

Handover Investigation and Neighbor Discovery Technique in Mobile IPV6

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Abstract

Recent improvements in wireless technologies allows mobile nodes to become reachable while moving around IPv6 network environment. Since mobility management mechanism is needed for the end users while roaming. In this paper we propose a Fast Handover Mobile IPv6 technique when the mobile node moves from one network to another network. After the successful completion of handover, the proposed system performs Duplicate Address Detection (DAD) for new mobile node. In this paper we propose Trust based Multipoint Relay- Neighbor Discovery Protocol (TMPR-NDP) for performing duplicate address detection. Finally, our simulation result shows that the proposed handover mechanism reduces latency, packet loss caused during handoff process and reduces the processing time caused during DAD.

Keywords: Care of Address (CoA), Elliptic Curve Cryptography (ECC), Fast Handoff, Handover, Mobile IPv6

1. Introduction

All IP networks have been quickly evolved with the future broadband wireless networks. Because of this rapid use of Internet, an IP mobility management technology related issues also rise to improve the mobility. Further all the IP networks will allow all the mobile users on different wireless location and provides better mobility services continuously. The Internet Engineering Task Force (IETF) has proposed a Mobile IPv6 protocol which is used for supporting IP related mobility. The MIPv6 protocols proposed in earlier stages do not provide an efficient result which provides poor performance result against nodes mobility.

An existing MIPv6 protocols provides a continuous roaming services between different access points when users move to different locations. To improve the handover latency and packet losses during user roaming process the Fast Mobile Handover has been introduced. Mobile IPv6 defines how mobile nodes are maintaining their connectivity when it moves from one Access Router (AR)

to another one access router. After changing the link layer point of attachment each mobile node can able to communicate with other nodes without changing of its IPv6 address with the help of Mobile IPv6. Here each mobile node is addressed with their home address when a mobile node shifting to another access point.

Neighbor Discovery plays a vital role for assigning IP address to the mobile nodes when the MN moves to the new network. For that, each mobile node should check the duplicate address existence for a particular requested address. So, our system has to perform DAD process for identifying an IP address existence i.e. whether the particular requested address have been already assigned or not. So, the MN is to send Neighbor Solicitation (NS) message, if the address is assigned already the corresponding node reply with a Neighbor Advertisement (NA) message. Otherwise no reply from the opposite side means the address is already assigned for some other nodes. In this paper we proposed Fast Mobile IPv6 handover mechanism when the mobile node mobile from one network to another network.

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After the completion of handover, we propose TMPR-NDP mechanism for neighbor discovery. It can effectively identify the duplicate address present in the network subnet. Our proposed neighbor discovery mechanism can efficiently reduce the processing time and delay caused during neighbor discovery. FMIPv6 reduces the packet loss and latency occurred during handover.

2. Basic Definitions

Here we list out some of the basic terms used in MIPv6 terminology and neighbor discovery.

2.1 Mobile Node (MN)

Mobile Node is a node which has the mobility nature and it can able to move from one network to another network. Those networks are named as home network and foreign network.

2.2 Home Network (HN)

Home network is a network where all the MNs are having permanent connection with home network. The home address of the mobile node and home agents are correspondent by subnet of this network.

2.3 Home Agent (HA)

A router that is located in the home network which is responsible for forwarding packets to mobile node when it is move from home network to the foreign network.

2.4 Correspondent Node (CN)

The Correspondent Node (CN) is a type of node that can perform communication with the mobile node. CN may be located in any kinds of network.

2.5 Foreign Network (FN)

Foreign network is a type of network used in MIPv6 where the MN is moves from the home network to this network. Then it has been attached to this network not in home network.

2.6 Care of Address (CoA)

The CoA is an IP address assigned to each mobile node. The Mobile Agent (MA) assigns this IP address (CoA) to the MN. The MN can communicate with this address

only when it is leave from the home network. In MIPv6 the foreign network can generate a Foreign agent CoA or Co-located Care of Address for communication.

2.7 Foreign Agent (FA)

Foreign is a type of router used in foreign network that assigns an IP address to the MN and attaches MN with the foreign network when MN is move from HN. It can forward and receives data packets destined for the MN.

2.8 Access Router (AR)

The default router for the MN is defined as Access Router (AR).

2.9 Previous Access Router (PAR)

It is a type of access router which is a default MNs router. Before starting the handover, this router is accessed by the MN. After performing handover, the MN moves to the new router

2.10 New Access Router (NAR)

After handover process NAR is a default router for the Mobile Node (MN). When a MN moves from old router, this router is assigned to the MN.

2.11 Access Point (AP)

Layer 2 device connected to the subnet of the IP is defined as Access Point (AP). AP can enable wireless communication service with MN.

2.12 Previous Care of Address (PCoA)

The valid IP address on the PAR's subnet is defined as PCoA. This address is an old IP address assigned for each mobile node in their home networks.

2.13 New Care of Address (NCoA)

The NCoA is defined as a valid IP address on the NAR's subnet.

2.14 Foreign Agent Care of Address (FA CoA)

By using agent advertisement message the MN gets an IP address of the foreign agent.

2.15 Co-Located Care of Address (CCoA)

By using Router Advertisements, or Dynamic Host Configuration Protocol, the foreign network temporarily assigns an IP address to the MN.

2.16 Duplicate Address Detection (DAD)

When a MN newly joins to a link, it should check its IP address whether it is already used or not. For that MN floods neighbor solicitation message to all MN in the link. DAD can eliminate the accidentally assigning of same address for two different interfaces in the same link. There is also possibility to create a duplicate global-scope address for the nodes which are not presented in the same link. All the possibilities can be eliminated by the DAD process.

2.17 Neighbor Discovery

In IPv6 neighbor discovery identifies the relationship between the mobile nodes i.e. between their neighbor nodes. By using neighbor discovery, we can identify the reachability states of each node in the sub network.

3. Mobile IPv6

The next generation internet protocol is being used in many field of networking for support mobility is named as Mobile IPv6. The Mobile IPv6 can support mobility in both homogeneous and heterogeneous network. Mobile IPv6 supports mobility of IP host by allowing them with at least two IP addresses which are: Home address and Care of Address. Here the home address represents permanent address of a node but the Care of Address is the address of mobile node that currently attached to an IP subnet. The Care of Address which is associated with the mobile node only when it visiting a foreign network and changes rapidly with the IP subnet and depending upon the node's movement. In Mobile IPv6 the mapping between home address to the corresponding CoA is done with the help of HA.

Since, the HA is a device located in HN of MN. For an example if a CN in the foreign network wants to send packets to the MN in the home network means the communication takes place through the HA only. First a CN sends packets to the MN's home address, and then this packet is intercepted by the home agent or to the foreign agent which has the direct contact link with the MN.

Otherwise, the CN will directly send packets to the MN. Commonly the home agent does not perform mapping for longer time. For that in MIPv6 each CN has its own binding cache which stores the home address and care of address pair. In case the registration information is not stored in binding cache, the CN directly send packets to the MN.

Since, in MIPv6 all the HA and CN should maintain binding caches about the changes point of attachment. In order to maintain the updated binding cache, all the mobile nodes should periodically inform to their home agents and correspondent nodes about their location changes and about its new care of address. So, each mobile node has to be updated with its new address when its binding cache lifetime expired or when it moves to the new location i.e. after performing the handover process. Since, each binding cache has its own lifetime, even if the MN not changing their location. So, all the HA and CN should necessary to update their binding cache before the lifetime expires. The MIPv6 makes the triangular routing mechanism and route optimization mechanism for forwarding and receiving data packets from and to the MNs.

By using tunneling mechanism MN and CN can send and receive their corresponding packets directly with each other by enabling route optimization protocol. It occurs when the changes in an IP connectivity.

In⁷ proposed a Secure Authentication Mechanism (SPAM) for seamless handover in Proxy Mobile IPv6 networks. In this paper separate techniques proposed to overcome handover latency, packet loss and signaling overhead. It provides much more security for users from various attacks in PMIPv6 networks. It also solves the problem of out of sequence and avoids packet loss by performing a bi-casting scheme. Piggyback technique reduces the signaling overhead caused during handoff. Finally, the simulation result showed that this SPAM can able to reduce handover latency, packet loss and signaling overhead.

In¹⁰ was proposed a study of multimedia application performance over Multiple Care-of Addresses in Mobile IPv6. In this paper they were evaluates how well multiple care of address provided an improved performance over multimedia applications in Mobile IPv6. Here they were stated two diverging types which are SIM and ONE. SIM simultaneously uses all available address and ONE uses one alternative address. The final simulation result showed that the demonstration cost increases signaling overhead.

In¹ presents some survey results about Proxy Mobile IPv6 Handover. This paper has been discussed on various handover procedure and their shortcomings. Several enhanced handover approaches proposed for eliminating the handover latency and packet loss by implementing buffering mechanism, altering additional messaging, changing message signaling sequence, deployment of new entities. The proposed approaches and schemes could not be cost effective and having large amount of bandwidth consumption, large amount of burden on network entities.

In¹⁶ suggested a performance comparison among Mobile IPv6, Hierarchical Mobile IPv6, and Fast Handovers for Mobile IPv6 and their combination. In Mobile IPv6 the Neighbor discovery is used by nodes for resolving the link layer address and among neighbors it maintains reachability states. The fast handover proposed in this paper is used to reduce the handoff latency. For that fast handover propose two different mechanisms: Anticipated and tunnel based handover. This paper also has been proposed hierarchical handover scheme for reducing the signaling load caused during node mobility. For that it proposed a mobility management within a local domain with the help of Mobility Anchor Points (MAP).

In² evaluates Queuing Algorithms on QoS Sensitive Applications in IPv6 Network. This paper surveyed various kinds of parameters for improving Quality of Service (QoS). It also discussed with a mechanism for improving QoS in both IPv4 and IPv6. It analyzed various algorithms like FIFO, WFQ and PQ and their impacts on real time applications in IPv6 are analyzed. Here PQ and WFQ are the most appropriate scheduling algorithm which are providing high QoS when compared to other scheduling algorithms.

In¹² suggested the Investigation of Handover Techniques in an IPv6 Mobile Network. In this paper, they investigate with different handover strategies for handover on Mobile IPv6. It only focused on efficient handover technique to reduce packet loss caused during handover process. In this paper FMIPv6 is implemented to evaluate the improvement in handover latency on Mobile IPv6. The FMIPv6 uses previous care of address and new care of address when a mobile node moves from the previous access router to a new access router.

In⁹ discussed with Comparative Performance Analysis of Mobile IPv6 Protocols. This paper they conducted a quantitative analysis of various Mobile IPv6 protocols.

The simulation result proves that proposed hybrid mobile IPv6 protocols and Fast Mobile IPv6 performs better latency when compared to others mechanisms in IPv6.

In¹⁷ proposed a Performance Comparison of Mobile IPv6, Hierarchical Mobile IPv6, Fast Handovers for Mobile IPv6 and their combination. In this paper they compared with various handover mechanisms like MIPv6, FMIPv6, HMIPv6. Hereby they were observed the result of single mobile user with respect to handoff latency, packet loss rate and bandwidth achieved for each station. It provides the deep understanding of various mechanisms and they simulated with Ns2 network simulator.

In¹⁸ discussed with Performance Evaluation of Fast Handover in Mobile IPv6 Based on Link-Layer Information. This paper improved with a Fast Mobile IPv6 handover mechanism. FMIPv6 is tries to reduce the handover delay by providing the fast IP connectivity between mobile nodes. Finally, they compared their proposed FMIPv6 with an existing MIPv6 mechanism. The comparison taken with handover latency, packet loss, throughput and handover delay.

4. Proposed Method

In this section we discuss with our proposed system and the mechanism we are going to use. In our proposed concept we use fast handover for performing handover mechanism in Mobile IPv6 and TMRP-NDP for performing Duplicate Address Detection. In this method, after performing the handover mechanism a mobile node starts the Duplicate Address Detection (DAD) process for identifying its link layer address. Our proposed handover method involves with initiation and where the network agent, changing the network condition, users identifies the need of handover process. For enhancing the features of handover FMIPv6 is used in Mobile IPv6. Our main aim in FMIPv6 is to configure a new Care of Address or an existing Care of Address, during a mobile node moves from one access router to another access router.

Fast Handovers for Mobile IPv6 is mainly designed to reduce handover latency by executing this, time consuming handover mechanism. Neighbor discovery is used to check and keep each node's reachability states, and their link layer address. When mobile nodes perform handover it should be identified by MAC address of each access routers. Router Advertisement message in IPv6 is required for the identification of access router's MAC address. During the process of router advertisement each

mobile node informs their neighboring nodes about their point of attachment by using the Binding Update (BU) message. The working principle of our proposed FMIPv6 is depicted in the following Figure 1.

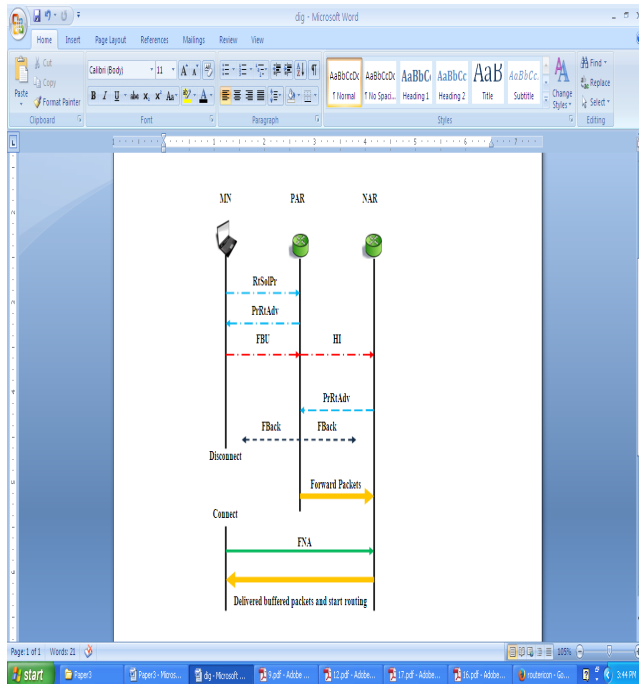


Figure 1. Working mechanism of FMIPv6 handover.

In FMIPv6 the access router is classified based on their functionalities i.e. Previous Access Router (PAR) and New Access Router (NAR) for the mobile node before the mobile node moves to the new access router. Commonly the Fast handover consists of three different phases which includes:

- Handover Initiation
- Tunnel establishment
- Packet forwarding

The handover initiation is performed by mobile node. If a mobile node needs to communicate with another mobile node located in different access router, then the mobile node starts with a Router Advertisement for Proxy Advertisement (RtSolPr) to the Access router which holds the mobile node. After receiving of RtSolPr message, the access router (AR) responds towards the MN with a Proxy Router Advertisement (PrRtAdv) message. Information about all the neighboring nodes and their corresponding links is contained in Proxy Router

Advertisement (PrRtAdv) message. In FMIPv6, the Care of Address is also classified into two ways as per the handover. Those are Previous Care of Address and New Care of Address. After receiving PrRtAdv, the MN sends a Fast Binding Update (FBU) message to the previous access router (PAR).

The tunneling phase is carried between NAR and PAR. During tunneling phase the FBU is used after performing handover, in which the packets from new location can be tunneled to new location i.e. PCoA of MN is bind with NCoA. Then Handover Initiate (HI) message is send to the NAR from the PAR to intimate regarding the handover. The reason for sending FBack message is to inform that the packet tunneling process is already in progress when the MN is attached to the NAR. Hereby the FBack message is sent from PAR to the NAR. The process of sending FBack message by the PAR is defined as “predictive” mode of operation.

The packet forwarding phase is performed for smoothening the handoff process. Based on the anticipating timing interval the packet transmission between PAR and NAR is performed. As per the mobile node’s timing requirement the handoff takes place that is said to be anticipated timing intervals. By sending a Fast Neighbor Advertisement (FNA) message, the Mobile node is connected to the new access router. This FNA message is sent between MN and NAR for announcing about their attachment with NAR. Confirmation about the New Access Router (NAR) uses FNA message. These kinds of timing interval are very difficult to generalize. Since, too early or too late of forwarding this time interval will produce huge amount of packet losses. Handover latency This is increased when huge amount of packet loss occurs. The final handover is denoted as:

$$P = a(x)(f x = Y, \text{ then } T + \text{ if } x = Z \text{ then } S)$$

Where,

\bar{a} - The channel used for communication

b - Value passed between all entities

S - Switch

T - Talk

These S, T are the communication taken place between both MN and CN. Here b / x denote the message from b to x that is (from/t).

After completion of fast handover process the mobile node in a new access router should identify its link layer

address and their neighbor's reachability states. For that an IPv6 performs Duplicate Address Detection (DAD) process during neighbor discovery. Duplicate address detection is the process of identifying available link layer address and eliminates the assigning of same address for two different interfaces in the same link. For that the MN sends a route solicitation (RS) message to check whether some other nodes are having that requested address. If no reply comes from any other nodes within a period of time, MN can assume that requested address is available. Then the MN can use that link layer address. Otherwise the MN receives Router Advertisement (RA) message from any one of the node, MN cannot use that address i.e. the requested address is invalid.

To reduce unnecessary flooding of router solicitation, message our proposed system uses a Trust Based Multipoint Relay Neighbor Discovery Protocol (TMRP-NDP). In our proposed concept we use multipoint relay nodes for avoiding unnecessary NS message flooding¹⁸. Figure 2 shows the working process of multipoint relay where stage1 performs normal DAD procedure and stage2 performs n-DAD for reducing time consumption between stage1 and stage2.

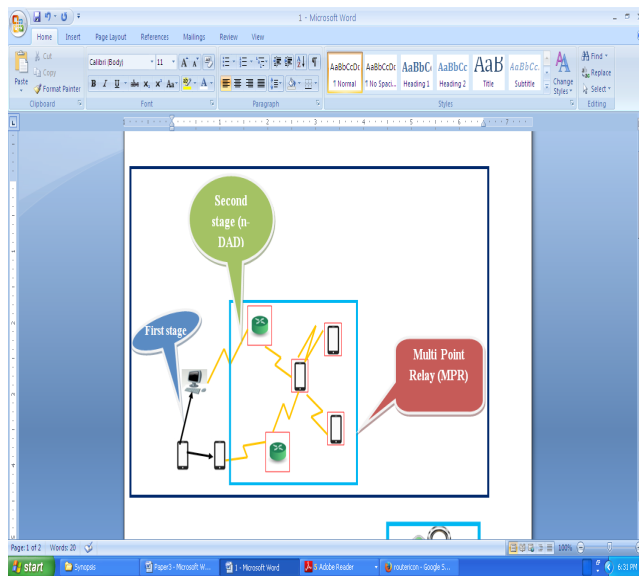
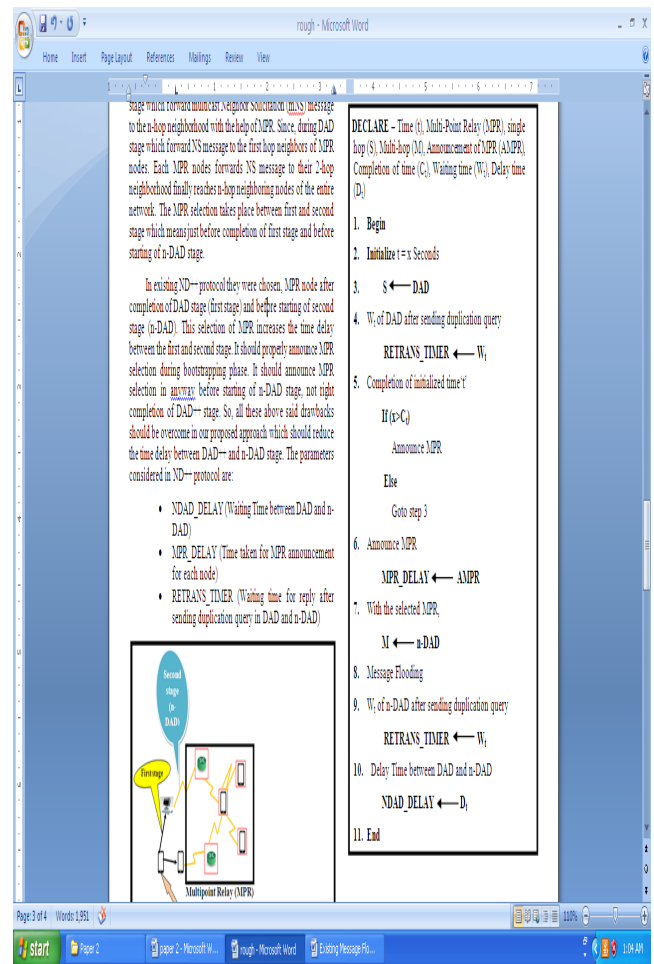


Figure 2. Process of Multi Point Relay (MPR).

During DAD process the MN forwards its neighbor solicitation message to the first hop neighboring nodes. This process is called as first stage i.e. DAD stage. After that the first hop neighboring nodes which forward those received packets to the second hop neighboring nodes.

This process is defined as n-DAD i.e. second stage of our proposed system. Here we are choosing the multipoint relay nodes in between first and second stage. From that we can reduce the time consumption takes place between two different processes. Finally, our experimental result produce low amount of time consumption to complete the entire task. The n-DAD stage is also named as extended DAD stage since it has been developed on the basic of extending the process of stage 1.



Algorithm 1. Step by step procedure of TMRP-NDP

After the reception of neighbor solicitation message, each node should verify their link layer address whether it is match with requested address. The Certificate Authority (CA) checks the key value of each node. If anyone of a node in the subnet already having that requested address means, a node will send Neighbor Advertisement (NA) message to a mobile node. From that MN can analyze that particular address is assigned. Then the MN can choose

another address by using same neighbor solicitation message and repeat the same process until no reply comes from the neighboring nodes.

From Algorithm 1 we can understand the working process of our proposed TMPR-NDP algorithm. In this proposed concept a timer is set in between different stages of processing. Our proposed TMPR-NDP protocol consists of two different delay measuring parameters which include: NDAD_DELAY and MPR_DELAY. The NDAD_DELAY is defined as the waiting time between DAD and n-DAD stage. The time taken for announcing MPR selection is defined as MPR_DELAY. From our proposed method the MN can assign its own MAC address.

5. Performance Analysis

This paper proposes how can a given system perform handover and neighbor discovery process in Mobile IPv6 networks. It deals with how the MN moves to new network from their existing network. After that the communications between mobile nodes are also discussed in this proposed paper. The proposed system concentrates to overcome the drawbacks proposed in an existing system. The main purpose of performance evaluation is to quantitatively evaluate an improvement that the mobile user would experience in a system using our proposed enhancement features.

5.1 Performance Metrics

Our proposed research is discussed with some of important parameters. Based upon the parameters enhancement, we proved that our proposed approach produces better result when compared to an existing system. The parameters to be studied are as follows:

- Handoff latency
- Packet loss
- Processing time

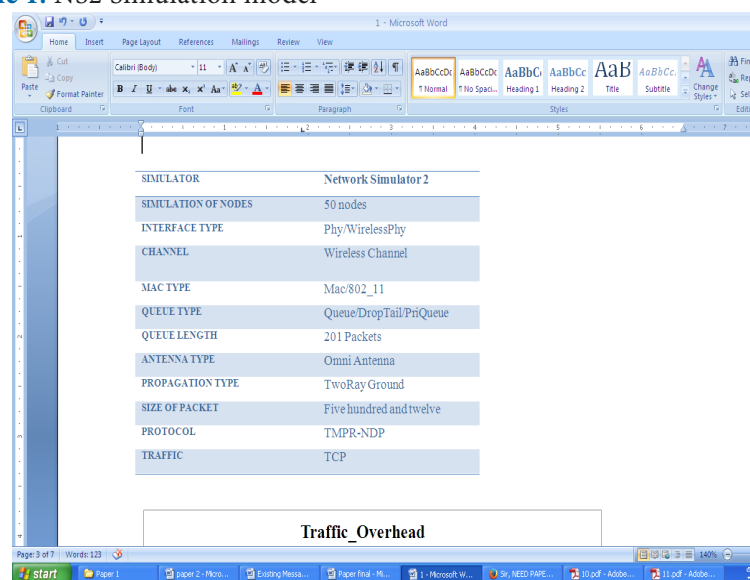
By means of these three parameters, our proposed system provides an efficient result.

5.2 Simulation Environment

With our Ns2 simulations we study the parameters in previous section. For our simulation we use 50 mobile nodes and each node having specific features. During simulation the nodes can move anywhere and in any direction

within their coverage area. Total simulation conducted in the area of 700*700 m. Here we set the bandwidth of Phy/WirelessPhy 250 mb. It consists of IEEE 802.11 MAC protocol which is uniformly distributed. We use Constant Bit Rate (CBR) for traffic management during packet transmission as well as TCP traffic. In our simulation we use CBR as our traffic source and use the packet sizes of 64 to 512 bytes. In our simulation the nodes and their mobility depends only on Random Waypoint Mobility Model which can be generated and executed by Ns2. Based on the mobility model mobile nodes are moves in the simulation environment.

Table 1. NS2 Simulation model



SIMULATOR	Network Simulator 2
SIMULATION OF NODES	50 nodes
INTERFACE TYPE	Phy/WirelessPhy
CHANNEL	Wireless Channel
MAC TYPE	Mac/802_11
QUEUE TYPE	Queue/DropTail/PriQueue
QUEUE LENGTH	201 Packets
ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	TwoRay Ground
SIZE OF PACKET	Five hundred and twelve
PROTOCOL	TMPR-NDP
TRAFFIC	TCP

Traffic_Overhead

Two Ray Ground propagation type is used for our simulation and it is shown in Table 1. Two Ray Ground is known as a radio propagation models which is used to compute received power when a packet is received between sender and receiver and vice versa. For our simulation, environment surrounding is selects the Pause Time. Pause Time is a time in which all the nodes in the networks are motionless but continued in transmission. Each node in the network selects random destination and moves to the destination at a speed that is distributed uniformly. If the pause time is 0 seconds means it corresponds to continuous motion. No motion between nodes means the pause time corresponds to N seconds. In our simulation model, packets are broadcast to their neighboring nodes as well as routers. Our proposed system performs simulation based on the above set features

which are the inbuilt types present in Ns2 network simulation tool.

5.3 Comparative Analysis

In this section we are comparing our performance results with an existing system by means of latency, packet loss, and processing time. Figure 3 shows the comparison result of packet loss between FMIPv6 and MIPv6. In that, our proposed FMIPv6 handover outperforms when compared to MIPv6 handover. Since, during handover process the overall latency reduced which automatically decreases the packet loss. Since, packet loss and latency are interrelated to each other. Packet loss is measured in term of seconds.

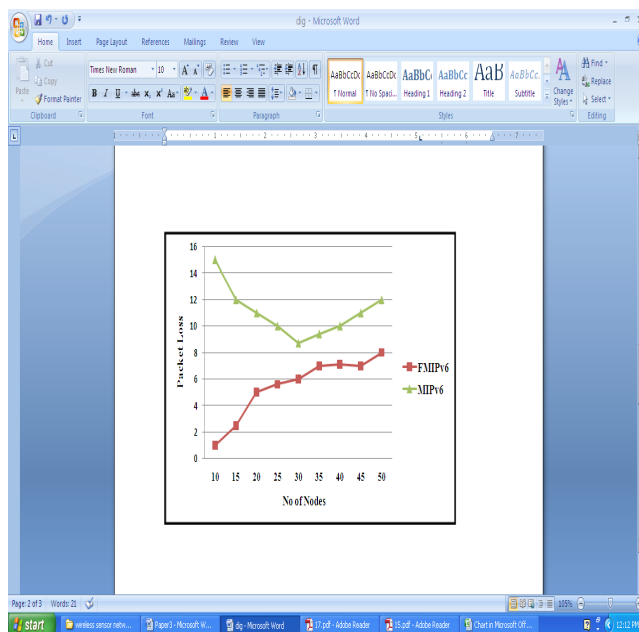


Figure 3. Packet loss comparison between FMIPv6 and MIPv6 for 50 nodes.

In our proposed system we choose only 50 numbers of mobile nodes for simulation. Each node in the networks are having mobility nature, it can move anywhere in the network in any direction. When the mobile nodes transfer from one network to another one network an IP address could change. A node is to be allowed to continue its session. During handover the coverage range and mobility management should be considered for further processing. In some cases, a node can move beyond its coverage range and it will automatically losses its packets and the latency of packet transmission will reduce.

From Figure 4 we can see the latency caused during handover when we employing two different kinds of handover mechanism. During handover how these two mechanisms are reacting that is the main aim of our analysis. The above said Figure 4 shows that our proposed FMIPv6 reduces latency during handover process. From the analytical result we can analyze MIPv6 is not suitable for large scale networks. The performance measurement used for latency calculation is by means of seconds. Basically latency is reduced when using our proposed FMIPv6 handover technique and increased when employing MIPv6 handover. For large scale mobile networks, the MIPv6 increases latency. From that we can conclude MIPv6 is not suitable for large scale networks i.e. when increase the number of nodes.

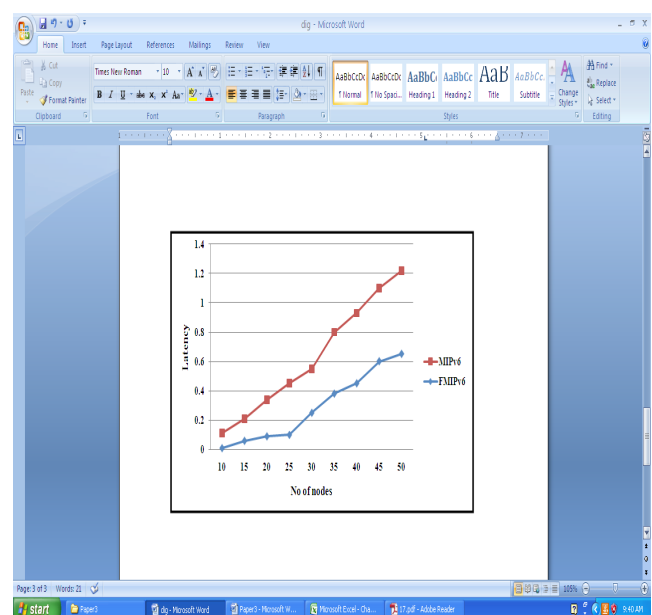


Figure 4. Latency Comparison between FMIPv6 and MIPv6 for 50 nodes.

Figure 5 shows the processing time takes for completing both TMPR-NDP protocol and a normal ND++ protocol. In this paper we used TMPR-NDP neighbor discovery protocol for Duplicate Address Detection (DAD). The ND++ is also a neighbor discovery protocol which does not provide efficient result when compared to our proposed method. Since during duplicate address detection, the ND++ increases the protocol overhead. Since, ND++ protocol uses the flooding mechanism which totally increases the processing time as well as protocol overhead. Commonly processing time is measured by means of seconds or mille seconds.

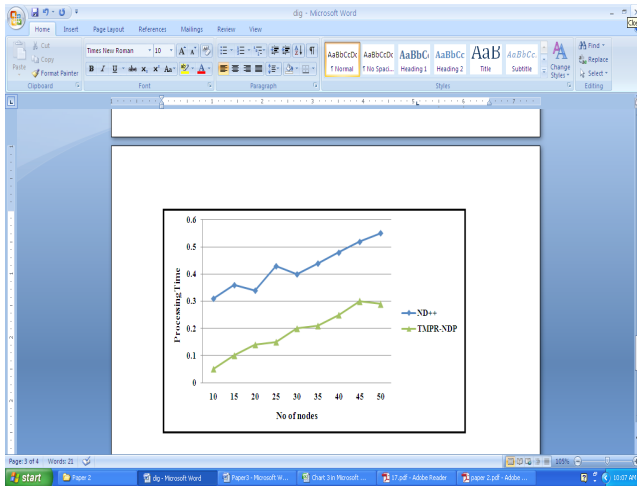


Figure 5. Processing Time Comparison between ND++ and TMPR-NDP for 50 nodes.

From the analytical result we can analyze our proposed FMIPv6 provide better handoff result when compared to MIPv6. At the same time TMPR-NDP provide best outcome for duplicate address detection than normal ND++ protocols.

6. Conclusion

In this paper we achieved result with the thorough knowledge of our simulation that required to supporting handover and neighboring discovery for Ns2. Since, an existing system does not support both handover as well as neighbor discovery simultaneously. All the existing papers autonomously support either handover mechanism or neighbor discovery process. But our proposed system can handle both categories and also provide efficient result when compare to an existing system. In this paper we reduced the latency caused during hand-off stage by using Fast mobile IPv6 handover technique. This Fast handover technique reduces packet loss caused by an increased latency. Since latency and packet loss are directly proportional to each other's.

As per our proposed analysis, this paper contains handover and neighbor discovery both of which increases overall processing time. To reduce the processing time caused during neighbor discovery process our proposed system offers TMPR-NDP protocol. When performing DAD process our proposed protocol can reduce the processing time. Our proposed TMPR-NDP support best level of security features. Finally, our experimental results provide reduced latency, packet loss and processing time.

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