UNIVERSITI PUTRA MALAYSIA

ENHANCED MOBILITY SOLUTION IN MOBILE IPV6 NETWORK

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By

ADENIJI OLUWASHOLA DAVID

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

June 2008

Dedicated to:

My parent: Sir and Lady A.A ADENIJI
My sustaining, kind mother, whom I am indebted with all love
My brothers and sisters
My beloved wife:

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Faculty: Engineering

The performance of Network Mobility (NEMO) used to manage network mobility does not provide satisfactory result in terms of delay, throughput and session continuity when dealing with multihomed mobile network. Enhanced Mobility Solution in Mobile IPv6 Network is extremely complex; the study addressed the multihoming issues of MIPV6 Networks on the basis of NEMO Basic Support, analyzes the benefits of multihoming and discusses implementation issues of all classes of multihoming possibilities. Additionally, Policy-based routing, as one of the multihoming benefits, is studied in particular.

A framework based on policy based routing protocol was proposed for handling both the inbound and the outbound traffic on a mobile network, under specified policies which consider packet characteristics, current network situation and user preferences. The interface selection algorithm was based on NEMO implementation structure using a technique of mutihoming which was extended to MIPv6 concepts.

The outcome of this research work are: a designed policy protocol for policy messages communication between the Mobile Router and the Home Agent, the framework is simulated using Network Simulator (NS2) with an extension of mobiwan, the result shows the end to end delay, average end to end delay, overhead, optimal routing path, average inter-packet latency and throughput of the developed system. The information from the analysis of the result shows that the enhanced solution has drastically reduced average packet delay to minimum with 72.5 %(0.040s to 0.011s), and end-end delay with 75 %(0.020s to 0.005s) compared with NEMO solution. Overhead in the mobile network was maintained by 10bytes per nested level by keeping the session.

The solution is important by enterprises in making decision to acquire internet connectivity for the purpose of connectivity redundancy and traffic load distribution optimization. This result is very important for time sensitive application that requires stable network condition.

Abstrak Tesis dibentangkan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan *Master of Science*

PENYELESAIAN PENAMBAH KEBOLEHGERAKKAN DI DALAM RANKAIAN MUDAH ALIH IPV6

Oleh

ADENIJI OLUWASHOLA DAVID

Jun 2008

Pengerusi: Sabira Khatun, PhD

Fakulti: Kejuruteraan

Prestasi kebolehgerakan rangkaian yang digunakan untuk mengurus kebolehgerakan rangkaian tidak mampu memberikan keputusan yang memuaskan di dalam aspek-aspek seperti kelengahan, truput dan kesinambungan sesi apabila menangani rankaian mudah alih 'multihomed'. Penambahan penyelesaian kebolehgerakan di dalam rangkaian kebolehgerakkan IPv6 adalah sangat kompleks, kajian menyatakan isu-isu 'multihoming' di dalam rangkaian MIPv6 berdasarkan asas sokongan NEMO, analisis faedah-faedah multihoming dan membincangkan keseluruhan kelas-kelas isu berkaitan kebarangkalian 'multihoming'.

Satu rangka kerja berdasarkan polisi penghalaan protokol dicadangkan untuk menangani kedua-dua trafik yang masuk dan keluar daripada rangkaian mudah alih, dibawah polisi-polisi tertentu yang mengambil kira aspek-aspek seperti ciri-ciri paket, keadaan situasi rangkaian dan keutamaan pengguna. Antaramuka untuk algoritma memilih adalah

berasaskan pelaksanaan struktur NEMO dengan menggunakan satu teknik 'multihoming' yang mana disambungkan kepada konsep MIPv6.

Hasil atau pencapaian kajian ini adalah: merekabentuk satu polisi protokol bagi polisi komunikasi mesej antara penghala mudah alih dan agen perumah, rangkakerja ini telah disimulasi menggunakan 'Network Simulator (NS2)' dengan sambungan kepada 'Mobiwan', keputusan yang diperolehi menunjukkan kelambatan hujung ke hujung, purata kelambatan hujung ke hujung, overhed, laluan penghalaan optima, purata kependaman antara paket dan truput sistem yang dibangunkan. Maklumat daripada analisis keputusan yang diperolehi menunjukkan peningkatan penyelesaian yang dapat mengurangkan purata kelambatan paket secara drastik kepada paras minimum dengan 72.5% (0.040s ke 0.011s), dan kelambatan hujung ke hujung dengan 75 %(0.020s ke 0.005s) berbanding penyelesaian menggunakan NEMO. Overhed di dalam rangkaian mudah alih dikekalkan pada 10 bait per paras sarang dengan mengekalkan sesi tersebut.

Penyelesaian ini adalah penting bagi usaha-usaha untuk membuat keputusan untuk memperoleh sambungan internet bagi tujuan lewahan sambungan dan pengoptimuman penyebaran beban trafik. Keputusan ini adalah sangat penting bagi aplikasi yang sensitif terhadap masa yang memerlukan keadaan rangkaian yang stabil.

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I certify that an Examination Committee has met on June 2008 to conduct the final examination of Adeniji Oluwashola David on his Master of Science thesis entitled "Enhanced Mobility Solution in Mobile IPv6 Network" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1981 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Member of the Examination Committee were as follows:

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Date: 30 December, 2008.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows;

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DECLARATION

I declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently submitted for any other degree at UPM or other institutions.

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ADENIJI OLUWASHOLA DAVID

Date:

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2. LITERATURE REVIEW

CHAPTER 1

INTRODUCTION

Wireless communication and proliferation of computers has brought us into an era of wireless networking. In an environment containing multiple wireless (and fixed) networks, user needs to dynamically change access in accordance with their preference or desired quality of service performance, without losing service connection. The Always Best Connected (ABC) [1] is an emerging trend in the 4G wireless and mobile communication systems. The ABC solutions have been providing multi-access to one terminal that moves between different networks. The end user has more than one interface that is capable to connect to the network. This may be cellular phone, notebook computer, PDAs, cameras, game devices and Bluetooth technology etc. A collection of such personal user devices may form Personal Area Networks (PANs).

The reach of a PAN is typically a few meters, and the devices in a PAN may or may not belong to the person in question. PANs can be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network. Some devices in a PAN may be able to access the Internet directly, while others may not. However, those less powerful devices could communicate with remote nodes by first communicating with the powerful devices inside the PAN.

A new concept, Personal Network (PN) is proposed by extending the concept of PAN [2]. Unlike the present PAN which has the limitation of coverage, PN has an unrestricted geographical span and incorporates devices into the personal environment regardless of their locations. The motivation of creating a PN comes from the belief that new technologies should be centered on the user to improve the quality of life without the need for the user to be aware of any technical details. The mobility issues discussed in IP layer by NEtwork MObility (NEMO) fits the domain of PN. Some of the mobility issues include nested mobility, multihomed mobile networks, route optimization and mobile devices from different administrative domains (security issues), etc.

1.1 Multihoming Support in NEMO

A multiple lanes of a road are real life example of multihoming. Efficiency can be seen as less traffic jam, and on top of that, following cars could take the other lanes rather than waiting. Load Sharing is carried out when a car arrives at the road entry, and selects a lane with little traffic; as a result, it would cost shorter time to get to the end of the road. Preference Setting means to specify the fast lane and slow lane (car lane), the choice of which lane to use is based on the vehicle speed (high or low speed) is determined. However, in multihomed network, the lanes are there but not visible; no cars on the lanes but data packets. The basic solution of NEMO in Multi-homing support can be evaluated into three main classified categories: (i) Fault-Tolerance/Redundancy, (ii) Load-Sharing and (iii) Policy. Fault-Tolerance/Redundancy occurs when the Mobile Network maintains at least one connection to the Internet, connectivity for all mobile nodes is guaranteed. This behavior is separated into two sub-classes: Without

transparency mean the lost of one connection to the Internet breaks the used transport sessions that use it; however, new transport sessions are possible. With transparency, the lost of one connection to the Internet is transparent for Layer 4 and above, i.e. lost of one connection does not disrupt transport sessions. Load-Sharing is achieved when the traffic load is distributed among different connections between the mobile network and the Internet.

Policy management on traffic can be done by any possible mechanism such as the kind/cost of connection and social policy based on scheduling. This policy allows the routers to route traffic from users through different Internet connections to balance the network load. In other words, it allows routing based on the source information of the packets, instead of the destination information used by traditional routing protocols.

1.2 Motivation and Problem Statements

IP protocol suffers from mobility restriction, since IP was designed for a stationary environment which makes mobility difficult. Several solutions like failure discovery and recovery delay, change of traffic characteristics and transparency have been introduced to support mobile devices which dynamically change it point of attachment to the Internet. The problem of mobility has also been addressed inside Internet Engineering Task Force (IETF) by NEMO working group since 1996, with the aim of providing stable solution to non availability of interface for mobile network. The concept of Multihoming addresses this problem by making mobile nodes keep connected

seamlessly without modification when roaming. However, the key factor in attaining the benefit of multihoming is to ensure that the handoff switches over from one network interface to the other interface with minimal interruption. Research to address this drawback in mobile IPv6 on interface connectivity mechanism is an active area especially in multihoming operation. Multihomed mobile networks enhance the session preservation of the Mobile Router (MR) used for Mobile Network Nodes (MNNs). Multihomed mobile networks share traffic load more efficiently by selecting the best available connection or enabling multiple connections simultaneously. Since all traffic goes through the MR in a mobile network, load sharing at the MR is critical. As noted, to ensure continuous connectivity, with a desirable Quality of Service (QOS), it is preferable for a mobile network to be connected via several interfaces, several access technologies and distinct access networks.

Considering the new generation Internet Protocol, IPv6, which has built in mobility support in its standard, this alleviates the drawback suffered in mobile IPv4 [3]. Mobile IPv6 is designed to be efficient, robust and scalable. However, IP technology is still far from the perfect solution [11]. IP was not developed to support each and every existing technology. However the extensions to Mobile IPv6 are still necessary in order to provide higher grades of services, including real-time application support.

A better strategy is to use Policy based routing protocol as a solution since session preservation is critical in NEMO. This solution provided will select the best available connection.

The objective of this thesis is to concentrate on multihoming based on performance in mobile network, then to propose an policy based -routing framework to overcome the of outbound packets not reaching their destination which is also known as “pinball problem”. The framework on policy routing is useful to handle both the inbound and the outbound traffic on a mobile network under specified policies which consider packet characteristics, current network situation and user preferences.

1.3 Research Aim and Objectives

The aim of this research is to simulate a policy-based routing protocol for performance of mobile IPV6 network.

The objectives of this research are as follows.

1. To develop a suitable algorithm for policy base routing framework.
2. To evaluate the performance of the proposed policy base routing framework based on end to end delay, average end to end delay, overhead, optimal routing path, , average inter packet latency and throughput of the developed systems.
3. To investigate the efficiency of the proposed algorithm by comparing with other related research works.

1.4 Brief Methodology

The proposed framework on the policy based routing protocol was investigated using Network Simulator 2.28(NS 2.28). Mobiwan, an extension tool for mobile IPV6 was used to facilitate the studies. Mobiwan running on NS-2.28 was installed on Xandros 2.0 a version of Linux operating system. The extension file compatible with Mobiwan was used during the installation to build NS. Network Animator (NAM) that comes with the NS provides good visualization of the simulation outcome. With the network simulator, the behaviors and characteristic of the protocol can be studied without the need to build a real network. Various parameters were set according to the purpose of the simulation to observe the network response. With the Mobile IPv6 extension module, namely MobiWan, the other Mobile IPv6 features like local mobility and global mobility can be investigated as well. The design input parameter for the simulation is shown in Table 1.1 below including the simulation parameters and values.

Table 1.1: Simulation Parameters and Values of the Network Model

Simulation Parameters	Simulation Values
Propagation time of wired link	1.8ms
Data rate	100Mbps
Simulation area	800 x 800 m
Packet size	1000k, 500k
Buffer size in Router	100kb
CBR source	2 for UDP/TCP
Simulation time	100sec

Results were obtained in terms of end-end delay, average end-end delay, overhead, optimal routing path, average inter-packet latency and throughput of the proposed framework. Furthermore, NAM enables us to visualize the outcome easily. Graphical outcomes provided by NAM are indeed much easier to decipher than the simulation trace files. NS2 is chosen as the simulation platform for this research because it is open source software that is free of charge. NS2 is a powerful and versatile network simulator. Moreover, NS has a large user base and it is continuously improved by contributors and researcher. Although NS2 can be operated in multiple operating systems. Linux xandros 2.0 is used as the operating environment because of its stability and the good integration of NS 2 with Linux.

Mobiwan a tool for simulating mobile IPv6 protocol was implemented as a set of NS Agents and a set of existing NS classifiers. During the simulation packet are sent to the home network were they are intercepted by the Home Agent and encapsulated to the primary care-of address of the mobile node by the default interface. This default interface must be available as the train moves from one base station to another as explained in the methodology. The source packet is checked in the entry binding cache. This packet of the mobile node is then encapsulated in order to determine the current access router (base station) by means of Router Advertisement and solicitation.

The availability and non availability of the interface is control by means of policies in which the best available and preferred interface priority matching is selected. The proposed policy framework was simulated using mobiwan an extension for implementing MIPv6 protocol on NS2 platform.

1.5 Study Module

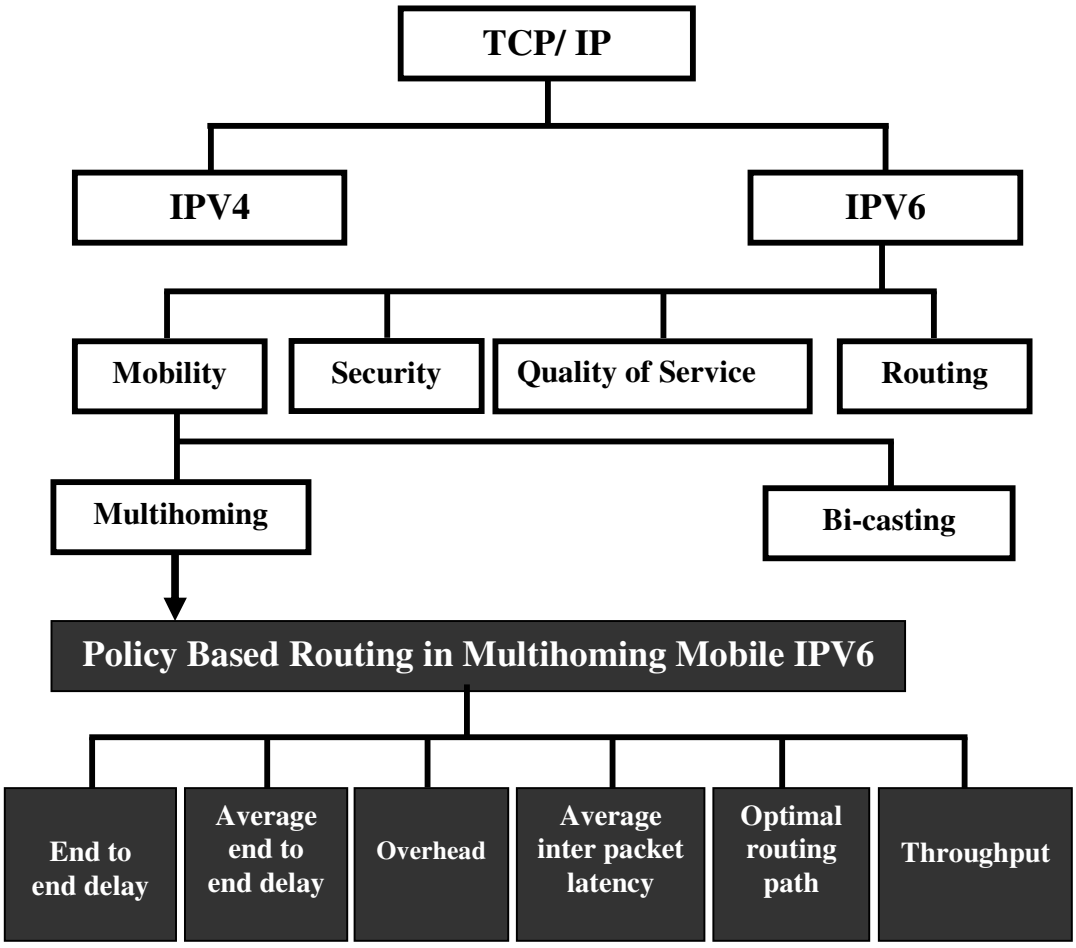

Figure 1.1: Study Module Chart

The flow on the study module begins with related proposal on TCP/IP, IPv4, IPv6, mobility and issues on multihoming which was discussed in the literature review. Policy based routing was proposed in the methodology and the implementation. The analysis of the result was explained in the discussion of result.

1.6 Research Contribution

The main contribution of this thesis is to give a viable solution for the multihoming configuration of mobile network with NEMO basic support. This solution may enable the service provider to disseminate information about cost, bandwidth and availability of internet access. The proposed policy-based routing framework is built on top of class one multihoming configuration. In this thesis a policy-based routing algorithm for both inbound and outbound traffic has been achieved by allocating various policy components on the MR and HA.

1.7 Thesis Organization

The rest of this thesis is organized as follows. Chapter 2 presents a short discussion on proposal issues on IP Mobility by IETF, the enhancement of mobile IPv4 and mobile IPv6, limitation of mobile IP, network mobility basic support protocol, multihoming

protocol, multihoming classification, requirement of multihoming configuration and related work in multihomed mobile network.

Chapter 3 describes briefly the simulator software module tools, structure of mobiwan in IPv6, NS2.28 allinone and mobiwan patch installation , the proposed policy based routing framework is explained in detailed in this section. Chapter 4 shows the different simulation results and performance analysis which was compared with some related work. Finally, we conclude in Chapter 5 with a discussion on the future work.