ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0066

Research on Routing Algorithm based on Wireless Mesh Network

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Abstract

With the development of wireless network technology, the requirement of wireless network QoS is higher and higher, and there is an urgent need for new network solutions. This paper mainly studies the opportunistic routing problem in wireless mesh networks. Traditional opportunistic routing will lead to problems such as low bandwidth utilization and unbalanced load. The selection and sorting of candidate nodes will bring a burden to the network. In order to solve the above problems, this paper proposes a reservation based dynamic opportunistic routing algorithm (BRDOA). By studying the status of candidate nodes, the node forwarding mode is improved, so as to reduce the network burden caused by candidate nodes. Experimental results show that the algorithm can effectively improve the network throughput, shorten the delay and significantly improve the QoS of wireless mesh network.

Keywords

Wireless Mesh Network, Dynamic Opportunistic Routing, Candidate Node, QoS.

1. Introduction

With the development of wireless network, the number and type of mobile terminals are increasing. Users' experience requirements for wireless networks are also increasing. There is an urgent need for better wireless network architecture to provide high throughput, low latency and high stability network [1-3]. Because of its high capacity, high speed, easy implementation and low cost, wireless mesh network is concerned by the major research institutions and departments. It is regarded as an important solution to the QoS of wireless network. The wireless mesh network is very easy to implement, so it applies to remote areas and is regarded as the solution of "last kilometer" network problem.

The wireless mesh Network routing is a hot issue in current research. At present, the main wireless Mesh routing is divided into the following categories: reactive routing, proactive routing, hybrid routing, opportunistic routing and network coding-based routing. The first three routing protocols are introduced into the wireless Mesh network from other network, the latter two are routing solution for the characteristics of wireless Mesh network.

Opportunistic routing is an important research direction of the wireless mesh network routing. Compared with traditional routing, opportunistic routing more fully embodies the characteristics of wireless network broadcasting. The opportunistic routing does not need to set up the routing in advance, but dynamically determines the data forwarding node in a competitive way. The candidate nodes need to be identified before the data is forwarded,and prioritize the candidate nodes according to the priority of the node[4]. All the candidate nodes will receive the data packet broadcast by the sender and the node that is the first to forward the data is the node that is actually forwarded. At the same time, other candidate nodes will give up forwarding the packet. The path of data forwarding is dynamically determined in this way of competition [5].

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Opportunistic routing improves the throughput and reliability of wireless mesh networks, and has become a hot spot of research. At present the main opportunistic routing are ExOR, SOAR and ROMER, etc. ExOR is the earliest opportunistic routing algorithm [6-10]. ExOR routing makes full use of the characteristics of wireless network broadcasting and selects the nearest points from the destination node as the next hop node. ExOR uses the ETX to measure the distance between the middle node and the destination node, thus determining the set of candidate nodes. ExOR routing gives full play to the openness of the wireless channel and improves the efficiency of data forwarding. However, the complexity of ExOR algorithm also limits the performance improvement of the algorithm, and the increase of the repeated data will make the performance of the algorithm decrease [11]. SOAR routing is an improved algorithm based on ExOR. It also uses ETX as routing metrics. It establishes the shortest path between the source node and the destination node, and avoids the data repetition and interference by setting the EXT threshold value. The algorithm concentrates the data transmission nodes near the shortest path, and improves the efficiency of the network forwarding [12]. ROMER is a routing algorithm that implements opportunistic forwarding according to grouping. Most of the research on opportunistic routing is focused on the selection of candidate nodes, the algorithm of candidate nodes and the determination of the number of candidate nodes is the main focus of research.

2. Problem Descriptions

In the wired network, the data link is less disturbed, the quality of transmission data is high, and the data loss rate is low [13]. Usually, data hopping and round-trip delay are used as the metrics of routing to illustrate the performance of network forwarding. In wireless networks, channel is used as a transmission path. In the process of data transmission, it is easy to be disturbed and the quality of the signal is not guaranteed. It is easy to cause data loss. Therefore, the wireless network shows that the route measurement method of link quality is different from that of wired network, usually using delay and bit error rate as measurement standards.

The traditional wireless Mesh network opportunistic routing has its own advantages, but there are also disadvantages. The research shows that in the process of using the opportunistic routing, the network nodes that are really responsible for forwarding are always the same batch of candidate nodes. Other candidate nodes have few chances of successful forwarding; data forwarding has been in a "monopoly" state. This may lead to the low utilization rate of resources and the unbalanced network load [14-18]. The high complexity of the wireless mesh network opportunistic routing measurement algorithm will also bring a burden to the network. The wireless mesh network opportunistic routing algorithm will choose some metric (such as ETX, ETT, etc.) to determine the candidate node set and sort the candidate node set, then forward the data, and candidate sets strive for forwarding opportunities through competition. The candidate node set needs to be sorted, which will bring additional overhead for forwarding nodes. These costs will seriously affect the network performance in terminal equipment intensive areas of wireless mesh network, especially the higher requirements for the quality of service business [19-25]. The problems may lead to the increase of network delay and the decrease of network resource utilization.

In order to solve the above problems, we studied the opportunistic routing candidate node algorithm, from the analysis of problems, reduce the number of candidate nodes will make the overhead of candidate nodes selection is reduced, but it will reduce the success probability of the network forwarding, increasing the number of data retransmission.

The number of candidate nodes for the set of opportunistic routing node (S) is n, and the probability of the success of the sending node to the candidate node is P1, and the probability of the candidate node(C1, C1, C1,…, Cn) forwarding to the target node (D) is P2, as shown in Figure 1.

The probability of the success of the opportunistic routing forward is:

$$P= (1-(1-P1)*n)*P2$$

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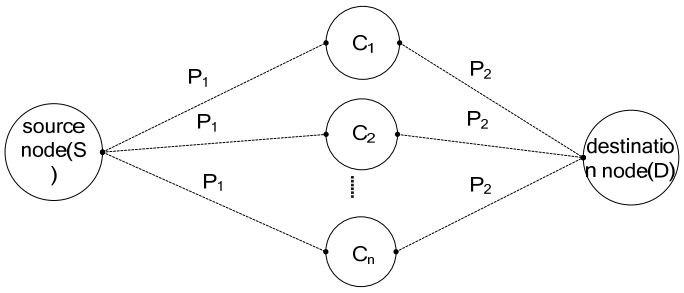

Figure 1. Opportunistic routing forwarding in wireless mesh network.

It can be seen from the formula that the number of candidate nodes will increase the success probability of network forwarding, which is inconsistent with the previous scheme to reduce the candidate nodes. Therefore, the selection of candidate nodes has an important impact on the efficiency of the network data forwarding. In this paper, the traditional opportunistic routing algorithm is studied and analyzed, and a dynamic opportunistic routing algorithm is proposed based on the traditional opportunistic routing algorithm. The algorithm improves the forwarding efficiency by retaining the candidate nodes, instead of constructing the optimal forwarding node. By reducing the network overhead of selecting candidate nodes, it improves the efficiency of data forwarding and improves the QoS.

3. Opportunistic Routing Algorithm based on Reservation

In order to improve the network load of the traditional opportunistic routing candidate nodes, this paper proposes a reservation based dynamic routing algorithm (BRDOA). By reducing the selection and sorting complexity of the candidate nodes. Network nodes need to learn some state information of nodes, such as candidate node change rate and time threshold.

network model and algorithm design:

In this paper, the network model is represented by G= (V, L). V represents a set of nodes in a network, vi∈V(i=1,2,…,N)represents any node in the network, N is the number of network nodes, N=∑vi; L represents the link set in the wireless Mesh network, and L(i, j)∈L represents any link from vi to vj. Network forwarding nodes need to maintain candidate nodes information in a time period ‘t’, and calculate the change rate of candidate nodes in this time period.

$$\boldsymbol{a_i} = \frac{\Delta \boldsymbol{f_i}}{\boldsymbol{f_i}} (\mathrm{i} = 1,2, \ldots, \mathrm{N})$$

The fi represents the candidate node when forwarding data for the i time, and the Δfi represents the number of change nodes relative to the last forwarding when forwarding data for the i time, and the αi represents the change rate of the next forwarding candidate nodes, and the average change rate of the candidate nodes within time ‘t’ is calculated by the αi, that is β.

$$\boldsymbol{\beta} = \frac{\sum \boldsymbol{a_x}}{\boldsymbol{j} - \boldsymbol{i}} (\mathrm{x} = \mathrm{i}, \mathrm{i}+1, \ldots, \mathrm{j})$$

The reserved set of candidate nodes is selected through the average change rate, and the nodes in the reserved set can be sorted by using the latest historical sorting data. However, the change rate varies with the time ‘t’. If the change rate is too large, there will be too much reserved candidate set data.

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This will not only improve the utilization of network resources, but also increase the impact of historical data on transmission. In this paper, the Pareto principle applied in many fields is introduced to deal with the above problem, which is 20% nodes determine the overall forwarding rate of the network. Therefore, set β maximum upper limit of βMax is: βMax = 20%, if β> 20%, then let the node automatically adjust the time 't', shortening the time 't' will reduce the transmission process and the node change rate, so as to achieve the purpose of controlling the β upper limit.

--algorithm description:

--initial t;

--fi←Candicate i;

--fi-1←Candicate i-1;

--αi←(fi- fi-1)/ fi;

--β←(αi+αi+1+……+αj)/(j-i);

--Pareto principle,βMax←0.2;

--if(β>βMax) reduce t and return 1;

--Forward data.

BRDOA algorithm determines the number of reserved nodes according to the historical forwarding data and the average change rate of reserved nodes. Based on the traditional opportunistic routing algorithm, it adds a candidate node reservation mechanism to reduce the system overhead caused by sorting.

4. Experimental Simulations

BRDOA is an opportunistic routing algorithm based on the traditional opportunistic routing algorithm. It realizes routing forwarding through the broadcast characteristics of wireless network together with ExOR and SOAR, and BRDOA uses the EXT metric method like ExOR and soar. Therefore, by comparing the algorithm performance of BRDOA, ExOR and SOAR, we can judge whether BRDOA algorithm can improve the network forwarding efficiency.

The BRDOA algorithm is verified by simulation experiments and NS2 simulation software is used for simulation. In order to verify the forwarding efficiency and network QoS characteristics of the algorithm, the delivery rate, end-to-end delay and throughput are selected as test indicators, and the BRDOA algorithm is compared with ExOR and SOAR algorithms. The experimental results show that the successful delivery rate, end-to-end delay and throughput of BRDOA are better than ExOR and SOAR. BRDOA algorithm effectively improves the network forwarding efficiency and improves the network QoS performance.

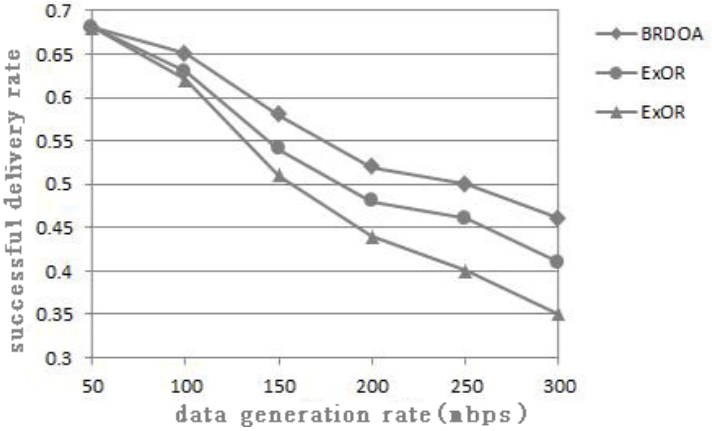

Figure 2. Comparison of delivery rate.

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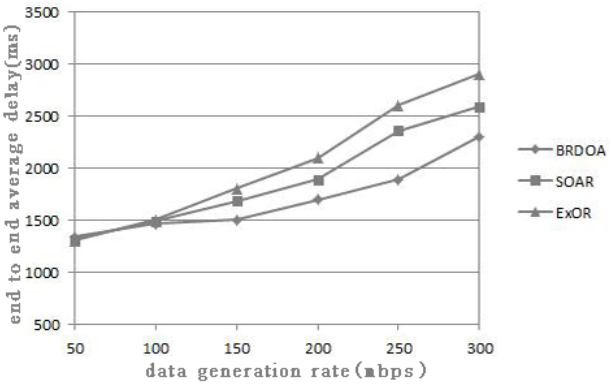

Figure 3. Comparison of delivery rate.

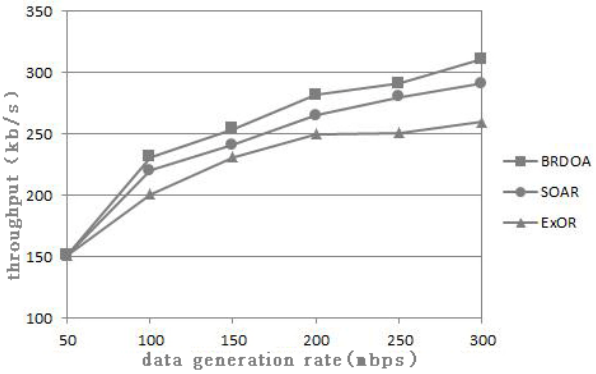

Figure 4. Throughput comparison.

5. Conclusion

As an important solution of wireless network, wireless mesh network will be valued by more and more units and departments. Opportunistic routing lays the foundation for wireless mesh network data forwarding and will also be further developed. BRDOA, as an opportunistic routing based on reservation mode, can improve the data forwarding efficiency of wireless mesh network and improve the QoS of wireless mesh network; the metric method of EXT is adopted to improve the routing performance. BRDOA algorithm proposed in this paper is verified by simulation experiments. Combined with the specific situation of wireless mesh network and adopting appropriate parameter settings, it will become an important solution for routing and forwarding of wireless mesh network in the future. However, BRDOA algorithm also has its shortcomings. The algorithm is not suitable for wireless mesh networks with idle networks. When the amount of network data forwarding is low, the candidate node collection process has little impact on the network overhead, so it is not suitable for BRDOA algorithm.

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