A RSVP Integration Method with Hierarchical Mobile IPv6 Networks

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Abstract

Because the Resource reSerVation Protocol (RSVP) was originally designed for stationary networks, it is insufficient to accommodate Mobile Nodes (MNs) which frequently change their points of attachment. This paper deals with how to integrate the RSVP and Hierarchical MIPv6 (HMIPv6), in order to quickly establish the QoS guaranteed path and minimize the service disruption when the MN moves around. That can be achieved with the utilization of the common path between the new and old path. Therefore a new method is proposed in detail to find out an anchor node and re-establish a new reservation path.

1. Introduction

Recently, with the fast development of wireless technologies, the mobile devices such as laptop computers, cellular phones are being used more and more frequently, it allows movement during communications and network access at a fair rate among nodes. Mobile IPv6 (MIPv6) [1] is designed for the next generation mobile Internet to manage MN's movements in wireless IPv6 network. Hierarchical Mobile IPv6 (HMIPv6) [2] is based on it, which is proposed to reduce the amount of signaling messages to correspondent nodes (CNs) and home agent (HA). and improve the performance of MIPv6 in terms of handoff speed. In HMIPv6, the mobility is classified into Intra-domain mobility and Inter-domain mobility. The MN needn't to send the binding update (BU) message to HA and CNs while the mobility occurs in a domain. Hence HMIPv6 can efficiently reduce the number of signaling messages that are delivered in the Internet.

In addition, many real-time multimedia IP applications such as video conferences, broadband interactive games, IP telephony and video IP phone are becoming more and more popular. To support those real-time services, Quality of Service (QoS) such as propagation delay and transmission rate must be guaranteed. Resource reSerVation Protocol (RSVP) is one of the feasible solutions to guarantee end-to-end QoS by making explicit resource reservation from a sender to receivers before the data transmission starts. It is a receiver-initiated signaling protocol support for IntServ network. However, the RSVP performs poorly in wireless mobile network due to the host mobility. The delay of establishing new reservation paths after handoffs may cause service disruptions in real-time services.

Some RSVP extensions have been proposed to resolve the mobility impact on RSVP in mobile computing environment. Here we shall discuss a scheme used in HMIPv6 environment to achieve better QoS guarantee by extending the mechanism proposed in [3], and specially introduce the operation of RSVP in inter-domain mobility. The rest of this paper is organized as follows. HMIPv6, RSVP, and some previous work are simply introduced in the section 2; and the proposed scheme is described in details in the section 3. Finally, some remarks of conclusion on our work are made in the last section.

2. Background and related work

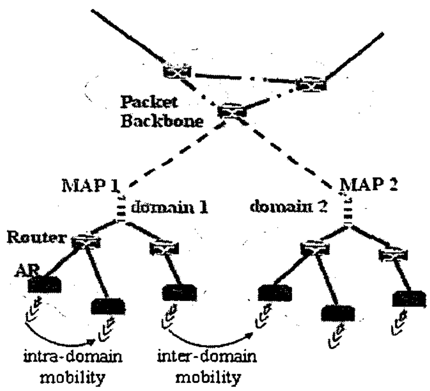

Figure 1. Hierarchical MIPv6 architecture

MIPv6 is a new version protocol that allows a MN to roam seamlessly from one Access Router (AR) to another by sending the BU message to HA and CNs at each handoff; but it takes much time and bears more signaling load. To overcome that, HMIPv6 is proposed, which utilizes new nodes called the Mobility Anchor Point (MAP) to divide the global Internet into domains. The MAP can receive all packets on behalf of the MN which it is serving and can encapsulate and forward them directly to the current address of the MN. When the MN arrives at a domain, it can get two addresses besides the home address (HoA): a Global care-of address (GCoA) and a Local care-of address (LCoA). The first one is used to register with HA and CN. A MN may use a MAP's address as the GCoA (extended mode) or form a GCoA on the MAP's subnet (basic mode) while roaming within a domain, only updating the GCoA when the handover occurs between two domains (inter-domain mobility).The second one is used for regional registration to MAP. It is updated when the handover occurs in a domain (intra-domain mobility). Figure 1 demonstrates the architecture of HMIPv6. That hierarchical structure can work better than the flat MIPv6.

RSVP provides a receiver-initiated resource reservation. It includes two important types of messages: Path and Resv. A sender sends a Path message associated with a specific data flow to a receiver, and all RSVP-capable routers on the path intercept it and set up soft path states for the data flow. Those path states include the previous hop (PHOP) of the flow and the traffic characteristics. After receiving the Path message, the receiver responds with a Resv message which contains desired QoS parameters. The Resv message traverses the reverse path back to the sender. If the required resources on links are all available, a soft reservation state will be established in each router. Otherwise, a ResvErr message will be generated and sent back to the receiver.

Some issues will be arisen when RSVP is used to provide QoS over a mobile network. The resource reservation path should be dynamically adapted along with the movements of MN. That is to say it must be re-established whenever a MN changes its access point with an active flow. Obviously it is slow, inefficient, and bandwidth consuming. The MN may suffer temporary disruption of service before the new reservation is re-established. On the other hand, the duplicated reservation may be preserved until resources on the old path are explicitly released or time is out, which would cause new session blocks in high mobility environment and lead to lower average levels of resource utilization at the same cost. At present, there already are some solutions having been proposed to deal with the issue of integrating the RSVP with MIP. For example, the MRSVP, which uses proxy agents to provide the advanced reservation models for real-time services is proposed in [4].The authors of [5] also raised an extended RSVP model based on IP multicast to support the advanced resource reservation.

The conception of flow transparent is proposed in [3] to maintain the common path between the new and the old reservation path during the MN handoff process. The MN mobility is transparent to flow QoS handling mechanisms by using HoA or flow label to identify a flow instead of CoA. It adopts a "mobility object" that contains the mapping between the HoA and the current CoA of the MN. That "mobility object" is carried in every Path message to help record the mobility information in the path state of each RSVP node. The Downlink Nearest Common Router (DNCR - the closest router to the MN, which is on both of the old and the new path for the flows from CN to MN) can be decided by comparing the HoA, the CoA and the previous RSVP hop. Thus the new reservation state can be established from the DNCR to the MN quickly. Using such scheme can minimize delays and use resources more efficiently. Here, we want to extend this mechanism in HMIPv6 networks.

3. Integrating RSVP with HMIPv6 networks

Some statistical results show that about 69% mobility is regional mobility, so the micro-mobility concept was proposed to define users' movement within a regional scope. HMIPv6 is one of the famous micro-mobility solutions. Therefore, we propose an interoperation scheme for integrating RSVP with HMIPv6 networks to provide better QoS services.

3.1 The setup of the basic reservation path

Initially, the basic reservation path should be established. When a MN locates itself in a domain, it can get a GCoA and a LCoA by receiving Advertisement message from AR. At first, it sends a regular MIPv6 Binding Update (BU) to the MAP. In basic mode, the BU will bind the GCoA of MN to its LCoA; in extended mode, the BU will bind the HoA of MN to its LCoA. If the registration with the MAP is successful, the MN would register its GCoA with CNs and HA by sending a BU that specifies the binding (GCoA, HoA) just as in MIPv6. After that registration, the CN can send a Path message that carries a mobility object to the MN by using the GCoA as the destination address. Thus the routing information that consists of the HoA and the current GCoA of the MN can be included in the Path state and be established on each intermediate RSVP router that receives the Path message.

When the MAP receives the Path message, it also establishes the Path state on itself. Moreover, it records some other information such as sender_Tspec, ADSPEC, etc. That information is carried by Path message to describe the traffic characteristics of the flow generated by a sender. On the other hand, it will modify the Path message and forward it to the MN by using the LCoA as the destination address. The mobility object carried by the Path message also contains the GCoA and the RCoA (in the basic mode) or the HoA and the RCoA (in the extended mode), and then the routing information can be established on each intermediate router from the MAP to the MN. After receiving the Path message, the MN will respond with a Resv message, and then the whole reservation path will be established successfully.

3.2 RSVP operation under Intra-domain mobility

In wireless network, the MN frequently changes its attachment. If the new attachment of the MN lies in the same domain with the old one, it is intra-domain mobility. It only obtains and registers the new LCoA to the MAP. The HA and CNs are not aware of the change of locality of the MN. When the MN registers its new LCoA to the MAP by BU message, it also sends the Pathreq message to the MAP, which is used for requesting the handoff Path message from the DNCR. The Pathreq message carries the mobility object, which contains the mapping between the GCoA and RCoA (in the basic mode) or between the HoA and RCoA (in the extended mode). Every intermediate RSVP router that has received the Pathreq message will check if the GCoA or the HoA in the Path state matches with the corresponding information in the mobility object of the Pathreq message. If they don't, then the router receiving the Pathreq message will forward this message to the next RSVP router, if they do, the router is the DNCR. That Pathreq message will trigger a handoff Path message for the flow from the DNCR to the MN, and then the Pathreq message will be discarded instead of being forwarded to the next RSVP router.

After the MN receives the Path message, it will respond a Resv message to the MAP, and then the new reservation path state is established. If there are packets being sent to the MN, the classification rules can be based on the GCoA (in the basic mode) or the HoA (in the extended mode); hence, the packets can be correctly forwarded to the destination. In addition, the DNCR can send a PATHTEAR message to the old location of MN to remove the reserved resources on the old path which are no longer needed. The figure 2 shows the reservation setup procedures for intra-domain mobility. The Binding Acknowledge message (BAck Msg) may be earlier or perhaps later received by the MN than the handoff message.

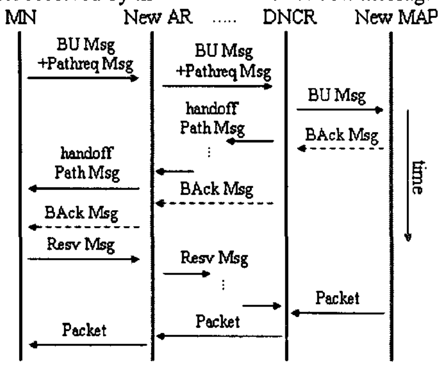

Figure 2. RSVP operate in intra-domain mobility

3.3 RSVP operation under Inter-domain mobility

When the MN roams from a domain to another domain, the path from the CN to the MAP and the path from the MAP to the MN are all changed. It will take much longer time to establish the reservation path again for the new location. Here we discuss a method to set up the reservation path more quickly. If inter-domain mobility occurs, the MN can gain a new GCoA from the new MAP and a new LCoA by auto-configuration. The MN should first register the new LCoA to its new MAP by a BU message (step 1a in figure 3). Here we add a Resv_Spec option to the BU message. The option carries the FLOWSPEC describing the receiver's desired resource reservation parameters, the flow identification (i.e. the SESSION object) and the CN address, which enables the MAP to configure a Resv message instead of the MN. At the same time, the MN sends a message to inform the old MAP of the address of the new MAP (step 1b). Then the old MAP sends Path_Spec message to the new MAP (step 2b), which contains recorded information such as sender_Tspec, and ADSPEC etc, so the new MAP can configure a Path message instead of CN by that recorded information.

If the MAP registration is successful, the MAP will send Binding Acknowledge message to the MN (step 2a). Simultaneously, the MAP can send a Pathreq message to the CN (step 2c) in the same method described in section 3.2, and the Pathreq message also contains the mobility object. The intermediate RSVP router that receives this message will compare the HoA recorded in Path state with the information in mobility object. If they are the same, then this router will act as the DNCR, and a handoff Path message for the flow indicated by the flow destination will be sent to the MN (step 3c). When the MAP receives the handoff Path message, it can respond a Resv message instead of the MN (step 4c). On the other hand, if the new MAP receives the Path_Spec message from the old MAP before it receives handoff Path message from the DNCR, it can configure a Path message to send to the MN (step 3a), otherwise it send the Path message in normal way after receiving the Path message from DNCR. After the MN receives the Path message, it can respond with Resv message (step 4a). In such method, the new reservation path can be set up quickly, because the MAP can send the Pathreq message instead of waiting the Pathreq message that ought to be sent by the MN. The process of reservation setup of inter-domain mobility is shown in figure 3.

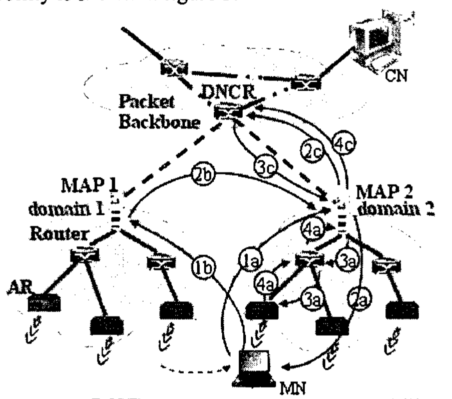

Figure 3. RSVP operate in inter-domain mobility

4. Conclusion

In this paper, we proposed a flow transparent HMIPv6 and RSVP interoperation scheme. It keeps the node mobility transparent from QoS flow handling mechanism. That mechanism contains the common path between the old path and the new path, using bandwidth and resource efficiently, minimizing the service disruption when the intra-domain mobility or the inter-domain mobility takes place, and reducing the reserved resource duplication on the new reservation path. However, the scheme proposed in this paper just considers the role of the MN only as a receiver, and what's more, some further numerical analysis for the scheme is also required.

References

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