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PERFORMANCE EVALUATION OF EFFICIENT AND RELIABLE ROUTING PROTOCOL ALGORITHM

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Abstract- Fixed-power wireless sensor networks are prevalent and cost-effective. However, they face mote failures, RF interference from environmental noise and energy constraints. Routing protocols for such networks must overcome these problems to achieve reliability, energy efficiency and scalability in message delivery. Achievement of these requirements, however, poses conflicting demands. In this work, we propose an efficient and reliable routing protocol (EAR) that achieves reliable and scalable performance with minimal compromise of energy efficiency. The routing design of EAR is based on four parameters expected path length and a weighted combination of distance traversed, energy levels and link transmission success history, to dynamically determine and maintain the best routes. Simulation experiments of EAR with four existing protocols demonstrate that a design based on a combination of routing parameters exhibits collectively better performance than protocols based on just hop-count and energy or those using flooding.

Index terms: Efficient And Reliable routing protocol (EAR), Route Request (RREQ), Route Reply (RREP) packet, Network Animator(NAM).

I. INTRODUCTION

Nowadays, there is a huge increase of handled devices. Laptops, mobile phones and PDAs take an important place in the everyday life. Hence, the challenge is now to make all these devices communicate together in order to build a network. Obviously, this kind of networks has to be wireless [1,2]. Indeed, the wireless topology allows flexibility and mobility. In this context, the idea of ad hoc networks was developed. An ad hoc network is a wireless network formed by wireless nodes without any help of infrastructure [3,4,5]. In such a network, the nodes are mobile and can communicate dynamically in an arbitrary manner. The network is characterized by the absence of central administration devices such as base stations or access points. Furthermore, nodes should be able to enter or to leave the network easily. In these networks, the nodes act as routers. They play an important role in the discovery and maintenance of the routes from the source to the destination or from a node to another one. This is the principal challenge to such a network. If link breakages occur, the network has to stay operational by building new routes. The main technique used is the multi-hopping which increase the overall network capacity and performances. By using multi-hopping, one node can deliver data on behalf of another one to a determined destination. Thus, the problem of range radio is solved[6,7,8,9].

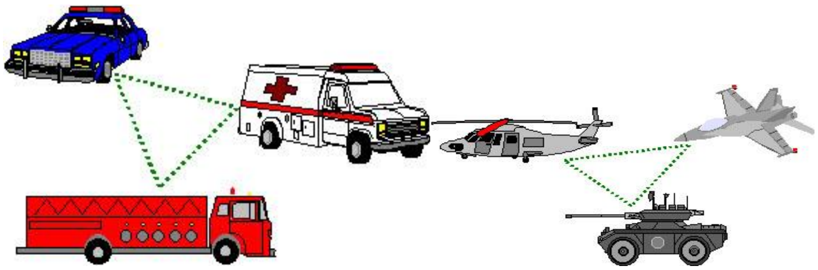


Figure1 :A Mobile Ad Hoc Network

II. Proposed System

The procedural design of EAR may be divided into three phases:

- setup,

- route selection,
- data dissemination.

2.1 Setup Phase

When a hub is powered on, it broadcasts an Advertisement (ADV) packet indicating that it wants to receive RPT packets. When a neighbouring node around the hub receives this ADV packet, it will store the route to the hub in its routing table . Nodes do not propagate the ADV packet received. When a node is powered on, it delays for a random interval of time before starting an initialisation process. A node starts the initialisation process by broadcasting a Route Request (RREQ) packet asking for a route to a hub. When a hub receives a RREQ packet, it will broadcast a Route Reply (RREP) packet. Similarly, when a node receives a RREQ packet, it will broadcast a RREP packet if it has a route to a hub. Otherwise, it will ignore the RREQ packet. Nodes do not propagate RREQ packets. When a node receives a RREP packet, it will store the route in its routing table. When it has at least one route to the hub it skips the initialisation process. By introducing random delay for each node to begin initialisation process, a portion of nodes will receive a RREP packet before they have begun their initialisation process. This enables faster propagation of routes and saves on the amount of control packets generated in the setup phase. A node may store more than one route to the hub. A route in the routing table is indexed using the next hop node’s ID - that is the ID of the neighbouring node. A node keeps only one route entry for a neighbour that has a route to the hub even though that neighbour could have multiple routes to the hub. For each route entry in the route table, only the best route is stored. The selection of best routes is described next.

2.2 Route Selection Phase

Ideally, the best route is the shortest as it incurs the lowest latency and consumes the least energy. In an actual environment, the performance of an RF link varies with physical distance and the terrain between nodes and should be accounted for in routing decisions. In EAR, shortest routes are initiallyadmitted into the routing table based on hop-count. As RPT packets flow through these links, less desirable ones will start to exhibit high packet loss rate and are eventually *blacklisted* and omitted from the routing table. Links that are omitted from the routing table may be re-admitted again only after a period of time. Some RF links are affected by temporary external disruption and should be given the chance to be readmitted.

This allows for adaptiveness. The mechanism uses a sliding window that keeps track of the last N attempts to route packets on a specified link. If a link fails to relay all packets in the last N consecutive attempts, then it will be blacklisted and omitted from the table. A metric, LinkScore, is defined as LinkScor$e$ = ($PE \times WE + PT \times WT$), where PE – energy level of the next hop node (0.0 to 100.0), WE – assigned weight for PE (0.0 to 1.0), PT – transmission success rate (0.0 to 100.0) and WT – assigned weight for PT (0.0 to 1.0)

Weights, WE and WT , may be determined empirically but their sum must equal 1. For example, in a low noise environment, the probability of successful transmission is higher. In this scenario, $WE = 0.7$ and $WT = 0.3$ may be chosen allowing routing decisions to focus more on energy conservation in path selection. Conversely, in a noisy environment, $WT = 0.7$ and $WE = 0.3$ could be chosen instead, giving higher emphasis to the selection of high reliability paths over energy conservation.

LinkScore then takes on a value from 0 to 100 and a higher value indicates a better link. An arbitrary value is initially assigned to PT as the link performance is unknown. PT rises (or drops) when subsequent packet transmissions succeed(or fail). PE starts at 100 and drops as a node consumes its energy resources.

LinkScore is used when there are two links of different routes with the same hub distance competing to be admitted to the routing table. When a new link is received and the routing table is full, link replacement is initiated. The search ignores blacklisted links and targets the link with the lowest LinkScore to be replaced. When there is more than one entry with the same LinkScore, the entry with the longest length is chosen to be replaced. This worst route is then compared against the incoming route and the shorter route is admitted into the routing table. If there is a tie in route length, then the route with the higher LinkScoreis admitted. Since each node stores and maintains the best available RF links in its routing table, packets travel on the best route from a node to a hub at the given time. Since the routing table contains only one entry to the next hop node, its size scales slowly with network size and multiple hubs.

2.3 Data Dissemination

Sensor nodes generate RPT packets at periodic intervals or sleep, waiting for some event to happen. An RPT packet contains information of interest to network users and has two fields in its header: ExpPathLen and NumHopTraversed The first field is the expected number of hops the packet will have to traverse before it reaches the hub. It is defined as:

ExpPathLen = NH × α, where $0.0 < \alpha \leq 1.0$, NH

is the number of hops from this node to the hub for the route selected. The route selected need not be the shortest but ExpPathLen is bounded by the network diameter. A is an assigned weight such that $0.0 < \alpha \leq 1.0$ since the minimum number of hops to reach the hub is at least 1. NumHopTraversed is the distance a packet has traversed and is initialised as 0. The packet is forwarded to the next node in the route. When the next node receives the packet, it will increment NumHopTraversed by one and compare it with ExpPathLen. The algorithm is as follows: By assigning $\alpha >> 0.0$, a packet may favour a route with better performing links rather than just the shortest route (Fig. 1). If the number of hops that a packet has traversed exceeds the expected number, there must be changes in the network topology. During this period of instability, the packet will take the shortest route to the hub. To prevent potential deadlocks from occurring, a variable BufUtilLvl is used at each node to store the current utilisation level of the packet output buffer.

A threshold value, BLThreshold, is defined where BLThreshold < Bmax (max size of buffer). If BufUtilLvl is greater than BLThreshold, the packet will be relayed on the shortest route to the hub. This buffer control mechanism ensures that newpackets will not be injected when the buffer is almost full and there will always be at least one buffer space for transitpackets to be routed.

2.4 Proposition 1

EAR is deadlock-free in a connected wireless sensor network.

Proof: We recall that ExpPathLen = NH × α. Let h be the number of hops traversed by a packet.

Case 1: ExpPathLen $\leq$ h: the data dissemination algorithm selects the shortest route in the routing table for forwarding. In the case of a tie, the route with the highest LinkScore is selected.

Selecting the shortest route at every intermediate node will lead the packet to a hub and no node is revisited.

Case 2: ExpPathLen > h: the data dissemination algorithm selects the route with the highest LinkScore in the routing table for forwarding. If there is a tie in LinkScore, the shorter route is chosen. In this case, the neighbouring node with the highest LinkScore may have the same hop count to the hub as the sender node and this may result in the packet being re-transmitted to the sender. Although a temporary loop may be possible, a deadlock can never occur since BLThreshold < Bmax and buffers will never be full. A packet will be forwarded on the shortest route if the packet output buffer exceeds BLThreshold, thus breaking the loop. ExpPathLen is bounded by the network diameter. If h ≥ ExpPathLen, the packet will travel on the shortest route to hub, as in case 1.

2.5 Proposition 2

The distance a packet travels before reaching a hub is bounded by NH+D, where D is the distance of the furthest node from the hub in terms of hops.

Proof: Consider a packet that is generated at node A. When α is set to 1, ExpPathLen = NH. When ExpPathLen > NumHopT raversed, the packet is forwarded to its neighbour node B which has the highest LinkScore. Node B may not be on the shortest route in the routing table and in the worst case, the packet will be relayed along the longest route at every intermediate node and the packet will traverse NH hops until ExpPathLen = NumHopTraversed. In the worst case, the packet will have been routed to the furthest node from the hub. Now, the packet will be forwarded on the shortest route and the packet will need a maximum of D hops to reach the hub.

Corollary 1: The routing algorithm of EAR is livelock-free.

Proof: In a non-ideal environment, loops formed are temporary and by Theorem 1, will eventually be exited. ByTheorem 2, a packet eventually arrives at a hub after a maximum of NH + D hops, where D is the distance of thefurthest node from the hub in hops.

III. Route Update

Sensor nodes continually update “best” routes in the routing table. Instead of explicit control packets, EAR uses the handshaking mechanism at the MAC layer. Route information is piggybacked onto both RTS and CTS packets. Fig. 2 illustrates this scenario. Nodes in blue have received updated routeinformation from either node X’s RTS or node Y’s CTS packet or both. RTS and CTS packets have to be received and processed by all nodes as part of the collision avoidance mechanism employed by the MAC protocol. Hence, utilisingRTS-CTS handshaking instead of separate DATA-ACK would result in more current route information for a node. As an example, EAR can use S-MAC (Sensor MAC) that has energy saving mechanisms. S-MAC uses the same four-way handshaking mechanism as IEEE 802.11 to achieve reliable link-to-link transmission. One of the energy-saving mechanisms known as *Overhearing Avoidance* specifies that nodes upon hearing a RTS or CTS packet that is not addressed to them will go into sleep mode. Periodically exchanging routing information between nodes is costly in terms of energy consumption and bandwidth usage. Piggybacking route information onto existing RTS and CTS packets incurs additional energy consumption as the packet size increases. However, no extra packets need be generated and additional costs are negligible compared to the cost incurred in relaying explicit route information (control) packets.

3.1 Cost analysis of route update

We show the energy and latency costs in piggybacking route information on the RTS/CTS packet compared to sending an explicit control packet. The energy consumed is proportional to packet size and we assume the energy cost to transmit 1 bit is 1 unit. Let K be the size of the route information in bits, W be the size of the routing control packet in bits and the bandwidth be B bits per second. Then, we have:

Energy cost of piggybacking = K units, Latency cost of piggybacking = K/B seconds,

- Energy cost of explicit control = (SRTS +SCTS +K +W + SACK) units, and

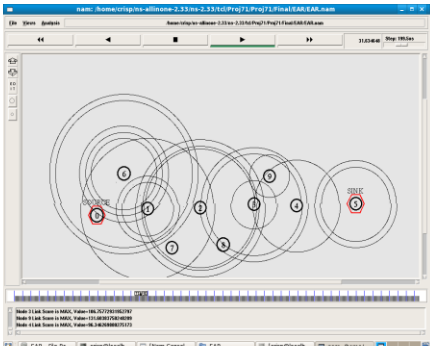
- Latency cost of explicit control = (SRTS/B) + (SCTS/B) + ((K +W)/B) + (SACK/B) secondswhere SRTS−RTS packet size in bits, SCTS−CTS packet size in bits and SACK − ACK packet size in bits..

IV. Results and Analysis Network Animator

NAM stands for Network Animator. This tool animates the network elements as described in the tcl script. A complete visualization is available to the user which depicts the networking concepts in the work. The animator takes the tcl file as the input and creates a nam and a trace file as outputs. NAM consists of tools forediting the network topology, navigation bar and a step size controller for time. With all these toola it is possible to vividly view how actually the works with finer resolution,.In time. The tools for editing include zoomer and controls for interfacing. A status bar at the bottom of the animator indicates the current status of the network elements.

Efficient and Reliable Routing
Positioning the Nodes in Terrian
Node 0 is Source and Node 5 is Destination

Fig 2:Creating Nodes



Node 3 Link Score is MAX, Value=106.75772931952797
Node 9 Link Score is MAX, Value=131.68303758240289
Node 4 Link Score is MAX, Value=96.34626900027517

Fig 3: Calculating Expected Path Length

4.1 Compare Graph–Energy Consumption

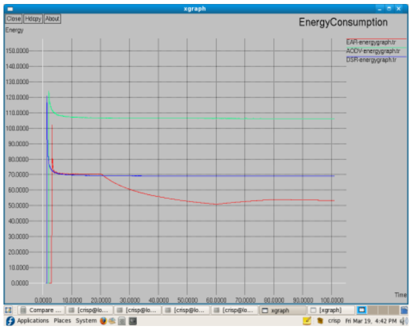


Fig4: Energy Consumption

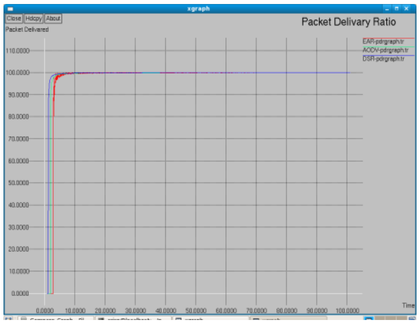


Fig5: Packet Delivery Ratio

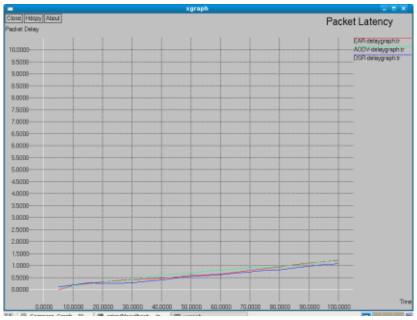


Fig 6: Packet Latency

There are five basic parameters to be analyzed. They are:

1. End to End Delay, 2. Packet Delivery Ratio,

3. Energy Consumption, 4. Network Load Analysis, 5. Object Speed Analysis.

4.2 End To End Delay

This analysis is taken between PSTN technique and SMAC.In this prediction technique is used to define future state energy. End-End delay refers to the time taken for a packet to be transmitted across a network from source to destination. In the above graph, as the time increases mobility of SMAC increases and the PSTN rate remains constant shown in fig 2,3.

Delay = Inter arrival between 1st and 2nd Packet /Total data packets delivered time

X axis → Time (sec)

Y axis → Mobility (m/sec)

4.3 Packet Delivery Ratio

Packet delivery ratio is the ratio between number of received packets received to the number of packets sent multiplied by hundred. This is a comparative analysis between SMAC and PSTN, as the time increases PSTN mobility gets increased. The greater value of packet delivery ratio means the better performance of the protocol is shown in fig 5.Finally Cetain analysis of packets sent and receives shown in fig 6.

Packet deliver ratio = (Number of packets received / Number of packets sent) ×100

X axis → Time in sec

Y axis → Mobility (m/sec)

4.4 Energy Consumption

Energy consumption is defined as the ratio of energy extended in each node on ideal state, sleep state, transmitting and receiving state (i.e.) energy consumed in each state to the total average energy consumed is shown in fig 4.

Energy Consumption = (Energy consumed in each node based on idealsleep transmit andReceive)/(Total average energy consumed)

Transmission Range = Throughput is varied with respect to the receiving signal strength

X axis $\longrightarrow$ Mobility (m/sec)

Y axis $\longrightarrow$ Energy(Joules)

V. CONCLUSION

To provide a solution to the problem of internal network attacks inside cloud centers, this paper proposes a passive IP trace back approach and an intrusion detection method. This method uses passive IP trace back to determine the real location of IP spoofing and control the attacks of the entire cloud based network. Our future work aims to provide the method with effective way to current limitation and detect the attacks in a real environment.

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