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Performance Analysis between Bi-directional Symmetric Rote Optimization in IPv4 and Adaptive Local Route Optimization in IPv6 Network

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ABSTRACT

Mobile WiMAX is a wireless networking system based on the IEEE 802.16e standard. In order to support mobility some kinds of handoff schemes must be adopted and the hard handoff is defined as mandatory. Hard handover defined as break before make scheme where packet drop ratio is more. To avoid such packet dropping a route optimization scheme to be used to avoid the un-necessary network re- entry point. There are two type of route optimization scheme is there one based on IPv4 network called bidirectional symmetric route optimization and another one used in Hierarchical mobile IPv6 network called Adaptive Local Route optimization Scheme. In BSRO scheme network suffering from triangular Routing problem where handoff latency is increase and throughput goes down .In the ALRO scheme, an MN informs the CN of the MN's LCoA, if the packet delivery cost is more dominant than the binding update cost. Otherwise, the CN is aware of only the MN's RCoA. Namely, the ALRO scheme minimizes either the packet delivery cost or the binding update cost depending on the session-to-mobility ratio (SMR) of each CN. So using this scheme route is optimized between two nodes and triangular routing problem is solved, handoff latency decrease and less no. of packet drop. The ALRO scheme used in one MAP domain where in the simulation result show that throughput of network increases as comparison to BSRO scheme.

Key Words: ALRO, BSRO,LCoA, RCoA

INTRODUCTION:

1. Now day's mobile devices and the wireless devices which are connected with the Internet is rapidly growing. Wireless links as well as networks, both mobile users and the services which are related to the mobility form the growing Internet infrastructure part. Such kind of mobile parts as well as wireless parts are basically connected to the wider, larger networks. Mastering of the main concepts in wireless, mobile as well as wired technology. mobile IP in nothing but the Internet protocol which is defined by the IETF (Internet Engineering Task Force) which allowing end users to keep the same address for the IP, and connection is alive while switching from one network area to another one[1]. The important feature of the mobile IP design is that all needed the functionalities for the managing and processing information of mobility which is embedded in well defined entities such as Foreign Agent (FA), Home Agent (HA), Mobile Nodes (MN's). Whenever the Mobile node moving from its HN (Home Network) to the FN (Foreign network), the packets correctly delivered to its present point of attachment based on the IP address of MN's, which is changing during the new attachment point. Hence in order to ensure the delivery of packets to the MN, MIP allowing the Mobile Node to use the two IP addresses for the same such as care of address (CoA) as well as Home Address. Here the Home address is fixed or static which is assigned to the Mobile Node at the Home Network, whereas Care of Address is dynamic which representing the current Mobile Node location [2]. There are many problems which are associated with the basic Mobile IP like HA overloading, fault tolerance of home agent, triangle routing problem etc. Hierarchical Mobile IPv6 (HMIPv6) [2] was proposed by Internet Engineering Task Force (IETF) to mitigate the high signalling overhead that is incurred in Mobile IPv6 networks when mobile nodes

(MNs) perform frequent handoffs. In HMIPv6 networks, a mobility anchor point (MAP) has been introduced in order to handle binding update (BU) procedures due to handoffs within a MAP domain in a localized manner, which reduces the amount of network-wide signalling traffic for mobility management. In HMIPv6 networks, an MN configures two care-of-addresses (CoAs): a regional care-of-address (RCoA) and an on-link care-of-address (LCoA). The RCoA is an address on the MAP's subnet, whereas the LCoA is an address configured to the MN's current point of attachment. An MN that enters a foreign network first configures its LCoA by the IPv6 address auto-configuration scheme. Also, it will receive a Router Advertisement (RA) message containing information on a MAP. The MN then configures a RCoA and sends a local BU message to the MAP. The local BU message includes the MN's RCoA in the Home Address Option and the LCoA is used as the source address of the BU message. This local BU message binds the MN's RCoA to its LCoA. The MAP will then perform duplicated address detection (DAD) for the MN's RCoA on its link and return a Binding Acknowledgement (BACK) message to the MN. After registering with the MAP, the MN must register its new RCoA with it's HA by sending a BU message that specifies the binding (RCoA, Home Address (HoA)) as in Mobile IPv6. The HoA is recorded in the home address option, whereas the RCoA can be found in the source address field. The MN also sends a BU message that specifies the binding information between the HoA and the RCoA to its current correspondent nodes (CNs), which achieves route optimization.

The rest of this paper is organized as follows: Section 2 provides technical background of basic operation of routing in Mobile IPv4 network. In section 3, provide technical background of Bidirectional Symmetric Route Optimization Scheme in IPv4 network. Then in section 4, discuss the Hierarchical Mobile IPv6 Network using Adaptive Local route optimization scheme. In section 5 performance comparison between the Bidirectional symmetric route optimization in IPv4 and Adaptive local route optimization in Hierarchical Mobile IPv6 network using NS2 simulator. In section 6 conclude the paper.

2. Basic Route Optimization in IPv4 Networks

This section describes the basic operation performed by the Mobile IP protocol. There are basically three operations such as Agent discovery, Registration and tunnelling is performed by original MIP.

Agent Discovery

MN have the main responsibility of discover the location of itself whether it is belong to Foreign network or home network. Such type of discovery handled by Agent solicitation communication process or by agent Advertisement [5]. The FA generally broadcast internet Router discovery protocol message for own network to permit the MN that visited in the network recently. For this purpose MN known about which networks it's belong to. If any situation MN does not receive any message, it is informed by the FA directly, this procedure called agent solicitation. After particular waiting time there is no response to the message then MN use DHCP (Dynamic Host Control Protocol) to allocate the new IP address.

Registration

After acquiring the new IP address, the IP registration process started. It is informed by the mobility agent with its new IP address of mobile nodes as well as its binding information such as mobile node home address as well as its care of address. This procedure also allows maintaining the TCP connection without the distribution as well as correspondent nodes in order to communicate directly with the mobile nodes [2]. Once the MN has its COA, MN then register that CoA to it's HA, which known where to forward its packets.

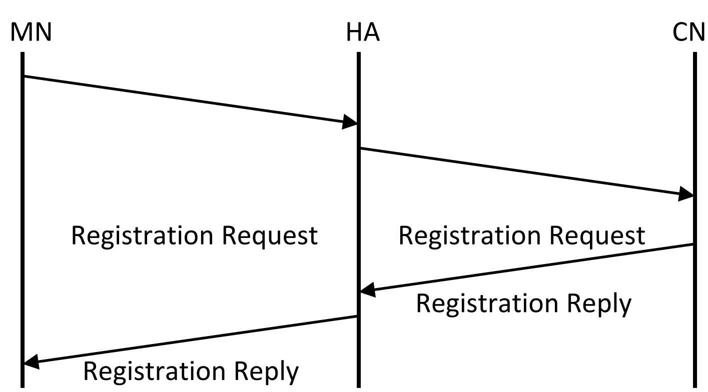


Figure 1: Indirect Registration

Based on the condition of the network and its configuration, MN directly or indirectly registers, step for the Indirect Registration are presented in the following ways

1. To start the registration process, MN send registration request to its Foreign Agent.
2. Foreign agent processes registration request, and send it to home agent.
3. HA send registration Reply in the form of permission or deny to the foreign agent
4. That registration reply processed by FA send back to the MN

Tunnelling

In the process of tunnelling packet deliver from mobile node to the home agent and home agent to the mobile node. To avoid the problem of route propagation, tunnelling is done by the foreign agent or the mobile node. Once the tunnel is established, it considered only as the end to end hop which from mobile node or foreign agent to home agent[7]. There is one major problem faced by the basic MIP configuration such as triangular routing problem. Packets that are travel from correspondent node to MH in a visited network are routed from CN to HA. It is the duty of HA to encapsulate the packet in a MIP tunnel. The tunnel is terminated in the FA[6]. Foreign agent forwards the packet with in layer two technologies to the MH. Correspondent agent supposed to have public IP address. It is possible for the Foreign Agent to directly forward the packet to the Correspondent node. Due to the triangular routing problem following problem arises in the network.

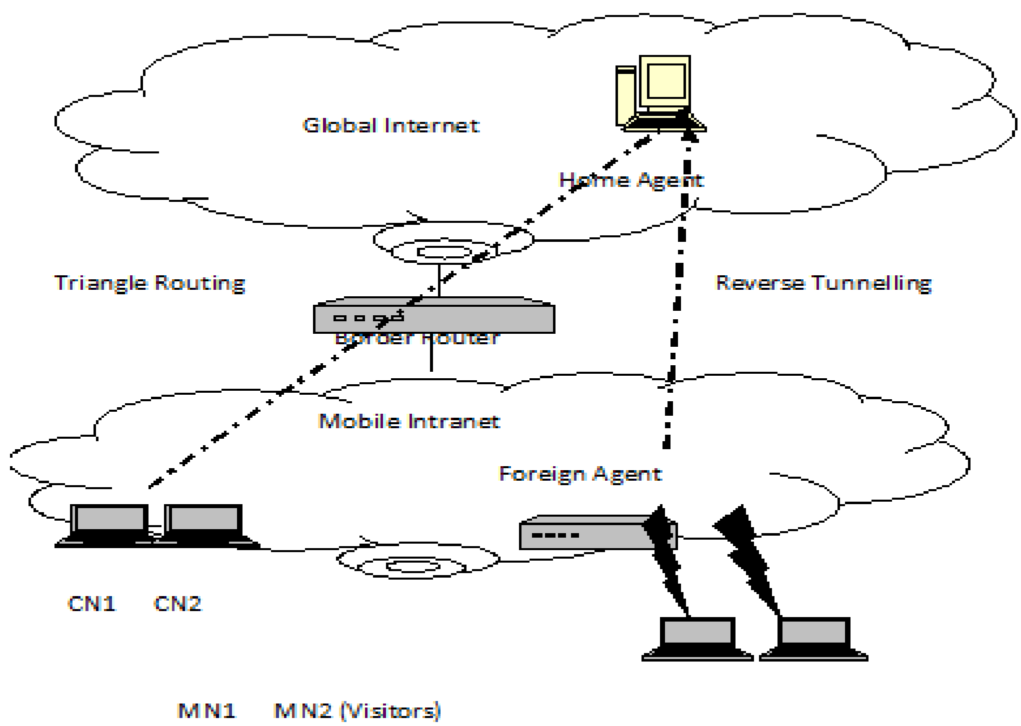


Figure 2: Tunnelling and Routing packets in MIP

1. Its increases the traffic in the network. Basically load of Home Agent is increased
2. It cannot support private addressing. Since the solution require unique IP address on every interface[4].

Router starts dropping of packet due to non consistent of source IP address. The solution of this triangular routing problem in the term of route optimization.

3. Bidirectional Symmetric route optimization in IPv4 network

This section describes the route optimization technique that optimize the route using three process

I. Bi-directional Direct Tunnelling

Correspondent agent start with routers, it will capture all packet that belong to correspondent nodes. When correspondent agent capture a packet sent from correspondent nodes, it does not have binding cache entry for the receiver of the packet. The agent will forward the packet as an ordinary datagram. As this thing is specified in the original route optimization protocol that normal packet may trigger the Home Agent to sending the binding update message to the sending correspondent node. While capture this binding message, the correspondent agent will create a new binding cache entry. It also starts to establish a mobility security association with the Home Agent [8].

If correspondent agent capture a packet sent from the correspondent node and its associated binding cache entry for the mobile node, it will encapsulate and tunnel the packet to the responsible Foreign Agent, and then FA de-tunnels and forwards the packet to the destination MN. Foreign Agent also recognize correspondent network with sending correspondent node support route optimization, so it will update its tunnelling cache entry according to its recognition.

Reversely, when a foreign agent receives a packet sent from a visiting mobile node to a correspondent node that matches a tunnelling cache entry, it will encapsulate and tunnel the packet to the destination correspondent node. If there is no tunnelling cache entry suitable for the destination of a packet, it will reverse tunnel the packet to the mobile node's home agent as usual. While the responsible correspondent agent intercepts this packet tunnelled from the foreign agent, it de-tunnels the packet and forwards it to the destination correspondent node. [8]

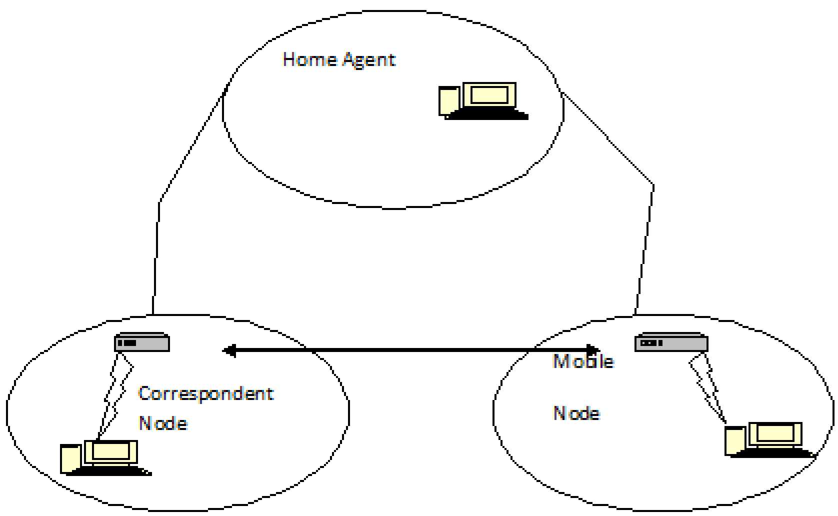


Figure 3: Bidirectional Symmetric Route optimization architecture

II.

Subnet based route optimization

A correspondent agent also used subnet masking to support subnet based tunnelling. It encapsulate packet from a correspondent node to a mobile node. The foreign agent receiving this packet will keep the subnet information in its tunnelling cache. Hereafter a foreign agent uses the subnet information to decide whether a correspondent node is behind a correspondent agent that support direct tunnelling. Whenever an MN send any packet to the CN in the route optimized correspondent network, the Foreign Agent can directly tunnel the packet to the destination through the responsible correspondent agent without passing through the home agent. To prevent the hijacking of a packet from MN to the Correspondent node a foreign agent should use the destination address of the packet, as the other destination address of the encapsulated packets. This type of subnet based route optimization reducing the control message for establishing and maintaining tunnels to the individual's nodes, this leads to reduce the size of binding and tunnelling cache entry. It is also have the maximum possibility of reusing the optimize route. Consider fig. 2 and 3 assume the route between CN1 and MN1 was established such that there is a binding cache entry for the MN in the correspondent agent and a tunnelling cache entry for the correspondent network in the foreign agent.

There are different -2 other ways to re-used the tunnel between CN1 and MN1 without additional establishment or maintain messages.

III. Binding Optimization

When a MN move from one zone to another zone an IP handover occur. It is the duty of the HA to keep the binding update list to send binding update message to all of its correspondent nodes.

A foreign agent can transmit packet directly to mobility aware correspondent agent. When MN move away from current zone, the FA can send binding update message directly to the correspondent agent, so on this process the message need not transfer through Home Agent. A complete route is optimized; it can send update message directly to the correspondent agent. However to support backward-compatibility with the base Mobile IP and route optimization protocols, the enhanced foreign agent still need to send a binding warning message to the HA to notify the home agent and the ordinary correspondent node that the mobility binding is updated.

4. Adaptive Local Route optimization technique in Hierarchical mobile IPv6 network

HMIPv6 means the Hierarchical Mobile IPv6 basically reduces the overhead of signalling overhead as well as latency of handoff which is associated with the MIPv6. Even if this protocol is support the optimization of the route among the mobile node in the correspondent node and mobility anchor point, but when the MN and CN is presented in the MAP domain, formation of a non-optimal done.

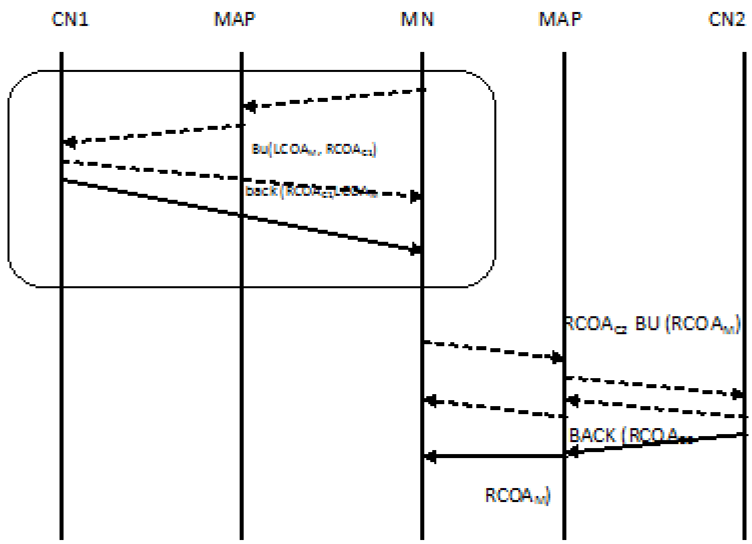


Figure 4: ALRO scheme

In this case, the route can be optimized by informing the CN of the MN's on-link care-of address (LCoA) when the MN hands off within the domain. However, this optimization may result in a higher binding update cost when the MN hands off frequently. To balance the trade-off between the binding update cost and route optimization, an adaptive local route optimization (ALRO) scheme is used. In the ALRO scheme, an MN informs the CN of the MN's LCoA if the packet delivery cost is more dominant than the binding update cost. Otherwise, the CN is aware of only the MN's RCoA. The configuration of Adaptive Local route optimization shown in fig. 4. Namely, the ALRO scheme minimizes either the packet delivery cost or the binding update cost depending on the session-to-mobility ratio (SMR) of each CN [9]. If the session activity of an MN is higher than its mobility rate, the LRO scheme is a more appropriate RO scheme. On the other hand, the GRO scheme is better than the LRO scheme when the mobility rate is relatively high.

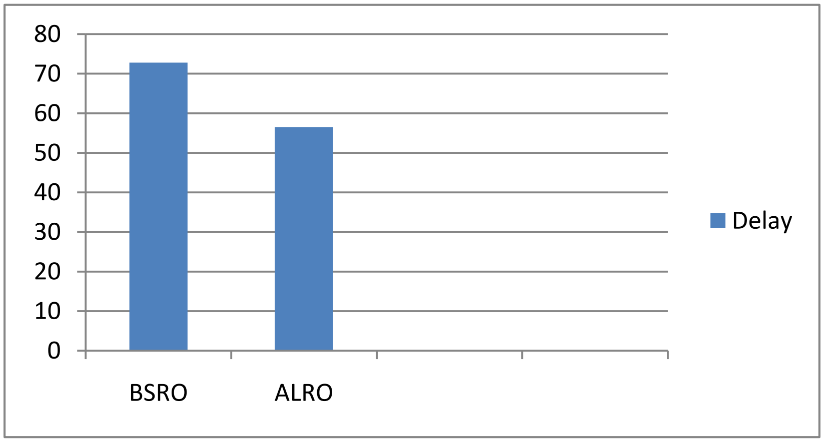
5. Simulation Results

NS2 is the Network Simulator with the version 2 which is specially targeted for the simulation of various kinds of networks. NS2 is also called as the discrete event simulator for the networking researches. Simulations as well as research level supports are provided by the NS2 for the networks like wireless networks, wired networks, wireless sensor networks etc by using the various kinds of communication patterns such as UDP, TCP, IP, CBR etc.

The data transmission delay during the handover is the measurement of the overall interruption of the data transmissions during the handover involving delays in every steps of the handover process. Using the no. of metrics (mobility service metric, UDP service metric, and TCP service metric) evaluate the performance of protocols.

Delay

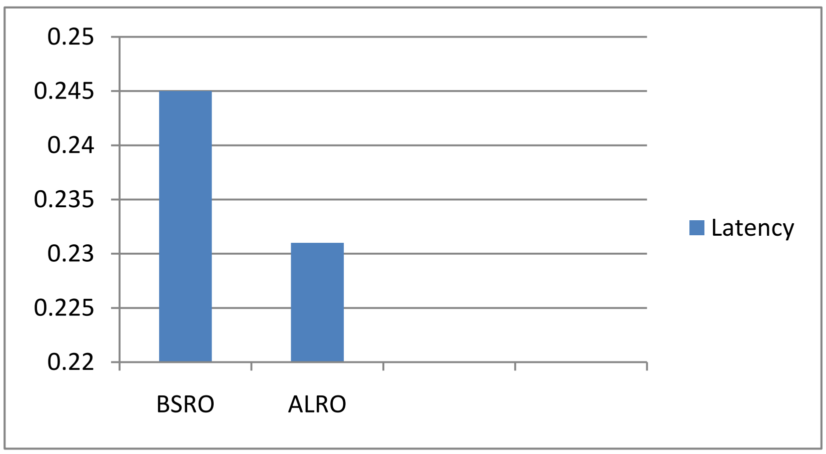
Handover delay is defined as duration of time for which the handover process is in progress. As graph shown that ALRO scheme in IPv6 network have better performance than the BSRO scheme. The ALRO scheme provide better route optimization at local or global level, so when handover occur its route is optimized and total time needed to complete handover process is reduced.



Graph 1: Handover Delay

Handover Latency

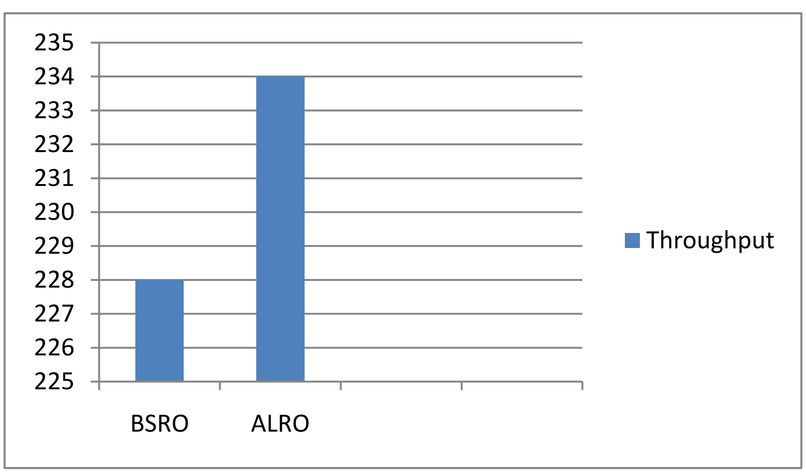
Handover latency is the total time interval of last packet received from the previous node and first packet received from the current node divide by the total no of handover occur. Handover latency is very important parameter to calculate the performance of the network. In the given graph showing that handover latency of ALRO scheme is reduced as comparison to the BSRO scheme.



Graph 2: Handover Latency

Throughput

The total delay time and handover latency decreased in the given ALRO scheme, its lead to less packet drop and handover occur in less time so the throughput of system is increased



Graph 3: Throughputs

6. Conclusion

Hard handover technique is the mandatory technique in mobile WiMax network. In mobile IP environment some type of route optimization technique needed to improve the performance of the network. In this paper two type of route optimization technique is discussed that based on IPv4 and IPv6 network. BSRO scheme provides subnet based direct tunnelling and binding optimization that have less capability to optimize the route as comparison to Adaptive local route optimization method that maintain the session to mobility ratio and maintain binding update cost at predefined threshold value so the total performance of system increased. The handover delay of the ALRO scheme reduced approximately twenty three percent and handover latency reduced to five percent, the throughput is increased by two percent. Thus on the basis of performance results of both the route optimization techniques, the route optimization technique called IPv6 based is performing slightly better as compared to the BSRO which is used IPv4 networks.

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