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Reducing Handoffs Delay in B3G Networks

Asad Ali [1], Muhammad Irfan [2], Zulfiqar Ali [2]

NUST School of Electrical Engineering and Computer Science [1], isamabad

Department of Electronic Engineering [2] Balochistan University of Information Technology and Management Sciences[2], Quetta

Email: asad.ali@seecs.edu.pk, {muhirfann, z.ali62 }@yahoo.com

Mobility Management in B3G Network

Abstract: Though Beyond Third Generation Systems (B3G) enable user to roam freely in the heterogeneous environment. But since the network is heterogeneous, so there arise number of problems due to heterogeneity. One such big issue is the proper management of the handoffs. When the nodes are mobile, they frequently change their current network, or switch to different access-point in the same network. So during such change of network, access-points or base stations, communications are normally interrupted or dropped. So in this paper, we have proposed a solution to handle handoff efficiently, so that there may be no interruption in communication.

Keywords: B3G Networks, Mobility Management, Handoffs, heterogeneous networks, mobile node.

INTRODUCTION

Although 2G and 3G have greatly enhanced the scope of communication, however, the induction of these technologies make it necessary for the service providers to change their existing Infrastructure. Instead of changing the infrastructure, in B3G networks, we strive to seamlessly and smoothly integrate the existing heterogeneous infrastructure with little or no modification to the existing protocols [2]. B3G networks have revolutionized the mobile communication. Mobile subscriber, while roaming will be able to obtain services across heterogeneous networks. The B3G [1] network will be able to facilitate seamless mobility across heterogeneous access networks. Mobility Management in B3G networks is one of the challenging research areas of future B3G network. Mobility management aims to provide uninterrupted, seamless connectivity to mobile users, while giving them the ability to access information anywhere, anytime and anyhow. In mobility management, we basically work on two things, that is, Location management and Handoff management. Location management helps network to determine the point of attachment of the mobile user while handoff management help him to as it moves around. While moving, the mobile node frequently changes its access point or the network to which it is connected. This change of access points or networks is known as handoffs. So some time when handoffs are not properly handled, a delay may occur due to which the connection may be interrupted or even may be broken. Once the connection is established between the nodes, the nodes must be given continuous service, that is, the connection must remain intact. The communication must not be interrupted or broken. This can be easily handled when the nodes are stationary. However, if nodes are mobile, the connection may be interrupted, if handoffs take longer time. So in this paper we have proposed a mechanism in which handoff delay has been overcome and thus the interruption in the connection is avoided.

Rest of the paper is organized as follows: In Section II, we will give the related work. In section III, the proposed scheme, in section IV, conclusion while in section VI, future work.

RELATED WORK

Handoffs are basically a difficult thing to be handled. Number of protocols has been proposed to handle frequent handoffs efficiently and effectively. Normally they are handled by mobility protocol such as MIP, SIP, and SCTP. All these protocols are designed to work at different layers and use different approaches to facilitate mobility. MIP works at network layer and it requires the deployment of two servers including Home Agent and Foreign Agent. However, MIPv6 improves the performance by removing the need for foreign agent. Once mobile node updates its new address with HA, it directly receives packets from providers. SIP works at Application Layer and requires the deployment of Redirect server and Proxy server for its functionality. The defect in the two protocols is that they couldn't be used in Ad-Hoc environment. The Stream Control Transmission Protocol (SCTP) works at transport layer and uses multi-homing to implement mobility management.

All the protocols discussed above, though they handle handoff in a quite good manner but however, they do not overcome the delay in the handoff.

In B3G, handoff request can be based on number of things like criteria of reducing the cost, optimization of resources in the network, service related requirements etc. Many solutions have been proposed with the aim of reducing the Handoff delay/Latency and many work have been done as well as going on. In mobility management handoffs are the most difficult things to handle, particularly when the handoffs are encountered very frequently. So a lot of work has been done in this regard.

[6] Provides a solution to a soft-handoff management at the IP layer which is based on registration process, duplication process, merging process and merging process. On the other hand in [7] the author shows a designed to provide mobility within a domain. The design emphasize on not to use MIP for global mobility management.

In [8] the author shows the architecture of B3G networks. In the proposed architecture the basic structural elements are software agents which can be either users, network providers or the Mobile Anchor Point (MAP). The proposed architecture focuses on the initiation and decision phases of the handoff mechanism. In order to support transparent mobility in All-IP networks, IST project EVOLUTE uses an approach which is based on domains. According to the EVOLUTE project, Cellular IP is used for micro-mobility to support fast handoff and paging within an administrative domain [9].

In addition to this, the issue of Handoff Latency is being highlighted at number of platforms like consortia, IEEE 802 LAN/MAN Standards Committee, Internet Engineering Task Force (IETF) and there are many others as well. They are putting their due efforts in finding the ways to optimize the handoff performance and a lot of work is being carried out in this regard. IETF extended the Mobile IP, IEEE formed Media Independent Handover working group in IEEE 802. Similarly there are numbers of task groups within IEEE 802.11 like IEEE 802.11r, which deals with issue of roaming and IEEE 802.11u which is aimed at providing interface to external networks.

Now let's talk about the problem arise when we are not using the Route Optimization in the operation of Mobile IP [10]. The reason we are mentioning this here is because it is actually the direction from where we have started our work.

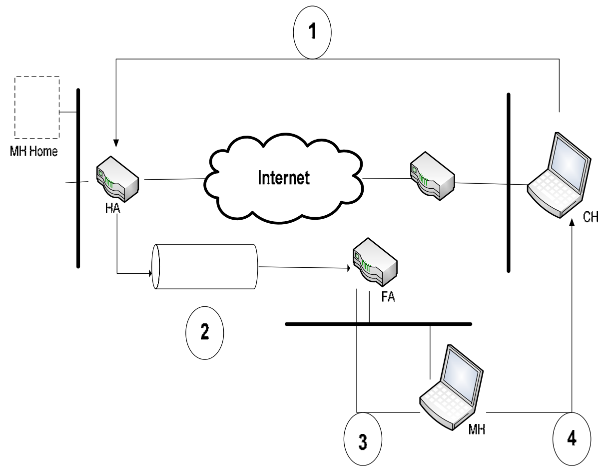

Fig. 1: Without Route Optimization

As seen and clear from the figure that because of No Route Optimization each time when CH wants to send some data to MH it will send that to HA, HA will encapsulate the data into another IP Packet to FA which later on deliver that to MH. With the introduction of Route Optimization solution we can get the solution in a way that HA after registering the CoA of MH will send the Binding Update Packet to the CN. As a result of which CH will bind the CoA with MH at its end, and start communicating with the MH directly.

With this however the problem arise when the MH moved and get associated with new FA so assigned new CoA, now CH can't be able to send the data to MH. In previously implemented solution HA will send warning message to CH to stop sending the date and this from where our work has started. We have attempted to lessen the burden on HA which is also the reason of delay, and tried to solve this problem by making MH send the warning to stop communication directly. How we have implemented this solution and what positive impact it has on the handoff latency reduction will be reviewed in the coming section.

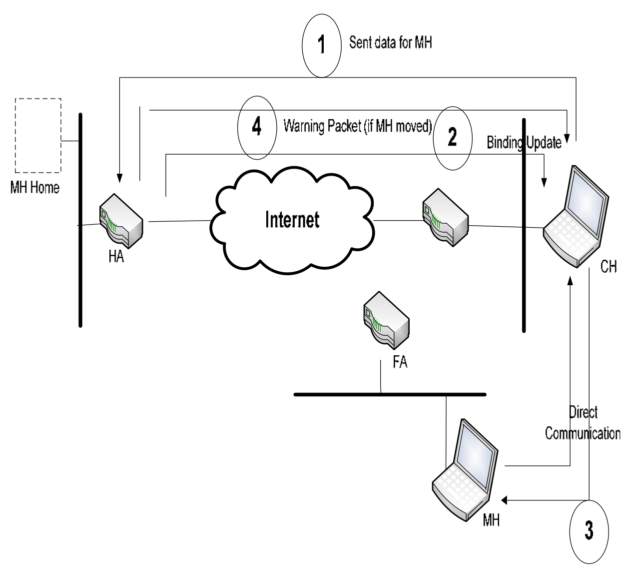

Fig. 2: Route Optimization

PROPOSED SCHEME

In this paper we have focused on the efficient handling of the handoff, so that there should be no delay in it. Thus, the user may not feel when it has change of access –point or the whole network. Mobile IP route optimization [12] extends the use of binding cache and binding update messages to provide smooth handoff. However, tunneled packets that arrive at the previous FA before the previous FA notification does are still lost. Such data loss may be aggravated if the MH loses contact with any FAs for a relatively long period of time.

In our proposed approach binding update messages are sent to CH using MIPV6 to avoid the need of binding cache and to support direct communication among CH and MH. Initially CH will start communication with MH through HA. HA will encapsulate its packets and tunnel it the FA, FA will decapsulate received packet, and will deliver these packets to the MH. Tunneling between the agents will be done using IP encapsulation within IP (RFC2003 [13]) or GRE, Generic Routing Encapsulation (RF2784 [14]).FA will decapsulate the data and will deliver it to the MH.

After receiving first packet from FA, MH knows about the original source of the packet, so it will send a binding update message to CH. In this way CH will be informed about the CoA of MH, CH will authenticate MH from HA, after authentication a direct communication session will be started between CH and MH. Now the problem arises when MH performs a handoff and joins a new FA, here is the possibility of data loss during handoff process. This problem was tackled by indirect data transmission from CH to old FA, and then to new FA which will buffer it and then will send it to the new FA [11]. We solved it by reducing the size of the sliding window to zero before the handoff take place, this is done to avoid data loss during handoff process and to reduce the delay incurred due to the indirect communication, as is done in [11].

A. Avoiding Data loss during Handoff process and reduction in the Handoff Delay

In our proposed technique on reception of a control message, CH will reduce sliding window size to zero. When MH gets registered with new FA it sends another binding update message with Authentication option field value equal to zero. From the binding update CH knows about new address of MH. CH will ensure this address from the HA, it will update its binding information and will start sending data by regaining its sliding window size. In this way our proposed scheme is not relaying on the old FA to get transmitted data during the handoff process neither this data is lost.

When an MH leaves an FA, it stores its authentication information for some period of time which could be used if the MH re-registers itself with old FA after a small time interval. By storing Authentication information the authentication delay could be reduced for MH those are frequently moving across a group of foreign networks.

In our proposed solution whenever an MH performs a handoff it will not rely only on its old FA and HA, instead we have distributed the work load among all entities properly i.e. FA, HA, CH and MH. We have divided the handoff process in three steps

New FA detection and evaluation to decide to which network the node connects to.

Registration and Authentication process with the new FA.

After establishing connection Notification process to inform the CH and HA about its new address. After performing first step of handoff process MH will send a control message (similar to the ACK) to CH, to reduce its sliding window size to zero. This information is sent in a TCP header, as sliding window size is controlled at the transport layer.

B. Reduction in CH Window Size and use of Authentication Option:

Whenever a node decides to perform a handoff it will send a Control message to CH announcing its window size equal to zero. This scenario is explained in the **(Fig. 3)** We also proposed an authentication option field to be included in the MIPv6 header. Authentication option can take one of the following two possible values.

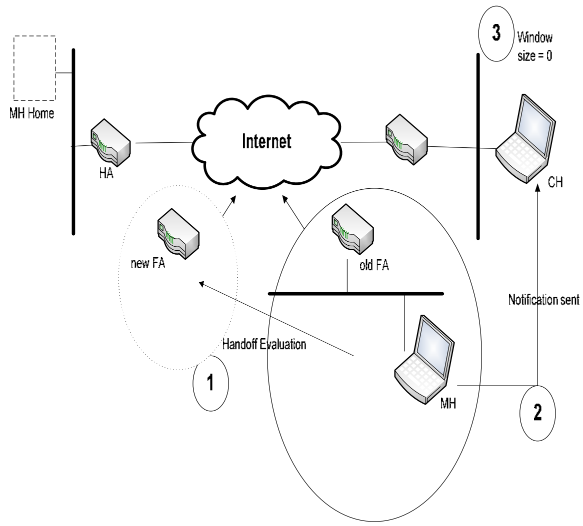

Fig. 3: MH Sends a Control Message to CH to Reduce its Sliding Window Size

After taking handoff decision MH will start its authentication and registration with the new FA. In our proposed scheme MH will not rely on the old FA to avoid data loss instead, it is handling it by itself. MH will get register with new FA; new FA will authenticate MH from it's HA. This is shown in **(Fig. 4)**.

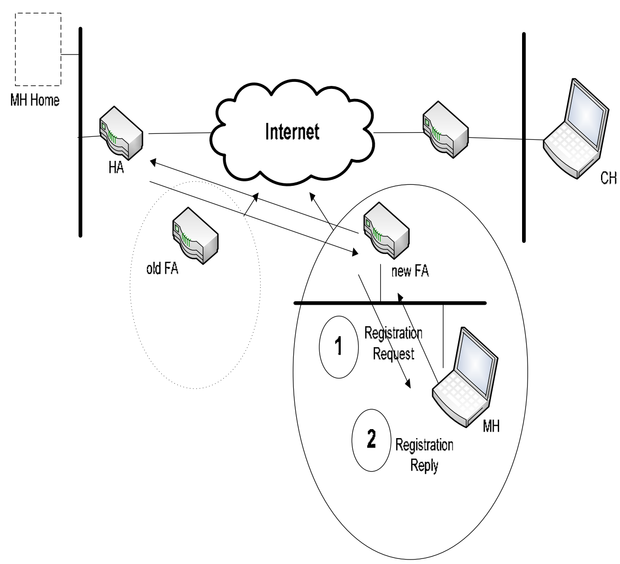

Figure 4: Registration with New FA

Here registration will take less time as compared to existing schemes as handoff decision is taken after evaluation. As soon as MH gets CoA from new FA it will sends another control message to the CH announcing its new Window Size, this message will be encapsulated in MIPv6 header. We have added an Authentication option=1, in the MIPv6 header options, when CH receive this message it will first authenticate the CoA provided in the binding update from the HA, after successful authentication CH will regain its previous window size. It is shown in the **(Fig. 5)**.

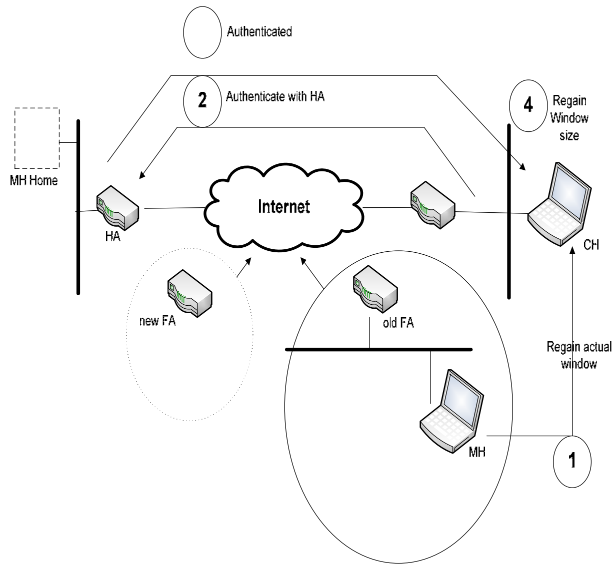

Fig. 5: Communication between HA and Old FA.

After completing this step communication among MH and CH is shown in the in **(Fig. 6)**.

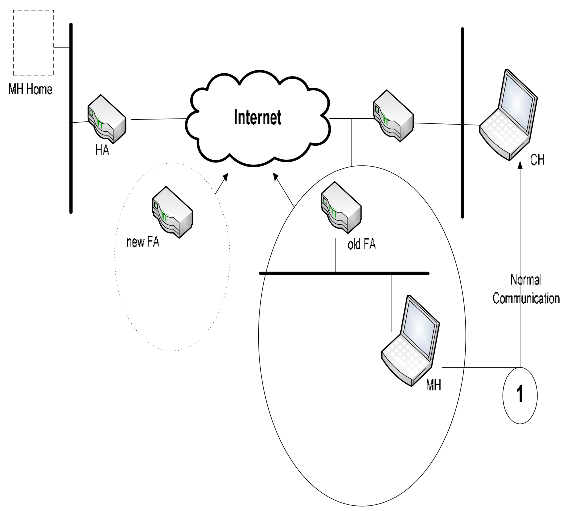

Fig. 6: Communication Among CH and MH After Binding Updates

C. Reducing Authentication Delay by keeping Authentication Information

After registering the new CoA of the MH, HA will send a notification message to the FA. HA will also send the expected time for which MH has leased a CoA from an FA. This time is represented by Allowed_Lease_Time. FA will use Allowed_Lease_Time in following way. It is shown in **(Fig. 7)**.

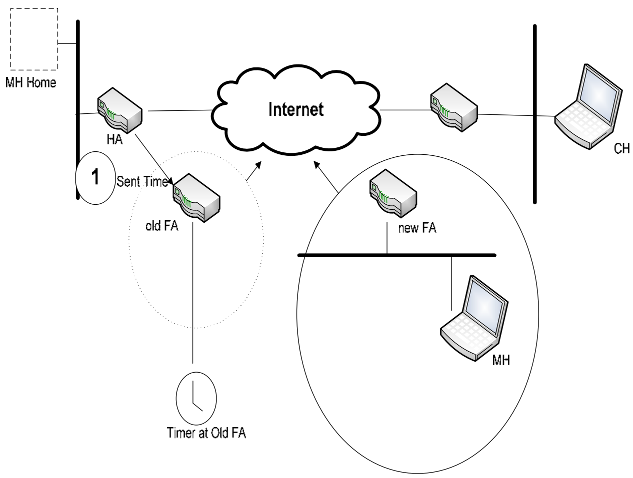

Fig. 7: Use of Timer to Rreduce Authentication Delay

One of two cases will happen and an appropriate action will be taken.

Here we are assuming that Expected_Lease_Time value is defined and stored for each FA locally. Expected_Lease_Time value should be defined in such a way that it reduces the storage burden on FA, as MH authentication information are stored at the old FA for the life span of timer whose value is less than Expected_Lease_Time. Expected_Lease_Time value could be greater for FA's that have large storage capacity and it must be small for FA's with less storage capacity.

Case 1:

If Allowed_Lease_Time>= Expected_Lease_Time,

Old FA will release the CoA assigned to MH, authentication information stored at the old FA will be deleted.

Case 2:

If Allowed_Lease_Time < Expected_Lease_Time.

In this case FA will start a timer and keeps the authentication information of the MH until the timer expires.

Keeping the authentication information will reduces the handoff delay for those mobile hosts which are switching among some FA's and joins an FA for a short span of time.

CONCLUSION

For Efficient and reliable handoffs management in B3G networks we have presented a scheme with two approaches , first to avoid data loss and to reduce handoff delays we worked on upper layer that is on transport layer and on IP layer to mange mobility seamlessly. In our approach we divide handoffs in three steps .initially a mobile host evaluates different handoff factors and take a decision on the basis of its evaluation. After deciding on a handoff MH sends a control message to CH, to stop sending data during handoff it is done to avoid data loss and to avoid indirect communication during handoff process.

In second step of handoff MH gets registered with a new FA , new FA authenticate it from HA and decides on the time for which CoA will be assigned to MH. After completing this process MH will send new binding update to CH with an additional option field set to 1, and its new Sliding Window size. On reception of this message CH will first

authenticate MH new CoA from HA, after authentication it will increase its sliding window size.
Finally in third step of handoff HA will send a Notification message to old FA along with the allowed time of MH registration with new FA. On the basis of this time FA will decided either to store MH information in its memory for later use or to prune it immediately to release its resources. This will considerably lessen the authentication time for mobile hosts, which are wandering among a group of FA's, while staying for a short span of time.

To the best of our knowledge, our adopted approach has not proposed or implemented before. Further work can be done on performing fast handoff evaluation and to optimize handoff triggering factors, which will further reduce the handoff time.

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