LOAD BALANCING GEOGRAPHIC ROUTING AROUND CONNECTING HOLES IN MOBILE WIRELESS SENSOR NETWORK

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***Abstract*—Adaptive Load Balancing Algorithm and Rainbow, a protocol for convergecasting in wireless sensor networks. Adaptive load balancing algorithm and rainbow features the cross-layer integration of geographic routing with contention-based MAC for relay selection and load balancing, as well as a mechanism to detect and route around connectivity holes. Adaptive Load Balancing Algorithm and Rainbow together solve the problem of routing around a dead end. The protocol is localized and distributed, and adapts efficiently to varying traffic and node deployments. Adaptive Load Balancing Algorithm and Rainbow significantly outperforms other convergecasting protocols and solutions for dealing with connectivity holes, especially in critical traffic conditions and low-density networks. Adaptive Load Balancing Algorithm and Rainbow shows is an energy-efficient protocol that achieves remarkable performance in terms of packet delivery ratio and end-to-end latency in different scenarios, thus being suitable for real network deployments.**

***Index Terms*— Botnet, P2P, intrusion detection, network security, botmaster.**

I. INTRODUCTION

Wireless sensor networks(WSNs) provides distributed sensing and seamless wireless data gathering which are key ingredients of various monitoring applications. The sensor nodes perform their data collection duties unattended, and the corresponding packets are then transmitted to a data collection point which is called the sink through multi-hop wireless routes techniques . The majority of the research on protocol design for WSNs has focused on MAC and routing solutions. An important class of protocols is represented by geographic or location-based routing schemes, where a relay is greedily chosen based on the advancement it provides toward the sink. Being almost stateless, distributed and localized, geographic routing requires little computation and storage resources at the nodes and is therefore very attractive for WSN applications. Many geographic routing schemes fail to fully address important design challenges which includes, routing around connectivity holes, resilience to localization errors and efficient relay selection. Connectivity holes are inherently related to the way greedy forwarding works. Even in a fully connected topology, there may exist nodes called dead ends that have no neighbors that provide packet advancement toward the sink. Dead ends are those node which are unable to forward the packets which they generate or receive. These packets will never reach their destination and will eventually be discarded.

An approach to the problem of routing around connectivity holes that works in any connected topology without the overhead and inaccuracies incurred by methods based on topology planarization. A cross-layer protocol, Adaptive Load-Balancing Algorithm whose main ingredients are geographic routing, load balancing, contention based relay selection and the Rainbow protocol which is used to route packets out and around dead ends,. The combination of the two protocols results in an integrated solution for converge casting in WSNs that, although connected, can be sparse and with connectivity holes.

II. RELATED WORK

According to its first and simplest formulation, geographic routing concerns forwarding a packet in the direction of its intended destination by providing maximum per-hop advancement [9], [10]. In dense networks, this greedy approach is quite successful, since nodes are likely to find a path toward the sink traversing a limited number of intermediate relays. Conversely, in sparse networks, packets may get stuck at dead ends, which are located along the edge of a connectivity hole, resulting in poor performance. A number of ideas have, therefore, been proposed to address the problem of routing around dead ends. WSN topologies are first "planarized" [12]. Geographic routing over planarized WSNs is then obtained by employing greedy routing as long as possible, resorting to planar routing only when required, for example, to get around connectivity holes. Heuristic rules are then defined for returning to greedy forwarding as soon as next-hop relays can be found greedily. Solutions based on planarization have several drawbacks. First of all, a spanner graph of the network topology needs to be built (and maintained in the presence of node dynamics), and this incurs non negligible overhead. Planar routing may then require the exploration of large spanners before being able to switch back to the more efficient greedy forwarding, thus imposing higher latencies. Moreover, in realistic settings, localization errors and non ideal signal propagation may lead to disconnected planar graphs or to topology graphs that are non planar. To make planarization work on real networks, a form of periodic signaling must be implemented to check that no links cross, as performed by the Cross-Link Detection Protocol (CLDP) . However, this is a transmission intense solution for WSNs, which eventually affects the network performance. .

III. PROPOSED SYSTEM

The proposed system is An approach to the problem of routing around connectivity holes that works in any connected topology without the overhead and inaccuracies incurred by methods based on topology planarization. A cross-layer protocol, Adaptive Load-Balancing Algorithm whose main ingredients are geographic routing, load balancing, contention based relay selection and the Rainbow protocol which is used to route packets out and around dead ends,. The combination of the two protocols results in an integrated solution for converge casting in WSNs that, although connected, can be sparse and with connectivity holes.

We enhance greedy geographic forwarding by considering congestion and packet advancement jointly when making routing decisions. The new relay selection scheme, which implements MAC and routing functions in a cross-layer fashion, achieves Performance superior to existing protocols in terms of energy efficiency, packet delivery ratio (PDR), and latency.

The Rainbow mechanism allows ALBA-R to efficiently route packets out of and around dead ends. Rainbow is resilient to localization errors and to channel propagation impairments. It does not need the network topology to be planar, unlike previous routing protocols. It is, therefore, more general than face routing-based solutions and is able to guarantee packet delivery in realistic deployments.

IV. SYSTEM DESIGN

Adaptive Load Balancing Algorithm

The protocol we propose in this paper, ALBA, is a cross layer solution for convergecasting in WSNs that integrates awake/asleep schedules, MAC, routing, traffic load balancing, and back-to-back packet transmissions. Nodes alternate between awake/asleep modes according to independent wake-up schedules with fixed duty cycle d. Packet forwarding is implemented by having the sender polling for availability its awake neighbors by broadcasting an RTS packet for jointly performing channel access and communicating relevant routing information (cross-layer approach). Available neighboring nodes respond with clear-to-send (CTS) packet carrying information through which the sender can choose the best relay. Relay selection is performed by preferring neighbors offering "good performance" in forwarding packets. Positive geographic advancement toward the sink (the main relay selection criterion in many previous solutions) is used to discriminate among relays that have the same forwarding performance. Every prospective relay is characterized by two parameters: the queue priority index (QPI), and the geographic priority index (GPI). The QPI is calculated as follows: The requested number of packets to be transmitted in a burst (back-to-back transmissions) is NB, and the number of packets in the queue of an eligible relay is Q. The potential relay keeps a moving average M of the number of packets it was able to transmit back-to-back, without errors, in the last _ forwarding attempts. The QPI has been designed so that congested nodes (with a high queue occupancy Q) and “bad” forwarders (experiencing high packet transmission error, i.e., with a lower M) are less frequently chosen as relays. The selection of relays with low QPI, therefore, aims at decreasing latency at each hop by balancing the network load among good forwarders.

The Rainbow Mechanism

The Rainbow, the mechanism used here to deal with dead ends. The basic idea for avoiding connectivity holes is that of allowing the nodes to forward packets away from the sink when a relay offering advancement toward the sink cannot be found. To remember whether to seek for relays in the direction of the sink or in the opposite direction, fig 1 shows each node is labeled by a color chosen among an ordered list of colors and searches for relays among nodes with its own color or the color immediately before in the list. Rainbow determines the color of each node so that a viable route to the sink is always found. Hop-by-hop forwarding then follows the rules established by adaptive load balancing algorithm and rainbow.

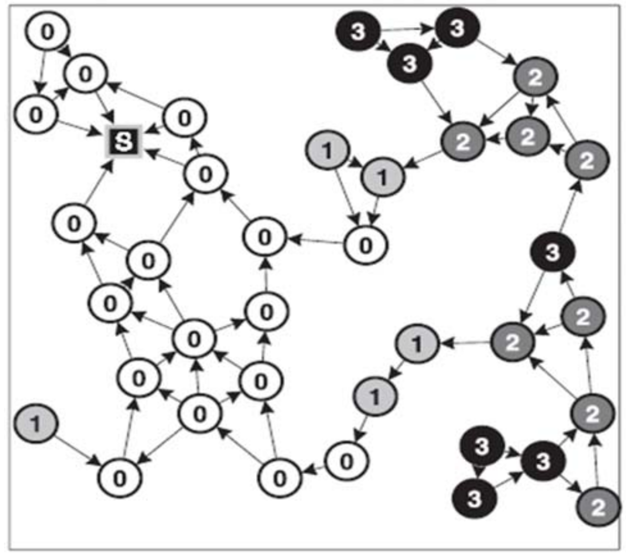

Fig 1.Rainbow Coloring

More formally, let x be a node engaged in packet forwarding. We partition the transmission area of x into two regions, called F and F^C, that include all neighbors of x offering a positive or a negative advancement toward the sink, respectively (see Fig. 2).

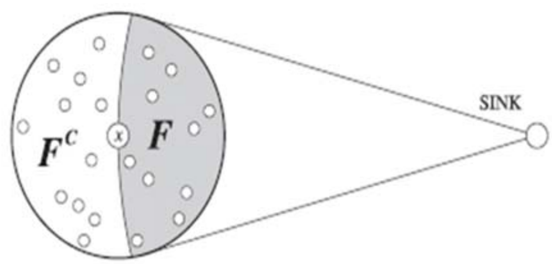

Fig 2. F and F^C

When x has a packet to transmit it seeks a relay either in F or F^C according to its color C_k, selected from the set of colors {C0; C1; C2; C3; . . .}. Nodes with even colors C0; C2; . . . search for neighbors in F (positive advancement). Nodes with odd color C1; C3; . . . search for neighbors in F^C (negative advancement). Nodes with color Ck, k >0, can volunteer as relays only for nodes with color Ck or Ck>1. Nodes with color Ck,k > 0, can only look for relays with color Ck>1 or Ck. Finally, nodes with color C0 can only look for relays with color C0.3 The nodes assume their color as follows: Initially, all nodes are colored C0 and function according to the standard ALBA rules (see Section 3). If no connectivity holes are encountered, all nodes remain colored C0 and always perform greedy forwarding. Since the nodes on the boundary of a hole cannot find relays offering positive advancement, after a fixed number Nhsk of failed attempts, they infer that they may actually be dead ends and correspondingly increase their color to C1. According to Rainbow, C1 nodes will send the packet away from the sink by searching for C0 or C1 nodes in region F^C. If a C1 node cannot find C1 or C0 nodes in F^C, it changes its color again (after Nhsk failed forwarding attempts), becoming a C2 node. Therefore, it will now look for C2 or C1 relays in F. Similarly, a C2 node that cannot find C2 or C1 relays in F turns C3 and starts searching for C3 or C2 nodes in F^C. This process continues until all nodes have converged to their final color. Note that, at this point, any node that still has color C0 can find a greedy route to the sink, i.e., a route in which all nodes offer a positive advancement toward the sink. In other words, once a packet reaches a C0 node, its path to the sink is made up only of C0 nodes. Similarly, packets generated or relayed by Ck nodes follow routes that first traverse Ck nodes, then go through Ck>1 nodes, then Ck>2 nodes, and so on, finally reaching a C0 node. As soon as a C0 node is reached, routing is performed according to Adaptive Load Balancing Algorithm greedy forwarding. A sample topology where four colors are sufficient to label all nodes is given in Fig. 1. In the figure, the numbers in the nodes indicate the color they assume. Higher colors are rendered with darker shades of gray. A proof of the correctness of the Rainbow mechanism is given in the supplemental material document, available online.

That proof, including convergence of the coloring mechanism in finite time and the loop-freedom of the determined routes, is performed through mathematical induction on the number h of changes of color in the route from a node to the sink. ALBA-R correctness is not affected by the presence of localization errors or by the fact that the topology graph is not a UDG, showing that our protocol is robust to localization errors and realistic propagation behaviors.

V. SYSTEM IMPLEMENTATION

This project involves two main methods for transmission of packets from sensor nodes to sink node. These are Adaptive Load Balancing Algorithm and Rainbow.

Adaptive Load Balancing Algorithm mechanism basically used to deal with dead ends and for avoiding connectivity holes is that of allowing the nodes to forward packets away from the sink when a relay offering advancement toward the sink cannot be found. To remember whether to seek for relays in the direction of the sink or in the opposite direction, each node is labeled by a color chosen among an ordered list of colors and searches for relays among nodes with its own color or the color immediately before in the list.

Rainbow determines the color of each node so that a viable route to the sink is always found. Hop-by-hop forwarding then follows the rules established by Adaptive Load Balancing Algorithm.

It consists following five modules

- **Initialization of network**

In this module nodes are created by using configuration parameters of network simulator, these nodes are deployed in fully connected topology. Mobility model (Random waypoint model) used in network to make nodes as mobile nodes. Mobile nodes are deployed in area as such to cover more area and sensor nodes are made mobile nodes to move freely in defined area. These nodes get information from various areas and forwards to data collection point called sink, sink will collect all the information from sensor nodes and these are used whenever needed.

- **Adaptive Load Balancing Algorithm and Rainbow**

Adaptive Load Balancing Algorithm is a cross layer solution for convergecasting in WSNs that integrates awake/asleep schedules, MAC, routing, traffic load balancing, and back-to-back packet transmissions. Nodes alternate between awake/asleep modes according to independent wake-up schedules with fixed duty cycle d. Packet forwarding is implemented by having the sender polling for availability its awake neighbours by broadcasting an RTS packet for jointly performing channel access and communicating relevant routing information (cross-layer approach). Available neighbouring nodes respond with clear-to-send (CTS) packet carrying information through which the sender can choose the best relay. Relay selection is performed by preferring neighbours offering “good performance” in forwarding packets. We describe Rainbow, the mechanism used by Adaptive Load Balancing Algorithm to deal with dead ends. The basic idea for avoiding connectivity holes is that of allowing the nodes to forward packets away from the sink when a relay offering advancement toward the sink cannot be found. To remember whether to seek for relays in the direction of the sink or in the opposite direction, each node is labelled by a color chosen among an ordered list of colors and searches for relays among nodes with its own color or the color immediately before in the list. Rainbow determines the color of each node so that a viable route to the sink is always found. Hop-by-hop forwarding then follows the rules established by Adaptive Load Balancing Algorithm.

- **Resilience to localization errors**

Neighbor's relationships are determined by real coordinates, each node identifies the neighbors closer to the sink (and therefore its color) based on its own and the neighbors estimated position (i.e., the position estimated through a localization protocol affected by error). Adaptive Load Balancing Algorithm and rainbow can successfully deliver all generated packets to the sink, even in case of high localization errors. The only impact on the performance is a limited increase in route length. The localization error decreases the number of nodes colored C0 , requiring a larger number of packets to go through longer routes.

- **Data transmission**

Once a relay is selected, a burst of data packets is sent (as many as the relay can queue) and each packet is individually acknowledged. If the ACK for one of the packets is missing, the sender stops the transmission of the burst, rescheduling the unacknowledged packet and the following ones in the burst for a later time, after a back off period. The contention overhear data transmissions, understand from the header that they have not been selected as relays, and go back to sleep. Similarly, the nodes that during a handshake realize that they will not be selected as relays go to sleep immediately.

- **Performance analysis**

  Performance can be analyzed by using parameters such are

  1. Packet delivery ratio
  2. Energy consumption
  3. End-to-end packet latency
  4. Overhead

VI. CONCLUSION

In this paper, we will propose and investigate the performance of ALBA-R, a cross-layer scheme for convergecasting in WSNs. ALBA-R combines geographic routing, handling of dead ends, MAC, awake-asleep scheduling, and back-to-back data packet transmission for achieving an energy-efficient data gathering mechanism. To reduce end-to- end latency and scale up to high traffic, ALBA-R relies on a cross-layer relay selection mechanism favoring nodes that can forward traffic more effectively and reliably, depending on traffic and link quality. Rainbow protocol will handle dead ends which is fully distributed, has low overhead, and makes it possible to route packets around connectivity holes without resorting to the creation and maintenance of planar topology graphs. Rainbow shows to guarantee packet delivery under arbitrary localization errors, at the sole cost of a limited increase in route length. Rainbow provides a more robust way of handling dead ends and better performance in terms of end-to-end latency, energy consumption, and packet delivery ratio.

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