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Optimization of Communication Routing- An Introduction to Optimal Control

Kaustav Jyoti Borah[1]
Department of Electronics and Comm Engineering
Gauhati University
kaustavjb@gmail.com

Jutika Borah[2]
Department of Electronics and Comm technology
Gauhati University
jutikaborah13@gmail.com

Abstract- Communication is nothing but transfer of information from source point to destination point over a medium and coming to Communication Routing it is a process in which to find how shortest and fastest communication is achieved between the two ends for the Optimization of the Network. In this paper I would like to discuss about how optimization is achieved in communication network through the application of information like accuracy, throughput, latency and mobility support and different protocols followed by networks for the optimized route. And I will also explain about advantages of network coding in improving the throughput over routing. Explained how different network algorithms are used for solving optimization problems in communication routing for example like genetic algorithm used in routing optimization of optical fiber communication networks. And discussed about Optimizing the layered communication Protocols.

Index Terms – IPV4, IPV6, Triangle Routing, Datagram's, Routing.

I. INTRODUCTION

A communication network in which it is a interconnection of different nodes to carry information from various sources to their respective destinations. To implement [1] this task number of protocols (algorithms) have to be developed to convert the information into bits and transport the bits reliably over the network. The increasing number of portable computers combined with the growth of wireless services, makes supporting Internet of mobility important. Many researchers have come to conclusion that Internet Protocol (IP) is the correct layer it implement the basic mobility support. The greatest challenge [2] for supporting the mobility at IP layer is handling the address change. In other words, it is required to keep uninterrupted connection among nodes when they change their IP addresses during the movement. The Transmission Control Protocol (TCP) is a predominant protocol in the Internet services The TCP/IP was originally designed for fixed Internet without mobility in mind. With the increase of mobility demands, it is[3] important to understand how TCP performance is affected over various existing mobility protocols, which in turn help in design new protocols or pursue improvements. Mobile IPV4 is a popular internet protocol used in the current IPV4 network.ith the next generation Internet emerging IPV6 , the mobile IPV6 protocol is designed to deal with mobility and overcome some problems suffered by IPV4 And also discussed about the problem suffered by IPV4 like the "triangle routing "problem and route optimization in mobile IP.

Terminology Used in Mobile IP:

1. **Mobile Node (MN):** A host or router that changes its point of attachment from one network or sub network to another.

2. **Home address (HA):** An IP address that is assigned for an extended period of time to a Mobile Node in the Home Network
3. **Home Agent (HA):** A router on a Mobile Node's Home Network which tunnels datagram's for delivery to the Mobile Node when it is away from home, and maintains current location information for the Mobile Node.
4. **Foreign Network:** Any network other than the Mobile node's Home Network.
5. **Correspondent Node (CN):** A peer with which a Mobile Node is communicating, it may be either mobile or stationary.
6. **Care-of-Address (CoA): T**he termination point of a tunnel toward a Mobile Node, for datagrams forwarded to the Mobile Node while it is away from home
7. **Link:** A facility or medium over which nodes can communicate at the link layer. A link underlies the network layer.
8. **Node:** A host or a router.
9. **Tunnel:** The path followed by a datagram while it is encapsulated.
10. **Virtual Network:** A network with no physical instantiation beyond its router (with a physical network interface on another network).

II. Triangle Routing

In the basic Mobile IP protocol, IP packets destined to a mobile node that is outside its home network are routed through the home agent. However packets from the mobile node to the correspondent nodes are routed directly. This is known as triangle routing. Figure illustrates triangle routing [4]. This method is inefficient in many cases. Consider the case when the correspondent node and the mobile node are in the same network, but not in the home network of the mobile node. In this case the messages will experience unnecessary delay since they have to be first routed to the home agent that resides in the home network. One way to improve this is Route Optimization.

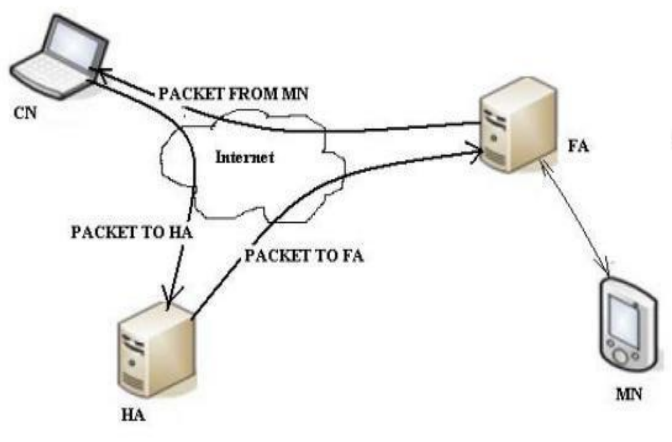


Fig: Triangular Routing

Triangular Routing Drawbacks:

Conventional mobile IP scheme allows transparent interoperation between mobile nodes and their correspondent nodes, but forces all data grams for a mobile node to be routed through its Home Agent. Thus datagram s to the mobile node are often routed along paths that are significantly longer than optimal [5]. This indirect routing can significantly delay the delivery of the datagrams to the nodes, ad it places an unnecessary burden on the network and the routers along its path through the internet so we can summarize the triangle routing drawbacks as follows:

1. Increase the delays per packet in datagrams transferred to the mobile node
2. Wastage of network resources.
3. Home agent bottle Neck
4. Delimits the scalability of mobile IP protocol

III. Drawbacks of Mobile IPV4:

Triangle Routing: As mentioned above datagram's going to the mobile node have to travel through the home agent when the mobile node is away from home but datagram's from the mobile node to other stationary internet nodes can be routed directly to other destinations. Routing optimization is the protocol used to eliminate the triangle routing problem.

Hands-off: Mobile IP was not designed for fast moving hosts. This is apparent in the movement detection algorithm in the specification, which contains two methods, which both are rather slow. The home agent handles all handoffs, although it may be far from the current network of the mobile node. The network delay adds to slow handoffs. Slow handoffs cause often packet loss, which is especially harmful to real-time applications, such as voice over IP or video streaming. TCP-based connections also suffer, since lost packets may be mistaken for congestion and result in TCP's slow starts mechanism. Since the home agent handles handoffs, they cause lots of signalling traffic between the mobile node and the home agent. In high speed LANs this is not an issue, but when low speed WANs are involved and lots of mobile nodes are performing simultaneous handoffs, network congestion may result.

Fragility: Although the home agent model is simple and easy to configure, it has the disadvantage of fragility. The mobile node becomes unreachable once the home agent breaks down. One possible solution is to support multiple home agents. If one conventional home agent fails, there are still other home agents who can take over the duty and route the datagram's to mobile node

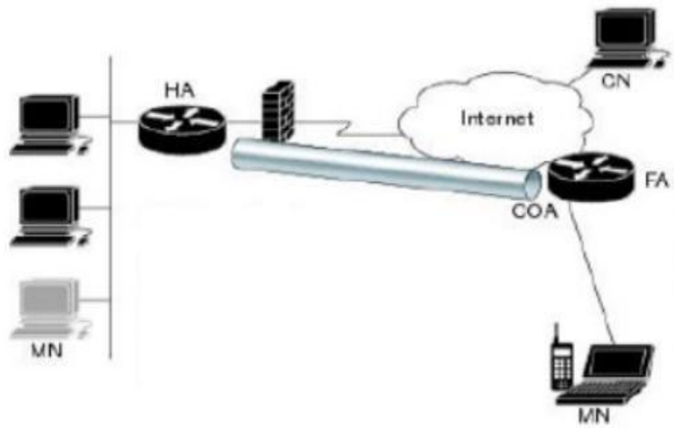
Routing Inefficiencies: The mobile IP specification has the effect of introducing a tunnel into the routing path followed by packets sent by the correspondent node to the mobile path. Packets from the mobile node on the other hand can go directly to the corresponding node with no tunnelling required.

Security Issues: A great deal of attention is being focused on the mobile IP coexist with the security features coming into use with in the Internet. Firewall in particular causes difficulty for mobile IP they block all classes of incoming packets from entering via the internet that appear to emanate from internal computers.

IV. Mobile IPV4 Routing Optimization:

Mobile IPv4 route optimization is a proposed extension to the Mobile IPv4 protocol. It provides enhancements to the routing of datagrams between the mobile node and to the correspondent node. The enhancements provide means for a correspondent node to tunnel datagrams directly to the mobile node or to its foreign agent care-of address. The basic idea underlying route optimization [6] is that the routes to mobile nodes from their correspondent nodes can be improved if the correspondent node has an up-to-date mobility binding for the mobile node in its routing table. With an updated binding, the correspondent node will be able to send encapsulated datagrams directly to the mobile node's care-of address instead of relying on a possibly distant home agent to do so.

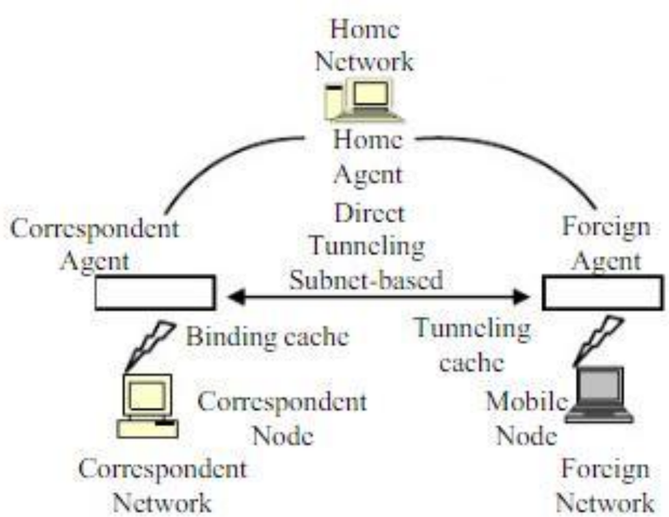
In the figure below when the MN moves from Home Network (HN) to Foreign Network (FN), MN registers with Foreign Agent (FA). After the successful registration, FA sends a binding update (BU) message to the HA. When the CN wants to communicate with MN, CN first send the traffic to the HA and HA tunnel them to the FA, FA de-tunnels the traffic and forward to MN. HA also sends a current up-to-date binding table of MN to the CN.



With an updated binding, the CN will be able to send traffic directly to the mobile node's care-of-address, instead of relying on a possibly distant HA to do so. But in this technique, when the number of mobile node has been increased then this technique does not give the scalable result. This technique can only be applied for inter-network communication and when the number of CN increases, the Handoff Delay packet loss and registration time will also be increased.

Bi-directional route optimization in Mobile IP over wireless LAN

This technique is proposed to support symmetric bidirectional route optimization in Mobile IP consi dering ingress filtering routers. Subnet-based direct tunnelling techniques are proposed to improve the routing efficiency for Mobile IP and a binding optimization technique to reduce the handoff latency for Mobile Nodes. An enhanced correspondent agent was introduced to collaborate with the Home Agent and the Foreign Agent to support these techniques. Figure shows present the overall design of the bidirectional route optimization. It is used to address the issues of Triangle Routing and ingress filtering in Mobile IP. The design introduces a Correspondent Agent which maintains the binding cache and intercepts all packets sent to and from the Correspondent Nodes. Symmetrically, a Foreign Agent, at the other end of the optimized route or tunnel, maintains a tunnelling cache for bidirectional route optimization. An entry of the tunnelling cache indicates that a Correspondent Node or Correspondent Network supports Route Optimization and direct tunnelling, so a Foreign Agent can directly tunnel a packet received from a Mobile Node to the Correspondent Node that matches a tunneling cache entry.



So a Home Agent or a Foreign Agent must b able to distinguish the traditional Correspondent node from the enhanced Correspondent Agent must also be able to distinguish a Node from a usual stationary node. By using this bi directional route optimization not only improves the routing efficiency but also reduces the handoff latency for mobile node. Also the packet transmission time and the traffic can also be reduced through the direct tunnelling.

Mobile *IPV6:*

Mobile IPV6 is the next generation protocol and is the near future, routers are going to become more faster and new technologies are going to reduce the internet delays. Mobility support in IPV6 is most important, as mobile computers are likely to account for majority or atleast a substantial fraction of the population of the internet during the life time of IPV6. The mobile IPV6 is just as suitable as mobility across homogeneous media as for mobility across heterogeneous media.

Important Characteristics of IPV6:

Whereas Mobile IP was added on top of the IPv4 protocol, in IPv6 mobility support is built into the IP-layer . In mobile IPv6 route optimization is an essential part of the protocol. Mobile nodes have a binding update list, which contains the bindings other nodes have for it. Correspondent nodes and home agents have a binding cache, which contains the home and care-of addresses of mobile nodes they have been recently communicating with. All signalling is performed via destination options that are appended to the base IPv6 header. Thus all signalling traffic can be piggybacked on datagrams with a data payload

Destination option

Base IPV6 header	**Destination Options**	**payload**

The destination options are:

- Binding update option, which is sent by the mobile node to its home agent and correspondent nodes to inform them of a change of location
- Binding acknowledgement option, which is sent in response to the binding update?
- Binding request option, with which a node can request a new binding update from the mobile node, when the binding is about to expire.
- Home address option, which the mobile node appends to all datagrams it sends while away from its home network. The home address option is used to avoid the negative effects of ingress filtering by using the topologically correct care-of address as the source address and including the home address in the option. The receiving node will then copy the home address to the source address before passing the packet to any transport level protocol.

Features of IPV6

Cancellation of FA: In Mobile IP, multiple MHs may

Share one FA's IP address, i.e., FA's CoA, to alleviate the inadequate supply of IPv4 address resources. In this case, the data packets forwarded by the HA shall pass through the FA before being delivered to the MH. However, the MH in Mobile IPv6 can find a default router in the foreign network to provide routing service. The rich address resources and IPv6 address auto-configuration function make it easy for the MH to obtain the CoA. Therefore the FA is no longer needed.

Route Optimization: Mobile IPv6 defines the header of the route that the CH can use directly to send data packets to the MH, making the route optimization a part of Mobile IPv6. By using direct routes in both directions the consumption of network resources is minimized. The 40-byte IPv6 headers consume extra bandwidth when compared to 20 byte IPv4 headers. However the use of routing header and home address option removes the need for constant tunneling, thus decreasing the bandwidth consumption. Although they both add overhead to packets they still are considerably smaller than IPv6 headers, which would be used in tunneling. The destination options used for signaling can be piggybacked which decreases the signaling overhead considerably, since the options are relatively small when compared to UDP packets.

Security Features: The enhanced security function of IPv6 is a great improvement to IPv4. Mobile IPv6 makes direct use of the function provided by IPsec, while Mobile IP should solve security problems by itself. Although IPv6 has better support for mobility than IPv4, it still needs Mobile IP to implement mobility management and provide transparent mobility for the application layer or high-level protocols.

IPV6 Addressing Modes:

1. Unicast: Address of single interface one to one delivery to single interface.
2. Multicast: Address a set of interfaces. One to many delivery to all interfaces in the set.
3. Anycast: Address of a set of interfaces. One to many delivery to a single interface in the set that is closest.

Applications That Uses IPV6:

Applications that use IPv6 are as varied in design as the mechanisms they deploy internally to accommodate the IP transport. Most, if not all, IPv4 applications that use IP for service delivery fall into three categories:

1. Unicast applications: These applications are best categorized as a one-to-one service delivery model.
2. Broadcast applications: These applications fall into the one-to-all service delivery model.
3. Multicast applications: These applications use IP for a one-to-many service delivery model.

IPv6 radically changes the IPv4 service delivery models by eliminating the broadcast paradigm and introducing the anycast paradigm. Anycast allows delivery to the “closest” (relative use) node of a group.

Vulnerabilities in Mobile IPv6:

1. Biggest vulnerability is authorization of Binding Updates
2. Firewalls and Mobile IPv6 do not work well together
3. Number of Problems for securing Neighbor discovery
4. Problem arises when roaming with a dual-stack architecture and interoperating between Mobile IPv4 and Mobile IPv6

Conclusion

With the increasing number of mobile hosts optimal routes are a goal worth striving for. Route optimization provides means for direct routes between the mobile node and its correspondent nodes. Technology-wise it provides a good framework of techniques to support direct routes. Deployment-wise it is rather problematic. It requires rather large changes to the operating systems of the correspondent nodes. It also requires a trust relationship between the correspondent node and the home agent of the mobile node. As a result of these requirements it probably will not be widely deployed in the near future. The situation will most likely change with the possible transition to IPv6, since mobility support will be a part of the protocol specification at that time. Thus route optimization will probably gain widespread support only via Mobile IPv6.

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