Chapter 7

CONCLUSIONS AND FUTURE SCOPE

7.1 CONCLUSIONS

Intelligent mobile agent based models suggested in the thesis work [86, 89, 91] make use of hierarchical network structures to facilitate scalable and responsive management architectures. Further, EM based model provides faster access to management information through database queries. An extensive survey of existing MA-based distributed network management system was done and shortcomings were identified which became the basis for the objectives of the work carried out in this thesis.

The proposed scalable and responsive MA-based network management models were designed and developed which effectively achieves the following objectives:

- **Integration with SNMP protocol:** It is achieved through an MA-to-SNMP gateway integrated within the MAA, which allows incoming MA objects to locally interact with SNMP agents.

- **Mobility Support for Management Components:** The architecture allows Management Components and services to move from host to host irrespective of management model

- **Scalability:** By deploying mobile agents the management data around the management station reduces significantly. However, if the data from the MIBs have smaller size than that of the mobile agent and the system contains a small number of nodes, the Client-Server paradigm could outperform the MA paradigm.

- **Fault Tolerance:** A mobile agent continues to perform its assigned task even if the communication with the originating platform is lost. Hence M-SNLMs
stationed in their sub-domains continue to perform all management tasks even if the inter-connecting links with management station is lost.

- **Computational Load on Management Stations:** In MA paradigm the computational load at the MS is reduced nearly to zero because of the management task is executed locally on the NEs involved in the task. Therefore under the MA paradigm the computational load locally at the NEs may increase, however the MS is no longer a bottleneck from the point of view of both traffic and computational load, and thus overall it presents a more scalable architecture.

- **Dynamic Service Deployment:** A mechanism using java class loaders has been designed to dynamically load and unload management services. This module can allows even introduction of any new service without shutting down the system or mobile agent agency.

- **MA itinerary planning:** MST based algorithm is proposed to further lower down the MA bandwidth utilization.

- **Dynamic Adaptation:** The M-SNLMs are deployed dynamically depending upon traffic or required managed devices in a given sub-domain. Once deployed, they can further create child M-SNLMs to take care of increase in network under their supervision or move within their domains for load balancing.

- **Protocol Independence:** It is achieved through offering a mediation layer in EM based model which can interact with agents belonging to different protocols.

- **Event based updates:** Publish/Subscribe interface is designed between network segments and EM platforms to keep database in sync with the network. Child M-SNLMs update parents by means of messages instead of polling nature found in SNMP.
The architecture of network management system designed in this work has been implemented using Java and the results obtained thereof were compared with the conventional system of client/server models for the following observations:

- Computational load on central manager in C/S is proportional to no. of nodes being managed and no. of data accessing on a node.
- In the MA paradigm, the traffic load around the management station is mainly generated by the reporting of the results from the various network elements. Under the assumption that the size of MA is negligible compared to total network management traffic generated in Client/Server architecture, the traffic around the central MS is reduced significantly. In general the raw data transportation from the NEs is much higher than the traffic generated by the reporting of the results from the NEs.
- At the same time, in the MA paradigm the computational load at the MS is reduced nearly to zero because the management task is executed locally on the NEs involved in the task. **Hence MS is no longer a bottleneck from the point of view of both traffic and computational load, and thus overall it presents a more scalable architecture.**
- In Client/Server model the remote interaction time increases with the increment of the number of MIB accesses at a certain network, whereas in the MA paradigm MIB accessing becomes a local interaction between the management entity and managed entity. Thereby drastically reducing the remote interaction time. **This leads to better responsiveness.**

### 7.2 FUTURE SCOPE

In this thesis various issues related to scalable network management have been addressed. But the following areas are still open for future work.

- **Security Management:** SNMP protocol framework offers very poor security model. MA based security could be investigated to enhance it. Java Cryptography
Architecture (JCA) can be considered to allow compliance and interoperability with MA based solution.

- **MAs management issue:** The suggested approaches could lead to high number of MAs. The issues need to be investigated for better management.

- **Other management functions:** MA application to other management areas like fault management, configuration management etc. could be investigated.

- **Web based management:** MA application along with emerging web technologies like web services, service oriented architectures etc. could also be explored for providing network management solutions.