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A Case Study of a Resource Reservation Protocol in IP Based Wireless Access Networks for ITS Service

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Abstract

For effective IP based service implementation on the wireless network environments, wireless networks including the ITS network have to support QoS guaranteed protocol such as a RSVP. RSVP is a resource reservation protocol for Internet environment, and its scalability makes easy to implement RSVP over the various IP transport technologies. But for the IP based ITS wireless network environment, RSVP is not suitable, since by its path setup procedure characteristic. In the wireless access network for ITS service, when a mobile node moves to other domain, it must perform registration procedure. But the registration procedure is time consuming steps, so if a RSVP session was already established in the previous domain, the RSVP session may be disconnected and the time to re establish a new RSVP session is long enough to cause serious packet loss.

In this paper, we propose a pre-path reservation mechanism for applying the RSVP in wireless access networks for ITS. In the pre-path reservation mechanism, the resource reservation procedure occurred during a mobile node's handoff time. An access point in wireless access network performs this procedure when the mobile node attempts handoff. The access point executes pre-path reservation procedure as a proxy, since the mobile node does not have IP address until the address allocation procedure is finished in a new domain.

Key Words : RSVP, ITS, Pre-path reservation

1. Introduction

The Internet protocol (IP) has been successfully adopted and implemented on current various network environments. While the concept of the communication to separate communication services into several types such as voice, video, and data has been developed, multimedia communication services are now supported on the common infrastructure. And, we can see the vendor's efforts to integrate heterogeneous networks each other [1,2]. Hence, the ITS will be provided upon and should be interconnected with the IP

The wireless ITS networks development enables users to communicate with each other regardless of

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their location, but this makes the mechanisms more complicated to maintain communication quality. In the wireless ITS networks, the IP performs the role as a main transport protocol. So, for supporting of IP mobility and IP quality of service (QoS) in the wireless ITS networks, we consider many other technologies related to IP.

To use IP based multimedia application on the wireless network environments, the problem of QoS guarantee became a critical issue. In the wired Internet environment, the resource reservation protocol (RSVP) is standardized as a good candidate to support QoS guarantee of IP data streams. But the RSVP path establishment procedure is not suitable for the wireless ITS network. That is, the RSVP for the Internet, performs a path setup procedure through the all links between a RSVP requesting node and a correspondent node (CN), even though the partial change of the RSVP path occurs. And the RSVP is a receiver oriented protocol that a client cannot start the path setup procedure before the client receives Path message from a server, so this characteristic obstructs the implementation of the RSVP in the wireless ITS networks [3,4].

In this paper, we propose the pre-path reservation mechanism for effective use of RSVP in IP based ITS networks. In the pre-path reservation mechanism, an access point establishes a RSVP path for mobile nodes during mobile node's handoff time. Or, the access point executes the pre-path reservation procedure when it detects layer 2 information of an adjacent new domain. And at this point of time, a mobile node does not get IP address from the access point located in a new domain, since the address allocation procedure is not performed in the new domain yet. By the pre-path reservation mechanism, a mobile node can get an established RSVP path after the registration procedure ends. Hence, the role of access points is important in the pre-path reservation mechanism and, we can expect that the RSVP can be applied in the wireless ITS network environment by our proposed mechanism.

For the operation proof of proposed pre-path reservation mechanism, we describe the state transition diagram and we can explain that this algorithm is good intrinsically for the reservation of wireless network resources in macro mobility environment.

The organization of this paper is as follows. Section 2, we present the explanation of the RSVP that was standardized in IETF and applying RSVP in wireless ITS networks. And, the pre-path reservation mechanism proposed is presented in section 3. Finally we conclude this paper in section 4.

2. RSVP in the Wireless ITS Networks

The RSVP is a resource reservation protocol that supports unicast and multicast applications, and was standardized in the Internet Engineering Task Force (IETF). The RSVP is a receiver oriented protocol, where the receiver of data flow makes resource reservation, and establishes a QoS guaranteed path for an end to end application data stream regardless of routing protocols. RSVP session groups and paths are changed freely according to a RSVP session state. These characteristics make sure the scalability and reliability of the network. Each session is identified by the protocol type of transport layer, the sender's IP address, the port number of receiver and so on. And to provide services for packets including specific session, RSVP messages contain detailed session specific information. The network nodes along the path negotiate and reserve the resources during a session setup procedure. This procedure is checked via the admission control module that decides whether a node can provide requested resources and its policy control that validates whether the user fulfills admitted con-

dition or not. If these validation procedures are satisfied, the node accepts or may modify related parameters to support requested QoS.

In the operation of the RSVP, the sender that sends a Path message is a server, and the receiver of the Path message is a client. The client receiving the Path message issues a Reservation message to establish a RSVP path. The Path message identifies the flows and, routers located on the path insert its IP address into the Path message to establish the path for specific data flows. Reservation message contains the QoS information that is requested by a client [3].

When there is a partial path change in the previous RSVP path, it must be re established between the client and the server. This characteristics of the RSVP path setup procedure is not appropriate to the IP based wireless access network for ITS since, in the wireless network, movement of a mobile node among the domains is frequent [4,5]. For the effective use of the RSVP in wireless ITS network, the path update procedure must be modified and access points located in the streets have to support the RSVP path setup procedure for mobile nodes.

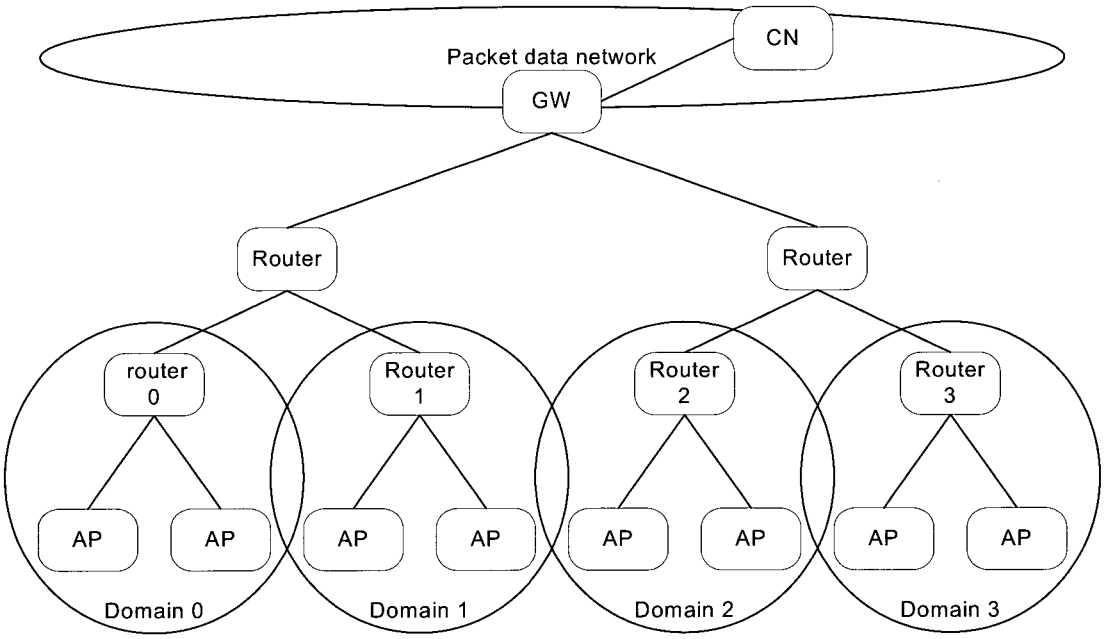
3. Proposed Pre-Path Reservation Mechanism

We propose a new pre-path reservation mechanism for a resource reservation mechanism for IP based wireless ITS network environment, which is designed to be used in macro mobility environment. For the pre-path reservation mechanism, routers and mobile nodes located in wireless ITS network need some additional capabilities as follows. First, routers can adjust its path and manage some RSVP sessions. When a router receives a MovementPending message from the downstream router, it compares the message information and that of RSVP session. If the same information is found in the received MovementPending message, the router knows that mobile node starts pre-path reservation procedure from the downstream path of the router itself. At this time, the first router that detects mobile node's pre path reservation procedure initiation becomes a crossover router (CR) and all routers placed on the RSVP network can be a CR.

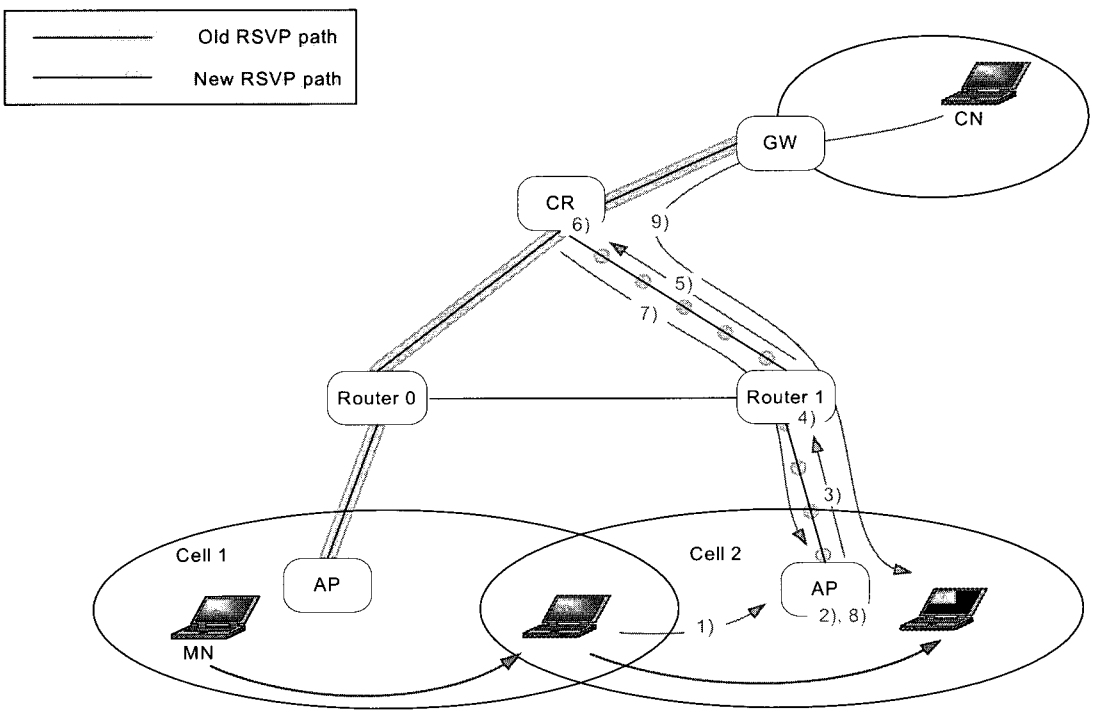
Secondly, routers have to process MovementPending and PathPreset messages. When a mobile node starts the pre path reservation procedure, it sends MovementPending message and this message reaches to a CR. If the mobile node is a server, MovementPending message contains the current RSVP QoS information and the IP address information of the mobile node itself. However, if the mobile node is a client, the same information contained in the MovementPending message but the function that requests a Path message to the CR is added. When the MovementPending message arrives at a CR, the CR sends a PathPreset message to the access point that is a proxy of the mobile node. The PathPreset message establishes a temporary RSVP path between access point and CR.

Finally, in the pre path reservation mechanism, an access point performs the pre path reservation procedure in substitute for a mobile node. The reason is that when a mobile node starts pre path reservation procedure, the mobile node does not have a new available IP address yet so, and other node is necessary to perform the pre path reservation procedure for the mobile node.

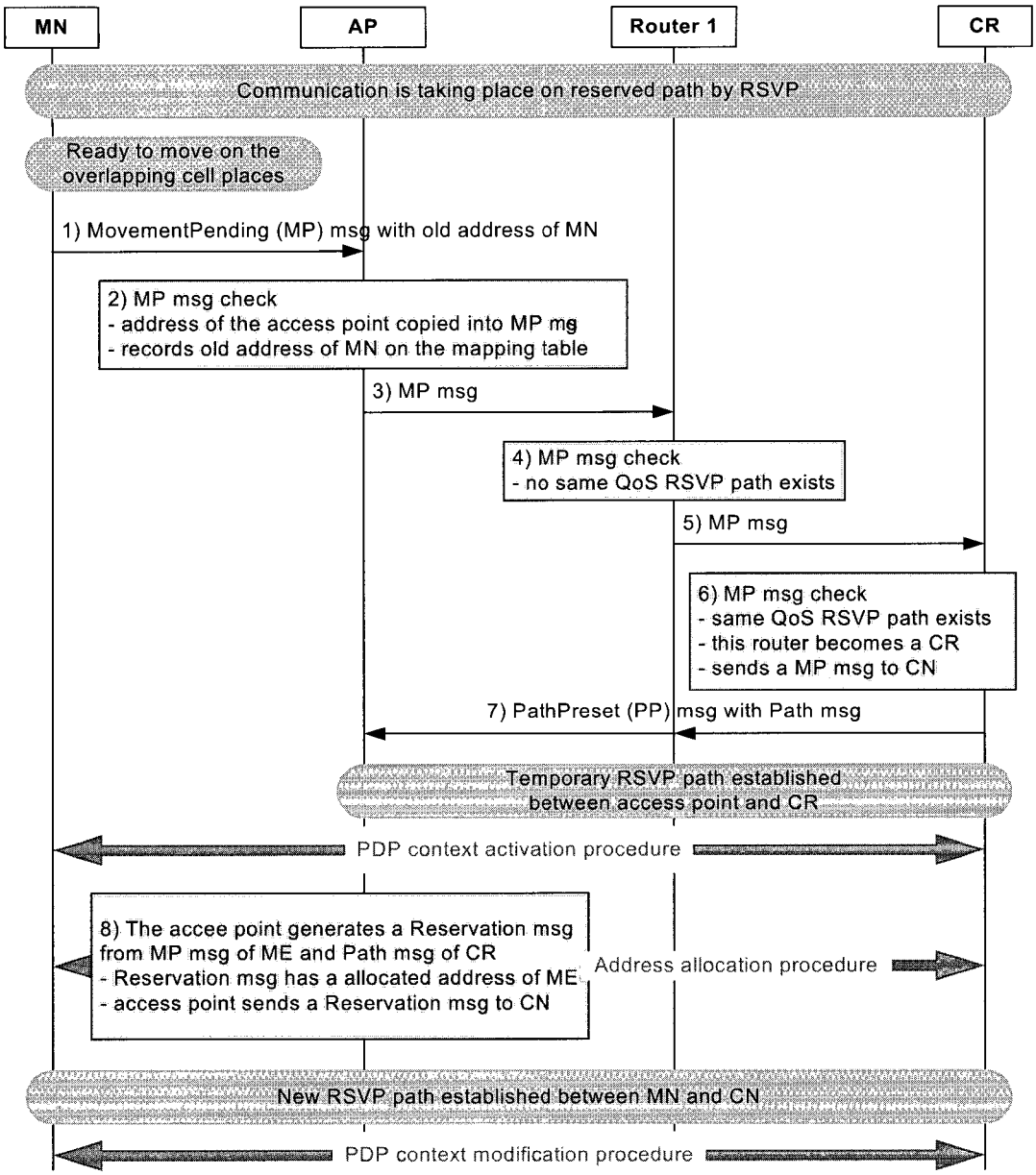
The network structure for pre path reservation mechanism is depicted in Figure 1, where we can see the tree structure for pre-path reservation mechanism, since tree structure is suitable to apply proposed mechanism. In Fig. 2, we show a roaming scenario by using the pre-path reservation mechanism. Here, we assume that a mobile node communicates



<Fig. 1> Network structure for the pre path reservation mechanism



<Fig. 2> Roaming Scenario by the pre path reservation mechanism



<Fig. 3> Operation of the proposed mechanism in the case of the MN being a client

with its CN on the RSVP path and the mobile node tries to move into an adjacent new domain

First, we describe the case that the mobile node is a server. When a mobile node arrives at the overlapped area of the current domain and an adjacent domain, it detects layer 2 information from the access point of a new domain. Then, the mobile node sends a MovementPending message including the current RSVP QoS information and the IP address information to an access point of a new domain. The new access point receives this message and puts its IP address in the MovementPending message as the

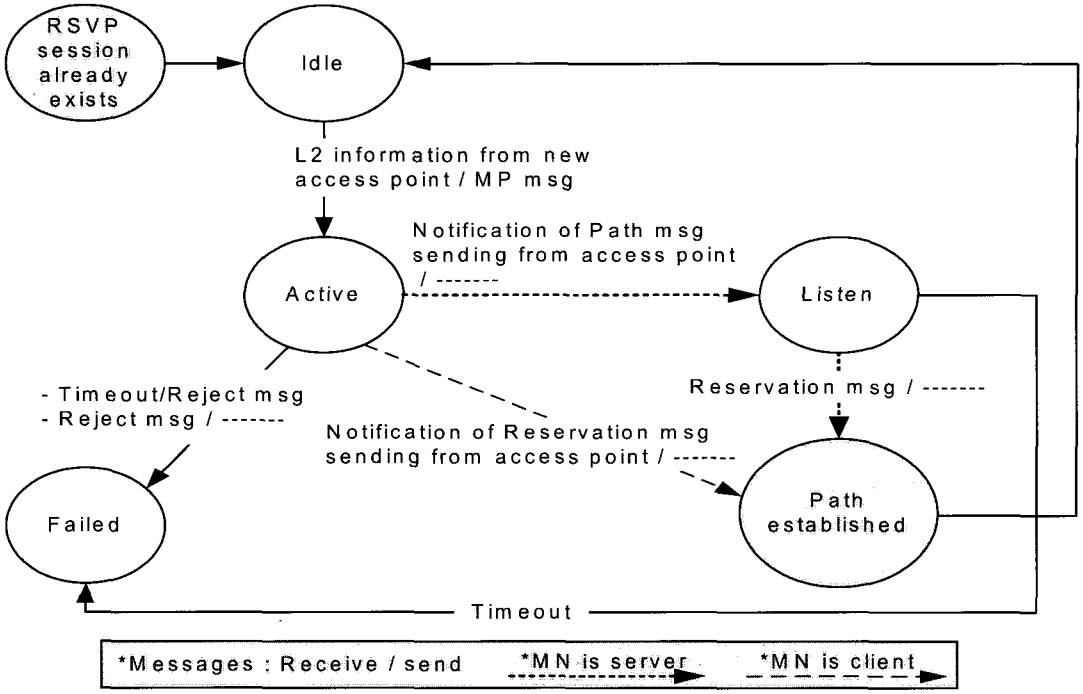
source address. And, the new access point stores the information of MovementPending message to identify the mobile node that requests a pre-path reservation procedure. From this point of time, the access point performs the procedure that finds a CR and establishes a temporary RSVP path for the mobile node.

The new access point receives MovementPending message from the mobile node, performs the pre path reservation procedure with sending this message to an upstream router or router 1 in Fig. 2. Then router 1 compares the RSVP sessions in its RSVP session list with information of received MovementPending message. In this scenario, the same information is not found in router 1 and hence it delivers MovementPending message to an upstream router. After the upstream router carries out the same process, if the same information is found in MovementPending message, this router become a CR. The CR detects the movement of a mobile node having a RSVP session, sends a PathPreset message to the access point for establishment of a temporary path, and then sends a MovementPending message to the CN. The CN receives the MovementPending message from the CR and knows that successive pre path reservation procedure will be followed.

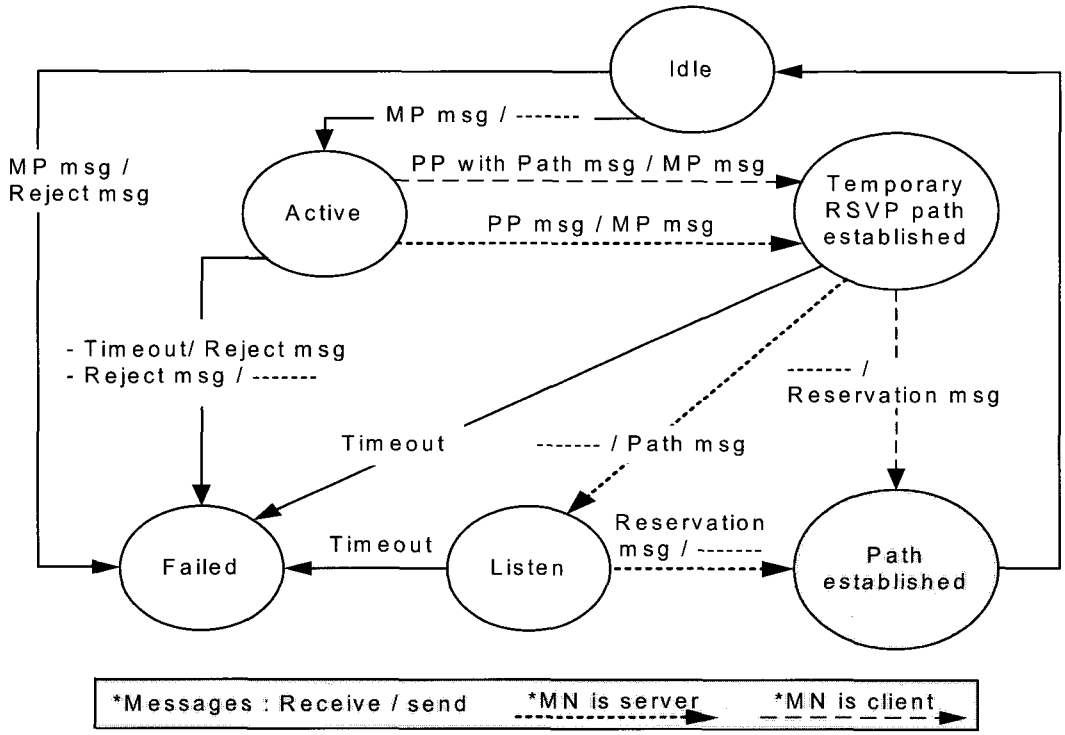
In the case that mobile node is a client, the CR sends a PathPreset message with Path message to the access point when a CR receives MovementPending message from the access point. During a registration procedure, the access point generates a Reservation message having an IP address of the mobile node as a source address. This message is sent to the CN, and the RSVP path is established. This operation is explained in Fig. 3.

Although we do not mention the version of the IP in this paper, the IPv6 will be a good candidate rather than IPv4 since the address allocation is more flexible and enough [7]. After, hence, the mobile node that requests a pre path reservation procedure starts the packet data protocol (PDP) context activation procedure to register itself in new domain, it gets global IPv6 address from the new domain via the address allocation procedure [8, 9]. For the address allocation to mobile nodes, the access points know the allocation mechanism of IPv6 address. Then, the access point generates a Path message having an IPv6 address of a mobile node as a source address, and sends this message to the CN. This Path message is delivered on the established temporary RSVP path, and routers on the path and CN compare this message with the MovementPending message that is received from the CR before. The routers and CN that receive Path message update their RSVP session information, and the CN sends Reservation message to the mobile node to complete the RSVP path setup procedure for mobile node.

To show the validation of the proposed mechanism, the state transition diagrams are considered with input and output events. Fig. 4 shows the state transition diagram of a mobile node where idle, active and listen states are defined for the path re establishment and failed state is defined when the reservation request is rejected or timeout happens. Compared to the state transition of a mobile node, those of access points and routers are more complicated. Fig. 5 shows the state transition diagrams of access points. Since a temporary RSVP path establishment is assumed, the state for this operation is defined. As you can see in the state transition diagram, the operation of our proposed mechanism can be assured to function well. When other elements which are not considered in this paper are inserted into the proposed mechanism according to new ITS services, the modified mechanism can be validated only by defining a new state and transition relationship in these diagrams.



<Fig. 4> State transition diagram of a mobile node



<Fig. 5> State transition diagram of an access point

4. Conclusion

In this paper, we propose the pre path reservation mechanism to use RSVP in the wireless ITS networks. In the pre-path reservation mechanism, the role of access points is important since the access point executes the pre path reservation procedure as a substitute for a mobile node. We assumed that two messages are defined for the proposed mechanism: MovementPending and PathPreset messages when a mobile node initiates a pre-path reservation procedure and establishes a temporary RSVP path between the access point and the CR. By our proposed mechanism, we can expect that use of the RSVP operates well in the wireless ITS network environment. That is, a mobile node can get a QoS guaranteed RSVP path before its registration procedure is finished in the new domain.

In the wireless ITS network, IP will be a main data transport protocol. But the characteristics and defects of IP make the vendors hesitate to participate in the newly proposed IP based wireless ITS network business. To quench this situation, other IPrelated technology must be studied and improved. Especially, for the real time multimedia services and third layer's mobility support, the proposed pre-path reservation mechanism has to be studied and a new scheme to cooperate with mobile IP related mechanisms must be researched.

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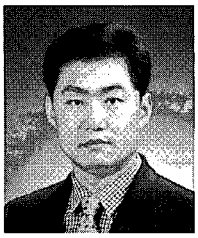

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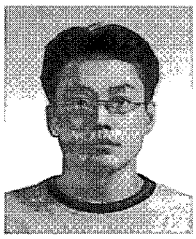

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