Ad-hoc 네트워크에서 Look-ahead Selective Flooding을 이용한 On-Demand 라우팅 프로토콜 성능 개선

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Performance Evaluation of On-Demand Routing Protocol using Look-ahead Selective Flooding in Ad-hoc Network

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Abstract

Ad-hoc networks are characterized by multi-hop wireless links, frequently changing network topology and the need for efficient dynamic routing protocols. In an Ad-hoc network, each host assumes the role of a router and relays packets toward final destinations. Because a packet is broadcast to all neighboring nodes, the optimality criteria of wireless network routing is different from that of wired network routing. In this paper I point out the more important cost factor than the number of links in the Ad-hoc network. A class routing protocols called on-demand protocols has recently found attention because of their low routing overhead since it performs a blind flooding to look for a path.

In this paper, I propose the method which reduces overhead by using the information of neighboring nodes and doing a selective flooding. Simulation results demonstrate better reduction of routing overheads with this scheme.

Keyword : Ad-Hoc network

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1. Introduction

In an Ad hoc network, mobile nodes communicate with each other using multi -hop wireless links. There is no stationary infrastructure. Each node in the network also acts as a router, forwarding data packets for other nodes. The routing protocol must be able to keep up with the high degree of node mobility that often changes the network topology drastically and unpredictably. To deliver data between the source and destination in this network, packets have to pass through the several paths because of the limited propagation scope of wireless network interface. Therefore, each nodes in the network has to activate its routing function so that it can store and forward packets to other mobile nodes whose packets cannot reach their destination nodes in a single hop. Because of the frequent moving and the limited power consumption in ad hoc network, well-defined routing scheme is required to communicate efficiently among mobile nodes [Royer & Toh ,1999].

However a number of routing protocols have been proposed so far, there is a problem with on-demand protocol scheme since it increases routing overhead due to the execution of blind flooding to locate a path[Broch et al., 1998].

In this paper, I propose a method which performs selective flooding by limiting neighboring node's information and wave range by threshold factor when query occurred as each node manages information on the neighboring nodes in 2-hops.

This paper is organized as follows. I describe the existing ad-hoc routing protocols in section 2. Then I propose selective flooding scheme in section 3. Simulation model and results are shown in section 4, 5 and section 6 conclude the paper and think for the future study.

2. Existing Routing Protocols for Ad-hoc network

A key protocol in Ad-hoc network is routing. Multi-hopping, mobility, large network size combined with device heterogeneity and bandwidth and battery power limitations make the design of adequate routing protocols a major challenge[Jubin & Tornow, 1987]. In recent years, various different routing protocol have been proposed for wireless Ad-hoc networks.

Existing routing protocols for Ad-hoc networks can be divided into two categories : table-driven and on-demand routing protocol based on when and how the routes are discovered. In table-driven routing protocols consistent and up-to-date routing information to all nodes is maintained at each node whereas in on-demand routing the routes are created only when desired by the source host[Royer & Toh, 1999].

2.1 Table-driven Routing Protocols

Basically the routing is a distributed form of the shortest-path problem. All nodes in the table-driven routing protocol scheme maintains the recent path toward other nodes into the routing table by continuous procedure to locate a path. Since then, whenever data transmissions are required data is transmitted immediately by the information of routing table.[Johanson et al., 1999]

General operation in table-driven routing protocol scheme is like this. At first, each node maintains the information of neighboring nodes which has to pass to get to the destined node and when the packets are received, by the destination identifier, packets are forwarded to the appropriate neighboring node. This packet forwarding process is repeated until the packet is delivered to the destination.

This typical ad-hoc routing protocol using this scheme is the DSDV(Destination Sequenced Distance Vector). Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes form new ones and thus avoids the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing time-driven and event-driven [Perkins & Bhagwat, 1994].

Propagation time is getting shorter by the maintenance of the recent paths, even though it has the problem of large routing overhead since routing tables are continuously maintained and managed.

2.2 On-demand Routing Protocols

As different from the table-driven routing protocol scheme, the path is established by the source node in on-demand routing protocol when data transmission is required. If the path from a certain node to the destination is required, route discovery process is performed immediately and thus discovered path is maintained until the route is no more needed or valid. The typical routing protocols using this scheme for ad-hoc network are DSR(Dynamic Source Routing), AODV(Ad-hoc On-demand Distance Vector) and so on.

DSR uses source routing where the source of a data packet determines the complete sequence of nodes through which to forward the packet. DSR builds routes on demand, using flooded query packets that carry the sequence of hops they passing through. Once a query reaches the destination, the destination replies with a reply packet that simply copies the route from the query packet and traverse it backwards[Broch et al., 1998].

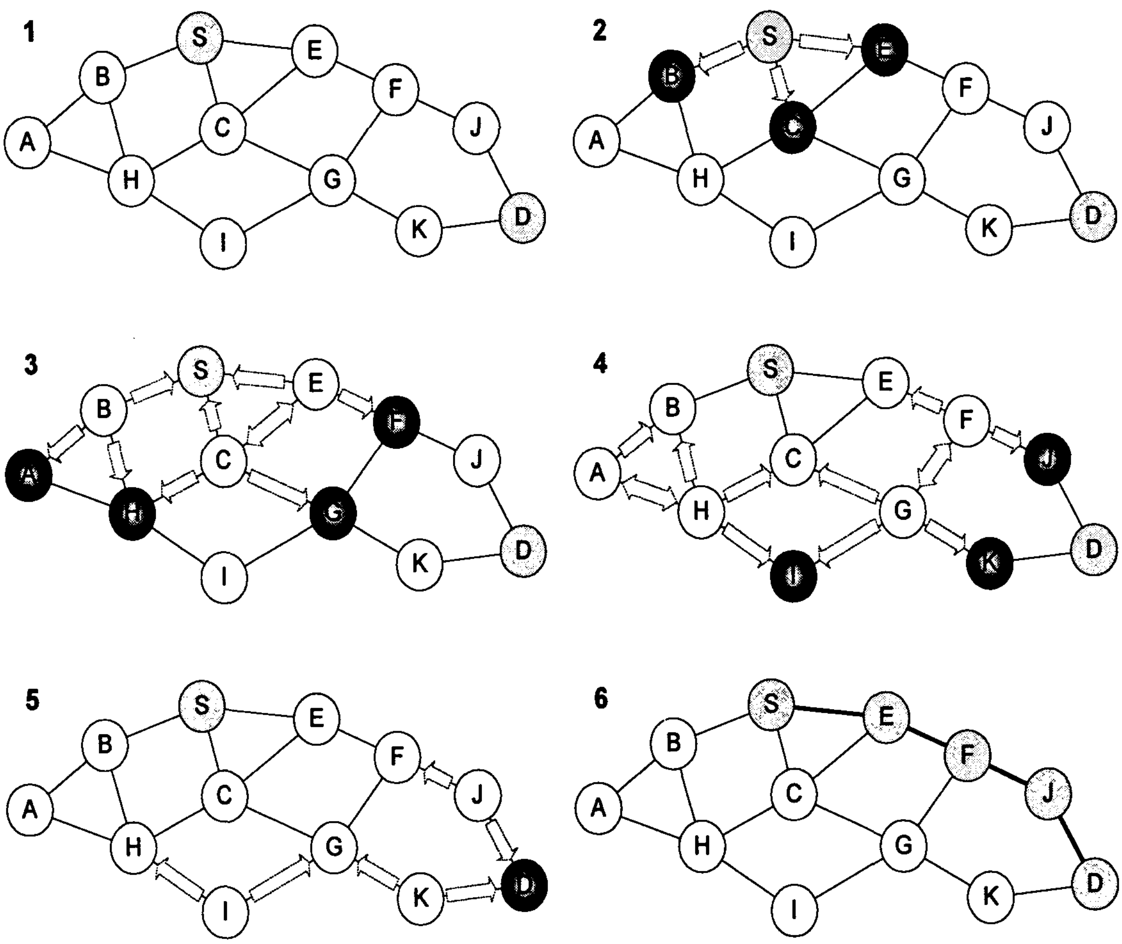
AODV is an on-demand variation of distant vector protocols. AODV is an improvement on the DSDV algorithm discussed in section 2.1. AODV minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes. AODV uses sequence numbers maintained at destinations to determine freshness of routing information and to prevent loops. In AODV, a network-wide query floods is used to create a route, with the destination responding to the first such query, much as in DSR. However, AODV maintains routes in a distributed fashion, as routing table entries, on all intermediate nodes on the route[Perkins & Royer, 1999 ; Perkins & Bhagwat, 1994].

Neither DSR nor AODV guarantees shortest path. This is particularly true if early quenching is used. However, earlier performance evaluation[Broch et al., 1998] shows that the lengths of routes discovered are usually comparable to those the shortest path protocols.

2.3 Problems of Blind Flooding

Flooding is a common operation used when a node needs to transmit a packet to all the other nodes in network. Flooding can performed by broadcasting, which is a method of transmitting to all the neighbor nodes within the transmitting range. Many routing protocols such as DSR, AODV need to 'flood' a route request to seek out a multi-hop route to the destination. Ad hoc multi-cast routing protocols can use flooding instead of complex multi-cast routing protocols[Haas et al., 2002].

An advantage of the on-demand routing scheme is that routing overhead is low unlike the table-driven routing scheme. As network size grows, routing overhead grows as well. This is why the route discovery procedure in the on-demand routing scheme is basically based on flooding, where the source floods the entire network with a query packet in search of a route to the destination. Although several optimization of the basic flooding mechanism



<Fig. 1> Path discovery procedure on On-demand scheme

have been proposed previously, the flooding scheme can still deliver the query to a very large number of nodes in the network, leading to a high routing overhead. The problem can be severe when the mobility is high(very frequent route discoveries) and/or the network is large(many routing messages generated in regions far away from the source and the destination)[Broch et al., 1998].

In figure 2, first of all, the route discovery procedure is achieved when data is transmitted from node S to node D. Node S floods RREQ(Route REQuest) packet to its neighboring nodes. A neighboring node that receives packet also floods RREQ packet to it's neighboring nodes. This procedure is repeated until RREQ packet arrives in the destination node D. When RREQ packet arrives in destination D, the route discovery procedure is finished with sending RREP(Route REPly) packet back to the source node S through the reverse path of delivering.

Such blind flooding scheme is a factor of reducing network performance due to the growing routing overhead as the number of nodes increase, because the query packet is transmitted to the whole network and then it affects the large scale of network.

3. Selective Flooding

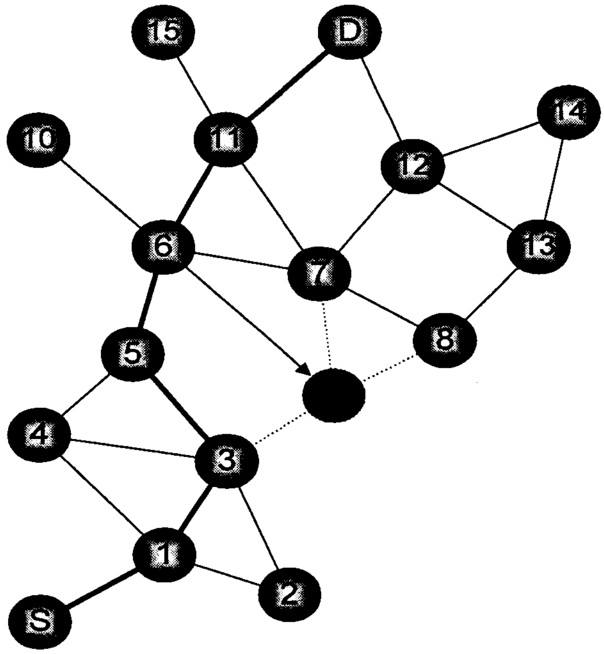
Various flooding schemes have been proposed to overcome the drawbacks of broadcast storms, but none have been considered as the satisfying method for Ad hoc routing protocols. Some schemes try to use heuristic methods to gain topological information, some others use neighbor information to understand the topological situation. Neighbor information can be useful in many ways, but it adds overhead, such as broadcasting hello packets periodically, and requires high algorithmic costs[Haas et al., 2002].

A selective flooding scheme proposed in this paper is based on spatial locality that a node does not move abruptly and supposing that the new route is not different much from the old route. Because the on-demand ad-hoc routing protocol scheme basically does not have the visibility on network topology, it has a disadvantage that does not cope actively with a changed route. Therefore, I propose in this paper that:

As every node manages information on neighboring nodes in 2 hops, it allows a bit of visibility to the moving nodes. Therefore it can work actively against changing path in 2 hops. And also changing path needs, in case of node moving more than 2 hops from the existing path, it prevents transmitting query packet for finding path as selective flooding query packet in existing path using threshold factor.

3.1 Information Management of 2-hop Length Neighbor Nodes

Information of neighboring nodes is known by a HELLO packet as well as continuous listening of data transmission on each node. Besides, when HELLO packet is delivered to the neighboring node, if the information of neighboring nodes is sent together, each node is able to maintain the information of neighboring nodes. Also changing of path by the



<Fig. 2> Path Recover using neighbor node information

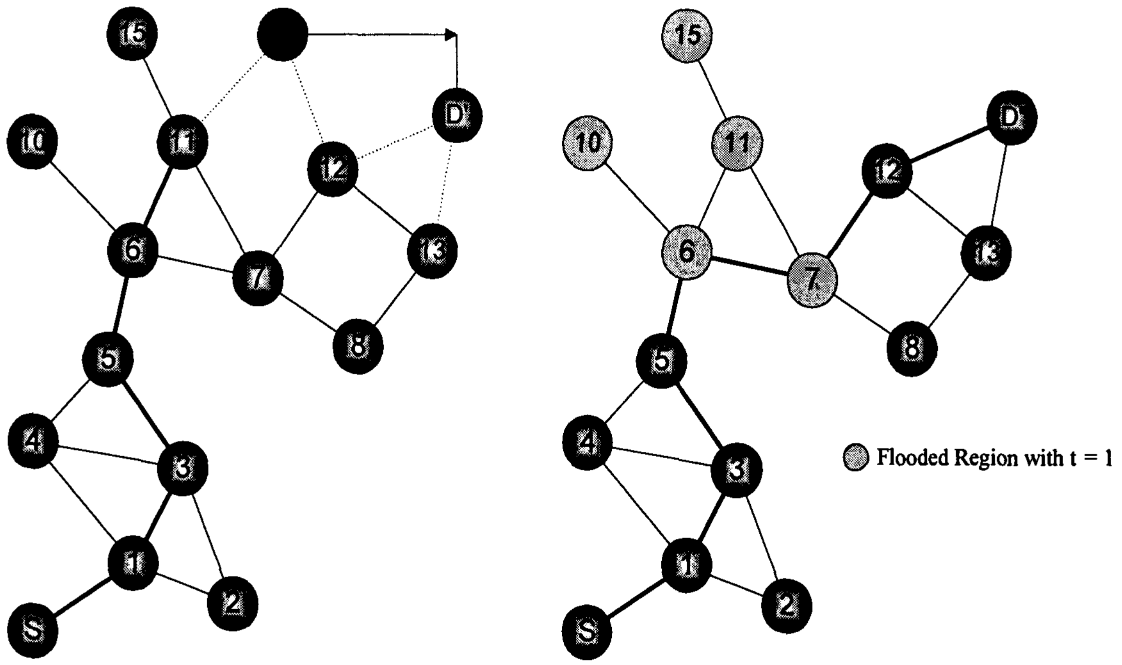
movement of node within the maximum 2 hops does not occur additional query so the reduction of routing overhead will be possible. In figure 2, in the case of transmission of packet through the existing path (S, 1, 3, 5, 6, 11, D), I may know that preexisting path is changed in node 3 by the information of neighboring node table as well as node 6 is it's own neighbor. Therefore, using this information, the path is to be updated to (S, 1, 3, 6′, 11, D) and then the packet is to be transmitted to node 6.

In node 6, the route is modified to (S, 1, 3, 6′, 7, 11, D) again because node 11 in the receiving path is in a 2 hops distance neighbor and then the packet reaches to the destined node. Like an example above, the path by the information table of neighboring node and the query to look for a path is not occurred.

The problem of this scheme is that the packet size grows because it has to send the information of the neighboring nodes periodically together. When each node sends a HELLO packet to its neighboring nodes by maintaining neighboring nodes table, if there is little difference from the existed table, it sends just a changed list without the information of neighboring nodes and then such scheme decreases the packet size.

3.2 Selective Flooding using threshold factor

Even if the old path is changed with movement of nodes, as a node does not move abruptly, the new path is not different from the old one and this can be recovered by using the information of the neighboring nodes. If the distance difference is greater than 2 hops is discovered, the query is isolated with threshold factor τ.



<Fig. 3> Selective Flooding using threshold factor τ

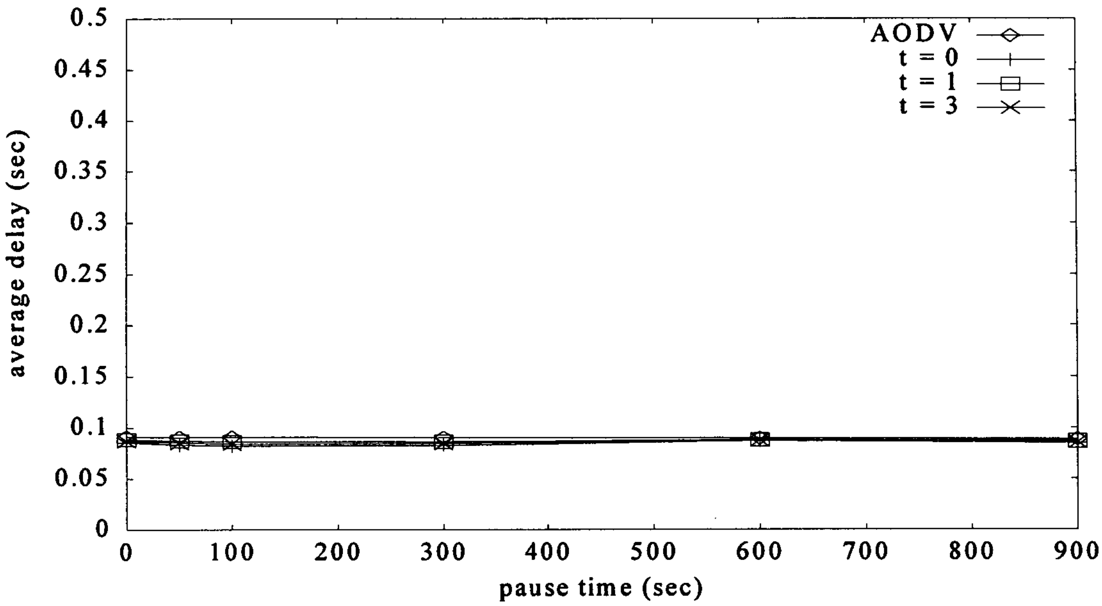
In figure 3, as node D moves, the packet which is propagated to existing path (S, 1, 3, 5, 6, 11, D) gets to recognize that the path is changed in node 6 and realize there is no existing path in neighboring nodes. So the packet try to find next node in the neighborhoods.

In case of a node, which is received query packet, dose not exist in the path, increase value of τ and if the value gets higher than established value than node does not flood packet any more. So it can selective flooding to node in regular range of existing path. In the follow example(figure 3), in case of maximum value of τ is 1, query which is started from node 6 gets to find a new path in out node-table of node 7.

4. Simulation Model

Simulation was carried out to evaluate the performance of proposed method using ns-2[Fall et al., 1999]. In a recent paper [IEEE, 1997], the Monarch research group at Carnegie-Mellon University developed support for simulating multi-hop wireless networks complete with physical, data link, and MAC(Medium Access Control) layer models on ns-2. The DCF(Distributed Coordination Function) of IEEE 802.11 for Wireless LANs is used as the MAC layer protocol. [IEEE, 1997] The 802.11 DCF uses RTS (Request-To-Send) and CTS(Clear-To-Send) control packets for data transmission to a neighboring node. The RTS CTS exchange precedes data packet transmission and implements a form of virtual carrier sensing and channel reservation to reduce the impact of the well-known hidden terminal problem [Tobagi & Kleinrock, 1975].

The mobility model used a random way point model[Broch et al, 1998; Johanson et al., 1999] in a regular square field. The field configuration is 1000m×1000m field with 50



<Fig. 4> Average Delay Time-low traffic

nodes. Here, each packet starts its journey from a random location to a random destination with a random chosen speed(uniformly distributed between 0-20m/s, Ymax = 20m/s). Once the destination is reached, another random destination is targeted after a pause. I vary the pause time between 0-900sec, which effects the relative speeds of the mobiles.

The radio model uses characteristics similar to a commercial radio interface, Lucent's Wave Lan[Eckhardt & Steenkiste, 1996] which has shared-media radio with a nominal bit rate of 2Mb/s and a nominal radio range of 250m. I use mobility and traffic models similar to those previously reported[Broch et al., 1998] using the same simulator. Traffic type is CBR(Continuous Bit Rate). The source-destination pairs are spread randomly over the network. Only 512 byte data packets are used. The number of source-destination pairs and the packet sending rate in each pair is varied to change the offered load in the network.

Simulations are run 900sec for 20-40 source node. Each data point represents an average of at least five runs with identical traffic models, but different randomly generated mobility scenarios. Identical mobility and traffic scenarios are used across pure AODV and AODV using selective flooding.

The following is the parameters for the simulation.

<Table 1> Simulation Parameter

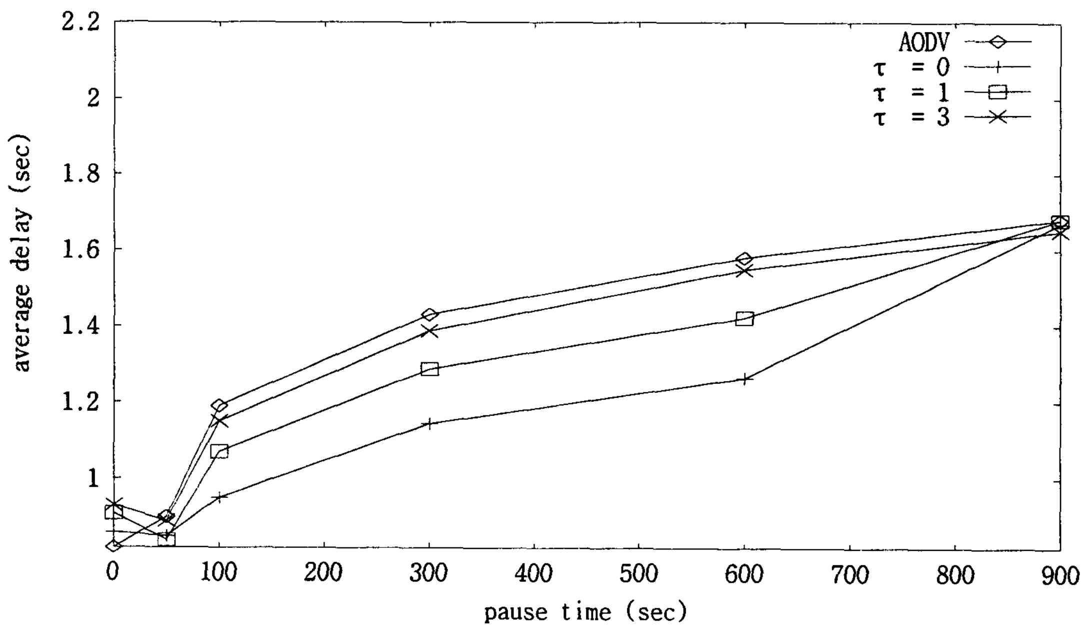
Mobility Model	Number of Nodes	50
	Environment Size	1000m×1000m
	Simulation Time	900sec
	Ymax	20m/sec
Traffic Model	Pause Time	0~900sec
	Traffic Type	CBR
	Packet Rate	4 packets/sec
	Packet Size	512byte
	Number of sources	20 / 40

5. Simulation Result

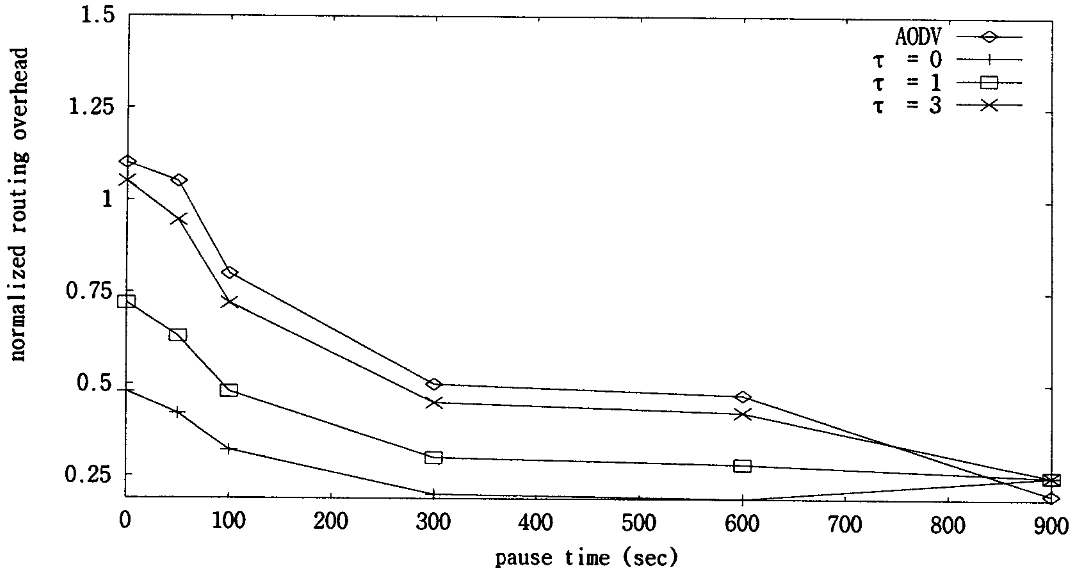
The protocol used in the simulation is a preexisted AODV that sends periodically a HELLO packet as internally for the management of the route. In addition to the preexisted AODV I have changed it to manage the information of 2 hops distance neighboring nodes and to be able to selective flooding and I have compared the performance with pure AODV routing protocol. The experiment has done as the AODV and threshold factor increases to 0, 1, 3 and threshold factor 0 means that is executed by the only information of 2 hops distance neighboring nodes.

The performing analysis has been implemented by two criteria. The first is a propagation delay. In the low traffic, the propagation delay is not able to compare with each other because it is too low as the whole. On the contrary, in the high traffic, I was able to find out that as propagation delay is lower the value of the threshold factor is also lower and propagation delay is high when the mobility is particularly a near medium value. In the high traffic, the reason propagation delay is higher under the low mobility may be due to the congestion of ad hoc network and as the mobility grows it is lower due to the settlement of the congestion.

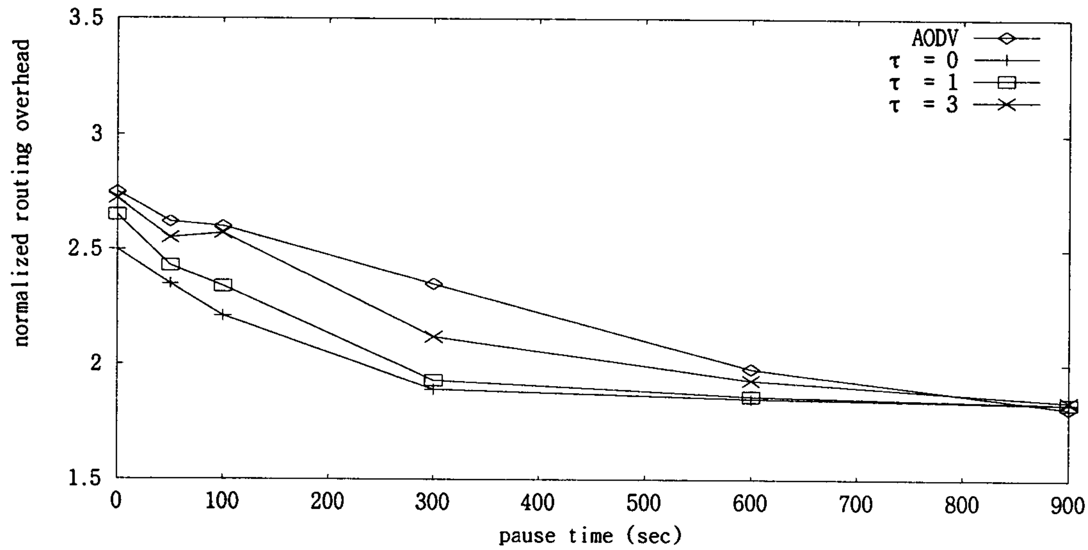
Secondly, the measurement of the routing overhead is regularized and indicated by the ratio of the routing packets to the entire routing packets. As you can see in the figure 6 and 7 I know that the routing overhead decreases extraordinarily as the threshold factor is lower and query is selectively flooding, in particular, under the medium mobility value. Constant routing overhead indicates that the changed path by moving nodes is recovered with the information of neighboring nodes without extra flooding.



<Fig. 5> Average Delay Time-High Traffic



<Fig. 6> Routing Overhead-low Traffic



<Fig. 7> Routing Overhead-High Traffic

6. Conclusion

Although the on-demand routing protocol is effective in ad hoc network, the blind flooding of query for route discovery restricts the effectiveness of the protocol. In this paper, I have confirmed by the simulation that the performance is enhanced through the selective flooding that uses the information of 2-hops distance neighboring nodes and the threshold factor.

Henceforth, our future tasks are to be focused on the on-demand routing protocol far from AOD and the effect of the selective flooding as well as to decide an optimized threshold factor value under the network mobility.

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◈ 이 논문은 2003년 4월 30일 접수하여 2차 수정을 거쳐 2003년 6월 13일 게재확정되었습니다.