INTERCOMPUTER COMMUNICATIONS

A THESIS

SUBMITTED TO THE FACULTY OF ENGINEERING,
ELECTRICAL DEPARTMENT, AIN-SHAMS UNIVERSITY,
CAIRO, EGYPT.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE

BY
MAMDOUH KAMEL IBRAHIM
B.Sc. Electronic Engineering

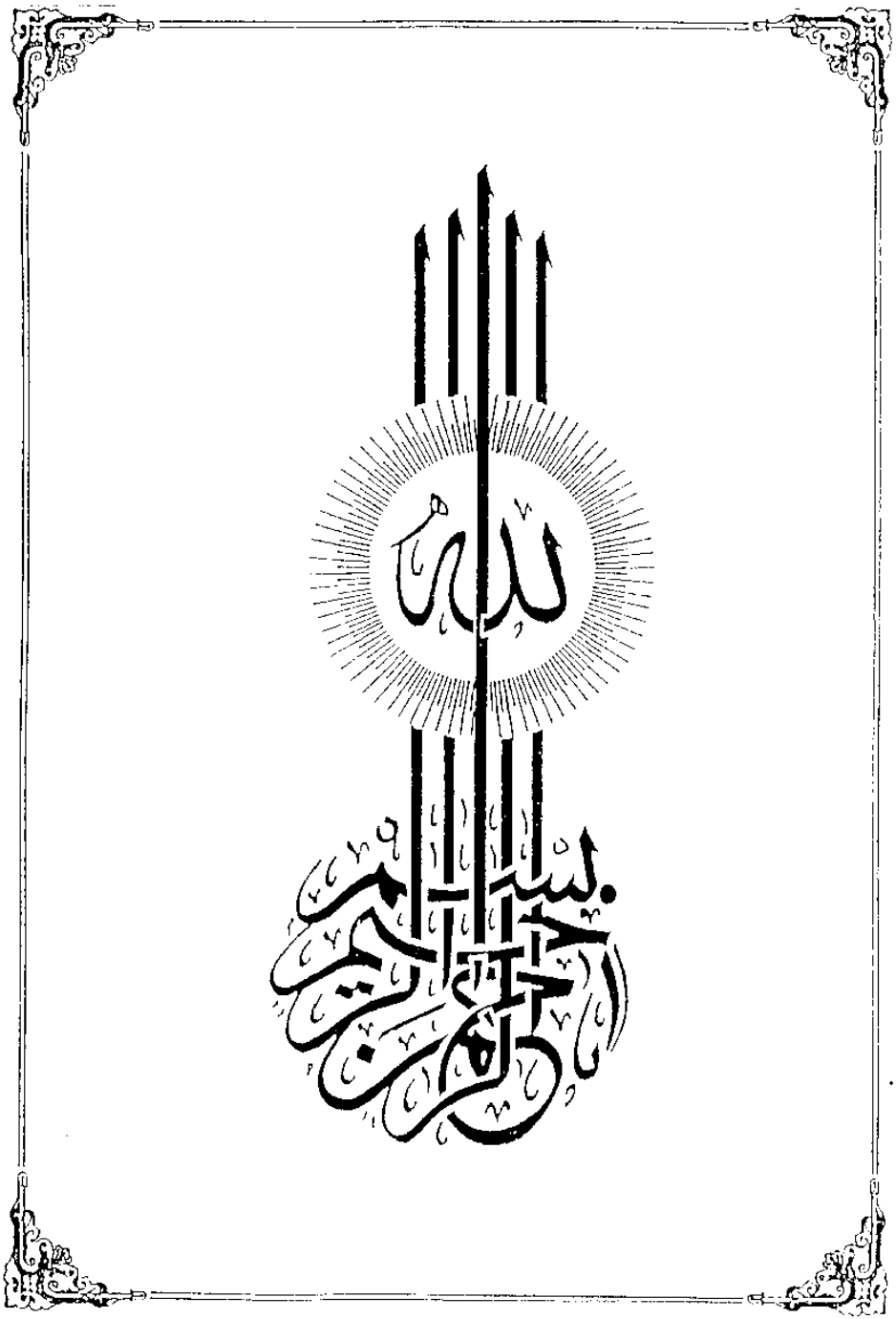
SUPERVISED BY

Dr. M. A. HASSAN
Prof. and Head of
COMPUTER & CONTROL LAB.
ATOMIC ENERGY ESTABLISHMENT.

Dr. M. A. R. GHONAIMY
Assistant Prof. ELECTRICAL DEPT.
FACULTY OF ENGINEERING,
AIN SHAMS UNIVERSITY.

1976

TO MY PARENTS



ACKNOWLEDGEMENT

THE RESEARCHER WISHES TO EXPRESS HIS DEEPEST GRATITUDE TO PROF. DR. M. A. HASSAN AND DR. M.A.R. GHONAIMY FOR SUGGESTING THE PROBLEM AND FOR THEIR CONTINUOUS HELP AND ENCOURAGEMENT, WITHOUT WHICH THE REALIZATION OF THIS PLAN WOULD NOT HAVE BEEN ACHIEVED.

THE RESEARCHER ALSO WISHES TO THANK PROF. DR. M.F. EL-FOOLY HEAD OF REACTORS DEPARTMENT FOR HIS ENCOURAGEMENT.

Summary of the thesis submitted to the Faculty of Engineering, Electrical Department, Ain Shams University for the degree of

Master of Science

Title: Intercomputer Communication

By: Mamdouh Kamel Ibrahim

The thesis is a study of the computer networking methods and prelimenary realization of a node used for interfacing minicomputers to a data communication channel. The problems discussed in this thesis are of appreciable current interest, this is caused by the significant advances in mini and micro computer technology as compared to the development of giant standard computers. This, coupled by parallel work on data communications has made the issue of computer network a subject of extensive study and research allover the world. Problems connected with network realization are those of network component choice, data communication channel realization, interfacing to the network and overall network operation to satisfy the design criteria. The thesis includes a discussion of the mini and micro computers as network elements. It also gives a broad introduction to data communication methods over

channels of different speeds. It then concentrates on the use of LSI chips for the realization of a sort of universal intelligent interface which could be used in a flexible way to interface different elements such as processor or terminals to a common data path thus forming the integrated structure.

The intelligent interface was realized using the INTEL 8008 microprocessor and associated chips from INTEL such as RAMs, PROMs and I/O ports. The speeds on the data channel are in the range of 3 M baud and this proved to be high data rate for the INTEL 8008 CPU to handle. To solve this problem a substantial part of the communication protocol was handled by special logic outside the microprocessor. The more elaborate part of the protocol including block checking and decision making was however left for the microprocessor.

CONTENTS
========

CHAPTER 1

SCOPE OF THE WORK

The field of data transmission is expanding at a very high rate and this is being caused by the increase in the computer population and their need to communicate. Computer networks have evolved for reasons of economics and efficiency to permit information resident in one computer to be shared with others, to enable a number of users to have remote access to a computing centre, and to control the flow of information from one point to another. A trend which is clear by now is to use networks consisting of a number of small computers (usually minis) used as an alternative to a single large computer. This is done to ensure that the computer system is operational at all times. It also can simplify system development if functions are partitioned carefully among the different computers. Such networks also permit greater economy by selecting computers that are the most cost effective for each part of the problem being solved.

Computer networks have evolved in much the same way as other types of networks such as in communications and power. The development of computer networks as well as the different network configurations are discussed in chapter (2). A desirable aim in designing a private network should be to reduce costs by making more efficient use of the individual communication lines. Clearly, this means

that as much traffic as possible must be carried by each line in the network, but in this case the failure of any line carrying a high traffic load is likely to be more serious for the network as a whole. This subject is examined in chapter (2) also, through studying the connection of a number of remote terminals to a central computer. The Advanced Research Project Agency (ARPA) network, one of the first elaborate networks, and the DEC Laboratory Interconnection Programming System (LIPS) network are presented at the end of chapter (2) as two examples of typical computer networks in operation today.

Chapter (3) deals with data transmission. The theoritical fundamentals concerning transmission of data over restricted bandwidth channels are explained and applied to construct an elementary data system. Some of the many problems faced by todays data transmission engineers are also examined.

When a basically analog system such as the present telephone network is used to carry data, a modem (modulator - demodulator) is used at each end. The various modulation schemes and their applications for data transmission are described and their characteristics such as efficiency of bandwidth utilization are discussed. Modern methods of binary data transmission directed to meet the growing need for the transmission of larger volumes of data over

presently available communication channels are also exposed.

The nature of errors over data communication channels and the basic techniques to deal with them are also discussed in chapter (3). The arrangement of a typical data system is also included.

Generally speaking, data communications involves the equipment or services used to pass information to or from a computer centre. Chapter (4) deals with the hardware elements of a computer network. The role of each element in both the transmission and processing of information is considered. The concept of distributed intelligence as applied throughout a computer network is presented. It is shown that the addition of intelligence to the various elements of a network can have the effect of reducing the traffic on the channels. The various functions of the different elements are considered. It is also shown how the addition of intelligence affects these functions. The role of microprocessors in adding such distributed intelligence at a relatively low cost is also considered in chapter (4).

Chapter (5) deals with interfacing a computer or device to a common data channel. The concept of handshaking to control the information flow in the system is

discussed. The use of an interface to link two autonomous systems shows the need for buffering. The association of a buffer with the interface is also considered.

The development of LSI technology has a great effect on the design of an interface. The circuits needed to interface a computer or a terminal to a serial data channel is now available on a single LSI chip. It is shown in this chapter how such LSI chips make the interface design much easier and faster. The use of a microprocessor chip in designing the interface is also considered. The advantages of the microprocessor based design interface are discussed showing how the intelligence level at the interface is raised enabling it to perform many functions rather than solving the communication problems.

The aspects of controlling a complex process is discussed briefly in chapter (6) which leads to the concept of high reliability distributed computer networks (HRDCN) architecture. The HRDCN structure is considered and its expected overall performance is also discussed.

The detailed design of the node is given in this chapter. It is designed around INTEL 8008 microprocessor chip with associated PROMs and RAMs in a more or less universal fachion. The operation of the node is also considered in both the transmitting and receiving modes.

A general resume and critique of the developed system is presented in chapter (7) including proposals for more advanced designs for future implementation.

Appendix A describes the general architecture of INTEL 8008 CPU which is used in the node realization. Appendix B includes a detailed description of INTEL 8212 I/O port showing the different modes of operation and the corresponding control inputs.

CHAPTER 2

INTRODUCTION TO COMPUTER NETWORKS

For the first decade of its development, computer technology was concerned with single, isolated computers. People brought their problems to the machines and carried away the results. Then experiments wer tried in which two computers interacted and computers were accessed from a distance. These were the beginnings of computer networks, the potential of which is still being explored.

2.1. Why a Computer Network:

Computers as local services are very restricted, because the data on which they work is hardly generated in the same location or destined for a user on the spot. Hence the use of computers from a distance is an important trend. Modern computers are increasingly being equipped with communications facilities to facilitate connection to communications networks to serve users who are widely spaced.

Another trend which now could be seen is the connection of two computers by a data network so that they can collaborate in executing a task. Systems are now in operation in which one computer depends on another for its