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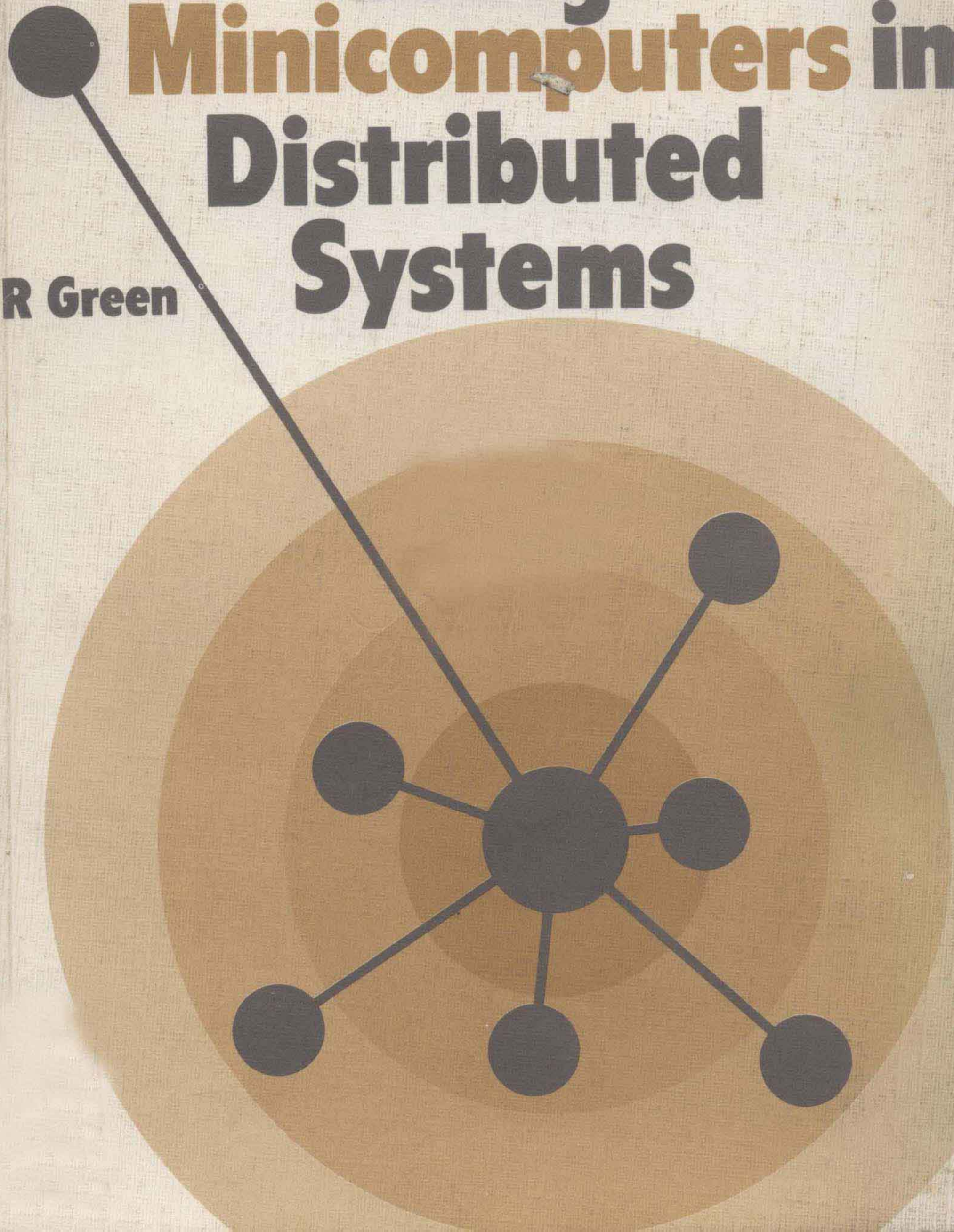
The National Computing Centre

Using Minicomputers in Distributed Systems

R Green



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by

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1 Introduction

PURPOSE

This book surveys the types of minicomputers available to the designer of commercial distributed computing systems. The implications of using minicomputers in this context are also considered.

The distributed computing philosophy embraces a growing range of system concepts and techniques, many of which depend on minicomputers for their implementation. This book, aimed at the data processing professional, describes how distributed systems are currently being configured using minicomputers, indicates characteristics of available minicomputers, and considers the implementation of remote minicomputer systems.

CONTENTS

The minicomputer market-place is extremely volatile: new products appear at a rapid rate, and manufacturers themselves proliferate. In addition non-manufacturing service companies play a major role in the supply of minicomputer systems. An effort has been made to distil the main factors affecting the use of minicomputers in commercial distributed computing systems.

Chapter 2 describes how minicomputers are used in distributed systems. A profile is also given of available products and how they are marketed. The following four chapters (3 to 6) describe four types of products (with case studies where appropriate):

- intelligent terminal systems;
- transaction processing systems;
- low-cost systems;
- real-time systems for the requirements of novel environments.

Minicomputer systems embody some concepts traditional in mainframe practice; indeed many file handling systems may be considered primitive.

In other areas, minicomputers exhibit conceptually different purposes than do mainframe systems. The focus is on these differences.

Finally Chapter 7 looks at minicomputer programming and at the implementation of remote communicating computer systems.

2 Distributed Systems and Products

DISTRIBUTED SYSTEMS

Many factors have encouraged the development of distributed computing systems. Probably the two most important in commercial data processing are the increasing demand for interactive computing and the fall in hardware costs (rendering distributed systems feasible).

Interactive requirements have led to the development of terminal networks serviced by a large centralised system. The problems of designing and running centralised networks are now well known: the implementation of such a system is now relatively straightforward but control of a large network remains difficult.

New systems have been designed to bring processing power, particularly with an interactive capability, close to the user. The minicomputer has been prominent in many of these designs, though it is worth noting that minicomputer systems can only be discussed generally in the narrow hardware sense: the last few years have seen major and varied developments in minicomputer software.

There are four common approaches to distributed computing systems:

- *centralised system enhancement,* involving local execution of some system functions (eg data validation);
- *minicomputer usage complementary to other systems,* exploiting particular hardware and software features of the minicomputer (eg for interactive processing) with periodic communication in batch mode with other systems;
- *compatible system usage,* deriving benefits from local processing but maintaining standard compatible programs and procedures;
- *novel systems,* designed to match the needs of an organisation and often employing co-operating processes running on geographically separate machines.

The last type is something of a 'catch-all' in that a wide variety of design ideas are currently being exploited. Most current systems fall into one (or more) of the first three categories where implementation is easier because of available hardware and software products. Any system which reduces or eliminates interactive communication over Post Office lines is easier to run and can achieve significant cost savings. This is so where dial-up rather than private circuits are used as the basis for the communications service.

ENHANCED CENTRALISED SYSTEMS

Central systems

Businesses with centralised functions will continue to need a centralised data processing capability. There are also other reasons why centralised computing systems will survive, eg political constraints, the need to protect investment, and the requirement for a large data processing capacity. Centralised systems can be enhanced by the use of local processing power to support the centralised application. Benefits of this approach include:

- reducing interactive work on the mainframe. This work is often burdensome on processing capacity and primary storage in large batch-orientated machines;
- relieving bottlenecks. By reducing the amount of interactive dialogue, reductions are also achieved in such factors as mainframe core occupancy, disk accessing, context switching and line utilisation;
- improving operator response time. Even where a large centralised system is not overloaded, response times are rarely equal to those in a dedicated local processor;
- improved resilience. The use of local processing power can enable limited local activities to continue in the event of mainframe or telecommunications lines failures. At the same time there may be considerable dependence on unduplicated local hardware;
- more relevant software. The availability of high-level system software performing certain specific functions (particularly data entry) can reduce program development and training costs.

Intelligent terminals

The trend toward using local processing power began early in the life of large terminal networks.

Originally, distributed processors were used for technical functions, eg for replacing hardwired units, for front-end processing, and for terminal concentrators. Minicomputer manufacturers were in the forefront of this movement, since often a minicomputer-based 'soft-centred' device was cheaper and more effective than the hardwired devices from mainframe manufacturers.

Such products were becoming common by the late sixties. Then user programmable terminals became available, offering distributed processing to users of large centralised systems. Sophisticated terminal software is now available for technical and system functions, encouraging mainframe manufacturers to offer their own programmable terminal products. For those wishing to adopt this route to distributed computing there is an increasing range of products.

Intelligent terminal systems are described more fully in Chapter 3.

COMPLEMENTARY MINICOMPUTERS

'Complementary' or 'competitive' minicomputers have sometimes been installed following user pressure when central dp departments have shown reluctance.

With a system used locally there is a case for local data processing, particularly if interactive working is required. The size of the application may be crucial. At one extreme, with large disks and high-speed printers (and other expensive peripherals), economies of scale may be achieved by centralised processing and by thus sharing resources. At the other extreme, entirely new applications using microcomputers are being developed. Between the extremes there is a range of interactive minicomputer products providing the effective solutions to many local application problems.

Some of the benefits from this approach are indicated:

- the development risk is more easily quantified; sizing an interactive application on a small dedicated system is significantly easier than on a large multipurpose mainframe. At the same time, caution is needed with applications using equipment at the top of a minicomputer range, since (apart from hardware duplication) no upgrade may be possible;
- by eliminating the need for interactive communications links, line costs can be considerably reduced where batch communications employ dial-up lines;
- local interaction will normally provide better operator response times than could be achieved using a remote mainframe. This should be investigated for specific cases. Many small configurations show dramatic response deterioration as the number of terminals increases;

- by eliminating dependence on telephone lines for some or all interactive activities, availability of the service is improved. Local equipment failure, although a problem for the affected site, is less troublesome for the company as a whole than is central system failure. Furthermore, it is often possible in the event of failure to utilise a machine at another site;
- the ability to schedule operations on a local basis leads to a better attitude to systems and more convenient usage;
- software for the development of interactive minicomputer systems has greatly improved over the last few years. Minicomputer-based systems often offer good performance at a considerably lower price than on the equivalent mainframe system;
- many systems have been designed specifically for interactive use, or offer file enquiry languages and database software. These features can reduce development effort, though at the expense of standardisation.

A significant drawback to this approach is the lack of a standard programming environment. The significance of a standard programming language increases considerably with the size of the application being developed. This is because the *investment* in systems coding and design is vulnerable if non-standard languages are used. Investment in programming skill should also be considered, although many small interactive systems are easy to program.

Minicomputer-based transaction processing systems (Chapter 4) and low-cost microcomputer-based systems (Chapter 5) are described.

LINKED COMPATIBLE SYSTEMS

Again, the aim with this approach is to gain operationally and in investment costs by siting processors locally and reducing telephone line traffic to periodic batch transmissions. However, non-standard hardware and software is avoided to protect investment and maintain flexibility.

Many of the advantages of the previous approach are preserved, especially the reduction in development risk, the reduction in line cost, improved response times and improved availability. Additional advantages derive from the compatibility of systems.

Compatible programming languages facilitate portable programs available at different sites. Programmer retraining is kept to a minimum and existing software investment is protected. Compatible operating methods can reduce training costs and encourage flexibility. Upward-compatible hardware allows flexibility of configuration and system growth.

New applications or changing load patterns can be accommodated in many ways. The designer may have the choice of upgrading an existing machine, installing a new one at the same or a different location, or moving some work to a different site. A high degree of compatibility of both programs and operations is required to maintain this level of flexibility, and normally such systems are built using equipment from the range of a single mainframe manufacturer.

It may be necessary to use only a subset of the language available (on a large machine) in order to remain compatible with small machines in the same range. Alternatively, in order to maintain compatibility, it may be necessary to 'scale up' an application to a large configuration. Independent minicomputer manufacturers are offering standardised features, especially with products designed to attack the mainframe market.

Two areas are particularly worthy of comment. Many users have successfully converted FORTRAN programs for use on minicomputers; and an increasing number of minicomputer manufacturers are offering batch facilities with COBOL. The COBOL facilities tend to vary significantly, many now offering ANSI-74 Level 1 but with differing Level 2 features.

In many cases distribution involves a change from batch to interactive working. This requires the initial redesign of large parts of existing systems. Once implemented, such systems should be portable within the distributed computing network.

NOVEL SYSTEMS

A growing number of the most sophisticated computer users are pioneering new uses of distributed intelligence (ie parallel processing systems with geographically separate processors). In the new systems the processors ('closely coupled') communicate with each other interactively; the systems function with real-time constraints. The distributed file system, for example, consists of a number of geographically-separate machines: they each hold files of local information and interact whenever information is required from remote files.

These types of distributed systems are often complex to develop and to operate. At present each new system must be designed from scratch; and, with few available standard products, tailor-made systems software is often required. There is emphasis on design considerations since such systems are intended to meet the precise needs of the individual organisation.

Software is often required for functions such as network control, inter-program communication, and remote resource access, in addition to the more familiar data processing facilities. The precise requirements of each individual location must be reflected in the software: tailor-made modular systems are often employed to limit the potentially large software requirement at each point. Examples of this type of system, and the associated development software, are discussed in Chapter 6.

PRODUCT AVAILABILITY

A growing range of hardware and software products is developing to meet the needs of distributed systems. Progress has been on an *ad hoc* basis, with little coordination from one product area to another. However, where needs fall into a well-defined category, appropriate systems are usually available.

Discrepancies often highlight the piecemeal approach in this area. There is, for example, a minicomputer manufacturer with an excellent transaction processing system and remote batch terminal emulation software allowing connection to a number of mainframes. However, the system and software cannot be used together since the emulators run under an operating system incompatible with the transaction processing system, and the file structures are also incompatible. Such anomalies are slowly being eradicated, but sometimes via larger operating systems and more expensive hardware.

In addition some of the distinctions between types of systems are becoming blurred, giving rise to new product requirements. For instance, there is a need for interactive systems which will simultaneously handle terminals controlling local processing and terminals controlling remote processing. Few existing transaction processing systems can communicate interactively with mainframes, and similarly few interactive terminals can support local transaction processing on any scale.

Novel system designs have created the need for new types of network software. Network control software is becoming available from minicomputer manufacturers, and new network architectures from mainframe suppliers. Minicomputers with modular real-time operating systems are being used as basic systems on which new operating system facilities can be developed.

MINICOMPUTER SOFTWARE

Minicomputer software is developing in various ways. Very basic systems are being marketed by minicomputer and microcomputer manufacturers for the many small (and acutely price-sensitive) applications. Larger systems software has developed in other directions.

Modular real-time systems have developed from the early minicomputers and are normally used for industrial and technical applications. These