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An Efficient Backbone Based Quick Link Failure Recovery Multicast Routing Protocol☆

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Summary MANET is a set of independent mobile devices which communicate through constrained wireless links over a relative bandwidth. Due to the mobility of devices, the topology of the network may change rapidly and unpredictably over time, making multicast routing and route maintenance a very crucial task. Plenty of protocols have been proposed for the construction of virtual backbone, but they have limitations in terms of control overhead, delay, throughput, energy consumption and mobility. As a part of multicast routing, virtual backbone construction has been proposed and classified into three different techniques: tree-based virtual backbone, cluster-based virtual backbone and dominating set-based virtual backbone. Upon this classification, plenty of protocols are available, and each protocol has some limitations in terms of control overhead, delay, throughput, energy consumption and mobility. Besides this, no existing backbone protocol has the scope of recovery of link failures. In order to overcome the limitations of existing protocols, our proposed protocol An Efficient Backbone Based Quick Link Failure Recovery Multicast Routing Protocol, it is a four phase protocol: Group Formation, Backbone Construction, On-demand Route Discovery and Route Maintenance. The main aim of the proposed protocol is to construct an efficient robust backbone to overcome the limitations of existing protocols and to provide a mechanism for the quick recovery of link failures by generating an alternate path from the point of failure to the destination, which can be adoptable in any sort of environment.

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Introduction

An infrastructure less network with a group of mobile nodes through wireless links is referred as mobile ad-hoc network (Vashist and Hema, 2013). Due to the high mobility of nodes in mobile ad-hoc networks results in dynamic topology, because of which the construction of backbone (Rewagad and Lodha, 2013), its maintenance and route recovery is highly challenging. In recent years, various protocols were designed for the construction of backbone (Ding et al., 2010; Ma and Jamalipour, 2011). All the protocols have their own limitations in terms of control overhead, delay, throughput, energy consumption and mobility. To overcome the limitations of existing protocols we propose a protocol to construct backbone along with link failure recovery. It includes creation of groups, backbone construction, on-demand route discovery and route maintenance. In case of link failure, it performs link failure recovery through localization to find an alternate path. It minimizes storage and control overhead on every node. Also reduces end to end delay, improves packet delivery ratio and throughput (Figs. 1 and 2).

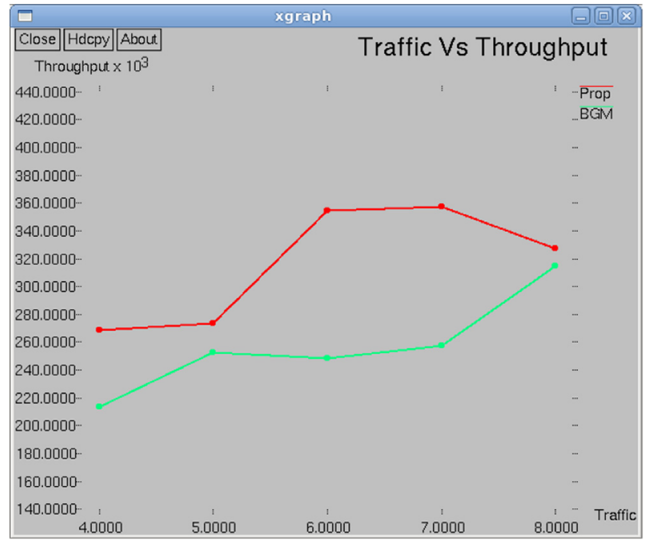

Figure 2 Traffic vs throughput.

Backbone Group Model

Backbone Group Model (BGM) (Akhtar and Sahoo, 2015) a set of nodes used to perform routing of packets over the network. It is a collection of minimum nodes, used in network activities by the cluster heads (CHs) taken for a threshold time, so that the responsibility of routing goes to all nodes of the Locality Groups (LGs) equally. It does not consider the reachability constraints of single hop distant LGs. It has two phases, one the cluster head selection-Locality Group creation phase and the other backbone creation phase (Akhtar and Sahoo, 2015). Initially every node exchanges its location packet with the neighbouring nodes, the node which possess high energy and power will be the CH. Then the neighbouring nodes form LGs by sending joining request to CHs. The node which exists in the coverage of two CHs with minimum distance of any one of CHs is elected as Boarder Node (BN) (Akhtar and Sahoo, 2015) and each group may have one or more BNs. Finding the maximum number nodes covered for each LG is formulated as a linear equation problem which can be solved by implementing any greedy method.

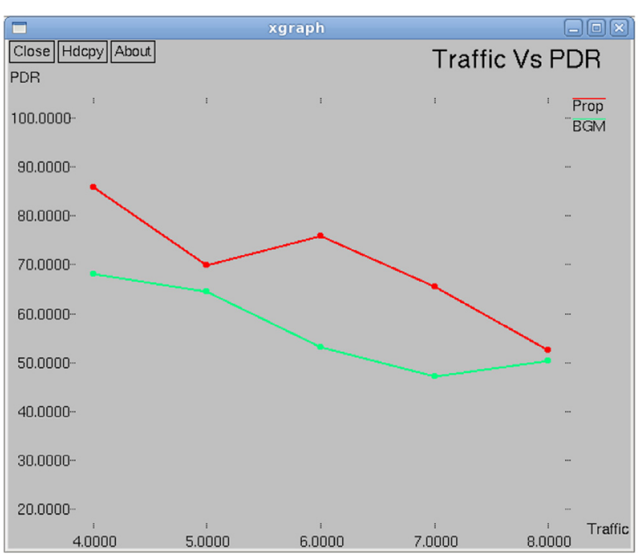

Figure 1 Traffic vs packet delivery ratio.

Clusterhead selection-Locality Group Creation Phase:

```
CH_selection {
    LG_formation() {
        On receiving location packet from n_i
        Loc_x,y(n_i) -> location_table(n_j);
        egy(n_i) -> energy_table(n_j);

    pwr(n_i) -> power_table(n_j);
        if(n_i_egy==max && n_i_pwr==max)  {
            Status(n_i)=cluster_head;  CH_announcement();
            sendLGJoin(n_id);       //to nearest cluster_head
                if(d(n_CH,n_RN)<min_dist) {
                    LG_list -> add(n_RN);   //n_RN become mem(LG);  } }
    BN_selection() {        // Boarder Node Selection
        if(d (n_CH,n_RN) < node_coverage*2)   {
            LG_list -> add(n_RN);   //n_RN become mem(LG);
            d1= d(n_CH1,n_LG1); d2= d(n_LG1,n_CH2); sum_dist=d1+d2;
                if(sum_dist < min_dist && d1 <= node_->coverage)  {
                    Status(n_LG1)=boarder_node;
                    BN_list -> add(n_LG1);     BN_announcement();  } } }
} }
```

Backbone Group Formation Phase:

```
BG_formation() {
    if(linear_eqn_prblm_solved) {
        BG_announcement(); }
}
```

Backbone Based Quick Link Failure Recovery Multicast Routing Protocol

An Efficient Backbone Based Quick Link Failure Recovery Multicast Routing Protocol is a hybrid protocol with the features of tree based and mesh based routing protocols. The proposed protocol overcomes the limitations of existing protocols. It has four phases: Group Formation, Backbone Construction, On-Demand Route Discovery and Route Maintenance. At the inception every node exchange HELLO packets with the neighbour nodes and compute 1-hop neighbouring count, the node which possess the highest count of 1-hop neighbour nodes will be elected as the core node and send core request to 1-hop neighbouring cores. Upon receiving reply from neighbouring cores backbone will be formed. When a source intends to transmit data packets firstly it checks its route cache if route found directly transmits data packets to destination. Else initiate the route discovery process and once route is found multicast data packets. In the transmission path of data packets if any link failure is encountered, upstream node initiates route discovery to generate an alternate path towards destination.

Group Formation Phase:

```
core_node_election() {
    if(1_hop_count(n_i) > 1_hop_count(nbn_i)) {
        status(n_i)=CORE;
        nb(n_CN) send(Join_Req);
        if(n_CN accepts Join_Req)  {
            status(nb(n_CN))=CORE_MEMBER;  } }}
```

Backbone Construction Phase:

```
backbone_process() {
    n_CN send(Core_Req);
    if(1_hop_nb(n_CN) accepts Core_Req) {
        Backbone formed;  }   }
```

On-Demand Route Discovery Phase:

```
odr() {
    S broadcast(RREQ);
    if(gets RREP from D)   {
    caching RREQ;
    send(data_pkt);  } }
```

Link Failure Recovery Phase:

```
link_failure() {
    if(link fails) {
        usn send(RREQ);
        if(gets RREP) {
            select(optimal_path);
            forward(data_pkt);    } }
    }
```

Simulation results

In this section, we compare the performance of our proposed protocol with Backbone Group Model (BGM) using Network Simulator (NS2) tool by considering various parameters in the area of $1000\,m \times 1000\,m$.

Conclusion

In this paper, an Efficient Backbone Based Quick Link Failure Recovery Multicast Routing Protocol is proposed for construction of backbone and recovery of link failures in mobile ad-hoc networks. The proposed scheme constructs a virtual backbone by forming multicast groups and provides an alternate path at the point of link failure based on localization to improve efficiency and reliability of MANET. Network model is designed to achieve reduced control overhead, more packet delivery ratio, high throughput, low jitter and less dropping ratio of packets. In comparison with Backbone Group Model (BGM), proposed protocol gives effective results in the presence of increased traffic and network size.

Conflict of interest

None declared.

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