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A Novel Approach with Hash to Reduce Vertical Handover Latency

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ABSTRACT

Communication with real time applications and inter-network technologies is voice of the day. Mobility management with low latency and packet loss is a big challenge in inter technologies communication. To address these issues, a novel approach for vertical handover scheme is proposed in this paper. Vertical handover plays an important role in reducing latency and packet loss, as it synchronize for the new care off address when home address gets invalid due to mobility. This process consists of two main operations 1) address resolution time and 2) network layer registration time. While synchronizing care off address, the proposed model reduces address resolution time by pre handover configuration and network layer registration time by reducing traffic signaling. The model ensures unique care off address for a mobile node, hence eliminates the duplicate address detection time which is one of the major contributors for latency in the previous vertical handover schemes. The approach is been validated through analytical comparison of the proposed model with the existing schemes like mobile IPv6, hierarchical mobile IPv6 and fast handover mechanism for optimization.

KEYWORDS: Vertical Handover, Handover Latency, Mobile IPv6, Mobility Management, Seamless Mobility.

1 INTRODUCTION

Mobility management is more complex in 4G networks. More research focus is required to develop a seamless mobility management protocol that ensures continuous connection to real-time high speed data and multimedia applications with low latency and packet loss [2]. Numbers of schemes have been proposed in literature to enhance the mobile IPv6 (MIPv6) and ensure seamless mobility during vertical handover [3]. Most of these enhancements are based on the following parameters;

Reduced network-layer registration time (by localizing the registration) Reduced address resolution time (by pre handoff registration). MIPv6 has extended features of IPv6 [4] and also solves the problem of mobility by introducing home agent (HA). This process is effective but takes time in discovering new subnet, care off address (CoA) generation and binding updates, which causes latency [7]. Hierarchical MIPv6 (HMIPv6) enhances MIPv6 by introducing hierarchal network structure [4] through mobile anchor point (MAP). MAP deals with handover process at local level, hence divides mobility into global and local mobility that reduces the network layer registration time with HA. Fast handover mechanism reduces address resolution time by performing pre-configuration [8]. Layer 2 triggers detect the mobility and generate the CoA in advance [9]. In the proposed model the visited network will inform the HA or MAP that the mobile node is approaching. The remaining synchronization will be done at each side individually with the help of an algorithm which will generate the same new care off address for the Mobile node based on previous IP address.

2 The Proposed Fast Handover Mechanism (FMIPv6) with Hash

FMIPv6 with hash is a novel scheme which combines Hierarchal mobile IPv6 and Fast handoff scheme with the hash algorithm.Registration in this model is not like a traditional 3 ways handshake process. The visited network informs the HA or MAP that the mobile node is approaching. At HA and MN side the hash algorithm generates the same care off address for mobile node (MN) based on previous MN IP address with the prefix of the new visited network, while synchronization for the network portion is made before the actual vertical handover takes place. After IP invalidation caused by mobility to foreign network, there is no need of synchronization between MN and Home agent for updating IP. In this way the network layer traffic signalling

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and registration time is reduced.This model is inspired by the huge number of addresses in IPv6 and Hash Function [1].

Hash Function produces same results every time for same inputs. In this model the Hash Function has to generate IP in a defined range, Hash Function is bound to produce an output from a define range of values. This eliminates the chance of IP conflict. Other schemes check the CoA for availability, which is known as duplicate address detection (DAD). The DAD time increases the overall latency of the handoff process. The proposed model ensures no IP conflict with no DAD time, hence overall latency is reduced. All this process is pre handoff at layer 2. The model performs the FMIPv6 operation in an improved mode up to this point.At network layer, when the signal strength of MN reaches its threshold value, it just sends an acknowledgement for the Handoff. All the concerned entities have the CoA address in advance. So they just start communication with the new care off address (nCoA) of the MN [1].

3 Performance Comparison of Mobility Schemes

3.1 Assumptions and Consideration

Before going into the comparison let us define some assumption and discuss the handoff differences among these schemes.

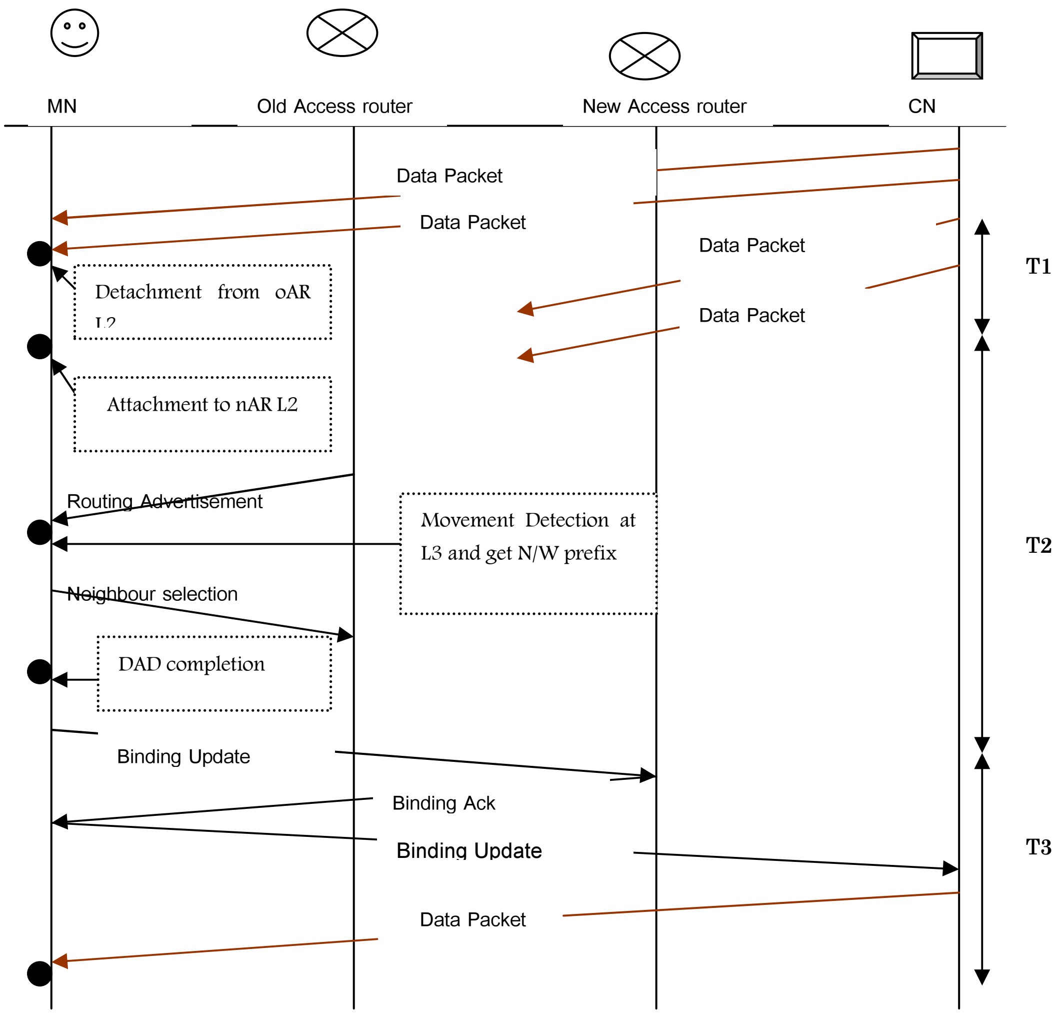


Figure 1. handoff latency components [6]

In MIPv6 the handoff latency is given by the round trip for binding update with HA, correspondent node (CN) or old access router (oAR) [6]. It starts when MN can no more listen for oAR and ends when packets are received from HA, CN or new access router (nAR). In HMIPv6 the handoff latency is the round trip time for binding update with MAP instead of HA or CN. In FMIPv6 the address resolution time is excluded from the latency as it is done in pre-configuration, so the latency is the delay between receiving the feed back acknowledgement (F-Back) and first packet from nAR.

The designed mobility scheme has the objective of reducing latency and packet loss during handoff process. The latency starts with the MN old AR detachment till the resumption of the communication through new AR [6]. Figure 1 shown below describes the latency component of handoff process,

Figure 1 T1 shows the L2 handoff process and has 12% of the total latency, T2 represents the latency in acquiring new CoA and DAD which is 87% of the collective latency. T3 is 1% of the total latency and consists of binding updating process.

$$T\text{-}handover = TL2\text{-}handover + TL3\text{-}handover \qquad 1$$

This research is focused on reducing L3 handoff latency but the proposed scheme reduces the latency in L2 as well. The L3 latency consists of two components,

$$T\text{-}L3handover = T\text{-}IPv6 + T\text{-}MIPv6 \qquad 2$$

Where

$$T\text{-}IPv6 = T\text{-}MD + T\text{-}CoA \qquad 3$$

T-MD is mobile detection time and T-CoA is care off address generation time.

$$T\text{-}MIPv6 = T\text{-}HA\text{-}\mathrm{Re}gistration + T\text{-}CN\text{-}\mathrm{Re}gistration \qquad 4$$

In the combination of HMIPv6 and FMIPv6 consideration, the latency is the time between the F-Back and BU with MAP and receiving the first packet from nAR. Every time the handoff, discussed, is initiated by the MN. In case of HMIPv6 the micro handoff is considered for the comparison only.

3.2 Studied Scenario

This section presents a slight handoff scenario described in [5] with modifications. The parameters are changed by adding the parameters of the proposed schemes.

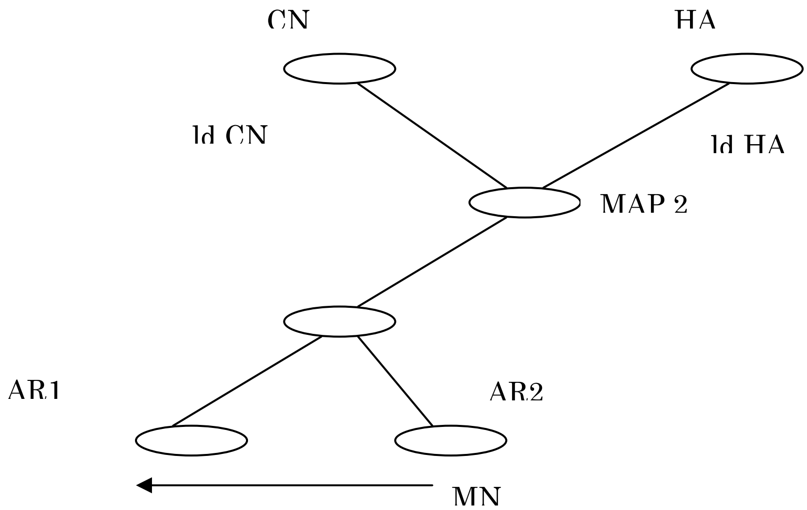


Figure 2. Scenario for analysis

The scenario shows a hierarchical topology. The HA is located at 1 while MAP is at 2 for HMIPv6. The wired link delay is represented by ld, Wd represents the wireless delay where #BU is used for the number of binding updates sent. The #BU may be 2 or 3 depending on the capability of the old access router (oAR) for the forwarding of BU. Handoff in MIPv6 and HMIPv6 is MN initiated and CoA configuration is stateless with DAD. Where the proposed scheme handoff is network initiated with no DAD because the scheme ensures the uniqueness of the new care off address (nCoA). The MN is moving from AR1→AR2.

Table 1 shows the latencies of the different IPv6 mobility schemes with detail of the contributors of total latency.

Table 1 Latencies of different IPv6 motilities Schemes

Mobility Scheme	Number of binding updates #BU	Wireless delay (Wd)	Link delay for MN (ld MN)	Link delay for CN (ld CN)	T-CoA (Time for care-off address generation)	Duplicate address detection time	Total latency
MIPv6	3	1	3	1	1	4	13
HMIPv6	2	1	1	1	1	4	10
FMIPv6	3	1	1	3	0.5	1	10.5
FMIPv6 With Hash	0.5	1	3	1	0.5	0	6

The overall handoff latency of the MIPv6 is,

$$L\text{-}MIPv6 = \#BU_{MIPv6} + Wd + ldHA + ldCN + TCoA + DAD \qquad 5$$

As forwarding is not allowed in MIPv6 the #BUMIPv6 = 3, the latency of each BU is 100% and for simplification consider it as 1. Similarly consider the Wd = 1 and ldHA=3 as there are three link distance for the nAR/MN and HA, ldCN=1 for all the schemes. T-CoA = 100% taken as 1 and the DAD=4 for each of the case because according to [6] 87% of the total latency is due to CoA and DAD. Hence the total latency for MIPv6 is;

$$Latency(MIPv6) = 3 + 1 + 3 + 1 + 1 + 4 = 13$$

Hierarchical MIPv6 introduces MAP's to reduce the traffic signalling. The total latency in hierarchical MIPv6 is;

$$L\text{-}HMIPv6 = \#BU_{HMIPv6} + Wd + ldHA + ldCN + TCoA + DAD \qquad 6$$

The #BUHMIPv6 = 2 as the BU for CN is optional in HMIPv6, Wd=1, ldHA=1 as the MAP is just one link away from nAR/MN, ldCN=1, TCoA=100% taken as 1 and DAD=4.

$$Latency(HMIPv6) = 2 + 1 + 1 + 1 + 1 + 4 = 10$$

The Fast MIPv6 enhances the performance by pre-configuration of the CoA. The latency at FMIPv6 is;

$$L\text{-}FMIPv6 = \#BU_{FMIPv6} + Wd + ldHA + ldCN + TCoA + DAD \qquad 7$$

The #BUFMIPv6 = 3 like MIPv6, Wd=1. ldHA=3 like MIPv6, ldCN =1, T-CoA =50% taken as 0.5 just assume as it is performed pre handoff, DAD=2 assuming it 50% pre handoff. So the total latency is;

$$Latency(FMIPv6) = 3 + 1 + 1 + 3 + 0.5 + 2 = 10.5$$

The HMIPv6 reduces the latency by 3

$$(L\text{-}MIPv6) - (L\text{-}HMIPv6) = 3$$

Where L-MIPv6=13 and L-HMIPv6 =10
And the FMIPv6 reduces the latency by 2.5

$$(L\text{-}FMIPv6) + (L\text{-}HMIPv6) = L\text{-}MIPv6(13.5) - 5.5 = 7.5$$

Where L-MIPv6=13 and L-HMIPv6 =10.5
The hybrid of HMIPv6 and FMIPv6 will reduce the handoff latency. The combine reduction of these two schemes is 2.5+3=5.5 so the total latency of this scheme is;

$$(L\text{-}FMIPv6) + (L\text{-}HMIPv6) = L\text{-}MIPv6(13.5) - 5.5 = 7.5$$

The total latency of FMIPv6 with Hash scheme is;

$$L\text{-}FMIPv6 + H = \#BU_{FMIPv6+H} + Wd + ldHA + ldCN + TCoA + DAD \qquad 8$$

The #BUFMIPv6+H =0.5 as the scheme minimizes the BU to Acknowledgements only which is 50% less costly then traditional BU. Wd=1, ldHA=3, ldCN=1, TCoA=0.5, DAD=0 as it ensures the unique CoA. So,

$$Latency(FMIPv6 + H) = 0.5 + 1 + 3 + 1 + 0.5 + 0 = 6$$

If we apply the scheme over the hybrid of FMIPv6 and HMIPv6 then the ldHA=1 and the total latency of the scheme becomes;

$$Latency(F + HMIPv6 + H) = 0 + 1 + 1 + 1 + 0.5 + 0 = 3.5$$

But the scheme enhancement is obtained by adding it with FMIPv6, because the HMIPv6 has additional overhead of the MAP.
This scheme reduces the latency almost 50% of the MIPv6. The chart below shows the result of the analytical comparison.

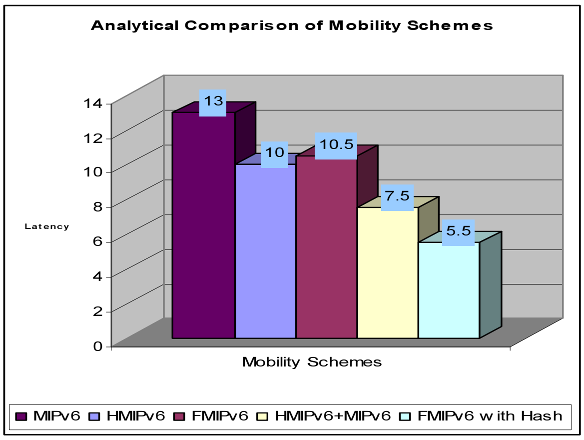


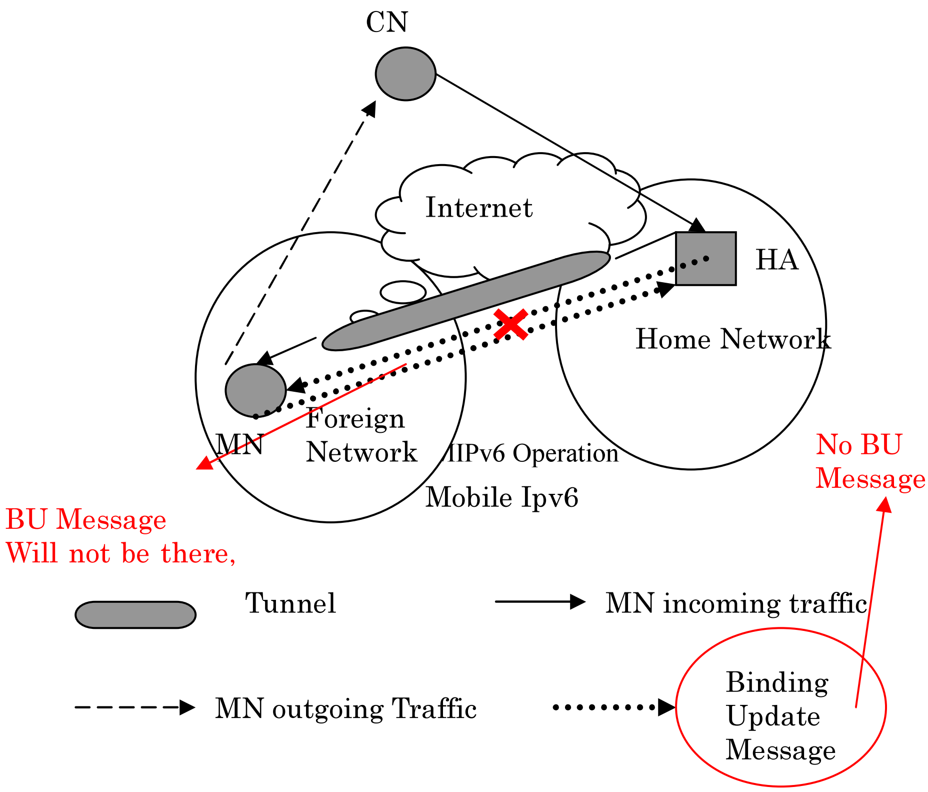
Figure 3. Chart of Mobility Schemes Latency

4 DISCUSSION OF RESULTS

Numbers of mechanisms are added to schemes to enhance the performance, but still the research is in progress to find the best scheme to support real time applications. The model proposed in this article, gives a clear direction for a new handoff scheme.

The proposed model is based on the FMIPv6 with hash function. The model also suggests a pool of IP's in every subnet for the nodes that enter to the network due to mobility. Each time the Hash function generates a unique IP from the reserved pool of IP's, so there will be no need for DAD. The hash function will generate the same IP at the HA side, so the traffic signalling will be limited to acknowledgment and routers advertisement only.

The achievement of the proposed model at layer 2 is to reduce address resolution time. This model also reduces the network layer registration time and modifies the MIPv6 basic operation [4] as shown in figure 4.



The binding update traffic signalling will be reduced to Acknowledgement only, as the CoA will already be present. Figure 5 shows handoff using FMIPv6 scheme.

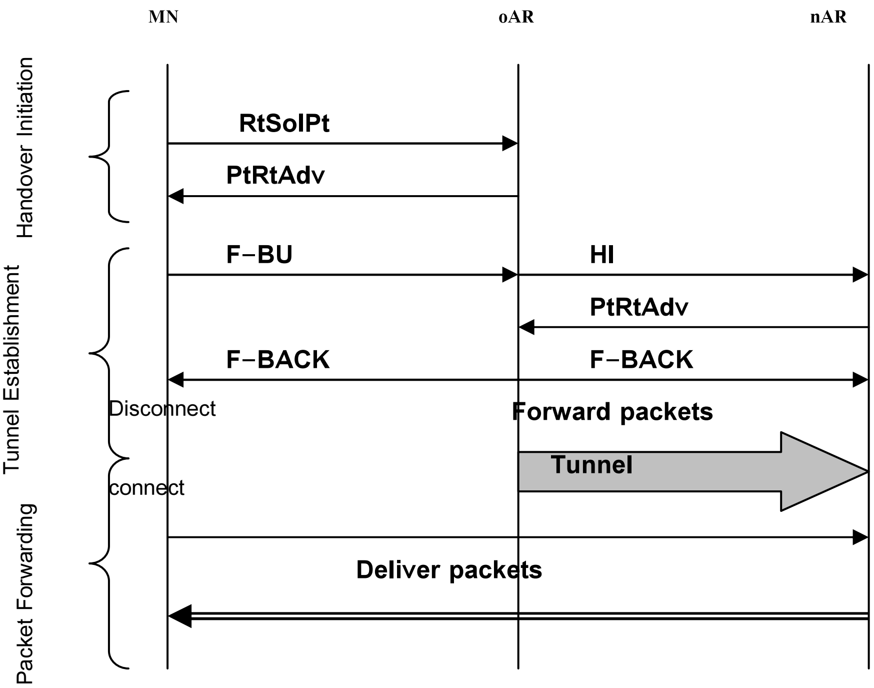


Figure 5. Basic operation of FMIPv6 [4]

The proposed model will enhance this operation and will modify the operation given in figure 8 by reducing the BU traffic signalling. In the proposed model the diagram given in figure 5 operation will become operational as shown in figure 6.

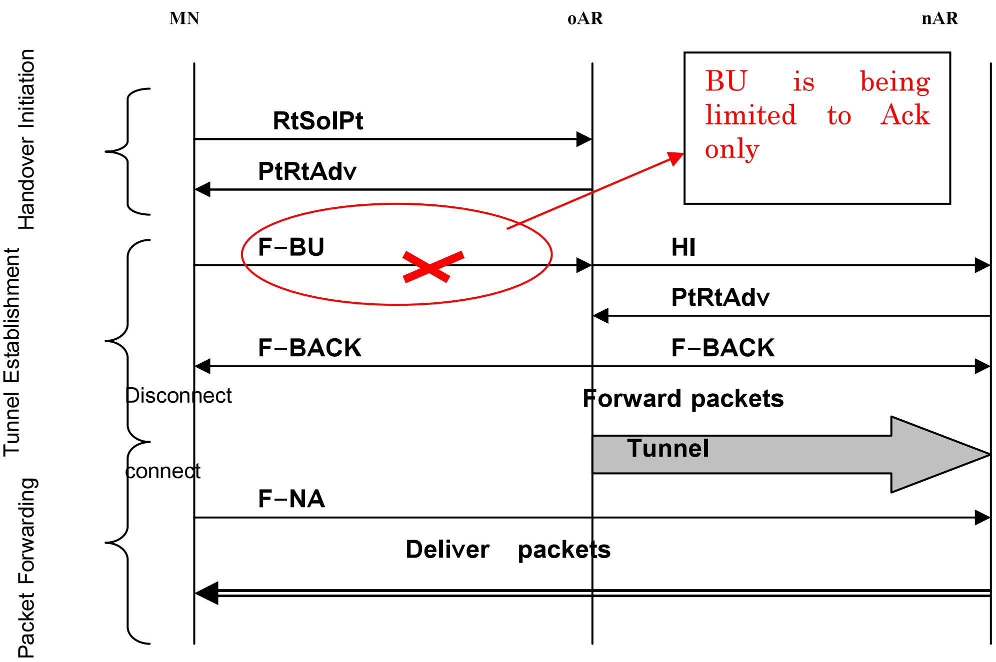


Figure 6. Modified FMIPv6 Operation

5 Conclusion

The proposed model has the capability to reduce latency and is more efficient than the previous models. The model has features both of the HMIPv6 and FMIPv6 with added capability of eliminating DAD by ensuring unique IP and reducing traffic signalling by minimizing the binding update traffic. The performance study of different mobility schemes shows that in different scenarios the performance of each scheme varies. The combination of two or more schemes can allow us to get an optimized scheme for the Vertical Handover. FMIPv6 with Hash has an optimized mechanism for address resolution and network layer registration to reduce overall latency. Further more it ensures unique IP and eliminates a major contributor of vertical handover latency, which makes the scheme obvious being an optimized one.

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