SOME STUDIES ON LOCAL AREA NETWORK FOR SAFETY SYSTEMS WITH APPLICATION TO RAILWAY SIGNALLING SYSTEM

by

K. VIJAYA KUMAR

A thesis submitted to the
Indian Institute of Technology, Delhi
for the award of the degree of

DOCTOR OF PHILOSOPHY

Department of Electrical Engineering
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
HAUZ KHAS, NEW DELHI-110016

January, 1994

CERTIFICATE

This is to certify that the thesis entitled "SOME STUDIES ON LOCAL AREA NETWORK FOR SAFETY SYSTEMS WITH APPLICATION TO RAILWAY SIGNALLING SYSTEM", which is being submitted by **K. Vijaya Kumar** to the Department of Electrical Engineering, Indian Institute of Technology, New Delhi, for the award of the degree of "**Doctor of Philosophy**", is a bonafide research work carried out by him under my supervision and guidance.

In my opinion, this dissertation has reached the standard fulfilling the requirements of all the regulations relating to the degree. The results contained in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

Date : Jan 31, 1994

Vinod Chandra

Vinod Chandra
Professor,
Department of Electrical Engineering,
Indian Institute of Technology,
New Delhi - 110016

ACKNOWLEDGEMENTS

I am immensely grateful to my supervisor, Prof. Vinod Chandra for his guidance and constant encouragement throughout the course of this dissertation. He has remained the driving spirit behind this work throughout.

My esteemed thanks are also due to Prof. P.V. Indiresan for his moral support and encouragement. I am thankful to Prof. S. Prasad for encouragement and use of the laboratory facilities and to Dr. K.S. Raghavan for useful suggestions.

I am also thankful to Shri S. Ravi, Adviser (Signal), Railway Board for his support and encouragement.

I express my sincere gratitude to Nirmallya Kar for providing invaluable support and assistance throughout the course of this dissertation.

Amongst friends, I am specially thankful to Mrityunjoy Chakraborthy for the moral support and sincere concern. I am thankful to Mr. R.P. Kapoor for drafting figures, Mr. H.L. Narang and Mr. R.L. Khanna for extending their cooperation on several occassions.

Finally, I express my indebtedness to my wife Shashi Kala for the sacrifices she has made in giving me full support for this work, while taking care of all the domestic responsibilities single-handedly.

K Vijaya Kumar

(K. Vijaya Kumar)

SYNOPSIS

Summary

This thesis deals with studies on a local area network for safety critical systems with application to railway signalling system. The local area network should meet the real time, safety and reliability requirements of the railway signalling application. For this purpose, the design of a fault-tolerant, fail-safe (FTFS) node using transputers has been developed. The FTFS node uses a new rotation-based leadership technique to meet the safety and reliability requirements. A local area network of FTFS nodes having dual ring topology is proposed. The real time communication issues of the network are addressed by proposing a schedulability model for the periodic messages. The performance measures of the network are evaluated by simulation. Subsequently, The implementation aspects for the specific application to railway signalling system, namely, the solid state interlocking system are described. Finally, the reliability and safety of the system are quantified. The chapterwise details of the thesis are briefly described as follows.

CHAPTER 1 Review of real time communication networks

Real time communication is timely delivery of inter-task messages and is essential to the completion of real time tasks before their deadlines. Chapter 1 introduces real time communication networks and contains a review of real time multiple access networks and real time multihop-networks. A review of network topologies is also given in this chapter.

DEDICATED

TO

my parents
and
my wife

CONTENTS

CHAPTER 4 REAL TIME COMMUNICATIONS IN THE NETWORK OF FTFS NODES HAVING DUAL RING TOPOLOGY

CHAPTER 5 AN APPLICATION TO MICROPROCESSOR BASED ROUTE INTERLOCKING SYSTEM FOR CONTROL OF TRAINS IN RAILWAY YARDS

CHAPTER 6 RELIABILITY AND SAFETY ANALYSIS

CHAPTER 7 CONCLUSIONS AND FUTURE WORK