Combined Host Identity Protocol And Cell Switching For Efficient Routing

Asst. lecturer. Hyder R. Hamandi
Department of IT, College of Technical Management Baghdad
Foundation of Technical Education
hyder_hamandi@yahoo.com

Abstract:

Network Mobility (NEMO) is concerned with managing the mobility of an entire network, which changes, as a unit, its point of attachment to the Internet and thus its reach ability in the topology. The mobile network includes one or more mobile routers (MRs) which connect it to the global Internet. A mobile network is assumed to be a leaf network, i.e. it will not carry transit traffic. In this paper the Host Identity Protocol (HIP) is used to implement NEMO network to provide seamless mobility with low packet overhead. Also, the NEMO Cell Switching (NCS)technique is implemented in the MR devices to provide more efficient route management. Based on the above, this paper proposes the use of the HIPNCS technique for NEMO networks to provide low latency and low packet loss services as well as the support for efficient route decision mechanism. The implementation of the proposed HIPNCS network is achieved using the OMNeT++ simulator and the INET/HIPSim++ package.

Keywords: Host Identity Protocol (HIP),INET/HIPSim++, Internet Connectivity Strength (ICS),Mobile IPv6 (MIP),NEMO Cell Switching (NCS),OMNeT++.

دمج تقنية بروتوكول هوية المضيف مع تقنية تبديل الخلايا للحصول على توجيه شبكات متنقلة أكثر كفاءة

م.م. حيدر رأفت عبد الرزاق حمندي
قسم تقنيات المعلوماتية / الكلية التقنية الإدارية بغداد / هيئة التعليم التقني
hyder_hamandi@yahoo.com

الخلاصة :

شبكة التنقل (نيمو) تعنى بإدارة التنقل شبكة بالكامل، والتي يتغير، كوحدة واحدة ، نقطة ارتباطها بشبكة الإنترنت، وبالتالي وسائلا لاتصال في الطوبولوجيا. تتضمن شبكة التنقل واحد أو أكثر من أجهزة التوجيه المتنقلة (راوتر متنقل) التي توصل إلى شبكة الإنترنت العالمية. إذ يفترض أن تكون شبكة التنقل عبارة عن شبكة طرفية،أي أنه

لنتحمل حركة مرور البيانات العابرة. في هذه الورقة سيتم استخدام بروتوكول الهوية المضيف (HIP) لتنفيذ شبكة متنقلة لتوفير التنقل السلس مع تلك بسيط في نقل البيانات إثناء عمليات التبدل. أيضا،سيتم تنفيذ تقنية تبديل خلايا الشبكات المتنقلة (NCS)في أجهزة الراوتر المتنقلة لتوفير إدارة أكثر كفاءة للشبكة. بناء على ما تقدم ،تقترح هذه الورقة استخدام هذه التقنية للشبكات المتنقلة لتوفير اقل خسارة في البيانات وكذلك إدارة أكفأ للشبكة المتنقلة،فضلا عن تقديم الدعم لكفاءة آلية أختيار المسلك الأنسب لنقل البيانات. ويتحقق تنفيذ الشبكة المقترحة باستخدام OMNeT برنامج محاكي (أومنيت++).

1. Introduction

Net work Mobility (NEMO) is an extension of Mobile IP (MIP) that enables an entire network to change its attachment point to the Internet [1]. Under NEMO, a Mobile Router (MR) takes over the role of the Mobile Network (MN) in performing mobility functions. Nodes that are attached to an MR are Mobile Network Nodes (MNNs). These MNNs are not aware of the network's mobility and do not perform any mobility functions. MRs also send binding updates to their Home Agents (HAs). However, binding updates from MRs also contain the NEMO network prefix. HAs will bind an entire NEMO network prefix to the MR's Care of Address (CoA) and forward all packets for that network to the MR [2].

Figure.(1) demonstrates the path of packets between a NEMO network and a CN. IP packets from a CN that are destined for a node on a NEMO network are delivered via standard routing on the Internet to the HA of that NEMO. HA tunnels the packets to the MR for delivery to MNN. Reversed packets take the same path in the opposite direction; the MNN sends packets to the MR to be tunneled to the home agent and then sent out to the CN via standard routing on the Internet [3].

2. Literature Review

1- H. M. Huang et al [4] discussed the problems facing the handoff operations in NEMO and 3rd Generation (3G) mobile systems, and proposed two methods of handoff: horizontal handoff (send packets in advance machine), and vertical handoff using handoff table. They achieved efficient host mobility in heterogeneous environments. 2010.

2- M. Dinakaran[5] used NEMO support protocol to maintain the sessions of all nodes in the mobile network with its home network and external nodes. He proposed two ways to optimize the NEMO routing technique for registered and unregistered Correspondent Nodes (CN) of the Mobile Network Node (MNN). In other words when an new CN wants to transfer data to an MNN, and when an MNN negotiates with an existing CN. 2010.

3- M. S. Woo et al [6] proposed a tunnel compress scheme for multi-tunneling in Proxy Mobile IPv6 (PMIPv6) based NEMO. The scheme consists of two parts: the first part is an inter-domain or wired Internet part. The other is an intra-part of nested mobile networks. In the inter-domain part, single IP-in-IP tunnel is created by connecting an innermost entry point with an outermost exit point in original multi-tunnels. In the same way used in the inter-domain part, single IP-in-IP tunnel is created from the outermost exit point and an innermost exit point in original multi-tunnels. 2010.

4- L. Bokor et al [7] presented the structural design and the functional details of the Host Identity Protocol (HIP) simulation framework (called HIPSim++) integrated into the INET/OMNeT++ discrete event simulation environment. They designed a real-life HIP testbed and compared the simulation outcomes with the reference results obtained from this HIP testing architecture. Their analysis show excellent accuracy and consistent operation of the simulation framework in terms of handover metrics (latency, and packet loss) and behavior when compared to the real-life experiences of the HIP testbed. 2009.

5- P. C. Newton et al [8] proposed a mechanism to reduce the delay in establishing route optimization (RO) by effectively maintaining a table that stores information about whether a node supports RO or not. In order to reduce the table size and search delay, information about RO support is stored in binary value. The outcome is to reduce time taken for fall back procedure that in turn reduces excessive delay in establishing RO. In general, it helps to offer better Quality of Services (QoS) to the customers. 2009.

6- A. Udugama et al [9] illustrated a performance evaluation of NEMO management protocol using PMIPv6. The main advantage of using PMIPv6 is the freeing up of the mobile host in doing any mobility related activities and thereby saving its resources. The saving of resources may result in their usage for other purposes or even enable otherwise capabilities restricted devices to operate in the PMIPv6 domains. 2009.

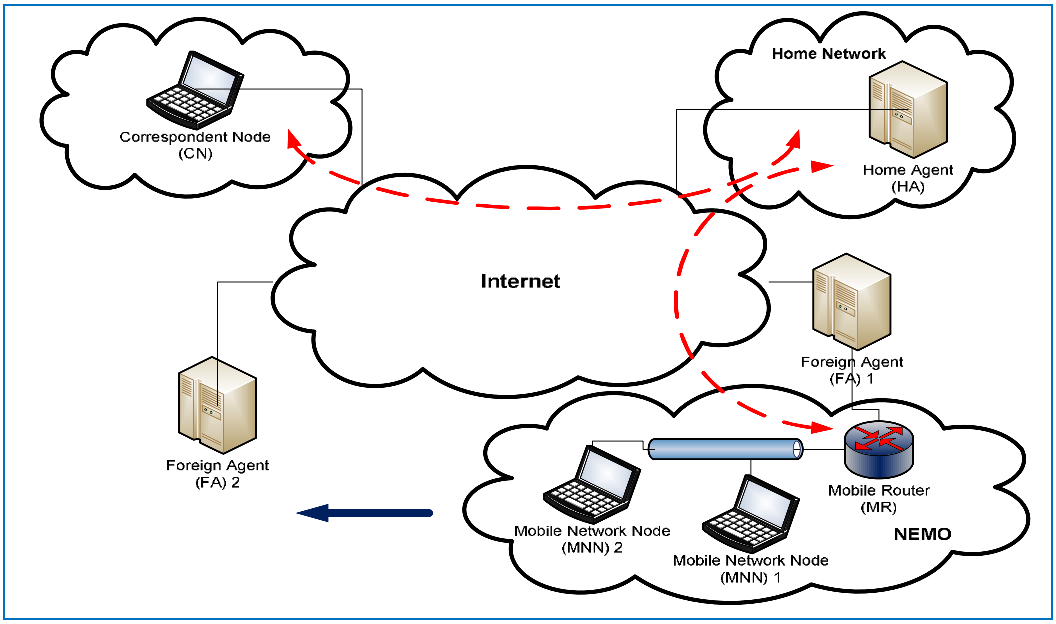

Fig. (1) Simple NEMO Scenario

3. THE HIP

The HIP aims to separate the different roles of IP addresses. While IP continues to act as pure locator, HIP introduces a new, globally unique namespace (the Host Identity namespace), which is a pool of identity representations called Host Identifiers (HIs). These namespace elements are of cryptographic names used to identify nodes.

Every HIP node has at least one HI and implements the functions required to handle the new namespace. The scope of the protocol includes the modifications and new methods that integrate the concepts of HIP into the existing Internet architecture. These functions form a new protocol layer, which resides between the transport and network layer. HIP separates application and transport layer connections from IP addresses thus enabling effective application of communication security techniques and mobility management [10].

4. IV. DESIGN OF HIP-NEMO NODES

In order to implement any NEMO network, an MR should be added to the network, this MR will take care of all the handoff operations that the network will face during its movement. A design of such MR has been implemented using the OMNeT++ simulator. In addition, other design modifications and additional nodes have been created and added to the HIPSim++ package to provide NEMO support. These nodes are discussed in the following subsections. All these nodes are designed to provide IPv6 support.

5. HIP-MR NODE CREATION

In order to implement and simulate HIP-NEMO, an HIP-MR node is created using the OMNeT++ simulator as shown in **Figure. (2).** This node will act as the MR node for the NEMO network. This node is not a part of the original HIPSim++ package, and is designed to fit the needs in the NEMO network. The mobility module in this node is added to provide mobility support to the MR. There are many types of mobility supported by the OMNeT++ network simulator, The **Basic Mobility** function is used for all mobile nodes in the proposed HIP-NEMO network. This node contains an application layer composed of TCP, UDP, and ping applications, a transport layer (tcp and udp), an HIP layer, a network layer, and MAC layer.

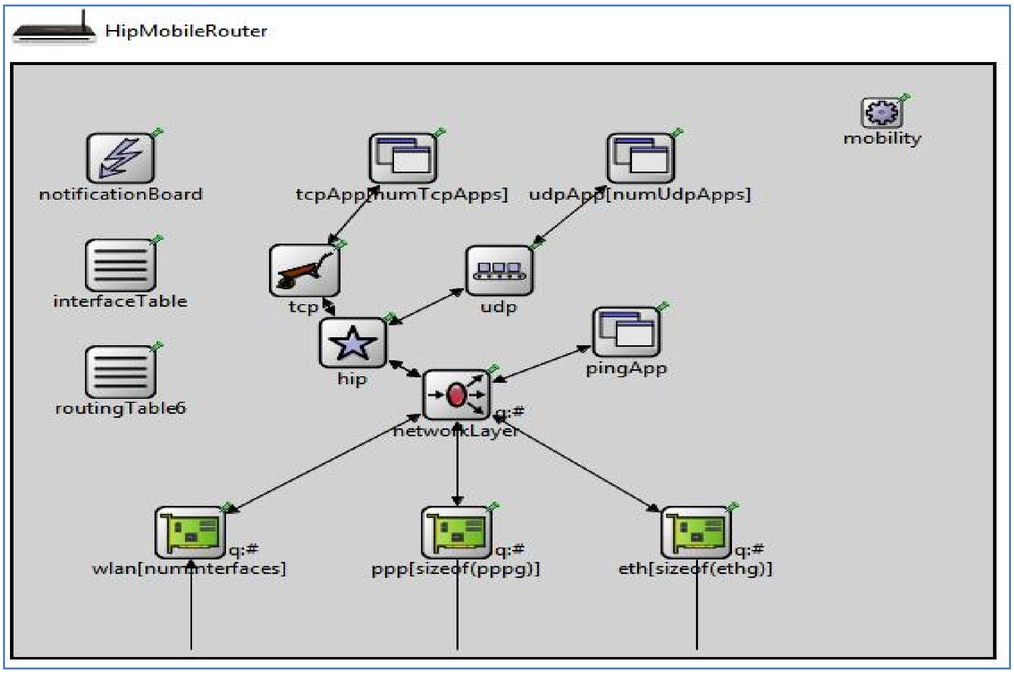

Fig. (2) IPv6 HIP Mobile Router Node Designed in OMNeT++

6. BASE STATION NODE CREATION

Base Station (BS) nodes are created using the OMNeT++ and added to the proposed HIP-NEMO NED file. These nodes are designed to have capabilities similar to any access point device **(Figure 3).** These nodes are not part of the HIPSim++ package. The mobility module is added here not to provide mobility function, but rather to provide channel control, since the mobility module provides both mobility functions and channel control features for any wireless device. Also the WLAN interface is not necessarily an 802.[11]wireless NIC card, the configuration of this interface module is specified in the omnetpp.ini configuration file.

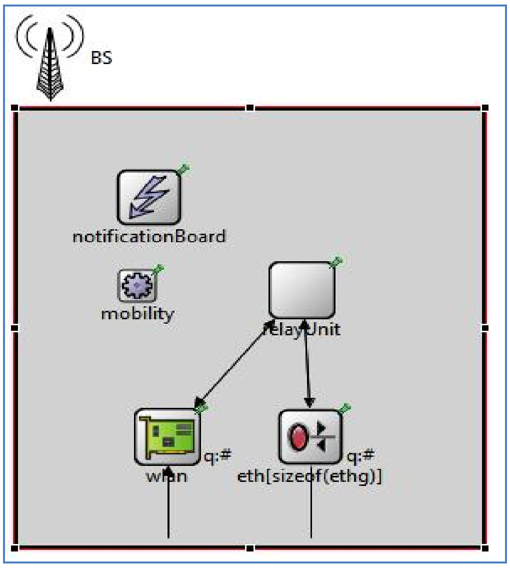

Fig .(3) BS Node Designed in OMNeT++

7. HIP-CELL PHONE NODE CREATION

An HIP-Cellphone node was created using the OMNeT++. This node is similar to any IPv6 host with HIP support (**Figure 4).** This node is not present in the HIPSim++ package and has been designed and added to be used in the proposed HIP-NEMO simulation.

This node is added to the network to show the interoperability of the proposed HIP-NEMO among various network topologies and transmission techniques. In the simulation scenario the transmission media and the transmission technique do not make an obstacle, and are not considered a problem, this is one of the main advantages of the proposed HIP-NEMO.

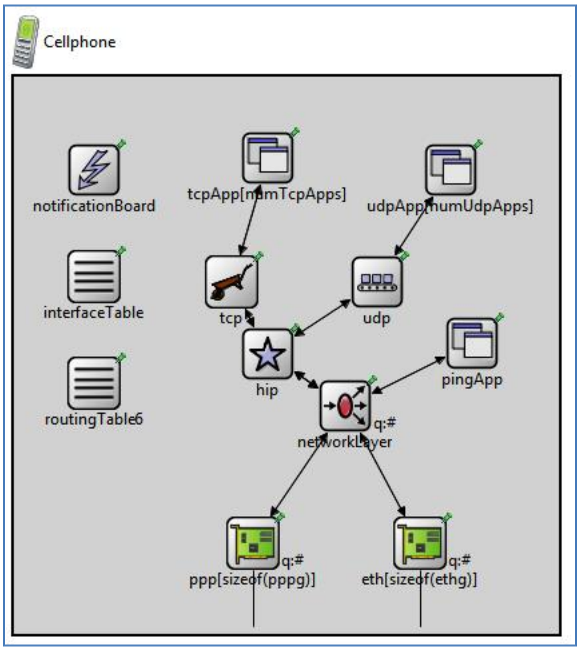

Fig.(4) IPv6 HIP Cellphone Node Designed in OMNeT++[12]

8. HIPNCS SIMULATION SCENARIO

The NCS algorithm[2]is modified and has been used to implement an HIP-NEMO simulation scenario. The modified algorithm flowchart is shown in **Figure (5).** This algorithm is used to implement a route decision operation for the proposed HIP-NEMO network.
The HIPNCS algorithm is implemented in the OMNeT++. This is achieved by creating a C++ file (routedecision.cc) and linking it to the simulation library.

The proposed HIPNCS algorithm is performed by the MR node to check Router Advertisement (RA) messages from all neighbor routers within its coverage range. These routers could be Access Routers (ARs) or other neighbor MRs. The MR node recognizes the type of the advertising router using the Extended Router Advertisement (ERA)message header. The MR is always connected to another router (AR or MR) this router is called the default router, and in most cases it has priority over the neighbor routers. This priority comes from the fact that the handoff operation causes undesirable latency and packet loss, so it is preferred to avoid handoff operations as much as possible.

In the proposed HIPNCS, the decision of executing a handoff operation depends on the Internet Connectivity Strength (ICS) parameter. The calculation of ICS is described in [9].
In the proposed HIPNCS simulation, only the hop distance metric will be used in ICS calculation. Other metrics can also be considered, and the C++ code implementation of the HIPNCS takes into account all the metrics of the original NCS. However, the use of other metrics is left as a future work.

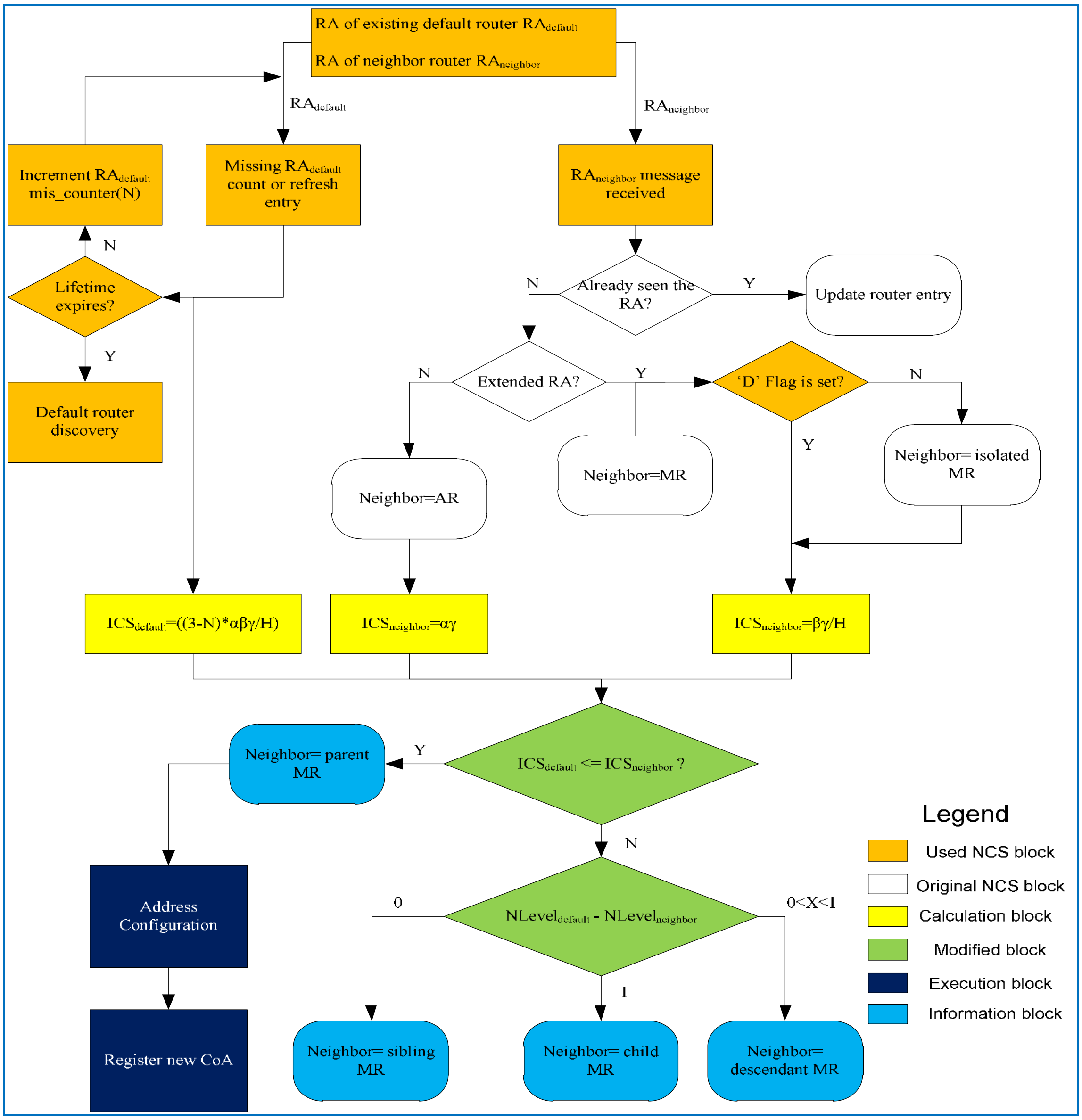

Fig. (5) Modified NCS Algorithm

i. Network Layout:

The proposed HIPNCS network is shown in Figure 6.The HIPNCS NEMO network (indicated by cloud in **Figure.(6)** starts at BS1, and moves to the right. After that the NEMO will perform handoff operation to BS2 (Same as previous scenario). At a certain point the HIPNCS NEMO network will be in the coverage range of BS4 at this point MR1 will perform the handoff decision operation to decide whether to change its point of attachment from BS2 to BS4.

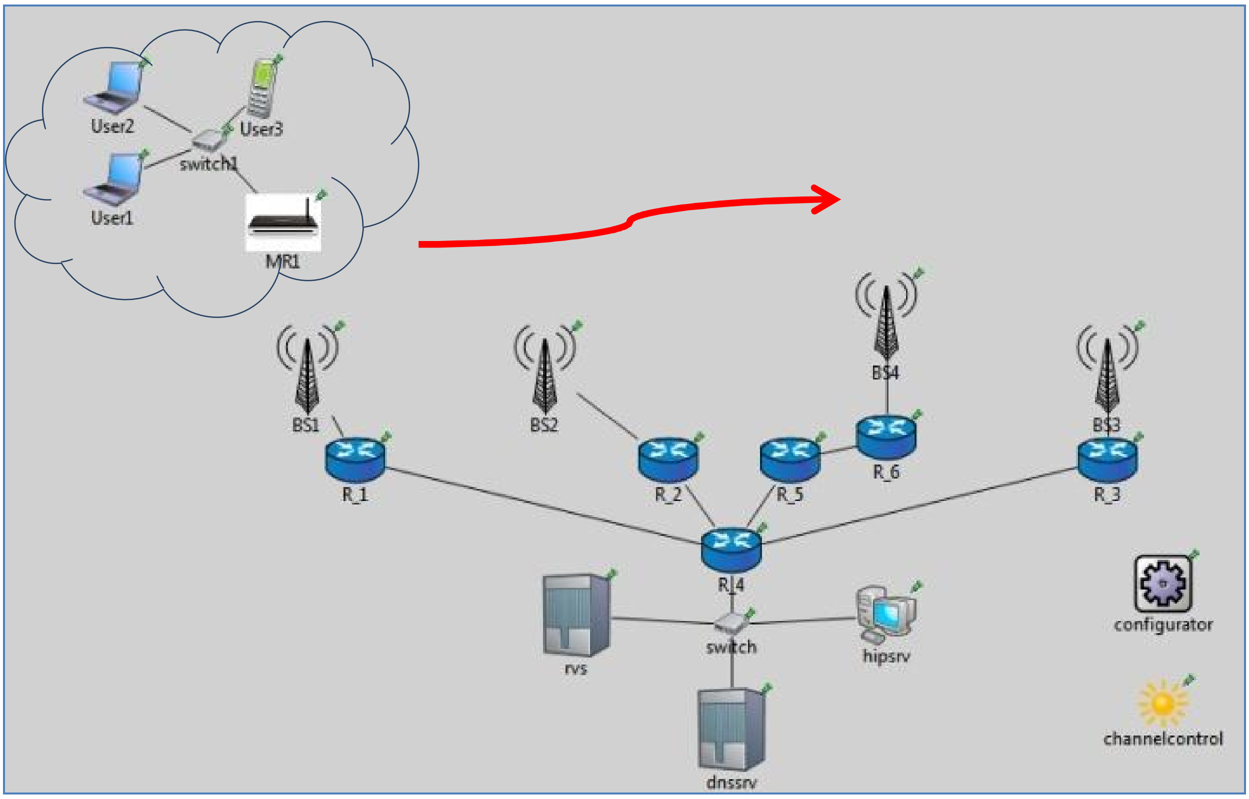

Fig. (6) Proposed HIPNCS Network Layout

ii. Simulation Results:

In order to evaluate the performance of our proposed HIPNCS technique, the above network was simulated using the OMNeT++ simulator. The Handoff (HO) latency was calculated by performing eleven simulations with different RA intervals for 3 handoff operations. **Figures.(7)** shows the results gathered from the simulation. The latency was defined according to [7] as the time elapsed between losing the connection at the old AP and the mobile sending out the third UPDATE packet while connected to the new AP. The node has to configure its new IPv6 address by means of stateless auto-configuration using RAs sent by the routers. And the HIP implementation has to handle the IP address change.

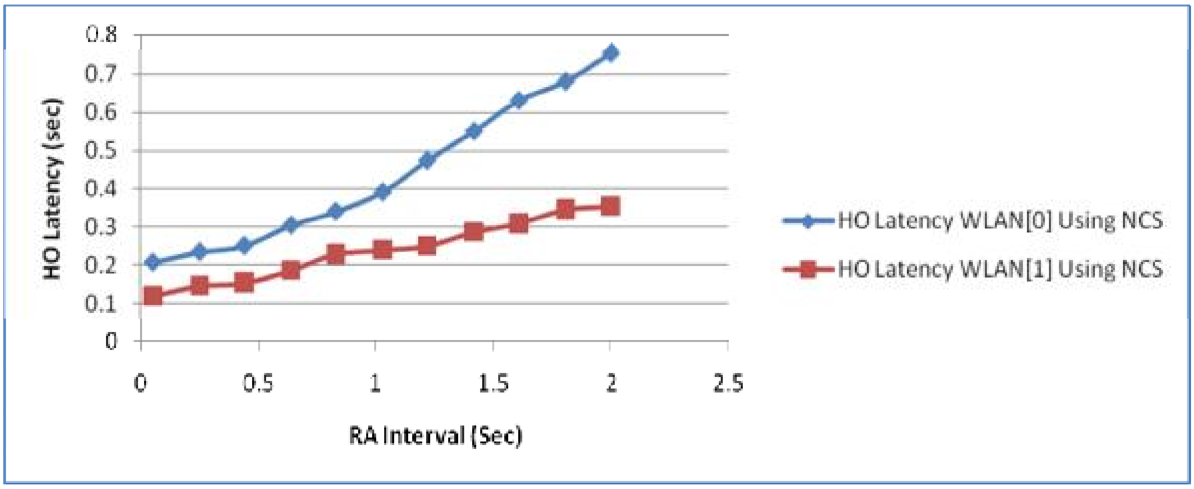

Fig.(7) Handoff Latency Measurements for the Proposed HIPNCS Technique

The packet loss during handoff is also calculated using the packets/sec received error free during the simulation of the proposed HIPNCS technique as shown in **Figure.(8)**. The figure shows that the number of packets lost during the handoff process is increasing dramatically with the increase of the offered data rate. The offered data rate is increased from 100 Kbps to 1 Mbps in 10 steps.

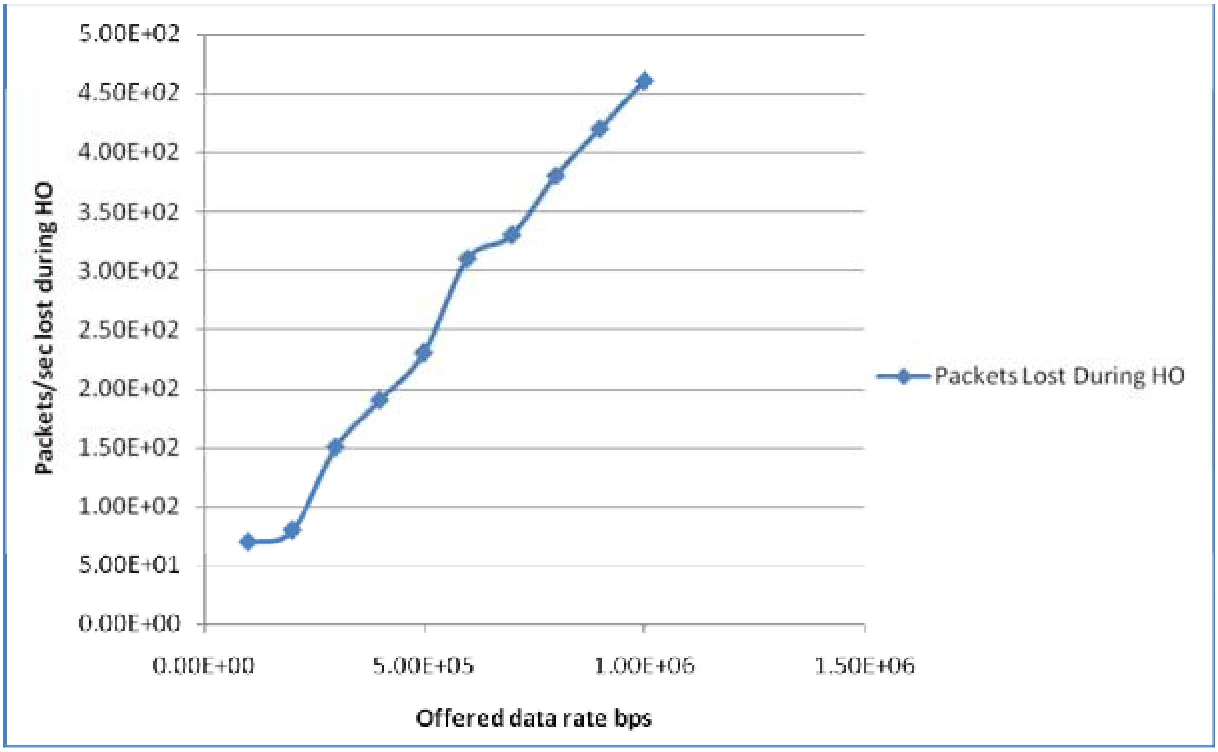

Fig. (8) Packet loss measurements for the proposed HIPNCS technique

The average throughput is also measured for the proposed HIPNCS technique as shown in **Figure.(9)**. It is obvious from the figure that the throughput of the NEMO network is reduced to its minimum amount of 400 Kbps at time t=6 sec which is the handoff period (4-8 sec).

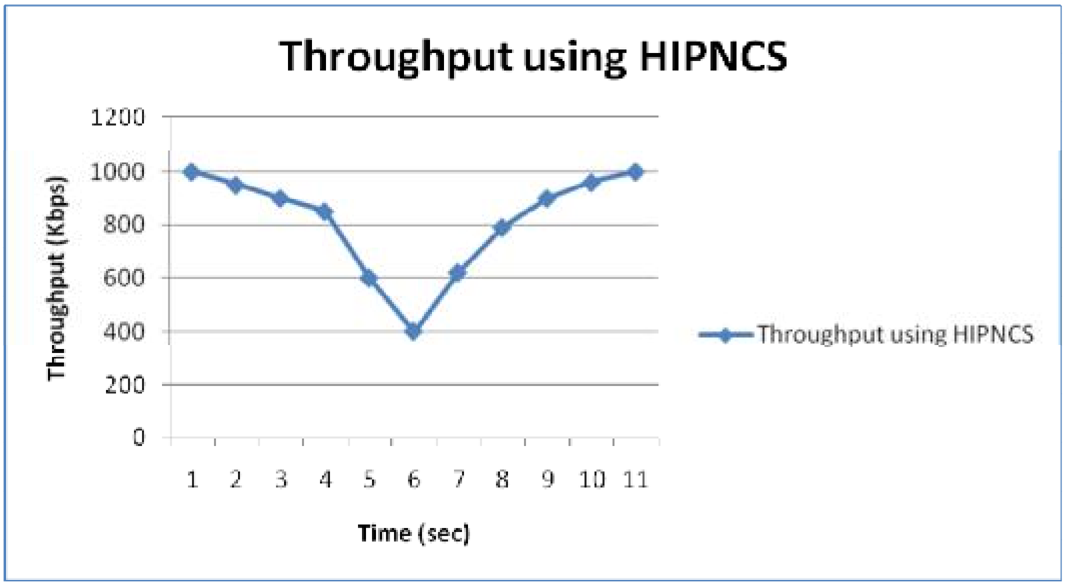

Fig. (9) Throughput Measurement for the proposed HIPNCS Techniques

9. CONCLUSIONS

In this paper, a simple simulation scenario for the NEMO network is introduced and the results are calculated using the OMNeT++ network simulator. Since BS4 has a larger number of hops until it reaches the AR (R_4), then the handoff is not performed and MR1 stay associated with the old (default) BS2 node. At this point only the hop count is considered in the handoff decision algorithm of the proposed HIPNCS. This is similar to the Routing Information Protocol (RIP) algorithm, which uses hop count as its only metric to decide the optimal routes to a given point, so it is possible to use RIP instead of HIPNCS. However, the proposed HIPNCS is used here for general cases in which many metrics should be taken into account when deciding the best route. If the NEMO network contains more than one MR that are not directly connected to BS, then HIPNCS must be used.

From the results above we can conclude that the proposed HIPNCS technique endures low handoff latency and packet loss compared to other techniques. Also, our proposed technique provides a good route decision mechanism due to the use of the NCS technique.

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