**mini**consult

# Minicomputers in Data Communication

The Course Proceedings edited by
G Cain Y Paker P Morse

The Proceedings

**Minicomputers in Data Communication**

*A Three Day Course at the Polytechnic of Central London*

*6 - 8 December 1972*

Edited by the Organisers
Dr. G. Cain
Dr. Y. Paker
Dr. P. Morse

# EDITORS' NOTE

The papers in this volume are selected from the material presented at a three-day course at the Polytechnic of Central London. "Minicomputers in Data Communication" ran on 6th-8th December 1972 and attracted a large international group of participants.

This document introduces the role of the minicomputer in transporting data. There can be no doubt that we are now in the midst of an era in which there is a rapidly increasing demand for techniques and facilities permitting widespread utilization of powerful computer installations. Networks are blossoming and minicomputers are being delegated major responsibilities in the monitoring, management and control of data flow.

The first paper describes the characteristics of minicomputers that make them attractive communication system components. Methods of acquiring and dispatching the data from analog and digital sources are then explored. Treatments of the transmission channel environment appear in the discussions of modem properties and the British Post Office network. Communications software and the overall considerations for design of networks employing minicomputers are given. Three descriptions of specific communications applications illustrate typical data network implementation approaches,

We have included a bibliography and glossary of relevant terms. Finally, there is a list of the companies that participated in the specialist exhibition of minicomputer and communication equipment held as part of the course.

In our capacity as Course Organisers, we appreciate the skill of the lecturers and chairmen in the presentation and discussion of the course topics. We must thank our entire support team for their steadfast and diligent efforts and, in particular, the special touch of Miss Lisa Spaducci and Miss Penny Green. We gratefully acknowledge the encouragement of Dr. Colin Adamson, the Director of the Polytechnic of Central London, which made this course possible. As Editors, we are grateful for the talent and perseverance of Miss Green and Mrs. Anna Hartley in producing the manuscript.

G. Cain

Y. Paker

P. Morse

The Polytechnic of Central London
September 1973

## COURSE PROGRAMME

**Wednesday 6th December 1973**

10:00 Registration Begins

12:00 Sherry Reception and Lunch

Afternoon Session

Chairman: Dr. G. Cain, PCL

14:00 Opening Remarks and Welcome - H.G. Jelf, Secretary, PCL

14:15 Introduction to Minicomputers and Data Communication - Dr. P.L.R. Morse, PCL

15:30 Tea

16:00 Short Distance Data Communication - Dr. E.T. Powner, UMIST

17:30 End of First Session

**Thursday 7th December 1973**

Morning Session

Chairman: Lt. Col. I.G. Kinnie, U.S. Army European Research Office

09:30 The Post Office Network - R. Smith, P.O. Telecommunications Development Department

10:45 Coffee

11:15 Long Distance Data Communication - J. Blackwell, Racal-Milgo

12:30 Lunch

Afternoon Session

Chairman: Dr. Y. Paker, PCL

14:00 Communication Software - I.F. Croall, UKAERE

15:15 Tea

*15:45 System Design Considerations for Data Communication Networks* - Professor R.L. Grimsdale, University of Sussex

17:00 End of Second Day's Sessions; Exhibition Opens

20:00 Dinner (Marylebone Road Building)

**Friday 8th December 1973**

Morning Session

Chairman: D.E. Hampton, Signals Research and Development Establishment

09:30 An International Banking Network Using Minicomputers - L.G. Woodruff, Logica

10:30 Reliable Telephone Exchange Control by Small Computers - J.M. Cotton, Plessey Telecommunications Research

11:30 Coffee

12:00 Software Problems in Front End Processing - V. Stenning, Systems Designers

13:00 Discussion of Morning Session Presentations

13:30 End of Academic Sessions; Lunch

Afternoon Session

14:45 Exhibition; Manufacturers' Presentations Begin

16:00 Tea

17:00 Course Ends

## COURSE DELEGATES

AITKEN, J.F.
The Hatfield Polytechnic

ALLINSON, J.S.
GEC Elliott

AMBROSE, J.E.
ICL - Dataskil

ANDERSON, O.V.
Standard Telefon og Kabelfabrik A/S, Norway

ASAN, G.
EIE Idaresi, Turkey

BARNFATHER, F.R.
Post Office

BATTLEBURY, D.R.
E.E.G.B.

BEAUMONT, B.
Electricité de France, France

BENZ, O.R.
British Railways Board

BERTSCHINGER, N.D.
Motor-Colombus, Switzerland

BISHOP, R.
Post Office Telecommunications

BLACKWELL, A.D.
Plessey Radar

BLAND, C.J.
ICL - Dataskil

BLOXHAM, P.A.
Kingston Polytechnic

BLYTHE, B.
Reed International Ltd.

BOARON, Ing. M.
FIAT, Italy

BOAS, C.S.
Post Office Telecommunications Development Department

BOOTY, P.
Government Communications Headquarters

BOUCHEZ, P.
Burroughs SA, France

BRITNELL, D.W.J.
The Plessey Company Limited

CAREY, W.M.
Shell Francaise, France

CHUBB, C.J.
Government Communications Headquarters

CLAYWORTH, J.J.
Reuters Limited

CLOSE, A.B.
Ministry of Defence (PE)

COBB, J.A.
Plessey Company Limited

COOPER, R.A.
Hewlett-Packard Limited

CROLL, M.G.
B.B.C.

CROZIER-COLE, P.A.
Independent Broadcasting Authority

CZAJKOWSKI, R.
The Plessey Company Limited

DARE, G.M.R.
British Railways Board

DOUGLASS, G.
British Railways Board

ELY, F.R.
University of Liverpool

ENTWISTLE, B.C.
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FEDIDA, S.
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FINDLAY, A.
Department of Trade and Industry

FOGAROLI, G.
Olivetti S.p.A., Italy

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Rowntree Mackintosh

GILES, P.
Plessey Services

GOODYEAR, Dr. C.B.
University of Liverpool

GOSS, B.R.H.
Post Office Data Communications Division

GOVAERTS, R.
Katholieke Universiteit Leuven, Belgium

GRIFFIN, M.
Gulf Oil Co. - E.H. Limited

GROCOCK, D.
British Steel Corporation

GROSS, J.P.
Brown Boveri Company Limited, Switzerland

HAMBROCK, K.
Hewlett-Packard, West Germany

HARRISON, M.E.
Teesside Polytechnic

HERDA, S.
Gesellschaft für Mathematik und Datenverarbeitung, West Germany

HOPPER, R.J.
CESCOM Electronics Limited

HUDSON, B.R.
Sunderland Polytechnic

HUDSON, G.P.
Post Office Research Centre

HUNT, E.
Ministry of Defence (PE)

IBBOTT, C.J.
Data Recording Instruments Limited

ISLER, R.
Armament Technology and Procurement, Switzerland

JAMISON, M.L.
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JAUNIN, M.
Ecole Polytechnique Fédérale, Switzerland

JARVIS, J.
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KELLNER, K.
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KENDLER, H.B.
The Gas Council

KIDD, R.
Atkins Research and Development

KIDDLE, C.J.
Central Computer Agency

KIM, A.
Burroughs SA, France

KINGSMILL, A.J.
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IBM (U.K.) Limited

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LUESCHER, B.
Hasler (GB) Limited

LUNN, J.L.
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MAGAUD, J.J.G.
Northern Ireland Polytechnic

MANDY, J.A.
ICL

MARTINS, J.A.
ICL

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CEGB Computing Bureau

POLDEN, R.
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ROBINSON, R.
Walmore Electronics Limited

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TUCK, A.
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UNWIN, R.T.
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Independent Broadcasting Authority

WAUMANS, B.L.A.
N.V. Philips, The Netherlands

ZILLIANI, M.
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WOODRUFF, L.G.
Logica Limited

## SPEAKER

JELF, H.G.
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CONTENTS

# An Introduction to Minicomputers and Data Communication

Dr P L R Morse
*Polytechnic of Central London*

**Dr. Peter L.R. Morse** read physics at Kings College, London, from 1959 to 1966, and gained the degrees of B.Sc., A.K.C. and Ph.D. He is at present a Senior Lecturer in the Department of Physics, PCL, and is a member of the Institute of Physics.
Dr. Morse's current activities include the development of computer controlled instrumentation systems and the development of postgraduate courses in instrumentation. He is active in the acquisition of major computing facilities for the PCL and the organisation of conferences and short courses on minicomputer technology.

# AN INTRODUCTION TO MINICOMPUTERS AND DATA COMMUNICATION

## INTRODUCTION

The application of digital computers in commercial and scientific fields is established and growing rapidly. Another emergent field is where minicomputers are being utilised as "nerve centres" in a variety of systems. We may group minicomputer activities into the following categories:

* communication
* control
* data acquisition
* data processing

In all of these, real-time response is important.

Data communication applications can be classified as pure telecommunications applications where the minicomputer operates as an integral part of the communication network, and pre-processing applications where the machine provides a flexible interface. In some system configurations both application types are integrated.

The growth of minicomputer technology is a result of the role of minicomputers in new fields of applications previously unexplored by manufacturers. Before reviewing the basic principles of minicomputers and their specific role in data communication we shall examine this emergence in more detail.

## THE EMERGENCE OF MINICOMPUTER TECHNOLOGY

### Growth of the Industry

Over the past six years the greatest growth in the computer industry has been in the minicomputer field. The first minicomputers were produced in 1962 for aerospace applications in the USA. Such machines became commercially available in 1966 and today over 40,000 systems have been installed world-wide. Figure 1 shows estimated delivery rates [1], which should reach 40,000 machines per annum by 1975. In the communications field 10,000 machines should be in use by this time (Figure 2).

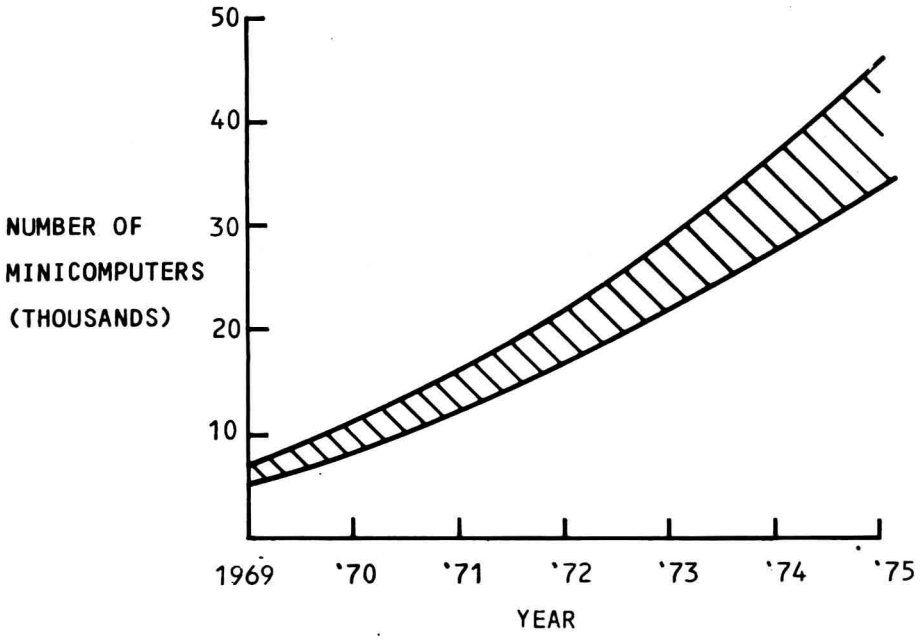


FIGURE 1 Production of Minicomputers

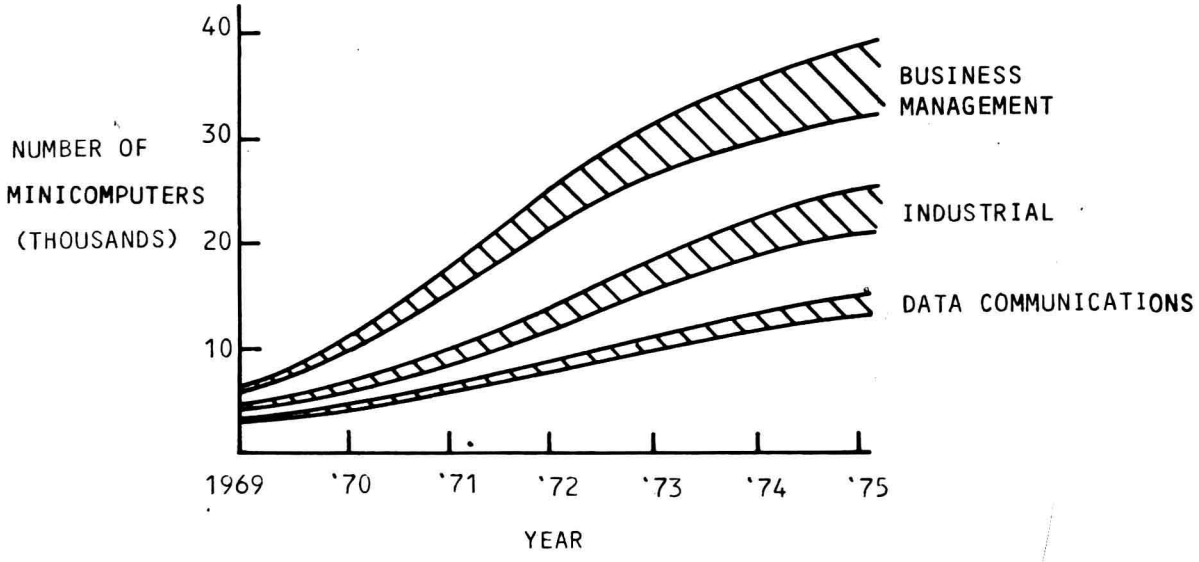


FIGURE 2 Number of Minicomputers in Use

Market studies have for some time indicated a downward trend in central processing (CPU) units. The ratio of total system to CPU costs will be 10:1 or higher by 1975, reflecting the growing value of peripheral devices and software interfacing.

## The Industry

Originally dominated by a few mainframe manufacturers, the minicomputer industry has expanded to include many mainframe and system manufacturers, peripheral suppliers, independent software houses, and system houses supplying turnkey systems. A large proportion of total sales are to original equipment manufacturers (OEMs). These are usually stripped-down versions of the machines. Large enterprises like IBM and Xerox, who possess the necessary resources for market penetration, have recently entered the field. New companies specialising in low cost peripherals and subunits for minicomputers are emerging under the impetus of systems/computer cost ratios which range from 2:1 to 10:1.

The necessary software and applications programs are developed by manufacturers, users, user groups, software houses, and OEM manufacturers. Expenditure for software development estimated at £50 M in 1969 could be £500 M in 1975. By then machines will use modular general-purpose software systems whose cost can be amortised over many applications.

Systems suppliers offer complete workable integrated turnkey systems for specific application areas. They are in competition with manufacturers for end-users. Total system service is a problem in this area.

## Definition of Contemporary Minicomputers

It is clear that no simple definition of a minicomputer exists, and that a comprehensive definition or classification must be in terms of price, performance and application. In many respects the performance of new minicomputers is better than their old big brothers, e.g. faster core cycle times and peripheral transfer rates (250 nsec and 30 M bit/sec).

Minicomputers have often been defined by price rather than performance. In 1969 they were classified with a system cost of £20 K; today a more reasonable figure would be £6 K.

Considering performance, minicomputers typically have:

* fast processing rates
* short word lengths
* versatile input/output (I/O) structures

Their cost is a function of word length, scope of instruction set, and I/O structure versatility. They vary with respect to the number of accumulators provided, instruction sets implemented, instruction decoding techniques and interrupt handling capability.

A small minicomputer system usually performs control, data acquisition and display. A large system performs all these functions in a time sharing mode, i.e. supporting foreground and background modes. Computers whose characteristics fall within the ranges of Table I can be classified as minicomputers.

| CHARACTERISTICS | FEATURES | | |
|---|---|---|---|
| | MINIMUM | AVERAGE | MAXIMUM |
| MEMORY | | | |
| Word Length (BITS) | 8 | 12 to 16 | 18 to 24 |
| Size (WORDS) | 1K - 4K | 4K - 32K | 1K - 64K |
| Increment Size (WORDS) | 1K | 4K | 8K |
| Cycle Time (μsec) | 8 | 1 to 1.75 | 0.3 |
| Parity Check | NO | OPTION | YES |
| Memory Protect | NO | OPTION | YES |
| Direct Addressing (WORDS) | 256 | 256 to 4K | ALL CORE |
| Indirect Addressing | NO | MULTILEVEL | MULTILEVEL |
| CENTRAL PROCESSOR | | | |
| General Purpose Registers | 1 | 1 to 4 | 8 to 16 |
| Index Registers | NO | 1 | 6 to 15 |
| Hardware Multiply/Divide | NO | OPTION | YES |
| Immediate Instructions | NO | YES | YES |
| Double Precision Arithmetic | NO | YES | YES |
| Byte Processing | NO | YES | YES |
| I/O | | | |
| Programmed Channel | 1 | 1 | 1 |
| I/O Word Size (BITS) | 8 | 8,12 or 16 | 18 or 24 |
| Priority Interrupt (LINES) | 1 | 1 - 64 | 1 - 256 |
| Direct Memory Access (DMA) | NO | OPTION | OPTION |
| Maximum Transfer Rate (characters/sec) | 125K | 400K to 600K | 1M |
| OTHER FEATURES | | | |
| Real-Time Clock | NO | OPTION | YES |
| Power Fail/Restart | OPTION | OPTION | YES |
| Disc | NO | YES | YES |
| SOFTWARE | | | |
| Assembler | YES | YES | YES |
| Compiler | NO | SEVERAL | MANY |
| Operating System | NO | NO | REAL-TIME |
| Price - 8K words of core memory + teletypewriter | £ 3k | £ 5k | £ 10k |

TABLE 1 Minicomputer Characteristics