CHAPTER IX

CONCLUSIONS AND FUTURE SCOPE

9.1 CONCLUSIONS

The aim of this research work was to contribute new ideas and techniques to improve efficiency of WDM networks. With this in mind, we proposed RWA protocols using distributed and centralized management schemes in which the optimal primary and backup lightpaths are computed based on the individual or combination of the route distance and congestion parameters. To enhance the operational revenue and profitability of the WDM network operator the communication traffic request is processed on the basis of priority and speed. The backup sharing technique is used to reduce the spare capacity reservation for a backup lightpath. In-addition grooming is also employed to utilize the bandwidth efficiently.

In Chapter I, we presented the basics of RWA, survivability, grooming and management schemes for optical WDM networks. Chapter I also highlights the motivation and purpose of the research work. Chapter II describes the advantages and disadvantages of the available solutions of the RWA, survivability and grooming methods.

We proposed compromise of least congestion and shortest distance (CLCSD) routing methodology in chapter III, to overcome the shortcomings of distance and congestion based routing methodologies. It considers the distance and congestion information to compute a route dynamically. As opposed to the reactive protocols, our proposed protocols with distributed and centralized methods as presented in Chapter IV to VIII are proactive in the sense that they avoid the chances of blocking. Furthermore, our approach is self-regulating, it automatically adapts to the traffic load variation across the network. By simulation results we have shown that these protocols have low blocking
probability and set-up time with high bandwidth utilization and throughput. Our findings on the proposed protocols are summarized as follows:

### 9.1.1 Distributed Systems

Fig. 9.1 summarizes the simulated results of proposed distributed protocols

- **In an efficient alternate RWA protocol**, the destination node selects the optimal route on the basis of route distance and congestion. Blocking probability, set-up time and the race conditions are reduced by using parallel approach and destination initiated reservation on the basis of conflict information. Further, to improve the network performance grooming is added to it. This protocol is referred as *efficient alternate grooming protocol*.

- **In an adaptive reliable multipath routing protocol**, the source node selects the optimal lightpath with lowest blocking probability to forward the high priority data. Low priority data are transmitted through non reliable lightpath. It also keeps probing the sub-optimal paths for their current blocking probabilities. When the blocking probability of the current optimal path increases or there is
a failure along the path, it adaptively shifts the traffic through the next optimal path.

- **Efficient exhaust-eventual RWA protocol** uses route distance and congestion to select the optimal path from the available lightpaths. It shows less blocking probability. In addition, network performance is relatively improved in comparison with the existing exhaust-eventual RWA protocols by using parallel approach and destination initiated reservation on the basis of conflict information. Grooming technique further improves the network performance. It is referred as *efficient exhaust-eventual grooming protocol*.

- **Efficient exhaust-instant RWA protocol** uses route distance and congestion to select the optimal lightpaths. Set-up time is less in this protocol as requests are routed upon arrival. In addition, network performance is relatively improved in comparison with the existing exhaust-instant RWA protocols by using destination initiated reservation on the basis of conflict information. Further, to improve the network performance grooming is added. It is referred as *efficient exhaust-instant grooming protocol*.

### 9.1.2 Centralized Systems

- **Centralized RWA protocol** uses two CMSs which share the requests and also if one fails other takes over. This improves the reliability and reduces the computational time. The network performance is further improved by using re-provisioning technique.

- **RWA protocol for larger networks** divides the network into sector networks. Here, blocking probability is reduced as the load to the each CMS is reduced. If any CMS fails, the backup CMS takes over making the network more reliable.

- **Multi-class centralized RWA Protocol** uses appropriate RWA methodologies depending on the priority and speed of the incoming traffic to identify the
optimal lightpaths. Operational revenue and profitability is increased by giving multi-class services.

9.2 POTENTIAL FOR FUTURE WORK

Many research efforts have been expended to the routing, wavelength assignment, survivability and grooming issues. However, there are issues to be addressed, such as:

- CLCSD methodology can be extended to consider the parameters like route blocking probability, number of hops and number of conversions.

- Centralized management scheme with two CMSs can be extended to three, where the third one can enter the network in case of failure of other CMSs and also as and when the load reaches the performance bottleneck of the network.

- Preempting technique can be added to the proposed multi-class centralized protocol. This technique helps high priority connections in case of lack of resources. So, whenever a high priority request is not able to find a lightpath then the CMS preempts the suitable low priority connection and allocates it to high priority connection.

- In chapter VIII the proposed protocol uses P set and C set with fixed number of channels. This method may fail to give better performance if more number of low priority or high priority connections needs to be established. So to overcome this problem, the number of channels in C set and P set can be varied as and when the low and high priority requests reach the threshold value for a particular time interval.

- In addition, all the proposed protocols are tested either by using a network without wavelength converters or with full wavelength converters. As wavelength converters are very expensive, the protocols can be tested with
partial wavelength converter networks. Similarly, grooming can be continued wherever it is required. By doing this, it can lead to a less cost and power consumption in the network.

• Simulation may be conducted to measure the dynamic set-up time.