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Abstract: With the development of wireless communication technology, video communication over the mobile ad hoc networks has been more and more applied. How to ensure the QoS of video communication is an important problem that should be solved quickly. In this paper, we propose a QoS routing algorithm for Video Streaming in MANET. The algorithm introduces multi-constrained QoS routing mechanisms, optimizes paths through bandwidth, delay, service priorities and congestion degree constraints. The simulation results show that, in medium speed or low-speed MANET where nodes are concentrated, this algorithm can perform well in respects like extending the life of the nodes, reducing packet delay and improving packet delivery fraction.

Keywords: Mobile Ad Hoc Network**;** QoS **;** multi-path routing; load balancing.

1. INTRODUCTION

With the development of wireless network technology, the video communications based on the mobile ad hoc network (MANET) has found an increasingly wide utilization in many fields such as intelligent transportation, disaster response and military command. In MANET networks, network topology changes frequently, the outage ratio of links is high, energy and transmission distance of a single node are limited, and data transmission needs collaboration between multiple nodes, so routing protocol seems very important[1,2]. At the same time, MANET also has problems like narrow channel, strong interference, high error rate, and node mobility, however, video transmission has high demands on the bandwidth, and it is sensitive to delay and packet loss, therefore, how to ensure the QoS of video communication in multi-hop network is an important problem that should be solved [3].

The present single-path routing protocols such as AODV[4] have the characteristics of easy to manage, configure and realize. But its network transmission efficiency is low, and routing costs a lot, also once the load becomes heavy, it is likely to cause congestion on the local node, and we can not ensure the QoS of video communication. Recently, multipath routing technology has become one of the hottest problems of MANET [5]. AOMDV [6] is a classic on-demand multipath routing protocol. AOMDV chooses two link disjoint paths of which the number of hops is fewest, chooses the way of main and standby routing to communicate, and it improves a lot in the aspect of reducing network overhead and improving network performance comparing to AODV. However, AOMDV neglects the change of node flow, so it is hard for AOMDV to achieve the purpose of load balancing [7, 8].

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Based on such considerations above, in this paper, we propose a QoS routing algorithm based on MANET network of video communication. This algorithm introduces multi-constrained QoS routing mechanisms, optimizes paths through bandwidth, delay, service priorities and congestion degree constraints to improve load balancing problems of video communication in MANET.

2. A QOS ROUTING ALGORITHM FOR VIDEO STREAMING IN MANET

2.1 Network Model and QoS Routing Parameter

Topology of wireless ad hoc networks can be abstracted into a weighted directed graph G(V,E),and V is a set of nodes, E is a set of single-hop links. For a viable path whose number of hops is n p={v1,v2,…,vn}, assuming bandwidth, delay, and link congestion degree are its QoS parameter, according to the concave features of QoS parameter, you can define bandwidth and delay as

$$B(p) = \min_{k=1}^{n-1} b(v_k, v_{k+1}) \qquad (1)$$

$$Delay(p) = \sum_{k=1}^{n-1} d(v_k, v_{k+1}) \qquad (2)$$

Link congestion degree can be defined as

$$F^k(p) = C(p) * E^k(p) \qquad (3)$$

And $F^k(p)$ stands for traffic flow congestion degree whose priority is k in path p, C(p) stands for the Buffer ration of service in link p.

We add different service priority queue in the routing buffer list (shown in Fig. (1)) through changing the routing table of AOMDV, and put them in order of priority in buffer strictly.

For newly arrived priority stream, it can only occupy the buffer whose priority is lower, and there we can get that,

$$E^k(p) = \sum_{k}^{m} \frac{S_n}{S} \qquad (4)$$

But for all service priorities in feasible path p, there

$$E^m(p) \le E^{m-1}(p) \le \dots \le E^k(p) \le \dots \le E^1(p) \qquad (5)$$

The introduction of a priority not only provides priority service of high-class traffics, but can also eases network congestion, and ensures the QoS of service stream better.
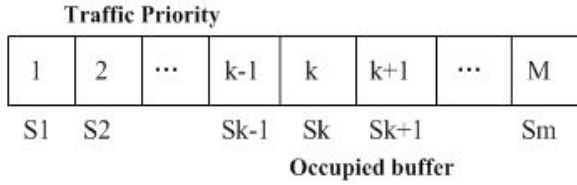
Fig. (1). Traffic priority queue in the buffer.

2.2 Implementation of the Optimization of QoS Routing

Referencing path priority function proposed in the literature [9], considering the constraint of path delay, bandwidth and link congestion degree comprehensively, we can define path preference function f(p) with multiple QoS Constraints,

$$f(p) = \alpha \frac{B(p) - B_{min}}{B_{min}} + \beta \frac{Delay_{max} - Delay(p)}{Delay_{max}} + \gamma(Congestion - F(p)) \qquad (6)$$

Bigger f(p) means better optimization of path. Here, Bmin and Delaymax stand for the minimum bandwidth and the maximum delay that algorithm specify, Congestion stands for link congestion threshold, α, β and γ are respectively weighting factors of the three above-described kinds of QoS constraints, and $\alpha + \beta + \gamma = 1$.

We add information like Priority_ID, Link min bandwidth, Link congestion degree and Link_max_delay in node route cache through changing the routing table of AOMDV (shown in table 1), so we can use f(p) to choose best paths. When a service stream whose priority is k arrives, the route discovery mechanism of AOMDV will be started first, source nodes will initiate route request RREQ, and RREQ is to be broadcast to the neighbor nodes. If any intermediate node receives multiple RREQ, it will record reverse route that 2 RREQ packet with biggest f(p) pass, then target nodes will send route reply (RREP) to source nodes, and intermediate nodes will feedback these paths recorded to source nodes through the shortest path that can be found. The source nodes build their own network topology diagrams by superimposing these paths information, and then choose 2 possible paths whose bandwidth, delay and congestion degree are best from these diagrams.

Table 1. The Routing Table Extended.

destination	sequence number
interface	advertised hop count
Last_hop	Next_hop
Route_list	Link_Survival time
Route_tag	Link_max_delay
Link_min_bandwidth	Link congestion degree
Priority_ID	congestion Threshold

2.3 Maintenance and Update of Routing

Choosing the best two routes as the primary and the alternate path to send service stream can avoid nodes with great congested degree, also can distribute traffic better, and it is good for the optimization of network resources. In the process of the data transmission, every link node maintains connectivity between adjacent nodes by send Hello packet (RREP without request), and keeps the latest routing information according to survival time and serial numbers. Each node has its own network topology diagram, no matter which node that data goes through, this node can find the appropriate path from their topology diagrams to send data.

When the primary route reaching the destination node fails, the destination node broadcasts route error information (RERR) to the source node and each intermediate node. When the source node sends the next packet, it will choose an alternate route as the primary route to send data, at the same time, the source node will find a new route to replace failure path from network topology diagrams. Only when the two paths fail, the source node will launch a new route to request a new search path. So, it inherits the advantages of multi-path routing of AOMDV well, and can maintain the stability and adaptability of path better, reduce control overhead caused by frequent failure of routing.

3. SIMULATION ENVIRONMENT AND RESULTS

This experiment used the Foreman video sequence, a software named JM14 based on JVT / H.264 video encoding compression standard to encode it. The sequence format is CIF (352 × 288), and the sending speed is 30fps. We created a network topology with 50 nodes in 800m × 600m space, and selected two nodes randomly from the 50 nodes as the sender and the recipient. The simulation parameters are shown in Table 2. Video data uses UDP protocol to transmit in wireless multi-hop network, and each frame of video sequence is encapsulated into plural UDP packets, and each data packet length is not greater than 1024 bytes. Extract parity frames from the video coding sequence to implement multi-path transmission. Set the receiver play buffer size to 5s for smoothing the packet delay jitter to improve the play fluency. Simulation time is 900 seconds. The result of the simulation performance takes the average of results of 5 simulations.

Table 2. Simulation parameters.

Name	Parameters	Name	Parameters
Space size	800*600	Node speed(m/s)	[0,18]
Number of nodes	50	Pause time	30 s
Movement model	Random waypoint	Simulation time	900 s
Data packet size	1024 B/512B	Link delay	[20,50] ms
MAC	802.11	delay constraint	800 ms
RF transmission range	250 m	bandwidth constraint	256 Kb/s

3.1 Network Lifetime Test

The network lifetime reflects the survival rates of network nodes and the stability of the whole network from a certain extent. Death of link nodes is generally due to local congestion, energy depletion, therefore, we test our algorithm and ability to balance load of AOMDV algorithm by increasing the amount of data sent in a static network environment. Other nodes keep sending CBR packets at a speed of 512B per second as source node sends video stream to target node. We can see it from Fig. (2) that, with the amount of data sent increasing, network load will be heavier, and dead nodes will be gradually increased. Because the proposed algorithm uses multi-constrained QoS routing, it can distribute traffic according to the degree of nodes congestion. At the time when network appears dead node obviously lags AOMDV, and in the same rounds which have many nodes, more nodes survive. But with survival nodes of the whole network becoming fewer and fewer, which causes that feasible paths become scarce, and proposed algorithms is not as good as AOMDV algorithm because of the additional routing overhead due to multi-constrained compute. This shows proposed algorithm is more suitable for network environment with concentrated nodes.
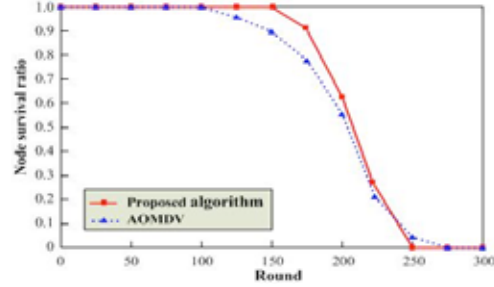

Fig. (2). The lifetime of the network with varying loads.

3.2 Packet Delivery Fraction and End-to-End Delay

We created multiple sports scene by setting different node speed to test the network throughput performance of AOMDV protocol and the proposed algorithm under different sports scene. In video communication, delay and packet delivery ratio are two important performance indicators that affect video communication quality. From Fig.(3) we can see that, in MANET where speed of nodes is less than 14m/s, average packet delay of algorithm proposed is lower than AOMDV. At the same time, packets decoded in the destination node are also more (shown in Fig. (4)). This is because in the network topology of the low and medium speed, the network is stable, ideal accessible paths are abundant, and the link is reliable. Because the proposed algorithms using multi-constrained optimal path and maintaining a path through the network topology, it can exhibit better fault tolerance and stability; but in high speed environment, it cannot perform well because active path fails frequently, and the probability of packet retransmission failure increases.
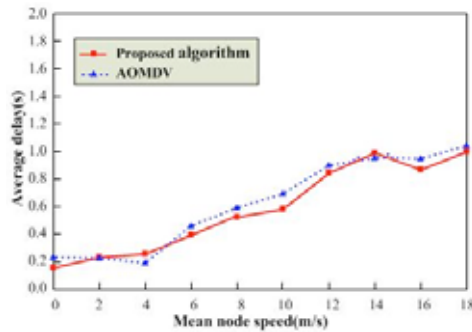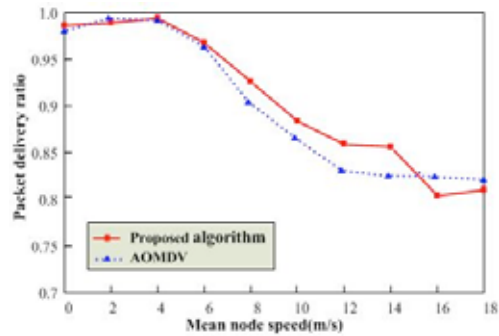

Fig. (3). Average packet delay with varying mobility.

Fig. (4). Packet delivery ratio with varying mobility.

4. CONCLUSIONS

In this paper, we propose a QoS routing algorithm for video streaming in MANET aiming at issues of traffic balancing and quality of service of multi-path video transmission over MANET. The algorithm introduces multi-constrained QoS routing mechanisms in AOMDV, optimizes paths through bandwidth, delay, service priorities and congestion degree constraints. The simulation result shows, in medium-speed or low-speed MANET where nodes are concentrated, the proposed algorithm performs well in aspects like extending the life of the nodes and improving network throughput.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

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