then call extract ( )
4. Extract (h, p)
   i. If $h > h_u$, $v \leftarrow$ son of u
   ii. (2) if $h = h_u$, $v \leftarrow$ sibling of u
   iii. (3) if $h = h_u$-1 $\leftarrow$ parent of node u
   iv. (4) if $h < h_u$-1 $\leftarrow$ parent of node u
5. Re-broadcast h u= h+ 1hu --> neighbors

Through broadcasting the packet and comparing h with h_u step by step, the layered network can be constructed. At last, each node is aware of its minimum hop count to sink node, and knows its parent nodes, sibling nodes and son nodes.

C. Route Discovery at Intermediate nodes

If an intermediate node obtains a RREQ packet from its neighbor, it calculates the potency at which it established the packet and energy level of the node. If the Signal strength is higher than the threshold value *CN(i.j)* then consistency count is increased by otherwise it is increased by

(t_{ij},p).Subsequent to this the RREQ is broadcasted. Intermediate nodes are not permitted to respond for the RREQ it received. If node energy is lower than t_{ij} or signal strength is less than (t_{ij}, p). , the RREQ is dropped.

Algorithm 2: Route discovery at intermediate nodes

1. Procedure : void RecvRREQ (Packet *p)
2. If Non-duplicate RREQ then
3. If V_j is the destination node then
4. Release RREP;
5. else
6. CN (i, j) = N(i) ⋂ N (j);
7. // obtain common neighbor set CN (i,j), V_k ∈ CN (I, j) ;
8. Sort CN (I, J) descending ordered by P_{ik} P_{kj} ;
9. H (i, j) = { C_{n1} }, CN {i, j} = CN {i, j} – {C_{n1}} ;
10. //Cn1 is forever the first item of CN{ i, j};
11. While CN(i,j) = Ø do
12. If check connectivity (H(i, j), Cn1) then
13. //Cn1 is within the transmission range of any node in H(i,j);
14. H(i, j) = H(i,j) Ù { Cn1};
15. end
16. Cn(i,j) = Cn(i,j) – Cn1
17. end
18. Calculate t_{ij} and call Back off (t_{ij} , p)
19. //Schedule a timer whose value is t_{ij} , then call forward RREQ (p) when the timer terminates
20. End

D. Route Selection at Destination

Algorithm 3: Route selection at Destination Node

1. Procedure : Void RecvRREP (packet *p)
2. If Non-duplicate RREP then
3. If $V_j = V_{i-1}$ then
4. Mark for my part as a guide node
5. Record V_i and H (i-1, i);
6. Acquire RREP's next-hop node id V_{i-2}
7. Fix V_i , H (i-1, i), V_{i-1} and H (i-2, i-1) to RREP
8. /* V_{i-2} is V_{i-1} upstream guide node, the partner set is ordered descending by the PRR toward the downstream guide node */
9. Call forward RREP (P);
10. Else if V_j ∈ H (j-1, i) then
11. V_j is a partner in H (i-1, i) ;
12. Record V_{i+1} , H (i , i+1), V_i and H (i-1, i) ;
13. Drop (P) ;
14. Else
15. Drop (P);
16. End
17. Else

When the purpose node obtains the first RREQ and it accumulates all the RREQ particulars in the route cache. Subsequent to the timer terminates; it discovers the path with maximum dependability factor and sends the RREP to it. The whole route demand that appears after timer concludes will be dropped.

E. Cooperative forwarding

The cooperative forwarding procedure in R3E is described as follows. The source node broadcasts a data packet, which includes the list of forwarding candidates (helper nodes and the downstream guide node) and their priorities. Those candidates follow the assigned priorities to relay the packet. Each candidate, if having received the data packet correctly, will start a timer whose value depends on its priority. The higher the priority, the shorter is the timer value. The candidate whose timer expires will reply with an ACK to notify the sender, as well as to suppress other contenders. Then, it rebroadcasts the data packet toward its downstream link. If no forwarding candidate has successfully received the packet, the sender will retransmit the packet if the retransmission mechanism is enabled. In order to forward data toward the destination with minimum number of transmissions, we can apply the basic greedy forwarding rule in geographic routing [20] as the relay priority rule in R3E, that is data packets are greedily forwarded to the neighbor geographically closest to the destination. In this way, R3E obviates the necessity of utilizing location information, while enabling data packets to be greedily forwarded toward the destination with the help of the robust guide path. Note that the relay priority rule can also adopt other variant metrics, example the one-hop throughput metric [19] to achieve the best path throughput. From the realistic link conditions in wireless networks, a potential forwarder with a higher PRR toward the downstream guide node possibly has a shorter distance from that guide node, as longer distances normally result in lower received signal strength and thus increased probability of packet loss.

V. FLOW CHART

Illustrates an overview of the packet transmission in a wireless sensor network. Initially sender will set one path as a actual path and also finding the route discovery to send the packet to the destination. Along with actual path set one path as a guide path and neighboring nodes are called as guide nodes. The flow chart will show the packet transmission from source to destination. First configure the network; number of nodes can be deployed into a sensor network.

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Next is to calculate the delay time of neighbor nodes in the actual path. It the delay is low means finds the best reliable transmission path. If not means calculate once again delay time.

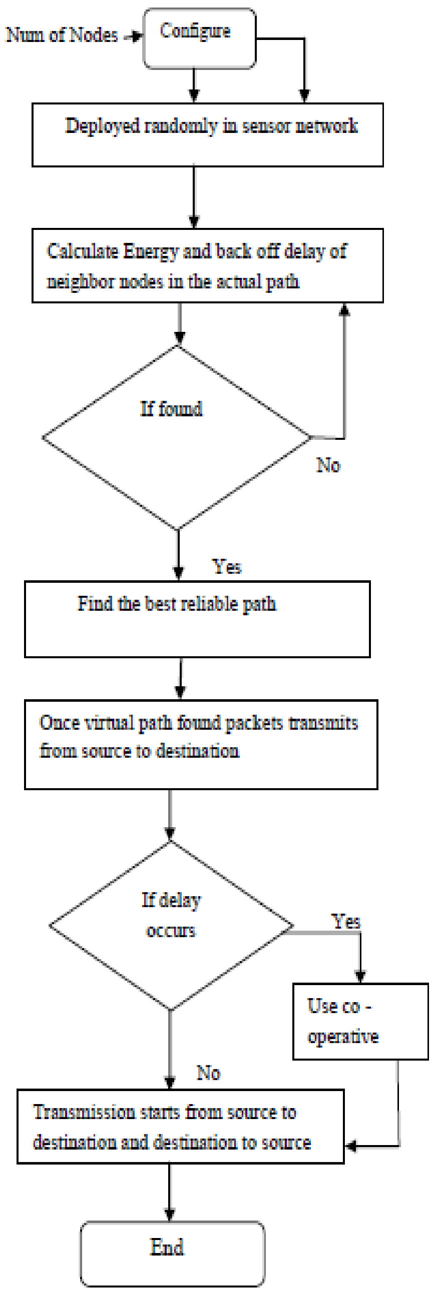


Fig 3: flow chart of packet transmission

Once the virtual path is found the packet will transmit the packet from source to destination. If any link failure occurs that time use a guide node to select another path and transmits a packet. Once the packet is reaches to the destination, destination is sends back ack to source. By using the back off scheme to achieve high energy efficiency and low delay.

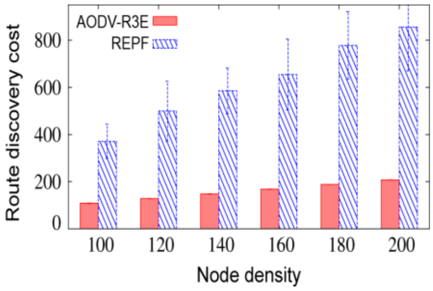
VI. COMPARISON

We first introduce the comparison baselines. We choose three routing protocols, described here.

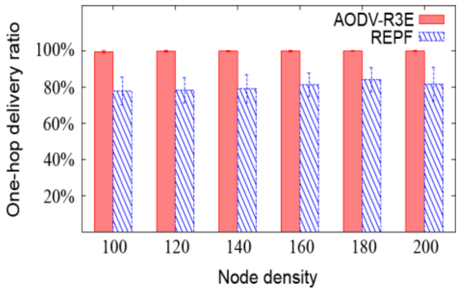
• *AODV-ETX [3]:* The route discovery phase finds a least-ETX (*expected transmission count*) path from a source to a destination. In AODV-ETX, the link layer retransmission is enabled, that is at most three retransmissions at each hop are sanctioned. Note that the other routing protocols do not adopt the retransmission mechanism.

• *REPF [12]:* 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, and alternative paths which have similar cost. However, REPF restricts the helper nodes to a very limited scope, that is, only the nodes which can connect the two-hop away primary forwarding nodes are considered as helper nodes, it does not fully utilize the forwarding opportunities provided by available neighboring nodes in evenly distributed networks.

• *GOR [23]:* In order to show that reactive protocol 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, that is 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.



The above figure shows route discovery cost v/s node density. The REPF protocol is uses the best path to send a packet from source to destination.



The above shows the hop delivery ratio compare to REPF the AODV protocol is having high delivery. So by using the back off scheme in reactive protocol is to enhance the delivery ratio and low latency. by using the we are also achieve the high throughput and high packet delivery compare to existing system. In this secure up/down stream reliable reactive protocol is handles the bit error overhead problem means it will uses a cooperative method to handle the transmission error or any network failure, if any problem occur it will change the path and send the packet to destination.

VII. CONCLUSION

Existing reactive routing protocols in WSNs to provide reliable and energy-efficient packet delivery against the unreliable wireless links. By using biased back off scheme in the route discovery phase is to find a robust virtual path and low latency. In case any link failure occurs that time intermediate node will search another path using guide node help and recover the problem without utilizing the location information. So data packets can be greedily progressed toward the destination along the virtual path. So by using a enhancement reactive protocol for packet transmission is more reliable and efficient.

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