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An Analytical Model to evaluate the Approaches of Mobility Management

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Abstract

Now a day's efficient mobility management for mobile users in wireless networking is a crucial issue. To maintain global mobility in IP networking the Mobile internet protocol has been proposed. To reduce the signalling traffic related to the Mobile Terminals (MTs) registration with the Home Agents (HAs), whenever their Care-of-Addresses (CoAs) change several mobility management strategies have been proposed. And for registration process they use different Foreign Agents (FAs) and Gateway FAs (GFAs) hierarchies. For better and enhanced -mobility MTs, the Hierarchical MIP (HMIP) and Dynamic HMIP (DHMIP) strategies localize the registration in FAs and GFAs, yielding to high-mobility signalling. The registration processes in the GFAs got limitations by Multicast HMIP strategy. And it provides lowest mobility signalling delay compared to the HMIP and DHMIP approaches to achieve high-mobility MTs. However, for frequent MT mobility it is a resource consuming strategy. Hence, To evaluate the mean signalling delay and the mean bandwidth per call according to the type of MT mobility we propose an analytic model. In all the studied cases the performance of MHMIP is more and accurate as compared to the DHMIP and MIP strategies .In this paper we are proposing the analytic model that allows the mobility management.

Keywords

Mobility management, mobile IP, signalling, terminals, network

1. INTRODUCTION

Mobile IP Terminology

1.1. Mobile IP

Mobile IP is an internet protocol designed to support host mobility. Its goal is to provide the ability of a host to stay connected to the internet regardless of their location. Mobile IP is able to track a mobile host without needing to change the mobile host's long-term IP address [2].

1.2. Agent Advertisement

An advertisement message constructed by attaching a special Extension to a router advertisement message. Foreign agents are expected to periodically issue agent advertisement messages. If a mobile node needs agent information immediately, it can issue an ICMP router solicitation message. Any agent receiving this message will then issue an agent advertisement.

1.3. Care-of Address

The termination point of a tunnel towards a mobile node, for datagram's forwarded to the mobile node while it is away from home. The protocol can use two different types of care-of address. A "foreign agent care-of address" is an address of a foreign agent with which the mobile node is registered, and a "co-located care-of address" is an externally obtained local address which the mobile node has associated with one of its own network interfaces. However, in some cases a mobile node may move to a network that has no foreign agents or on which all foreign agents are busy. A collocated care of address is an IP address obtained by the mobile node that is associated with the current interface to a network of that mobile node. The means by which a mobile node acquires a collocated address is beyond the scope of Mobile IP. One means is to dynamically acquire a temporary IP address through an Internet service such as Dynamic Host Configuration Protocol (DHCP). Another alternative is that the collocated address may be owned by the mobile node as a long term address for use only while visiting a given foreign network.

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1.4. Correspondent Node
A peer with which a mobile node is communicating. A correspondent node may be either mobile or stationary. This node sends the packets which are addressed to the mobile node.

1.5. Foreign Network
Any network other than the mobile node's Home Network. It delivers information between the mobile node and the home agent.

1.6. Home Address
A permanent IP address that is assigned to a mobile node. It remains unchanged regardless of where the mobile node is attached to the internet.

1.7. Home Agent (HA)
A router that maintains a list of registered mobile nodes in a visitor list. It is used to forward mobile node addressed packets to the appropriate local network when the mobile nodes are away from home. After checking with the current mobility bindings for a particular mobile node, it encapsulates datagram's and sends it to the mobile host's current temporary address.

1.8. Foreign Agent (Fa)
A router that assists a locally reachable mobile node that is away from its home network. It delivers information between the mobile node and the home agent.

1.9. Mobility Agent
An agent which supports mobility. It could be either a home agent or a foreign agent

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, and MHMIP. Numerical results show that the MHMIP mobility approach compares very favourably 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 and MIP approaches. It also shows the robustness of the MHMIP approach in the sense that for critical scenario corresponding to the extreme situation where all handoff events are localized at the multicast group borders, this approach essentially yields to

1) A lower mean bandwidth per call than the DHMIP and MIP approaches;
2) A lower mean handoff delay per call than that offered by the MIP approach;
3) A lower mean handoff delay than that offered by the DHMIP except in case of frequent inter-GFAs handoffs with a network configuration having a high number of links involved in MHMIP path reestablishment.

Since we expect a diversity of multimedia applications for future IP mobile networks, we recommend using the MHMIP approach in networks parts carrying delay sensitive and/or low mean bandwidth consumption type of applications and this according to the mobility type.

2. RELATED WORK

IP multimedia applications are becoming popular in the packet-based wireless networks. The integration of these applications in wireless networks requires the support of seamless terminal mobility. Mobile IP (MIP) has been proposed by the Internet Engineering Task Force (IETF) to provide global mobility in IP networks. It allows maintaining mobile terminals ongoing communications while moving through IP network. IP mobility in wireless networks can be classified into macro- and micro mobility. The macro mobility is the MT mobility through different administration domains. The micro mobility is the MT movements through different subnets belonging to a single network domain. For micro mobility where the MT movement is frequent, the MIP concept is not suitable and needs to be improved. Indeed, the processing overhead related to location update could be high specifically under high number of MTs and when MTs are distant from the HAs yielding to high mobility signalling delay.

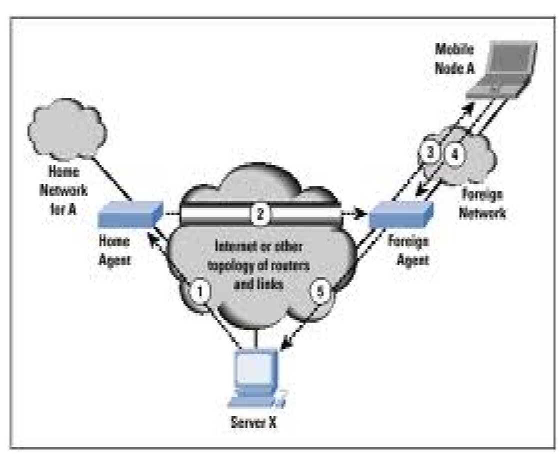

Fig 1: Mobile Internet Protocol

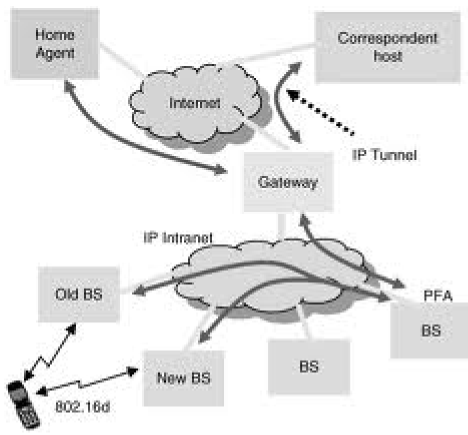

Fig 2: Hierarchical Mobile Internet Protocol

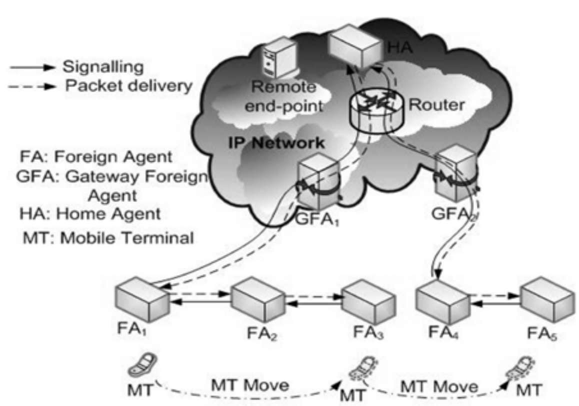

Fig 3: Dynamic Mobile Internet Protocol

Difference between M-IP and D-MIP (DM-IP)

Mobile IP (M-IP) enables mobile nodes to move from one IP subnet to another without getting disconnected. Mobile IP makes host mobility possible. Triangular routing exists in M-IP which is vulnerable to message delay due to longer network path. DM-IP reduces message delay by eliminating triangular routing and significantly improves the overall TCP/IP throughput in mobile environment.

DM-IP is a variation of source routing protocol . In DM-IP initially the packet is sent to the *home agent* of the mobile node. Figure 1 illustrates the difference between M-IP and DM-IP. In M-IP triangular routing, as shown by the broken lines, cannot be avoided but in DMIP it is eliminated. The steps of DM-IP are as follows

Case 1: When corresponding node is initiating the connection
a. The first packet is sent to the home location of the mobile node.
b. If mobile node is in its home location, then the existing routing algorithm is used. No need to change the current routing mechanism.
c. When the mobile node is away from home location, then the *home agent* of the mobile node tunnels the packet to the *foreign agent* of the mobile node. The mobile node invokes dynamic Source routing (DSR). Note that this mechanism avoids triangular routing.

Case 2: When mobile node is initiating the connection.
a. If mobile node is at its home location then send the packet using the current routing algorithm.
b. If mobile node is away from home location, then the DSR is invoked and the packet is sent to the destination.

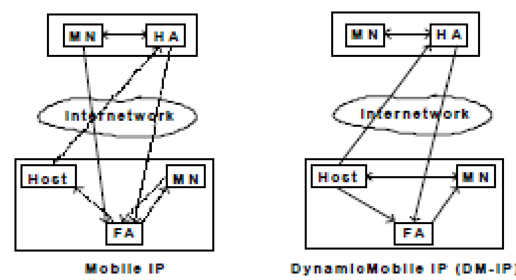

Fig 4: Difference between MIP and DMIP

3. PROPOSED ALGORITHMS

In this section, we propose the following algorithms for mobility management:

a).MIP (Mobile IP)
b) HMIP (Hierarchical MIP)
c) DHMIP (Dynamic HMIP)

a. MIP

In the MIP protocol, Mobile Terminal (MT) registers with its home network from which it gets a permanent address (home address). This address is stored in the Home Agent (HA). It is used for identification and routing purpose. L and L^r are random variables with general distributions and with mean $\overline{L}$ and $\overline{L^r}$, respectively.

The mean bandwidth per call is

$$\overline{B^r} = \frac{1}{q_f}\left(\overline{L}B^{PD} + \frac{q_a}{q_f}B^{PR}\right) \quad \text{Eq . (1)}$$

In (1), the first term $\frac{1}{q_f}\overline{L}B^{PD}$ is the bandwidth of the original connection and the re-established paths. The

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G.Vijaya kumar et al, Int. J. Comp. Tech. Appl., Vol 2 (5), 1413-1418

second term $\frac{q_a}{q_f} B^{PR}$ is the signalling bandwidth due to the path reestablishments.
The mean handoff duration per call is

$$\overline{D^r} = \frac{q_a}{q_f}(\overline{L^r} D^{PD} + D^{PR}). \quad (2)$$

In (2), the term **qa/qf** represents them number of handoffs for a call. The term $\overline{L^r} D^{PD} + D^{PR}$ represents the handoff delay which is the sum of the delay for resource allocation on the re-established path $(\overline{L^r} D^{PD})$ and the signalling delay (D^{PR}).

b. HMIP

Hierarchical Mobile IP (HMIP) has been proposed to reduce the number of location updates to HA and the signalling latency when an MT moves from one subnet to another .In this mobility scheme, FAs and Gateway FAs (GFAs) are organized into a hierarchy. L^h, L^{hp}, and L^{hs} are random variables with general distributions and with means $\overline{L^h}$, $\overline{L^{hp}}$, and $\overline{L^{hs}}$, respectively.
The mean bandwidth per call is

$$\overline{B^h} = \frac{1}{q_f}\overline{L^h} B^{PD} + L^{hr} B^{PD} + \frac{q_a'}{q_f} B^{PR}. \quad (3)$$

In (3), the first term $\frac{1}{q_f}\overline{L^h} B^{PD}$ is the bandwidth used on the original path and the re-established paths. The second term $L^{hr} B^{PE}$ is associated to the multicast resources used by the call in the GFA hierarchies. The last term $\frac{q_a}{q_f} B^{PR}$ is the signalling bandwidth due to the path reestablishment following the GFA handoffs.
The mean call duration per call is

$$\overline{D^h} = \frac{q_a'}{q_f}[\overline{L^{hp}} D^{PD} + D^{PR}]. \quad (4)$$

In (4), the term $\frac{q_a'}{q_f}$ is the mean number of handoffs of a call. The second term $[\overline{L^{hp}} D^{PD} + D^{PR}]$ is the handoff delay which is the sum of the delay of resource allocated on the re-established path $(\overline{L^{hp}} D^{PD})$ and the signalling delay (D^{PR}).

c. DHMIP

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 tunnelled along the FAs hierarchy to the MT. The hierarchy level numbers are dynamically adjusted based on mobile user's mobility and traffic load information. L, L^p, and H are random variables with general distributions and with mean $\overline{L}$, $\overline{L^p}$, and $\overline{H}$, respectively.
The mean bandwidth per call is

$$\overline{B^p} = \frac{\overline{L}}{q_f} B^{PD} + \frac{q_a(1-p)(1-q_f)\overline{H}}{q_f[1-(1-pq_a)(1-q_f)]} B^{PD} + \frac{q_a}{q_f}(B^{PE} + pB^{PR}), \quad (5)$$

While the mean handoff delay per call is

$$\overline{D^p} = \frac{q_a}{q_f} D^{PD}[(1-p)\overline{H} + p\overline{L^p}] + \frac{q_a}{q_f}[D^{PE} + pD^{PR}]. \quad (6)$$

4. SYSTEM OVERVIEW

In the Proposed model the following Modules will be taking major task to fulfil the requirements

1. Network
2. Agent
3. Hierarchical Mobile IP (HMIP)
4. Dynamic Hierarchical Mobile IP (DHMIP)
5. Mobile IP Network Simulation

1. Network

Client-server computing or networking is a distributed application architecture that partitions tasks or workloads between service providers (servers) and service requesters, called clients. Often clients and servers operate over a computer network on separate hardware. A server machine is a high performance host that is running one or more server programs which share its resources with clients. A client also shares any of its resources; Clients therefore initiate communication sessions with servers which await (listen to) incoming requests.

2. Agent

Mobile Terminal (MT) registers with its home network from which it gets a permanent address (home address). This address is stored in the Home Agent (HA). It is used for identification and routing purpose. If MT moves outside the home network visiting a foreign network, it maintains its home address and obtains new one from the Foreign Agent (FA). FAs and Gateway FAs (GFAs) are organized into a hierarchy. When an

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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 with its HA using a publicly routable address of GFA. The packets intercepted by the HA are tunnelled to a new GFA to which the MT is belonging (e.g., GFA2following MT handoff from FA3 to FA4 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.

3. Hierarchical Mobile IP (HMIP)

Hierarchical Mobile IP (HMIP) has been proposed to reduce the number of location updates to HA and the signalling latency when an MT moves from one subnet to another subnet. 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.

4. Dynamic Hierarchical Mobile IP (DHMIP)

DHMIP approaches because the path reestablishment is performed only between HA and GFAs. However, the bandwidth used by an MT for packet delivery is high because several connections are used for packets' transfer to the MT. It is clear that the total bandwidth used for signalling and packet delivery in MHMIP approach is higher than that used by the other approaches. Nevertheless, in case of MTs with high mobility (high handoff requests), the multicast resource in the GFA groups are reused by the MT every handoff event that occurs during its call holding time. Consequently, we expect that the MHMIP mean bandwidth per call for MTs with high mobility is no greater than that of the DHMIP and MIP mobility approaches. We also expect that the MHMIP mean handoff delay (including signalling and packet delivery delays) is smaller than that of the DHMIP

5. Mobile Ip Network Simulation module:

Mobile Host (MH), with the respective Home Agent (HA) and three Foreign Agents (FA). A circle around each agent symbolizes the range of that agent's network. When the MH is within the range of an agent's network it is considered connected to that network. Messages sent between agents are symbolized by a letter. When a message is to be tunnelled, we show the tunnelling process by putting the message in a package and then sending it to its destination. When arriving at the destination the letter is unpacked

5. RESULTS

Fig. 5 illustrates the mean bandwidths per call for MHMIP and DHMIP mobility management approaches. It shows that the MHMIP mean bandwidth per call is smaller than that obtained with the DHMIP approach. This mean bandwidth represents a performance measurement that an IP network operator can use to determine the needed resources to be deployed in the network to service a certain number of MTs. The MHMIP mobility management approach is the method that allows cost reduction in terms of resources usage compared to the DHMIP approach.

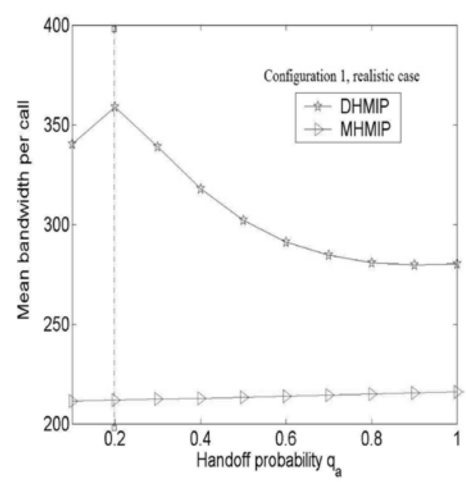

Fig 5: Mean Bandwidth per call

Fig 6 illustrates the B^p/B^{PR} ratio variation for different values of the probability p. We note that lower is p higher is the mean bandwidth per call. Moreover, we note a different behavior of this bandwidth between the intervals $q_a \le 0.3$ and $0.3 \le q_a \le 1$. For $0.3 \le q_a \le 1$, the mean bandwidth value decreases while it increases in the interval $q_a \le 0.2$ for different values of $p\ (p = q_a/6, q_a/4, q_a/2)$ and still increasing in the interval $0.2 \le q_a \le 0.3$ for $p = q_a/6$ this is in fact due to the low probability of path reestablishment p and the frequent use of path extension in the interval $q_a \le 0.3$. Hence, less frequent path reestablishment usage for DHMIP mobility management approach involves a high mean bandwidth per call consumption.

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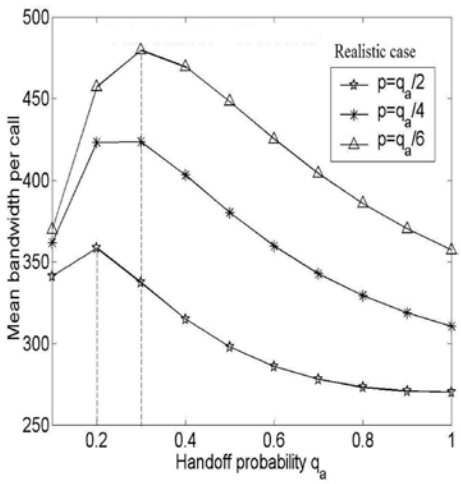

Fig 6: Mean bandwidth per call variation

6. CONCLUSION

In this paper we proposed three mobility management approaches: MIP, DHMIP, and MHMIP which evaluates the mean handoff delay per call and the mean bandwidth per call The results shows that the MHMIP mobility approach is very favourable among the other approaches which shows the Robustness .For critical scenario this approach yields to a lower mean bandwidth per call , a lower mean handoff delay per call than that offered by the MIP approach, a lower mean handoff delay than that offered by the DHMIP. According to the mobility type we suggest using the MHMIP approach in network parts carrying delay sensitive and/or low mean bandwidth consumption

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