Literature Review on Mobile MPLS Techniques

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Abstract— Mobile MPLS (Multi Protocol Label Switching) is a new technique which integrates the Mobile IP (MIP) and MPLS and thus inherits the advantages of both. MIP supports the mobility whereas MPLS provides faster streaming throughout the network, hence providing requisite QoS to the application. The objective of this paper is to survey the efforts that have been done to enhance the MIP functionality by integrating with MPLS and also to guarantee QoS provided to the users by the network. It first briefs the MIP and MPLS, along with their shortcomings. From there it examines the different initiatives to improve the performance of network in terms of hand-off, delay, QoS, Optimal path selection and lots more.

Keywords-Mobile IP, MPLS, Trinagle routing, Quality of Service(QoS).

I. INTRODUCTION

The wireless technology nowadays has advanced to a great extent, providing numerous services to users at several scales. The number of mobile users has rapidly increased in recent years. With the introduction of various applications and services, mobile internet usage has increased many times. These services including email, web browsing, audio/video streaming, internet phone and real-time multimedia requires different levels of quality of services. The networks must be capable of providing appropriate quality of service for a particular application, thus providing satisfactory service.

In view of this Mobile IP (MIP) have been introduced which provides the services to the mobile users, such that any one from anywhere can have access to the services. Thus, providing Macro-mobility and Micro-mobility as well. However, it does not guarantee the Quality of Service (QoS) provided to the services offered to the users. The packets used to travel through non-optimal paths in terms of delay and bandwidth. Hence is not a successful technique to provide services in an efficient manner.

To overcome this problem, route optimization techniques have been introduced which helps to select optimal path from source to destination in terms of delay, bandwidth and jitter. However, the conventional IP tunneling of the packets is a time consuming process in which each intermediate router need to match the destination IP address. Hence a new technology was introduced namely Multi Protocol Label Switching (MPLS) which eliminates the use of conventional IP address matching and is faster routing technique. Hence, providing appropriate QoS to the applications.

By integrating the two technologies – Mobile IP and MPLS, a new technique have been developed known as MOBILE MPLS, which inherits the advantages of both the techniques and providing efficient system.

The remainder of this paper is organized as follows. Section 2 provides brief review of MIP and MPLS. Section 3 is about the survey done on various parameters taking into consideration MIP. Finally section 4 concludes the paper.

II. MOBILE IP AND MPLS PERSPECTIVE

A. Mobile IP

Mobile IP (MIP) acts as core of mobility management mechanism for various networks, providing universal roaming solution. It support continuous and seamless connectivity, i.e. Mobile Node appears always on home network of the mobile device and can have access to any service at any time and any place. Hence with MIP, any device (node) willing to communicate with the mobile node can send the messages to mobile node's home address without any need to know about its current location.

Each mobile node is identified by its permanent home address. While away from its home network, a mobile node is associated with a care-of address (CoA). MIP specifies how a mobile node registers with its home agent and how the home agent routes data packets to the mobile node through the tunnel. Such a network is inefficient in the terms that whenever any node will send the message to mobile node, the message needs to pass through Home Agent (HA) in its home network, which led to a triangle routing problem. Hence MIP alone is unable to provide adequate QoS to the network.

B. MPLS

To provide QoS along with mobility management, MIP has been integrated with MPLS (Multi Protocol Label Switching). MPLS provides for efficient routing, forwarding, switching and traffic flows through the network. It operates between the layer 2 (Data link Layer) and Layer 3 (Network layer) of OSI model. With MPLS packet-forwarding decisions are made solely on the contents of the label, without the need to examine the packet itself. Hence the latency is reduced here, as in conventional IP forwarding each router examines whole IP header in order to decide the next router.

In MPLS, data transmission occurs on Label Switched Paths (LSPs). LSPs are a sequence of labels at each and every node along the path from source to destination. LSPs are established either prior to the data transmission or upon detection of a certain flow of data.

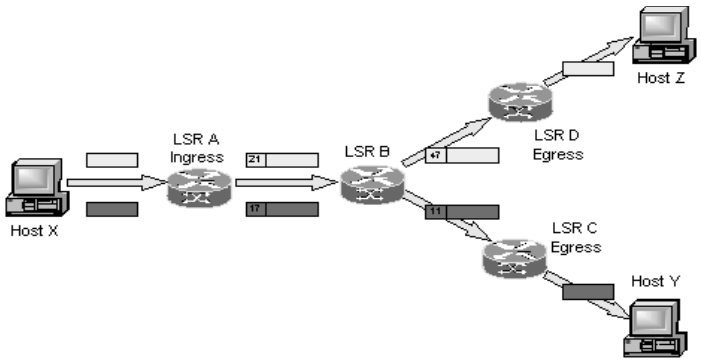

Figure 1. MPLS Network ComponentS.

The labels are distributed using label distribution protocol (LDP). Each data packet encapsulates and carries the labels during the journey from source to destination in the MPLS domain. High speed switching of data is possible because the fixed length labels are inserted at the beginning of the packet and can be used by routers to switch packets quickly between the links.

The routers are known as LSR and LER. LER i.e. Label edge routers which are at the edges of the network as shown (LSR ingress and egress) and LSR i.e. Label switching routers which are intermediate routers. Ingress LSR insert the label into the packet and egress pop up the label and forward it towards the intended destination.

Figure 1 shows an MPLS network. In this Host X sends a data packet to Host Z, which is first received by LSR A (Ingress LSR or LER) and adds a label to the packet for its intended destination. LSR B swap the label on the packet received with the outgoing label for the next router. At the end LSR D (egress or LER) pops up the label from the packet and forwards it to the intended target. Thus the processing delay at each intermediate router is reduced to a greater extent as the routers need only to examine the contents of the label. Thus MPLS reduces the delay and guarantee QoS to the services.

III. CHALLENGES

From various literatures, challenges in the networks with mobile nodes have been identified. These challenges take different aspects into consideration. These issues can been categorized as follows.

A. Triangle Routing Problem

Whenever any MN moves to a foreign network, it registers with its new CoA to its HA. Thus when HA receives any packet with destination address of MN, it forwards the packet to the MN in foreign network. Thus, every packet with destination address as MN, need to route through the HA. Hence a triangle is formed between the MN, HA and Correspondent Node (CN) which sends the packets.

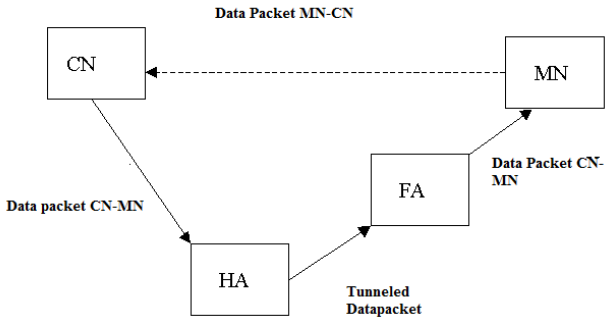

Figure 2. Triangle Routing Problem.

B. Hand-Off Support

When a MN moves from one Base Station (BS) to another, it need to register with new BS such that now it is connected to the remaining network through new BS. This transition for a MN of signal transmission from one BS to adjacent BS as MN moves around is referred as Hand-off. Due to mobile nature of the nodes, hand-off is one of the issue need to consider for successful communication because with no hand-off, link failures are more frequent as MN keep on moving around.

C. Quality Of Service

QoS refers to several related aspects that allow the transport of traffic with special requirements. These aspects include bandwidth requirement, throughput, end to end delay, jitter, errors and dropped packets. These factors vary for different applications and require a threshold value of these to have successful communication. Networks sometimes do not guarantee to provide requisite QoS to a particular application which may led to link failure. Thus high QoS is pre-requisite sometimes, which is not provided ny every network and is another challenge.

IV. REVIEW ON MIP MPLS EXTENSIONS

The following are the work done in the field of wireless communication specifically increasing the efficiency of MIP by various new techniques and integrating it with MPLS to provide an efficient system.

Profile based MPLS [1] is a scheme which helped to avoid the triangle routing problem. In this authors proposed that each mobile user maintains a profile that includes user regular behavior like user's mobility pattern, travel schedule etc. if the CN is able to obtain the profile of mobile user, it can predict the current location of user (to some extend of accuracy) and forward the traffic directly to the user, thus eliminating triangle routing problem. There are two approaches by which CN can access the profile of user. One is distributed approach, in which the mobile users itself distribute its profile after receiving the request from CN and performing authentication. But major drawback of this approach is that this increases the load on the mobile user. Second approach is centralized approach, in which there is a profile server which keeps the track of profiles of various mobile users and distribute them whenever receive a request.

One major advantage of proposed scheme in [1] is that the CN can send all the packets to the mobile user whereas in other schemes like route optimizations some of the packets need to be forwarded to home agent in

the beginning phase. However this scheme is not much successful because of increase in overhead signaling. Hence a lot of bandwidth resources get indulged in providing the nodes with the profile of users.

Optimized Mobile MPLS [2] managed to reduce the triangle routing problem further. This approach aims to make the process of registration and LSP setup (or maintenance) be carried out simultaneously to reduce handover latency and signaling redundancy. A new MPLS header has been introduced which includes some information on setting up or maintenance of LSP. This header has one request field which specifies the action to be performed by a current router. If Req=0 means to request the next hop to allocate label to FEC; Req=1 means to request the next hop to update the lifetime of LFIB; Req=2 means to request the next hop to ignore MPLS header, mainly used for error control.

Hence with the introduction of MPLS header the processes can be executed at the same time, thus improving the overall performance of the network. But at the same time, this increases the signaling overhead and complexity at each intermediate router.

The work in [3], called hierarchical MPLS, supports micro mobility and macro mobility. This scheme provides smoother handoff in delay sensitive applications and hence improves the QoS provided by network. The authors divided a network into several subnets such that each subnet is an MPLS domain. All the data is switched between the subnets established. With this hierarchical approach whenever a mobile node moves from one MPLS subnet to another subnet, there is no need to communicate with the HA and thus provides faster and reliable handoff. Also reduces signalling overhead to be sent to HA for re-registration and thus resources are also preserved reducing congestion in the network.

The major plus point of this scheme was that it reduces end to end delay up to a greater extent along with decrease in jitter to traffic during hand-off periods.

B-MPLS protocol [4] is again an integrated version of MIP and MPLS enhancing the hand-off ability of the nodes with no data loss. This protocol is based on layer 2 information and pre-establish technique. It allows seamless handover in micro mobile networks using buffer technique. The proposed protocol utilizes the Layer2 information reported by Mobile node to the serving Foreign Agent (FA), sent periodically. FA is involved in pre-established LSPs and buffering time. The FA itself decides when to buffer the data packets, when to stop buffering and when to forward the buffered packets to the new FA. The serving FA uses some parameters like signal strength received from mobile node, its buffer size, priority of Mobile node etc. to take decisions. For instance when the signal strength received from MN drops certainly to the minimum threshold level, the serving FA will start buffering the packets. After receiving a notification of successful handover from new FA, the old FA will stop buffering and forward the packets to the new FA. Hence no data is lost and provides fast and efficient handover.

Thus this protocol [4] further enhances the performance of mobile MPLS providing no data loss with faster and efficient hand-off technique. However on the other hand it increases the signalling overhead in the sense that the MN needs to send periodic information to the serving FA, thus it can increase the congestion in the system.

The recovery technique [5] is a significant requirement for traffic management to support QoS guaranteed tunnels, according to link/node failure or topology changes in mobile network. The recovery scheme proposed named as Modified Flexible Mobile MPLS Signalling (MFMS), can handle multiple failures problems with faster rerouting. One of the advantage of this recovery scheme is that it is based on local recovery i.e. there is no need to re-establish the whole path from ingress LER to egress LER, only the affected part of LSP is re-established around the node failure. On detection of failure the upstream node find the appropriate Merge Point of recovery (MP). The upstream node then sends recovery LSP setup messages (RLS) to a number of nodes around the node failure. Response time of RLS message returned from each node and number of hops are taken into account to select the nearest MP. Hence this recovery scheme is suitable for multiple failures with no need to pre-reserve backup paths.

In [6], authors introduced cooperation of MIP enhanced with QoS constraint based routing mechanism (MIP-ROQS) and architecture. This addresses the traffic congestion at home agent while providing QoS over optimal routes. In MIP-ROQS, HA is equipped with CBR algorithm which intake the information like resource availability or congestion in access network and performs position and routing analysis which helps to determine optimal path from CN to MN. It takes into account the hop count between the intended nodes (position), total end to end delay, and packet loss and bit error rate (routing) and compare these values for different paths. As a result the most appropriate path for data transmission satisfying the required QoS. Integration of MIP-ROQS with MPLS architecture, further improves the performance of the whole network as ROQS CBR fits easily into MPLS network.

Hence the integration of above techniques has a number of benefits. MIP supports the mobility, ROQS helps in indentifying the optimal path and MPLS provides fast routing ability on the selected paths.

The route optimization technique introduced in [7], overcome the triangle routing problem along with providing requisite QoS. The authors introduced a correspondent agent (LCA) located at each Label edge router (LER) in each network. This LCA keeps track of current location of MN on behalf of CN. As these LCAs acts as LER, hence each incoming packet need to go through these agents to enter the intended network. LCA thus optimize the path of the packet without any need of additional agent since it already has the binding information of the MN.

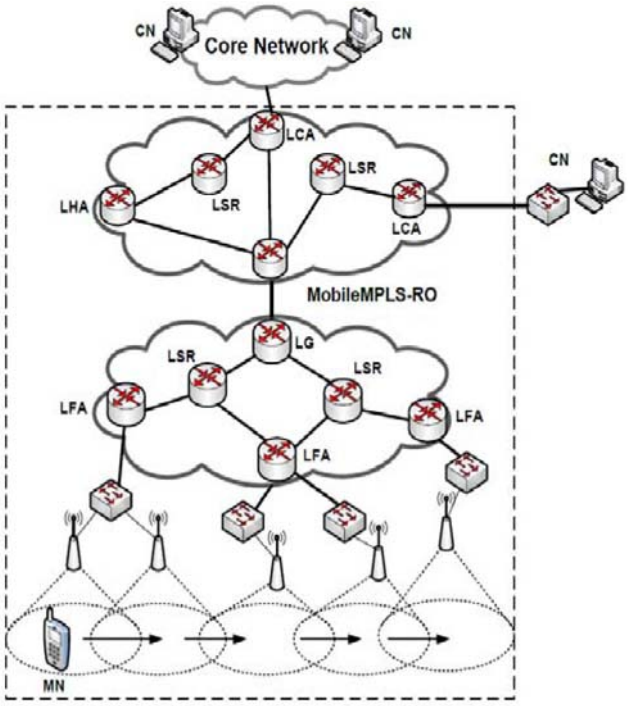

Figure 3. MOBILE MPLS-RO hierarchical network

Thus LCA present at the edge of the network, as shown in figure 3, can directly route the packet to the current location of MN without intervening the HA. Hence the triangle routing problem has been avoided. Since LCA is part of the network as shown in figure 3, it maintains the authentication of information. Thus the proposed scheme avoids the triangle routing problem and reduces the end to end delay, providing appropriate QoS.

V. CONCLUSION

The various initiatives discussed above improve the performance of Mobile MPLS in various aspects. With the hand-off techniques, network provides smoother hand-off with no data loss along with low signalling. For improving the QoS provided by the network, optimal path need to be selected with network supporting traffic engineering. For faster streaming of data with minimal delay, route optimization have been introduced which not only reduces the end to end delay but also avoids the triangle routing problem. Thus we can conclude that Mobile MPLS technique have characteristics as well as benefits that are pre-requisite for the networks carrying different services to the mobile users.

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