# QoS in Mobile IPv6

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**Abstract:** As we know, there are two types of Internet Quality of Service (QoS): Intergrated Services (IntServ) and differentiated Services (DiffServ). They are designed in the context of a static environments (fixed hosts and networks) and as a result, these schemes are not fully adapted to mobile environments, especially when Mobile IP is used as the mobility management protocol. In this paper a new two-plane two-tier QoS architecture is proposed based on the advantages of IntServ and DiffServ. Then we describe how the architecture guartanees the end-to-end QoS. Finally the existing Mobile IPv6 signalings such as Binding Update (BU), Binding Request (BR) and Binding Acknowledge (BA) are extended in order for QoS negotiation and advance resource reservation.

**KeyWords:** Quality of Service (QoS), Mobile IPv6, QoS Architecture, QoS negotiation, End-to-end QoS

## 1 Introduction

The main drawback of the current Internet is the lack of QoS support. QoS support, however, is essential for business and real-time applications such as Internet Telephony and on-line video retrieval. During the last years the Internet community spent many efforts to develop an Internet QoS architecture based on the Integrated Services [IntServ] architecture and the Resource Reservation Setup Protocol (RSVP) [RFC2205]. However, the IETF RSVP working group stated that RSVP and the IntServ approach can not be deployed in large-scale Internet backbones due to scaling and billing problems. Differentiated Services [DiffServ] are a new approach for QoS support in the Internet. Both DiffServ and IntServ approaches have been designed in the context of a static environments (fixed hosts and networks) and as a result, these schemes are not fully adapted to mobile environments, especially when Mobile IP is used as the mobility management protocol. There are several issues about QoS in Mobile IPv6: Handover and roaming in heterogeneous QoS domains, Roaming between dissimilar media, No advanced resource reservation, No QoS negotiation/signalling for heterogeneous domains, Duplicated signallings for InServ Mobile IP, Packet loss & delay when handover [KMLH01].

Over the past several years there has been a considerable amount of research within the field of QoS support for Mobile IP. Several problems occur when DiffServ is used in conjunction with Mobile IP. These problems can be classified into the following five categories: Network provisioning in mobile environments, Lack of dynamic configuration, Definition and Selection of Service Level Agreements (SLAs), Mobile Flow Identification, Billing [BCS99]. Two key components seem to be very valuable for the integration of DiffServ and Mobile IPv6 protocols : Adaptivity and DiffServ Signaling Protocol.

For wireless networks, In [TBA98], Talukdar et al. Have proposed the MRSVP signaling protocol as part of the augmented Integrated Services architecture presented in the previous section. RSVP, as originally envisioned, cannot support mobility independent reservations. So the MRSVP proposal suggests making resource reservations to all locations where the mobile node is expected to visit during the lifetime of the connection. The mobile node will make an active reservation to its current location but it will also make passive reservations to each of its locations in its mobility specification. Should provide a *base* layer. Above that, applications should be able to adapt to changing network conditions both in the wireline infrastructure as well as over the wireless link.

[IC98] presents an extension of the RSVP and characterises the static reservation process used in RSVP and also characterises its existing extension to the MRSVP [TBA98] protocol. A soultion which does not require a specification of the mobility set is presented.

Terzis et al. [TSZ99] proposed a signalling protocol for wireless and mobile networks that allows a mobile host to set up and maintain reservation along the path to its current location as it moves from one subnet to another. The protocol works by combining pre-prvisioned RSVP Tunnels [ZWKT98] with Mobile IP.

[FZHNS98] gives an oultine and solutions to the problem of running RSVP signalling in Mobile IP networks using optimised routing and discuss a basic solution to this problem. By modifying RSVP at mobile and correspondent nodes to become aware of MIPv6 addressing. A simple repair that allows RSVP flows to be established between the fixed network and mobiles is given.

All of these above proposals for providing services to mobile users are based on RSVP and have scalability problem inherited from the RSVP. So IP Mobility along with RSVP makes the head of th author of [T01 ] hurt. The intersection of Mobile IP with RSVP is not well understood. [T01] attempts to bring forth issues with their interaction, as well as diagram how a naïve RSVP and Mobile IP hosts would likely interact, assuming they implemented the protocols correctly.

In this paper, a two-plane two-tier QoS architecture for mobility networks is proposed in section 2. Following this we describes how the proposed architecture guartanees the end-to-end QoS in section 3. In section 4 the existing Mobile IPv6 signalings such as Binding Update (BU), Binding Request (BR) and Binding Acknowledge (BA) are extended in order for QoS negotiation and advance resource reservation, and the conclusions are given in section 5.

## 2 QoS architecture

The state-based IntServ architectural model admits the potential to support greater level of accuracy, and a finer level of granularity on the part of the network to respond to service requests based on advance reource reservation. As noted in [RFC2208], there are several areas of concern about the deployment of this form of service architecture. With regard to concerns of per-flow service scalability, the resource requirements (computational processing and memory consumption) for running per-flow resource reservations on routers increase in direct proportion to the number of separate reservations that need to be accommodated. By the same token, router forwarding performance may be impacted adversely by the packet-classification and scheduling mechanisms intended to provide differentiated services for these resource-reserved flows. Although the IntServ is not widely deployed, its ideas are very suited for wireless network for resoruce reservation.

The stateless-based DiffServ is more approximate in the nature of its outcomes. Here there is no explicit negotiation between the application's signaling of the service request and the network's capability to deliver a particular service response. If the network is incapable of meeting the service request, then the request simply will not be honored. In such a situation there is no requirement for the network to inform the application that the request cannot be honored, and it is left to the application to determine if the service has not been delivered. The major attribute of this approach is that it can possess excellent scaling properties from the perspective of the network. Of course this approach does introduce some degree of compromise in that the service response is more approximate as seen by the end client, and scaling the number of clients and applications in such an environment may not necessarily result in a highly accurate service response to every client's application.

QoS is very important to Internet especially to Mobile IPv6. This paper proposes a QoS architecture framework with preliminary protocol specifications for Mobile IPv6 networks. The architecture is based on IPv6 and DiffServ which has no scalability problem as IntServ in that traffic are aggregated and forwarded in backbone network based on per hop behaviors. In the proposed architecture, there is at least one global server and several local nodes in each Network Administration Domain (NAD). The server is referred to as the Global QoS Agent (GQA), and local nodes are referred to as local QoS Agents (LQA). LQAs are ingress nodes of the Differentiated Service (DS) domain. They reside generally in the edge of wired backbone networks to which Radio Access Networks (RAN) connectbv. The GQA retains the global information of the domain, and informs LQAs what to do when traffic comes in. The Mobile Node (MN) has the QoS signaling with LQA and LQA has the QoS signaling with GQA. The actual traffic generated by MN goes through the default router. The GQA and LQA are in control plane and the default routers are in transport plane. By retaining the global information in central server and separating control and transport, the architecture is flexible, easy to add new services, and more efficient for mobile environment. The existing signalings of Mobile IPv6 are extended for QoS signaling. To implement the QoS control and management mechanisms, we use COPS [RFC2478] as the protocol for exchanging message between GQA and GQA and between GQA and LQAs. Figure 1 is the control plane of the proposed architecutre.

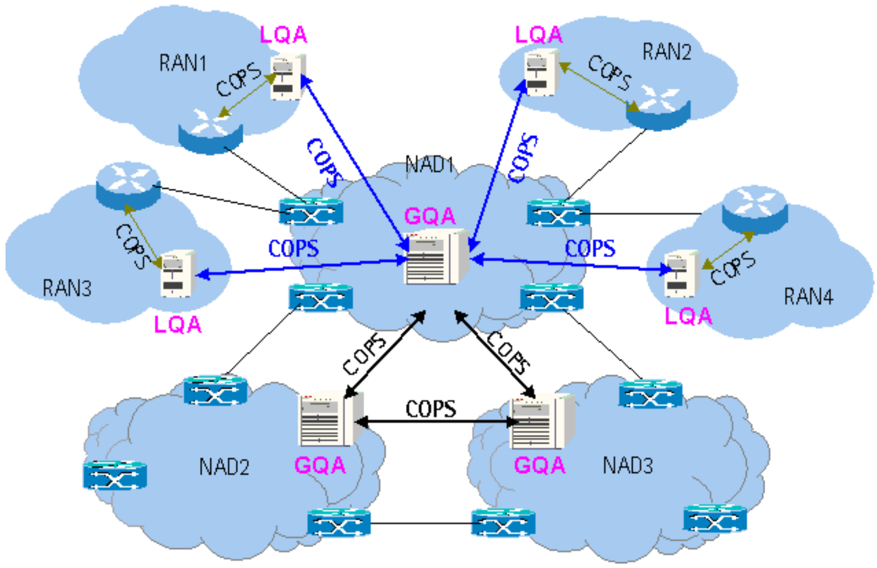


Figure 1 The control plane of the architecture

The tenet of our design is what we call Two-Tier QoS mechanisms. By this term we mean that QoS mechanisms should be done in two levels. The first level is Intra-NAD QoS mechanisms inside each NAD while the second level is Inter-NAD QoS mechanisms across neighboring NADs. Following the paradigm of Internet Routing, each NAD is free to choose whatever mechanism it deems proper for internal QoS mechanisms as long as its bilateral resource agreements with neighboring NADs are met.

### 3 End-to-end QoS guartanees

Meeting QoS guarantees in mobility network systems is fundamentally an end-to-end issue, that is, from application to application. In our architecture there is a GQA acts as the QoS manager for each administrative domain. Neighboring GQAs communicate with each other to establish Inter-domain QoS agreements such as SLAs.The aggregate traffic crossing domain borders is served according to relatively stable, long lived bilateral agreements. End-to-End QoS support is achieved through the concatenation of such bilateral agreements [TWOZ99].

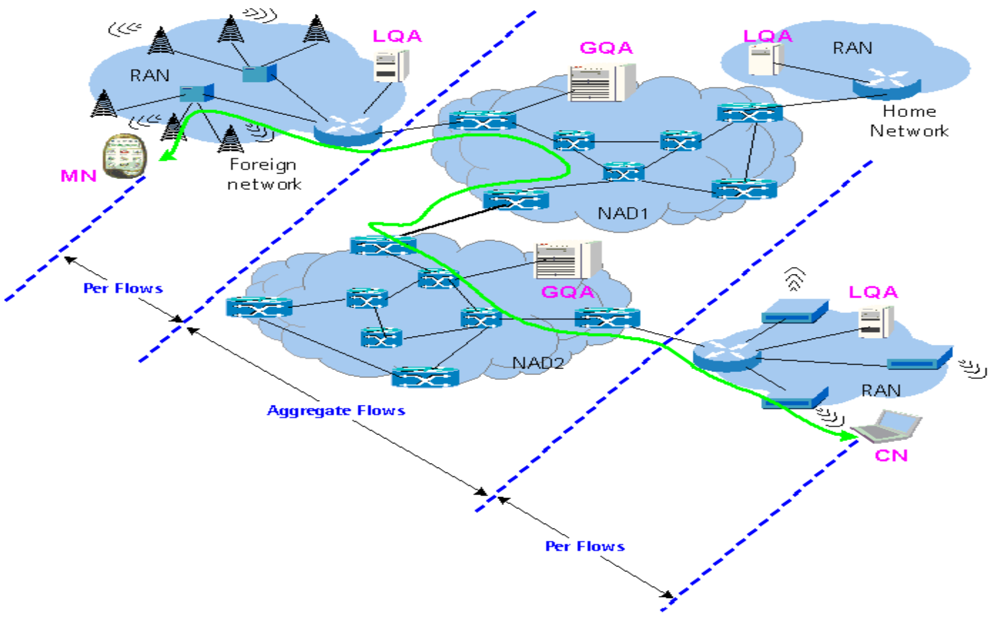


Figure 2 The end-to-end QoS guartanees

In the proposed architecture we made use of the ideas borrowed from RSVP/IntServ to extend the signalings of Mobile IPv6 as QoS allocation protocol for the per-flow traffic in the RAN. When the traffic leaves the RAN, per-flow traffic is aggregated to form aggregate-flows in the border router. Moreover DiffServ is selected in the backbone network and the QoS for aggregate flows between NADs is guaranteed by the other mechanisms [RFC2996], [FCFB99] and [RFC2998]. Other QoS protocols such as MPLS [MPLS]can be selected in the backbone network too.

Figure 2 is a picture about End-to-End QoS Guarantee.

## 4 Extended QoS signallings

In [CK00] a new IPv6 option called "QoS Object" is introduced. Depending on the context, the QoS Object is included as a Destination Option or a Hop-by-Hop Option in IPv6 packets carrying Binding Update and Binding Acknowledgment messages. When included as a Hop-by-Hop Option, QoS Object triggers certain QoS procedures at the intermediate network domains. This document describes these QoS procedures for the cases of best-effort, MPLS, DiffServ and IntServ domains, which practically cover all the cases of QoS enabled network domains that would be available in near future.

Binding Update (BU), Binding Acknowledge (BA), Binding Request (BR) are defined in the [MobileIPv6]. They are used for informing of the movements of the MN. Based on the mechanisms of these signalings, special Mobile IP protocol options to be exchanged between MN / default router / QoS Agents are defined here. In this section we define some special Mobile IPv6 protocol options to extend the existing signalings for QoS negotiation which allows a MN to indicate the kind of desired service.

There are four scenarios of QoS negotiation in our QoS architecture: MN will send data to the CN, MN is sending data to the CN, MN will receive data from the CN and MN is receiving data from the CN. Here is a example of the procedure of QoS negotiation when the MN will send data to a CN and Figure 3 depicts the procedure.

1) MN sends an extended BU with QoS Object Option to the default Router.

2) The default router of the MN receives the BU message and informs the LQA of the MN's QoS request contained in the QoS Object Option followed with BU by the COPS Request message.

3) If the LQA admits the MN’s traffic to enter its RAN by performing some admission control policys, the LQA replies by sending a success COPS Decision message to the default router containing the appropriate parameters for the corresponding interface of the default router. Otherwise a failure COPS Decision message is replied.

4) After getting a success COPS Decision message, the default router replies by sending the configuration result (i.e. success or failure) to the LQA via a COPS Report message. Ohterwise the default router dose not replies to the LQA.

5) The default router informs the MN whether or not be admitted to enter the RAN by sending an extended BA message to the MN. If admitted the following steps will be continued, otherwise the procedure ends.

6) After successfully admitted to enter the RAN, MN will inform its CNs by sending BU message.

7) The CN receives the BU message and constructs a BA message for replying the BU message sent from the MN.

8) The default router of the CN deals with the BA message containing QoS Object Option which may be same as the option contained in the BU message or may be modified by the CN and forwards this message to the LQA via the COPS Request message.

9) If the LQA can meet the QoS Request based on some QoS Control policys, it replies to the default router of CN by sending a success COPS Decision message containing the appropriate parameters for the corresponding interface of the default router. Otherwise a failure COPS Decision message is replied.

10) After getting a success COPS Decision message, the default router replies by sending the configuration result (i.e. success or failure) to the LQA via a COPS Report message. Ohterwise the default router dose not replies to the LQA.

11) The default router forwards the extended BA message to the MN.

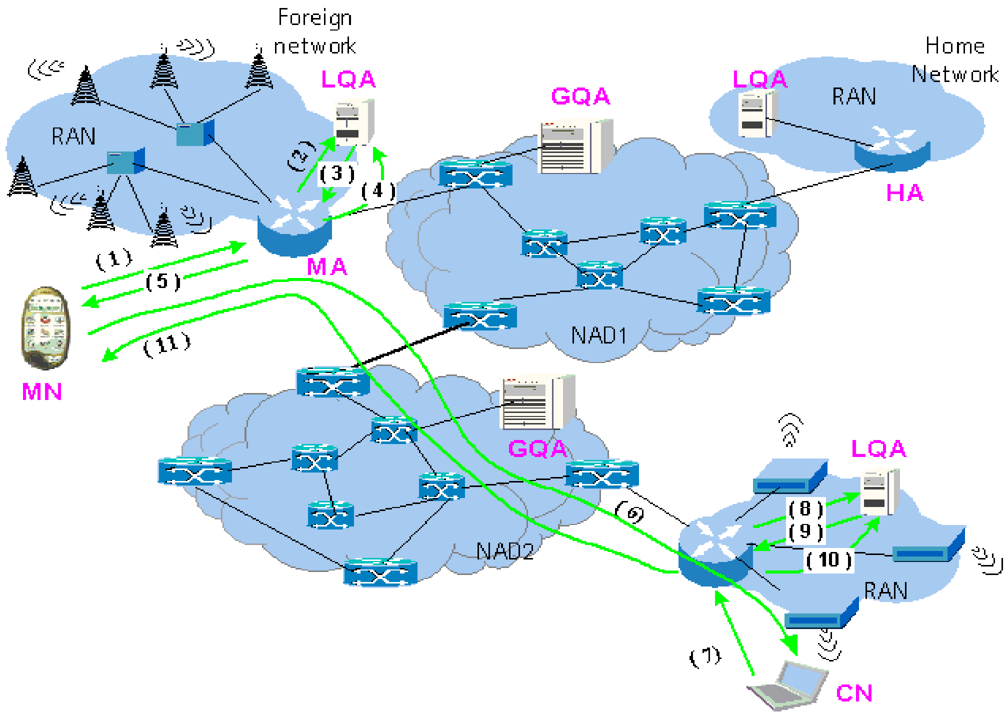


Figure 3 An exampel of the procedure of QoS negotiation.

Because of limited size of paper, the detailed information about extended BU, BA, BR is not presented here.

## 5 Conclusions

IntServ and DiffServ are designed in the context of a static environments (fixed hosts and networks) and as a result, these schemes are not fully adapted to mobile environments, especially when Mobile IP is used as the mobility management protocol. In this paper a new two-plane two-tier QoS architecture is proposed based on the advantages of IntServ and DiffServ and how the architecture guartanees the end-to-end QoS is described. Finally, in order for QoS negotiation and advance resource reservation the existing Mobile IPv6 signalings such as Binding Update , Binding Request and Binding Acknowledge are extended. Now some simulations are doing for the proposed extended QoS singalings and the design of the QoS architecture has been finished in our Lab..

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