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A QoS Awareness Scheme Sustaining Seamless Handover for Network Mobility

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Abstract

Objectives: This article proposes a new scheme known as (Diff-FH NEMO) to enhance seamless handover for the users within network mobility. **Methods/Analysis:** The proposed scheme adapts the method of Fast Hierarchical Mobile IPv6 (FHMIPv6) to shrink binding locality signaling issues. Furthermore, it exploits DiffServ depiction to pull off silky delivery of real time trafficking in heterogeneous network mobility. Network Simulator (NS-2) tool version 2.28 and analytical analysis are utilized to implement and assess the performance of the proposed scheme. **Findings:** Network Mobility (NEMO) basic support protocol (RFC 3963) endorsed by Internet Engineering Task Force (IETF) to enlarge the maneuver of Mobile IPv6 for better unremitting Internet connectivity to the users of mobile network. Here the protocol swaps mobility task function from mobile nodes to NEMO' router. In mobility network the router is identified as Mobile Router (MR), which executes location update with its Home Agent (HA) to launch a bi-directional tunnel between the HA and MR. NEMO is premeditated with explication so that network mobility is transparent to the nodes in order to ease location update signaling that could happen by each Mobile Network Node (MNN). Yet, delays in data delivery and higher overheads are expected to transpire because of unnecessary multiple encapsulations of data packets and sub-optimal routing. **Novelty/Improvement:** The proposed scheme intents to curtail the packet loss and moderate the handover latency as well.

Keywords: DiffServ, FHMIPv6, NEMO, QoS

1. Introduction

Neither IPv4 nor IPv6 implement many Quality of Service (QoS) features. IPv6 certainly provides more than IPv4 does with its traffic class, flow label fields, and its extension header. The Internet protocol over few years back, was supporting only single service rank called Best Effort (BE). With BE service, network would compose the preeminent exertion to convey packets to their destinations without exceptional resources allocated or guarantees to any packets. Namely, traffic sorted out as fast as possible but there is no pledge to delay, jitter, loss, bandwidth and throughput. Mostly, the Internet protocol permits the complexity to settle at the end points so the network's core can remain relatively trouble-free. As the beginning of a profound revolution, the Internet has made possible new applications such as (VoD, VoIP and Internet telephony) but the ways of communicating with them were never thought possible. The reason begin that, real time applications can't tolerate delay jitter or loss of data in transmission. To overcome these problems, numerous protocols of Internet Engineering Task Force (IETF) tackle resource assurance and service differentiation under the umbrella of QoS. Three imperative architectures endorsed by IETF to permit Internet providers and telecommunication operators to grant QoS guarantee to users for example Integrated Services (IntServ)[1], Differentiated Service (DiffServ)[2] and Multiprotocol Label Switching (MPLS)[3].

The current trend in the expansion of real-time Internet applications and the speedy development of mobile world designate that the upcoming Internet architecture will include bear diverse applications with diverse Quality of Service (QoS) necessities, despite of running on rigid or mobile terminals. Nowadays, statistics are estimated that additional mobile users will

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be linked to the Internet compared to desktop PCs users. Apparently, in statistical sense the mobile internet users will take over desktop Internets users by 2014 as shown in Figure 1. Since the amount of mobile computing devices such as (laptop, iPad, smart phone and PDA) significantly rises and the wireless network infrastructure is swiftly spread over the globe, the obligation of sustaining network mobility services on the Internet has emerged specially in environment like transportation systems (e.g., submarine, aircraft train and bus), Personal Area Network (PAN) and Car Area Network (CAN). Among all QoS models, the DiffServ appears to be as a prospective model for Network Mobility (NEMO) environment, because of its virtues such as free per- flow reservation, low control overhead due to the nonexistence of an external signaling and low complexity per-node. Even though NEMO basic support protocol can barely reduce the Binding Update (BU) traffic by using the mobile router, it inherits some limitation of MIPv6 such as the delay of movement detection and configuration of a new CoA. Consequently, the proposed scheme puts in to practical F-HMIPv6 protocol to pull off a seamless handover with lesser handover latencies and a smaller amount signaling overhead.

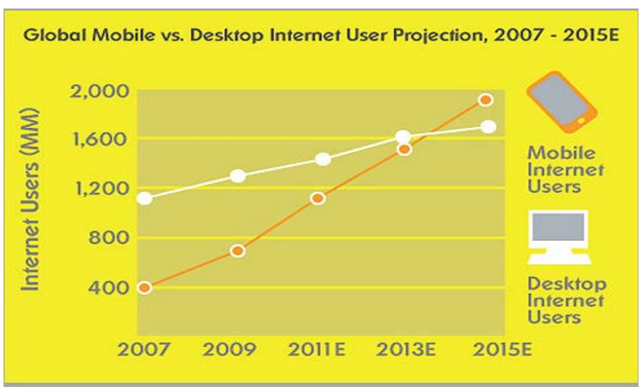

Figure 1. Mobile vs. desktop Internet users[4].

Many research works have been recently suggested in literature to enhance the performance of NEMO basic support protocol, since not only devices can be connected to the Internet but also massive vehicles though; mobile devices can easily get Internet connectivity even within public transport vehicles. In this paper[5] a novel resource reluctance protocol named NEMO Reservation (NEMOR) proposed to support QoS guarantee in NEMO situation. Authors used standard signaling protocol named NSIS that exploits benefits of both IntServ and DiffServ models to offer a appropriate QoS to NEMO. This work constructs a virtual tunnel of reserved resources to make convinced the aggregation of diverse flows using RSVP. The claim proposition was developed in two phases: The MR-HA and HA-CN. Nevertheless, the NEMOR protocol was considered as obsolete Internet draft. Authors in this paper[6] proposed that the MRs' HAs ought to aid RO between CR, MR and a router serving the CN. Nonetheless, this approach got some obstacles. It demands conservation of a soft-state at the CR in addition to the MR and it does not explain how to notify the CR punctually of changes in the MR's CoA. Route updating can be done quicker if an MR rather than a HA launched the RO technique once the network roamed. This paper[7] pitches the idea of a Mobility Anchor Point (MAP) from Hierarchical MIPv6. It meant to detach routing between the correspondent note and the MAP (inside and outside NEMO). HMIP-RO applies a customized version of HMIPv6 to broadcast MAP advertisement messages. Therefore, the MR possesses two care-of addresses (CoAs) (i.e., regional CoA from the MAP and on-link CoA from its nearby MR). Packets to the MR can be dispatched via the MAP, once the HA has been notified by the regional CoA of the MR and the on-link CoA of the MAP, respectively. Yet, whenever the MR roams to the sphere of another MAP, same issue might happen with NPI. This paper in[8] proposed evenhanded key for a scheduling algorithm in NEMO. The authors analyzed the performance of priority scheduling and fair scheduling. They suggested a scheduling algorithm Adaptive Rotating Priority Queue (ARPQP) that has bared QoS guarantees for the higher priorities and preserves the rational throughput for the lesser priorities. Another work in[9] proposed a combined route optimization scheme that figures out numerous types of RO issues via Path Control Header (PCH). The Home Agent (HA) piggybacks the PCH on the packet which is back warded from Mobile Router (MR). Any PCH-aware routing capability on the route has to formulate a RO tunnel with MR via the Care-of address of MR limited in the PCH. In result, optimizing the routes can be achieved by means of default HA-MR tunnel throughout the simple PCH interpretation. Another attempt in this paper[10] to propose an enhanced scheme based on FHMIPv6. This scheme essentially deliberates the Normalized Edit Distance to analyze and executes a combined-detection function between MN and MAP.

This article is prearranged as follows. Section 2 introduces background of Differentiated Service model and network mobility protocol. Section 3 explains concept of the proposed scheme. At last, conclusion is deliberated in Section 4.

2. Research Background

This section will explore the idea of DiffServ QoS model in brief and network mobility as well.

2.1 Differentiated Service

The Differentiated Services (DiffServ) model is premeditated to range large networks and customer population. It upgrades the scalability by letting complication to the network edges and the network core is maintained as effortless as possible for the classification and packet handling functions. To be precise, packets are classified based on the DiffServ Codepoint (DSCP) into different service classes. This type of classification is well-known as behavior aggregate (BA). Packets are firstly policed, marked and shaped by edge routers, conforming to the resource obligation arranged by the Service Level Agreement (SLA). The routers at the core of the network deal with packets depending on a Per Hop Behavior (PHB). So, based on node position in the DS domain topology, it should carry out one of the following actions:

- Ingress and egress nodes (edge routers) get to perform traffic conditioning based on a Traffic Conditioning Agreement (TCA) flanked by their DS sphere and the peering sphere which they attach to as shown in Figure 2. The Traffic Conditioning Agreement or (TCA) is a subset of Service Level Agreement (SLA). It includes parameters regarding to traffic profiles, performance metrics (such as latency, throughput, and drop priorities) and instructions on how out-of-profile packets will be treated. Packets are divided to cumulative flows and marked consequently. In case of the cumulative flow is over profile, the EF packets have to be policed and the AF packets will be marked with a higher dropping precedence.
- Interior nodes (core routers) do not implement traffic conditioning as depicted in Figure 3. They only classify and forward the packets to hosts within a DS domain (but not between DS domains). Classification and the forwarding to the relevant queues are made based on the DSCP. The core router does not need to process per flow signaling and resource reservation. So, it is relatively easier to implement in the Internet and have a better scalability.

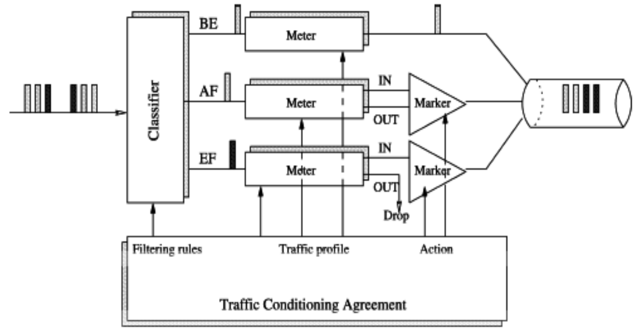

Figure 2. Edge router functions.

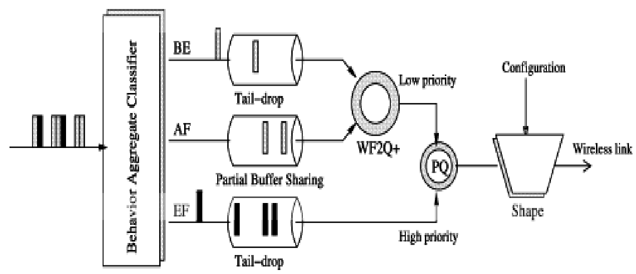

Figure 3. Core router functions.

Resource distribution is carried out by the Bandwidth Broker (BB) in a federal way, without energetic resource reluctance signaling and reservation status preservation in the central part routers[11]. It is an agent in charge of allocating favored service to users as demanded. Also, it used to configure the network routers with the proper forwarding behavior for the distinct service. In addition to Internet best effort service, DiffServ provides two different services of PHBs: Expedited Forwarding (EF) and Assured Forwarding (AF). EF is proposed to bear premium service for real-time applications that involve harsh guarantee on delay, bandwidth, packet loss and jitter. The codepoint for the EF is 101110. On the other hand, the AF is used to assemble extra “elastic” services that compel necessities only on throughput without any delay or Jitter restrictions. Four AF classes are defined in relation to three drop precedences.

2.2 Network Mobility (NEMO)

NEMO basic support protocol is de facto standard extension of Mobile IPv6 (MIPv6). The network of NEMO comprises at least one Mobile Router (MR). The MR has been initiated to handle the mobility of entire nodes within NEMO. As an alternative of updating all the home addresses of Mobile Network Nodes (MNNs)

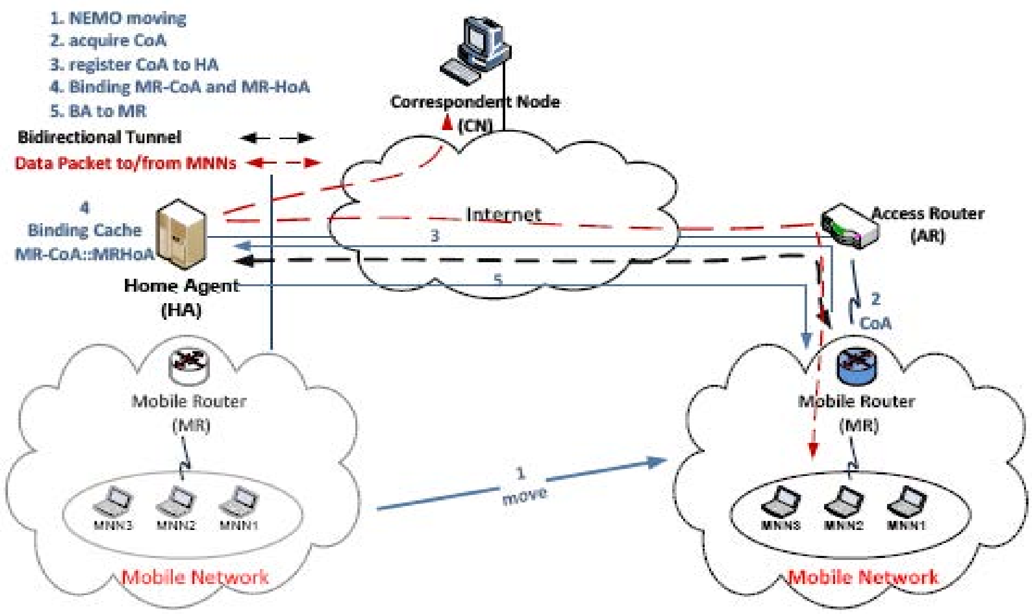

Figure 4. Basic architecture of NEMO BS.

within its network, the MR needs only to send a Binding Update (BU) message to its Home Agent (HA) in order to register the location of its mobile network as shown in Figure 4.

If the NEMO is static, it will have a continuing fixed address called a Home Address (HoA) and fixed network prefixes called Mobile Network prefixes (MNPs) as illustrated in Figure 5. These addresses stay set to the mobile network when it is far from the home network. Precisely, MR's HoA persists unaffected in spite of its attachment point in the Internet. Nevertheless, these addresses contain topological implication only when the mobile network remains in the home network.

Type	Length	Reserved	Prefix Length
Mobile Network Prefix			

Figure 5. NEMO mobile network prefix option.

As the mobile network moves to foreign network, the MR acquires an address from the foreign network called the Care-of Address (CoA). Afterward, the MR will send a BU message to its HA (located in the home network) in order to map and bind its HoA and MNPs with the newly configured CoA. The BU's message format is shown in Figure 6. After a successful conclusion of binding process, a bi-directional tunnel is launched between the CoA of the MR and HA. All the packets sent by the Correspondent Node (CN) to the MNNs are intercepted by the HA and encapsulated with an extra IPv6 header with MR's CoA as the destination address. Mostly, the packets can only now be transferred to intend mobile network node in NEMO via HA-MR tunnel. As a final point, the MR receives the encapsulated packets in its CoA, removes the outer IPv6 header and looks up its routing table to send all received packets to MNNs within the mobile network[12].

8 bits	8 bits	8 bits	8 bits
Payload proto	header len	MH Type	reserved
checksum		sequence number	
A | H | L | K | M | R	reserved	lifetime	

Figure 6. NEMO binding update message format.

3. Materials and Methods

3.1 The Proposed Scheme

The scheme (Diff-FH NEMO) has been proposed initially in[13] to provide QoS with mobility management for end users in roaming network. The proposed scheme also enhances Route Optimization (RO) within network mobility to enable undeviating path communication between the MNN and CN in the Internet. The depicted topology in Figure 7 presents the proposed scheme when DiffServ Mobile Router (DMR) roams from outside the old MAP domain towards new MAP domain which is known as macro/inter mobility mode. Here, the HA and the CN have to be informed of the change in this situation unlike the micro/inter mobility mode. The proposed scheme exploited the use of route optimization support for Mobile IPv6 available in the correspondent nodes to provide route optimization for mobile networks. Therefore, when DMR sends a BU to the CN that is situated within the site, the CN would be able to send data packets marked with DSCP into IPv6 packet header directly to the DMN and then to intended MNN without MAP or HA intervention. Any IPv6 packet can be define as a block of data that incompasss header and payload.

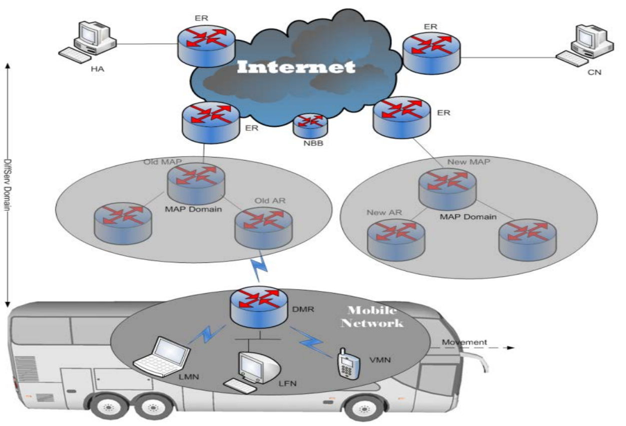

Figure 7. The proposed network topology in macro/inter movement.

The IPv6 specification is addressed in (RFC 2460, 1998). Mobile IPv6 comes up with a new IPv6 extension header known as Mobility Header (MH). The Mobility Header is used to hold all Mobile IPv6 messages (RFC 3775, 2004). Binding Update (BU) message is one of numerous Mobile IPv6 messages that are encoded as options in Mobility Header. As soon as the Binding Update (BU) is integrated in the Mobility Header, the field MH type in the binding update message format is set to 5 as shown in Figure. 8.

IPv4 and IPv6 packet header have one byte identified by the TOS (Type of Service) and Traffic Class (TC) field respectively. In DiffServ context, those fields are switched by the DS-Field. The coded value in DiffServ model is referred to as the DS Code Points (DSCP) as illustrated in Figure. 9. Six bits of the DS field are used as a codepoint (DSCP) to select the PHB for packet experiences at each node. In addition to a two-bit currently unused (CU) field is reserved for future use (RFC 1999). The value of the CU bits is ignored by differentiated services-compliant nodes when determining the per-hop behavior to apply to a received packet.

The procedures actions in macro/inter mode, are typically indistinguishable to micro/inter mode excluding that the bi-directional tunnel is recognized between old MAP and NAR situated in the new MAP sphere. The sequence of messages and control flows for macro/inter

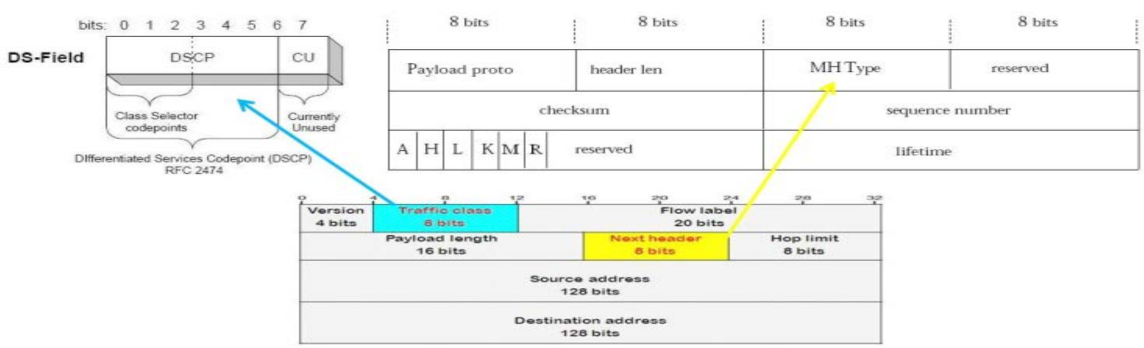

Figure 8. IPv6 fixed header containing TC and MH byte.

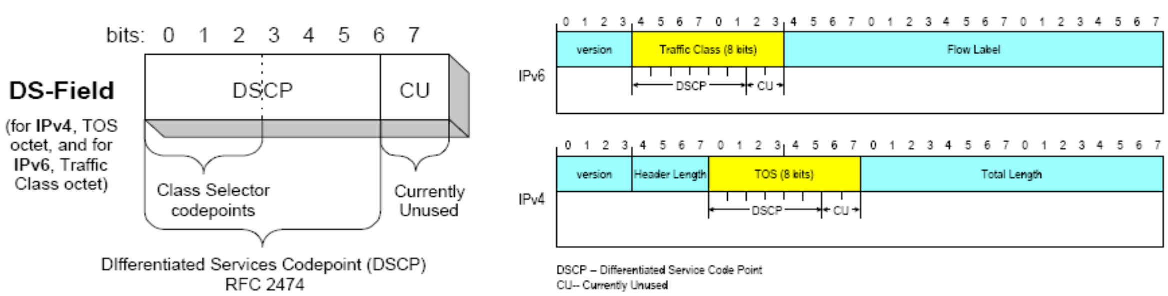

Figure 9. Differentiated service code point in IPv4 and IPv6.

mobility mode are illustrated in Figure. 10. The detailed description of operation procedures are summarized below:

- Based on Layer 2 handover anticipation, the DMR sends proxy router solicitation (RtSolPr) message to OAR for neighborhood prefix discovery (i.e. in order to obtain the network information right away).
- As retort to the RtSolPr message, the OAR sends the proxy router advertisement (PrRtAdv) message to the DMR, which comprises information about new LCoA for the DMR to use in the NAR region. So, the DMR would foresee the occurrence of the macro mobility handover.
- With the information incorporated in the received the PrRtAdv message, the DMR generates both a New LCoA based on the prefix of the NAR and a New RCoA based on the prefix of the New MAP.
- Then, DMR sends a Fast Binding Update (FBU) message to the old MAP in order to bind the previous PLCoA with new NLCoA.
- Once the old MAP got FBU message from the DMR, it will sends a HI message to the new AR that the DMR expects to move into. The NAR ought to carry out a Duplicate Address Detection (DAD) process for the NLCoA requested by the DMR. Concurrently, the NAR sends a HI message to the new MAP in order to request the DAD test for the new RCoA asked by the DMR. In response to the HI message, a HAck message should be sent back to the NAR and old MAP at the same time.
- Next, the old MAP sends Fast Binding ACK (FBACK) messages toward the DMR over PLCoA and NLCoA. At this very moment the layer 2 handover would take place. As a result, the old MAP establishes bi-directional tunnel to NAR with all the data packets that have been marked with a Differentiated Service Code Point (DSCP) value into IPv6 packet headers.
- The MAP commences forwarding the data packets toward the NAR by using the established tunnel. The data packet may store in the NAR for a while until the DMR announces its presence on the new link by sending Router Solicitation (RS) message with the Fast Neighbor Advertisement (FNA) option to NAR. Consequently, NAR delivers the buffered packets to the DMR. Therefore, the packet loss can be reduced in macro mobility handover. Moreover, the DMR decapsulates the tunnel and forwards DSCP data packets to intend MNN based on MNP.
- The DMR should perform the local registration by using Local Binding Update (LBU) and Local Binding ACK (LBA) messages with the new MAP. The LBU includes new LCoA, new RCoA at the new MAP and MNP.
- When the new MAP receives the LBU, it will stop the packet forwarding to NAR and then clear the tunnel established from the old MAP for fast handover.

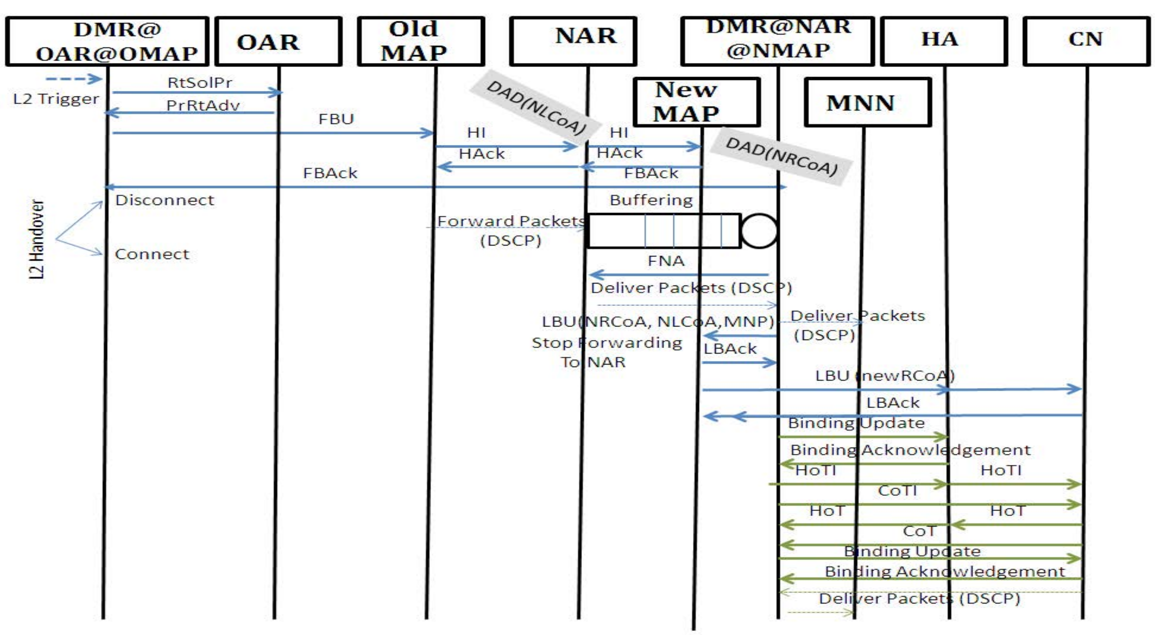

Figure 10. The sequence messages for macro/inter mode in the proposed scheme.

The MAP stores the bindings in the Binding Cache (BC) and forwards the LBU to the DMR's Home Agent (HA) and Correspondent Nodes (CN) as well, in order to make them aware of the current RCoA. Then, it will receive (LBAck) simultaneously.

- Finally, after completion of the local registration in Macro/Inter mobility handover, the DMR must send Binding Update (BU) message to the HA in order to report to about its movement toward new MAP with New RCoA. So, the BU will bind the DMR home address with its NLCoA (which is located in the new MAP with new RCoA). Enabling route optimization in the proposed scheme is done by sending BU to CN as well. Nevertheless, return routability (RR) procedure test has got to perform before carrying out binding update process at CN , so that BU will be authentic and does not instigate from a third party/ malicious DMR. The procedure of Return Routability process is briefly expounded as following points: The DMR sends a Home Test Init (HoTI) message indirectly to the CN by under passing the message via the HA. Then, the DMR sends a Care-of Test Init (CoTI) message directly to the CN. After that, the CN sends a Home Test (HoT) message replying to the HoTI message (i.e., sent indirectly to the DMR through the home agent) followed by the CN sends a Care-of Test (CoT) message replying to the CoTI message (i.e., sent directly to the DMR). So, finally the CN can send the packets optimally straight to the DMR instead of intercepting by the HA or MAP.

4. Conclusions

The mobile networks take part in a crucial character for communication and information technology. Lately, we have noticed a set of hosts that wanders away cooperatively as a whole single unit for example on trains, buses, planes. Hence, protocols for mobility support demand to be unlimited to support an individual mobile device but also an entire mobile network as well. In this paper, we have presented the techniques of the proposed scheme (Diff-FH NEMO) in case of inter domain movements. We have proposed QoS-based mobility management approach to diminish the packet loss and delay throughout handover procedure in network mobility (NEMO) context. The proposed scheme has deployed Differentiated Services (DiffServ) model to provide various services classes to users of real-time applications in NEMO. Moreover, it overcomes the issue of NEMO inefficient routing by deploying the technique of MIPv6 route optimization. Therefore, the proposed scheme could be embraced to co-occur with the standard NEMO basic support protocol to contribute with superior QoS for the mobile users. Meanwhile, Network Simulator (NS-2) tool version 2.28[14] is being used to implement the proposed scheme and analytical analysis is being developed concurrently to conduct and generate the signaling cost.

5. Acknowledgements

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