Efficient Shortest Path Routing (ESPR) Algorithm for Multicasting in Wireless Mesh Network

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Abstract
Today’s fast and mobility oriented era of communication the networking infrastructure requires efficient communication. SPT and MCT are the two standard algorithms to provide efficient communication in wireless networking. SPT provides communication by recognizing the shortest path in a tree and propel the packet throughout this path. Since failures exist in the network, the SPT algorithm resists the failure by sending an ICMP messages which increases congestion ratio and rerouting of the packets while MCT algorithm forwards the packets on the basis of least number of transmissions. As the MCT algorithm transmits by consuming less number of cost, but during failure of intermediate links, it is also having the scope of improvement in the efficiency, i.e. transmission cost, rerouting cost and complexity of the network. These drawbacks are overcome by the proposed algorithm which works efficiently during failure of intermediate links. NS-2 is used to simulate the results and shown the results with comparative analysis of three algorithms

Keywords: WMN, SPT, MCT, Congestion, ESPR.

1. Introduction
In wired computer network, as the number of users increase in the network, there will be a demand of some novel technologies that can oversee the issues like mobility and as a result wireless computer network is developed. In wireless network, wired connection is not needed and because of this feature, there is an exponential growth of users for Internet access. As we all know communication in wireless network runs for substantial purpose, Wireless Mesh Network (WMN) become a promising concept to solve the challenges in today’s scenario in cost effective aspects to the service provided by adopting three features i.e. self-structuring, flexibility and self-management [1, 2].

WMN [3], as shown in figure-1, is made up of two types of nodes, first, wireless mess client and second, wireless mesh router. The wireless mesh router has routing capability and not having any resources like- memory and power constraints while wireless mesh clients has resources like-memory and power constraints but not having any routing capability. Mesh router has less mobility so it is mostly viewed as a stationary node. The mesh router which connects the other mesh routers and clients to the backbone or Internet is called a mesh gateway. Mesh gateway is also practiced to connect any two mesh networks [3].

Fig. 1. Wireless Mesh Network

Fig. 2. Multicast Routing

Multicast Routing [5, 9] is a type of communication where information is delivered to a set of destination nodes simultaneously as shown in figure-2. In this, the delivery of messages is managed at each layer only once. The duplication of messages is provided only at branch layer where links are differentiated to the destination node. Even though Multicast Routing is applied in different applications like- teleconferencing, video conferencing and email sending, researchers on Multicast Routing in WMN is still in its early days. Shortest Path tree (SPT) [6] and Minimum Cost Trees (MCT) are the two underlying approaches of multicast routing.

The aim of SPT algorithm is to create a tree such that the distance between source and destination should be minimal. The most commonly used SPT algorithms are Dijkstra [7] and Bellman- ford [8].
The goal of MCT is to downplay the overall cost of the tree. On comparing both trees SPT and MCT, the end to end cost of SPT is lower than that of MCT. The distance between source and destinations is maximum in case of MCT that means the average path length of SPT is lower than MCT. The complexity of MCT is more than the SPT. Due to its higher complexity rate, the majority of routing protocols is based on SPT i.e. distance vector multicast routing (DVMR) [11], Multicast Open Shortest Path First (MOSPF) [12].

2. Related Work
In this section, the computation cost of SPT and MCT have been compared. This comparative study evaluates the drawback of both algorithms during communicating the data in the network. For this study, the WMN [4], as shown in figure-3 have deemed.

The network consists of a source node S, two destination node D₁, D₂ and four forwarding nodes. Firstly the SPT [11] has calculated and then the MCT [6].

SPT algorithm, forwards the packet by constructing a shortest path tree to the destination node. Let us consider a source node S which wants to transmit a packet to a destination node D₁ and D₂. As shown in figure-3, source node S will transmit the packet to D₁ and D₂ by choosing S-C-E-B-D₁ and S-C-E-B-D₂ paths, therefore, the cost of packet transmission from S to D₁ is 4 (1+1+1+1) and from S to D₂ is 4 (1+1+1+1) and the overall cost for transmitting the packet from source S to D₁ and D₂ is 5(S-C-E-B-D₁ and B-D₂).

Now, another multicast routing algorithm MCT has been considered for the computation. Instead of considering the cost, it sends the packet by choosing the path having less number of transmissions. By showing in Figure-4, MCT choose S-A-B-D₁ and S-C-E-D₂, so, the cost of transmission from S-D₁ is 3(2+2+1) and from S-D₂ is 3(1+1+3). The overall cost of packet transmission from S-D₁ and S-D₂ is 10.

3. Proposed Approach
In the previous section, some of the disadvantages associated with both SPT and MCT algorithms are identified. To overcome above mentioned drawbacks we have suggested an algorithm efficient shortest path routing (ESPR). As shown in table-1.

Table-1 shows if a node Nᵢ wants to send the packets to destination node Dᵢ and Dⱼ, initially node Nᵢ will check for the failure case using through an ack (acknowledgement). If ack is received within RTT then there is no failure in the network and node Nᵢ will send the packet to destination Dᵢ and Dⱼ using SPT algorithm. In other case if ack is not received within RTT that means failure exist in the network and the previous node Nᵢ₋₁ will choose the next shortest path from the Routing table and send to the destination nodes Dᵢ and Dⱼ.
Table 1. ESPR Algorithm

<table>
<thead>
<tr>
<th>Terminologies used:</th>
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<tbody>
<tr>
<td>S = source node</td>
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<tr>
<td>D1 and D2 = two destination nodes</td>
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<tr>
<td>Ni = current node</td>
</tr>
<tr>
<td>Ni-1 = previous node</td>
</tr>
<tr>
<td>N = Network</td>
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<tr>
<td>RTT = Round Trip Time</td>
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</table>

1. Select a node Ni from a network N.
2. if (an ack receives within RTT) 
   Then
   No failure exists
   Node Ni sends the packet using SPT algorithm
3. else
   node Ni-1 chooses another path
   Ni-1 send the packet to destination D1, D2

The proposal utilizes the concept of SPT i.e. source node S transmits the packet by choosing the shortest path to the destination node, but in case of failure instead of sending an ICMP message to the source Node S, the failure detected node will choose another shortest path (by considering its routing table) that leads to destination node D1 and D2 and starts transmitting the packet through that path. The failure case is shown in the figure-5.

In normal cases (when no failure exist inside the network), ESPR works same as SPT i.e. Source node S sends the packets to the destination node D1 and D2 through S-C-E-B-D1 and S-C-E-B-D2, while during failure, i.e. if link C-E fails, as node C is not able to get an acknowledgement within its (Round Trip Time) RTT, it will immediately choose another path to send the packets to the destination node D1 and D2 through S-C-B-D1 and S-C-B-D2 path. The corresponding flowchart of our algorithm is shown in figure-6.

4. Performance Evaluation

So far we have discussed our proposed algorithm with both previous approaches and shown how the proposed algorithm works in the failure cases. In this section we have simulate our work in NS-2 simulator on different network sizes and shown the corresponding graphs of SPT, MCT and ESPR in terms of throughput, resiliency.

Fig 7. Throughput and resiliency of SPT

Furthermore we have construct a table of all three algorithms using two parameters i.e. throughput (in term of cost) and resiliency (against node failure). The above graphs and table clearly shows that PA works efficiently in failure cases as compare to SPT and MCT. Finally we conclude our paper in table 3 by showing the features, pros and cons of SPT, MCT and PA.

Fig 8. Throughput and resiliency of MCT
Table 3. Pros and cons of SPT, MCT and ESPR

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Throughput (In terms of cost)</th>
<th>Resiliency (Against node failure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPT</td>
<td>7-node</td>
<td>8</td>
</tr>
<tr>
<td>MCT</td>
<td>15-node</td>
<td>12</td>
</tr>
<tr>
<td>PA</td>
<td>30-node</td>
<td>19</td>
</tr>
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</table>

5. Conclusion and Future Work

In this work an ESPR multicast algorithm has proposed which ensures efficient transmission in WMN during failure. The task was simulated in NS2 at different network sizes and found that cost of transmission is less as compared to other algorithms i.e. SPT and MCT. The proposal has introduced several advantages over SPT and MCT i.e. minimizes numbers of computations, congestion ratio and re-routing of packets. Further to achieve more precise results of ESPR algorithm, it will be analyzed in the physical environment and the results will be revised for other doable measures.
References


