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Crossover Router Based Handoff Scheme for Path Reservation in Hierarchical Mobile Network

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Abstract: This study presents a crossover router based handoff scheme for path reservation in hierarchical mobile network and named Hybrid based Fast Handoff Mobility Network (HFHMN). The scheme is able to minimize the delay of service disruption that occurs during handoff process in a micro-mobility network. The proposed algorithm makes one-step forward advance of reservation before the Mobile Node (MN) handoffs take place. It then identifies the location of Crossover Router to minimize the waste of bandwidth. The Network Simulator Version 2 (ns2) is selected to evaluate the proposed handoff scheme and the numerous results indicate that the proposed new handoff scheme improves handoff efficiency.

Key words: Handoff, micro-mobile network, delay, crossover, hybrid mechanism

INTRODUCTION

With the rapid development of communication techniques, it becomes practical to talk with anyone anywhere (Lian *et al*., 2009; Li and Salleh, 2007; Cui *et al*., 2011; Jun and Hua, 2010). Hence, many people choose the wireless devices due to the convenience they provide. When a large number of these devices are accessing mobile networks, handoff occurs which could lead to service disruptions, packets loss and accumulative delay. Typically, handoff procedure generates the route break and the packets are discarded. The failed route produces much overhead due to lost packets being re-sent by source node to reestablish a new path. Therefore, a lot of bandwidth is consumed which results in higher overhead. If a mobile node moves drastically from one place to another, it suffers considerable security problem (Pecho *et al*., 2009; Li *et al*., 2009; Huo *et al*., 2011). As a result the quality of the service would be significantly degraded. Hence, providing real time data traffic has become even more important feature of mobile networks in recent years. Micro-mobility network means that a small scale of movement of a mobile across diverse administrative domains, the handoff happens when mobile node moves between access routers with one Mobility Anchor Point (MAP) domain. In order to offer seamless service in micro-mobility networks, MN must re-establish a new path from the new location to the source as quickly as possible. Therefore, any delay caused by handoff procedure should be minimized and this has garnered attention of researchers to solve the problems. The research attempts to find a more efficient algorithm which can support shorter delay time caused by signaling handoff and reservation performance can be further improved.

This study proposed a model called Hybrid based Fast Handoff Mobility Network (HFHMN) with dual-objectives-to minimize handoff latency and redundant network resource utilization. In order to present the new handoff scheme, this research will present the Crossover Router Scheme and Pointer Forwarding Scheme firstly.

The Crossover Router Scheme was first introduced by Sanda *et al.* (2007), it involves two types-Upstream and Downstream Crossover Router Node. Upstream Crossover Router Node is the node closest to the data sender, in which the state information is diverged from data receiver to data sender after handoff. Downstream Crossover Router Node is the node closest to the data sender, in which the state information is converged from

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data sender to data receiver after handoff. As shown in Fig. 1, mobility causes the signaling path for upstream diverge, there are nodes A, B, C and D. When mobile node moves, the previous signaling path becomes idle; the new path needs to be quickly established. Node A is considered as a crossover router node.

The Pointer Forwarding Scheme modifies the move and operates when a mobile node moves from one router to another (Fang, 2002; Ei and Furong, 2010). A router has to make an itinerary to visit several sites where it collects resources to accomplish its mission (Camponogara and Shima, 2010; Farhan *et al*., 2011). It informs its Visitor Location Register at the new Router Access, which determines whether to invoke the basic move or the forwarding move.

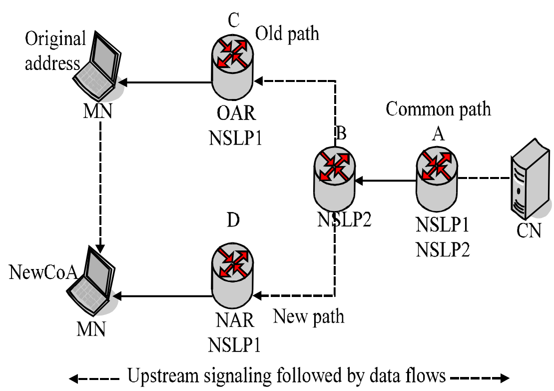

Fig. 1: The topology for upstream NSIS signaling flow due to Mobility (Lian *et al*., 2009)

MICRO-MOBILITY HANDOFF ALGORITHM

Hybrid based Fast Handoff Mobile Network (HFHMN): Here, the research proposes a new Hybrid based Fast Handoff Mobility Network (HFHMN) for resource reservation. HFHMN incorporates the good features of Crossover Router Scheme and Pointer Forwarding Scheme. The Crossover Router Scheme can reduce QoS handoff delay (Tseng *et al*., 2003; Sun *et al*., 2011) and Pointer Forwarding Scheme grantees the quality of services.

The Operation of HFHMN with Sender-initiated Mobility Reservation Protocol (SMRP): The Sender-initiated Mobility-support Reservation Protocol (SMRP) (Shangguan *et al*., 2000) is a lightweight reservation protocol which designed with less complexity, wherein the path-finding and path-reservation are working together.

First, it needs to modify the Pointer Forwarding Scheme mechanism and renewing the second SMRP path using crossover router. As the research described above, Pointer Forwarding Scheme can provide very short handoff delay when reservation path needs to be modified. Crossover Router Scheme provides the minimum path change. When mobile node moves to a new base station, the first step is to set up a new reservation path. The old base station should receive Spec message sent from the new base station and at the same time, the old base station add path between old and new base station.

Figure 2 illustrates HFHMN which combining Crossover Router Scheme and Pointer Forwarding Scheme

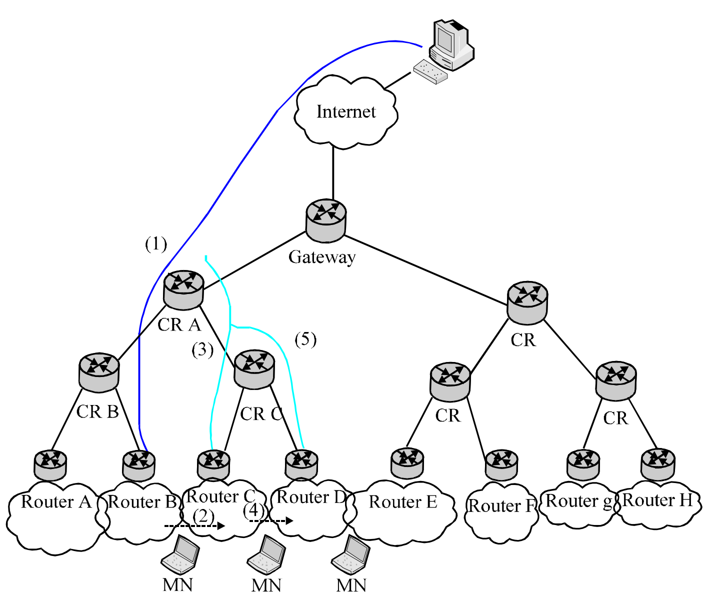

Fig. 2: Path retransmissions by HFHMN

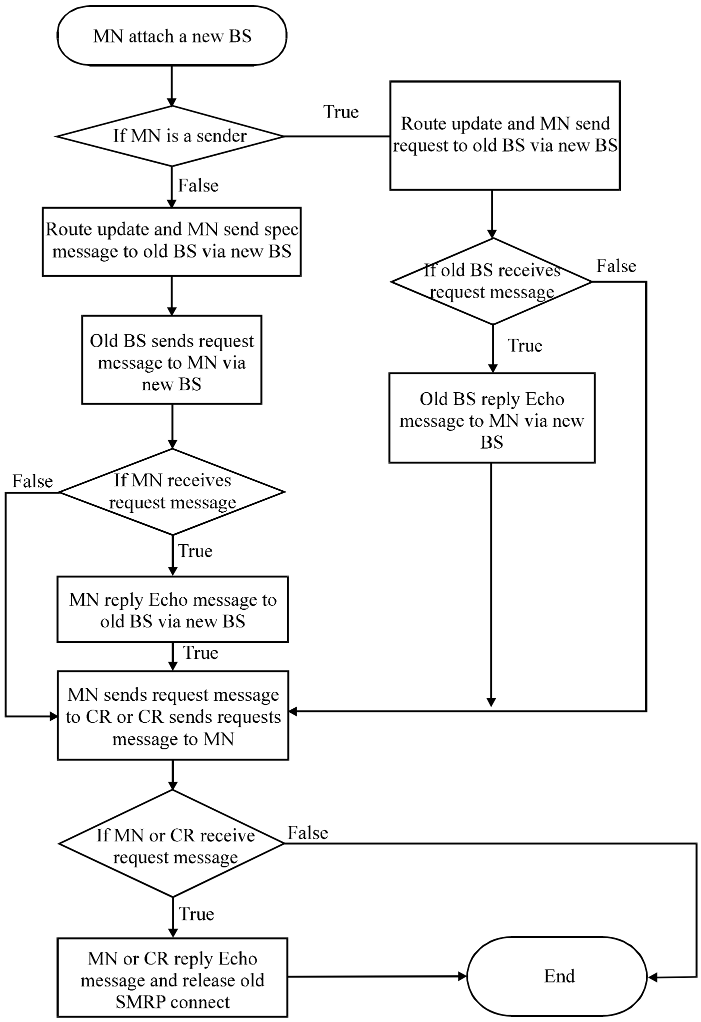

Fig. 3: Flow chart for path retransmission by scheme HFHMN

mechanism. In Fig. 2 the line (1) represents the initial SMRP path between Correspondent Node and mobile node. When mobile node 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 mobile node moves to the router C, the first step is to add a new segment of SMRP path passing though router C and router B. The second SMRP connection would be established along the router C through router CR C to router CR A as the line (3). In this case, the second step can only modify the SMRP between the routers CR A to router C. After second step, the SMRP path goes along the router C through router B to Correspondent Node, will be released. However, when mobile node moves to router D, the first step will remain the same as described above and establish the SMRP path through old base station as shown in line (4). As the second step in this case, the sender of the SMRP connection modifies the SMRP path between router CR C and router D. therefore, the SMRP path between the gateway router and router CR C will not be modified in the proposed scheme.

Figure 3 shows the flow chart of the SMRP path retransmission by HFHMN. All of the procedures depend on the HFHMN. The mechanism is as follows: if mobile node is the sender and it attaches a new base station, the system updates the route by sending a request to the old base station via the new base station immediately, when the old base station receives the request message successfully, it replies the ECHO message to mobile node via new base station. When mobile node is a receiver, the system updates the route and MN sends the Spec message to the old base station via new base station. Afterwards, the old base station sends the Request message to the mobile node via the new base station.

When mobile node receives the message, mobile node replies Echo message to the old base station via the new base station. Afterwards, mobile node sends Request message to crossover router or crossover router sends Request message to mobile node. After mobile node or crossover router receives the Request message, it replies ECHO message and at the same time, releases the previous path connection.

EXPERIMENTAL SIMULATION

In this study, Ns2 (Jae and Claypool, 2005) was used to simulate the proposed model and to evaluate the performance of the SMRP. Figure 4 shows the SMRP implementation structure. The SMRPAgent is an agent and one of the key components in the SMRP. It maintains the path and reservation state on all the SMRP nodes, generates the SMRP messages and processes as the incoming SMRP messages. Another primary component in the SMRP is the SMRP-Link. It connects nodes and supports the SMRP signaling and bandwidth reservation in our simulation by using the WFQ Queue.

Figure 4 illustrates that each SMRPAgent attaches itself to the sending node which generates the simulated Request messages for a data flow and wraps them into the simulated IP packets. A simulated Request message is then forwarded to the down link by the routing agents in Ns2. The SMRPsigmode of the SMRP-Link will intercept the Request message and pass it to the SMRPAgent. According to the Request message, if there is no SMRP-resv object for the data flow, the SMRPAgent will set up a particular SMRP-resv object and bind it to a corresponding SMRP-session object. To implement this procedure, the SMRPAgent invokes Admission Control (ADC) and then the ADC calls an Estimator (EST) to estimate the current usage of this link and make the admission decision for the request. For an admitted request, the Packet Queue is inside the WFQ Queue. If the QoS request is equal to or less than the admitted request, then the reservation session will fail. In order to make a successful reservation, packets of the data flow will enter the corresponding PacketQueue and then be served according to the order of the reservation. Otherwise, the packets will enter the best-effort PacketQueue. The resources for best-effort data flows in the SMRP-Link are decreased, accordingly.

Following this, the SMRPAgent stores the information for the admission decision and the available resources obtained from the Admission Control. For an admitted request, a PacketQueue is added into the WFQ

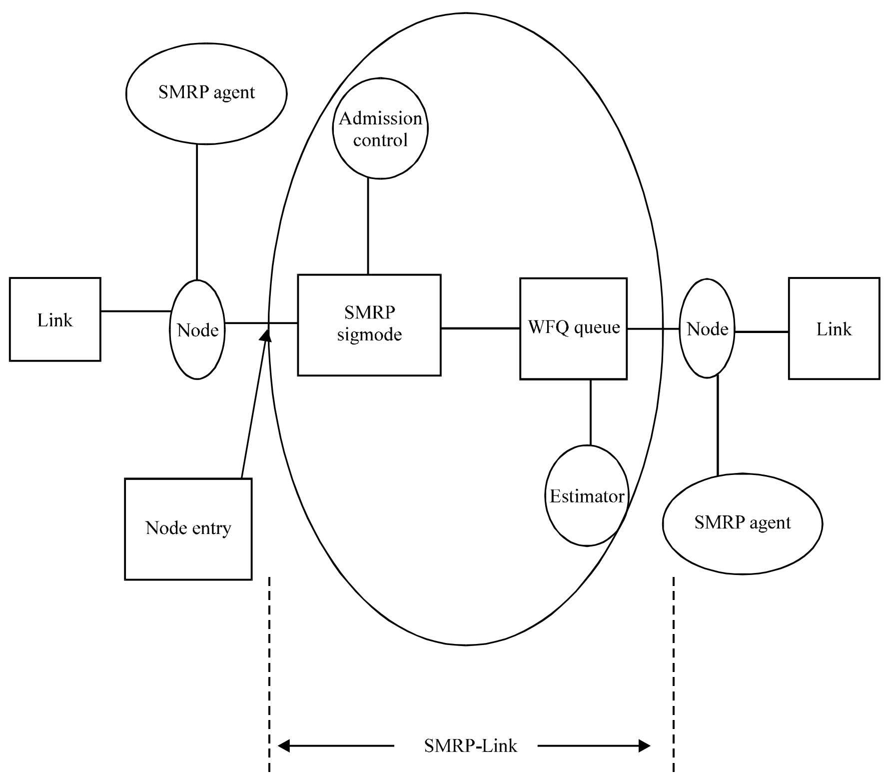

Fig. 4: SMRP architecture

Queue of the SMRP-Link, or updated based on the request. Meanwhile, the SMRPAgent returns a new request message to the SMRP-Link, which reflects the current processing results and to continue the signaling procedure. Each SMRP-Link and SMRPAgent processes the request message in the same way. Finally, the SMRP Agent in the receiving node receives the request message and it automatically replies the sending node with a simulated Echo Response message to finish the whole signaling procedure. To achieve a successful reservation, packets of the data flow will enter the corresponding Packet Queue to get the desired service.

RESULTS AND DISCUSSION

Here, the research analyzes the experimental results obtained from the simulation. The results are presented based on the handoff delay time, packet drop probability and throughput as performance metrics to evaluate the performance of SMRP with two different schemes (Crossover Router Scheme: CRS, HFHMN). Through the arrangement of result data from the simulation, by "tr.out" file, the data is analyzed.

Figure 5 shows a comparison of the results of simulation time vs. reservation handoff delay time between the SMRP with different schemes (CRS and HFHMN). From the simulation results, the research concludes that the HFHMN scheme shows better performance than the CRS. This is because the HFHMN scheme is a combination of the features of the pointer forwarding scheme and the CRS scheme and can make advance resource reservations when a short handoff occurs. The reservation connection is renewed with the existing reservation connection in the proposed scheme by referring to the renewed PHOPpath and NHOPpath. However, the reservation connection is not setup in the CRS scheme. Therefore, the delay time in the HFHMN scheme is lower than the delay time in the CRS scheme.

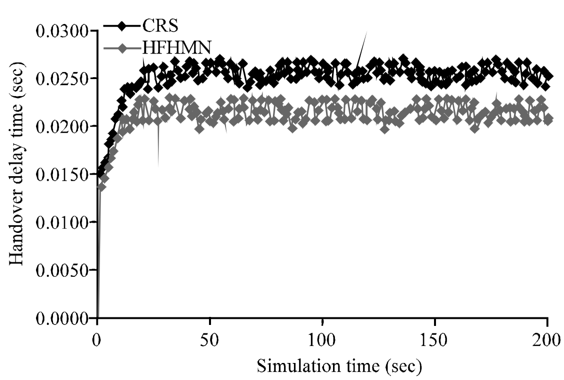

Fig. 5: Delay vs. simulation time

From Fig. 5, the average delay time of the hybrid scheme is 0.0250 sec and the average delay time of Crossover Router scheme is 0.0211 sec. It is also found that the delay time is proportional and regular because the mobile node performs in a micro-mobility network and it changes its location frequently. Whenever, the mobile node crosses the overlapped area, it renews its reservation connection by applying the pointer forwarding scheme. When the mobile node leaves the overlapped location, it changes the crossover router scheme in order to reduce wastage of bandwidth.

CONCLUSION

This study presents a HFHMN, working with reservation protocol in micro-mobility networks. By using Crossover Router Scheme (CRS), the reservation delay reduced, but Crossover Router Scheme does not guarantee the quality of service when MN moves. To overcome it, a HFHMN has been introduced which combines the advantages of CRS and Pointer Forwarding Scheme (PFS).

The research has evaluated the reservation protocol with HFHMN, analyzed its performance by comparing with CRS in hierarchical micro-mobile network environments. The performance has been evaluated through NS2 simulator in metric of reservation handoff delay. The simulation result showed that the reservation protocol with HFHMN has better performance than with CRS. Therefore, it is found that in a micro-mobility environment, the pointer forwarding scheme would be best alternative for efficient location management because mobile hosts always move locally at a region in most time.

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