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A Mobile IPv6-Based Architecture for Mobility of Mobile Terminals in Heterogeneous Networks

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ABSTRACT-The evaluation toward next-generation wireless networking brought life to the concept of technology and services integration. The success attained by the Internet, on one side, and by cell phone networks, on the other, led to visions of "next-generation networks," integrating the two different philosophies. On one hand, Internet protocol (IP) technology has been developed in order to support a new range and variety of services, previously only possible with circuit switching technologies, due to the very low cost of Internet access. On the other hand, cellular telephony technology also boomed during this Internet evolution, bringing commodities now very keen to humans: mobility and reachability. It was then natural to associate both concepts as a universal data-based mobile access network. In wireless networks, efficient management of mobility is a crucial issue to support mobile users. The Mobile Internet Protocol (MIP) has been proposed to support global mobility in IP networks. Several mobility management strategies have been proposed which aim reducing the signaling traffic related to the Mobile Terminals (MTs) registration with the Home Agents (HAs) whenever their Care-of-Addresses (CoAs) change.

KEYWORDS: Mobile Internet Protocol, Care –of – Addresses, Mobile Terminals, IP Networks

1. INTRODUCTION.

With the rapid development in wireless communications in recent years, the necessity for sufficient IP addresses to meet the demand of mobile devices, as well as flexible communications without infrastructure, are especially considerable. The Next Generation Internet, Internet Protocol version 6 (IPv6) [1-2], targets at sufficient IP addresses to enable users to attach to the Internet and promotes mobile wireless commerce (m-commerce). Additionally, most current mobile devices are equipped with IEEE 802.11 wireless
local area network interface cards. It supports infrastructure and ad hoc modes. The infrastructure mode requires all mobile devices to directly communicate to an access point. In ad hoc mode, mobile devices dynamically form a mobile ad hoc network (MANET) with multi-hop routing. Clearly, the ad hoc mode allows for a more flexible network, but its aim is not to connect to the
Internet. Much attention has been paid to IP address auto configuration and IPv6 extension for MANETs [3-5] in recent years. IPv6 auto-configuration mechanism [3-4] allows a node to generate a link-local IP address. Extension has also been made to be suitable for MANET [5]. However, global connectivity for a mobile node is not supported in [5]. Later on, [6-7] address how to provide global connectivity for an IPv6-enabled MANET. In these works, a MANET node can acquire a global IPv6 address from an Internet gateway, and then access to the Internet through the gateway. Routing in MANETs and the IPv6 network is based on existing protocols. Currently, existing MANET routing protocols, such as Ad-hoc On-demand Distance Vector (AODV) [8], Optimized Link State Routing Protocol (OLSR) [9], and Zone Routing Protocol (ZRP) [10], typically only maintain routes locally within the reach of a MANET.

1.1. Related Work.

Analytic models are proposed to compute this number such as the total signaling traffic for location update and packet delivery is transferred with minimal network resource and low delay, respectively. Nevertheless, this approach requires that each FA is able to act as an FA and a GFA. Moreover, it adds processing load on the MT to estimate the average packet arrival rate and the subnet residence time. Hence, the main advantage of this approach is the system robustness enhancement since the GFA failure affects only the packets routing to MTs belonging to this GFA. The disadvantages are the system infrastructure and MTs costs which could be high. The DHMIP approach has been proposed to reduce the location update messages to the HA by registering the new CoA to the previous FA and building a hierarchy of FAs. Hence, the user's packets are intercepted and tunneled along the FAs hierarchy to the MT. The hierarchy level numbers are dynamically adjusted based on mobile user's mobility and traffic load information. Fig. 1 illustrates an example of DHMIP approach with a maximum of hierarchy level number equal to 3. When MT is attached to F A2, F A3, F A5, or F A6, the CoA update is sent to the previous FAs. If the MT becomes attached to F A4 the level number reach the threshold and the MT will set up a new hierarchy. The MT registers its new CoA directly to the HA. In this approach, the location update to the new FA, which is close to the previous FAs, could be less expensive than that to the HA. In [1], authors propose an analytic performance model to evaluate the signaling transmission, the packet delivery, and the total costs of HMIP, HDDMIP, and DHMIP mobility approaches using a one-dimensional random walk model. The performance analysis shows that the DHMIP scheme outperforms compared to the HMIP and HDDMIP ones.

1.2. IPv6-based MANET.

In this session, we give an overview of the proposed IPv6-based MANET [4]. To construct an IPv6-based MANET, we propose a self-organizing addressing protocol to organize nodes into a tree structure. The logical address of a node is automatically configured when it joins and leaves. Based on the tree topology, we then propose a new routing protocol, which is based on longest prefix matching, for MANET. IPv6 is supported on MANET such that each mobile node automatically configures its global IPv6 address and connects to the global Internet via an access router. Meanwhile, mobile IPv6 is also supported to allow a mobile node moves from one MANET to another. Finally, we also show how to implement information sharing applications on the IPv6-based MANET. In the following, we shall describe more detail information of each proposed mechanism

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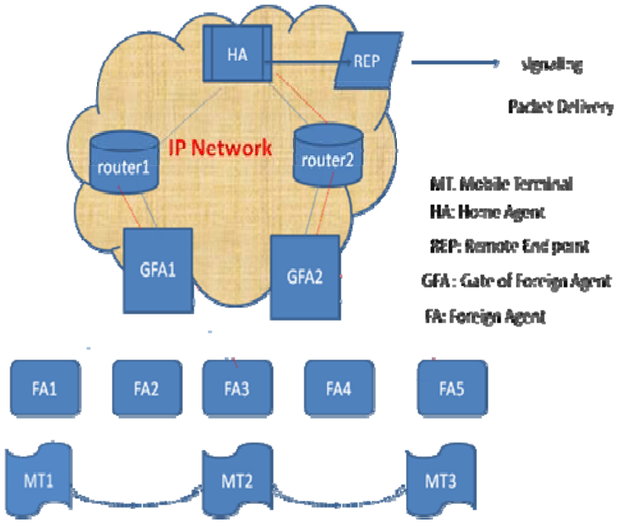

Fig1: MIP and DHMIP mobility approaches

2. MOBILITY STRATAGIES

Hierarchical Mobile IP (HMIP) has been proposed to reduce the number of location updates to HA and the signaling latency when an MT moves from one subnet to another. In this mobility scheme, FAs and Gateway FAs (GFAs) are organized into a hierarchy. When an MT changes FA within the same regional network, it updates its CoA by performing a regional registration to the GFA.When an MT moves to another regional network, it performs a home registration withits HA using a publicly routable address of GFA. The packets intercepted by the HA are tunneled to a new GFA to which the MT is belonging .The GFA checks its visitor list and forwards the packets to the FA of the MT .This regional registration is sensitive to the GFAs failure because of the centralized system architecture .Moreover, a high traffic load on GFAs and frequent mobility between regional networks degrade the mobility scheme performance The main contribution for this paper is to design a Mobile IPv6-based overlay network architecture for heterogeneous environments, designed entirely based on IPv6, that aims to be implemented seamlessly irrespectively of the supporting network infrastructure. All transmission technologies are handled at the physical and data-link layers, imposing IPv6-based protocols for all higher layer communications and signaling. The architecture builds on Mobile IPv6 including improved fast handover, and integrates quality-of-service and authentication, authorization, accounting, and charging control per user. The most critical issues of the proposed architecture mainly related to the handover process finally, the performance of the design was calculated and observed.

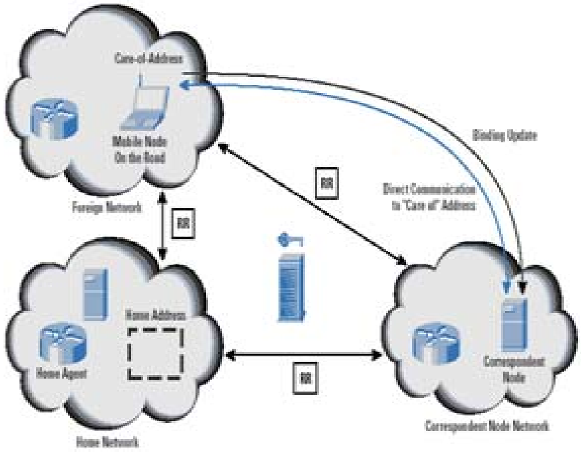

Fig 2: Route Optimization

3. ANALYTIC MODEL

This section describes the analytic model and the set of established assumptions.

3.1. Assumptions

Generally, during each handoff, a path reestablishment is required to maintain or to improve call quality. This reestablishment uses signaling messages and involves a change in the number of links of the mobile connection. Note that the three mobility approaches described here are based on a mobile connection path reestablishment which leads to perform the following operations:

- CoA update with the HA,
- New path establishment from HA to FA for DHMIP and MIP, and from HA to GFA for MHMIP,
- User data traffic transfer from the previous path to the new one,
- Previous path discard.
- The DHMIP uses also path extension which requires additional signaling messages to establish the path part that extends the mobile connection from the previous FA to the new one when the mobile move and becomes attached to this latest.
- Each connection is subjected to a certain number of handoffs through its life duration (call holding time). This latest is divided into n time intervals enough small to allow the occurrence and the end of only one handoff during this interval. In each time interval, we define

The proposed discrete time model is a generalization of the one proposed in [5]. The novelty of this model consists in the definition of generic analytical model that applies to more than one handoff approach and that allows to compute not only mean bandwidth due to handoff but also mean handoff delay of the analyzed handoff approaches. The temporal diagram given in Fig. 4 is used to compute these means. First, we compute the bandwidth and the delay within each interval and their means over the handoff events. Then, we compute the bandwidth and the delay sums over the total call holding time. Finally, we evaluate their means over all the call durations. In order to understand the monetization mechanism, we illustrate by taking as an example the mean bandwidth computation. In this figure, the holding time of ongoing call is divided into each time interval] i, i + 1], at most one handoff may occur.

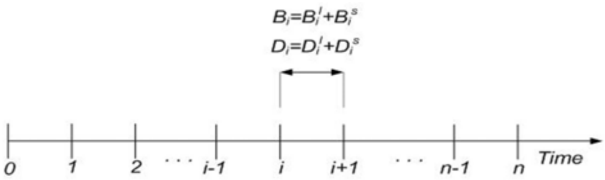

Fig 3: Discrete diagram of Call Holding Time

$$B_i = \begin{cases} B_i^L + B_i^S & \text{if a hand off occurs in } [i, i+1] \\ B_i^L & \text{otherwise} \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The mean of Bi over the handoff events is given by

$$E\,[Bi] = E[B_i^L] + E[B_i^S] \qquad (2)$$

For fixed value of n, the totals mean band width B (n) used by an ongoing call during the n time interval is

$$B[n] = B^L[n] + B^S[n] = \sum_{i=0}^{n-1} E[B_i^L] + \sum_{i=0}^{n-1} E[B_i^S] \qquad (3)$$

As the call duration n is a random variable, the mean bandwidth is calculated over all the call durations n=1………..∞.With our assumptions, the probability that a call runs n periods is defined as P(n):

$$P\,(n) = qf(1-qf)^{n-1} \quad \text{where } n=1,2,3,\ldots \qquad (4)$$

From the above equations we have calculated the bandwidth ratios for different inputs i.e. data traffic and Image traffic.

4. Result Analysis

We observed the ratios of data traffic and image traffic and the values identified as given below.

	Bandwidth Ratio		Bandwidth			
			Data Traffic for B^{FD}/B^{FR}		Image Traffic for B^{FD}/B^{FR}	
			0.5	0.8	0.5	0.8
1	$B^p_{FR}\ \bar{B}_{FR}$	RC	1.80	1.77	3.62	3.59
		CC	1.56	1.62	2.93	3.12
	$B^r_{FR}\ \bar{B}_{FR}$	RC	1.36	1.30	2.41	2.32
		CC	1.16	1.18	1.87	1.96
2	$B^p_{FR}\ \bar{B}_{FR}$	RC	2.66	2.64	8.95	9.0
		CC	2.18	2.30	5.87	6.66
	$B^r_{FR}\ \bar{B}_{FR}$	RC	2	1.93	5.93	5.79
		CC	1.60	1.66	3.58	4.00

Fig 4: Bandwidth Ratios for different data

Based upon the tested values the graphs were plotted for the different types of data. We tested the bandwidth based upon voice traffic and as well as on data traffic.

The below graph gives the performance variations of DHMIP and MIP bandwidth ratios on Data Traffic and is almost similar here.

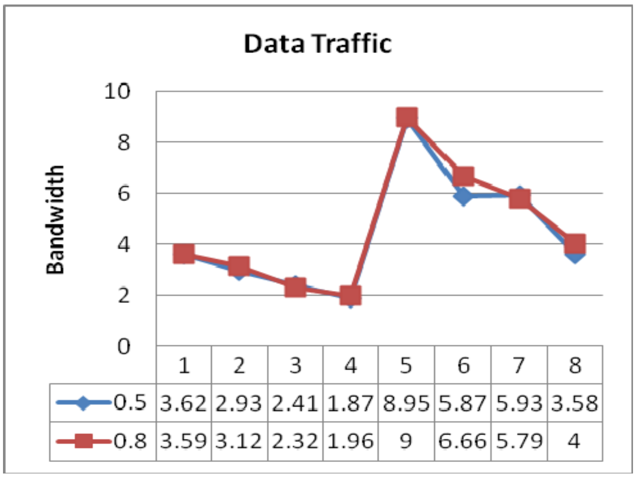

Fig 5: Comparison chart for MIP and DHMIP Protocols on Data Traffic

The below chart shows the performance variations of DHMIP and MIP bandwidth ratios on Image Traffic and observed that is showing the almost similar results for both the protocols.

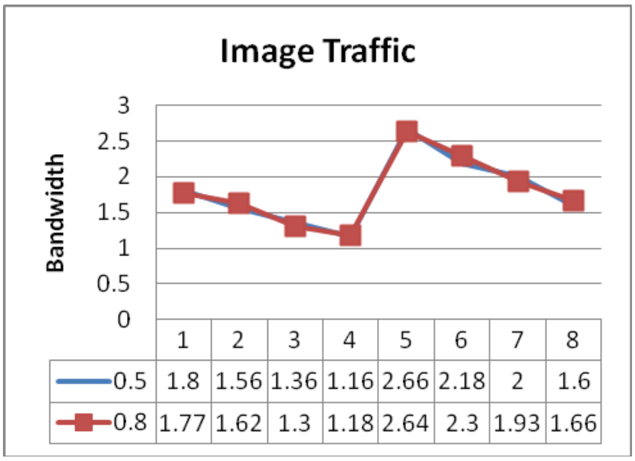

Fig 6: Comparison chart for MIP and DHMIP Protocols on Image Traffic

5. CONCLUSION

In this paper, we have proposed an analytical model which evaluates the mean handoff delay per call and the mean bandwidth per call of three mobility management approaches: MIP, DHMIP .Numerical results show that the DHMIP mobility approach compares very favorably with the previously considered mobility approaches. More specifically, our analysis gives in almost all cases a lower mean handoff delay per call and a mean bandwidth per call than those offered by the DHMIP approach in networks parts carrying delay sensitive and/or low mean bandwidth consumption type of applications and this according to the mobility type.

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