Australian Journal of Basic and Applied Sciences, 5(5): 386-396, 2011
ISSN 1991-8178

Simulation Evaluation of DiffServ Approach Integrated in MIPv6Networks

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Abstract: Nowadays the Best-Effort (BE) service that is provided by the Internet is not good enough. Namely, it is adequate only for traditional Internet applications such as e-mail, web browsing and file transfer. However, recently we have seen a hug revolution in real-time applications like IP-telephony, multimedia conferencing, e-commerce, audio and video streaming. These types of applications require resource assurance and service differentiation to offer QoS guarantees (i.e. high bandwidth, low delay and/or delay variation). Working on providing QoS in the Internet has led to three distinct approaches endorsed by Internet Engineering Task Force (IETF) namely, IntServ, DiffServ and MPLS. Above all, the most promising one due to its simplicity and scalability advantages is Differentiated Service (DiffServ). The DiffServ approach was initially designed without mobility in-mind. It is still not fully adapted to mobile environments yet. Obviously, integrating QoS with mobility support seems to be needed to fulfill the necessity of users. Therefore, one of main requirements of next generation IP based networks is providing QoS for real-time traffic that will be transporting through MIPv6 networks. This paper aims to propose a new scheme that takes the advantage of DiffServ to enhance QoS in the mobile IPv6 network. The proposed scheme was evaluated by using NS-2. The proposed scheme is benchmarked with the standard MIPv6 which was proposed by IETF. The obtained results show that the proposed scheme outperforms the standard MIPv6 protocol in terms of packets loss and handover latency.

Key words: QoS; DiffServ; Mobile IPv6.

INTRODUCTION

A new era of real-time applications such as, video conferencing, Voice over IP (VoIP) and Video on Demand (VoD) requires better than best effort service. Matter of the fact they require QoS guarantees. The QoS for real-time applications is mainly characterized by bandwidth, packet loss rate, delay and jitter. The emergence of new mobile devices (e.g. PDAs, laptop and palmtop computers), mobile networks and real-time applications are rapidly increasing nowadays. There is rapid growth necessity to provide QoS to mobile devices, since the wireless communication devices are getting more powerful, cheaper and widely used. In fact, it is anticipated that more mobile users will be connected to the Internet rather than PCs users. These mobile users are interesting to get similar QoS in mobile terminals as in fixed terminals (i.e. wired networks) in order to run real-time applications properly.

Mobile IPv6 is a network layer protocol for enabling mobility in IPv6 networks. It grants uninterrupted network connectivity while the mobile node (MN) roams among various access points and keeps changing its point of attachment into the network over time. Nevertheless, the MIPv6 protocol doesn't provide QoS guarantees to its users same as traditional Internet IP (Johnson, 2004). Basically, all the users will have same level of services without considering about their application's requirement. This poses a problem to real-time applications that required QoS guarantees. To gain more effective control of the network, incorporated QoS is needed. Within a QoS-enabled network the traffic flow can be distributed to various priorities. Also, the network bandwidth and resources can be allocated to different applications and users. Internet Engineering Task Force (IETF) working group has proposed several QoS solutions for static network namely, Integrated Services (IntServ) (Braden, 1994), Differentiated Service (DiffServ) (Blake, 1998), and Multiprotocol Label Switching (MPLS) (Rosen, 2001). IntServ grants per flow guarantees but it faces some scalability issues. While DiffServ

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is more scalable compared to its competitors, it provides only service differentiation for large aggregates of network traffic without the need to maintain per-flow state and signaling in every router. MPLS (RFC 3469, February 2003) is an advanced forwarding scheme. It offers an alternative to IP-level QoS. It extends routing with respect to packet forwarding and path controlling. An MPLS packet has a header that is encapsulated between the link layer header and the network layer header. These QoS solutions are designed in the context of a static environment (i.e. fixed hosts and networks). Consequently, they are not fully adapted to mobile environments. They essentially demands to be extended and adjusted to meet up various challenges involved in mobile environments.

There are several issues about QoS in Mobile IPv6: Constrains in wireless link characteristics (i.e. low bandwidth, high bit error rate and power constrains), Handover and roaming in heterogeneous QoS domains, Roaming between dissimilar media, When MN using Mobile IP tunneling mechanism some QoS information may invisible there, No advanced resource reservation, No QoS negotiation/signaling for heterogeneous domains, Duplicated signaling for IntServ Mobile IP, Packet loss and delay when handover, Mobile IPv6 using built-in IPSec technology that may result in difficultly classifying packet (Kan Zhigang, 2001).

Among those QoS models that were proposed by Internet Engineering Task Force (IETF), DiffServ has been chosen and preferred to be integrated with mobility approach due to several reasons: In addition to its simplicity and scalability advantages, the use of RSVP as a signalling protocol rises several issues including signalling overhead and setup delays on roaming events (Mitzel, 2000). As the IP tunnel used by the MN is implemented by an IP-in-IP encapsulation scheme, routers inside an IP tunnel used in Mobile IP are not capable of recognising RSVP signalling messages (i.e. PATH and RESV messages) (Braden, 1997). Although, the tunnelling of packets reduces the packet loss, it places a burden on routers and entails extra signalling and retention of state in the routers. The complexity in DiffServ domain is pushed out to the edge routers where the traffic classification and conditioning would take a place. In contrary, the core routers are maintained as simple as possible to reduce the burden and achieving better scalability. Moreover, when DiffServ is used in conjunction with Mobile IP the lack of dynamic configuration is occurred. To overcome this issue, DiffServ introduces Bandwidth Broker (BB) which can support dynamic renegotiations by allowing BBs to negotiate SLAs with different ISPs. Thus the DiffServ could be scalability supportive in mobile environment. Multiprotocol Label Switching (MPLS) model faces some complexity problems since the routers in MPLS domain have to run different routing algorithms for finding the best QoS paths. Configuring switched tables in MPLS can be quite complex, which leads to scalability problems. Furthermore, the characteristics of the wireless LAN environment exclude any tight bounds on performance measures. For instance, it would be useless to reserve sufficient resources via RSVP to guarantee a worst case delay for a high priority flow, if the delay on the wireless link cannot be guaranteed.

The rest of the paper is organized as follows. Section 2 introduces the related works that have done in integrating DiffServ within mobile environment. Section 3 describes the proposed scheme (DiffServ-MIPv6). Section 4 discusses the performance evaluation. Finally, the conclusion and future works are given in Section 5.

Related Work:

There are many papers and research works concerning about QoS for mobile network. Some of them discuss and investigate open issues about integrating DiffServ with mobile networks.

DiffServ QoS provisioning for real time traffic in frequent handoff MobileIPv6 networks (Patil, 2006) and provisioning QoS in differentiated service domain for MIPv6 (Mohamad, 2003) are based on the idea of DiffServ model. However, the differences of them are: First, the former approach uses to obtain resource allocation architecture for evolving next generation mobile IPv6 networks. The IPv6 networks are made to communicate via currently most popular IPv4 Internet through tunneling. In this work use of DiffServ eliminates the signaling overhead on mobile node during frequent handoff scenario. Second, another work was proposed acceptable fairness of services for better QoS support for real-time traffic based on scheduling algorithm named Round Robin Priority Queuing (RRPQ). Fairness is desirable property in allocation of bandwidth especially for a link shared with multi flows of traffic. Both approaches inherit from DiffServ model the advantages of scalability.

Previous work in this paper (Jaseemuddin, 2002) investigated a study of profiled handoff for DiffServ-based mobile nodes, which shows transferring contexts to the new edge routers of wireless subnets helps various marking schemes reach stability earlier. This work is important in designing connection admission control algorithms at the radio edge router (RER). However, more investigation is required to analyze the relative performance impact on the traffic at the new AR caused by the flows that are handed over to the new AR.

The Quality of Service and Mobility for the Wireless Internet (Garcia-Macias, 2003) approach extends DiffServ to control resource utilization on each wireless cell and limits number of active hosts to keep the load sufficiently low. It also adopts the idea of IntServ by adding a QoS signaling for QoS negotiations between mobile nodes and access router. All mobile nodes and access routers provide DiffServ functions, i.e. the edge and core router functions, so that traffic sources are controlled in each wireless cell.

The authors in this paper (Wei Wu, 2003) evaluated end-to-end QoS support in MIPv6 with IEEE 802.11e by using both IntServ and DiffServ. They found that the loss of Router Advertisement message of MIPv6 adversely affects the handoff performance. Therefore, they assigned Router Advertisement messages a higher priority in IEEE 802.11e in order to improve mobile performance. However, they did not consider mapping between classes of DiffServ and those of 802.11e. In other words, the primary issue in integrating IntServ, DiffServ and IEEE802.11e is that service mapping is not only between IntServ and DiffServ but also between IntServ/DiffServ and IEEE802.11e.

Another work in (Misun Kim, 2008), (Kim, 2007) identified the use of differentiated service (DiffServ) model to provide various demand of new application in mobile IPv6 networks. The major contribution of this work is to proposed operational procedures and cost evaluation schemes for seamless connection during a mobile node (MN) changes its network attachment point to satisfying its QoS requirement. Moreover, priority queue is used to manage three types of services and their performances are evaluated. Even though, the work presented procedures for acquiring the MN’s service profile and additive information in the messages according to MN’s moving area, fast handoff and security problems need to construct more efficiently.

The Proposed Scheme:

The most important intention of studying QoS support in mobile environment lies in two aspects: One concentrates on how the node mobility affects end-to-end QoS guarantees. While the second concentrates on how to apply the existing QoS technologies in wired networks to wireless networks, namely how to append mobility support to these solutions and how these solutions suit the wireless link characteristics (Chu-da,2004).

The topology depicted in Figure (1) represents the proposed architecture that it is based on an IPv6 network with mobility support and DiffServ model supported in the Core Network to offer privilege QoS guaranteed service. Where, ER is Edge Router at ingress/egress of the network, CR is Core Router in the backbone network, CN is the Correspondent Node (it is considered to be a stationary node), MN is the Mobile IPv6 Node and BB is the Bandwidth Broker to optimize the existing resources. The Models based on BBs decouple the QoS control plane from the data plane. Since many control plane functions are performed per flow, scalability can be greatly enhanced by offloading these responsibilities from the core nodes (Bouras, 2007). In addition, the Access Router (AR) is connected to one or more Base Stations (BS) to provide connectivity to Mobile IPv6 nodes. It is also responsible for resource co-ordination for Base Stations to which it is attached. For the sake of simplicity, it is assumed that the (AR_i) supports functionality of the ingress Edge Routers.

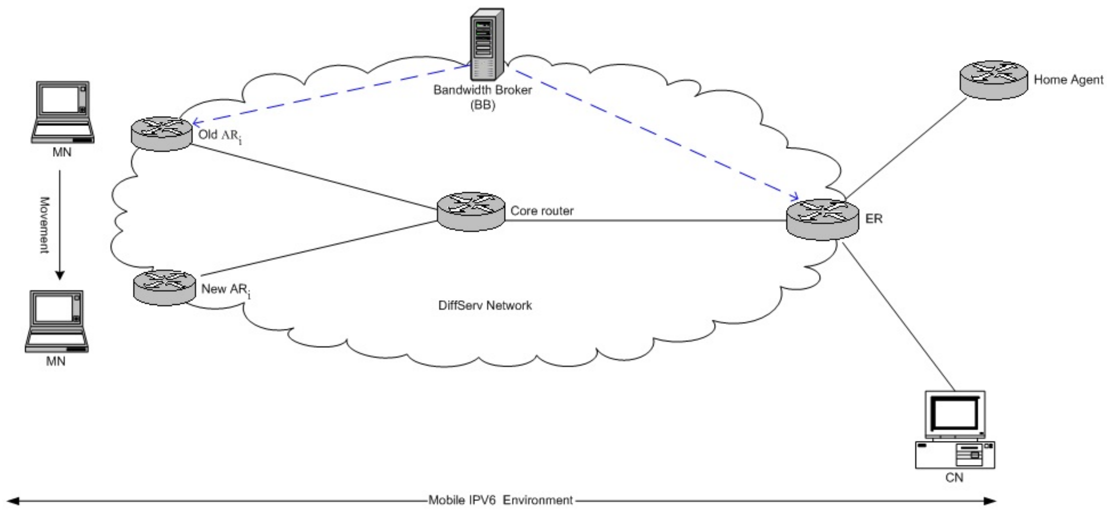


Fig. 1: DiffServ support within Mobile IPv6 Network

The Proposed Scheme Operations:

The proposed scheme (DiffServ-MIPv6) is built on the use of the basic mechanisms in DiffServ model such as traffic classifier and marker to enforce priority to a particularly signal message in the standard MIPv6 protocol and then constrains the traffic accordingly. Therefore, these mechanisms expect to minimize the packet losses as well as reduce handover latency in the proposed scheme.

Handover Procedure:

The mobile node intuitively moves from Old AR_i (OAR_i) to a New AR_i (NAR_i) when it performs handover procedure. The Mobile IPv6 node used to maintain two addresses: permanent address which is used when the Mobile in its home network and temporary address which is used when the mobile in the visited network. The permanent address is called Home address (HoA) while the temporary address is referred to as care of address (CoA) which is used to provide information about the MN's current location.

At the first three steps in Figure (2) The MN is still exchanging the packets with the CN via the Old AR_i. The ingress ER that was embedded in (OAR_i) will mark the packets with different DSCP values into IPv6 packet header and then forward packets to the next hop. The only way for the MN to know that it has been moved from subnets to another (or from OARi n attach to the NAR_i) is by performing movement detection (MD).

As soon as mobile node signs up into the coverage area of a Base Station that is connected to a new Access router (AR), it will broadcast Router Solicitations (RS) messages in order to discover one or more default routers/ Access Routers neighboring to it. As per MIPv6, the recipient of a router solicitation will result in sending a Router Advertisement (RA) messages from each Access Router on-link. Router advertisement messages allow listening devices to discover the default router's IP and link-layer addresses. These messages also provide important information about the router such as its address (or addresses, if it has more than one) and how long the host should retain information about the router.

Basically, mobile nodes sustain a list of Base Stations. That list records from which Base Stations the MN supposes to get Router Advertisement Messages (RA)s. As a Base Station list has to be updated, MIPv6 node will directly check its BS list when receives any (RA) message.

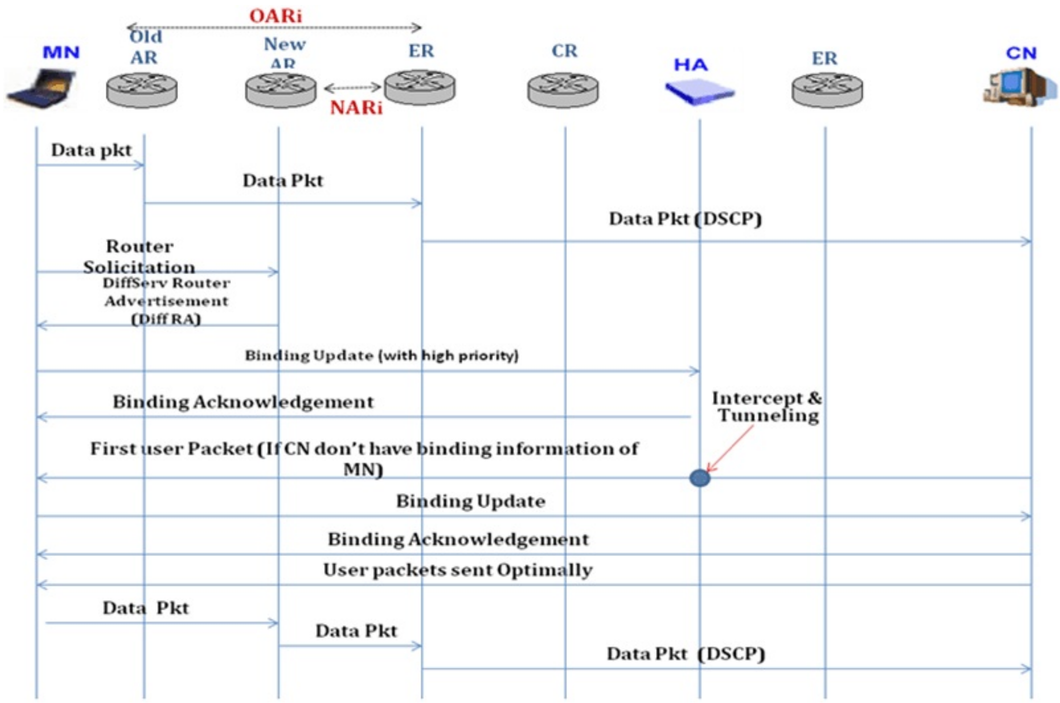


Fig. 2: Signalling Messages and data forwarding in proposed scheme.

If this Base Station:

1. Is not in the BS list, the mobile node will initiate handover to attach itself to another new Base Station.
2. Is actually in the BS list, the mobile node refreshes the lifetime entry of this Base Station.

If (RA)s are dropped for some reasons, here mobile node cannot detect its movement to a new link instantly (Wei Wu, 2003). The worst scenario could be happened when MN is in the place of overlapping coverage area of two (BS)s. if the loss of (RA) occurs at that time, the Mobile Node will be switching between two (BS)s repetitively, resulting in the ping pong handover problem.

The New AR_i will send the extended DiffServ router Advertisement (Diff RA) messages to the MN. The MN will use the information in (Diff RA) to check whether the link-prefix is changed or not. As we know that each link has at least one unique prefix that identifies the link. So that, if the MN notices the link prefix is changed, it will figure out the movement was occurred. Here the Mobile Node has acquired a new Care of Address (CoA) at the time it moved to a new sub-network. Thus, it needs to register the CoA with Home Agent (HA) and this is will done by sending binding update message (BU). Also, the MN will use the information in the new (Diff RS) as hint to forward the BU with high priority.

The Home Agent (HA) used to hold the mobility of the MN through maintaining MN's current location information. It needs to store this information in its binding cache in order to forward packets addressed to the mobile node's home address from CN. The CN stores that information in its Binding cache as well. Binding cache is usually maintained by both CN and HA. Each entry in the binding cache contains the mobile node's home address, CoA and the lifetime that indicates the validity of the entry. After that, home agent (HA) will respond by sending binding acknowledgment (BA) to MN to indicate the reception of BU as shown in Figure (2).

Next, the communication steps proceed by intercepting and tunneling the packets that have sent from correspondent node (CN) by the HA in order to be destined to the Mobile home address (HoA). This happens only when a correspondent node either does not yet have a binding for the mobile node (correspondent registration is in progress) or does not support Mobile IPv6. At this point, the MN knows the address of the CN by looking at the source address of the packet header. Therefore, the MN does not have to tunnel the packets through the HA but instead it can send them directly to the destination address of the CNs. Once the MN registers BU with CN and received BA in return. Now the CN and MN can only send the packets (communicate) optimally to each other instead of going through the HA. Basically, they make the use of the IPv6 Routing Header Option (i.e. type 2 routing header and Destination option header), therefore no tunneling and encapsulation for the packets anymore. Incoming and outgoing packets are kept marking differently with certain code point to to create several packet classes in the proposed architecture.

The Proposed Scheme Challenge:

When the mobile node moves from one link to another, its home agent (HA) will continue forwarding packets to its previous care-of address until the mobile node updates the home agent about its movement (Sun, 2002). This results in packet losses as shown in Figure (3). Thus, it is important for the mobile node to update the home agent as soon as movement to a new link is detected.

However, the Mobile Node might face some challenges in Home agent registration process. The problem arises when binding update message is lost due to congestion in the wireless channel or for other reasons. Whereby, the mobile node will be unreachable while it is been away from its home network.

In view of the fact that BU messages might be lost due to abnormal condition into the network, this is will invoke a new retransmission of BU request periodically after a timeout. Causing some sort of handover latency for the mobile node as well as packet losses. Therefore, minimizing or completely eliminating the loss of (BU) messages is the main key approach in this proposed scheme.

In short, the handover performance will be adversely affected, as the loss of Binding update (BU) message in Mobile IPv6 does occur. The proposed scheme develops to manage the performance of MN' handover by employing DiffServ to work out the problem of the Binding Update (BU) messages loss. The intention is to achieve acceptable seamless handover with desirable QoS required for real time applications.

The mechanism of the proposed scheme aims to exploit and utilize the existing building blocks in DiffServ (such as classifier, meter and marker) to improve QoS guarantees Service for the mobile hosts. To accomplish that the Binding Update that came from MN to the intended home agent will be given high priority in the flow of Expedited Forwarding (EF) by the ingress edge router (ER) that was embedded in a New AR_i (NAR_i) in the proposed architecture. The Mobile IPv6 defines a new IPv6 extension header known as mobility header. The mobility header is used to carry the Binding update (BU) message in addition to other Mobile IPv6 messages. In other words, the mobility header is used as a switch to indicate which message is included on it. When a binding update is included in the mobility header, [MH type] field is set to 5 in the binding update message format. Moreover, in IPv6 packet header there are 8 bits for Traffic Class field (TC) corresponding to the Type of Service (TOS) in the IPv4 header. The use of this field enables Differentiated Services (DiffServ). In general, hosts or routers can set this field to indicate that certain packets require priority forwarding over others (e.g. real-time versus Best-Effort forwarding). The DiffServ code point "101110" is always being assigned to DS field of packet header that carries BU. Accordingly, the BU will be forwarded as the EF flow with high priority. The EF is the premium class of service that can be offered by the DiffServ platform. It provides a flow with small delay and jitter as well as with low packet drop rate. To achieve such performance, EF packets have higher priority than other classes in DS domain (e.g. Assured Forwarding and Best Effort). Expedited Forwarding requests that every router in the cloud of DiffServ should constantly serve EF flow that carrying the binding update message as fast as possible. Since the scheduling queue in Expedited Forwarding flow is very small or almost empty, the BU message is rarely being dropped (Jacobson, 1999).

Priority Queue algorithm (PRI) has been chosen as a scheduler at all of ER and CR to provide QoS in MIPv6 networks. It can provide service differentiation by classifying the arriving data to different priority classes. The PRI scheduler at the output link is very strict to ensure that EF will always get better treatment compared to AF and BE class (Ferrari, 2000). Also, it has the advantage of being simple and easy to implement as scheduler for traffic at each output link in DiffServ domain.

Extended Router Advertisement Message:

The proposed scheme relies on the DiffServ functions without any additional extensions in the existing framework. However, slight modification to MIPv6 messages is necessary in order to bring Quality of Service guarantee for Mobile host.

This approach extends the MIPv6 Router Advertisement (RA) message (RFC 4443, March 2006) to include DiffServ QoS desired information on certain Access Routers. This is to notify the Mobile Node (MN) with pre-defined the service classes in DiffServ and the current available resource in the AR even before the MN performs handover as shown in Figure (4). The new message is referred to as DiffServ Router Advertisement (Diff RA) message.

It can be seen form figure (4) that the three sub-fields include the recent available bandwidth and dropping percentage information of each class of service on Access Router. While the last row indicates that the proposed scheme assigns EF flow to binding update (BU). The New AR_i (NAR_i) sends (Diff RA) message to the MN as in figure (2) which includes the following information:

- The three classes available by the DiffServ (i.e. the Expedited Forwarding, Assured Forwarding and Best Effort services classes)
- The percentage of drop precedence that is used for policy restriction according to the three classes
- The available bandwidth reserved for each class.
- Specify the EF to the binding Update message.

Managing and control the traffic resource is important for every Mobile app in order to operate properly. So, if the MN moves into an overlapping area of multiple New AR (NAR_i)s, it will use the advertised information as criteria to choose the new access router with best matches resources available.

However, the available bandwidth of the link depends on the number of active hosts in a cell and on the aggregated traffic of each class. So, the Access Router which is in charge of QoS management in a cell should be informed about the bandwidth required by each mobile host, keep track of the number of host, and configure the parameters of the DiffServ mechanisms to obtain desired behavior (Antonio, 2003).

Performance Evaluation:

Network Simulation version two (NS-2) (Teerawat Issariyakul, 2008) is used as a simulation platform to implement the proposed scheme (DiffServ-MIPv6). The simulation has been conducted to compare the performance of the proposed scheme with the standard MIPv6 protocol. The implementation and evaluation are performed by extending Nortel DiffServ module (Peter Pieda, 2000) and the MIPv6 module included in FHMIP extension (Hsieh).

Performance Metrics:

In order to evaluate the performance of the proposed scheme, two main performance criteria need to be considered in the simulation. Those are exhibited as follows:

Handover Latency:

Generally, the handover latency refers to the amount of time that it takes for the MN to be granted access into a new network. In particularly, it is the time that elapses between the last packets received via the old route and the arrival of the first packet along the new route after the handover. The latency is an important performance criterion for real-time applications -delay sensitive applications- for instance VoIP and video on demand (VoD).

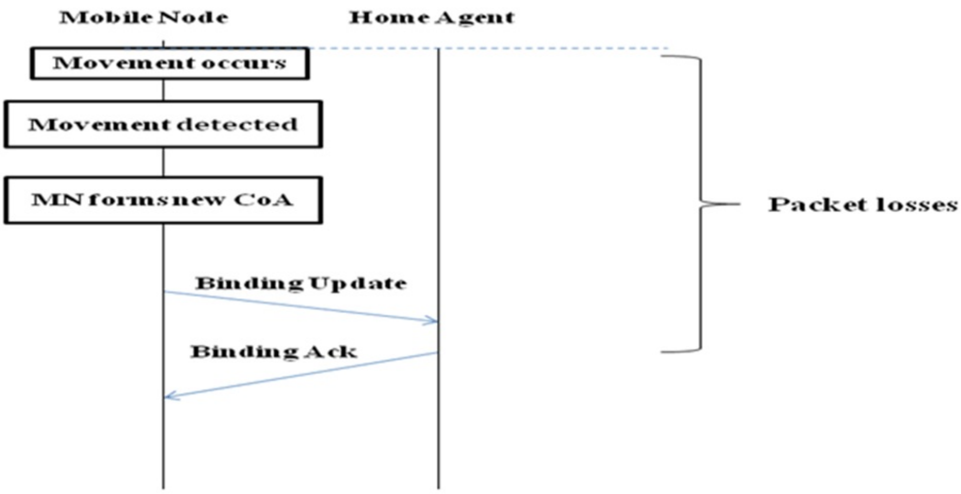


Fig. 3: Binding update and associated packet losses.

8 bits	8 bits	16 bits
Type	Code	Checksum
Cur Hop Limit	M | O | H | Reserved	Router Lifetime
Reachable Time		
Retransmission Time		
DSCP=EF	Drop precedence %	Bandwidth (Kbps)
DSCP=AF	Drop precedence %	Bandwidth (Kbps)
DSCP=BE	Drop precedence %	Bandwidth (Kbps)
BU=DSCP(EF)		

Fig. 4: The format of DiffServ router advertisement (Diff RA).

Packet Losses:

It is the amount of packets dropped, lost or corrupted (never reach the intended destination) during the handover. In this framework the packet loss rate is defined as the number of lost packets due to the transfer divided by the total number of packets sent by CN.

Simulation Setup:

The simulation scenario with all the participating entities and links is depicted in Figure (5). It illustrates the network topology that is used in the simulation part with some assumed values. This topology reflects the setup of scenario consists of a Correspondent Node (CN) and Home agent (HA) that are connected to an Edge router (ER1) with 2ms link delay and the transmission rate for the link is 1 Mbps. The link bandwidth between ER1 and the CR is 1 Mbps link with 5 ms link delay. The CR is further connected to the edge routers ER2 and ER3 with 5ms link delay over 1 Mbps links. ER2 and ER3 are connected to OAR and NAR with 2ms link delay over 1 Mbps links. All nodes possess a hierarchical address as indicated in the Figure (5).

The wireless technology that has been used in the access network is a simple 802.11 between the base stations and the MN. Where, the access router radius is 50 meters for the coverage area in each subnet. Also, the overlapping region between two ARs is 10 meters. When the simulation gets starting the MN is close to HA and launches an UDP session with CN. A "UDP" agent is attached to the Correspondent Node. The connection is established form the source "UDP" agent to "null" agent attached to the Mobile Node. A "null" agent frees the packets received. "CBR" traffic generator is attached on the top of "UDP" agent at CN. The "CBR" is configured to generate 1 K Byte packets at the rate of 1 Mbps. The "CBR" is set to start at 10 sec and stop at 100 second.

This kind of traffic models real time data and is used because of its ease in studying protocol comparisons. The simulation time starts from zero second and finishes at 100 sec. After eleven seconds the Mobile Node is moved in the subnet of the OAR. Later on the MN moves and signs out from the previous subnet toward NAR with a rate of 1 meter/second (approximate human walking speed) that is exactly at twenty second from the simulation start time. Traffic management algorithms used in the simulation are, token bucket for admission control, RED for Buffer management and Priority queue as scheduler in the DiffServ domain. It is assumed that the allocating and controlling of the resources are been taken under control (i.e. the MN gets the required bandwidth in all access router domains). Therefore, this eliminates the need for Bandwidth Broker for simplicity of simulation setup. The source is assumed to be the CN which is fix node to avoid simultaneous mobility problem that might happen, while the MN is the destination.

Packet Loss Result

The graph in figure (6) represents comparison of packet loss rate between the proposed scheme, MIPv6 and Diffserv with MIPv6 implementation (i.e. when there is no priority to BU or when BU was assigned with other classes rather than EF). In the consecutive mobility environment, when the Mobile Node (MN) speed was varied (from 2 km/h to 14 km/h), the percentage of packets loss increases noticeably. This is due to the failure of the Home Agent (HA) registration when the binding update message BU does experience link congestion in the standard MIPv6. The congestion of the network is made in this scenario by setting the total source load to more than 1 Mbps to achieve highly link congest. Also, the packets loss excessively increases at HA when the binding lifetime for the BU at binding cache was expired. Therefore, the packets that intercepted by HA to be send to the intended MN will be dropped. It can be observed that from figure (6) the proposed scheme (DiffServ-MIPv6) is relatively decreased the packets loss rate less than the standard MIPv6 and DiffServ with MIPv6 implementation. The proposed scheme hires the edge router in DiffServ to assign the BU with high priority in the flow of Expedited Forwarding (EF). Consequently, the probability of burst losses of the packets is being decreased and improved Figure (7) studies the probability of dropping BUs with respect to the network load. In this scenario the capacity of link was modified in the network topology to 800 kbps which is acceptable to run real time application e.g. video conferencing. It is found that if the BU doesn't assign with high priority as in the standard MIPv6 and the network is under load less than 0.8 Mbps, the probability of dropping BUs is about 2% (i.e. the BUs were dropped slightly).

Whilst, if the network load is more than 800 kbps (i.e. exceeding the saturated bandwidth for the link), the probability of dropping the BUs becomes larger. Namely, it may reach more than 20% which is adversely affects the handover performance. On the other hand when the BU is assigned with high priority as in the proposed scheme (DiffServ-MIPv6), the drop is not often encountered even if the network is congested.

The Handover Latency Result:

Figure (8) shows the handover latency when the network load was varied concurrently from 200 to 1600 Kbps in case of the proposed scheme, the standard MIPv6 and DiffServ with MIPv6 implantation. Also, in this scenario the capacity of link was modified in the network topology to 800 kbps. It is can be noticed that when the network load is increased the handover latency is relatively increased (especially when the traffic load is exceeding 800 kbps). The standard MIPv6 has the worsen handover performance compared to others. This is because the increase of the load leads to congestion in the network that may cause handover delay (lost of the BU). The BU loss in the standard MIPv6 instigates the MN to retransmit the BU message periodically to the Home Agent (HA) until an acknowledgement is received (i.e. based on exponential back-off algorithm) or the maximum timeout value for binding was reached already which is obviously takes longer time.

Such retransmission is done based on an exponential back-off algorithm (Hesham Soliman, 2004). According to this algorithm, the MN doubles the time between retransmission every time a BU message is sent. The first BU would require more time since the MN has to perform (DAD) procedures. The default value for initial timeout period is supposed to be 1 second. Thus the retransmission with exponential back-off will be

(1 second, 2 seconds, 4 seconds and so on). Handover latency in proposed schemed is being improved and decreased the overhead of the BU retransmission. The obtained results show that the proposed scheme outperforms the standard MIPv6 and DiffServ with MIPv6 implementation in terms of handover latency. Eventually, it can be concluded that the binding update message has a negative impact in the handover latency if it is dropped due to the network congestion.

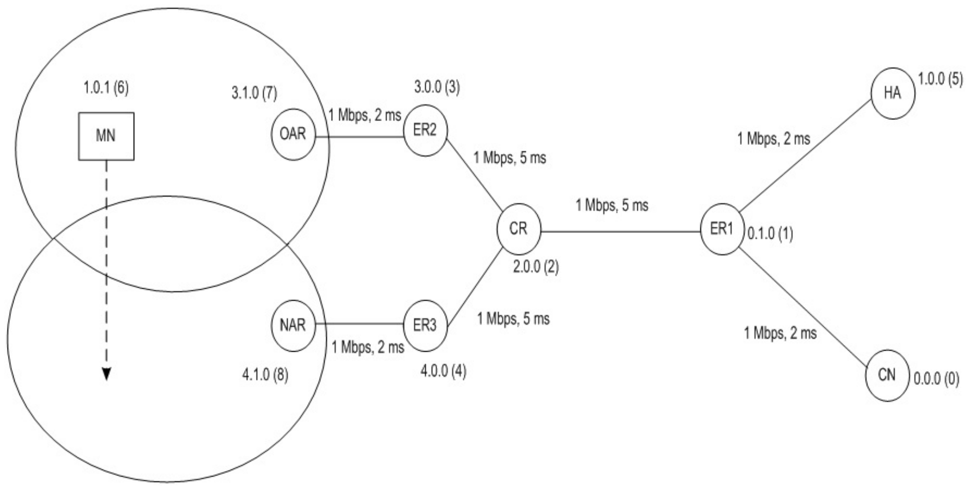
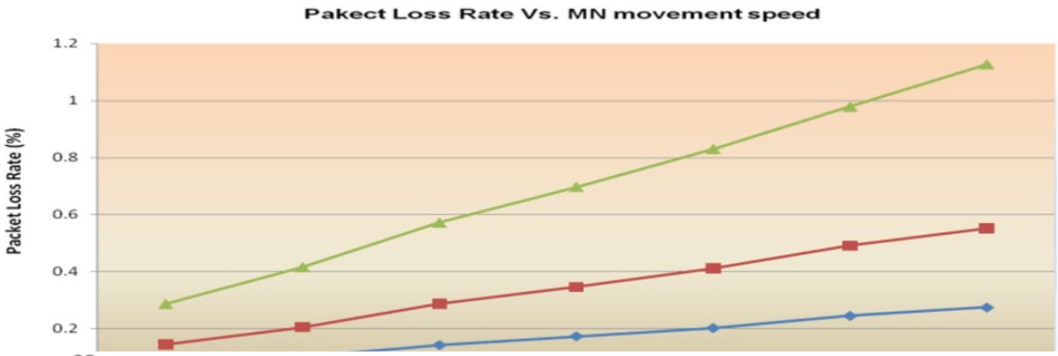


Fig. 5: The network topology for simulation.



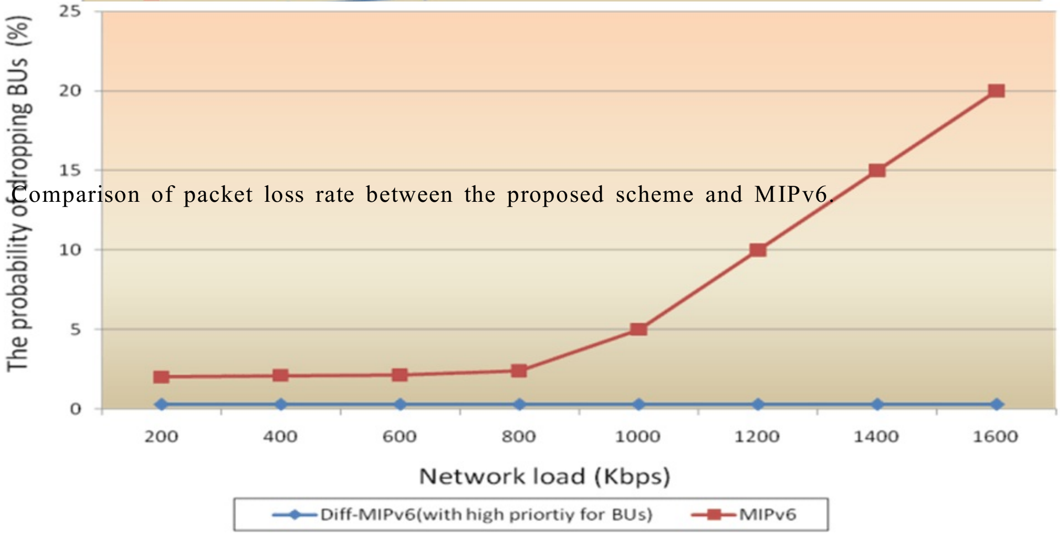


Fig. 6: Comparison of packet loss rate between the proposed scheme and MIPv6.

Fig. 7: Network load vs. the probability of dropping BUs in the proposed scheme.

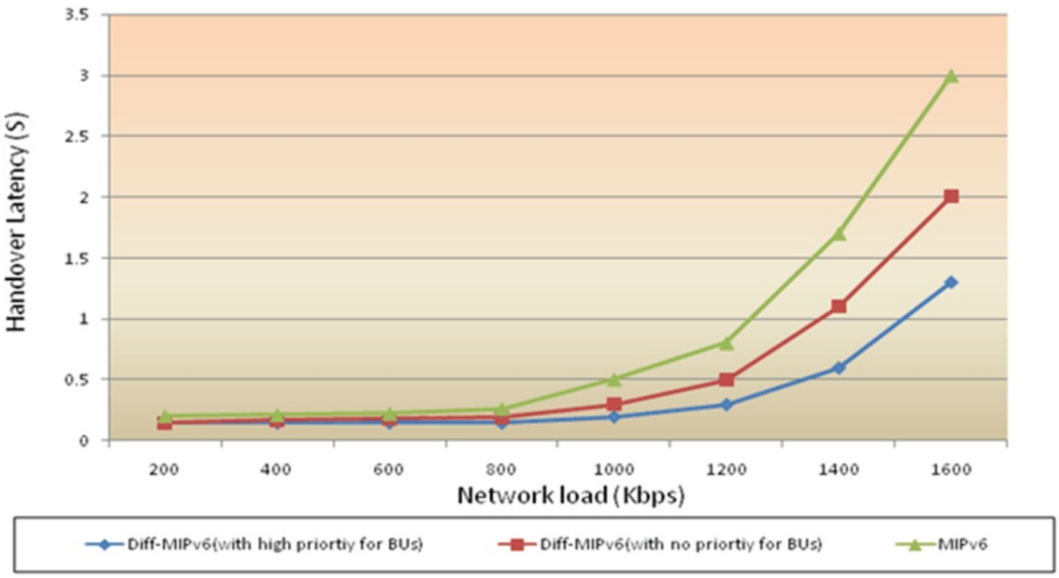


Fig. 8: Comparison of handover latency between the proposed scheme and MIPv6

Conclusion:

High packet loss rate and handover latency are greatly encountered in MIPv6 as major drawback. They cause user perceptible deterioration for real-time traffic. Taking this perspective into account, the proposed scheme intends to enhance Mobile IPv6 network to achieve better QoS. This paper has proposed a new scheme (DiffServ-MIPv6) which is deployed DiffServ model to provide QoS guaranteed service in mobile IPv6 networks. It extends router advertisement message to assign high priority to Binding Update (BU) massage. In order to evaluate Quality of Service within Mobility environment, Network Simulation version two (NS-2) is used. The simulation results have being obtained from the comparative analysis of the proposed scheme and the standard MIPv6. It shows that the proposed scheme reduces handover latency for the mobile node as well as alleviates packet losses. Therefore, the proposed scheme could be adopted to co-exist with the standard MIPv6 for offering better QoS to the mobile users. The open areas that could be taken under consideration for the future work are: QoS in the proposed scheme is only provided in Diffserv Network area, there is no service guaranteed between Mobile Node (MN) and access point (AP). Thus, IEEE 802.11e could be used as a mechanism to promise QoS between MN and APs. The dynamic DiffServ resource reservation could be also incorporated in the proposed scheme. Using the concept of dynamic Service Level Agreement (SLA) for mobile node with bandwidth brokers. The SLA needs to be designed between different ISPs.

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