FAST RSVP HANDOVERS IN MOBILE IPV6

Daniel Plasto [1]

[1] School of Information Technology, Bond University

ABSTRACT: Recent research in mobility management has culminated in an extension to the Mobile IPv6 protocol which reduces the latency during the handover of a mobile node from one network link to another. The benefits of this extension are most apparent to real-time applications; however the Resource ReserVation Protocol (RSVP) used by many of these applications negates the effect of the changes because a new RSVP session must be established after each handover. The purpose of this paper is to suggest an extension to the RSVP protocol that will minimize the delay involved in establishing new RSVP sessions during handover. The paper will initially examine existing research in the areas of RSVP and fast handovers for mobile IPv6, and then define an algorithm with which to extend the RSVP protocol. Finally, a software simulation of the proposed protocol and of the standard RSVP protocol will be considered with the ultimate purpose of testing the performance and effectiveness of the proposed protocol.

INTRODUCTION

Multimedia applications are becoming more and more popular on the Internet and many of these applications have special requirements related to the handling of their data over the network. Protocols have been developed which can supply these applications with a certain Quality of Service however these protocols have been designed for the fixed Internet and are invalid in a mobile scenario. The integration of mobility management protocols and Quality of Service protocols is of vital importance due to the growing market for mobile multimedia applications. This paper proposes an extension to the Resource ReSerVation Protocol which makes it operable in a mobile situation.

RSVP is used by real-time applications to reserve resources along a path from one node to another. When one of these nodes is mobile and changes its point of attachment to the Internet the RSVP session must be re-configured along the new data path. The mobile node cannot do this until it has determined its new care of address and sent a binding update to its correspondent node. This process coupled with the excessive delay involved in the initiation of the RSVP session maintenance process leads to considerable degradation of services during handover.

The scheme proposed in this paper allows the RSVP session to be updated earlier in the handover process by establishing an RSVP tunnel from the old access router to the new access router and routing packets sent to the old care of address through this tunnel to the mobile node. Once the mobile node has established itself as a new Internet end-point another end-to-end RSVP session can be established along the new data path to the mobile node. Finally, data can be sent using the new RSVP session and the old session can be terminated.

The advantage of this approach is as follows: as soon as the mobile node has link layer connectivity with its new access router it can initiate the RSVP update process using its old care of address. Communications can continue along this path while the mobile node completes the configuration of its new care of address and of the new RSVP session.

BACKGROUND

The Mobile IPv6 protocol [JP03] defines a mechanism with which mobile nodes can remain reachable while changing their point of attachment to the Internet. More specifically, it allows a mobile node to be identified by a static IP address, known as its home address, as well as any number of care of addresses, which change when the mobile node performs a ‘handover’ and moves from one link to another. The mobile node can at any time be reached via its home address in which case the packets are transparently routed to its care of address. IPv6 nodes which are communicating with a particular mobile node (correspondent nodes) have the ability to establish bindings between home addresses and care of addresses and thus send packets directly to the mobile node using its care of address.

Ongoing sessions which are defined using IP end-points (for instance TCP) are not terminated during handover in Mobile IPv6 because the mobile node is always identified by its home address. However, there is a period of time during handovers in which the mobile node cannot send or receive packets. This time period results in handover latency.

The Fast Handovers for Mobile IPv6 protocol [RK03] is an extension to the Mobile IPv6 protocol which aims to minimize this disruption. It allows a mobile node to keep using its old care of address while it is still establishing itself on the new link. Packets are sent to and from the mobile node via a bi-directional IPv6 tunnel from its new access router to its old access router using the mobile node's old care of address. This approach means that the mobile node is reachable using the old IP address almost as soon as it has link layer connectivity with its new access router, and has a significant effect on the performance of real-time and Quality of Service sensitive applications.

RSVP, or the Resource ReSerVation Protocol [BZB97], is used to request and establish a certain Quality of Service from the network for a particular one-way data flow. It results in resource reservations at each node along the data path and ultimately in a soft state end-to-end Quality of Service agreement which is maintained by the RSVP software at the receiver end.

RSVP operates on top of IPv4 or IPv6, but becomes ineffective when hosts are mobile. When a mobile node performs a handover, the end-to-end RSVP session must be reconfigured along the new path from the receiver to the sender. This will cause considerable delay as the state of an RSVP session is updated using periodic maintenance packets rather than with a trigger based method.

Mobile RSVP is an ongoing research area and many papers have suggested ways to manage RSVP handovers [MA01]. [TBA98] describes a technique to improve handover latency using advanced reservations. Advance reservation techniques try to use a mobility profile to set up passive RSVP sessions to all destinations the mobile node might visit for the duration of the session. This concept is inherently wasteful and relies on the presumption that the set of possible destinations a mobile node will visit can be accurately predicted. [CH00] also presents a protocol based on predictive advance reservation techniques.

[JRG98] introduces fundamental changes to the way in which the Mobile IPv6 protocol operates, and [LLC02] is dependant on the deployment of the IDMP Quality of Service framework. Both of these approaches are undesirable as they are difficult to deploy and have little chance of achieving wide-scale use.

[TSL99] uses a concept known as RSVP tunnels [TKW00] to provide faster RSVP handovers in Mobile IPv4. The algorithm makes minimal changes to the RSVP and Mobile IPv4 protocols and is an elegant solution to the RSVP handover problem for Mobile IPv4. However the algorithm becomes invalid under Mobile IPv6.

This paper examines a solution to the mobile RSVP problem that mirrors the functionality of the Fast Handovers for Mobile IPv6 protocol using RSVP tunnels.

THE PROPOSED PROTOCOL

The standard RSVP protocol operates in the following manner during regular Mobile IPv6 fast handovers:

The mobile node notifies its old access router of the IP address of its new access router. The old access router sets up a bi-directional IP-in-IP tunnel from itself to the new access router and once this is done forwards packets destined for the mobile node through the tunnel to the new access router which sends them directly to the mobile node. This tunnel is ineffective for RSVP data, because the new access router has no RSVP state set up for the session. The periodic refresh messages of RSVP will eventually establish the state in the new access router after an undetermined amount of time.

When the mobile node has negotiated its new care of address, it will send a Binding Update message to the correspondent node advising it of the new care of address. Once the Binding Update has been received, the packets sent to the mobile node will be routed differently and again they will pass through routers which have no established Quality of Service agreements for them. The refresh messages sent by RSVP will eventually configure the session along this new data path.

This approach leads to two periods of time where RSVP data is passing through routers which are not yet aware of their requirements and will result in excessive degradation of service which is unacceptable for the Quality of Service sensitive applications which use RSVP.

The solution presented in this paper solves the problem by immediately creating a second tunnel, from the old access router to the mobile node. This second tunnel is RSVP aware, and provides a Quality of Service guarantee from one end to another. In this manner the packets from or to the correspondent node are transparently passed through the tunnel to the mobile node with no degradation of service.

The mobile node then sends the Binding Update, and instead of directing all traffic to the new care of address, the correspondent node and mobile node can continue sending data using the old care of address and only send the RSVP refresh packets along the new data path. Once the sender has received confirmation that the RSVP session has been reconfigured along the new data path both parties can begin to send data packets using the new care of address. By default the RSVP state information will remain in the routers along the old data path for 5.25 times the period of time between refresh messages. If more time is needed to set up the new data path, the lifetime of the old data path can be extended simply by sending refresh messages along the old data path.

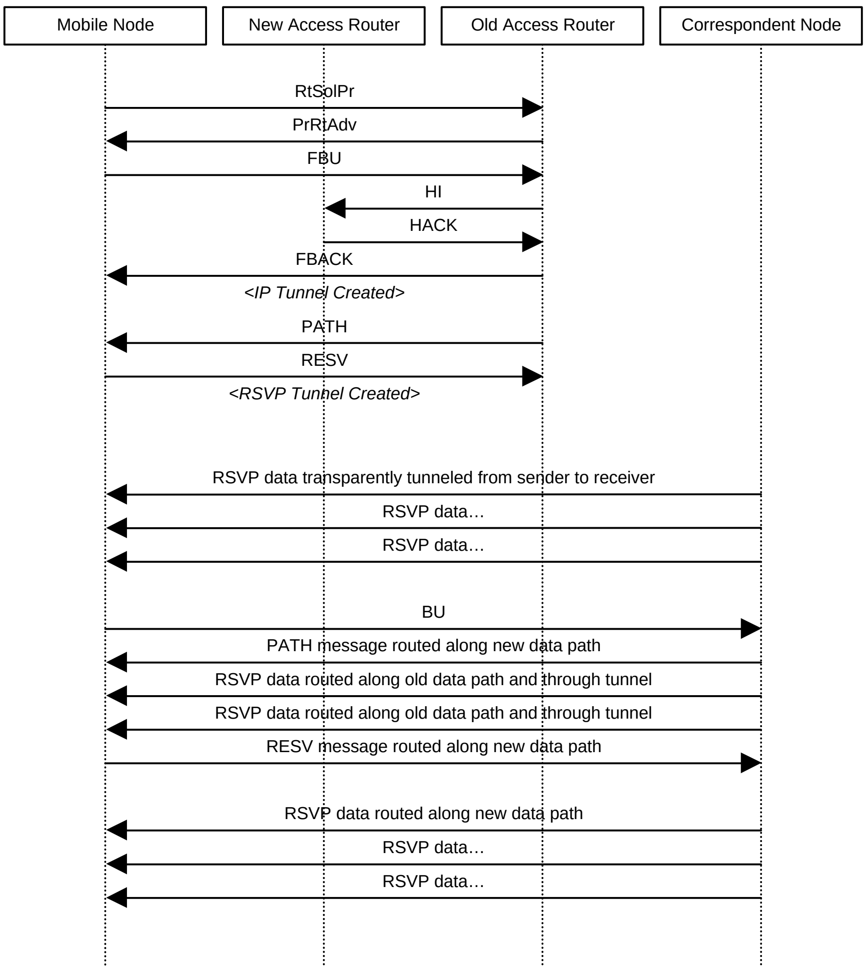

Figure 1. The protocol messages exchanged between the mobile node, old access router, new access router and correspondent node in the proposed protocol.

In order to implement this functionality the following changes need to be made to the RSVP protocol:

Immediately after the old access router has received the 'HACK' message from the new access router as confirmation that the IP-in-IP tunnel has been created, the old access router must send a 'PATH' message to the mobile node to set up a standard RSVP session. The Tspec traffic specification descriptor in this 'PATH' message must be set to accommodate the aggregate flow of RSVP traffic to or from the mobile node. Upon receiving the 'PATH' message the mobile node must reply with a 'RESV' message which describes the aggregate data flow of all RSVP data to or from the mobile node.

This sets up the RSVP tunnel from the old access router to the mobile node. When the mobile node is ready it will send a Binding update to the correspondent node as usual. Once this has happened, the RSVP sender must send the 'PATH' message to set up the RSVP session along the new data path to the receiver. The RSVP software must also remember the old care of address of the mobile node and address data packets sent to or from the mobile node using this old care of address.

When the sender receives the 'RESV' message in reply to the 'PATH' message it sent to configure the new data path, it can begin sending data packets along the new data path by addressing them to the mobile node's new care of address. Note that the sender should not send an RSVP 'tear down' message to remove the RSVP state information along the old data path, as this has a high probability of deleting routers in the new data path as well. The RSVP state information stored in the routers that are no longer used must be allowed to time-out on its own.

Figure 1 shows the messages which are exchanged during handover in the new protocol.

TESTING THE PROPOSAL

In order to determine the feasibility and effectiveness of the proposed changes to the RSVP protocol a simulation model will be considered. This model is designed for use with the NS2 Network Simulator software developed by the Information Sciences Institute at the University of Southern California.

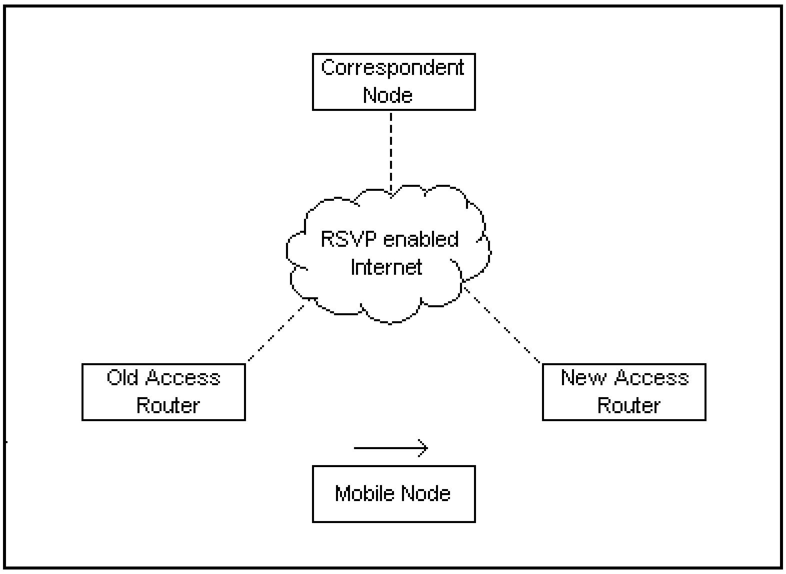

Figure 2. The network architecture that will be used to test the protocol. The mobile node is first connected to the old access router, and then the new access router. The two access routers may or may not be directly connected.

The model must mimic the handover process and test a number of scenarios which could occur during handover and which may affect the behaviour of the protocol. The scenarios which will be tested include: mobile node as RSVP receiver, mobile node as RSVP sender, a data path that shifts but still passes through the old access router, a new access router that is RSVP un-aware, fast movement from one network link to another, and a situation where an RSVP refresh message is received by the mobile node or correspondent node before the RSVP tunnel can be established.

The simulation must accommodate all these situations as well as normal operation of the protocol. It must also demonstrate the slow time out of old RSVP states in routers to permit the evaluation of this inefficiency.

Figure 2 shows the simple topology that will be used.

CONCLUSION AND FUTURE RESEARCH

There is not at present a generally accepted method with which to provide Quality of Service mechanisms to the fixed Internet, let alone to mobile hosts. However, the numerous schemes which have been proposed must be extended to support real-time and Quality of Service sensitive applications for mobile nodes.

The protocol extensions described in this paper suggest changes to the RSVP protocol which aim to make the protocol practical for mobile hosts by reducing the delay occurring in RSVP handovers. The future research into testing this proposal will ultimately determine its feasibility as an extension to the RSVP protocol.

ACKNOWLEDGEMENTS

Many thanks to Dr. Zheng Da Wu for his guidance with both technical and literary issues, and the Bond University School of Information Technology which sponsored this research.

REFERENCES

[BZB97] R. Braden, L. Zhang, S. Berson, S. Herzog, S. Jamin. Resource ReSerVation Protocol (RSVP) --Version 1 Functional Specification. *Internet RFC 2205*, September 1997.

[CH00] W. Chen and L. Huang. RSVP Mobility Support: A Signaling Protocol for Integrated Services Internet with Mobile Hosts. In Proceedings of IEEE Conference on Computer Communications (INFOCOM), vol. 3, pages 1283-1292. 2000.

[JP03] D. Johnson, C. Perkins. Mobility Support in IPV6. *Internet Draft*, June 2003, work in progress.

[JRG98] R. Jain, T. Raleigh, C. Graff, M. Bereschinsky. Mobile Internet Access and QoS Guarantees using Mobile IP and RSVP with Location Registers. *ICC International Conference on Communications*, vol. 3, pages 1690 – 1695. 1998.

[LLC02] S. Lo, G. Lee, and W. Chen. Mobile RSVP and Fast Handoffs in IP-Based Wireless Networks. *IEEE Region Ten Conference*, 2002.

[MA01] B. Moon and H. Aghvami. RSVP Extensions for Real-Time Services in Wireless Mobile Networks. *IEEE Communications Magazine*, vol. 39, pages 52-59, December 2001.

[RK03] R. Koodli. Fast Handovers for Mobile IPv6. *Internet Draft,* March 2003, work in progress.

[TBA98] A. Talukdar, B. Badrinath, and A. Acharya. MRSVP: A Reservation Protocol for an Integrated Services Packet Network with Mobile Hosts. *Wireless Networks*, vol. 7, No. 1, 2001.

[TKW00] A. Terzis, J. Krawczyk, J. Wroclawski, and L. Zhang. RFC 2746 - RSVP Operation over IP tunnels. *Standards Track RFC*, January 2000.

[TSL99] A. Terzis, M. Srivastava, and L. Zhang. A Simple QoS Signaling Protocol for Mobile Hosts in the Integrated Services Internet. In Proceedings of the Conference on Computer Communications, *IEEE Infocom*, *Mar. 1999.*