CHAPTER 5

CONCLUSION
With over a decade of research efforts aimed at performance enhancement of QoS-aware routing protocol in mobile ad hoc networks much still needs to be done since so far most of the development has happened in terms of modification of conventional AODV by incorporating some supporting protocols. Although many fundamental issues have been studied, MANETs are still in the development phase due to their design complexity. Therefore, a large research space remains open for further exploration. Among the many challenges for MANETs, obtaining QoS is of particular interest due to the popularity of real-time applications. While there has been some research on protocols to support QoS in MANETs, there are still many unsolved problems in this domain. The current study aimed at addressing those issues. The results of the current study are summarized, the contributions are highlighted and potential future research guidelines are discussed in this concluding chapter.

5.1. Conclusion

A host of existing QoS-aware routing protocols for mobile ad-hoc networks were studied so as to identify the associated issues and the salient features. It was observed that communication among hosts in QoS-aware routing protocol for mobile ad-hoc networks faces two limitations: accurate bandwidth estimation and energy estimation. The layered architecture is not efficient enough to provide optimized performance. Hence the study attempts at QoS routing based on bandwidth estimation for performance enhancement in mobile ad-hoc networks.

This study lead to the development of a performance enhancement QoS-aware routing protocol which incorporates an admission control scheme and a feedback scheme to meet the QoS requirements of real-time applications. It incorporated performance enhancement QoS into routing and introduced bandwidth estimation by disseminate bandwidth information through “Hello” messages. A cross layer approach which included an adaptive feedback scheme and an admission scheme to provide information about the current network status to the application was implemented. Simulation using NS-2 showed that performance enhancement of QoS-aware routing protocol was achieved in terms of increased packet delivery ratio without impacting the overall end-to-end throughput. At the same time the ends to end delay was significantly reduced as compared to conventional AODV.
Two different methods of estimating the bandwidth were compared in detail using different topologies and different weight factors. The “Hello” bandwidth estimation method performed better than the “Listen” bandwidth estimation method since the bandwidth was being released immediately in it. The “Hello” and “Listen” schemes work equally well in static topologies by using large weight factors to reduce the congestion and by minimizing the chances of lost “Hello” messages which incorrectly signal a broken route. In a mobile topology, “Hello” performs better in term of end-to-end throughput, and “Listen” performs better in term of packet delivery ratio. From the perspective of overhead, “Listen” does not add extra overhead, but “Hello” does add overhead by attaching neighbors’ bandwidth consumption information in the “Hello” messages.

A Modified QoS-aware routing with node delay analysis (MQWAODV) incorporating minimum end to end delay guarantee in mobile ad-hoc networks was developed. It could overcome this short coming of AODV protocol. The proposed method proves to be more efficient method when the networks were not very stable since it could better estimate the residual bandwidth in case of frequent route breaks. This Protocol discovered routes based on bandwidth constrained path delay in addition to hop count instead of hop count only. Route maintenance was more efficient than the existing standards as consumed bandwidth was updated immediately. In modified protocol, the routes were less loaded and therefore fewer packets were dropped due to reduced congestion. Simulations done using NS-2 showed that normalized overheads were much less in MQWAODV as compared to conventional AODV, that too without much impact on overall end-to-end throughput. The overheads were largely reduced in MQWAODV which improves scalability. Further the Delivery ratio was significantly improved and end to end delay was reduced in MQWAODV with different node mobility as compared to AODV.

Further a QoS-aware precedence based routing protocol (PBRP) for multiple application in queue with different bandwidth requirement was developed. This scheme was much effective where networks were not very stable since it could better estimate the residual bandwidth in case of frequent route breaks. Proposed protocol discovered multiple routes based on bandwidth availability in addition to hop count only. Route maintenance was more efficient than the existing standards of AODV. These characteristics make the protocol more suitable for real-time data and voice transmission applications in MANETs.
Simulation using NS-2 showed that QoS-aware precedence based routing protocol (PBRP) approach gave significant improvement in terms of certain QoS parameters like end-to-end delay, overheads, end to end throughput and packet delivery ratio for different weight factors along with different node mobility as compared to conventional AODV.

It can be concluded that QoS is the most important issue in latest computer networks. As MANETs exhibit a distributed and uncertain environment, QoS-aware precedence based routing (PBRP) is deemed most suitable for such networks.

5.2. Future Work

Much needs to be done to finally realize stable support for QoS in MANETs. Future work in this area can be divided into two parts – detailed work on remaining issues to be solved layer by layer and combining the layers into a complete system.

Proposed protocols have not considered any predictive way to foresee a route break, which degrades the performance in mobile topologies. Therefore, route maintenance based on signal strength might help to reduce the transient time when the required QoS is not guaranteed due to a route break or network partition, so that the routing protocol can react much better in mobile topologies.

MAC protocol design is a very challenging task in MANETs. DMAC only partially solves the QoS problem, which is far from sufficient. DMAC does not currently offer scheduling based on different priority level. Therefore, designing a MAC protocol that fully supports QoS is the subject of future work.

The accurate measurement of the capacity of a multi-hop mobile network is an open issue right now. Further study of the 802.11 MAC layer’s behavior could be helpful to understand this capacity issue. Also, in a real scenario, shadowing will cause a node’s transmission range to vary, and it will not be the ideal circle that is assumed here. How to incorporate these non-idealities into proposed protocol is the subject of future research.
Furthermore, incorporating different transmission ranges among all the hosts and analyzing fairness among the hosts will be explored in future work. The ultimate goal is to provide a model from the application layer to the MAC layer for supporting service differentiation.