Implementation of Multiple Heterogeneous Interface Mobile Node in NS2

Sachin Dattatraya Patil
sdp.sachin@gmail.com

Varshapriya Jyotinagar
varshapriyajn@vji.org.in

Abstract - In the next generation of the mobile network there will be the future of the heterogeneous interface. As it provides the multiple interface at the same time hence will connect to the many interfaces at the same time but will connect to the best one at the time so it will provide the better connectivity at all time. The 4G’s main feature is always providing best connectivity to speedy network. As 4G is providing the mobile-ip connectivity hence will support the voice over ip. This project will provide multiple interfaces to the NS hence will helpful for the research and educational purpose. This paper will provide the idea of creating heterogeneous interface to mobile node architecture in NS. The NS2 is open source so this will provide good environment for the research work. In this paper we are going to explain the architecture of the adding multiple interface to NS2 model.

Keywords - Multiple interfaces, NS2, Heterogeneous environment in wireless.

I. INTRODUCTION

Accessing wireless services and application on the move has become a norm among casual or business users these days. Due to societal needs, technological innovation, and networks operators’ business strategies, there has been a rapid proliferation of many different wireless technologies. In many parts of the world, we are witnessing a wireless ecosystem consisting of wide-area, low-to-medium-bandwidth network based on access technologies such as GSM, GPRS, and WCDMA, overlaid by faster local area networks such as IEEE 802.11-based Wireless LANs and Bluetooth Pico-networks. One notable advantage of wide-area networks such as GPRS and 3G networks is their ability to provide access in a larger service area. However, a wide-area network has limited bandwidth and higher latency. 3G systems promise a speed of up to 2Mbps per cell for a non-roaming user. On the other hand, alternative wireless technologies like WLAN 802.11 and Personal area network (PAN) using Bluetooth technology have limited range but can provide much higher bandwidth. Thus, technologies like WWAN and WLAN provide complementary features with respect to operating range and available bandwidth. Consequently, the natural trend will be toward utilizing high bandwidth data networks such as WLAN, whenever they are available, and to switch to an overlay service such as GPRS or 3G networks with low bandwidth, when coverage of WLAN is not available. Adding to the existing public networks, some private institutions (i.e., universities) have joined the fray to adopt wireless infrastructure to support mobility within their premises, thus adding to the plethora of wireless networks. With such pervasiveness, solutions are required to guarantee end-user terminal mobility and maintain always-on session connections to the Internet. To achieve this objective, an end device with several radio interfaces and intelligent software that would enable the automatic selection of networks and resources. A “hot” item, frequently debated in the wireless community these days, is whether there is such a thing as a “fourth generation” (4G) of wireless systems that is likely to appear after the successful deployment of the current third-generation (3G) systems, say five to ten years from now. This new generation of wireless systems is supposed to complement and replace 3G systems, as well as second- generation (2G) systems that have already been in use for about a decade. A “classic” approach would design such a “system” in the same way as previous generations of wireless systems, that is, yet again focus on higher data rates (now beyond 2 Mb/s) and find new frequency bands for a worldwide standard (e.g., [1]). For a number of reasons, however, it is not obvious that the roadmap is this straightforward. One of the main concerns is that 4G wireless infrastructures will be deployed in an environment where many other types of wireless, and wired, communications systems are already present. Furthermore, some people argue that future wireless communications will become focused on services and user needs, thereby forcing the mixture of available wireless infrastructure elements to be used in a more transparent way. In that case, the previously so important air interface standard and frequency band issues will become secondary concerns. By definition it is difficult to make precise statements on the nature of this kind of vision. An important factor contributing to this uncertainty is that we have very limited knowledge about the future environment in which a 4G wireless infrastructure should function. Which of today’s systems will still exist when a potential 4G infrastructure is deployed? Which systems and solutions will be considered successful then? What technical bottlenecks will be apparent 10 years from now? What market impact will 3G wireless systems have? How will this affect user behavior and user demand? How much money are prospective users willing to pay for services provided over this infrastructure? As these questions indicate, defining relevant research topics with regard to future systems is not an easy task. Nevertheless, experience tells us that fundamental research related to 4G systems has to be carried out today in order to make it possible to deploy them a decade from now.
The tremendously increasing of the use of wireless networks for various applications has been seen in the recent years and it will continue in the future. Mobile users are facing the fact that many heterogeneous radio access technologies coexist, ranging from wireless LANs to cellular systems. No technology has emerged as a common and universal solution which makes the current trends today toward design of All-IP wireless networks, where radio cells are under the control of IP Access Routers for signaling and data transmission. In such as networks, an IP-device with multiple interfaces can roam between different networks regardless the heterogeneity of their access technologies. In the next generation of wireless networks a mobile node equipped with multimedia-enabled wireless devices will be expected to use real-time and non-real time applications at any time anywhere from diverse networks. Furthermore mobile nodes are expected to conduct multiple communications sessions at the same time (e.g. voice, video or downloading). Hence the mobile node has to implement multiple heterogeneous interfaces to facilitate connection to different types of access technologies. Following figure shows a mobile node having multiple heterogeneous interface to connect to different types of networks such as Satellite network, Wireless network, Cellular network etc. The mobile node can access the multiple networks simultaneously or one at a time which is best suited depending on applications. To implement this NS2 (Network Simulator) is chosen as NS2 is an open-source event-driven simulator designed specifically for research in computer communication networks. Also the cost of hardware is saved as we need not buy the hardware. To investigate network performance, researchers can simply use an easy-to-use scripting language to configure a network, and observe results generated by NS2. NS2 consists of two key languages: C++ and Object-oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e., a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events (i.e., a frontend). We need to deal with Link layer of TCP/IP reference model as interfaces are implemented in Link Layer.

This idea will support the following features:
- Mobility management is spitted between local and global domains. As such, access network operators will have the flexibility to choose the mobility management inside their networks. The main advantage is that the access provider is free to choose any option for local mobility, including layer 2, layer 3 or legacy mobile technologies.
- It supports handovers with QoS through a common framework for mobility and QoS signaling in heterogeneous technology networks. This common framework is based on the IEEE 802.21 draft standard.
- It supports host multihoming - the host owns multiple physical network interfaces and concurrently gets access through them.
- It explores an identity based mobility management solution through the independent and general management of identities - this would enhance from traditional network mobility protocols towards a solution for mobility of identities.
- It integrates MANETs (ad-hoc networks) and NEMOs (mobile networks) in the mobility architecture.
- It integrates broadcast networks, also considering unidirectional networks without return channel. It also supports QoS in multicast services running through broadcast networks.
- It integrates ubiquitous and pervasiveness concepts for customized services to the users.

II. LITERATURE SURVEY

As we have seen in past lot of work is done at various institutes but no one succeeded yet because of their own issues. Some of which projects are explained here below 1) MITF which was carried out at the University of Río de Janeiro. The goal was to implement multiple interfaces, and to adapt the AODV routing protocol accordingly, and it was done using NS-2.28. However, since the project stopped, it was not possible to fully evaluate concrete results of this research [9]. 2) TENS this project was done at the Indian Institute of Technology of Kanpur, India. Its main objective was to improve the NS-2.1b9a implementation of the IEEE 802.11 protocol on various aspects, like the MAC and physical layers’ model, as well as adding multiple interface support for that specific NS version [9]. 3) Hyacinth this is probably the closest work to ours. The corresponding project was originally carried out at the State University of New York for NS-2.1b9a, and there is available information on how to use it over NS-2.29. Its main drawback is that it provides quite a static configuration, in which all nodes within the scenario need to incorporate up to 5 different interfaces; in addition, a static (manual configureable) routing agent was implemented to use this multi-channel capability, and according to our best knowledge, there is not available information on how to modify existing routing agents (e.g. AODV) so as to be able to use the multi-interface capability [9]. As network usage and demand for speed, multimedia support and other resources has increased, the wireless world had to look for a new generation technology to replace the third generation. This is where the 4G (fourth generation) has been introduced. The main
characteristic of the 4G communications systems will be a composite communication model. Where different kinds of technologies such as cellular, satellite and Wireless Local Area Networks and wired networks will interact to provide an optimum service at anytime from anywhere to the mobile node. Cellular networks as General Packet Radio (GPRS), Universal Mobile Telecommunication Systems (UMTS) and CDMA support a low bandwidth over a high coverage. On the other hand systems as WLAN provide a high bandwidth (up to 54 Mbps) for a small coverage area. Therefore the integration of WLAN and cellular systems can efficiently achieve a suitable capacity and QoS for the mobile node.

![Schematic of a mobile node under the wireless extensions to NS.](image)

Fig. 2. Schematic of a mobile node under the wireless extensions to NS.

4G wireless communication is expected to provide better speed, high capacity, lower cost and IP based services. One of the main desired feature of 4G technology is High usability and global roaming. The end user terminals should be compatible with any technology, at anytime, anywhere in the world. The basic idea is that the user should be able to take his mobile to any place, for example, from a place that uses CDMA to another place that employs GSM. So every mobile node in 4G network needs to have multiple interfaces. Another feature of a 4G mobile system is “Always Best Connected” (ABC) which enable users to choose the best available access networks in a way that best suits their needs. Multiple interface mobile node only can use ABC service. The motivation for this project is gained by the fact that every mobile node in the future 4G network should have multiple heterogeneous interface in order to satisfy the desired features of 4G networks.

In literature survey I have studied architecture of Fourth Generation (4G) Networks and history of digital communication system. In this I have studied First Generation (1G), Second Generation (2G) and Third Generation (3G) Systems. 1G was based on analog technology and basically intended for analog phones. It was launched in the early 1980s. It introduced the first basic framework for mobile communications like the basic architecture, frequency multiplexing, roaming concept etc.

2G was a revolution that marked the switching of mobile communication technology from analog to digital. It was introduced in the late 1980s and it adopted digital signal processing techniques. GSM (Global System for Mobile Communication) was one of the main attractive sides of 2G and it introduced the concept of SIM (Subscriber Identity Module) cards. 2.5 G was basically an extension of 2G with packet switching incorporated to 2G. It implemented hybrid communication which connected the internet to mobile communications. Support for multimedia transmission is striking feature of 3G. It employs both circuit switching and packet switching strategies. 3G systems promise faster communications services, including voice, fax and Internet, anytime and anywhere with seamless global roaming. 3G system has some problems. It cannot roam between different services and in heterogeneous networks. So Every node must provide multiple heterogeneous interface to facilitate roaming across heterogeneous networks [1][3][4].

Vangelis Gazis, Nikos Housos proposed 4G Network Architecture in [6]. The discussion about 4G mobile has given the vision of “Always Best Connected” (ABC) mode of communication. This sketches heterogeneous communication system consisting different wireless access networks, where the user enjoys seamless connectivity and ubiquitous access to applications over the combination of wireless systems available which is most efficient. They identified the major developments in the fourth generation mobile communication market, presented the technical aspects of the fourth generation network architecture and analyzed the implications of the “ABC”.

Chan-Wah Ng and Thierry Ernst explored the benefits of having multiple access interfaces when these nodes employ layer-3 protocols such as Mobile IP or Network Mobility Basic Support to gain persistent access to the Internet while changing their points of attachment to the Internet [7].

A. The basic wireless model in NS

The wireless model essentially consists of the MobileNode at the core, with additional supporting features that allows simulations of multi-hop ad-hoc networks, wireless LANs etc. MobileNode is the basic N/SNode object with added functionalities like movement, ability to transmit and receive on a channel that allows it to be used to create mobile, wireless simulation environments. The class MobileNode is derived from the base class Node. MobileNode is a split object. The mobility features including node movement, periodic
position updates, maintaining topology boundary etc are implemented in C++ while plumbing of network components within MobileNode itself (like classifiers, dnx, LL, Mac, Channel etc.) have been implemented in Otcl. The network stack for a mobilenode consists of a link layer(LL), an ARF module connected to LL, an interface priority queue(IFq), a mac layer(MAC), a network interface(netIF), all connected to the channel. These network components are created and plumbed together in Otcl. The five ad-hoc routing protocols that are currently supported are Destination Sequence Distance Vector (DSDV), Dynamic Source Routing (DSR), Temporally ordered Routing Algorithm (TORA), Ad hoc On-demand Distance Vector (AODV) and Protocol for Unified Multicasting Through Announcements (PUMA).

B. Requirements and Working Assumptions:

In this section we present all the requirements that we would like to fulfill with our development, and we also enumerate the working assumptions that we have made. First, we opted for using different instances of the wireless channels at the Tcl level, rather than multiplexing them on a single object, since this is probably better aligned with the intrinsic architecture of the simulator. Using different instances of the channel at the Tcl level provides also a greater flexibility and eases the changes that are required within the corresponding C++ files. Another additional advantage of this approach is that in this way it is easier to change their characteristics (e.g. transmitting power or energy levels) from the scenario script. Hence, one aspect that will not be added to our implementation is the interchannel interference. Furthermore, and in contrast with the previous works on this issue, one of the most relevant aspects of our implementation is that it should allow the user to define a different number of interfaces per node, i.e. not all nodes need to implement the same number of interfaces. In addition, the number of channels used in a single simulation could also be parameterized and nodes should be able to randomly connect to a subset of the defined wireless channels, thus giving a complete flexibility to the user. We understand that this level of flexibility, that needs to be accomplished from the scenario script, would be really important so as to evaluate different types of situations. In addition, our intention is that the modified model could be used with any of the existing (or new) routing agents (but the ones based on the SRNode), but it would also be nice being able to maintain the legacy behavior of the simulator, so that already existing scripts would still be valid. One of the drawbacks that we observed on the previous works on this aspect is that they usually force the simulations to use their particular characteristics or, otherwise, the simulator will not probably work properly. Taking all the above into consideration we can summarize the requirements we would like to cope with as follows:

- [REQ.1] The number of channels in a particular scenario should be modifiable.
- [REQ.2] The number of interfaces per node is variable, and do not need to be the same for all nodes within a single scenario.
- [REQ.3] Each node within the same scenario could connect to a different number of channels (of the ones that had been previously defined).
- [REQ.4] Routing agents may take advantage of the modified model, but legacy operation of the simulator must be preserved, so as to ensure backwards compatibility.

III. MULTIPLE INTERFACE NODE MODEL

Taking the discussion of the previous section into consideration, Figure 3 presents the high level architecture of the “modified” MobileNode. As can be seen, each node would have as many copies of the original chain of entities (the one shown before) as many interfaces it has. In addition, the single module which is not repeated is the “Propagation Model”, since our initial assumption was to work exclusively with IEEE 802.11 networks, in which nodes could use more than one channel at the same time; in these circumstances, the use of a simple propagation model is sensible. However, it should not be too complicated being able to extend the current model so as to be able to add flexibility also on the number and types of propagation models to be used. For incoming traffic, there are not many differences to the original operation of the simulator. Incoming packets arrive through the corresponding channel and travel through the different entities in ascending order; since the last module of every interface, the “Link Layer” is connected to the same common point (the “Address Multiplexer”), all packets are handled by the appropriate agent (either the routing protocol or the application), independently of the interface the originally arrived through. On the other hand, for outgoing traffic, it is worth highlighting that the intelligence of selecting the appropriate interface needs to be within the routing agent; as can be seen, this is the point in which the decision needs to take place. The changes that are required in their C++ implementation to be able to select the appropriate interface are extensively discussed [9].

We can use this structure for both homogeneous as well as heterogeneous. As shown in the figure there are many interfaces are connected to the propagation model and the routing agent as these interfaces may be the same or may be different. As in case of homogeneous both may be wifi/wimax/Bluetooth/Gprs and in case of heterogeneous there will be the combination of wifi/wimax/Bluetooth/Gprs. The heterogeneous interface provides the flexibility of using the any interface as best one available at the moment. The special characteristic of the heterogeneous interface is providing the best available network from wifi, wimax and the GPRS. It will get connect to the best available network at the moment and will continue the service. As we are implementing it in NS2.34 it is having the difficulty it is not providing the

Copyright © 2012 IJEIR, All right reserved
other interface. As currently available interface is wifi only for our project. So we have to deploy the other interface first like wimax or GPRS. Hence this is the third module of our project adding wimax to the NS2.

A. Related Work To Heterogeneous Model

A lot of work in the field of heterogeneous interface mobile node and 4G network has been done and is still going on. Josh Broch, et.al. presented a solution for supporting heterogeneous network interfaces in a multi-hop wireless ad hoc network. Extending this technique, they have shown how to connect an ad hoc network to the Internet, and how to use Mobile IP to support nodes visiting the ad hoc network. They have implemented and validated these ideas using a real ad hoc network, which had been in regular use for approximately 5 months. In addition, they discussed how the proposed techniques could be applied to even more general scenarios.

Mo Li, et.al. have presented a multi-interface scheme for IEEE 802.21 media independent handover[2]. The proposed scheme is compatible with transport protocols already in use, e.g. TCP and UDP. It works well with Mobile IPv4 without particular setting in agent routers. A dual-interface MH (mobile host) model has been designed and implemented in NS 2.29 to validate the proposed scheme. The comparison results (with single-interface MH) show that dual interface can effectively decrease data transmission break time and end-to-end packet delay in handover. Moreover, dual-interface can eliminate the influence of the advertisement interval on handover delay. This would make end-to-end packet delay independent of access domain in handover. Such a feature would especially favor NG (Next Generation) heterogeneous networks that may be based on disparate technologies and run by multiple operators.

Hyun-Jong Kim, Won-Seok Choi have proposed a method[5] to support handover between heterogeneous access technologies for multiple interface (MIF) mobile node (MN) in the Proxy Mobile IPv6 (PMIPv6) domain. They analyzed the reduction of handover signaling cost in the proposed MAT (MAC Address Translation) method. In order to testify the efficiency of the proposed method, they compared the PMIPv6-MIH with the proposed PMIPv6-
MAT in the side of handover cost. The more the number of MAG which LMA manages is large, the more signaling cost dramatically increases. It has been identified that signaling cost of proposed method is reduced approximately 30 percent than the existing PMIPv6-MIH scheme.

IV. IMPLEMENTATION ISSUES

As we have been discussed in previous sections we have to implement first homogeneous model for wifi then we have to add the wimax model to the NS. After that we will introduce the heterogeneous model to the NS. For adding homogeneous model we don’t have many changes to the cpp code. As we are having most of the changes in the tcl code so we have to concentrate on the tcl code. For homogeneous model we have to change the two classes in tcl code of the NS. The first class is the lib class under the directory of tcl/lib and the second class is the mobilenode class. As we have to change the lib class just we have to add the iface to the wifi model i.e. we are adding the multiple iface to the model. All these changes we have to do in the node config class and to create wireless node procedure. Then the next changes we have to do in the mobilenode class file. First we have to do changes in the add-target procedure, then add-target-rangent procedure. Also we have to do some changes in cpp code of the mobilenode, channel and mac-802_11 classes. After changing all these we have to some changes in routing agent also as we are changing all these classes it have to works with routing agents class also hence we have to change the routing protocol code. As we are considering here the example of AODV routing agent hence we will do the changes to the same class.

The next implementation phase will be the adding wimax module to the NS. We have to create the module of wimax and add to the NS. For creating the wimax module we can take the help of already implemented wifi module in NS and will do changes according to the the wimax. After creating all these wimax module we have to add the homogeneous model to the wimax model.

After creating wifi and wimax homogeneous models we work on our main project concept i.e. on heterogeneous model. For heterogeneous model we have to do changes in both i.e. in tcl as well as in cpp of the routing agent protocol mostly. Because before it was having only one interface now it will be having two interfaces. So firstly we have to add both interfaces to the routing agent and then have to choose best one available at the moment. Hence for this purpose we have to do looping of the both interfaces and have to choose best one of them.

After all these we have to create the test cases in the tcl and have to run in the NS to check the heterogeneous environment.

VI. FUTURE WORKS

As we have described in the implementation issues we are going to create the heterogeneous model for wifi and the wimax interfaces. In the future work we can add the many interfaces to the NS and can implement for the heterogeneous environment. Like wimax we can add interfaces for the GPRS, Bluetooth, UMTS, and many more. And can do looping of all these interfaces under the routing protocol agent. As we are adding here only the wimax interface to the NS because of time limit we can extends this project by adding the many interfaces to the NS. As our ultimate aim is to check the heterogeneity for the NS if it is firstly working for two interfaces then we can add the many interfaces later then we can check for many interfaces.

REFERENCES

[9] Adding Multiple Interface Support in NS-2 Ram’on Ag’uero Calvo University of Cantabria ramon@tmat.unican.es Jesüs Perez Campo University of Cantabria jesus@tmat.unican.es January, 2007

AUTHOR’S PROFILE

Sachin Dattatraya Patil
I have the experience of lectureship in engineering college in the subject of Information Technology. I have the membership of Computer society of India (CSI).

Varshapriya Jyotinagar
varshapriyajn@vjti.org.in