Poster: Fast RSVP -- A Resource Reservation Protocol for Mobile IPv6 Networks

Yi Sun, Bin Feng, Yucheng Zhang, Gengfa Fang, Jinglin Shi and Eryk Dutkiewicz

I. Background

Accompanied by the development of mobile communication technologies and the increase of available wireless transmission bandwidth, deploying multimedia services in next generation mobile IPv6 networks has become an inevitable trend. However, multimedia sessions containing real-time voice and video are very sensitive to delay and delay jitter, and hence have strict QoS requirements. To fulfill the QoS needs of such multimedia sessions, adequate network resources must be reserved for their transmissions. This can be done using the Resource Reservation Protocol (RSVP) that IETF proposed in 1997.

However, RSVP is designed for hardwired and fixed networks. When applying RSVP in wireless mobile environments, a lot of problems arise:

- RSVP control messages cannot be identified in the tunnel which mobile IP protocol relies on.
- RSVP protocol has no advanced resource reservation mechanisms which are necessary in mobile environment.
- RSVP protocol cannot distinguish resource reservation requests from different kinds of sessions in mobile environment.

II. Objectives and Advantages

In recent years, experts and scholars all over the world have carried out a lot of research work on resource reservation schemes in mobile environments and a series of representative proposals [1]-[4] have been made. Unfortunately, these schemes all have their inherent problems which prevent them from running satisfactorily. Therefore, we propose a new protocol, Fast RSVP, to reserve resources in mobile IPv6 networks.

The main advantages of Fast RSVP are as follows: (1) Through reserving resources ahead of time in the target subnet, the scheme realizes mobile node handover with QoS guarantees. (2) The scheme utilizes a handover prediction mechanism to determine the handover target subnet so as to avoid resource wasting due to over-reservation in all neighbor subnets. In addition, when handover prediction fails, the time of rebuilding a resource reservation path is short, so the impact of failed prediction on the QoS of sessions is minimized. (3) In Fast RSVP, by setting up a neighbor tunnel between two adjacent subnets during handover, the mobile node can make full use of the resources already reserved on the old path and need not set up resource reservations on a totally new path, thus the forced termination rate of sessions due to handover can be significantly reduced. (4) The scheme cooperates with the route optimization mechanism in the Mobile IPv6 protocol to realize resource reservation on the optimized route after handover, thus avoiding resource wasting by a triangular route. After resource reservation on the optimized route is completed, session data is switched to the optimized route seamlessly. (5) The scheme eliminates duplicate reservations on the nodes and links shared by the old and new routes, when reserving resources on the optimized route after handover. (6) The scheme distinguishes reservation requests from different kinds of sessions, giving handover sessions a higher priority, thus greatly reducing the forced termination rate of sessions due to handover while maintaining high performance of the network.

III. Methods

In Fast RSVP, a handover process with QoS guarantees could be divided into 2 stages: (1) setup of the resource reservation neighbor tunnel and (2) resource reservation on the optimized route. After the mobile node (MN) moves to a new subnet, it first communicates with the corresponding node (CN) utilizing the resource reservation tunnel which is set up ahead of the handover event. Then MN gets stable in the new subnet, and it starts the resource reservation process on the optimized route. After resources are successfully reserved on the optimized route, the sessions between MN and CN are smoothly switched from the reservation tunnel to the new optimized route.

The implementation of Fast RSVP needs to modify two modules at different layers: mobile IP module and RSVP module. We define a set of messages between the two modules to let them cooperate with each other.

Yi Sun is a student with the Institute of Computing Technology, Chinese Academy of Sciences, Beijing, 100080, P.R. China (phone: 86-10-62600711; e-mail: sunyi@ ict.ac.cn).

Bin Feng is a student with Beijing University of Posts and Telecommunications, Beijing, P.R. China (e-mail: fengbin@ict.ac.cn).

Yucheng Zhang is a student with University of Electronic Science and Technology of China, Sichuan, P.R. China (e-mail: zhangyucheng@ict.ac.cn).

Gengfa Fang is a student with the Institute of Computing Technology, Chinese Academy of Sciences, Beijing, P.R. China (e-mail: gengfa.fang@ict.ac.cn).

Jinglin Shi is a faculty with the Institute of Computing Technology, Chinese Academy of Sciences, Beijing, P.R. China (e-mail: sjl@ict.ac.cn).

Eryk Dutkiewicz is a faculty with the University of Wollongong, Wollongong, Australia (e-mail: eryk@uow.edu.au).

Based on the handover prediction result made by the mobile IP module, the RSVP module of MN can set up a resource reservation tunnel with the handover target subnet ahead of the handover event, thus realizing MN handover with QoS guarantees. Also, by adding a new cache (Pending Cache) maintained by the mobile IP module and utilizing several indication messages between the RSVP module and the mobile IP module, Fast RSVP can realize resource reservation on the optimized route and ensure that the session data are switched from the old path (neighbor tunnel) to the new optimized route seamlessly.

In order to better mark the multimedia sessions in mobile environments, Fast RSVP imports a new object MSESSION to replace the SESSION object in the traditional RSVP protocol. Compared with the SESSION object, MSESSION adds a “home address” field in the object. In mobile environments, the RSVP router should label a multimedia session based on the content of MSESSION and set up the corresponding Path State and Resv State accordingly. The introduction of the home address in the MSESSION object is helpful to eliminate duplicate reservations on the nodes and links shared by the old and new routes, when reserving resources on the optimized route after handover (this mechanism is named “path merge” in Fast RSVP).

In addition, in Fast RSVP, resource reservation requests from different kinds of sessions are encapsulated in different types of messages, so we import the Guard Channel mechanism into Fast RSVP to give handover sessions a higher priority, therefore reducing the forced termination rate of sessions due to handover.

IV. Simulation Results

To verify the efficiency of Fast RSVP, a series of simulation tests have been taken.

We first constructed a simulation scenario to measure the end-to-end packet delay of a voice session. The results showed that by adopting Fast RSVP the end-to-end packet delay was restricted to within 0.3 second all the time, while when using the RSVP tunnel [1] the packet delay exceeded 1s during the handover time. Therefore, our Fast RSVP can realize mobile node handover with QoS guarantees and offer seamless switching of session data from the old path to the new one after resource reservation on the optimized route is completed.

We also simulated and analyzed the impact of different tunnel policies (no tunnel [2], [3], [4], home tunnel [1], and neighbor tunnel in our scheme) on the network performance indicators such as new session blocking rate P_b, handover session forced termination rate P_f, overall session completion rate P_c etc. The results indicated that employing the tunnel caused a slight rise in P_b (home tunnel 1%, neighbor tunnel 3%) but greatly reduced P_f (home tunnel 5%, neighbor tunnel 8%) and improved P_c (home tunnel 4%, neighbor tunnel 7%) when the system offered load is 0.7.

In addition, we performed a simulation test to estimate the impact of the path merge mechanism in Fast RSVP on network performance. The result showed that the path merge mechanism significantly enhanced the optimized route reservation successful rate P_o (maintaining it above 95%) and also improved P_b, P_f and P_c accordingly.

Finally, we performed simulations to estimate the impact of special reservation for handover sessions in Fast RSVP on network performance. This mechanism reduced P_f (6%) at the cost of a rise in P_b (8%) and P_c (2%), when the system offered load was 0.8 and the reservation ratio was 0.1.

V. Conclusions

Aiming at supplying QoS guarantees to multimedia sessions, we proposed a new protocol, Fast RSVP, to reserve network resources in mobile IPv6 networks. The protocol, with the cooperation of the mobile IP and RSVP modules, can help a mobile node realize fast handover with QoS guarantees. Also, through the new mechanisms such as resource reservation on the optimized route and path merge, Fast RSVP avoids the resource wasting problem due to triangular routes and duplicate reservations. In addition, Fast RSVP introduces a new way to distinguish reservation requests from different types of sessions, giving handover sessions a higher priority and thus greatly reducing the handover session forced termination rate while maintaining high performance of the network. An overall comparison of our protocol with other traditional schemes is listed in Table I.

References

[1] A. Terzis, M. Srivastava and L. Zhang. A Simple QoS Signaling Protocol for Mobile Hosts in the Integrated Services Internet. In Proc. of INFOCOM1999, NY, pp 1011-1018

[2] A. K. Talukdar, B. R. Badrinath and A. Acharya. MRSVP: A Resource Reservation Protocol for an Integrated Services Network with Mobile Hosts. In Wireless Networks Vol. 7 2001, pp 5-19

[3] W. Chen and L. Huang. RSVP Mobility Support: A Signaling Protocol for Integrated Services Internet with Mobile Hosts. In Proc. of INFOCOM2000, Tel Aviv, Israel, pp 1283-1292

[4] H. Jeon, M. Kim, K. Lee, J. Mo and D. Lee. Link Layer Assisted Multicast-Based Mobile RSVP(LM-MRSVP). In Proc. of ICOIN2005, Cheju Island, Korea, pp 452-462

TABLE I
Comparison of Fast RSVP with Other Schemes

	RSVP Tunnel [1]	MRSVP [2]	Multicast RSVP [3]	LM-MRSVP [4]	Fast RSVP
Smooth handover with QoS guarantee	No	Yes	Yes	Yes	Yes
Avoiding over-reservation in all subnets	Yes	No	No	Yes	Yes
Avoiding resource wasting by triangular route	No	Yes	Yes	Yes	Yes
Avoiding resource wasting by duplicate reservations	No	No	No	No	Yes
Making full use of the already reserved resources on the old path	Yes	No	No	No	Yes
Distinguishing different types of reservation requests	No	No	No	No	Yes
Not suffering from handover prediction failures	Yes	Yes	Yes	No	No