Conclusions and Future Work

This research was aimed at designing an efficient IP mobility scheme, compliant / interoperable with the Mobile IP standard of IETF and also to develop mechanism supporting adaptive provisioning of predefined quality of service levels with minimal signaling overhead. We have been able to achieve them in this research work.

7.1 Conclusions

In the past few years, there has been an explosive growth of the Internet, mobile computing and portable communication devices. While mobile devices, including notebook computers, continue to improve with respect to size, mass and capabilities, the Internet grows at even faster pace. The trend of adding mobility to Internet and next generation telecommunication networks into a unified multimedia network will make it possible to deliver IP based applications to mobile users. Mobile IP has been standardized by the IETF to support mobility in an IP based network.

It was observed through the extensive review of the literature that the mobility of only mobile node was supported in Mobile IPv6 and it was communicating with a static
correspondent node. Unless the mobility of correspondent node is included, Mobile IPv6 would not be a complete mobility solution. In this research work, we proposed the mobility of correspondent node and two additional mobility combinations of mobile node and correspondent node in Mobile IPv6. The inclusion of mobility of correspondent node required several changes in Mobile IPv6. The *mobility header*, *binding update list* and *type 2 routing header* of Mobile IPv6 protocol were modified. New procedures like *reverse return routability procedure*, *mobile registration* and *correspondent tunneling* were also added in Mobile IPv6 protocol. We used OMNeT++ for simulation of Mobile IPv6 with correspondent node mobility and evaluated the performance of these mobility options. The performance of these two new mobility combinations was compared with Mobile IP and it was found that one of the combinations performed similar to Mobile IPv6.

To improve the performance of other combination with the mobility of mobile node and correspondent node in Mobile IPv6, a new scheme called *Improved Mobile IPv6* was proposed. *Improved Mobile IPv6* integrated the features of fast handoffs and hierarchical MIPv6 with the mobility of correspondent node in Mobile IPv6. We evaluated the performance of *Improved Mobile IPv6* with different cases of mobility of correspondent node through a simulation study that allowed detailed analysis of signaling overhead, delay characteristics and rate of successful packets for mobile node and correspondent node involved in handoffs with varying speed of mobile and correspondent nodes. It was observed through simulation results that the performance of *Improved Mobile IPv6* was better than Mobile IPv6.
IP based networks have become an important vehicle to transport the real time interactive multimedia applications. It is therefore necessary for these networks to change from an unreliable, best-effort based network to a reliable network suitable for a broad range of distributed applications and services to mobile users with various requirements for reliability and QoS guarantees. To provide QoS to mobile nodes, a number of schemes including mobile RSVP (MRSVP) and hierarchical MRSVP (HMRSVP) for IPv4 based networks were proposed. These schemes were not efficient. In this thesis, we proposed Improved Hierarchical Mobile ReSource reserVation Protocol for IPv6 (Improved HMRSVPv6), which included all possible mobility combinations of mobile node and correspondent node of Improved MIPv6 and features of HMRSVP to efficiently reserve the resources for real time multimedia data transfer. There were six cases of handoffs and QoS which were proposed in this thesis. Unlike HMRSVP our Improved HMRSVPv6 made advanced mobile passive reservations and prevented resource reservation in duplicate path. It was observed through simulation results that Improved HMRSVPv6 performed better than other QoS provisioning protocol for mobile nodes.

Terrestrial networks have mostly been used to transport the real time interactive multimedia applications so far. These applications are sensitive to delay and jitter. The integration of TCP/IP with an open standard like digital video broadcast return channel via satellite (DVB-RCS) made it possible to have two way communication in satellite network. Interactive multimedia applications were sent using Edusat based IP based networks with user terminal installed at 131 locations all across India. The performance of multimedia data transfer including voice and video with reference to QoS parameters in this satellite network was analyzed. The main focus was on VoIP (voice over IP)
applications. The results showed that satellite networks based on DVB-RCS could carry voice and video traffic and offered good quality of service in terms of packet loss and jitter but were poor to quality in terms of packet delay.

7.2 Future Work and Open Problems

Every researcher seeks to investigate some problems. The more one probes, the more issues arise. So, a research work would be incomplete if it does not indicate a future course of action. To round off our discussions, we identify below some of the problems, which need to be examined. These issues shall provide guidelines for future research to anybody interested in this area of research.

- There are a number of mobility solutions for the IP based networks. The mobility of correspondent node can also be used in other mobility protocols and then the performance of these enhanced protocols can be evaluated.

- The simulation of Improved Mobile IP can be done for the next generation all IP networks.

- In case of resource reservation protocol, the role assumed by the communicating nodes is important. When a node is mobile and it has packets to send, it sends path message to the receiver (correspondent node) to specify the characteristics of the traffic. In case mobile node is a receiver, it will receive path message and will reply with resv message to request reservation of resources. When the concept of mobility of mobile node and correspondent node is used, there are four possible combinations for mobility of nodes. Besides that MN and CN can be either a sender or receiver. In all there are eight possible combinations in which resource reservation can be made. In this thesis, it is assumed that MN is a receiver and CN is a sender. When the roles of these nodes is changed, the
performance of other combinations can be evaluated and compared with the
*Improved HMRSVPv6*.

- **RSVP** is being used for QoS provisioning in IntServ based networks. However, in recent years, several other applications of signaling have been defined. For example, signaling for label distribution in Multi Protocol Label Switching (MPLS). The possibility of use of *Improved HMRSVPv6* can also be explored for these applications in future work.

- Wireless local area networks based on 802.11 can be implemented and the mobility of the nodes within this WLAN can be incorporated in the satellite based IP network. The performance of real time multimedia applications with the mobile nodes can be measured.