A MULTIPLE MULTICAST SERVER DISTRIBUTION SCHEME FOR REDUCING THE END-TO-END PATH DELAY AND OVERALL LOAD IN ATM NETWORKS FOR SINGLE SOURCE APPLICATIONS

A thesis submitted in partial fulfillment for the degree of
Master of Science

By

Abd El-Hamid Gamal El-Barbary
B.Sc., Faculty of Engineering, Alexandria University, 1996

Supervised by

Prof. Dr. Mohamed N. El-Derini
Department of Computer Science and Automatic Control
Faculty of Engineering, Alexandria University

Dr. Wafaa A. El-Haweet
Department of Computer Science and Automatic Control
Faculty of Engineering, Alexandria University

Dr. Magdi A. Ahmed
Department of Computer Science and Automatic Control
Faculty of Engineering, Alexandria University

Alexandria
2002
ACKNOWLEDGMENTS

First of all, Thanks to ALLAH by whom all blessings are given, then:

I wish to express my deepest gratitude and appreciation to my supervisors Prof. Dr. Mohamed N. El-Derini and Dr. Wafaa A. El-Haweet for their support, guidance and patience. Dr. Nazih never hesitated to give time and advice without whom I would have never accomplished this work. He is the one who guided me to the main ideas and keys of this work. The efforts and encouragement of Dr. Wafaa were the engines that powered this work.

I am very grateful and thankful to all my family for their support. I do really thank my parents that without their prayers, support, encouragement and love I wouldn’t be able to do a piece of this work. My wife deserves the best appreciation for her invaluable support, backing and contributions in this work. Finally, I can never forget how my father in law encouraged me to fulfill this work.

I do really thank every one of the staff of the department of Computer Science & Automatic Control from whom I learned to open my mind to learn every thing.

Last but not least, my deepest gratefulness goes to Dr. Mohamed A. Youssef, Eng. Wael Abd El-Kader and Eng. Ahmed Abo El-Soud in the Multimedia Center - Arab Academy for Science & Technology and Maritime Transport, where I work. They gave me time and support to achieve this work.
ABSTRACT

IP multicasting has been one of the most interesting topics for research communities and network service providers for its large scale emerging applications, while ATM has been widely considered as the next generation communication technology offering high speed transmission of different types of data. ATM multicasting using Multicast Address Resolution Server (MARS) and Multicasting Server (MCS) for supporting multicasting over ATM networks has been presented as an efficient scheme for supporting IP multicast over ATM. Selecting which nodes of the network should act as MCSs affects the network performance and has been under research. On the other hand, Internet TV, Distant Learning, and File Distribution are emerging large-scale multicast applications in which only a single source has to deliver data to all hosts participating in the multicast group. In this thesis, we introduce a new scheme for electing MCSs among all hosts in the network. The role of this scheme is to minimize both the end-to-end path delay and the overall load across the network for single source applications. The end-to-end path delay has been widely used in research to represent the average path delay which packets suffer when travelling from their source to their destinations. A new measure of the network overall load is introduced in this thesis. The overall load is determined by calculating the number of packets' copies multiplied by the number of hops done to complete the transmission of one packet from the sender to all members in the multicast group. A large number of simulation experiments have been done to investigate the performance of the new scheme and compare it to other schemes introduced in previous work. We could reduce the average of the end-to-end path delay and the overall load of the network in many cases especially when there are large enough MCSs relative to the number of hosts in the network.

Table of Contents
Chapter 1: Introduction 1
1.1 What is Multicasting 1
1.2 IP Multicasting 2
1.3 IP Multicasting Over ATM 2
1.3.1 VC Mesh 4
1.3.2 Multicast Server(MCS) 5
1.3.3 Tradeoffs between VC Mesh and MCS 5
1.4 Single Source Applications 6
1.5 Objective 6
1.6 Thesis Organization 6

Chapter 2: Previous Work and Motivations 8
2.1 Multiple MCS 8
2.1.1 Fault Tolerance Using Multiple MCSs (Protocol A) 9
2.1.2 Fault Tolerance and Load Sharing Using Multiple MCSs(Protocol B) 9
Chapter 6: Conclusion And Suggestions For Future Work

6.1 Conclusion

6.2 Suggestions For Future Work

   6.2.1 Extending the Model to Work in a Multi-Source Applications.
   6.2.2 Finding a Criteria to Choose Among Equal Weighted Nodes

References
List of Figures

1.1 Comparing Unicast, Broadcast and Multicast ........................................... 1
1.2 MARS Architecture .................................................................................. 4
1.3 VC Mesh ................................................................................................. 4
1.4 MCS ........................................................................................................ 5
2.1 Fully Multiple MCSs Model ................................................................. 12
2.2 Hybrid Multiple MCSs Model ................................................................. 13
2.3 Example of Multicast Tree Construction ............................................... 14
3.1 Flowchart of Weight Calculation Algorithm ........................................... 19
3.2 Example of a Simple Cluster ................................................................... 20
3.3 Node Weights Initialized to Zeros ......................................................... 20
3.4 Shortest Paths and Final Values of Node Weights .................................. 22
3.5 Flowchart of Equal Weighted Node Elimination Algorithm .................. 24
4.1 Dividing The Network to 3 Clusters with 3 MCSs ............................... 27
4.2 Shortest Paths and Node Weights When the Source at Node 16 ............ 29
4.3 Clusters Generated by the HWF Model When the Source is Node 16 .... 29
4.4 Clusters Generated by the LADF Model When the Source is Node 16 ... 30
4.5 Packets on Links When Node 12 is MCS .............................................. 33
4.6 Packets on Links When Node 13 is MCS .............................................. 33
4.7 Example of MCS Loads ......................................................................... 35
5.1 Simulation Sample Network ................................................................... 38
5.2 Average Shortest Path for Source Positioned on All Locations .............. 40
5.3 Average Shortest Path for a Centered Source ....................................... 42
5.4 Average Shortest Path for a Far-Leaf Source ....................................... 44
5.5 Overall Load for Source Positioned on All Locations ............................ 47
5.6 Overall Load for a Centered Source ..................................................... 49
5.7 Overall Load for a Far-Leaf Source ..................................................... 51
5.8 Load Average Deviation for Source Positioned on All Locations .......................... 54
5.9 Load Average Deviation for All Centered Source ............................................. 56
5.10 Load Average Deviation for a Far-Leaf Source .............................................. 58
6.1 Choosing Between Equal Weighted Nodes ...................................................... 64

List of Tables

2.1 Multiple MCS Protocols ................................................................. 11
3.1 Shortest Paths From Source Node 7 to All Nodes ......................................... 21
3.2 Cluster Nodes Sorted According to Their Weights ........................................ 23
4.1 Calculating the End-to-End Path Delays ...................................................... 27
4.2 Average Path Delay for All Nodes ......................................................... 28
4.3 Calculating the End-to-End Path Delays (HWF Model) .................................. 30
4.4 Calculating the End-to-End Path Delays (LADF Model) ............................... 31
4.5 Calculating the Average End-to-End Path Delays When Node 13 is MCS ........ 34