Proposal for an Ad-hoc Routing Protocol considering Traffic Conditions and Evaluation of UDP using a Redundant Route

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***Abstract*—We propose a new ad-hoc routing protocol named "PD-OLSR"(Protocol Dependent-OLSR) which makes the best of UDP and TCP, based on separate routing tables for UDP and TCP. It also enables the route selection to avoid network congestion, considering traffic conditions of nodes. In this paper, we show summary of PD-OLSR and performance evaluation. As a result of simulation, we confirmed that there are cases where we can get better performance with an increased number of hops by taking a redundant route, rather than taking the shortest one.**

I. Introduction

In IP networks, there are communication types of UDP and TCP that have completely different throughput characteristics. However, protocols standardized or currently proposed are assumed to be used with the same control method for both protocols, and they don't fully utilize the performance. For these issues, we have been proposing PD-OLSR (Protocol Dependent-OLSR) [1] which is the extension of OLSR (Optimized Link State Routing) [2]. OLSR is a typical protocol of Proactive types. In PD-OLSR, routing tables (hereafter "RT") are generated separately for UDP and TCP to select the best route for making use of their characteristics. In this paper, we show the summary of PD-OLSR and simulation result of RT generation for UDP.

II. PD-OLSR

A. Methods for Route Selection in UDP and TCP

In multi-hop communication, the characteristics of UDP and those of TCP are quite different. We have measured the changes of throughputs by changing the number of hops in simulations. Fig. 1 shows the result of UDP and TCP respectively. In the case of UDP, it is seen that no degradation of throughput occurs when the number of hops increases, as long as there is a margin in the bandwidth. From this fact, in the case of UDP, a redundant route with a larger number of hops is considered to be permissible, rather than the necessity of selecting the shortest route. Contrary to UDP, in the case of TCP, the throughput greatly degrades in proportion as the number of hops increases. This is because TCP has a feature of using up the entire bandwidth by the congestion control, and the network bandwidth is shared by nodes in multi hop communication. Accordingly, we select the most suitable route from among all available routes in the case of UDP and from among the shortest routes in the case of TCP.

In order to create RT for UDP and that for TCP separately, we create traffic information to be used for the route selection

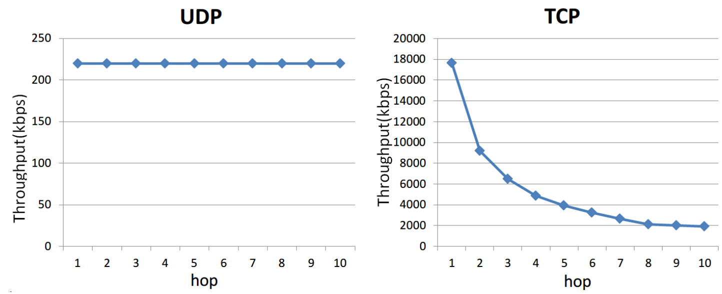

Fig. 1. UDP and TCP throughput in multi-hop communication

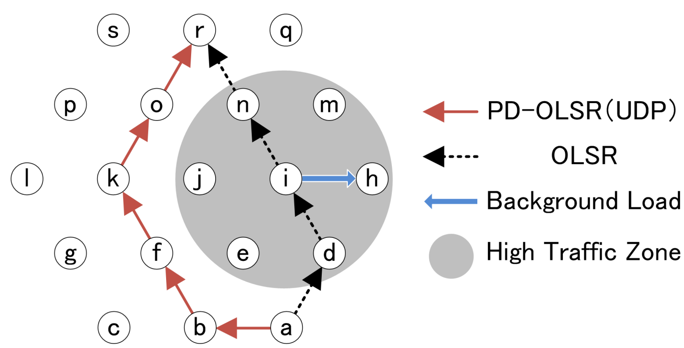

Fig. 2. Route comparison of OLSR and PD-OLSR

also separately. While we use the UDP Traffic as traffic information in the case of UDP, we use the TCP Session numbers as the traffic information in the case of TCP.

B. Route Selection

Fig. 2 shows an example of UDP routes, selected by OLSR and PD-OLSR respectively. The Figure indicates the example where a route is created from Node *a* towards Node *r*, when background load is generated from Node *i* towards Node *h*. In the case of OLSR, one of the shortest route shown by the dotted lines (*a-d-i-n-r*) is chosen based on the number of hops. If there are multiple shortest routes, the decision as to which route to take is left to the implementation. Thus, in the case of OLSR, there is a possibility that load is concentrated to a certain specific node and the throughput goes down as a result of many occurrences of packet losses. On the other hand, in the case of PD-OLSR, its route selection is made based on the state of communication which Node *a* has grasped, as indicated by the solid lines (*a-b-f-k-o-r*) in the Figure. In this

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TABLE I. SIMULATION CONDITIONS

Network conditions		Communication status	
Form	Ad-hoc Network	Type	CBR
Standard	IEEE802.11g	Transport protocol	UDP
Nodes	37	Packet size	200[Bytes]
Coverage area	Neighbor node	Rate	64[kbps]
Communication pair			
Selection method	Random		
Sessions	50		

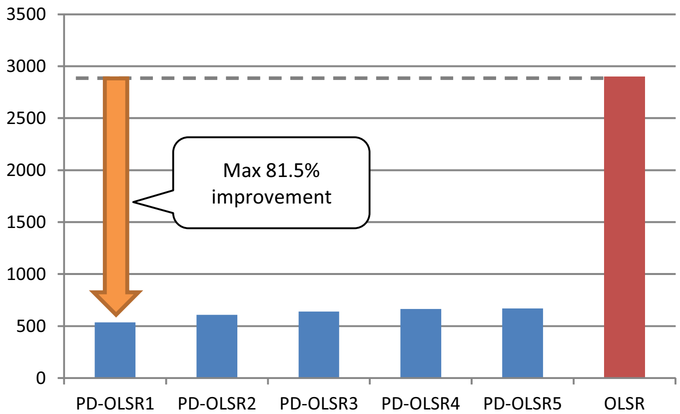

Fig. 3. Drop packets

case, although the number of hops increases, communication avoiding the node with high load is realized.

III. PERFORMANCE EVALUATION

In this Section, we show the results of the simulation based on ns-2 [3], using RT generation function for UDP. We investigated what influence it would give to the packet loss and communication delay time, when giving a heavy load to the network by UDP communication assuming VoIP.

A. Simulation Conditions

Conditions for the simulation are shown in Table I. The configuration of nodes was arranged in the same manner as Fig. 2 and the number of nodes was 37. The time period for the simulation was set at 530 seconds, and the number of UDP sessions was gradually increased at intervals of 10 seconds, starting at 30 seconds after the beginning of the simulation. In the simulation, link metric is the sum of the cost equal to the one-hop (hereafter ”hop-cost”) and traffic information across nodes. Hop-cost is the multiplication of coefficient α and the highest traffic value of the nodes in the network. The degree of redundancy increases when α is small. We made comparisons for the cases where the coefficient α of Link Metric in PD-OLSR was set at 1-5, and for the case of OLSR.

B. Result of Evaluation

We show the results of the number of drop packets during the simulation in Fig. 3, and the rates of improvement of drop packets and communication delay time in Table II. Here, PD-OLSRi (i=1-5) indicates that the coefficient α is i.

TABLE II. IMPROVEMENT RATE OF DROP PACKETS AND DELAY

	Drop	Improvement Rate	Delay [ms]	Improvement Rate
PD-OLSR1	536.5	81.50 %	4.074964	35.60 %
PD-OLSR2	607.2	79.06 %	4.180526	33.94 %
PD-OLSR3	640.1	77.93 %	4.214415	33.40 %
PD-OLSR4	665.8	77.04 %	4.214985	33.39 %
PD-OLSR5	669.2	76.93 %	4.217285	33.36 %
OLSR	2900.2	-	6.327999	-

As the results of the simulation, we found out that we could improve the rate of drop packets all the time when the coefficient of PD-OLSR is within the range of 1 to 5, compared with OLSR. The improvement rate of drop packets increases when coefficient is small, and the maximum improvement rate is 81.5% compared to the case of OLSR. It can be seen that packet loss decreases when redundancy of route is large. This means that the most suitable route is not necessarily the shortest route. However, redundant routes make the traffic in the network large and may accelerate the saturation of the whole network. The question that which coefficient is the most appropriate depends on network topologies. In respect of the delay times, though no difference was observed from the difference in the coefficients, an improvement rate of about 33% is observed for all cases. From this fact, we can tell that we are able to shorten the delay times, by making the route selection based on the consideration of the congestion state of communication.

IV. CONCLUSION

In this paper, we proposed ”PD-OLSR” as an ad-hoc routing protocol considering the congestion state of communication. In our proposal, we generate RTs for UDP and TCP separately, and make full the characteristics of UDP and TCP, by adopting different routing processes for both. When we implemented the RT generation function for UDP to a simulator, based on our proposed method and made an evaluation, we could confirm that the rate of drop packets was improved by 81.5% in the best case. By changing the coefficients to adjust the redundancy, we could also determine that the most suitable route is not necessarily the shortest route. Hereafter, we will implement the RT generation function to TCP as well, and conduct a performance evaluation in various different environments including the UDP/TCP coexisting environment.

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