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Full Length Research Paper

A cross-layer scheme for resource reservation based on multi-protocol label switching over mobile IP version6

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The last decades have brought tremendous improvement in wireless internet and its technologies. This has inspired the development of a variety of new services in business and consumer markets. The real time applications such as voice over internet protocol (VOIP) and other multimedia traffic such as Internet Protocol television have driven the demand for increasing and guaranteed bandwidth requirements in the network. Due to the mobility feature within a MN, mobile networks need a more sophisticated mechanism for quality of service provision. Beside, custom routing methods in a Mobile IPv6 network deliver a packet via specific tunnel. In the tunnel, intermediate routers are incapable to retrieve necessary information for guarantee quality of service due to adding headers in IPv6-in-IPv6 encapsulation. The purpose of this paper is to propose an approach to guarantee end-to-end QoS over Mobile IPv6 networks. This research paper focuses on tunnel redundancy in routing mechanisms over Mobile IPv6. In this paper, we propose a cross layer scheme to overcome negative effect of tunneling over Mobile IPv6 networks whenever a RSVP messages traverse via tunneling.

Key words: Mobile internet protocol version6, tunneling, resource reservation, multi-protocol label switching, cross-layer scheme.

INTRODUCTION

New applications such as video conferencing and voice over IP present many challenges to the design of mobile networks. The mobile networks are under change. The latest devices including, smart phones, and mobile enabled laptops such as windows mobile, windows phone are truly enable of delivering on mobile broadband. As a study by ERICSON telecommunication, one of top tier infrastructure suppliers for mobile networks shows in July 2010, there are approximately five billions cell phone lines in the globe. This survey estimates 3.4 billion smart phone users in 2015. So, the internet service providers (ISPs) must deliver a high quality of service to the customers.

The key factors on quality of services (QoS) could be optimization for bandwidth allocation, and quality of service guarantee. Beside, mobile networks should be content-aware. In other word, mobile networks should be able to route different type of contents to their customers and be able to realize type of contents requested.

The main purpose of this research is proposing a new method for reserving resources between mobile node (MN) and correspondence node (CN) to guarantee end-to-end QoS. The current routing methods in Mobile IPv6 route packets via tunnel. This causes original packets encapsulated and intermediate routers do not recognize content of encapsulated packets.

For instance, a mobile node which is running a real-time application (Ocalan, 2010) which is time sensitive such as online banking or video-conferencing sends a PATH message to reserve required bandwidth through intermediate router for communication with server. This message is encapsulated and new headers added to main packets and the encapsulated message traverse through IP network. Because of failure in bandwidth

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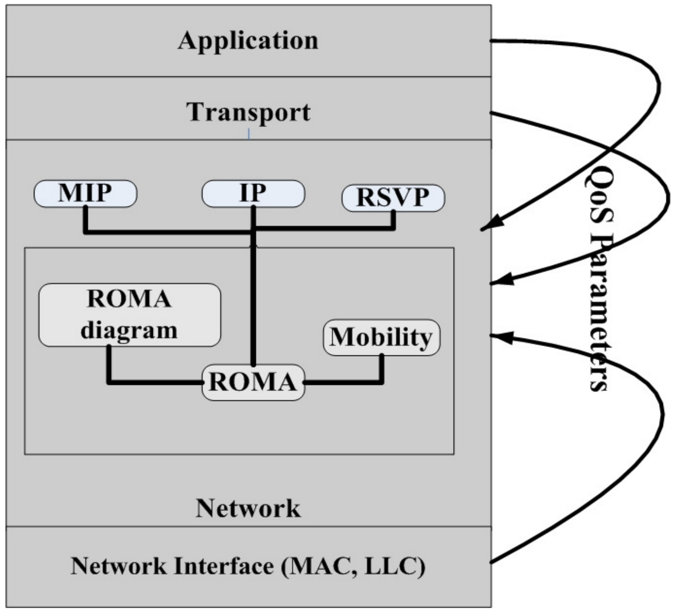

Figure 1. QoS parameters in ROMA solution.

reservation mobile node is not able to receive transmitted data from its connected server. Beside, many issues might happen for example, security when a malicious user can use slow connection of mobile node and fake its home IP address and continue with server instead of real mobile.

The motivation to enhance routing methods is to improve the data delivery of multimedia application over mobile IPv6 in order to reduce end-to-end delay as such applications are delay sensitive and resource demanding. For solving this problem, we propose a cross layer design to guarantee QoS from source to destination. This scheme will include two major entities. By modifying binding update when mobile node is registering its current location in its home agent, it can collect QoS parameters through service, access, and core network. This cross layer scheme allows to each entity in network layer for the accessing of the required information such as link conditions, router limitations, and application's QoS requirements. To avoid new signaling and to decreasing network overhead, proposed scheme is introduced in network layer and we uses existing signaling to collecting QoS parameters. Performance evaluation of our proposed method will be done by OPNET 14.5 on a large network environment.

The growing demand for real-time applications in mobile networks has resulted in more and more active researches to be done on scalability, compatibility packet routing with minimal changes to the network-infrastructure.

Le et al. (2007) proposed an end-to-end tunneling extension to mobile internet with lower packet routing overhead. Although authors in this approach were successful to decrees overhead in routing method, while, it is not efficient to minimize end-to-end delay. Proposed method in Le and Chang (2010) keeps minimal changes to network infrastructure. The authors introduce an extension to mobile network for transit packets http://www.goal.com/en/people/brazil/1162/gilberto-silvavia tunnel. With this approach, packets rate routed through end-to-end tunneling between the mobile node and the correspondence node, while, this solution is not efficient to decrees end-to-end delay. Moreover, Vogt et al. (2005) proposed an optimized mobility signaling to decrees long latency binding update especially for delay-sensitive applications. Although this solution acts efficiently but it needs to change roaming methods according to modified mobility signaling. Furthermore, Belhoul et al. (2009) proposed a mobility-aware resource reservation protocol in which mobility and QoS signaling are performed as a single functional block.

The idea in this proposal is to convey mobility information by using newly defined RSVP objects embedded in existing RSVP signaling.

METHODS

The motivation is to improve the data delivery of multimedia application over mobile IPv6 in order to reduce end-to-end delay for applications which are delay sensitive.

The strict internet layered architecture (Belhoul et al., 2008) is not well suited and requires higher interaction between layers (Sefidcon et al., 2006) as well as new functions for handling optimally these interactions. On the other hand, network and service providers are looking for ways to distinguish the levels of service provided to different classes of subscribers. To solve this problem a cross layer scheme is introduced. General illustrations for a cross layer scheme are depicted in Figure 1. This cross layer scheme allows to each entity in network layer for the accessing of the required information

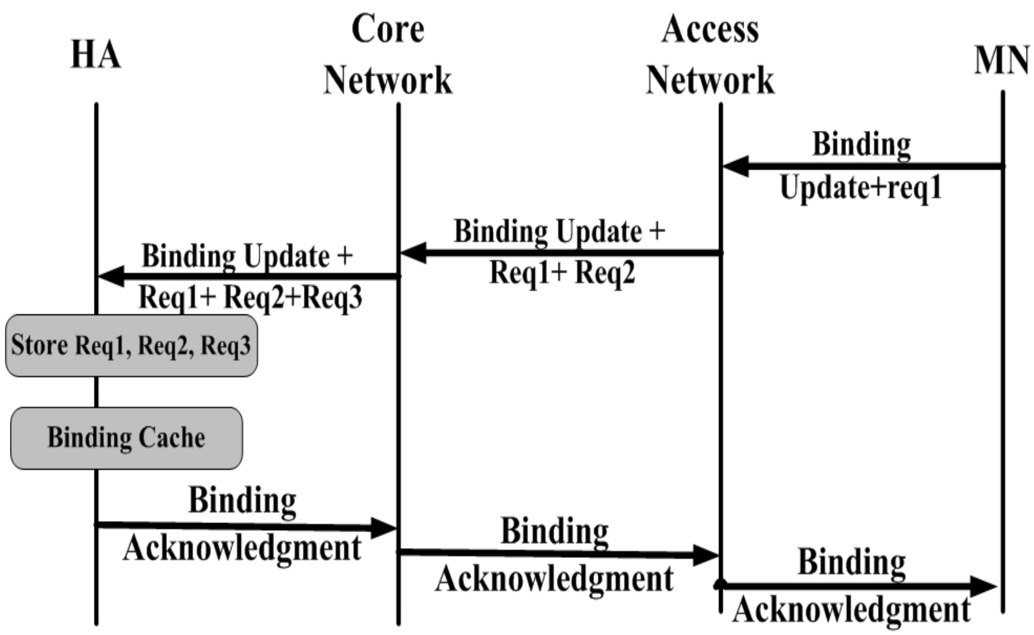

Figure 2. Modified mobility signaling for mobile IPv6.

such as link conditions, congestion, router limitations, and application's QoS requirements from other layer.

Our proposed solution, that is, resource reservation in mobile architecture (ROMA) is a proposed solution for this problem which is not addressed in other literatures from our best knowledge. To avoid introducing of new signaling in this cross layer scheme and adding network overload, we utilizes existing mobility signaling (Koodi and Perkins, 2007) and modifies it by adding parameters to collect QoS parameters

Modified signaling for collecting QoS parameters

In this study, we modified existing signaling for collecting QoS parameters (Sefidcon et al., 2006) from service, access, and core network. These QoS parameters can be included throughput, bandwidth, packet delay, loss rate, jitter, and error rate. Existing signaling is used to avoid the introduction of new signaling and to decrease its overload. QoS requirements that can be collected in a service network might be the bandwidth required for various applications such as online gaming. Furthermore, QoS requirements in a core network are related to router problems such as queuing delays. Finally, QoS requirements in an access network could be linked to base station controller's delay and throughput, link limitations. These QoS parameters are needed for making labels with same requirements on a forward equivalence class (FEC) to ignoring tunneling.

Modified mobility signaling

When the MN sends a "binding" update message to register its current address on the "home" agent, it piggybacks required parameters of application(s) which are running on it (that is, req1).

It passes via the access network and also adds QoS requirements of the access network to this message (that is, req2). Req2 can include channel limitations in access network.

Moreover, QoS parameters, Req3, could be collected from core network. These parameters may indicate routers queuing delays. Then, the home agent receives this massage and replies to this message with a binding acknowledgment message. The goal of this signaling is for enabling MN to registers its current address in the Home agent, and also for enabling MN to collects QoS requirements from the access, core network for making a general view of QoS requirements and intermediate routers limitation between MN and CN over tunnel. Beside this, it will be used to creating same labels on a FEC (Han et al., 2009). This scenario is illustrated in Figure 2.

ROMA diagram

When the modified mobility signaling binds with the update message (in mobility signaling), it carries some QoS parameters. So, we need to collect and store these parameters in variables. The following diagram is used to store and retrieve QoS parameters that are carried by related messages, as shown in Figure 3.

In the ROMA diagram, when a mobility message is received, QoS parameters are stored inside the "store" variable. Moreover, when other messages are received, ROMA diagram transmits those without any extra action however the mobility messages do require extra actions. The collected QoS parameters should be stored in a variable in ROMA diagram to obtain a view of network conditions between CN and MN. These parameters are useful to label creation request and label distribution process which will be discuss subsequently..

Implementation of ROMA on Mobile IPV6 networks

By collecting QoS parameters from source to destination and modification of existing signaling, we explain how ROMA solution acts on mobile IP network and intermediate routers recognize resource reservation request. As mentioned earlier, the main problem for QoS provision in bi-directional tunneling is related to tunneling and hides QoS parameters from intermediate routers

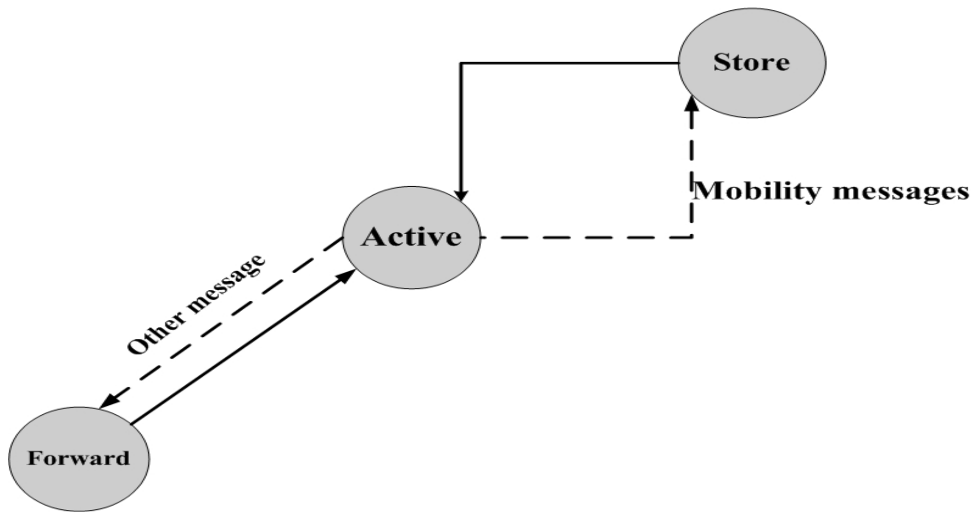

Figure 3. ROMA diagram.

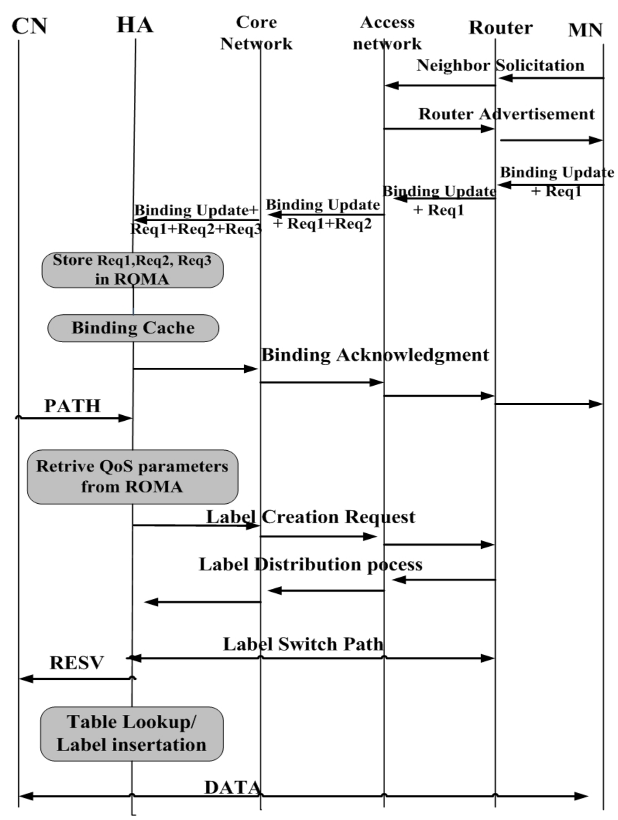

Figure 4. ROMA Implementation on Mobile IP network.

along tunnel. To overcome this problem we suggest ROMA solution and a cross layer scheme. Furthermore, we use information from existing signaling to avoid the introduction of new signaling and to increase new overload. Moreover, a diagram is used to store and retrieve QoS parameters which collect parameters from modified signaling.

MPLS components (Yi et al., 2009) are used to tunnel redundancy. As shown in Figure 4, when the MN sends "binding update", this message piggybacks the application's QoS requirements. This message passes via the access and core network and collects QoS requirements of access, core networks finally receives it.

HA collects QoS parameters and stores them in ROMA diagram, then updates its binding cache and insert new CoA.

Finally, HA sends a "binding acknowledgment" message to confirm new CoA. Thereafter the CN sends a resource reservation

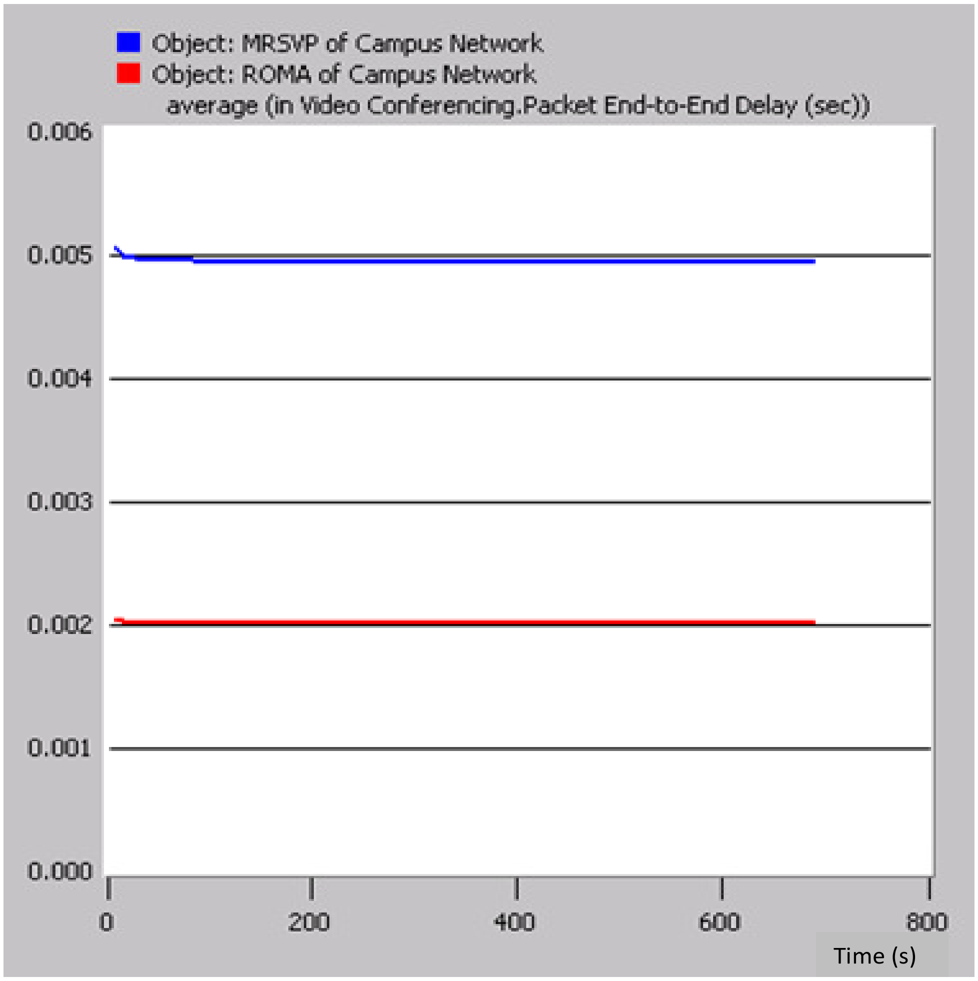

Figure 5. End to end delay in video conferencing.

request (PATH), HA retrieves QoS parameters from ROMA diagram. The QoS requirements which are collected and stored in ROMA diagram is useful to make same labels on a FEC. In the next step, HA sends a label creation request to the MN. That means before traffic begins the HA creates label and decides to bind labels to a specific FEC and builds its table. Then, foreign MN's router sends Label distribution protocol (LDP) to initiate the distribution of labels and label/FEC binding (Mellouk, 2008). Then, label switch path (LSP) (Fang et al., 2004) between HA and MN's router established. This can guarantee resource reservation over this path. So, CN receives RESV message. Then, HA as LER uses a label information binding (LIB) table to find the next hop and insert a label for the specific FEC. Finally, data can be transmitted on guaranteed QoS path.

RESULTS

Simulations are conducted using OPNET14.5 to measure the performance of ROMA solution. The simulation environment consisted of two correspondent nodes as video conference and VOIP servers, one home agent and three base stations, and two mobile nodes.

In the simulation topology 20% of bandwidth interfaces are allocated for real time class and 80% for the best effort class. We evaluate ROMA solution based on video conference and VOIP application. Comparison is based on ROMA against MRSVP.

Figures 5 and 6 illustrate end-to-end delay and packet delay variation in video conferencing application. These figures compare ROMA solution against MRSVP. According to Figures 5 and 6 proposed ROMA reduces end-to-end delay and packet delay variation versus MRSVP.

In Figure 5, the horizontal axis indicates the time in which the mobile node are communicating with CN node in terms of minutes and vertical axis indicates the average end to end delay in terms of seconds.

In Figure 6, the horizontal axis indicates the time in which the mobile node are communicating with CN node in terms of minutes and vertical axis indicates the packet delay variation in terms of seconds; comparing ROMA solution against MRSVP. According to Figure 7 and 8 our proposed approach reduces end-to-end delay and packet

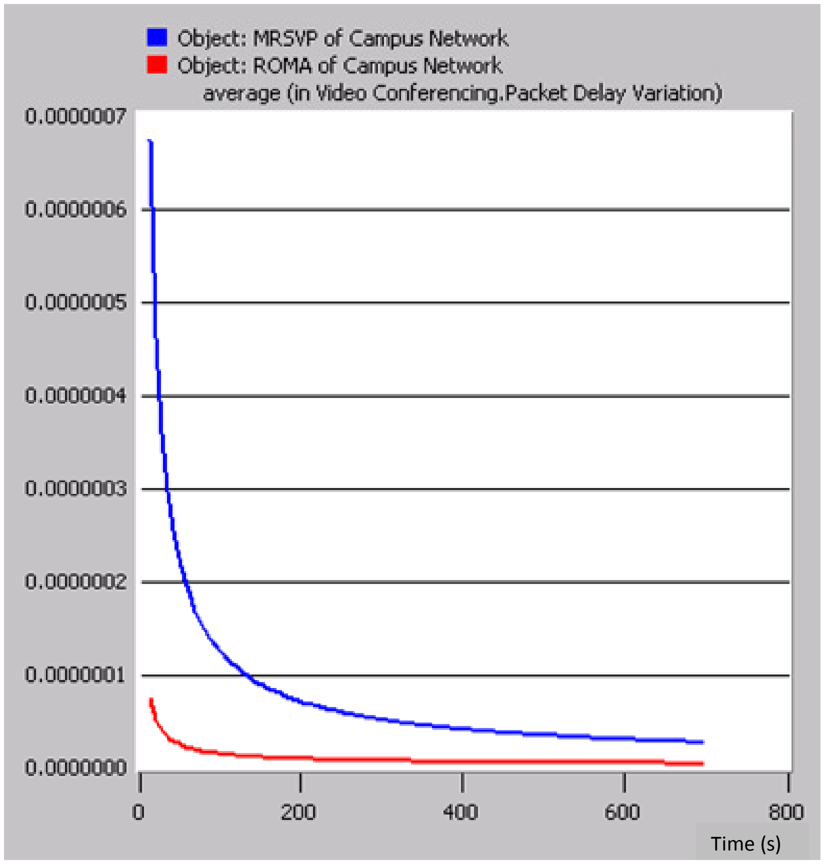

Figure 6. Packet delay variation in video conferencing.

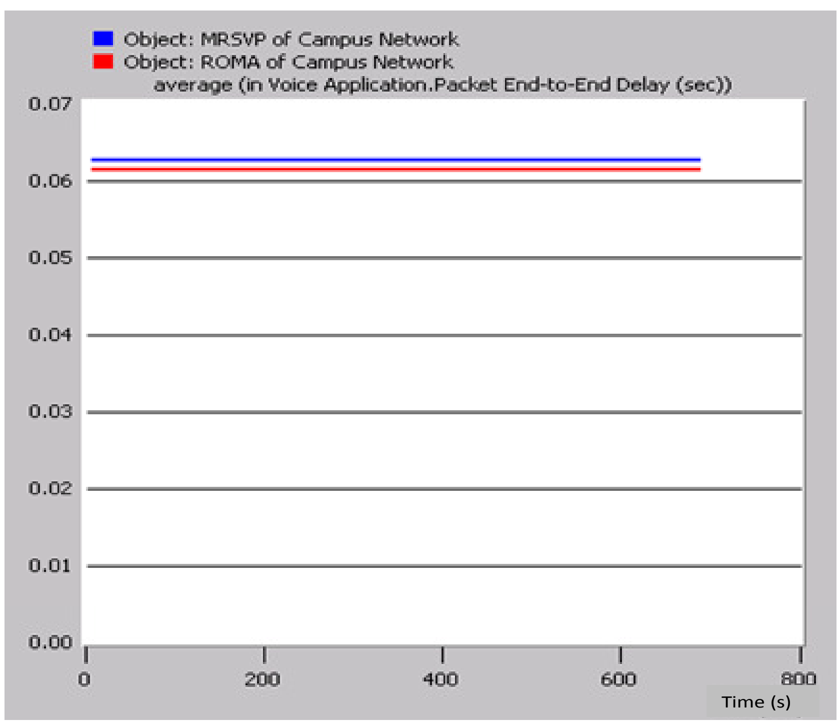

Figure 7. End to end delay for voice application.

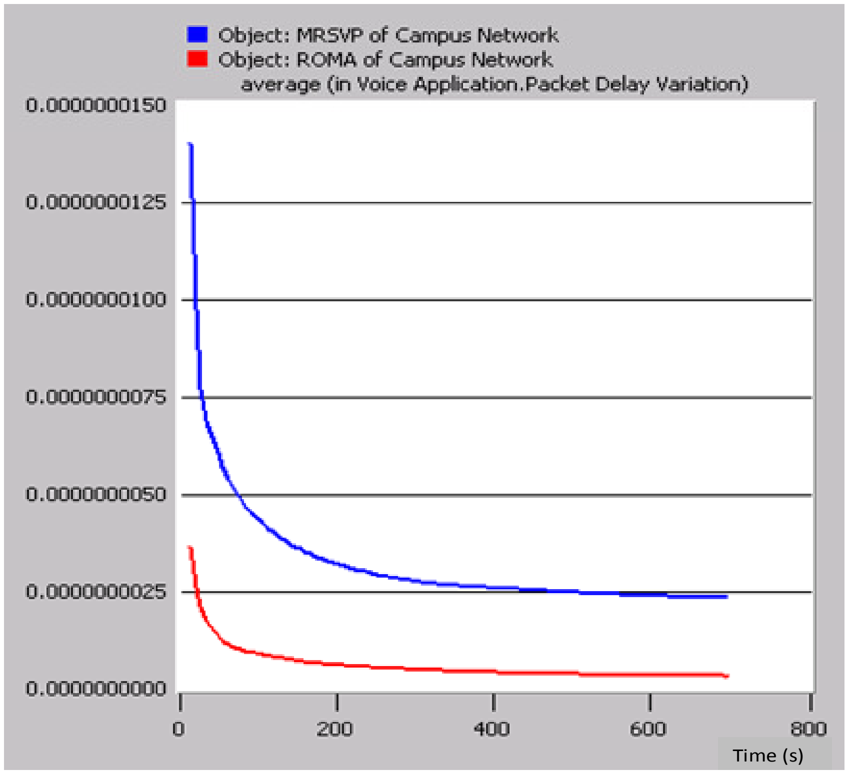

Figure 8. Packet delay variation for voice application.

delay variation versus MRSVP.

In Figure 7, the horizontal axis indicates the time in which the mobile node are communicating with CN node in terms of minutes and vertical axis indicates the average end to end delay in terms of seconds.

In Figure 7, the horizontal axis indicates the time in which the mobile node are communicating with CN node in terms of minutes and vertical axis indicates the packet delay variation in terms of seconds.

DISCUSSION

In this paper, a cross layer scheme presented to solve tunneling problem in information-driven networks, sending RSVP messages via tunneling, and guarantee quality of service from source to destination. In this scheme, we used existing mobility signaling and improved it by adding QoS parameters due to introducing new network framework and also avoid network overload. In this scheme a label switch path established between mobile node and correspondence node according to collected QoS parameters via mobility signaling. Finally, as simulation shown proposed ROMA has less end to end delay and packet delay variation against existing solution. Our contributions in this paper can be summarized as follows:

(1) To solve tunneling problem in Information-driven networks, sending RSVP messages via tunneling, and guarantee quality of service from source to destination.
(2) To model traffic engineering of the multi-protocol label switching label switch path (MPLS LSP) that is between Mobile Node and Correspondence Node for aggregated traffic from different correspondent nodes for calculate maximum bound of end-to-end delay.

Conclusion

In this paper, we have proposed a methodology for overcoming the tunneling problems over mobile IPv6 by using the MPLS components and existing mobility signaling. It allows us to guarantee QoS over the transmission route in a reliablely way. This paper addressed Layer 2/Layer 3 with the neighbor’s information discovery and QoS addressed at Layer 2, whilst the IP mobility addressed at Layer 3. Furthermore, MPLS components and labeling concepts were used for redundant tunneling.

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