Implementing Lightweight Reservation Protocol for Mobile Network Using Hybrid Schema

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Abstract – This paper presents our method to improve lightweight reservation protocol. This was inspired by the ever increasing volume of multimedia traffic over the Internet which demanding quality of service beyond the traditional best-effort. The Integrated Services model relies on the Resource reservation Protocol (RSVP) for signaling and reserving resources. RSVP uses the receiver-initiated reservation mechanism to set up the reservation which executes protocol complexity and incurs additional processing and storage overheads on the routers. Due to heavyweight characteristic, many researchers changed the focus to the lightweight reservation protocol. In this paper, we propose a lightweight signaling protocol of Sender-initiated and Mobility-support Reservation Protocol (SMRP) with Crossover Router (COR) as an extension to SMRP. COR scheme cannot provide smooth handover as it affects the SMRP in Mobile hosts. This is the main disadvantage of COR scheme. Pointer Forwarding Scheme makes an advance resource reservation only a forwarding one-step path from the sender along the forwarding chains. In order to make SMRP more suitable for Mobile hosts, we propose a hybrid method combining the advantages of COR scheme with Pointer Forwarding scenarios. We use ns2 Java version network simulator to test it. We evaluate the performance of SMRP in a mobile network environment. The results show that the hybrid scheme can support seamless and also efficient SMRP path rerouting during handoff in respect of decreased the drop probability.

Keywords: QoS, Wireless Network, RSVP, SMRP, Hybrid Schemes, Resource Reservation

1 Introduction

With the fast growth of multimedia applications, the needs for several classes of different quality of services have rapidly developed. Most of the multimedia applications are real-time applications and require low-delay and low-jitter. These applications will request the network to provide better service to guarantee quality of service (QoS). So, QoS signaling has been one of the hottest topics in the network research area [11, 28].

RSVP [3] [5] [9] [10] [24] [29] is a signaling protocol that applications use to request resources, and supports to guarantee QoS. Path message and Resv message are the two main messages in RSVP. Path message is sent downstream towards the receivers along routes calculated by the underlying routing protocol. This creates a reservation state in each intermediate node. When RSVP session is built up, the path state and the reservation state are maintained in the network by periodically sending the refresh Resv and Path message. This is a heavy setup mechanism which could limit the success of RSVP, especially at the intermediate nodes. A lot of messages characterize the exchange of messages between nodes [4]. There is a real need in a simpler and an easier to implement resource reservation mechanism [4]. In [7] propose a lightweight resource reservation protocol Sender-initiated Mobility-support Reservation Protocol (SMRP) with the implementation in Crossover Router (COR) scheme. COR scheme [11] is proposed as an extension to SMRP to facilitate the reservation handover for mobile hosts. However, the COR scheme cannot provide smooth handover; path retransmission cause extra delay during handoff in mobile environment.

The Pointer Forwarding scheme [8] makes advance resource reservations only a forwarding one-step path from an MN along the forwarding chains. This mechanism can thus reduce the length of the links to reserve newly at each handoff.

In this paper, we present our idea is to combine the COR with Pointer Forwarding (PF) scheme in order to decrease SMRP reservation path retransmission delay in wireless network. The paper is organized as follows - section 2 provides a deeply literature review about the reservation approaches in fixed and wireless network, and also the related work for SMRP; section 3 model the solution which decrease the SMRP path retransmission delay time; section 4 describes the experimental simulation; section 5 describes the experimental results and analysis, and conclusion in section 6.

2 Literature Review

In this section, we discuss the resource reservation approaches in fixed and wireless network, and the problems for those approaches. Afterwards, we discuss the related work for Sender-initiated and Mobility-support Reservation Protocol (SMRP), and the problem for SMRP with COR scheme in wireless network.

2.1 Resource reservation approach in fixed network

There are a number of signaling protocols to guarantee QoS resource reservation [15, 23, 26] and amongst them the most famous one is the Resource Reservation Protocol (RSVP). Resource reservation Protocol (RSVP) [9, 25] is used to provide QoS guarantee for integrated service in Internet. It can be used to reserve resources for both unicast and multicast flows in the Internet. In this protocol, reservation is receiver-initiated reservations is supported depending on application needs.

RSVP used to request a specific service along the data path. By passing RSVP messages hop-by-hop, all devices along the path of the data flow can be make aware of the flow's QoS requirements and then reserve resources for this flow. RSVP messages are transmitted directly on the top of the IP protocol and have their own Protocol ID value, specified in the basic IP Header (RSVP=46). Figure 1 shows the header format of RSVP message.

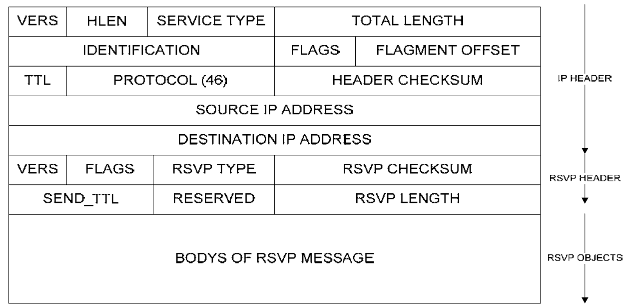
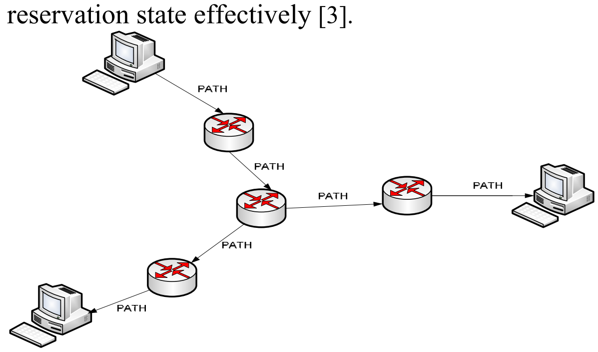
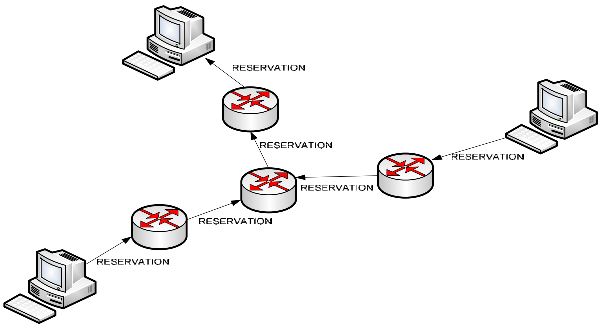


Figure 1: The Header Format of RSVP Message

There are seven types of message in RSVP: PATH, RESV, PATH Error, RESV Error, PATH Tear, RESV Tear, and RESV Confirmation. Each of these messages is comprised of the RSVP message header, followed by a set of objects. The objects contain the necessary information for describing the flow characteristic and required QoS parameters. Two mainly messages in RSVP: PATH and RESV. Figure 2 Path message traverses towards receiver, the router on the path will setup the corresponding path state. The path state includes the routing information and the sender's characteristics. After the path message arrives at the receiver, the receiver sends a Resv message along the path for the specific flow. The Resv message follows along the reverse path traversed by the Path message to the sender. If the routers have enough resources along the path, then a reservation state is established. Afterward, the sender and the receiver will periodically send the path message and resv message to remain the reservation state effectively [3].



(a)



(b)

Figure 2: RSVP basic operation (a) RSVP PATH message sent by sender and (b) RSVP RESV message sent by receiver.

2.2 Resource Reservation Approaches in Mobile Network

Many applications require real-time services become popular, so there is a growing demand that future mobile networks should provide quality-of -service (QoS) to the mobile users. QoS is regarded as a vital feature for the next generation Internet [12 , 13]. QoS signaling protocol also become very important protocol in mobile internet. Below are some reservation approaches in mobile network.

2.2.1 RSVP-RA

RSVP is hard to be implemented in mobile networking environments. Furthermore, other resource reservation proposals have problems such as wasting bandwidth, delay, processing overhead and so on. To solve the problems, [14] proposed the RSVP-RA called RSVP Agents. An RSVP agent manages a list of mobile hosts requested QoS through foreign agent. When an RSVP agent accepts QoS requested by a mobile host, it prepares RSVP tunnels to cells where the mobile host is expected to visit soon. If the foreign agent does not know who is the next cell that a mobile host to visit, then the RSVP agent reserves bandwidth to all neighboring cells. When the receiver receives requested QoS from the sender, an RSVP agent forwards the message to the current foreign agents, and then transmits Path messages to neighboring foreign agents.

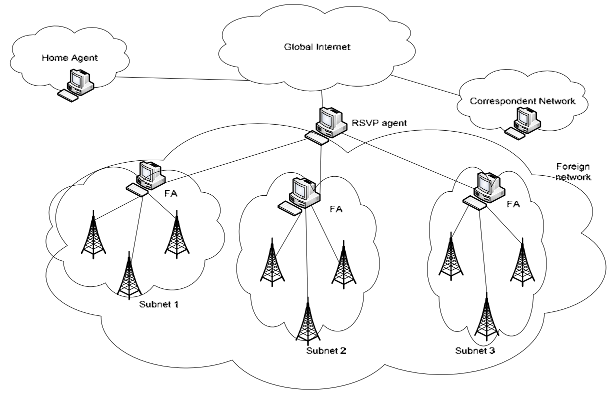


Figure 3: RSVP-RA Architecture

This protocol modified based on RSVP so that RSVP works in mobile networking environments with reduced signaling overhead. An RSVP agent has many foreign agents as shown in Figure 2-3. When a sending host transmits a Path message to a mobile host using RSVP, the agent will manage the reservation and intercepts path message and then make foreign agent reserve resources in advance.

Now we discuss a reservation setup procedure by the proposed protocol as shown in Figure 4. A mobile host requests QoS to its foreign agent during the registration process (shown as 0). The foreign agent immediately will send a request-QoS message to the RSVP agent (shown as 1). When the foreign agent receive the requestQoS message, the RSVP-RA send sendRspec message to foreign agents (shown as 2). When the RSVP agent receives a Path message, it will forward the message to the current foreign agent (shown as 3). Next, the RSVP agent built up tunnel sessions and sends the path message to neighboring foreign agents (shown as 4). Receiving the Path message, the current foreign agent forwards it to the mobile host and the mobile host replies to the sender with a Resv message (shown as 5). In this way, the resource reservation is set up. The foreign agents will reply prepareResv message to the RSVP agent, based on the Flow-spec received from the RSVP agent. In this way prepared reservation is set up (shown as 6). This resource reservation protocol is in mobile networking environments. It modified RSVP to RSVP agent to guarantee required QoS. It reduces packet delay, bandwidth overhead and the number of RSVP messages.

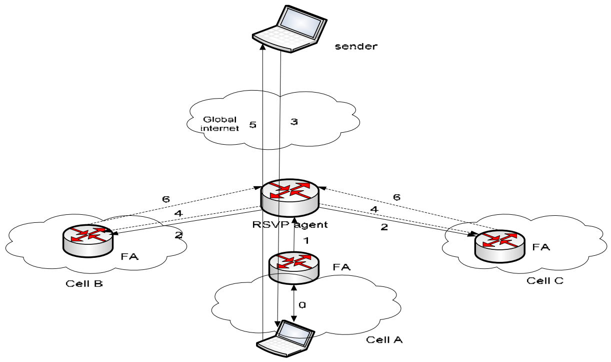


Figure 4: Reservation Setup

2.2.1 Mobile RSVP

In [1] proposed Mobile Resource reservation Protocol (MRSVP) to achieve the desired mobility independent service guarantees for real-time multimedia applications in an Integrated Service Packet Network. MRSVP protocol makes advance resource reservations at multiple locations where an MH may possibly visit during the service time. The MH can thus achieve the required service quality when it moves to a new location where resources are reserved in advance.

MRSVP needs proxy agents to make reservations from the locations of the sender to the locations of the receiver. A proxy agent is called a *local proxy agent* if it is within the location where an MH currently visits, or it will be called *remote proxy agent* if it is within the MH's neighboring network. The local and remote proxy agents are recorded in a Mobility Specification (MSPEC). The MSPEC indicates the set of locations where an MH may possibly visit next. When a recipient MH moves to a new location, it needs to search all of the proxy agents in its neighborhood and then update MSPEC using a *Proxy Discovery Protocol* [1]. The updated MSPEC is sent as a Receiver_MSPEC message to the sender. By examining the Receiver_MSPEC message, the sender can obtain the locations where the recipient MH sends a Receiver_SPEC message to all remote proxy agents recorded in MSPEC. This remote proxy agents can thus retrieve the QoS guaranteed parameters for the recipient MH's services.

In MRSVP, there are two types of Path messages and two types of Resv messages [1], these are: Active Path message, Passive Path message, Active Resv message, Passive Resv message. The active resource reservation is built from the local proxy agent of the sender to the local proxy agent of the recipient, and passive resource reservation paths are built from the remote proxy agents of the sender to the remote proxy agents of the receiver. The active reservation is the path that packets are transmitted, the passive reservation paths are only reserved in advance without any actual packet Rows. When the MH moves to a new location, MRSVP will change the passive reservation to an active state, and the original active reservation will be changed to a passive state at the same time. In this way, a seamless handoff for QoS guarantees can be retained using the MRSVP protocol. But MRSVP wastes too much bandwidth in making advance resource reservations. This excessive resource waste may degrade system performance significantly.

2.2.2 HMRSVP—Hierarchical Mobile RSVP

HMRSVP [2] protocol is to use RSVP with a Mobile IP [27] regional registration protocol to make advance resource reservations only when the handoff delay last long time. When an MH moves, it must register to its home agent (HA) first. But when the HA is far away, the registration process will waste too much resource. The Mobile IP regional registration protocol records the regional registration process when an MH makes an intra-region movement [6]. HMRSVP adopts the hierarchical concept of Mobile IP regional registration and makes advance resource reservations for an MH only when the MH visits an overlapped area of the boundary cells of two regions.

As shown in Figure 2-5, the MH is currently visiting network 2. So, the HMRSVP only establishes an active resource reservation along the path from the sender to the MH without making any advance resource reservation. In Figure 5, when the MH resides in an overlapped area of the boundary cells of two regions, the HMRSVP will establish an extra passive resource reservation along the path from the sender to network 3 which is the MH's neighboring region. In this scenario, the HMRSVP establishes a passive reservation because the MH may make an inter-region movement to a new region. MRSVP only establishes excessive passive reservations on all the MH's surrounding cells which cell the MH is currently visiting, HMRSVP only makes an advance resource reservation on the MH's neighboring boundary cell.

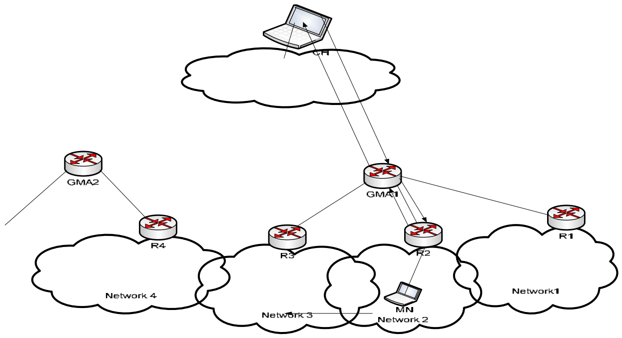


Figure 5: Makes an Intra-region Handoff

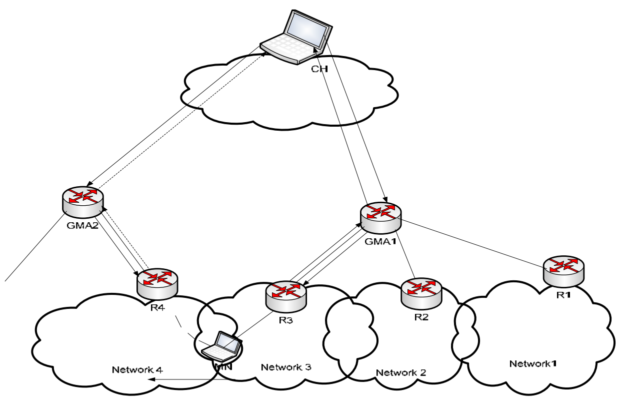


Figure 6: Makes an Intra-region Handoff

2.3 An Overview of Lightweight Resource Reservation

Many researchers try to develop new resource reservation protocol, which use simple sender-initiated reservation (which means sender send path message combine with reservation message) mechanism to reduce the complexity. Example are Boomerang protocol [17], YESSIR protocol [16, 18], ST-II [19], Ticket, DRP. In [16] the author proposed a simple reservation mechanism called YESSIR. YESSIR uses RTCP to transport the reservation and refresh messages. This protocol does not need new signaling messages and, it does not need to keep track of the path from the sender to the receiver because the reservations are sender-initiated. In [20] packets are marked to distinguish reserved traffic from best-effort traffic. Intermediate routers learn about traffic specification and requested resources by observing data traffic of the flow. This is called learn by example procedure. This replaces the signalization mechanism of RSVP. In [21], the authors presented a simple resource reservation protocol for point-to-point communications. In [22], authors presented a simple resource reservation protocol based on a single control message called the boomerang message. This message carries all needed parameters for the reservation session from the source to the destination and backwards. During the message trip intermediate routers can adapt reservation parameters. This simplifies the signalization mechanism for the reservation session.

In the following section, we will introduce lightweight reservation protocol.

2.3.1 SMRP Protocol Overview

In [7], it proposed a lightweight resource reservation protocol for mobile host; its aim is to reduce the RSVP message state to reserve resource which combines the Path message and Resv message. When the mobile host receives the SMRP message, it will reply the sender with an Echo message, after that, the sender can start to send data to the receiver. SMRP likes RSVP; it is not a routing protocol but works with current and future routing protocols. In general, SMRP has two special characteristics:

-----Sender-initiated: SMRP is basically a sender-initiated reservation approach which combines the path selection and resource reservation into one process. That is, path finding and resource-reservation will be combined together and initiated by senders.

-----A sender is responsible for finding the path and reserving the resources. A receiver in SMRP is responsible for informing the sender of the final reservation results along the whole data path by replying an Echo message to the sender.

A reservation in SMRP is applied to data flows of the same session. A “soft” state mechanism is also employed in SMRP. But the SMRP-Resv needs to be refreshed. When there is no data packet is transmitted, the sender needs to send reservation message periodically to maintain the reservation. When data packets use the reservation, there is no need for refreshing. In this way the overhead can be decreased significantly.

2.3.2 Reservation Messages in SMRP

In general, SMRP has three fundamental messages: **Request, Echo** and **Teardown**

A **Request** message consists of four parts (as shown in Figure 7): A *Processing field* is used to inform nodes about refreshing time and record the latest reservation results along the data path. A *FilterSpec field* is used to identify a particular flow to a particular session. A FlowSpec field describes the required QoS. The Request message is forwarded hop-by-hop from sender to receiver to make reservation along the data path. If the mobile host (MH) is away from its home network and the Request message is tunneled to it using Mobile IP, the format of the tunneled Request message is as shown in Figure 3.1(b).

Version 6	Traffic Class	Flow Label	
Payload Length	Next header=0	Hop Limit	
Source Address = Sender's IP Address			
Destination Address = MH's Home-Address			
Processing Field			
FilterSpec Field			
Session Field			
FlowSpec Field			

(a) IPv6 Packet with Request message [7]

Version 6	Traffic Class	Flow Label	
Payload Length	Next header=0	Hop Limit	
Source Address = HA's Address			
Destination Address = MH's Care-of-Address			
Processing Field			
FilterSpec Field			
Session Field			
FlowSpec Field			

(b) IPv6 packet with Request message [7]

Figure 7: IPv6 packets with Request message

An **Echo Response** message (shown in Figure 8) is similar to a Request message. The Echo message stores the final reservation result and some network information gathered by the Request message along the data path. A **teardown** message in SMRP is used to explicitly teardown the reservation for a data flow.

Version 6	Traffic Class	Flow Label	
Payload Length	Next header=0	Hop Limit	
Source Address = MH's Home- Address			
Destination Address = Sender's IP Address			
Processing Field			
FilterSpec Field			
Session Field			
FlowSpec Field			

Figure 8: An Echo message from an MH receiver [7]

2.3.3 Operation of SMRP

A sender first generates a Request message for a data flow. The data flow is classified into a particular SMRP session, and the Request message is forwarded hop-by-hop to the receiver. Each intermediate node makes a reservation along the data path processes by Request message. The reservation is made for the merged QoS request of the session, which the data flow belongs to. No matter whether the reservation is successful or not, the current node will store reservation request results. In the SMRP-Resv state of the data flow, modify the Request message according to current processing results and forward the message to next hop along the data path.

After receiving the Request message, the receiver generates an Echo message according to the information in the Request message and then sends the Echo message back to the original sender directly. If the receiver is away from its home network, its home agent will intercept the message on behalf of the mobile node. After checking the message, home agent will reserve resources as required if there are enough resources. HA then will modify the Request message and tunnel the message to MH's current location.

3 Integration Schemas into Resource Reservation

3.1 SMRP Path Retransmission by Crossover Router Scheme

In [7] proposed a lightweight SMRP mechanism which simulated by COR scheme. Figure 2 illustrates an example of SMRP path retransmission by crossover router. In this figure, the line (1) represents the initial SMRP path from the gateway router to router A. At the same time, the dash line means MN is moving at the new location. When a MN performs handoff, the SMRP path will be retransmitted. As shown in figure 2, the MN moves from router A to router E. At first, the MN reached router B, then the MN sends route update message toward gateway. And via the crossover router discovering algorithm described above, crossover router B realizes that it has become a crossover router. Therefore the SMRP path rerouting only happened between router B and crossover router B as shown in line (2). In this scheme, the crossover router can be the intermediate routers between BSs and gateway router and the SMRP path rerouting will only be performed between the between the BS and the MN.

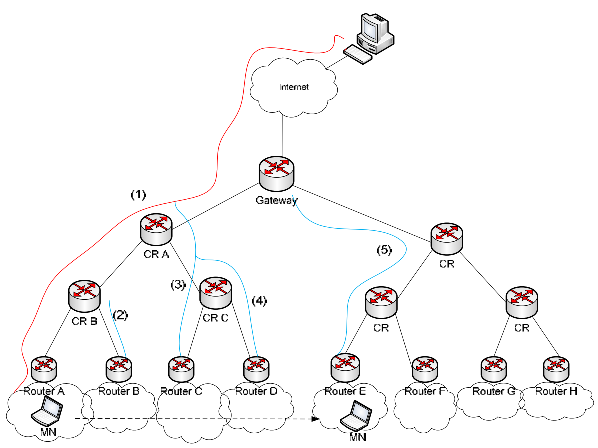


Figure 7: SMRP Path Retransmission by COR router

3.2 SMRP Path Rerouting by Pointer Forwarding Scenario

The Pointer Forwarding scheme [8] makes advance resource reservations only a forwarding one-step path from an MN along the forwarding chains such as shown in figure 3, router A, Router B and router C, to router H. This mechanism can reduce the length of the links to reserve newly ???? at each handoff. However, it may cause extra long SMRP path due to triangle routing or loop routing after several handoffs [8].

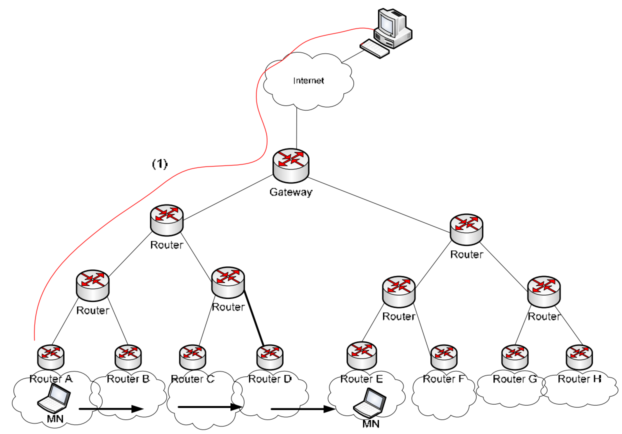


Figure 8: Signaling Path retransmission by PF

In figure 8, the line (1) stands for the SMRP session between CN and router A. As long as the MN moves between the forwarding chains which are router A to router H, the SMRP connection will only be retransmission by adding the new SMRP path within the old base station and new base station such as line (2) in this figure. Pointer Forwarding scheme can provide very short QoS handoff delay time, it will exhaust significant network resource due to the long forwarding chain.

3.3 Hybrid Resource Reservation Mechanism

This hybrid scheme combines the benefits of Pointer Forwarding mechanism and Crossover router mechanism. First, we should modify by using the crossover router discovery mechanism and renewing the second SMRP path by crossover router. When the MN moves to a new base station, the first step is to rebuild a new SMRP reservation path. The old base station should receiver Spec message sent from new base station and at the same time, the old base station should add the SMRP path between old and new base station. Then, the intermediate node will realize that it becomes a crossover router and triggers a PATH message to MN in order to establish the second SMRP connection. After that, the reservation path will be released.

Figure 9 illustrates hybrid scheme (PF & CR) which combining Pointer Forwarding and crossover router discovery mechanism. In this figure, the line (1) represents the initial SMRP path between CN and the MN. When the MN moves from router B to router C, the first step which the SMRP path would be changed as the line (2) shown. Thus, when the MN moves to the router C, the first step is to add a new segment of SMRP path passing though router C and router B. Then, the second SMRP connection would be established along the router C through CR C to CR A as the line (3). In this case, the second step can only modify the SMRP between the CR A to router C. After second step, the SMRP path goes along the router C through router B to CN, would be released instantly and the data flow will transmit on the path from the gateway through the CR A CR C to router C. however, if the MN moves to router D, the first step will remain the same as described above and establish the SMRP path via old base station such as line (4). As the second step in this case, the sender of the SMRP connection will modify the SMRP path between the CR C and router D. therefore, the SMRP path between the gateway router and CR C will not be modified in the proposed scheme.

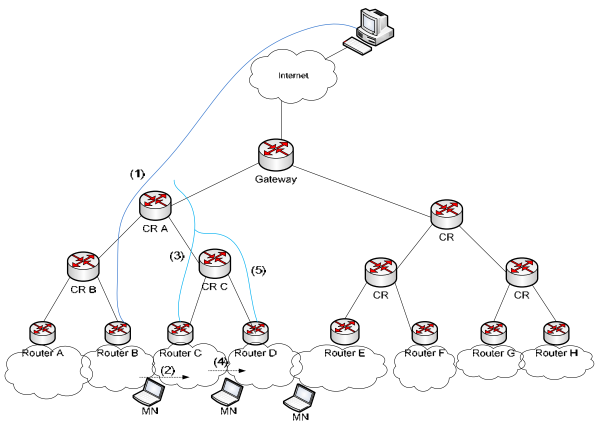


Figure 9: Path retransmission by hybrid scheme

4 Experimental Simulations

In this session, we will examine the efficiency of our schemes through experimental simulation for the micro-mobility environment. The simulation results will be compared to other schemes with discussion.

After the protocol design presented, this session will proceed by presenting the implementation of our proposal design. It discusses how SMRP was implemented with different scheme in ns-2 simulator [30]. Here introduced three schemes which are, COR, PF and hybrid scheme. After that, we introduced the hybrid mechanism (COR-PF) which is the research that we are focus on implementing.

4.1 SMRP Path Retransmission by COR Algorithm Testing

Figure 10 shows the flow chart of the SMRP path retransmission by CR algorithm. All of the procedures of this algorithm depend on the discovery mechanism of the crossover router. The discovering of the first crossover router is as follows: a special COR message (a variation of the Echo message generated according to the reservation state of the data flow) is defined for COR scheme. The CR should respond REQUEST message or ECHO message actively instead of the gateway router or the sender. In the other words, if the CR receives PATH or RESV message, the CR should act as RSVP sender or receiver. The SMRP message transmitted from Node1 to Node2 and finally arrived in Node3. The Node1, Node2, Node3 is the mobile node, Node0 is crossover router. These four nodes are together working on the mobile network. From this figure, we have verified that the SMRP messages are successfully transmitted on the Crossover Router scheme. The Iteration is 10, the Tension is 20. At 1.0 second, node 0 sends a request message (QoS request of 0.5M/s rate) to node 2 for a data flow with flow ID 10. At 13.0 second, node 0 teardowns the reservation. These running a result prove that the simulated SMRP mechanism works correctly.

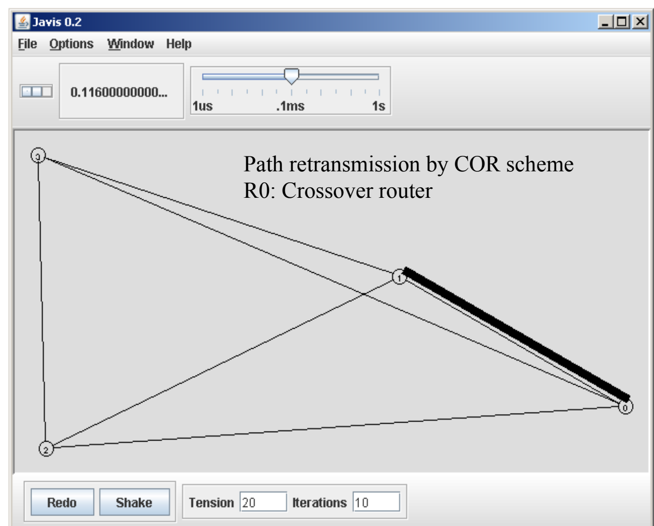


Figure 10: Reservation message pass through COR scheme

4.2 SMRP Path Retransmission by PF Algorithm Testing

In this scenario, the SMRP connection path will be forced to establish a reservation link between old BS and new BS. Once the MN attaches a new BS, the SMRP path will be renewing by adding a SMRP reservation path between the old BS and the new BS. Hence, if the resource of the link between old and new BS is enough for the SMRP session requirements, the retransmission RSVP connection is successful.

In Figure 11, the SMRP messages transmitted from Node5 to Node3, Node2, Node0, and finally arrived in Node1. These nodes are together working on the Pointer Forwarding scheme in mobile network. We have verified that the SMRP messages are successfully transmitted on this network. The Iteration is 10; the Tension is 20.

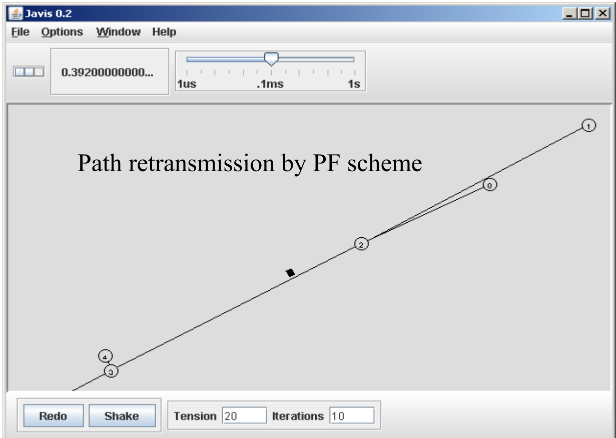


Figure 11: Reservation message pass through PF scheme

4.3 SMRP Path Retransmission by Scheme 1(PF & CR) Testing

The first step of the SMRP path retransmission procedures is the same as the PF scheme. The difference between these two schemes is establishment of second RSVP connection path. In scheme (PF & CR) the crossover router acts as sender instead of gateway router if the MN is a receiver.

In Figure 12, the SMRP messages transmitted from Ro, R2 and finally arrived in R4. R0 is a mobile node, R2 is crossover router. R1 and R3 are the routers in different networks. From this figure; we have verified that the SMRP messages are successfully transmitted on the mobile network. The Iteration is 10, the Tension is 20.

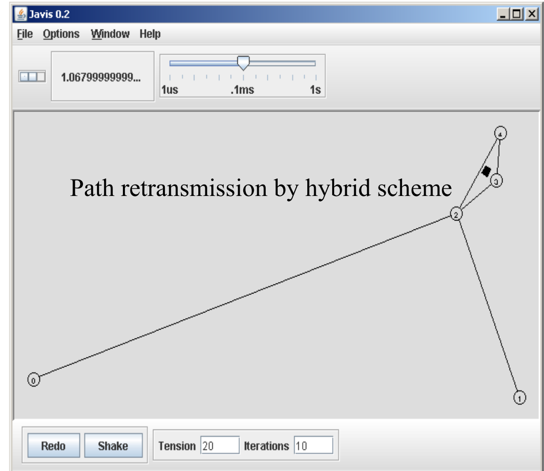


Figure 12: Reservation message pass through hybrid scheme

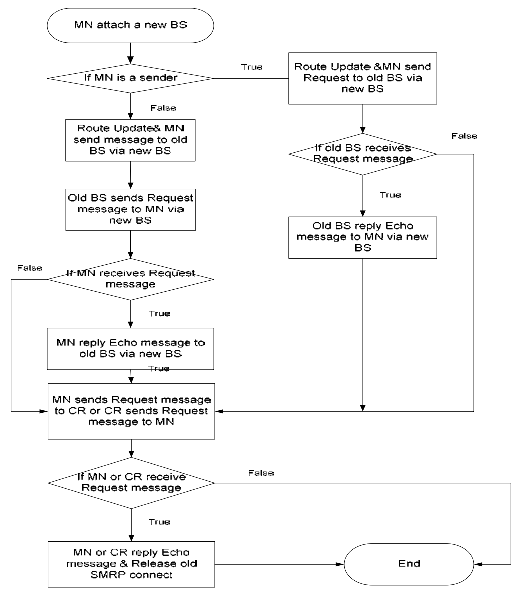


Figure 13: Flow Chart for Path retransmission by Scheme COR-PF

5 Results and Analysis

5.1 Handoff Delay Time

Figure 14 shows that the effect of MN number to the handoff delay time in the case of two different schemes. From this figure we can know that no matter what kinds of scheme used, the handoff delay time becomes longer with the increasing MN number. When the number of MN increases from seventy-five to one hundred twenty-five, the handoff delay increases significantly. From the simulation result, we can see that

COR-PF scheme has better performance than COR scheme in the aspect of handoff delay time.

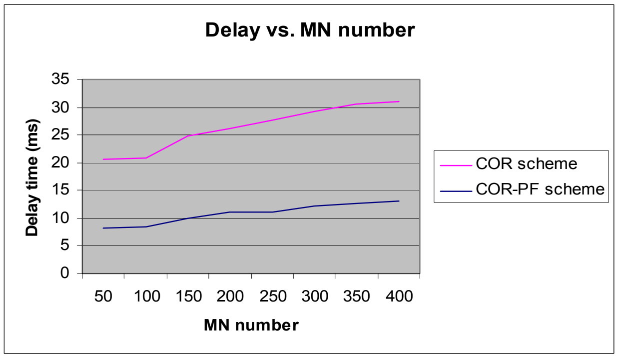


Figure 14: Delay vs. MN number

5.2 Simulation Result of Drop Probability

As drawn in figure 15, we can see the simulation result, the MN number is 400. When the MN number is more than three hundred and twenty-five, the drop probability will be decreased significantly.

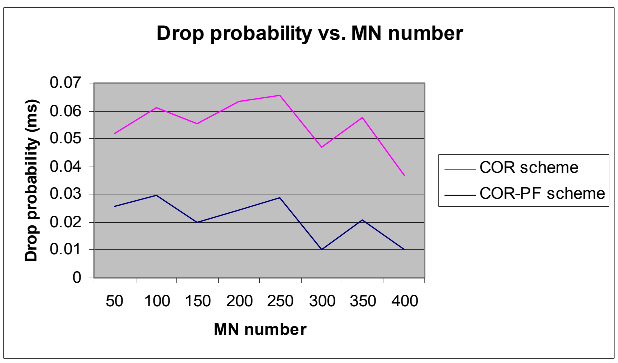


Figure 15: Delay time vs. MN number

5.3 Simulation Result of Efficiency

In figure 16, we can see the COR-PF scheme has better performance than COR scheme. But we also can see when the MN number increased; the efficient will be affecting and decreased significantly. From the simulation result we can see the hybrid scheme (COR-PF) can provide better system efficiency.

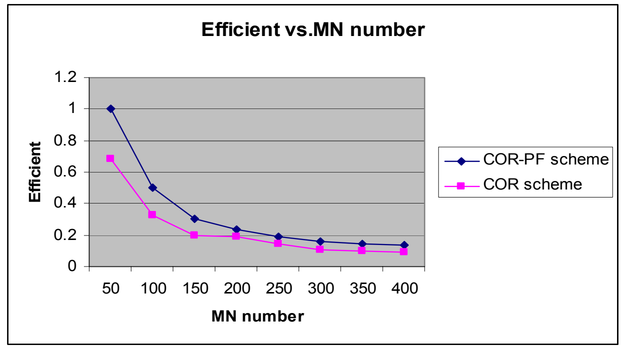


Figure 16: Efficiency vs. MN number

6 Conclusions and Future work

In this paper, we presented the crossover router and Pointer Forwarding scheme to deal with the lightweight resource reservation protocol—SMRP protocol so as to reduce the delay and improve the network resources efficiency. The hybrid scheme (COR-PF scheme) supports low drop probability.

In conclusion, the hybrid scheme (COR-PF scheme) shows the good performance in respect of resources efficiency, handoff delay time. Furthermore, no matter which scheme we choose to use, the handoff delay time is only related to the MN number. Thus, scheme Corssover router and Pointer Forwarding scheme shall be suitalabe for various topologies. But our proposed shceme use more link bandwidth than COR scheme. Therefore, we can see the hybrid scheme can guarantee the better QoS during handoff, so SMRP will be more suitable for the mobile network if using the hybrid scheme.

In the future work, there is one issue which is worth to carry out research, that is the COR discovery mechanism. There may be a more efficient algorithm to find out crossover router quickly, the SMRP handoff delay time can also be reduced which needs to be investigated further.

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